ARL-SR-0519 • Apr 2026

DEVCOM ARMY RESEARCH LABORATORY

Machine Learning for Everyone: Empowering the Force with AI/ML (2021–2025)

by Mark A. Tschopp

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ARL-SR-0519 ● APR 2026

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REPORT DOCUMENTATION PAGE

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED	
		START DATE	END DATE
April 2026	Special Report	01/01/2026	04/01/2026

4. TITLE AND SUBTITLE

Machine Learning for Everyone: Empowering the Force with AI/ML (2021–2025)

5a. CONTRACT NUMBER	5b. GRANT NUMBER	5c. PROGRAM ELEMENT NUMBER
5d. PROJECT NUMBER	**5e. TASK NUMBER**	**5f. WORK UNIT NUMBER**

6. AUTHOR(S)

Mark A. Tschopp

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

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8. PERFORMING ORGANIZATION REPORT NUMBER

ARL-SR-0519

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

DISTRIBUTION STATEMENT A. Approved for public release: distribution unlimited.

13. SUPPLEMENTARY NOTES

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14. ABSTRACT

The “Machine Learning for Everyone” initiative was developed to address the Army’s growing need for AI and ML literacy. What began as a single effort to unpack AI/ML concepts has grown into a transformative program, reaching over 3,000 participants (including 2,000 Army participants from 173 Army organizations). Designed to make AI/ML accessible to Soldiers and civilians, the course’s core philosophy was to turn the AI “black box” into a “glass box,” using Excel-based demonstrations to teach the fundamental concepts without sacrificing technical depth. Over 5 years, the initiative evolved from small workshops into large-scale virtual events and has since spun off into specialized courses, including the “AI for Soldiers” strategic broadening seminar. This report details the design, evolution, and measurable impact of this initiative, and serves as a case study in using a creative, bottom-up approach to build a data-centric workforce in support of the Army’s digital transformation.

15. SUBJECT TERMS

artificial intelligence; machine learning; neural networks; natural language processing; robotics; large language models; Information, Autonomy, and Teaming Science

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES
a. REPORT	b. ABSTRACT	C. THIS PAGE		
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UU	271

19a. NAME OF RESPONSIBLE PERSON	19b. PHONE NUMBER *(Include area code)*
Mark A. Tschopp	301-938-5389

STANDARD FORM 298 (REV. 5/2020)
Prescribed by ANSI Std. Z39.18

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Acknowledgments

I extend my deepest gratitude to ARL for providing me the opportunity to bring AI and ML to the broader workforce. This initiative has been a rewarding journey, made possible by the support and collaboration of many individuals and teams.

I would like to acknowledge the contributions of those who have played pivotal roles in the execution of various AI/ML courses over the years:

- Mr. Denver Gallardy (ARL) for his Distribution A reports on ballistics, which became a staple for regression and classification models.
- Dr. Adrienne Raglin (ARL) for facilitating connections with the Spelman College faculty.
- Dr. Michael De Lucia (ARL) for co-leading the "ML and Cybersecurity" course.
- Mr. Darrell Roll (ARL) for providing audio/visual assistance during the first 800-person course.
- Dr. Alex Kott (ARL) for delivering the opening speech in the inaugural course.
- The Jedi Council (Drs. Sean Hu, Priya Narayanan, Matt Marge, Maggie Wigness, and Garrett Warnell [ARL]) for their engaging panel session on AI/ML applications.
- Dr. Robert Arp (AMSC) and the U.S. Army Training and Doctrine Command's Army Management Staff College faculty for their support and collaboration.
- Mr. Stephen Riley (retired Army, Google) for guest speaking in year two.
- Drs. John Fossaceca (ARL), Brian Sadler (ARL), and Reggie Hobbs (ARL) for their inspiring kickoff talks.
- The team at Rock Island Arsenal for introducing this course to the Joint Munitions Command HQ and Army Sustainment Command HQ workforce.
- Ms. Jenna Swartout (ARL), Mr. Steven Park (ARL), and other Public Affair colleagues for authoring press articles on the success of these courses.

Special thanks go to the team behind the "AI for Soldiers" course. I am grateful to my co-leads, Dr. Reggie Hobbs and MAJ Matthew Work (Futures and Concepts Command [FCC]), as well as Mr. Chris Oliver (ARL), Dr. John Fossaceca (ARL), Dr. Joe Rexwinkle (ARL), Mr. Christopher Stolz (FCC) and all the guest senior leader speakers: MG Stephanie Ahern (HQDA), COL Michael Wagner (FCC), Dr.

Patrick Baker (ARL), Dr. Scott Schoenfeld (ARL), Dr. David Stepp (ARL), Mr. Dietrich Wiegmann (ARL), Dr. Romeo Del Rosario (ARL), Dr. Brian Henz (ARL), Dr. Corde Lane (ARL), Dr. Amar Marathe (ARL), and Mr. Karl Kappra (ARL).

Finally, I want to thank the participants and contributors who have engaged with these courses over the years. Your questions, insights, and enthusiasm have made this journey especially rewarding. Assessing the full impact is challenging, but hearing the real-world effects on individuals has been energizing and inspiring. This experience is a testament to the power of pursuing bold ideas and trusting the process.

Executive Summary

What started as a single idea—to teach the fundamentals of ML in a transparent, accessible way—grew into the "Machine Learning for Everyone" course, reaching over 2,000 Army participants across 173 organizations in 5 years. This course did not just talk about AI; it taught the real concepts, math, and algorithms behind it. It turned the AI "black box" into a "glass box," where participants could see the inner workings of AI. The goal was simple: empower Soldiers and civilians with the knowledge of how AI works, so they can use new AI tools smartly and effectively to support Army transformation. The results are clear:

- **Unprecedented Scale:** Engaged 3,025 participants from 327 unique organizations, with 78% from DoD entities.
- **Measurable Learning Impact:** Achieved a 138% improvement in participant understanding above random guessing on fundamental ML concepts.
- **Transition to AI for Soldiers Course:** Expanded the seminal ML course into the "AI for Soldiers" strategic broadening seminar, which achieved 100% "Excellent" ratings from participants in its most recent iteration.
- **Broad Organizational Reach:** Successfully engaged 17 Army commands and 173 suborganizations, from senior leaders to early-career professionals.

The course succeeded because it solved a real problem, and because it was built on a foundation of listening to feedback from Soldiers and civilians, constantly refining the content, and tackling challenges head-on. The Army needs people who understand AI not just as a concept, but in practice. Using simple tools like Excel and relatable examples, this course made ML accessible and transparent, all without sacrificing technical depth. This approach did not just expand AI/ML literacy one person at a time; it built a network of skilled people for the Army.

The end of the "Machine Learning for Everyone" course on May 4–5, 2026, is not a conclusion but a transition. The spirit of this initiative lives on through the "AI for Soldiers" seminar and is inspiring new deep-dives into topics like transformer models, directly supporting the Army's goal of building a data-centric workforce.

This report details the course's design, delivery, and results, but its story is a testament to a simple truth: a focused, creative idea, pursued with passion, can have an outsized impact.

1. Introduction

1.1 Why ML and AI Matter for the Army

AI and ML are central to future military capability. These technologies influence operational decision-making, drive transformation, and support the development of next-generation systems across the U.S. Army and the Department of War (DoW). Beyond their technical promise, senior leaders have emphasized that the successful adoption of AI depends not only on advanced algorithms and infrastructure, but also on a workforce that knows how to use AI technologies on a daily basis. This includes creating new career paths for Soldiers to engage with AI/ML systems effectively.[1]

Senior Army leaders have been clear that educating the workforce about AI is important. As part of the Army's broader approach to readiness and transformation, the Army Chief of Staff has identified four institutional focus areas—warfighting, delivering ready combat formations, continuous transformation, and strengthening the Army profession—that guide what the Army focuses on and how it develops its people.[2] These themes underscore AI and ML training as a cornerstone for building the Army's future skills in operations and analysis. Brigadier General Stephanie Ahern emphasized the direct connection between training and mission effectiveness, stating that developing AI literacy is essential for future operations. She further noted that the ability to collaborate with AI experts and apply AI concepts operationally is "extremely essential to the Army mission."[3]

Similarly, DoW guidance makes it clear that AI competency must become part of the routine professional skill set for both Soldiers and civilian personnel. In announcing an enterprise generative AI capability, Secretary of War Pete Hegseth stated that AI should not be viewed as a specialized or occasional tool, but rather as a normal part of everyone's job. He asserted that "AI should be in your battle rhythm every single day; it should be your teammate."[4] This guidance highlights a shift toward normalizing AI use across roles and organizations, reinforcing the need for broad-based education and practical familiarity.

The message from senior Army leaders is clear: new AI tools are useless if people do not know how to use them. Consistent training is therefore critical. It's not just about building technical skill; it's about preparing Soldiers and civilians to make

smart decisions, lead technical teams, and use AI effectively and responsibly in their mission.

1.2 From Strategic Priority to Workforce Demand

While senior Army and DoD* leaders have articulated the strategic importance of AI and ML, clear ways for Soldiers and Army civilians to build fundamental skills in these areas have lagged behind this guidance. This gap was particularly evident during the early COVID period, when digital transformation accelerated across research, engineering, and operational communities. Despite surging interest in AI and ML, opportunities for structured, Army-accessible education remained limited due to a lack of resources, infrastructure, and formal training programs.

The Army's vast and diverse workforce made it difficult to teach AI/ML to everyone. With over one million active-duty Soldiers, reservists, and civilian personnel, initial efforts focused on senior leaders and specialized cohorts to make sure that leaders understood the basics. However, this approach left much of the broader workforce without access to AI/ML education, creating a gap that this initiative sought to address. In the absence of training, perceptions of AI are often polarized—ranging from uncritical optimism to outright skepticism—both of which posed risks to informed adoption and responsible use.

To address this unmet demand, an initiative emerged at the U.S. Army Combat Capabilities Development Command (DEVCOM) Army Research Laboratory (ARL) to provide introductory ML training tailored specifically to the Army and DoD workforce. The approach emphasized presenting ML concepts in a manner that was transparent, intuitive, and directly connected to real-world problems familiar to engineers, scientists, and analysts. Early offerings took the form of informal seminars and live, interactive sessions, which quickly revealed the extent of pent-up demand. Participation and engagement far exceeded expectations, underscoring the workforce's strong desire for accessible and mission-relevant AI/ML education.

A defining feature of the course design was its emphasis on pulling back the curtain on ML. To lower barriers to entry, ML algorithms were demonstrated using widely available tools—most notably Microsoft Excel—allowing participants to follow the step-by-step development of models within a familiar environment. Concepts such

*When referring to the past, the acronym DoD is used and in present time, DoW is used.

as neural networks, deep learning, and more advanced architectures were presented not as opaque "black boxes," but as logical extensions of simple algorithms. The goal was to turn the black box into a glass box, where participants could see the inner workings for themselves. These algorithms were explained and unveiled in real time, enabling participants to understand their mechanics, question their assumptions, and apply them to practical problems. This approach reframed AI not as an abstract or intimidating concept, but as a collection of mathematical and data-driven methods that participants could understand and use.

Equally important was the instructional approach. The courses incorporated live demonstrations, interactive discussions, and carefully chosen references to popular culture to sustain engagement and reduce intimidation. While these elements enhanced accessibility, the primary driver of the course's success was the effort to make ML understandable for everyone.

Early efforts to introduce AI/ML education in the Army followed a top-down strategy, focusing on training senior leaders, decision-makers, and specialized cohorts of Soldiers in computer science courses. That approach prioritized those who would shape policy or lead technical teams but faced limitations in scale, as the Army's vast workforce required a broader reach. In contrast, this initiative began at the opposite end—empowering Soldiers and civilians at all levels, including those furthest from technical expertise. This bottom-up approach connected the leaders' goals with the people doing the daily work.

Over the subsequent 5 years, continuous feedback and iterative refinement shaped the evolution of the course. Early offerings began as in-person sessions for small groups, but as demand grew, the format expanded to accommodate larger audiences and deeper content. Key milestones included the transition from a 1-day introduction to a 2-day format, the inclusion of advanced topics such as recurrent neural networks, transformers, and natural language processing (NLP) following the release of ChatGPT in late 2022, and the integration of generative AI concepts into broader discussions.

Throughout these changes, the central objectives remained constant—building ML literacy that enabled participants to engage intelligently with AI technologies, collaborate effectively with technical experts, and make informed decisions about their application. By addressing the problem of scale, this approach helped meet the

Army's growing demand for AI/ML education, making sure that the Army's goals became real skills for the workforce.

This report documents the development, evolution, and impact of these AI and ML courses over 5 years of online and in-person delivery. It shows how timely, accessible education turns the Army's strategic goals into real skills for the workforce, reinforcing the Army's efforts to modernize and prepare for the future.

2. Course Design and Delivery

2.1 Course Design Philosophy

The "May The Course Be With You: Machine Learning for Everyone" course* was designed to make ML accessible, engaging, and practical for a broad audience of Army scientists, engineers, and professionals. Over the years, it has evolved into a 2-day event that balances technical depth with an approachable teaching style, using creative ways to break down tough ideas. The course was built on one simple idea: more people should know how ML works.

The Star Wars theme was chosen to provide levity and engagement for a subject area that could be mathematically intensive. Using pop culture was an effective way to explain complex technical content.†

The inaugural course was held on May 4th, 2021, with a Star Wars-inspired theme in honor of "May the Fourth" (Figure 1). The agenda was crafted to introduce participants to ML concepts in a single day, balancing essential knowledge with advanced topics. The agenda for the first year included an ML primer, ML basics, neural network basics, and advanced neural network architectures. The day started with a kickoff talk by ARL's chief scientist, Dr. Alex Kott, who discussed the incredible progress in ML from the days of pattern recognition decades ago to the advanced algorithms of the then-present time. The day concluded with a special "Jedi Council" panel session featuring ARL ML experts who discussed Army applications in computer vision, NLP, robotics and autonomy, battlefield sensing, and AI for command and control. Excel-based demonstrations were interwoven throughout, culminating

*Throughout this report, we refer to this course series as "Machine Learning for Everyone" or ML 101. Variations of ML 101 denote modified versions for specific venues, audiences, or content areas.

†Perhaps some of it was for the instructor as well—how do you stay energetic after 6–8 h of talking about the math and concepts of ML? This is the way.

Figure 1. The "May The Course Be With You: Machine Learning for Everyone, ML 101" course tackled the math, concepts, and algorithms of ML in an engaging virtual course.

in a hands-on do-it-yourself neural net session. The primary goal of the course was to make ML education available to everyone, giving them a real foundation to start from. Many introductory courses at the time tended to gloss over technical details, while this course tackled them head-on, explaining complex concepts in a way that was accessible to nonexperts. The success of this inaugural course led to the ARL Honorary Award for Impactful Communication in 2021.

The course's broad reach is clear from the variety of events and the number of participants over the years. Figure 2 shows the approximate timeline of various events over the years associated with this ML and follow-on AI courses. The success of the "Machine Learning for Everyone" course led to many other related offerings: coupling the ML content with focused application areas in additive manufacturing or cybersecurity; teaching faculty about ML with a university collaborator (e.g., Spelman College) or within the U.S. Army Training and Doctrine Command's (TRADOC's) Army Management Staff College (AMSC); mid-year offerings for ARL and other Army partners; teaching an AI 101 course (first in AMSC Contin-

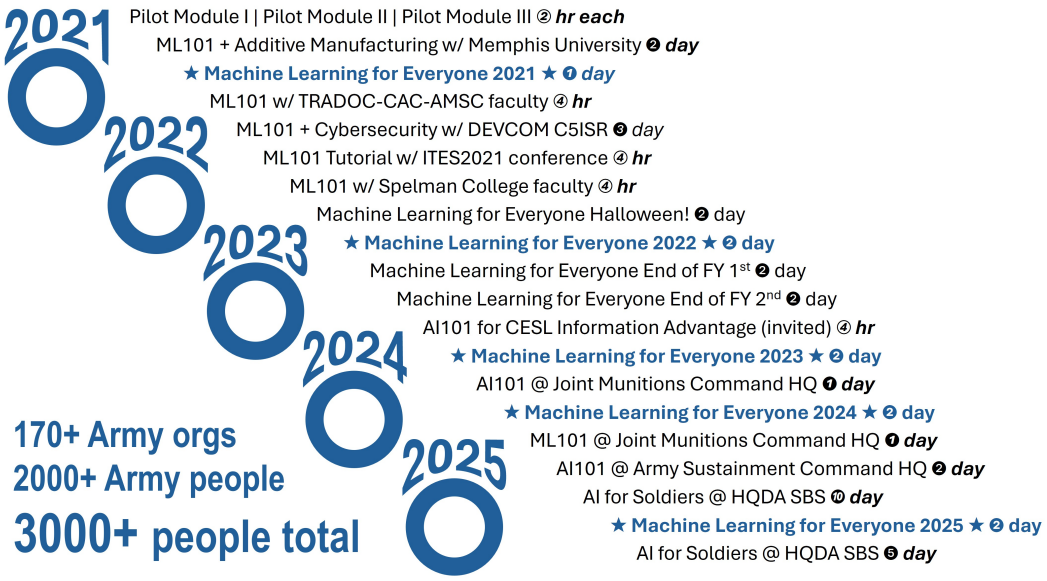


Figure 2. A visual timeline showing how content, duration, and delivery methods evolved from 2021-2025.

uing Education for Senior Leader [CESL] course, later in Army commands); and most recently, incorporating this within a one-/two-week "AI for Soldiers" strategic broadening seminar for Headquarters, Department of the Army (HQDA).[5,6] Table 1 provides a summary of most* the courses offered, their delivery formats, and attendance numbers. The flagship "May The Fourth" courses have consistently drawn large audiences, while other similar courses have drawn smaller numbers due to their format (in-person) or marketing (limited audience). Over the course of 5 years, these diverse offerings have reached over 3,000 participants across the Army and its partners, spanning roles from senior leaders to technical specialists. Additional details about the various course venues and their origins are provided in Appendix A.

*A few offerings were left out: teaching the AMSC faculty about ML, giving an invited ML 101 tutorial at the International Test and Evaluation Symposium, teaching ML 101 as part of AMSC's CESL Information Advantage course, and other guest/invited seminars over the years (multiple AMSC kickoff data science talks, introduction to ML for DEVCOM Chemical Biological Center, ML 101 seminars at Northwestern University, Carnegie Mellon University, University of North Texas, etc.).

Table 1. Summary of AI/ML courses and attendance (2021–2025): The flagship "May The Fourth" courses consistently drew the largest audiences, while specialized and in-person offerings reached targeted groups. Over 3,000 participants have attended these various events since 2021.

Event	When	Delivery	Attendees	Notes
ML 101 Module 1	2021	Virtual	69	Introductory module
ML 101 Module 2	2021	Virtual	44	Introductory module
ML 101 Module 3	2021	Virtual	38	Introductory module
May The Fourth	2021	Virtual	810	Star Wars-themed flagship course (1-day)
May The Fourth	2022	Virtual	253	Star Wars-themed flagship course (2-day)
May The Fourth	2023	Virtual	365	Star Wars-themed flagship course (2-day)
May The Fourth	2024	Virtual	297	Star Wars-themed flagship course (2-day)
May The Fourth	2025	Virtual	360	Star Wars-themed flagship course (2-day)
ML 101 (Spelman)	2021	Virtual	25	Collaboration with Spelman College faculty
ML 101 + AM (Memphis)	2021	Virtual	98	Combined with Additive Manufacturing for University of Memphis
ML 101 + Cyber (C5ISR)	2021	On-site	40[a]	Combined with Cybersecurity for DEVCOM C5ISR
May The Course Halloween	2021	Virtual	68	Halloween-themed event
May The Course EOFY	2022	Virtual	189	EOFY event (First offering)
May The Course EOFY	2022	Virtual	157	EOFY event (Second offering)
May The Course (RIA JMC)	2024	On-site	30[a]	RIA JMC
AI 101 (RIA JMC)	2023	Hybrid	100[a]	RIA JMC
AI 101 (RIA ASC)	2024	On-site	30[a]	RIA ASC
AI for Soldiers SBS	2024	On-site	24	HQDA SBS
AI for Soldiers SBS	2025	On-site	28	HQDA SBS
Total			**3,025**	

[a] Registration numbers are approximate for these events.

The course succeeded because of its creative and engaging teaching methods, which included pop culture references, Excel-based demonstrations, and a focus on interactivity. Star Wars and other pop culture elements were woven throughout the course to add humor and keep participants engaged. For example, the course opened with a scrolling text introduction in the style of Star Wars, modified to reflect ML themes. Slides featured characters, quotes, and memes, to add some fun to the dense technical material. Participant feedback highlighted the effectiveness of this approach, with comments such as, "The Star Wars references were well done and helped keep it fun," and "I liked the Star Wars theme—it lightened the mood and did not drag the dense material into the dark side."

Building on the success of the ML 101 course series, the "AI for Soldiers" course is the next chapter in this endeavor. This course is aimed at future military leaders, combining the original's core principles with advanced topics and strategic thinking. It builds on the original's success by bringing together a team of experts from ARL and other Army partners, like the Futures and Concepts Center (now Futures and Concepts Command) and Artificial Intelligence Integration Center. This strategic broadening seminar is already making an impact on the Army's future leaders and on advancing the Chief of Staff of the Army's priorities, as conveyed by BG Stephanie Ahern, Director of Strategy, Plans, and Policy:[7]

> Dear Mark, [. . .] sincere thanks for your tremendous expertise, skill, and dedication to again lead the AI Strategic Broadening Seminar for 28 of the Army's future NCO, Warrant, and Officer leaders. I'm also grateful that I could participate—and be inspired!—by the Friday discussions and presentations. I believe to my core that this course is squarely advancing the CSA's priorities—strengthening the profession, continuous transformation, and warfighting. Yet your & Reggie's roles were what enabled the real development of our people to happen.
> THANK YOU!!

2.2 ML Content Progression

This course design follows a specific learning path for participants with limited or no formal ML background. The goal was to lead nonexperts to neural networks quickly without watering down the technical content. This streamlined approach meant that many traditional ML algorithms could be discarded* in favor of the essential algorithms that would lead directly to neural networks: linear regression and logistic regression.

Linear regression is an ML model where the inputs X_i are connected to the output Y through an equation of the form of $Y = mX + b$ for single linear regression (one X), where m and b are model parameters. For multiple linear regression,

$$Y = \sum_i \theta_i X_i + \theta_0, \tag{1}$$

where θ_i are the slope terms acting on the inputs and θ_0 is the intercept term, i.e., the model parameters. Logistic regression builds upon linear regression by applying a nonlinear function—the sigmoid function—to the intermediate linear portion Z:

$$Z = \sum_i \theta_i X_i + \theta_0 \tag{2}$$

$$Y = \frac{1}{1 + \exp^{-Z}}. \tag{3}$$

Logistic regression is a computational graph with one node, i.e., a single-layer perceptron. The combination of both linear and nonlinear for logistic regression prepares participants for a node in the neural network, where a linear computation is first applied:

*While Gaussian process regression and support vector machines were included in the initial offering, they were quickly removed when feedback from participants showed that they were far more interested in neural networks and their applications than these "other" ML algorithms, despite their continued use for some applications (kernel-based methods, gradient-boosted decision trees, decision trees, support vector machines, and other traditional statistical learning models).

$$Z_i^{[l]} = \sum_j W_{ij}^{[l]} A_j^{[l-1]} + B_i^{[l]}, \tag{4}$$

where the superscript $[l]$ denotes the layer, subscripts i and j are the indices for nodes in the current l and prior $l-1$ layers, W_{ij} and B_i are the weight and bias model parameters, A_j are the activations from the previous layer (inputs X are referred to as zeroth-level activations $A^{[0]}$ in this context), and Z_i are the preactivation node values. Z_i is then input to a nonlinear activation function, which can be:

$$A_i^{[l]} = \max(0, Z_i^{[l]}), \tag{5}$$
$$A_i^{[l]} = \max(\alpha Z_i^{[l]}, Z_i^{[l]}), \text{ or} \tag{6}$$
$$A_i^{[l]} = \tanh(Z_i^{[l]}), \tag{7}$$

for rectified linear unit (ReLU), leaky rectified linear unit (Leaky ReLU), or the hyperbolic tangent activation functions, respectively. Breaking down the mathematics with a simple Army ballistic example helps demonstrate this progression to participants who may not have previously encountered these equations. The concepts around this progression help supplement their understanding of ML: how to determine optimal model parameters (loss and cost functions), how to train model parameters (gradient descent), how to assess model complexity (variance versus bias tradeoff), and how to address overfitting (hyperparameters, regularization). Introducing these concepts early, when the models are simpler, means that important concepts for neural network operation are potentially easier to grasp. Later, in neural networks, these concepts are updated to reflect the additional complexity. In this manner, the course intentionally adds complexity one step at a time.

Once participants understood these fundamentals, they were ready for more complex ideas. After teaching traditional neural networks, the course moves on to advanced architectures like convolutional neural networks, sequence models, and transformers. All of these still build on that same core idea of a linear step followed by a nonlinear one, but now adapted for different kinds of data like images, text, or audio. This is the part of the course I updated the most over the years. Trying to cover all of these advanced topics in a single day was too much for people who

started the morning not knowing what linear regression was. Adding a second day gave me the time to slow down and introduce these ideas properly, which made a huge difference in how well people understood them.

The word map of the ML concepts within the course is shown in Figure 3. This is the original word map from year 1 of the course when I took out a pencil and brainstormed the question "What topics about ML should more people know about?" All these concepts remain important years later; however, many new concepts have entered the course over the years, stemming mainly from the popularity of transformer models. These additions include attention mechanisms, self-attention, positional encoding, and the transformer architecture itself.

ML for NLP has gained significant attention since the emergence of OpenAI's ChatGPT in November 2022. In earlier versions of the ML course, the concepts behind large language models were presented in the Sequence Models section, which discussed how recurrent neural networks, gated recurrent units, and long short-term memory models worked. This section was intentionally designed to handle any kind of sequence, whether it was words or signal readings from an internet-of-things de-

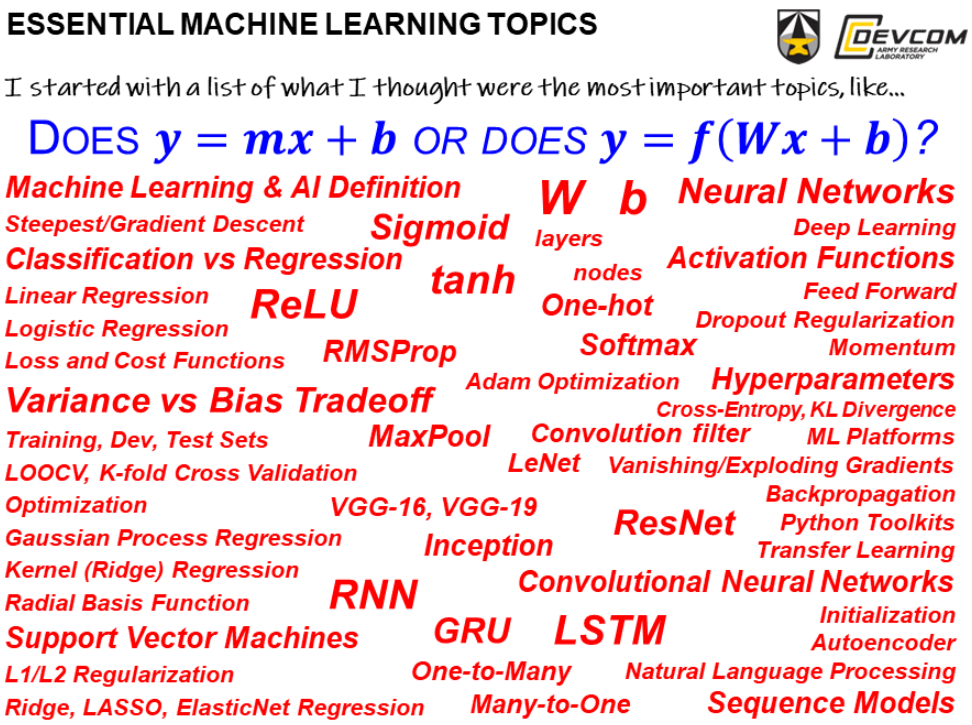


Figure 3. Slide from the ML 101 course showing word map of essential ML concepts taught within the course.

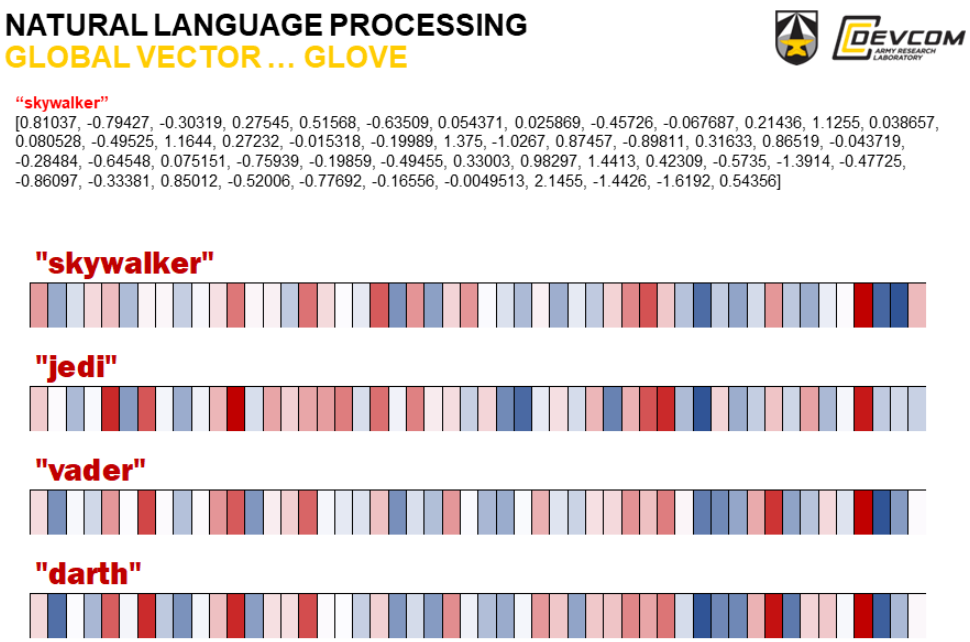


Figure 4. Slide from the ML 101 course's section on NLP showing the GloVe and embedding vector representations for various words, leading up to transformer models.

vice. This approach was purposely chosen because describing how large language models map words into an embedding space, where embedding vectors are consumed by different sequence models, would have made the course much more complex and taken too much time. In May 2023, a dedicated NLP section was added to elaborate on the concepts of embedding space, embedding vectors, and how neural networks use them. The often-cited GloVe (Global Vectors for Word Representation) embedding vector dictionary was integrated into Excel (the 50-dimensional version) to demonstrate the relationships between words and their embedding vectors. Figure 4 shows a colorized version* of several words like skywalker, jedi, vader, and darth. These word embeddings form the foundation for learning how Word2Vec works, how these models are trained, and how the modern transformer architecture operates.

*i.e., conditional formatting in Excel was used to color the values of the 50-D embedding vector

2.3 Use of Excel in Teaching ML

What made this course different was the choice to use Excel to explain the algorithms, math, and concepts of ML. I know that for most people, especially programmers, Excel is not the first tool they would choose—Python is. But that's exactly why Excel works so well for this audience.

However, Python requires knowledge of both programming and its syntax, which means that a course using Python to teach ML also has to teach how to program with Python and what the syntax is for simple Python operations—information that is not needed for many taking the course to simply learn about ML. Additionally, even when comfortable with Python programming, many functions completely hide what is happening underneath the hood. An advantage (and a potential disadvantage) of Python is that it allows users to use a function without specifically knowing what the algorithms are doing between the input and output of the function—i.e., it is a black box of sorts. Some courses handle this by abstracting ML to a level where none of the underlying algorithms are covered in much depth, if at all.

Excel is a tool that most people already have and can be used to dive into the details of these algorithms. While it is possible to use the programming Visual Basic for Applications (VBA) backend to code up functions in Excel*, many of the ML algorithms can be implemented with only cell formulas.

Most participants are very comfortable in Microsoft's Excel, much more so than in a programming language like Python. However, I quickly learned that most participants did not know the Excel techniques and functions I was using. In fact, so many participants were unfamiliar with these functions that a "A Few Good Things To Know in Excel" document was created to introduce the various needed functions. This document was created and distributed ahead of time, in part because of feedback indicating that the Excel examples went by quickly in embedded videos (likely because an unfamiliar function or technique was being used). By providing this Excel document to participants ahead of time, it helped people actually understand the ML algorithms as they were implemented in Excel, and it could also spur use in their daily jobs.†

*Using the Excel VBA background is a programming language also, hence requiring learning VBA programming and syntax.

†Some participants commented that they have subsequently used these functions on data within tables and spreadsheets in Excel (without ML).

Excel Functions for ML

A few Excel functions and features were especially useful for teaching:

Basic functions and features:

- **Naming variables** is a feature whereby a single cell or a thousand cells can be given a name to refer to values in those cells. Upon naming the cells, this name can be used like a variable in formulas to refer to those cells, instead of using Excel's row-column (RC) notation (e.g., `A1:Z100`), which I find can be confusing. It is much easier to understand how `MMULT(A,W)+B` relates to Equation 4 than the same Excel formula with RC format used.
- **Dynamic arrays** are a feature in Excel that allows formulas to spill results into adjacent cells, enabling calculations that return multiple values to dynamically adjust based on the size of the output. Selecting the upper right cell in a dynamic array and appending a # sign (i.e., `A1#`) selects all values within the dynamic array. The dynamic part means that if the size of the cells changes, the dynamic array reference automatically adjusts.
- **MMULT()** is the function in Excel for matrix multiplication. This function forms the basis for linear regression, is used for computing the intermediate calculation Z in logistic regression, and heavily used to compute the preactivation values Z in neural networks.

Advanced Functions:

- **LET()** is a function in Excel that allows the user to define and reuse variables within a formula, making complex calculations more efficient and easier to read. By assigning names to intermediate values, redundant calculations can be avoided. This function provides another way to define variables within formulas that connect back to the mathematical equations from ML. For example,

```
=LET(X, B29:G38, theta, C16:C21, Z, MMULT(X,theta),
    yhat, 1/(1+EXP(-Z)), y, I29:I38, loss, -y*LOG(
   yhat)-(1-y)*LOG(1-yhat), cost, AVERAGE(loss),
   yhat)
```

defines input `X`, model parameters `theta`, calculates `Z`, calculates the prediction `yhat`, defines output `y`, calculates `loss`, calculates `cost`, and returns the prediction `yhat`.*

- **Solver** is a function in Excel that performs optimization given an objective function (the cost function that is calculated for the model) and the cells that need to be changed (i.e., the model parameters, $\{W, B\}$). While the number of model parameters that Solver can accommodate is not very large, it is effective at showing how an algorithm like gradient descent works.

Visualization Features:

- **Conditional formatting** is a feature that is used to colorize the model parameter values. In this respect, participants can easily observe how larger model parameter values indicate how sensitive the prediction is to the (normalized) inputs. This was also used to show how weights within a multilayer neural network attend to activations in the previous layer, and why it gets complicated to explain the connection between prediction and inputs.

Neural Networks in Excel

As demonstrated in Figure 5, Excel formulas can be used to create a simple multilayer neural network. In the course, 1–2 min videos show how Excel functions compute the Z and A values for first and second layers, the loss and cost functions, and even regularization. The only formulas needed for forward propagation to compute a regression prediction are `MMULT` (matrix multiplication) and `MAX` or `TANH` (maximum or hyperbolic tangent) for the activation function. For a classification ML model, `MMULT` and `EXP` (exponential function for the sigmoid function) are needed.

Additional simple functions are needed for optimization of the model parameters: `(A1-B1)^2` for the L2 (mean squared error) loss function (for arbitrary cells `A1` and `B1`) and `AVERAGE` for the cost function; `SUMSQ` takes the sum of squares for the regularization component. When people see that a neural network is just a series of matrix multiplications and a simple function, it effectively broke down what participants perceived as an overwhelmingly complex subject. The Solver optimization

*The odd-numbered entries are variable names, the even entries are the cells or formulas, and the last variable (or formula) is the value(s) returned to the spreadsheet.

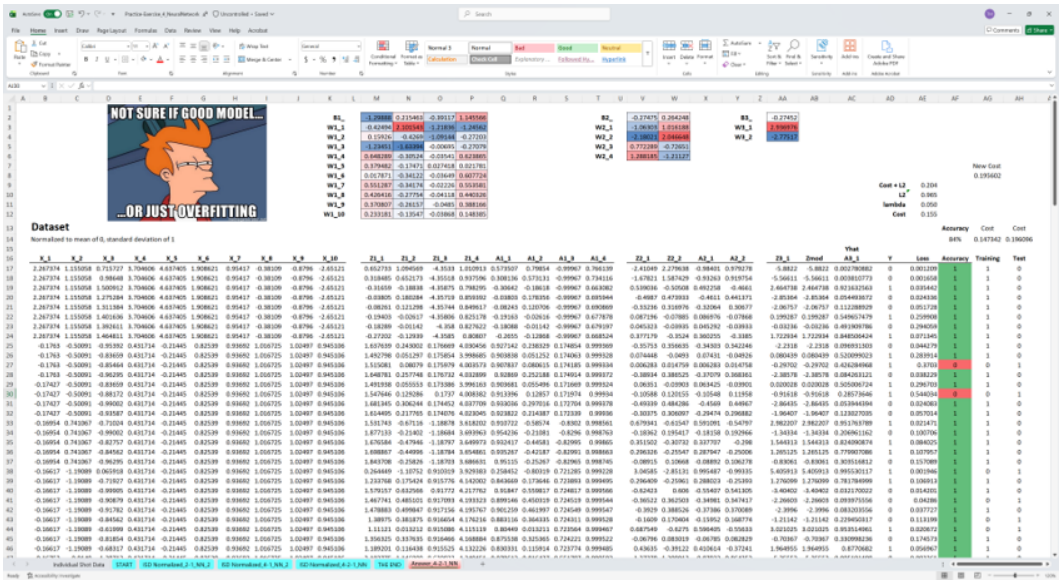


Figure 5. Simple neural network example in Excel with ten inputs, one output, and two hidden layers with four and two nodes, respectively. The colorization of the model parameters (top) and walk-through of the equations for the hidden layer up to prediction node (bottom) assisted in understanding how neural networks work.

tool can be used to show how the model parameters can be altered to minimize the cost function, and conditional formatting can be used to highlight the highest positive and negative model parameters (shown in Figure 5), in turn explaining which input parameters the model is prioritizing to improve its predictions.

Practical Implementation

The Excel examples were designed to mirror the course progression of ML concepts, as shown in Figure 6. Starting with simple linear regression, the course gradually built up to logistic regression, single-layer perceptrons, and multilayer neural networks. Various Excel files were created and distributed to participants ahead of time along with step-by-step instructions for creating the ML models. In many versions of the course, time is set aside for participants to enter the formulas themselves on their computers and to communicate any problems they are having in real time—even if only one person openly communicates a problem, it is likely that in a class of hundreds, others have similar problems. This helped solve the problem with "the Excel goes by too quickly."

These Excel demonstrations and tutorials make ML algorithms tangible and relatable. Feedback underscored the impact of this approach, with participants noting

that, “The Excel examples were great, because they demystified ML,” and “Mark used Excel in a way that made the linear algebra tangible. Outstanding teaching style.”

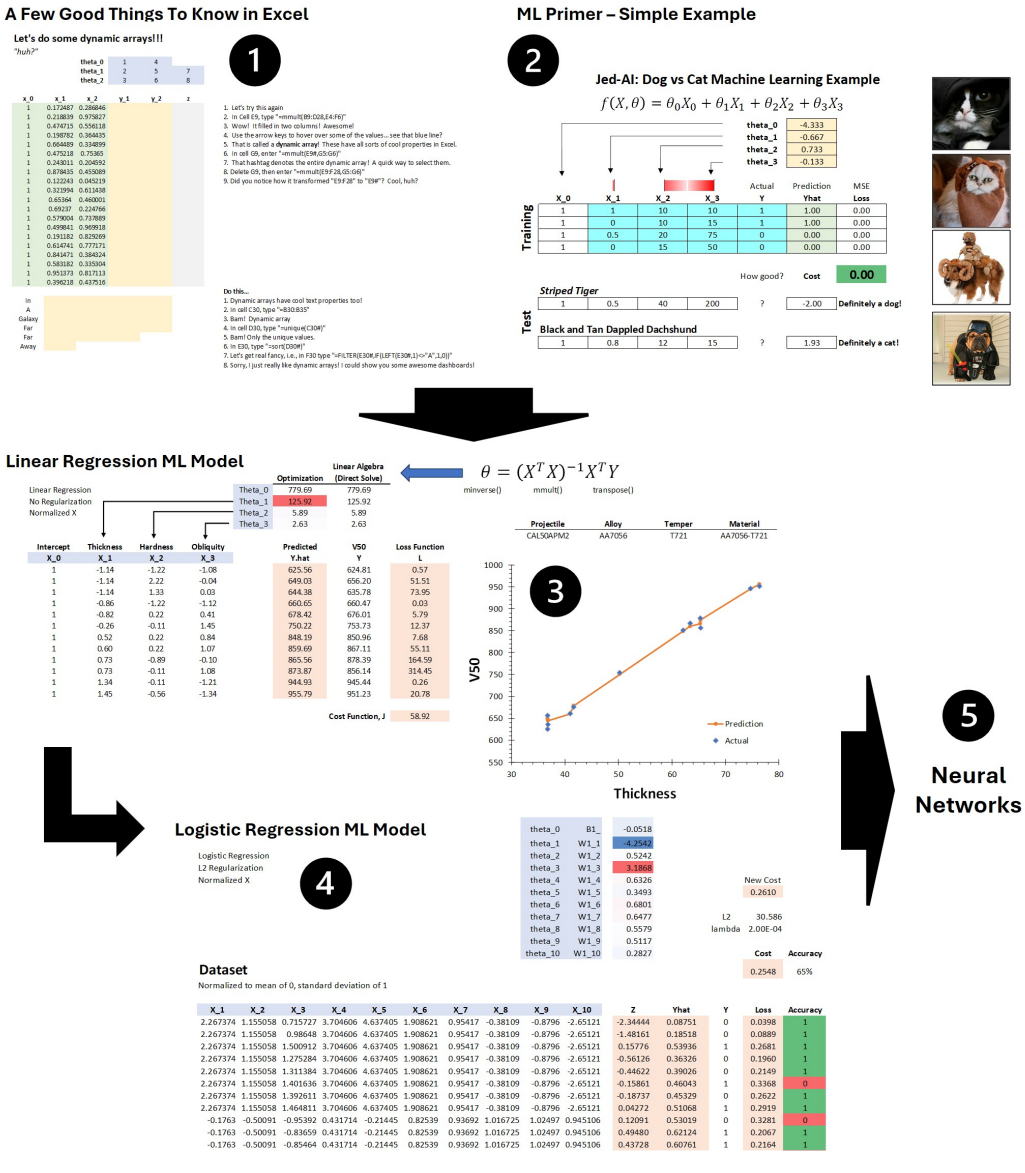


Figure 6. The Excel progression from basic formulas (“A Few Good Things To Know in Excel”) to a simple linear example to multiple linear regression and logistic regression to complex neural networks.

Advanced Applications

The neural network "zoo" part of the course expanded into more complex neural architectures—from convolutional neural networks (CNNs) to autoencoders and generative adversarial networks (GANs) to sequence models (RNNs, GRUs, and LSTMs) and transformer architectures. The question becomes "how do I show some of the inner workings of these more complicated architectures in Excel?"

For CNNs, Figure 7 demonstrates an example included in the pre-course Excel file. It allows participants to select various filters—average, blur, horizontal and vertical edge, Gaussian, and even custom filters—to visualize the effect on an image that was generated for the course, exposing them to how image filters work. A separate page shows the matrix multiplication of a 3×3 averaging image filter on an image to show the underlying mathematics of image processing filters and also how image boundaries are taken into account.

For NLP neural networks, word embedding dictionaries were uploaded into Excel to show examples of how various words are represented by a vector of numbers, e.g., in this case, the 50-dimensional GloVe embeddings. As shown in Figure 8, multiple tabs within this Excel spreadsheet show the common representations of words within the same word grouping, including different months of the year (top) and different singers (bottom, one-word names only). Examples like this allow par-

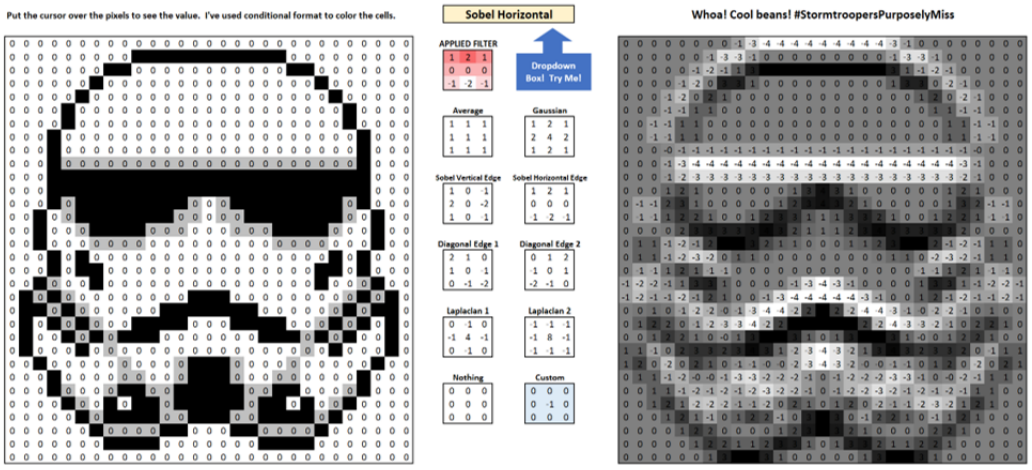


Figure 7. Example of image filters implemented in Excel being applied to an input image, showing the original (left) and corresponding output (right). Convolutional neural networks operate by applying layers of image filters with trainable parameters to improve computer vision-based predictions.

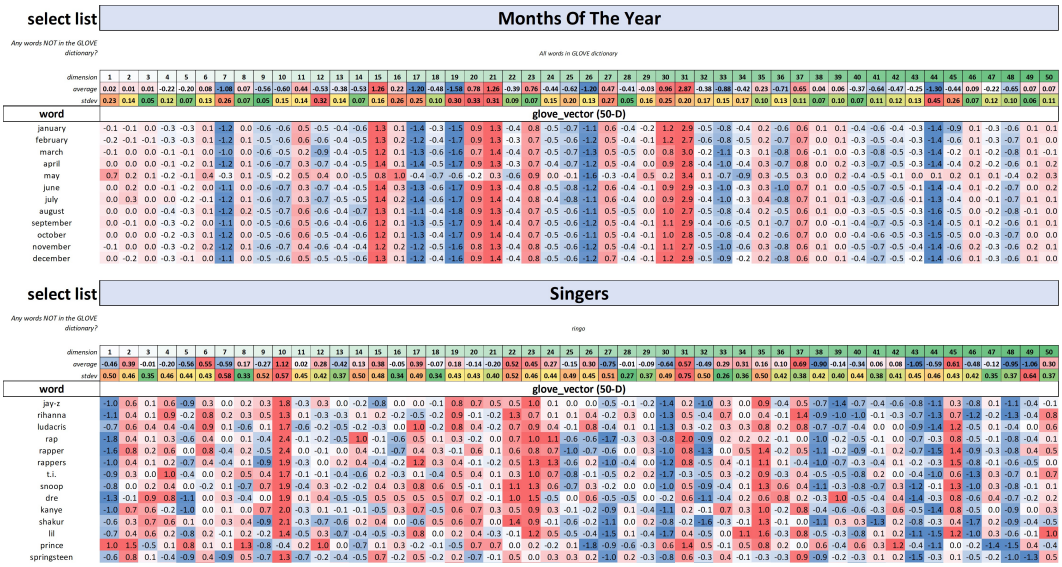


Figure 8. Example of 50-dimensional word embeddings for the GloVe dictionary. In this example, a word list under different groups allowed participants to choose "Months of the Year" (top) or "Singers" (bottom) and visualize the word embedding values in a blue-white-red (negative-positive) color scale.

ticipants to explore the database and notice patterns such as "Why does the embedding for 'may' look different than the other months of the year?" and "Why does 'prince' look different from the other singers?"*

2.4 Marketing and Engagement

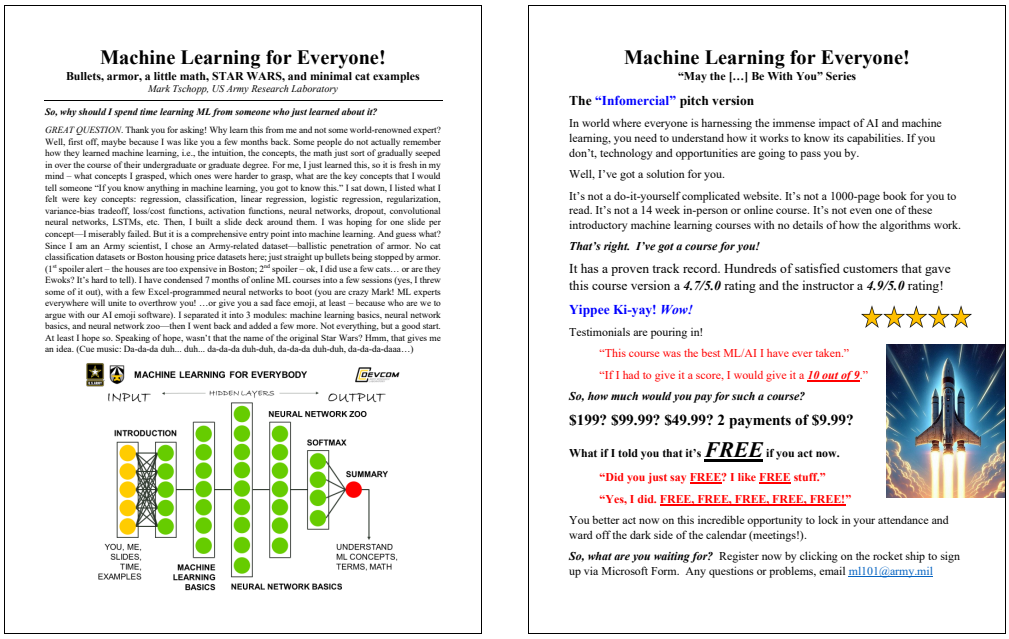
The success of the "Machine Learning for Everyone" course was driven as much by its creative marketing as its content. I did not have a formal marketing plan; the promotions grew organically from a simple desire to make ML approachable and fun. Using humor, pop culture references, and honest messaging connected with people in a way I never expected, and these outreach efforts were key to the course's widespread reach and impact.

Organic Marketing Strategy

One of the standout elements of the marketing was the Star Wars-themed campaign, which tied ML concepts to iconic characters and themes from the franchise. Catchphrases like "Machine Learning for Everyone! Bullets, armor, a little math, STAR

*The answer to these questions stems from thinking about the statistical co-occurrence of these words compared with the other words in the word group. "May" is also a verb and is likely used more often in that context than the other month/verb "march." "Prince" also denotes the son of a king, which is more popularly used than the singer.

WARS, and minimal cat examples" and "May the First Be with You?!" captured attention and added a sense of levity to the promotional materials. The campaign even featured testimonials from fictional characters, such as, "Feel the power of machine learning flow through you with this course. Join the dark side of machine learning, and rule over data with unmatched prowess," and "Innovative and informative, this course is. Learn to use the Force of machine learning, you will." While initially intended as a lighthearted way to engage participants, the campaign proved to be highly effective in drawing interest from a wide audience.



Machine Learning for Everyone!

Bullets, armor, a little math, STAR WARS, and minimal cat examples

Mark Tschopp, US Army Research Laboratory

So, why should I spend time learning ML from someone who just learned about it?

GREAT QUESTION. Thank you for asking! Why learn this from me and not some world-renowned expert? Well, first off, maybe because I was like you a few months back. Some people do not actually remember how they learned machine learning, i.e., the intuition, the concepts, the math just sort of gradually seeped in over the course of their undergraduate or graduate degree. For me, I just learned this, so it is fresh in my mind – what concepts I grasped, which ones were harder to grasp, what are the key concepts that I would tell someone "If you know anything in machine learning, you got to know this." I sat down, I listed what I felt were key concepts: regression, classification, linear regression, logistic regression, regularization, variance-bias tradeoff, loss/cost functions, activation functions, neural networks, dropout, convolutional neural networks, LSTMs, etc. Then, I built a slide deck around them. I was hoping for one slide per concept—I miserably failed. But it is a comprehensive entry point into machine learning. And guess what? Since I am an Army scientist, I chose an Army-related dataset—ballistic penetration of armor. No cat classification datasets or Boston housing price datasets here; just straight up bullets being stopped by armor. (1st spoiler alert – the houses are too expensive in Boston; 2nd spoiler – ok, I did use a few cats… or are they Ewoks? It's hard to tell). I have condensed 7 months of online ML courses into a few sessions (yes, I threw some of it out), with a few Excel-programmed neural networks to boot (you are crazy Mark! ML experts everywhere will unite to overthrow you! …or give you a sad face emoji, at least – because who are we to argue with our AI emoji software). I separated it into 3 modules: machine learning basics, neural network basics, and neural network zoo—then I went back and added a few more. Not everything, but a good start. At least I hope so. Speaking of hope, wasn't that the name of the original Star Wars? Hmm, that gives me an idea. (Cue music: Da-da-da duh… duh... da-da-da duh-duh, da-da-da duh-duh, da-da-da-daaa…)

Machine Learning for Everyone!

"May the […] Be With You" Series

The "Infomercial" pitch version

In world where everyone is harnessing the immense impact of AI and machine learning, you need to understand how it works to know its capabilities. If you don't, technology and opportunities are going to pass you by.

Well, I've got a solution for you.

It's not a do-it-yourself complicated website. It's not a 1000-page book for you to read. It's not a 14 week in-person or online course. It's not even one of these introductory machine learning courses with no details of how the algorithms work.

That's right. I've got a course for you!

It has a proven track record. Hundreds of satisfied customers that gave this course version a ***4.7/5.0*** rating and the instructor a ***4.9/5.0*** rating!

Yippee Ki-yay! ***Wow!***

Testimonials are pouring in!

"This course was the best ML/AI I have ever taken."

"If I had to give it a score, I would give it a ***10 out of 9***."

So, how much would you pay for such a course?

$199? $99.99? $49.99? 2 payments of $9.99?

What if I told you that it's *FREE* if you act now.

"Did you just say FREE? I like FREE stuff."

"Yes, I did. FREE, FREE, FREE, FREE, FREE!"

You better act now on this incredible opportunity to lock in your attendance and ward off the dark side of the calendar (meetings!).

So, what are you waiting for? Register now by clicking on the rocket ship to sign up via Microsoft Form. Any questions or problems, email ml101@army.mil

Figure 9. A few pages from the marketing flyer (full page layouts in Appendix B) for the "Machine Learning for Everyone" course, showcasing the creative and humorous approach to promotion.

The Marketing Flyer

The marketing flyer (shown in full in Appendix B and partially in Figure 9) exemplifies the organic and authentic approach that defined the course's outreach. Rather than relying on polished messaging, the flyer adopted a conversational tone that directly addressed potential participants' concerns. For example, it tackled the obvious question: "So, why should I spend time learning ML from someone who just learned about it?" The response was honest: "Well, first off, maybe because I was like you a few months back…For me, I just learned this, so it is fresh in my mind—what concepts I grasped, which ones were harder to grasp." This recent

learning experience in ML at the time of creating the course helped connect with an audience that was similarly trying to understand this complex topic.

The flyer also incorporated humor and self-deprecating commentary that made the technical content feel accessible. Statements like “I was hoping for one slide per concept—I miserably failed” and “You are crazy Mark! ML experts everywhere will unite to overthrow you! . . . or give you a sad face emoji, at least” added levity and broke down barriers for participants who might otherwise feel intimidated by ML. This authentic voice made people feel comfortable enough to sign up.

Another unique aspect of the flyer was its adoption of an infomercial-style pitch. Complete with testimonials* (“If I had to give it a score, I would give it a 10 out of 9"), pricing jokes ("$199? $99.99? $49.99? 2 payments of $9.99? What if I told you that it’s FREE"), and calls to action (“You better act now on this incredible opportunity"), this tongue-in-cheek format entertained readers while effectively showing people what the course had to offer. The humor and creativity of this approach made the flyer memorable and contributed to its success in driving registrations.

Army-Relevant Content

The course’s use of Army-relevant datasets further distinguished it from other ML offerings. As highlighted in the flyer: “Since I am an Army scientist, I chose an Army-related dataset—ballistic penetration of armor. No cat classification datasets or Boston housing price datasets here; just straight up bullets being stopped by armor.” This emphasis on practical, mission-relevant examples resonated strongly with the target audience, which included researchers and technical professionals in defense and government sectors. By grounding abstract concepts in familiar, job-relevant contexts, the course immediately demonstrated its practical value to participants.

Key Lessons

Looking back, the informal, conversational marketing was a huge reason for its success. The humor and creative themes connected with people in a way traditional marketing never could have. It created a sense of connection that broke down the barrier between me and the participants, making them feel comfortable enough to ask questions. It proved that even in technical fields, focusing on being relatable

*The included testimonials sound made up but were real anonymous feedback from the course.

instead of overly formal is what works. This approach did not just get people to sign up; it set the tone for a supportive learning environment where people felt safe to explore tough ideas.

The unexpected success of these efforts highlights the value of creativity and relatability in outreach, even in technical fields. By focusing on being accessible and engaging instead of being overly formal, the course's promotional approach successfully attracted a wide audience and set clear expectations for its tone and content. This strategy not only drove registrations but also contributed to a positive learning experience, as participants felt encouraged to interact and explore ML concepts in a supportive environment.

2.5 Technology Platforms and Delivery

Building on the creative marketing efforts that attracted participants, the technology platforms and delivery methods of the "Machine Learning for Everyone" course played a big role in keeping them engaged. While the focus of the course remained on delivering engaging and accessible content, the logistics were key for handling huge audiences and keeping people involved.

Course Delivery and Participant Experience

- **Platform Selection and Audience Management.** The course primarily utilized Microsoft Teams as the delivery platform, using both meeting and live event formats depending on audience size. Initially, Teams live events were used to accommodate over 800 participants, requiring multiple ARL personnel to manage questions and screen sharing. In subsequent iterations, standard Teams meetings proved effective even with hundreds of participants, offering enhanced interactivity while maintaining manageable logistics.

- **Content Design and Engagement Strategies.** To maintain participant engagement in the virtual environment, the course incorporated animated PowerPoint presentations, pre-recorded Excel demonstrations, embedded YouTube videos, and pop culture references (memes and relevant imagery). These multimedia elements helped overcome the limitations of live demonstrations (i.e., attention span challenges) while keeping content accessible and entertaining.

- **Registration and Data Management.** Initially, registration was managed

through email correspondence. After 800 people registered for the inaugural course, subsequent courses utilized automated registration via Microsoft Forms, enabling efficient capture of participant information including email addresses, names, familiarity levels, and comments into a centralized spreadsheet. This information was used to send follow-up communications about the course,* add participants to Teams meetings, and integrate personalized content into the course introduction (participant titles, organizational word clouds, distribution of ML familiarity levels).

- **Technical Challenges and Solutions.** Several platform limitations required innovative workarounds. Teams automatically muted audio during screen sharing, disrupting embedded videos and audio content in presentations. To address bandwidth constraints, participants were instructed to disable cameras and microphones. These solutions maintained audio quality while ensuring stable connections for large audiences. Additionally, the instructor's inbox was overwhelmed with emails following the first course, leading to the establishment of a dedicated email alias (ml101@army.mil) to properly filter questions and technical issues.

- **Delivery Method Comparison and Insights.** Three delivery formats were systematically tested: live online, hybrid, and in person. Live online delivery proved most effective, offering optimal scalability and participant flexibility to join or leave as needed. Hybrid formats presented significant challenges, requiring complex question relay systems between in-person and online audiences. In-person sessions worked well for smaller groups but lacked scalability and required all participants to be colocated. Notably, recorded sessions received minimal viewership compared with live attendance, suggesting that real time interaction was a key engagement driver.

Participant Support and Continuous Improvement

- **Continuous Improvement and Feedback Integration.** I used Microsoft Forms to collect detailed feedback before and after the course. This made

*For example, participants who described themselves as very familiar with or an expert in ML received an email prior to the course to manage expectations. Feedback from previous sessions indicated that expert-level ML practitioners were occasionally frustrated with the slower pace designed for beginners. This proactive communication helped align expectations and improve overall participant satisfaction.

it easy for people to share their thoughts and for me to get the data I needed to analyze the course's impact and keep making it better.

- **Frequently Asked Questions (FAQs).** To handle common questions, I created and sent out a detailed FAQ document. This document provided answers to common technical questions that arose in the chat during the course. This also presented the opportunity to share participant statistics, participant feedback, and the overall excitement/atmosphere within the course chat. Examples of the FAQ document are shown in Appendix C (as well as candid responses and other summarizing information about the course) and a subset of common questions are featured in Appendix D.

- **Participant Recognition.** Upon completing the course, participants received a certificate of completion, recognizing their engagement and essential understanding of AI/ML concepts. The certificate was a formal "thank you" for their effort and, hopefully, a motivator to keep learning. An example of the course certificate is shown in Figure 10.

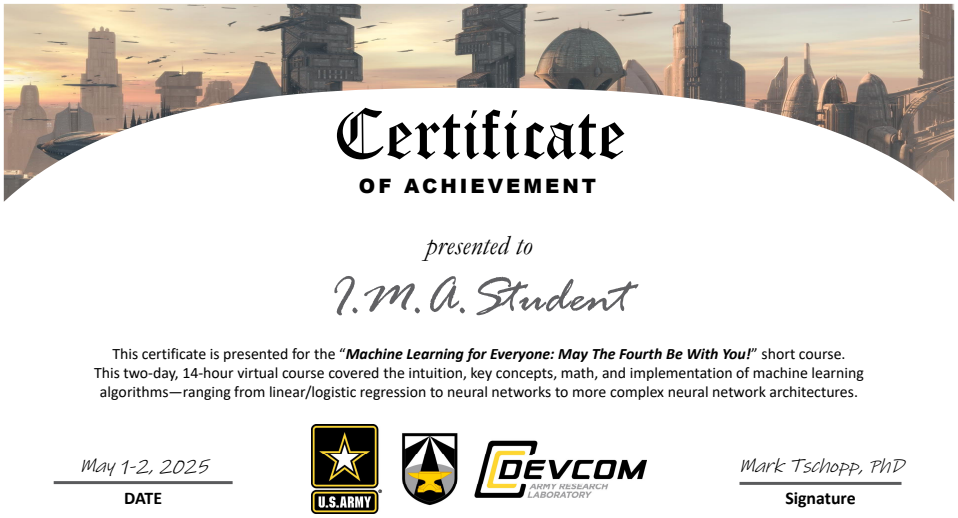


Figure 10. Example of the "Machine Learning for Everyone" course certificate, provided to participants upon completion.

A huge reason the virtual format worked so well was the real-time chat, which created a genuine learning community. Participants actively asked questions, shared resources, and engaged in lighthearted exchanges with both instructors and peers. The friendly tone and humor made people feel comfortable participating. This sense of community did not just make the course more fun; it was a huge factor in why people were so satisfied and learned so much. In the end, the technology helped more than it hurt, proving that you can teach huge audiences online and still keep them engaged.

2.6 Press Coverage and Course Impact

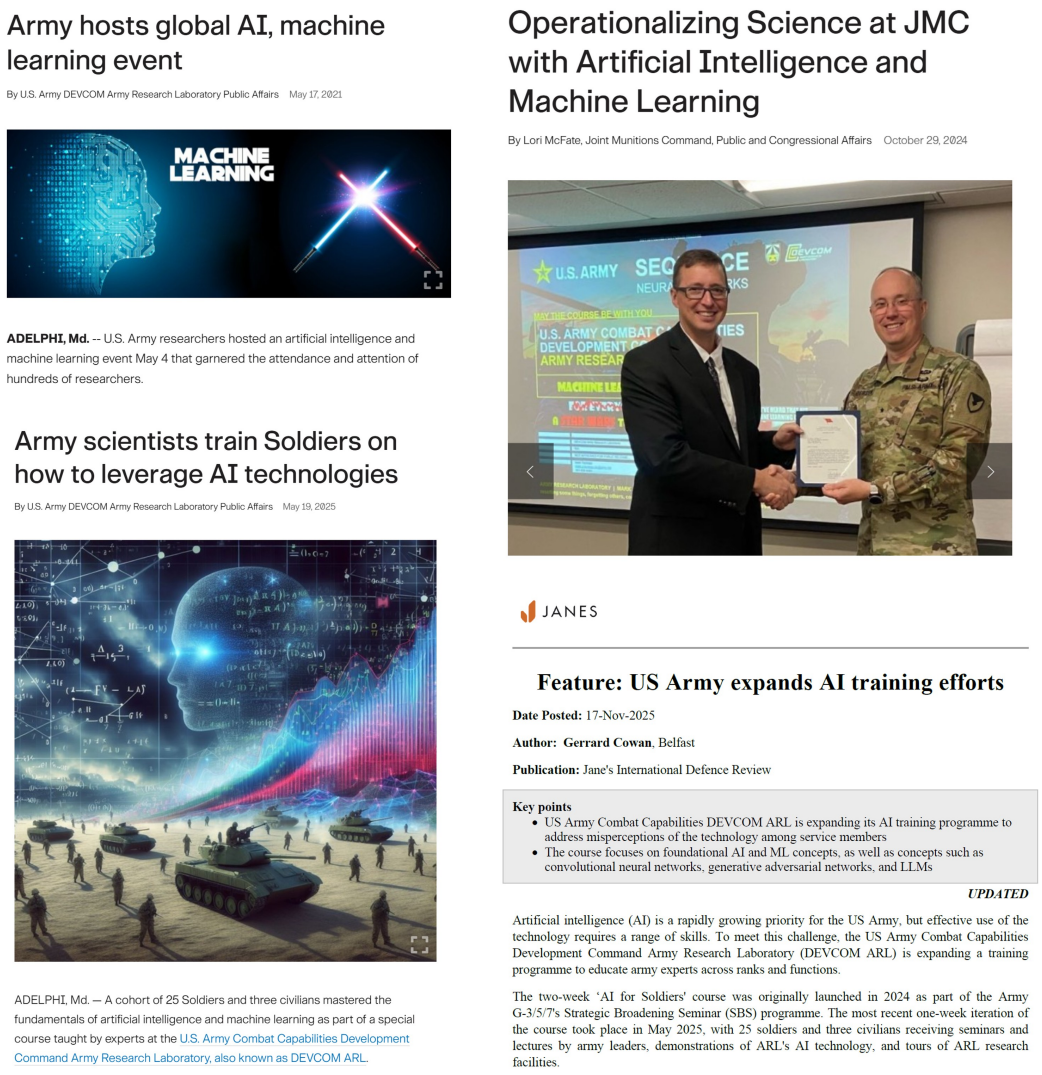
Press coverage amplified the course's success, which helped spark interest in future courses and broadened its reach across the Army, DoW, and beyond. One of the most powerful endorsements came from Gen. John M. Murray, former Commanding General of Army Futures Command (AFC), who included this summary in his report to the Secretary of the Army:

> "A great demonstration of Army leadership in the field of machine learning, and an incredible job by Mark. What started as a good idea, some initiative, and a desire to spread knowledge, was met with incredibly positive feedback. His short course showcased not only the challenges associated with building neural networks, but the Army's efforts to harness these capabilities."
>
> – Gen. John M. Murray, Commanding General (R), AFC

Here are summaries of a few of the most impactful articles (shown in Figure 11):

Army Hosts Global AI, Machine Learning Event.[8]
(17 May 2021)
This article covered the inaugural "Machine Learning for Everyone: May the Fourth Be With You" event, which attracted over 800 registrants from across the Army, DoD, academia, and industry. The course featured a Star Wars-themed campaign, Army-relevant datasets, and hands-on Excel demonstrations to simplify ML concepts. Dr. Alexander Kott, ARL Chief Scientist, emphasized the transformative impact of AI/ML on warfare, stating, "Today, AI is a truly transformative force, perhaps the most transformative phenomenon that has happened in warfare in many centuries." As the course instructor, I reflected on the importance of making ML accessible, noting, "Machine learning should be incorporated as a very powerful

tool in that toolbox, one that allows us to transform data into knowledge, ask questions to supplement our own understanding, and ultimately make those important decisions faster."



Army hosts global AI, machine learning event

By U.S. Army DEVCOM Army Research Laboratory Public Affairs May 17, 2021

ADELPHI, Md. -- U.S. Army researchers hosted an artificial intelligence and machine learning event May 4 that garnered the attendance and attention of hundreds of researchers.

Army scientists train Soldiers on how to leverage AI technologies

By U.S. Army DEVCOM Army Research Laboratory Public Affairs May 19, 2025

ADELPHI, Md. — A cohort of 25 Soldiers and three civilians mastered the fundamentals of artificial intelligence and machine learning as part of a special course taught by experts at the U.S. Army Combat Capabilities Development Command Army Research Laboratory, also known as DEVCOM ARL.

Operationalizing Science at JMC with Artificial Intelligence and Machine Learning

By Lori McFate, Joint Munitions Command, Public and Congressional Affairs October 29, 2024

JANES

Feature: US Army expands AI training efforts

Date Posted: 17-Nov-2025

Author: Gerrard Cowan, Belfast

Publication: Jane's International Defence Review

Key points

- US Army Combat Capabilities DEVCOM ARL is expanding its AI training programme to address misperceptions of the technology among service members
- The course focuses on foundational AI and ML concepts, as well as concepts such as convolutional neural networks, generative adversarial networks, and LLMs

UPDATED

Artificial intelligence (AI) is a rapidly growing priority for the US Army, but effective use of the technology requires a range of skills. To meet this challenge, the US Army Combat Capabilities Development Command Army Research Laboratory (DEVCOM ARL) is expanding a training programme to educate army experts across ranks and functions.

The two-week 'AI for Soldiers' course was originally launched in 2024 as part of the Army G-3/5/7's Strategic Broadening Seminar (SBS) programme. The most recent one-week iteration of the course took place in May 2025, with 25 soldiers and three civilians receiving seminars and lectures by army leaders, demonstrations of ARL's AI technology, and tours of ARL research facilities.

Figure 11. Highlights from press coverage of the AI/ML courses across four key articles spanning multiple years. These snippets showcase the course's evolution, widespread impact, and recognition received from Army leaders and participants.

Operationalizing Science at JMC with AI and Machine Learning.[9]

(29 September 2024)

This piece focused on the capstone AI/ML course delivered for JMC's "Data Analytics Booster Month" training series, focusing on providing Soldiers and Civilians with a solid understanding of AI/ML concepts and mathematical principles. The course objectives included understanding core concepts, mastering the mathemat-

ics, exploring key algorithms, and sparking curiosity. Referring to the misconceptions people have about ML and AI, I emphasized the importance of making sense of AI/ML, stating, "AI and ML are not just buzzwords; they are powerful tools that are revolutionizing how we approach complex problems. By demystifying these technologies, we are empowering our Soldiers and Civilians to leverage data-driven insights and make more informed decisions; ultimately, enhancing our operational capabilities."

This course also aligned with the Army's vision for AI/ML as critical enablers of future warfare, a point echoed by Brig. Gen. Ronnie Anderson Jr., JMC's commander, who shared a real-life example of AI/ML on the battlefield: "We are now using AI and ML to help make targeting decisions immediately. What used to take minutes to determine a target, we can now identify a threat in an environment, determine if it is an enemy or not, in seconds. The imagery bank is so deep now, and we have changed the targeting sequence and decision-making process."

Army Scientists Train Soldiers on How to Leverage AI Technologies.[3]
(May 19, 2025)
This article reported on the week-long "Artificial Intelligence for Soldiers" course, a program designed to provide mid-career Army officers, warrant officers, and non-commissioned officers with an in-depth understanding of how to leverage AI for their specific roles in the Army. I emphasized the strategic importance of AI, stating, "AI holds the extraordinary potential to swiftly analyze the deluge of data present within the future battlefield and to deliver actionable insight to Soldiers at the speed of relevance. We want this course to equip Soldiers with the knowledge and decision-making capabilities to harness AI as a tool to gain a competitive edge over our adversaries."

Participants praised the course's ability to make complex AI concepts accessible to nontechnical audiences. Capt. Nathan Jackson noted, "The instructors did a phenomenal job breaking down complex concepts like convolutional layers, generative adversarial networks, and transformer models into digestible lessons, even for non-technical folks." Maj. Gen. Stephanie Ahern, U.S. Army's Director of Strategy, Plans and Policy, congratulated the participants and emphasized the importance of continued engagement in AI technologies, stating, "Your ability to work with experts who are working with AI every day and your ability to apply AI in the field are

extremely essential to the Army mission. Please continue to be an agent of change; you are a part of the solution, and you are not in it alone."

Feature: US Army Expands AI Training Efforts.[10]
(17 November 2025).
This Jane's *International Defence Review* article detailed how ARL expanded its "AI for Soldiers" program to address misconceptions of AI and educate Soldiers across ranks and functions. I emphasized the importance of showing how AI/ML algorithms work, stating, "We wanted to unpack the algorithms and math that's really at the heart of this. We're pulling back the curtain." The program also highlighted AI's limitations, with Maj. Matt Work, chief of the Disruptive Technology branch at the Army Futures and Concepts Center, noting, "AI can synthesize information and provide readouts, but it's not truly going to analyze anything. It still takes human imagination and intuition to build a course of action for a battle plan."

Participants praised the course for bridging the gap between civilian and military applications of AI. Capt. Kelly Lewis, G3 Plans Officer in 3rd Armored Corps Sustainment Command, described AI as a "force multiplier," stating, "The training emphasized that AI is not intended to replace the analyst or decision maker, but rather to augment our capabilities by accelerating information processing and identifying potential insights." Capt. Nathan Jackson, an Air Defense Artillery officer, added, "The course gave me a clear framework for how AI can support Army operations beyond the buzzwords."

Participants also got hands-on demonstrations at ARL's Robotics Research Collaboration Campus R2C2, where they saw how AI is being integrated into robotics and autonomous systems, e.g., the Defense Advanced Research Projects Agency Robotic Autonomy in Complex Environments with Resiliency program for unmanned ground vehicles. CW3 Parker Toothill, a Chemical, Biological, Radiological, and Nuclear warrant officer, noted the importance of reconciling theory and practice, stating, "It taught AI and ML in small, easy-to-understand sections, from neural networks to NLP, and showed how the Army uses these technologies in areas like robotics and autonomous systems." Full interview questions and responses are included in Appendix E.

3. Course Participants

A diverse group of people from across the Army, DoD, academia, and industry have attended the "Machine Learning for Everyone" course—over 3,000 in total. These participants came with all levels of ML knowledge, from complete novices to experts. To better understand who was attending and why, I collected registration information that included their job, organization, self-reported familiarity with ML, and what they hoped to get out of the course.

3.1 Familiarity with ML

Participants came to the course with a wide range of ML knowledge. Figure 12 shows what people said about their own familiarity with ML prior to attending the course. The majority of participants described themselves as either "Somewhat Familiar" (28.5%) or "Slightly Familiar" (40.5%), which shows the course was especially good at reaching people who had some exposure to the topic but are not yet confident in their understanding. A smaller proportion of participants came in as "Not at All Familiar" (21.5%), highlighting the course's accessibility to complete beginners. These people often said they wanted to learn the basics and get over their intimidation of ML.

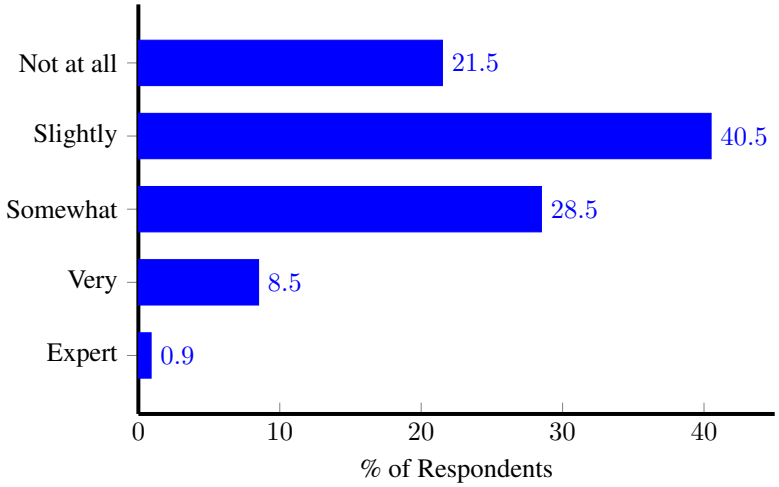


Figure 12. Participant familiarity with ML prior to the course, categorized by self-reported levels ranging from "Not at all" to "Expert." The data highlights the course's accessibility to beginners while also attracting participants with varying levels of prior exposure.

Conversely, only 8.5% of respondents identified as "Very Familiar," and less than 1% described themselves as "Experts." Feedback from advanced participants revealed that many were curious about the course's unique teaching methods, such as

the use of Excel-based demonstrations to explain complex ML concepts. Others appreciated the opportunity to refresh their understanding of fundamental principles, which they found valuable for communicating technical concepts to nonexperts in their own work. The data proves the course reached its target audience: individuals who are "somewhat familiar" or "slightly familiar" with ML.

3.2 Participant Organizational Representation

The "Machine Learning for Everyone" course has drawn participants from a wide range of organizations, spanning military, government, industry, and academic sectors. Table 2 provides a breakdown of participant organizations, broken down into broad categories.

The Army accounted for the largest share of participants, with 68.7% of attendees (2,078 individuals) representing 173 unique Army organizations. This huge turnout from the Army shows the course was directly in line with Army priorities and its success in engaging the Army workforce across diverse commands and functions. Overall, DoD organizations—including the Army, Air Force, Navy, and other DoD entities—comprised 78% of participants (2,360 individuals from 222 unique organizations). This broad DoD participation highlights the course's relevance to military transformation efforts and its appeal across service branches.

Table 2. Breakdown of participant organizations by sector and affiliation.

Organization	Unique	No. People	%
Army	173	2078	68.7
DoD	22	113	3.7
Air Force	16	88	2.9
Navy	11	81	2.7
DOC	1	172	5.7
DOE	7	40	1.3
NRC	1	33	1.1
NASA	1	1	0.0
Industry	29	40	1.3
Academia	67	379	12.5
DoD Total	222	2360	78.0
Government Total	232	2606	86.1
Total	327	3025	100

Government organizations* as a whole represented 86.1% of participants (2,606 individuals from 232 unique organizations), emphasizing the course's focus on supporting public-sector professionals. The large participation from government entities makes it clear that there is the growing recognition of AI/ML as critical capabilities for national security and public service missions.

While the majority of attendees were from military and government entities, the course also attracted participants from industry (1.3%) and academia (12.5%) when registration was open to external participants. The academic participation, representing 67 unique institutions, speaks to the course's value for educational and research communities. Industry participation, though smaller in percentage, included 29 different organizations, indicating interest from the private sector in learning about AI/ML as well.*

This organizational distribution shows the course's success in reaching its primary target audience—Army and DoD professionals—while also bringing people together from different sectors. The diversity of participating organizations, spanning 327 unique entities, shows that the course material is useful everywhere and can build AI/ML literacy across the entire defense and government community.

3.3 Army Command Participant Representation

The "Machine Learning for Everyone" course has engaged participants from across 17 Army commands, reflecting its broad appeal and relevance to diverse units and organizations. Figure 13 illustrates the distribution of participants, with the size of each icon representing the number of participants from that command.

AFC accounted for the largest share with 1,189 individuals, underscoring the strong alignment with AFC's mission to modernize and innovate within the Army. This large number of participants shows the command's focus on emerging technologies and future capabilities development. Other major contributors included Army Materiel Command (AMC) with 246 participants and HQDA with 221 participants,

*Non-DoD government organizations include the Department of Commerce's National Institute of Standards and Technology (DOC), Department of Energy national laboratories (DOE), Nuclear Regulatory Commission (NRC), and National Aeronautics and Space Administration (NASA).

*The course was primarily marketed to military and government entities, with limited outreach to academia, industry, and non-DoD agencies during the first year. The strong interest from these sectors in year one suggests that the course content resonates with broader audiences, even though subsequent iterations focused almost exclusively on Army professionals.

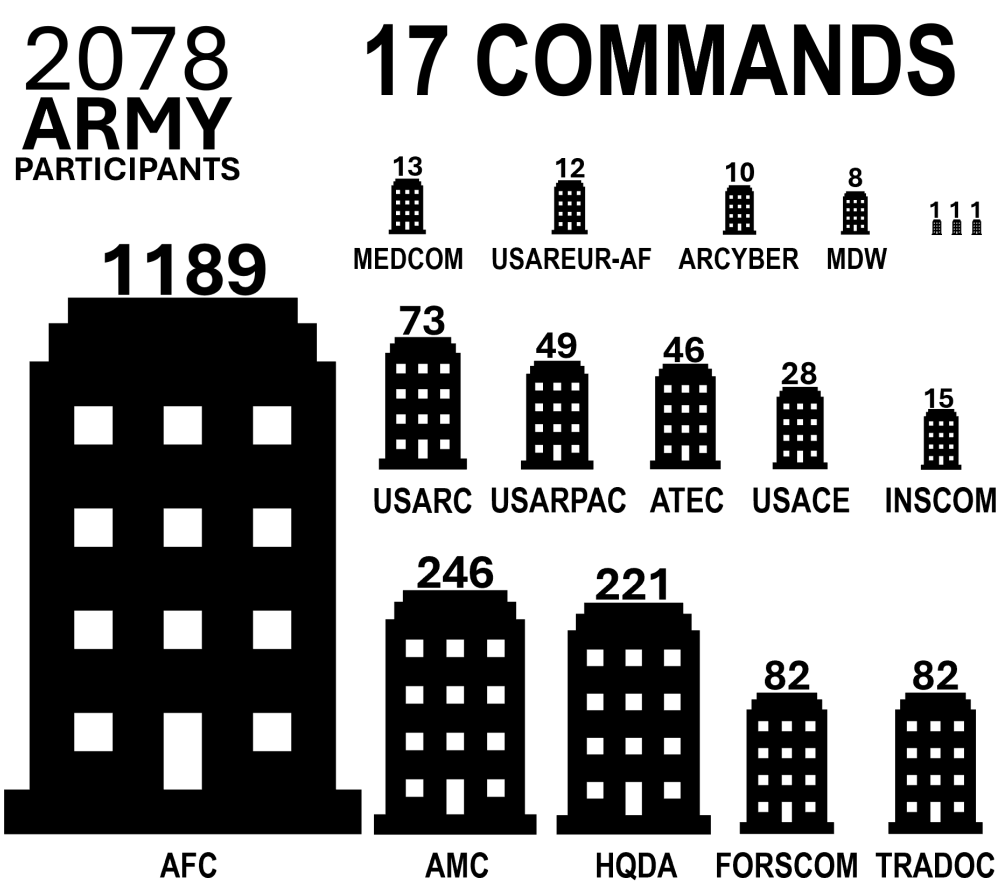


Figure 13. Participant distribution across 17 Army commands. The size of each icon represents the number of participants from that command (number also given).

highlighting the course's relevance to logistics, sustainment, and strategic leadership functions. Commands such as Forces Command (FORSCOM) and TRADOC each contributed 82 participants, demonstrating the course's applicability to operational readiness and training initiatives.

While other commands had lower participation, this likely reflects the course's reliance on word-of-mouth recommendations and limited targeted marketing efforts rather than lack of relevance to their missions. It is clear from the broad representation across organizations, operational entities, and strategic leaders that the Army increasingly sees ML as a critical tool for transformation, readiness, and innovation.

Building on this command-level analysis, the course has drawn particularly sig-

nificant participation from organizations within Army commands, with DEVCOM leading in both the number of attendees and the diversity of organizations represented. Figure 14 illustrates this distribution across 173 organizations within Army commands.

ARL accounted for the largest share at 543 participants, followed by other DEVCOM Centers: Aviation and Missile Center (AvMC, 150); C5ISR Center (150); Armaments Center (AC, 96); Data and Analysis Center (DAC, 87); CBC (87); Soldier Center (SC, 70); and Ground Vehicle Systems Center (GVSC, 24). This concentration within DEVCOM is not surprising given that it represents one of the Army's largest science and technology organizations, with a workforce naturally aligned with advanced technology concepts and research applications.

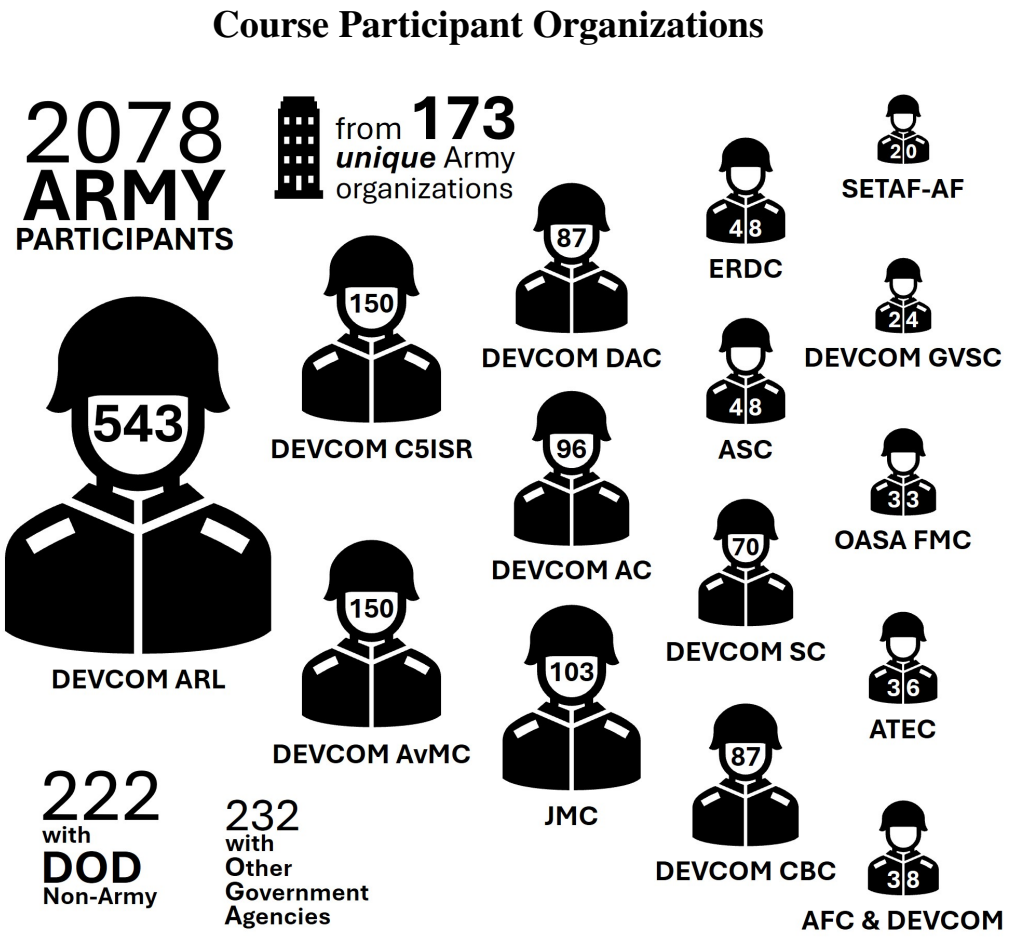


Figure 14. Participant distribution across 173 organizations within Army commands. The size of each icon represents the number of participants from that organization (number also given).

Other notable suborganizations, such as JMC and Army Sustainment Command (ASC), reflect participation from in-person and hybrid courses conducted in 2023–2024, which drew significant local attendance. The distribution pattern highlights the broad interest in AI/ML within the Army's science and technology enterprise, while also demonstrating the course's appeal to operational and sustainment communities when directly accessible through targeted delivery formats.

3.4 Participant Roles and Titles

The participant roles and titles are listed in Appendix F. The diversity of participant roles is reflected in the word cloud shown in Figure 15, which was generated by breaking down multi-word position titles into individual words. The most frequently occurring words include "engineer" (540 occurrences), "research" (277 occurrences), and "scientist" (237 occurrences), highlighting the strong representation of technical and research-oriented professionals. This pattern aligns with the course's focus on making ML accessible for technical audiences who need to understand and potentially apply these concepts in their work.

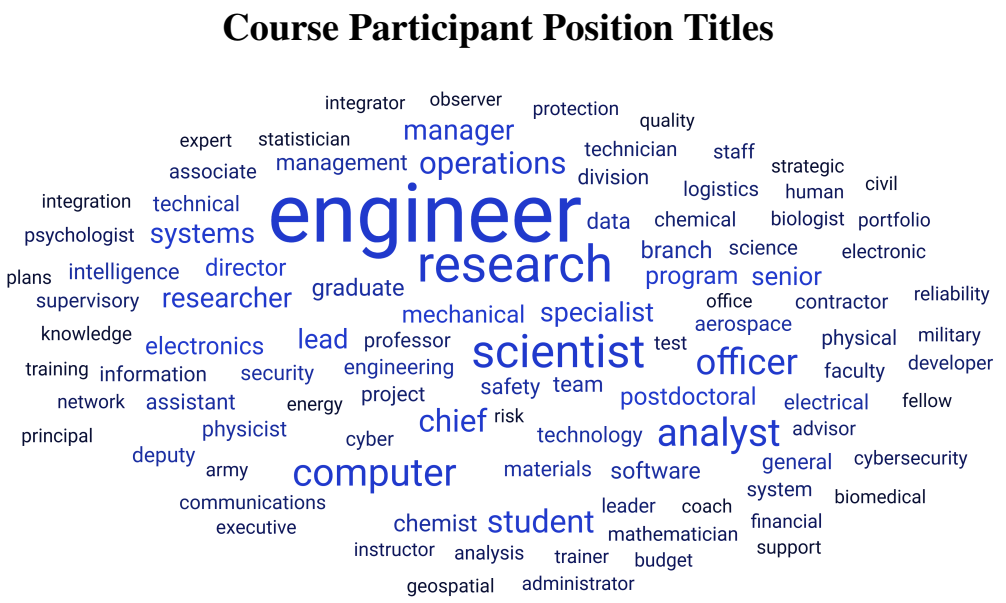


Figure 15. Word cloud of participant position titles. Larger words represent higher frequencies, with "engineer," "research," and "scientist" being the most common. The word cloud was generated by breaking down multi-word position titles into individual words.

Other prominent words, such as "chief," "specialist," "student," "postdoctoral," and "manager," indicate the course's appeal to a broad range of roles, from early-career

professionals to senior leaders. The prominence of words like "computer," "systems," and "cyber" shows the course's relevance to technology-focused fields, while terms like "officer" and "analyst" show the large participation from military and operational communities. Overall, the word cloud shows the course's diverse audience spanning engineering, research, leadership, and operational roles.

To provide a more structured analysis of participant backgrounds, position titles were aggregated into broader categories based on functional similarities. Table 3 presents this categorization, revealing several key insights about the course's audience composition.

Operational and analytical roles represented the largest category with 401 participants, including G-staff officers, Operations Research and Systems Analysts (ORSAs), and other related positions. This significant representation indicates how relevant the course is to military operations and decision-making processes. Management and leadership roles (337 participants) and computing and software professionals (286 participants) also featured prominently, reflecting the course's appeal to both technical practitioners and those responsible for guiding technology adoption within their organizations.

Educational roles, including students, graduate researchers, and postdoctoral researchers, accounted for 192 participants, highlighting the course's accessibility to early-career individuals and those in academic transitions. This participation suggests the course's value for building core knowledge among the next generation of technical professionals.

The technical and scientific categories demonstrate the course's broad appeal across engineering and scientific disciplines. Materials scientists, chemists, and physicists (141 participants) represented a significant portion, while specialized categories included electrical and electronics engineers (89 participants), mechanical and aerospace engineers (79 participants), and a diverse group of specialized scientists and engineers (121 participants) encompassing roles from civil engineering to psychology and bioinformatics.

General engineers (134 participants) and scientists/researchers (107 participants) reflected participants who did not specify their exact discipline, while academia and training professionals (57 participants) captured both university faculty and Army

Table 3. Aggregated breakdown of participant positions by functional category.

Category	Count	Example roles
Operational and analytical roles	401	Operations research and systems analysts (ORSAs), G-staff officers: operations, intelligence, communications and IT, information systems, security, logistics, personnel
Management and leadership roles	337	Branch chief, chief, supervisory, team leader, lead, project lead, program lead, project manager, program manager, director, deputy director
Computer and software roles	286	Computer scientist, computer engineer, systems engineer, software engineer, software developer, data scientist
Educational and research roles	192	Student, graduate student, graduate research assistant (GRA), intern, postdoctoral researcher
Material scientists, chemists, physicists	141	Materials engineer, material scientist, physicist, physical scientist, chemical engineer, chemist
General engineers	134	Engineer, general engineer, research engineer
Specialized scientists and engineers	121	Civil engineer, environmental engineer, structural engineer, hydraulic engineer, psychologist, physiologist, mathematician, statistician, biologist, biomedical engineer, biomechanical engineer, bioinformatics
Scientists and researchers	107	Scientist, research scientist, researcher, senior scientist
Electrical and electronics engineers	89	Electronics engineer, electrical engineer
Mechanical and aerospace engineers	79	Mechanical engineer, aerospace engineer, airworthiness engineer, computational fluid dynamics engineer
Academia and training professionals	57	Faculty, assistant/associate/full professor, instructor, trainer, observer controller/trainer

instructors/trainers.* This distribution demonstrates the course's success in attracting a diverse audience spanning technical, operational, leadership, and educational roles, showing that ML concepts are useful in all kinds of jobs.

3.5 Participant Motivations

Participants provided a wide range of motivations for attending the ML learning and AI courses. These diverse individual responses are listed in Appendix G. Looking at all the reasons people gave, a few key themes emerged. Understanding why people came gives a real sense of the course's impact and how it met their different needs. This subsection categorizes participant motivations into key themes, supported by representative statements that illustrate their perspectives.

Professional and Work Applications. Many participants expressed interest in the course for its direct applicability to their professional roles. People wanted to use AI/ML to do their jobs better, support Army transformation initiatives, and improve decision-making processes. Representative statements include the following:

- "I want to apply machine learning techniques to analyze sensor data and improve predictive maintenance for Army systems."
- "Understanding AI concepts will help me support automation and workflow optimization within my team."
- "I hope to gain skills that allow me to contribute to modernization projects involving data analytics and advanced computing."
- "Learning these tools will enable me to communicate effectively with ML experts and incorporate AI into our research pipelines."

Research and Technical Applications. Many participants highlighted research-oriented motivations, emphasizing how they could apply AI/ML to their ongoing projects, thesis work, and scientific investigations. Many saw the course as a way to gain a deeper understanding of algorithms, improve experimental design, and enhance data analysis capabilities. Representative statements include the following:

- "I am using machine learning in my thesis project and want to better understand neural networks and their applications."

*This count does not include participants from the ML 101 courses conducted with Spelman College, Army Management Staff College (AMSC), and the University of Memphis, which engaged many faculty. The numbers reported in this section reflect only those who registered for the main "Machine Learning for Everyone" course.

- "Learning ML concepts will help me apply advanced computational techniques to material property prediction and simulations."
- "I want to gain literacy in AI/ML to enhance my analysis of complex experimental datasets."
- "Understanding machine learning will enable me to develop predictive models for research in imaging and chemical kinetics."
- "I hope to deepen my knowledge of AI/ML to apply it effectively in my data-driven research projects."

Personal Learning and Curiosity. Many participants expressed motivations driven by general curiosity, lifelong learning, and interest in emerging technologies. These learners often sought to broaden their understanding of AI and ML for personal growth, professional awareness, or enjoyment of the subject matter. Representative statements include the following:

- "I'm always interested in learning about new technology and how I can apply it to my work."
- "I enjoy learning new things and want to explore AI/ML concepts in a fun, accessible way."
- "Curiosity about how neural networks and machine learning operate motivates me to take this course."
- "I want to expand my knowledge of AI/ML to stay current with emerging trends in technology."
- "Interest in understanding machine learning stems from a desire to be better prepared for future applications in my field."

Refresher and Continuing Education. Several participants indicated that they were taking the course to refresh previous knowledge or update skills with new developments in AI/ML. Representative statements include the following:

- "Took it last year. Interested in getting a refresher."
- "Annual AI/ML review to stay updated on best practices."
- "I want to update my ML knowledge with the latest techniques and tools."

Skill Expansion and Future Preparedness. Many participants expressed a desire to build essential skills for future projects, career growth, or emerging technology initiatives. Representative statements include the following:

- "To build a foundation for ML to use in future assignments."
- "Skills required in future assignments and technology initiatives."
- "Upskilling to remain competitive and relevant in my field."

Implementation and Operationalization. Participants frequently emphasized interest in applying ML techniques in practical contexts, including operational workflows, research and development projects, or information technology and sensor systems. Representative statements include the following:

- "To see how ML can be implemented and advance program capabilities."
- "Want to leverage ML to improve all aspects of IT development, security, and operations."
- "Hands-on experience applying ML models to real-world problems is important to me."

Bridging Technical and Leadership Roles. Several participants in managerial or oversight roles highlighted a need to understand AI/ML to guide teams, evaluate technical claims, and make informed decisions. Representative statements include the following:

- "I supervise people developing and implementing AI and ML."
- "I want to be able to better understand the computer science folks and contractor claims."
- "Learning ML helps me make informed decisions in technical leadership roles."

Domain-Specific Applications. A number of participants emphasized using ML within their specialized fields, particularly robotics, autonomy, materials science, cyber operations, and sensor systems. Representative statements include the following:

- "Application to autonomy of land and air vehicles."
- "Research applying ML for fluid-structure interaction systems."
- "Using ML to enhance materials characterization and predictive modeling."

Strategic Alignment. Some participants aimed to understand AI/ML within the context of organizational priorities, transformation initiatives, or DoD strategy. Representative statements include the following:

- "ML likely has implications for DoD strategic planning."
- "Army Modernization efforts make understanding AI critical."
- "To gain a foundational understanding of ML in the DoD context."

Hands-On Tool Familiarization. Many participants wanted practical, hands-on experience with AI and ML tools, including Excel, Python, or other computational platforms. Representative statements include the following:

- "Learning how to do ML in Excel rather than Python."
- "Hands-on experience is critical for understanding ML workflows."
- "I want to be able to build and test simple ML models myself."

In the end, the wide range of motivations shows just how broad the course's appeal really was.

4. Course Impact

To measure the course's impact, I focused on answering three simple questions: Did people actually learn anything? Did they find the course valuable? And what did they say about it in their own words?

To find the answers, I used a few different methods. A true/false test helped me see what common misconceptions were being cleared up. Surveys after the course provided hard numbers on participant satisfaction. And finally, their written comments gave me their personal take on the experience. Putting all three together gives a full picture of the course's impact, from the data to the personal stories.

4.1 Learning Outcomes

The true/false test was designed to assess participant understanding of ML concepts and identify common misconceptions. The test gave me valuable insight into what people knew well and where their understanding was weak. Here, I'll break down the test results, show some interesting patterns in the answers, and demonstrate the course's impact on what people learned.

4.1.1 Test Design and Results

The test consisted of 40 statements, equally divided between true and false, and was designed to challenge participants' understanding while minimizing the impact of random guessing. Figure 16 shows the test. Each correct answer was worth 2.5

points, unanswered questions earned 1.25 points, and incorrect answers received 0 points. False statements were intentionally crafted to sound plausible, avoiding bias-inducing words like "always" or "never." This scoring system encouraged participants to answer confidently while revealing gaps in core knowledge.

The test results showed some intriguing patterns in what people understood. Figure 17 shows a breakdown of participants answering the true statements, the false statements, and leaving them blank, as well as the frequency with which they were correct or not. Many of the false statements were crafted to sound true. Therefore, it was not surprising to find an asymmetry in what participants answered, i.e., for every one false statement answered, there were 1.8 true statements answered. Remarkably, true answers were more likely to be incorrect when compared with false answers. While Figure 17 visualizes the statistics, the real story is in the questions themselves: What are the common misconceptions people have about ML? And what do they actually know well? Let us examine the statements participants answered correctly and incorrectly.

4.1.2 Correct Responses

The most correct statements are listed in Figure 18. Given that most statements were designed to sound true (and participants guessed "True" at a much higher rate), it does not necessarily mean people truly understood the material. Only one out of the top 14 correct statements was actually False: A classifier with 100% accuracy on the training set and 70% accuracy on test set is better than a classifier that attains 70% accuracy on the training set and 75% accuracy on test set.

Some of these correct responses may suggest that participants are somewhat familiar with terms like generalization, training sets, and test sets—concepts that can often be inferred from their names. For example, the term "generalization" intuitively implies the ability to apply knowledge broadly, while "training set" and "test set" suggest distinct phases of model evaluation. Similarly, the correct identification of the ReLU activation function may indicate recognition of the term, even if participants lack a deeper understanding of its mathematical definition.

Interestingly, many of the correctly answered statements involve specific technique names, such as autoencoders, ridge regression, recurrent neural networks, or one-hot encoding. This suggests that people might have assumed a statement was true just because it used specific technical terms, even if they are unfamiliar with the

The MACHINE LEARNING concepts test

T	F	The ReLU activation function is the same as max(-x, x).
T	F	When using a tanh activation function in a neural network, it is important to randomize the parameters with a mean of 0.
T	F	Four common types of activation functions are tanh, ReLU, squeaky ReLU, and sigmoid functions.
T	F	A classifier with 100% accuracy on the training set and 70% accuracy on test set is better than a classifier that attains 70% accuracy on the training set and 75% accuracy on test set.
T	F	One-hot encoding is often used for categorical variables.
T	F	Softmax activation function is often used within hidden nodes for multiclass neural networks.
T	F	The mmult function in Excel is associated with linear regression.
T	F	In Excel, generating a neural network with ReLU is much easier to implement than with a tanh activation function.
T	F	As the number of features increase, the syntax for matrix multiplication operation stays the same in Excel if you name variables.
T	F	Hyperparameters are additional parameters in the model that make it perform better.
T	F	The weights in a neural network model are a good example of hyperparameters.
T	F	Logistic regression is a combination of linear regression and a tanh activation function.
T	F	Logistic regression is equivalent to a neural network without hidden units and one output node with a sigmoid activation function.
T	F	A low loss value means the difference between the data point and the model prediction is low.
T	F	It is a good idea to evaluate which neural network architecture to use with the cost function of the training set.
T	F	The cost function of the test set can be used to evaluate how your model does on new data.
T	F	Mean squared error or L2 loss function is commonly used for classification problems.
T	F	Leave one out cross-validation is the most extreme case of k-fold cross-validation.
T	F	For small datasets, simple machine learning models can be just as good as complex neural networks.
T	F	The more nodes in a neural network layer, the greater the randomization of parameters (i.e., their magnitude) should be.
T	F	The bias in a neural network model is the same thing as a slope in a linear regression model.
T	F	The output node for a neural network regression model is often a linear activation function.
T	F	For the same image size, a convolutional neural network will require more parameters than a conventional fully-connected neural network to capture image responses.
T	F	Autoencoders and PCA are types of unsupervised machine learning models.
T	F	Recurrent neural networks and gated recurrent units are types of supervised machine learning model used for time series.
T	F	Grid search over hyperparameters is the most efficient way of finding the optimal hyperparameters.
T	F	In gradient descent and stochastic gradient descent, you update a set of parameters in an iterative manner to minimize the cost function.
T	F	Logistic regression is an example of regularization of a linear model.
T	F	Regularization can result in an increase or a decrease in model parameters to help with overfit models.
T	F	In linear regression, using an L1 regularization penalty term results in sparser solutions (less features) than using an L2 regularization penalty term.
T	F	One way to deal with correlated features is to use a regularized model like ridge regression.
T	F	Increasing the amount of regularization is always desirable, it just takes more time to train the model.
T	F	A machine learning model is good when the training error is low.
T	F	The generalization of a machine learning the model can be evaluated with a test set.
T	F	Separating the dataset into three parts is recommended for optimizing neural network hyperparameters.
T	F	High model variance is associated with high variance in the features.
T	F	Low model bias is associated with simple models.
T	F	The variance versus bias tradeoff is associated with overfitting of a model.
T	F	A model is demonstrating high bias across different training sets. Increasing model complexity will reduce the bias.
T	F	With respect to the variance vs bias tradeoff, using a model with less bias is better than a model with more bias.

Figure 16. The statements of the ML true/false test (20 true; 20 false).

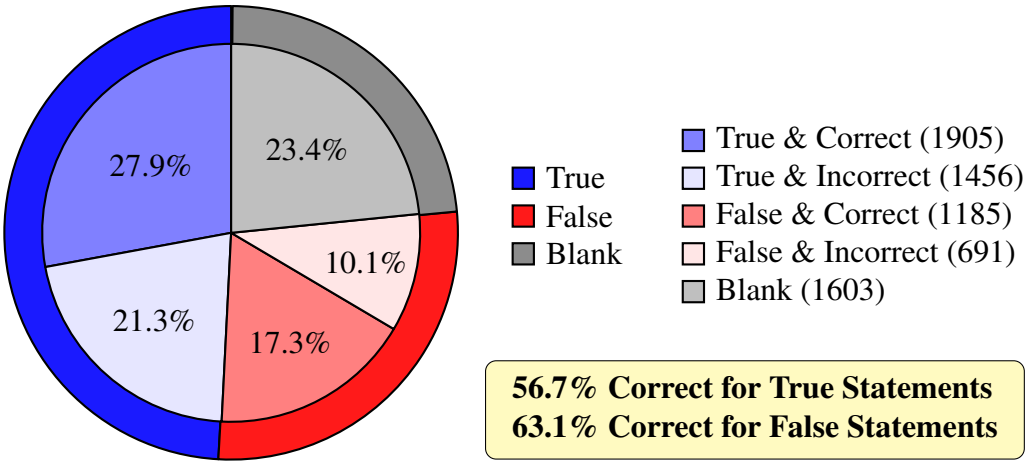


Figure 17. Nested pie chart showing overall distribution of responses (outer ring) and breakdown into Correct and Incorrect (inner ring).

underlying concepts. The use of precise terminology can lend credibility to statements, but it may also lead to incorrect assumptions when participants rely on the presence of technical terms rather than their understanding of the concepts.

4.1.3 Incorrect Responses

The most missed statements are presented in Figure 19. Interestingly, all of the listed statements are false, in stark contrast to the correctly answered ones. This list reveals that many of the fundamental concepts of ML remain unfamiliar to those taking the test. With 50% being the expected result from random guessing, low percentage scores indicate that a majority of people were confidently selecting incorrect statements.

This confusion usually boiled down to two things: people did not know the definitions of key terms (such as hyperparameters, model variance, loss functions, softmax, and regularization) and they did not understand how those terms fit together in a larger concept (e.g., logistic regression with tanh or L2 loss with classification). Occasionally, individuals may have fallen into the trap set by deceptive statements, such as the one introducing "squeaky ReLU" in the least noticeable position within the list of activation functions provided in the third statement (28%), which is a classic example of what psychologists call the serial positioning bias.

The most CORRECT statements

92% The generalization of a machine learning the model can be evaluated with a test set.

87% In gradient descent and stochastic gradient descent, you update a set of parameters in an iterative manner to minimize the cost function.

85% The variance versus bias tradeoff is associated with overfitting of a model.

83% Recurrent neural networks and gated recurrent units are types of supervised machine learning model used for time series.

82% Autoencoders and PCA are types of unsupervised machine learning models.

80% A low loss value means the difference between the data point and the model prediction is low.

79% One-hot encoding is often used for categorical variables.

79% For small datasets, simple machine learning models can be just as good as complex neural networks.

77% **(F)** A classifier with 100% accuracy on the training set and 70% accuracy on test set is better than a classifier that attains 70% accuracy on the training set and 75% accuracy on test set.

76% The cost function of the test set can be used to evaluate how your model does on new data.

74% One way to deal with correlated features is to use a regularized model like ridge regression.

73% Separating the dataset into three parts is recommended for optimizing neural network hyperparameters.

73% Regularization can result in an increase or a decrease in model parameters to help with overfit models.

72% When using a tanh activation function in a neural network, it is important to randomize the model parameters with a mean of 0

Figure 18. The statements most answered correctly in the ML true/false test. The false statement is marked with "F;" all other statements are true.

4.1.4 Pre- and Post-Test Results

The test results reveal significant improvement in participant understanding of ML concepts. Participants who took the test after the course scored an average of 65.5 points, compared with 56.5 points for those who took it before. While the after group described themselves as slightly more familiar with ML (average ML familiarity score of 2.43 vs. 2.08 [self-reported] on a five-point scale), a linear regression analysis showed that this prior familiarity could only account for 1.9 points of the

The most INCORRECT statements

24%	It is a good idea to evaluate which neural network architecture to use with the cost function of the training set.
26%	The more nodes in a neural network layer, the greater the randomization of parameters (i.e., their magnitude) should be.
31%	Logistic regression is an example of regularization of a linear model.
32%	Hyperparameters are additional parameters in the model that make it perform better.
32%	With respect to the variance vs bias tradeoff, using a model with less bias is better than a model with more bias.
36%	High model variance is associated with high variance in the features.
36%	Softmax activation function is often used within hidden nodes for multiclass neural networks.
38%	The weights in a neural network model are a good example of hyperparameters.
38%	Mean squared error or L2 loss function is commonly used for classification problems.
38%	Four common types of activation functions are tanh, ReLU, squeaky ReLU, and sigmoid functions
46%	In general, generating a neural network with ReLU is much easier to implement than with a tanh activation function.
48%	A machine learning model is good when the training error is low.
50%	Logistic regression is a combination of linear regression and a tanh activation function.
50%	For the same image size, a convolutional neural network will require more parameters than a conventional fully-connected neural network to capture image responses.
51%	Grid search over hyperparameters is the most efficient way of finding the optimal hyperparameters.
53%	Increasing the amount of regularization is always desirable, it just takes more time to train the model.
58%	Low model bias is associated with simple models.

Figure 19. The statements most answered incorrectly in the ML true/false test. All statements are false.

increase. The real nine-point jump shows that the course itself made a huge difference.

When considering the improvement above random guessing (Figure 20), the results are even more striking. Participants who took the test before the course scored

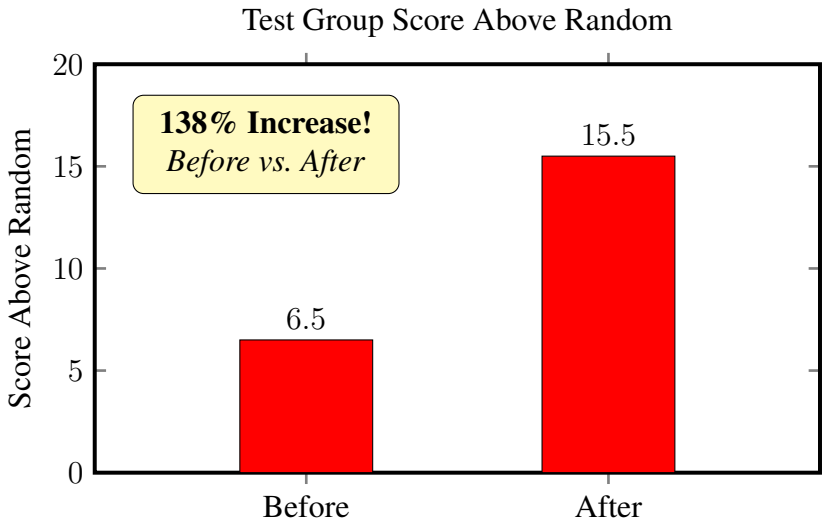


Figure 20. Comparison of scores above random for participants before and after the course.

an average of 6.5 points above random, while those who took it after scored 15.5 points above random—a 138% increase. This improvement shows how important the course was for addressing knowledge gaps and giving people the tools to work with ML concepts more effectively. This improvement was also reflected in anonymous and private communications, such as the feedback: "Thanks for all your efforts in putting together a great class last week! I learned a lot. The posttest questions—while still challenging—were easier to answer than the pretest."

These findings highlight how important the course was for addressing gaps in knowledge around ML concepts. The test results not only highlight common misconceptions and areas of strength but also reveal the lack of knowledge many participants possess about ML. The patterns in the answers suggest people were often using mental shortcuts or guessing, not answering from a deep understanding. In many cases, participants appeared to guess at statements based on their experiences with true/false tests, looking for giveaways or relying on the perceived credibility of technical terms. When faced with tricky or deceptive statements, many opted to leave them unanswered.

If nothing else, these results prove how important this course was in addressing core knowledge gaps and shedding light on ML concepts. Future iterations of the course can be tailored to emphasize clear definitions, practical applications, and the significance of key terms. Addressing common misconceptions and bridging

the gap between recognition and comprehension will ensure participants not only recognize technical terms but also understand their relevance and use in ML.

4.2 Quantitative Feedback

4.2.1 Survey Design and Results

After the course, I asked participants for anonymous feedback. The survey used a five-point rating scale (from "Strongly Disagree" to "Strongly Agree") for a series of statements and also included an open-ended question: "What did you think of the course? Anything else you wish to add?" A screenshot of the full survey is in Appendix H.

The survey began by asking participants to rate their familiarity with ML prior to the course, then presented 10 statements to evaluate the course content, the quality of instruction, and how confident they felt in applying ML concepts. The breakdown of responses for these statements is shown in Figure 21.

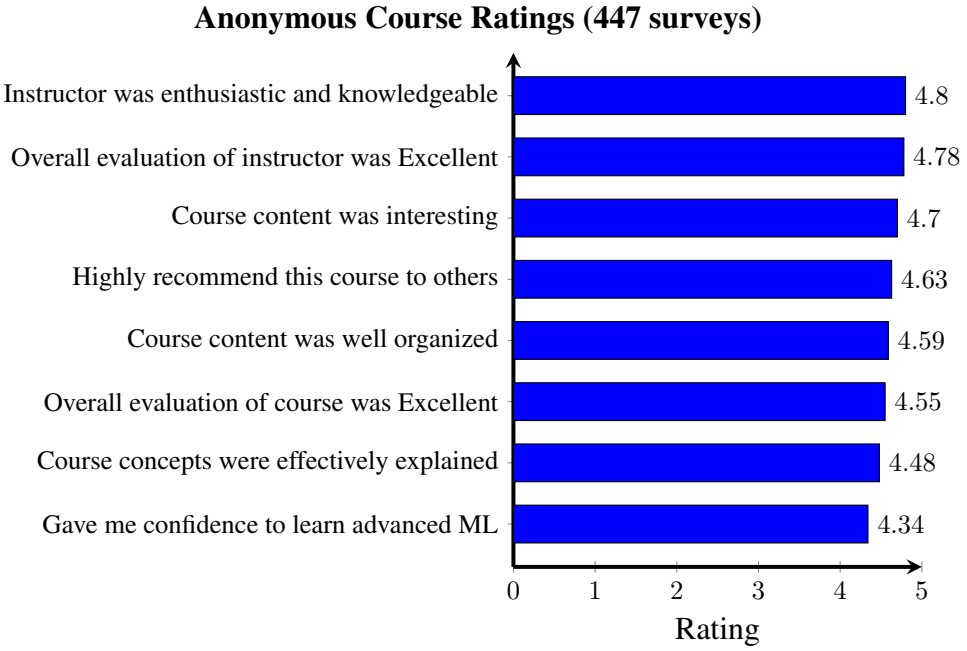


Figure 21. Anonymous course ratings (447 participants) from 2020–2025 for different statements from 1 (strongly disagree) to 5 (strongly agree). The paraphrased statements that the participants were asked to evaluate are listed in the horizontal bar chart along with the corresponding average value (out of 5).

Overall, the feedback was overwhelmingly positive, reinforcing the course's value and impact. To get more meaningful answers, I intentionally used strong words in

the survey statements. For example, the survey used terms like “excellent” rather than “good” to better capture distinctions in participant sentiment. This phrasing gave me a clearer picture of what was working and what was not.

Among all evaluation statements, the highest ratings were for “instructor was enthusiastic and knowledgeable” and “overall evaluation of the instructor was excellent.” The lowest score was consistently for “the course gave me confidence to do more advanced learning,” which is understandable given that many participants entered the course with little to no familiarity with ML. Even so, this score remains encouraging, as a large number of participants still strongly agreed with the statement. These high scores are a strong endorsement, showing that people valued both what was taught and how it was taught.

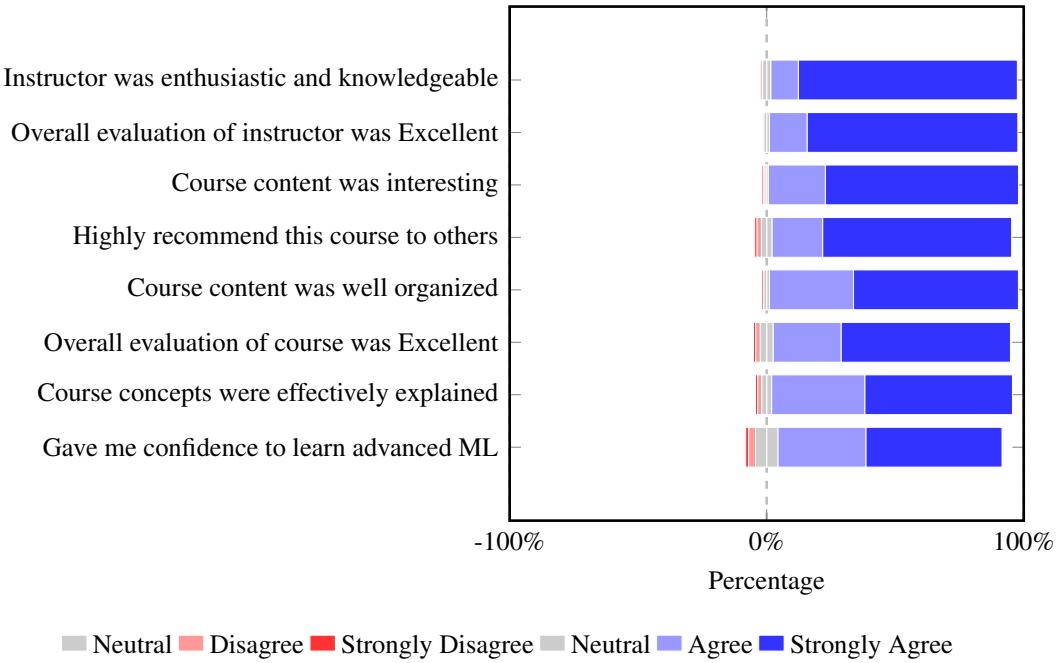


Figure 22. Stacked horizontal bar chart showing Likert scale responses split into disagree and agree regions.

4.2.2 Response Analysis and Trends

Figure 22 provides a detailed breakdown of the Likert scale responses, split into disagree and agree regions. The ordering of evaluation statements matches Figure 21, which clearly shows that the high average scores are because most people chose “Agree” or “Strongly Agree.” While neutral or disagree scores can affect average ratings, very few participants selected disagree options across any statement.

Consistent with the overall pattern, the most disagree responses came from the statement about confidence in advanced learning—understandable given that many participants entered the course describing themselves as "Not at all Familiar" with ML before the one- or two-day program. This makes sense: the course was great at building a foundation, but it's natural that people still need more time to feel confident with advanced topics.

The positive feedback trends have remained consistent across different course iterations and years. For example, the 2025 "AI for Soldiers" course demonstrated exceptional satisfaction levels, with the following percentages representing participants who either agreed or strongly agreed with each statement:

- (100%) My overall evaluation of the course is Excellent.
- (100%) My overall evaluation of the instructors is Excellent.
- (100%) I would highly recommend this course to others.
- (100%) The instructors were enthusiastic and knowledgeable about the course material.
- (100%) The presentations and course materials explained the course concepts effectively.
- (100%) The presentations and course materials were well organized.
- (100%) The course gave me confidence to ask better questions about AI and AI systems.
- (95%) The course gave me confidence to inform others about what AI systems can and can't do.
- (95%) The course gave me confidence to do more advanced learning (or understand more advanced concepts) in the area.
- (95%) The presentations and course materials were interesting.

These fantastic results from the 2025 course show that the teaching methods continued to get better and more effective. The course's continued success, year after year, is a direct result of participant satisfaction. The fact that participants consistently "highly recommend"* the course to others has been instrumental in its continued growth and impact across the Army and beyond.

*Similar to choosing the adjective "excellent" over "good" for the statements, "highly recommend" was used instead of "recommend."

4.3 Qualitative Feedback

This subsection focuses on the anonymous long-text feedback submitted through the after-course survey. The written comments give you the story behind the numbers, offering a much deeper understanding of the course's real impact. To extract meaningful patterns from this feedback, I used a panel of NLP models to analyze sentiment, objectivity, and emotion. This approach gave me a structured way to make sense of hundreds of comments and added a new layer of understanding to the survey ratings.

Participants shared a range of feedback, from brief comments like "Enjoyed the class. Awesome job!" to more detailed reflections:

- "Just wanted to send a note and let you know how much I appreciated the effort you have put into the ML 101 course! Having it as a two-day course made it doable within my schedule and the information was great! I imagine an enormous amount of time has gone into this course and it will be extremely valuable in my work going forward. It is inevitable that more and more AI/ML will become part of my research and this intro was exactly what I needed to get me started, which has seemed like a daunting task up until now. Thank you and have a great weekend!"
- "Thank you for what you do. It was obvious that you put a lot of love and effort into this topic. Nicely done!"
- "Thank you again for putting this course together. I don't have much feedback on the technical aspects or the course outline. However, I found it extremely valuable to learn/relearn aspects of Machine Learning. I found a new appreciation for how ML can be applied/can't be applied. It allows me to set realistic expectations for the military and be able to communicate it with both service members and researchers."
- "I'm taking some training on Machine Language from ARL. This guy is delightfully obsessed with Star Wars. The course opened with script rolling up the screen. It has theme music for opening and breaks. He is wearing a Jedi cloak and occasionally brandishes a light saber. Don't end your government career without experiencing something like this.

  P.S. Oh, and the course content and delivery is phenomenal. It's making me feel smarter."

4.3.1 NLP Methodology

The course feedback comments were processed using various language models to extract a more quantitative meaning. What started as an analysis of the sentiment of word choices evolved into using multiple different NLP models to evaluate sentiment, objectivity, and emotion; i.e., these models operate as a "panel of experts," each providing a unique perspective on the comments. Four models were chosen as agents to address different features within the comments. The subsequent information describes the notional questions that these models are answering, the models, their architecture and technique, the datasets that these models are trained on, the output used, the functional role of these agents, and the justification for their use.

Did this person use positive or negative words?

Model: TextBlob[11,12]

Technique: Word-Based Analysis

Model Architecture: Algorithmic (Not a neural network). It does not learn from data but applies a predefined dictionary of word scores.

Dataset: Predefined sentiment words, primarily from the Pattern library.[13,14]

Output: A single, continuous polarity score ranging from -1.0 (most negative) to +1.0 (most positive).

Role in this Analysis: Word Analyst.

Justification: To get a simple, reliable baseline of the raw positive or negative words used. Because of its simplicity, it is not misled by complex sentence structures, sarcasm, or context that can confuse more advanced models. It provides a reliable measure of raw word choice.

Does this read like a standard positive/negative review?

Model: distilbert-base-uncased-finetuned-sst-2-english[15]

Technique: Multiclass classification

Model Architecture: Transformer (DistilBERT). This is a distilled version of the BERT model, trained to be significantly smaller and faster than the original while retaining most of its contextual understanding capabilities.

Dataset: The Stanford Sentiment Treebank (SST-2) dataset,[16] which consists of approximately 11,855 sentences extracted from movie reviews, each labeled as either positive or negative.

Output: A binary classification (POSITIVE or NEGATIVE) along with a (softmax) confidence score.

Role in this Analysis: Review Analyst.

Justification: To see if the comment reads like a typical positive or negative review (like what would be seen for a movie). Trained on movie reviews, this model understands how a sentence builds towards an overall positive or negative conclusion, making it a good proxy for formal, well-constructed feedback.

Is this person expressing a strong, direct, or informal emotion?

Model: cardiffnlp/twitter-roberta-base-sentiment-latest[17]

Technique: Multiclass classification

Model Architecture: Transformer (RoBERTa). This is a robustly optimized version of the BERT architecture that was pretrained on a significantly larger dataset and with different training techniques, leading to better performance on downstream tasks.

Dataset: Fine-tuned on a massive dataset of over 124 million tweets, collected between January 2018 and December 2021.

Output: A three-way classification (POSITIVE, NEGATIVE, or NEUTRAL) along with a (softmax) confidence score.

Role in this Analysis: Social Media Expert.

Justification: To catch the sentiment in casual, informal language—the way people actually talk online. Because it was trained on tweets, this model is highly effective at identifying sentiment that might be missed by models trained on more formal text, such as sarcasm or feedback that uses casual phrasing. Its inclusion of a "Neutral" category is also crucial for filtering out purely descriptive or objective comments.

What specific emotions are being expressed in this comment?

Model: SamLowe/roberta-base-go_emotions[18]

Technique: Multilabel classification

Model Architecture: Transformer (RoBERTa). This model uses the same base architecture as the social media model but has been fine-tuned for a more specific, fine-grained classification task.

Dataset: The GoEmotions dataset, a human-annotated corpus of 58,000 Reddit comments, labeled for the presence of 27 distinct emotions plus a "neutral" category.

Output: A set of scores for each of the 28 emotion categories. A sigmoid function is applied to each score, resulting in a probability between 0 and 1 for the presence of each individual emotion. This allows a single comment to be strongly associated with multiple emotions.

Role in this Analysis: Psychologist.

Justification: To provide the "why" behind the sentiment. While other models determine if feedback is positive or negative, this model identifies the specific emotional drivers. This allows for a deeper understanding of student feedback, distinguishing between negative comments driven by "disappointment" versus those driven by "confusion," or positive comments driven by "gratitude" versus those driven by "amusement."

To make the emotion analysis more actionable for this report, the raw emotion labels were mapped to three high-level themes based on the emotions detected. The emotion label "neutral" was excluded as it does not provide a clear thematic signal. The highest rated emotion was always used. A threshold of 0.18 was used to identify prominent secondary/tertiary emotions. The three themes are included here:

- **Key Strength.** Indicates a positive experience. Mapped from admiration, amusement, approval, desire, excitement, gratitude, joy, love, optimism.
- **Area for Improvement.** Indicates a point of friction or negative feedback. Mapped from anger, annoyance, confusion, disappointment, disapproval, fear, remorse, sadness.
- **Insight/Learning.** Indicates a cognitive shift or "aha!" moment. Mapped from curiosity, realization, surprise.

Figure 23 illustrates the analysis process for a single comment. Each comment is processed by the panel of experts, consisting of four NLP models: TextBlob (Word Analyst), DistilBERT (Review Analyst), RoBERTa–Twitter (Social Media Expert), and RoBERTa–GoEmotions (Psychologist). The corresponding outputs are shown in the next layer (below): the first three models return either a sentiment polarity (TextBlob), positive/negative class (DistilBERT), or positive/negative/neutral class (RoBERTa–Twitter), while the last model returns a list of emotion labels (RoBERTa–GoEmotions).

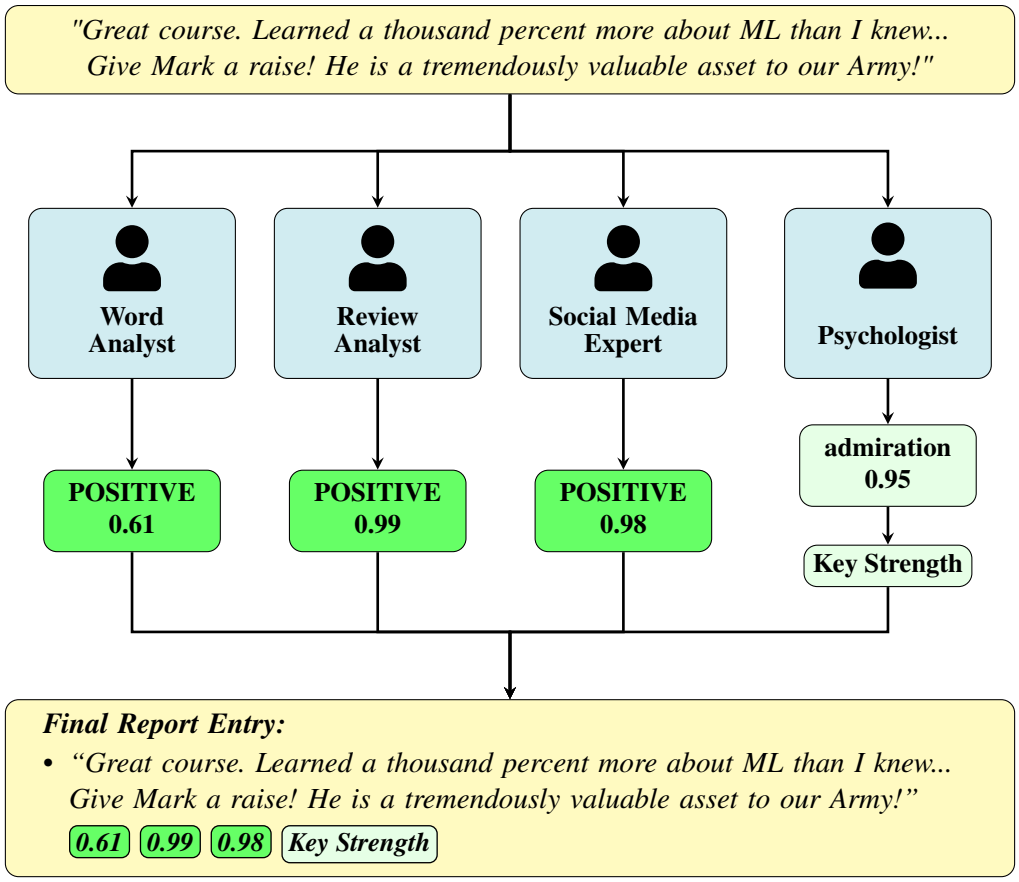


Figure 23. An example of the "panel of experts" analysis process for applying multiple sentiment analysis and emotion models to participant feedback.

The TextBlob sentiment polarity is mapped onto positive ($x > 0$), negative ($x < 0$), and neutral ($x = 0$) classes; the RoBERTa–GoEmotions emotion labels are then mapped into themes. All of these results are then aggregated into the final entry format. A few items of note about the tags after the quote. First, the positive, neutral, and negative classes are indicated by the color of the tags (green, gray, and red, respectively). Second, the light green and light red colors are also used for themes Key Strength/Insight/Learning and Area for Improvement, respectively. Comments are sorted by sentiment polarity and included in Appendix I.

4.3.2 Model Analysis and Behavior

In Figure 23, the comment is processed by the "panel of experts," and this demonstrates how to interpret the findings. First, TextBlob analyzes the words and tokens used to come up with a 0.61 prediction of sentiment polarity for the entire comment. However, when broken into parts, "great course" scores 0.80, "Learned a

thousand...” scores 0.50, “Give Mark a raise!” scores 0.00, and “He is a tremendously valuable asset...” scores 0.42.

Testing other variants reveals that “great” scores 0.80, “course” scores 0.00, and “great!” scores 1.00—demonstrating that the word analyst focuses on adjectives and their positive/negative sentiment. Interestingly, this example shows that tokens like “!” modify the polarity of adjectives but do not affect the “Give Mark a raise” sentence (0.00 with and without the “!”). If “thousand” percent were modified to “million” or “hundred” percent, the polarity for this sentence does not change, even though increasing one’s knowledge by a percent versus ONE MILLION PERCENT would represent an incredibly significant difference in meaning. Despite these shortcomings, the polarity scores often align well with human interpretation of comments (as evidenced by the comments and scores in Appendix I).

The transformer-based models provide a different perspective. Both assign positive classifications to this comment with high confidence scores (0.99 and 0.98), reflecting the output of the sigmoid function. These models excel at understanding context around each word and interpreting entire sentences based on their training data. However, they are not without limitations. The DistilBERT model assigned “positive” to every part of the comment except “Learned a thousand percent more about ML than I knew...” Regardless of the percentage used (even “hundred billion percent more”), this model consistently returns “negative” for such phrases. This suggests the model struggles with hyperbole, possibly due to spurious correlations learned during training—many negative movie reviews containing “... more than ...” constructions (e.g., “the movie was nothing more than a cheap imitation”) may have led the model into predicting that this pattern is always negative. Fortunately, context helps: adding “Great course” before the phrase converts the prediction to “positive” with a score of 0.98.

The RoBERTa–Twitter model demonstrates superior handling of informal language and hyperbole. This model assigns “positive” to every phrase within the comment, correctly interpreting “thousand percent” as positive hyperbole. Interestingly, all other values—hundred, million, hundred billion—were also classified as “positive,” except when “a percent” increase is used. The model has apparently learned to recognize both hyperbole (thousand or million percent as positive sentiment) and understatement/sarcasm (“a percent” as a way of saying “I learned nothing from

this course").

The RoBERTa–GoEmotions model focuses on emotion detection. Here, "admiration" received a score of 0.95 (very confident), while the next highest emotions of "approval" and "neutral" scored 0.08 and 0.02, respectively. Since these other emotions fell below the threshold, they would not contribute to a theme. Even if they did, "approval" also falls under the Key Strength theme, and "neutral" is discarded. In this manner, emotion labels serve as indicators of positive or negative sentiment. Common emotions for Area for Improvement included "confusion" (uncertainty about concept explanations) and "disapproval" (objections to mathematical content despite multiple warnings). In the end, using this "panel of experts" provided a much richer, more nuanced way to understand what people were really saying.

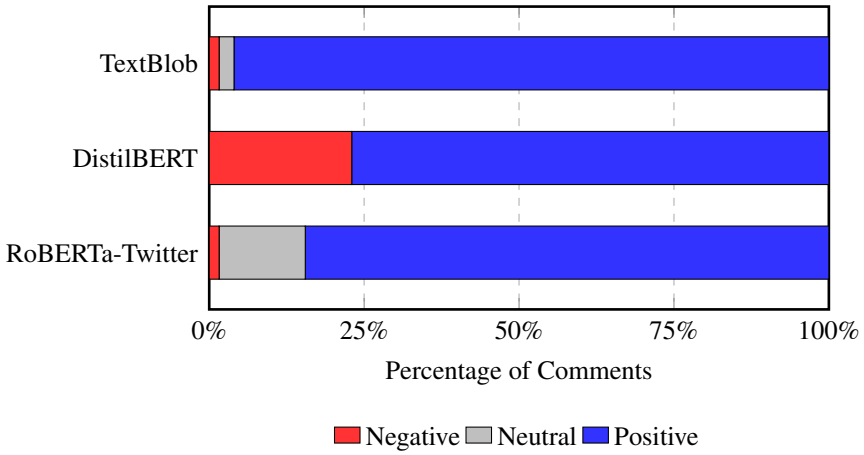


Figure 24. Percentage breakdown of (positive/neutral/negative) sentiment classifications for each model.

Figure 24 shows the breakdown of negative, neutral, and positive labels for each model. TextBlob produces the most positive labels (96%), while DistilBERT produces the least (77%). The RoBERTa–Twitter model generates the most neutral labels. DistilBERT shows the most disagreement with the other sentiment analysis tools—over 40 comments were labeled "negative" by DistilBERT but "positive" or "neutral" by the other models.

The following examples illustrate this disagreement. Notice that the second tag (red box) denotes "negative" for the DistilBERT model, often with high confidence, despite the comments appearing positive to human readers:

- "I thought it did a great job of explaining the math and implementation of ML. As a 101, I would not add anything else."
  0.80 **0.99** **0.92** **Key Strength**

- "Favorite Part: I have to pick a favorite session??? I was intrigued with the whole thing! Improvements: It worked via TEAMS but I truly feel that this training would serve everyone better as a face-to-face training. Mark was a great speaker and being through TEAMS did not serve him justice! Additional Comments: With the talk of AI and Machine Learning, the two day course would be beneficial. Thank you so much for the information you provided today, Mark!"
  0.50 **0.96** **0.97** **Key Strength**

- "This was an excellent and well-structured course. Having demonstrations in Excel made it more accessible. I wish there had been more time to work with some of the hands on demonstrations. Also, the information on the last day was quite dense – and I felt like I may have missed a connection somewhere, in order to truly understand it."
  0.47 **0.93** **0.94** **Key Strength**

- "Instructor made it fun, but there was still a lot of material over my head!"
  0.37 **0.98** **0.81** **Key Strength**

- "Wow! Course was fantastic. I was pretty intimidated by the whole idea of machine learning beforehand but this primer really helped take the edge off. I'm the kind of person who needs to be able to look under the hood of tools before I'm comfortable using them and the way Mark unpacked the equations and approaches used in the various methods was great! [...] Also, more Futurama please!"
  0.36 **0.87** **0.91** **Key Strength**

- "I understand you are trying to reach a broad audience, but I would have preferred a course with more math included."
  0.28 **0.99** **0.73** **Key Strength**

4.3.3 Feedback Highlights

Instead of focusing on where the models disagreed, it's more interesting to look at where they all agreed. **266** comments were classified as positive by all three

sentiment analysis models. Here is some of the most enthusiastic feedback where all three sentiment models agreed the comment was positive:

1. "I absolutely love this course! Content is spot on for those of us in the audience unfamiliar with AI/ML. I went from having zero sum knowledge to working knowledge of AI/ML applications and parallels between coding languages used and usage of Excel spreadsheet. It is more than plentiful to pique interest from the layperson, but more so to continue to expand on learned knowledge in a formal certification program or degree program. Hats off to Mark! Intent met!!"
   0.70 **0.99** **0.97** **Key Strength**

2. "Amazing course. I program in Python, but did appreciate showing steps in Excel to eliminate the focusing on code. Mark is super motivated, and a great speaker, instructor who has a true passion for this material."
   0.52 **0.99** **0.96** **Key Strength**

3. "I thought it was really terrific! An excellent introduction to the entire field of Machine Learning. Probably the best government training that I have ever taken."
   0.50 **0.99** **0.98** **Key Strength**

4. "Absolutely awesome. The instructor is a "natural teacher," someone who is just born to teach. I would recommend that he find a regular venue to practice and develop his teaching abilities. [...] Truly awesome talent, presentation, pedagogy, everything."
   0.44 **0.99** **0.97** **Key Strength**

5. "The course was great! The use of Excel is far superior to high level programming languages like Python. This method really shows what's going on under the hood. A+"
   0.43 **0.99** **0.98** **Key Strength**

6. "The content was intriguing and very eye-catchy. The instructor was excellent teacher. The concept was well-presented, very easy to understand at the surface level. Started with literally no background or training in ML, I have learned a lot more than I would ever had thought I can be. Thanks again for the great content and thanks for making me (generalized as someone who

doesn't know anything about ML) understand and stay focused throughout the whole course. Thanks!"
0.42 **0.99** **0.98** **Key Strength**

7. "Honestly, this was one of the best courses I've taken in my professional career! It was a really good overview, but I felt like it still had enough depth to be very useful. I've recommended that all my coworkers take future versions of this class."
0.40 **0.99** **0.98** **Key Strength**

8. "From the perspective of someone who is just starting to dive into the world of machine learning, I thought this course was great! Mark was knowledgeable, well-organized, and clearly enthusiastic about the material. I appreciate the use of Star Wars to help keep things fun and engaging! I also liked that Mark chose to demonstrate neural network building in Excel rather than Python or MATLAB. It was an intuitive way to visualize the process without getting bogged down by syntax and esoteric functions, even if Excel would not be the most practical way to develop neural networks for a real application. [...] Overall though, this was a great experience, and I would definitely recommend this course to others!"
0.36 **0.99** **0.96** **Key Strength**

9. "This was so great! If I had to give it a score, I would give it a 10 out of 9. Thank you for putting this material out there and making it approachable for people who don't have backgrounds in linear algebra or other advanced maths. The pacing of the material was great and sending out the Excel spreadsheets in advance was highly conducive to helping me follow along during the lesson. Also very grateful for all the additional resources you pointed out. [...] Thanks for making something I once thought was unattainable actually seem much more accessible!"
0.34 **0.99** **0.96** **Key Strength**

10. "I have organized a few all day workshops—Mark maintained energy and engagement with a virtual audience all day long. Doing that without being able to read the audience is a challenge. Mark's energy and ability to communicate the concepts was impressive, ... most impressive. [...] Mark used Excel in a way that made the linear algebra tangible. "Data" is a matrix, coefficients are values in a table—which is very different than a matrix variable in RAM. I

think your approach of using Excel made me see the process far better than any linear algebra scripts implemented in MATLAB or Python. Outstanding teaching style. [...] I learned a lot and am inspired to try more. Too bad more DoD training isn't like this workshop."
0.29 0.95 0.91 Area for Improvement Key Strength Insight/Learning

11. "The Star Wars theme and preludes into our training each morning.... so good..... I felt my mind was loose and limber after watching all the videos and memes and ready to go when you started the training. I enjoyed the course and yes, there were times when the math was deeepppp, too deeeeep for my gray matter even so I tended to zone out during those times.... but overall I did learn more about how the algorithm's work in AI. I also appreciate the brevity of the course allowing my mind room to breath [...]."
0.27 0.99 0.95 Key Strength

5. Conclusion

Over 5 years, the "Machine Learning for Everyone" course grew from a simple idea to teach a few ML concepts into a transformative initiative for change, reaching over 2,000 Soldiers and civilians across 173 Army organizations. It proved that accessible, engaging education can have an outsized impact, turning that idea into real skills for the Army. The results speak for themselves:

- **Unprecedented Scale:** Engaged 3,025 participants from 327 unique organizations, with 78% from DoD entities.
- **Measurable Learning Impact:** Achieved a 138% improvement in participant understanding above random guessing on fundamental ML concepts.
- **Exceptional Satisfaction:** Maintained consistently high ratings (4.3–4.8 out of 5.0) across all evaluation metrics, like excellent instructor (4.78) and highly recommend the course (4.63).
- **Transition to AI for Soldiers Course:** Expanded the seminal ML course into the "AI for Soldiers" strategic broadening seminar, which achieved 100% "Excellent" participant ratings for the course in its most recent iteration.
- **Broad Organizational Reach:** Successfully engaged 17 Army commands and 173 suborganizations, from senior leaders to early-career professionals.

The course succeeded because it was different by design. It turned the AI "black

box" into a "glass box" using everyday tools like Excel and engaging themes, proving that complex topics can be taught clearly without sacrificing technical depth. Participants did not just learn about what ML does; they learned how it works. This new understanding gave them the confidence to talk with technical experts, judge AI tools for themselves, and apply what they learned to their own jobs.

This was not just a training course; it was a lesson in how the Army can develop its people. The course grew organically, driven by word-of-mouth from participants, proving that if you offer high-quality, relevant training, people will come. It showed that a bottom-up approach—empowering individuals at all levels—is a powerful way to connect leadership's vision with the people doing the daily work.

The end of the "Machine Learning for Everyone" course on May 5, 2026, is not a conclusion but a transition. Its success has created a legacy, serving as a blueprint that continues to evolve. The spirit of this initiative lives on through the ongoing "AI for Soldiers" strategic broadening seminar for Army leaders and is inspiring new, in-depth courses, including a technical deep dive into transformer models.

Ultimately, the story of this course is a testament to a simple but powerful idea: a single person with a passion to solve a real problem can spark meaningful change across an entire organization. This initiative is not an isolated case; it is one of many examples of grassroots innovators across the Army picking up the torch to solve critical challenges from the ground up. It is also a credit to the leaders who foster an environment where such innovation can thrive—leaders who understand that taking care of their people is the most effective way to take care of the mission. It shows that the most effective way to prepare for the future is to invest in our people, empowering them with the knowledge and the confidence to build it themselves.

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Appendix A. Course Venues

While the "Machine Learning for Everyone" series and "AI for Soldiers" courses are now delivered annually, the timeline and summary in the preceding main body of the report show numerous additional venues and variants. This appendix documents the specialized courses and collaborations that emerged from the success of the core initiative.

Surprisingly, even before the popular "Machine Learning for Everyone" course, there were a few opportunities to give the course to different audiences. For instance, U.S. Army Combat Capabilities Development Command (DEVCOM) Army Research Laboratory (ARL) researchers working with Spelman College faculty on several ML and AI projects asked for me to give a "Machine Learning 101" course to faculty at Spelman College as part of an Educational Partnership Agreement.

There was also an opportunity to give a two-day virtual "Machine Learning 101 and Additive Manufacturing" course in March 2021 with a University of Memphis faculty collaborator with expertise in additive manufacturing. The positive impact of these specialized courses is exemplified in the kudos letter shown in Figure A-1, which highlights the exceptional feedback received from the University of Memphis collaboration. The course had 98 registered attendees from University of Mississippi, Mississippi State University, University of Memphis, and many regional industrial partners such as Smith and Nephew, St. Jude's, West Cancer Center, and the FedEx Institute of Technology.

The additive manufacturing example data came from a recently published paper on modeling the laser bed fusion process for Ti-6Al-4V. Figure A-2 shows the Excel spreadsheet layout from the tutorial, where attendees' neural network models performed just as well as the original artificial neural network from the paper. The feedback was all extremely positive, much along the lines of feedback from one faculty member: "It is an excellent course. AI/ML are great tools to add. Breaking complex forms into simple Excel documents is brilliant. One can visualize and understand what is going on."

After the success of the ML course, other Army organizations were interested in educating their workforce. One impactful spin-off from the course was a three-day "Machine Learning 101 and Cybersecurity" course for DEVCOM C5ISR, a collaboration with ARL's Dr. Michael De Lucia in August 2021. This in-person course integrated much of the content from the ML course but expanded the con-

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April 1, 2021

Dear Dr. Mark Tschopp,

I want to personally thank you for offering the Machine Learning (ML) for Everybody Workshop at University of Memphis (UM) on March 13—14, 2021. The workshop was one of the more highly attended activities that we have held at UM, which included 98 registered attendees! The number of attendees from UM's faculty, staff, undergraduate students, and graduate students was extraordinary, which spanned across multiple disciplines from engineering to biology and chemistry to human resources. The workshop also attracted nearly an equal amount of attendees from nearby universities such as University of Mississippi and Mississippi State University as well as from local and regional industries such as Smith & Nephew, St Jude's Children Research Hospital, West Cancer Center, and the FedEx Institute of Technology.

The feedback that I have personally received from my colleagues and students at UM as well as other attendees have been all positive about the scientific value of the workshop and the delivery methods. Moreover, an anonymous survey from the workshop attendees where we collected their feedback for the 2-day workshop has been very inspiring and positive. For example, much of the feedback is along the lines of what one faculty member captured: "It is an excellent course. AI/ML are great tools to add. Breaking complex forms into simple excel documents is brilliant. One can [actually] visualize and understand what is going on."

Once again, thank you for reaching out with this excellent educational workshop. It was really great to work with you to bring this to fruition. I look forward for future collaborations between our institutions.

Sincerely,

Ebrahim Asadi

Assistant Professor of Mechanical Engineering

Director of Metal Additive Manufacturing Labratory (MAML) at Herff College of Engineering

Co-Leader of Additive Manufacturing Research Cluster at FedEx Institute of Technology

Figure A-1. Kudos letter from the "Machine Learning 101 and Additive Manufacturing course" in 2021.

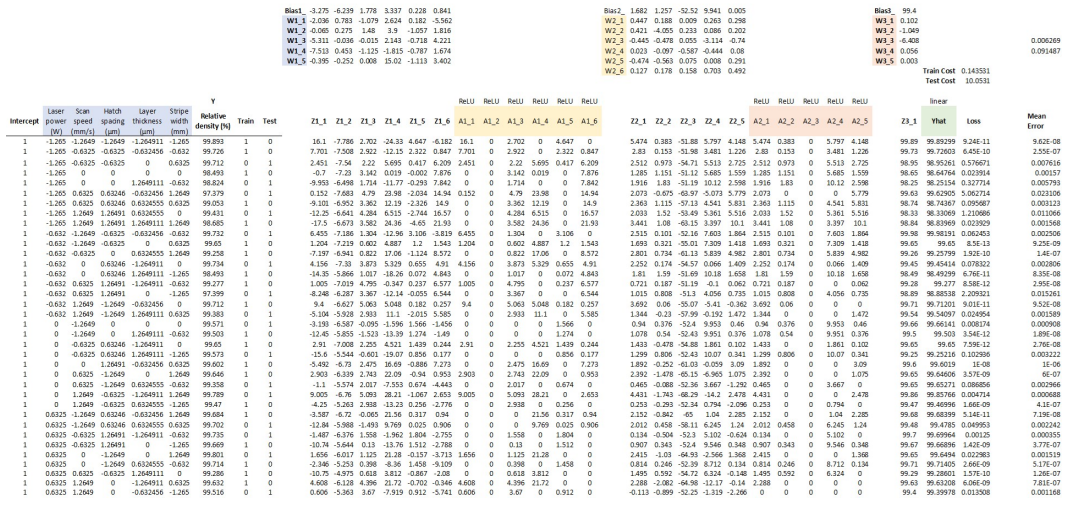


Figure A-2. Example of the Excel 6-5-1 neural network (six nodes in first layer, five nodes in second layer, one output node) using data from a designed experiment of additive manufacturing parameters in the open literature.

tent to include cybersecurity examples and various other ML algorithms, including gradient-boosted decision trees.

After taking a number of Continuing Education for Senior Leaders (CESL) courses on leadership, future warfare, management development, etc., I had the opportunity to give a two-day "Machine Learning 101" course to the faculty of the Army Management Staff College (AMSC) at Fort Leavenworth. The benefit to the Army is that teaching ML to AMSC faculty has the potential to reach a broad cross-section of the Army as AMSC continues its mission to educate and develop the Army Civilian Corps for leadership and management responsibilities throughout the Army (see Figure A-3).

As a direct result of these discussions, several outcomes emerged: 1) faculty shared their feedback on how to improve the effectiveness of the course, 2) the AMSC instructors invited me back as an invited lecturer for "Artificial Intelligence 101" in their CESL course "Information Advantage,"* 3) I was invited to give multiple kickoff "DATA is the new bacon: Why Data is Sizzlin' Right Now" talks for their Data Foundations courses, and 4) Dr. Robert Arp served as a guest speaker for the

*Feedback from AMSC faculty include "And on behalf of the remaining MDO faculty here at AMSC, I would like to say thank you, thank you, thank you. I had mentioned your name when asked about who might be able to step in, and I can't tell you how relieved I was that you were doing it." and "Thank you very much Dr. Tschopp! You have always been quick and generous to help MDO team out here in AMSC! We are very much grateful to you!"

second “Machine Learning for Everyone” in 2022.

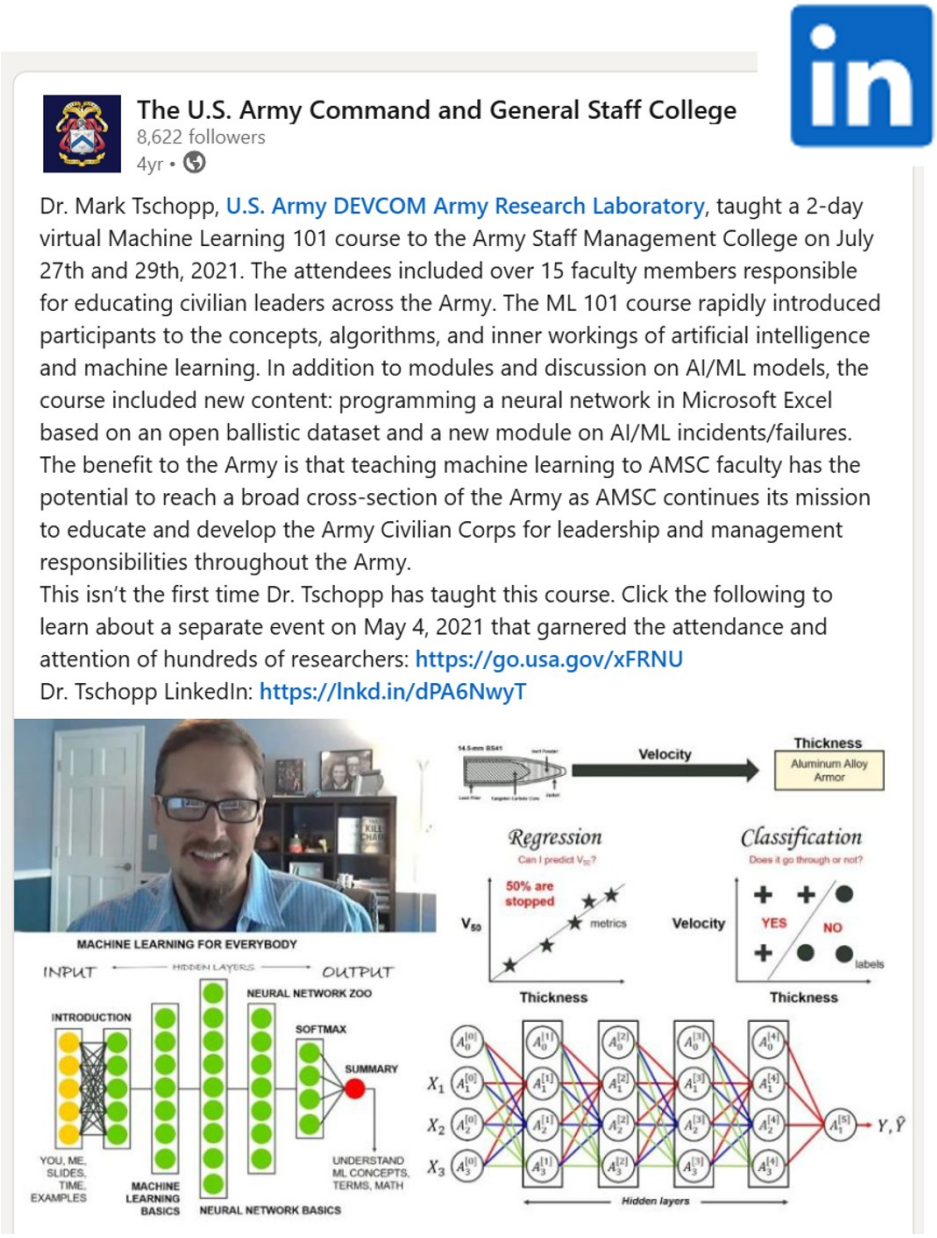


Figure A-3. LinkedIn post from the U.S. Army Command and General Staff College about teaching ML 101 to faculty responsible for educating civilian leaders within the Army.

The short course on AI conducted for AMSC in 2022 expanded into a full-day “Artificial Intelligence 101: A Gentle Introduction to Artificial Intelligence” course in 2023 and was delivered to approximately 100 participants at the Army Materiel Command’s (AMC) Joint Munitions Command (JMC) headquarters (HQ) at Rock Island Arsenal (RIA). Given the interest in this course, JMC HQ asked me to teach

a three-day "Machine Learning 101" course as the final culminating training for their "Data Analytics Booster Month" (e.g., see press[1]). BG Ronnie Anderson Jr., JMC's commander, recognized Dr. Tschopp with the Commander's Challenge Coin for sharing his AI and ML knowledge to the RIA and JMC workforce. Stemming from these courses, the AMC Army Sustainment Command (ASC) HQ at RIA also asked me to teach a two-day "Artificial Intelligence 101: A Gentle Introduction to Artificial Intelligence" course.

As an example of the change in content, Figure A-4 presents the outline slide for the AI 101 course, organized into three primary sections: AI Foundations, AI and ML, and AI in Application. The AI Foundations section covered broad topics such as defining AI and distinguishing what AI is not, delving into the history of AI from the 1940s and 1950s, and exploring the reasons behind the emergence of AI at this particular juncture. The AI and ML section delved into various ML algorithms, including unsupervised and supervised algorithms. It provided insights into how neural networks are trained, the concepts of deep learning, the functioning of convolutional neural networks, the mechanics of sequence models and large language models, and an introduction to reinforcement learning. The final section explored AI applications, addressing successes and failures, discussing the risks and ethics associated with AI, analyzing the global landscape of AI with a focus on China, and examining the future trajectory of AI.

Given the number of different ML and AI courses and the positive feedback, ARL was asked to deliver a two-week "AI for Soldiers" course as part of the Strategic Broadening Seminar (SBS) series in 2024.[2] The SBS training series brings Army personnel together to learn from top-tier academic institutions, senior military leaders, business executives, and international experts; at the time, the AI for Soldiers course was the only SBS led and taught by a government entity. I was asked to lead the effort to pull together (with coleads Dr. Reggie Hobbs and MAJ Matt Work, Futures and Concepts Center) a cohesive inaugural course—involving over 100 people at ARL—that exposed Soldiers to the foundations and concepts of AI/ML as well as the applied AI research happening within this research space. This course has

[1] Operationalizing science at JMC with artificial intelligence and machine learning. McFate L, Joint Munitions Command, Public and Congressional Affairs; 2024 Oct 29.

[2] Tschopp MA, Hobbs RL. Artificial Intelligence for Soldiers 2024: experiences and lessons learned from the inaugural course. DEVCOM Army Research Laboratory (US); 2024 July. Report No.: ARL-SR-0497.

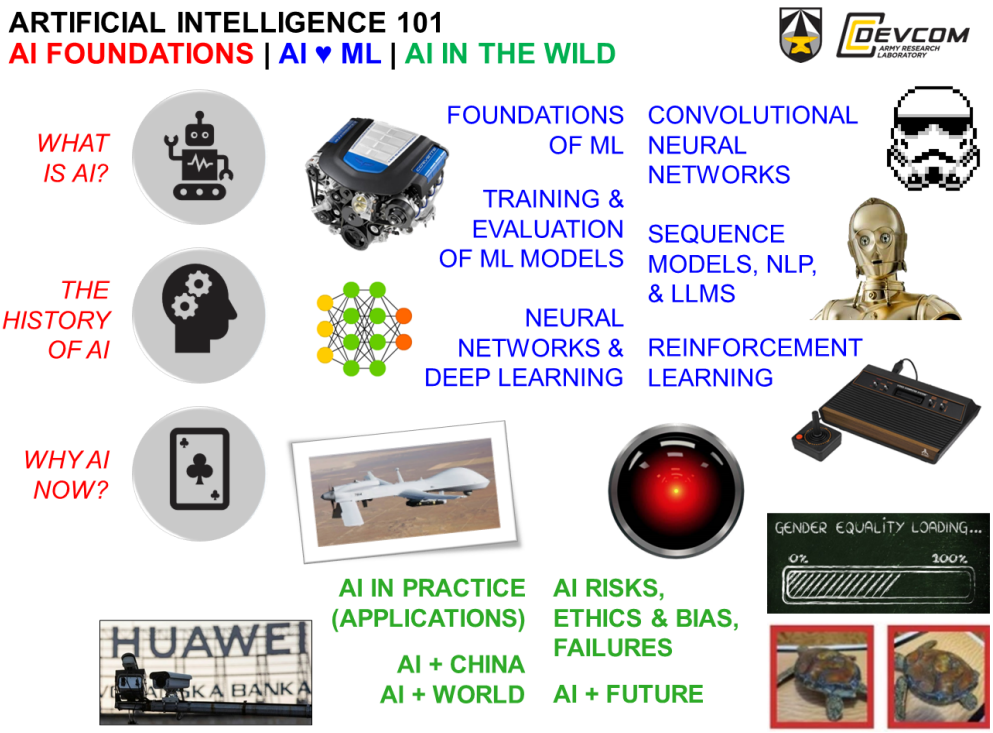


Figure A-4. Outline slide for AI 101 one-day short course.

since been expanded to two sessions in FY26. The full details of the AI for Soldiers course are detailed in two reports (2024[2] and 2025[3]).

[3]Tschopp MA, Hobbs RL, Work, M. Artificial Intelligence for Soldiers 2025: enhancing AI readiness for the U.S. Army. DEVCOM Army Research Laboratory (US); 2025 June. Report No.: ARL-SR-0506.

Appendix B. Course Marketing Package

This appendix appears in its original form, without editorial change.

Machine Learning for Everyone:

May The First Be with You?!

(A Star Wars Journey)

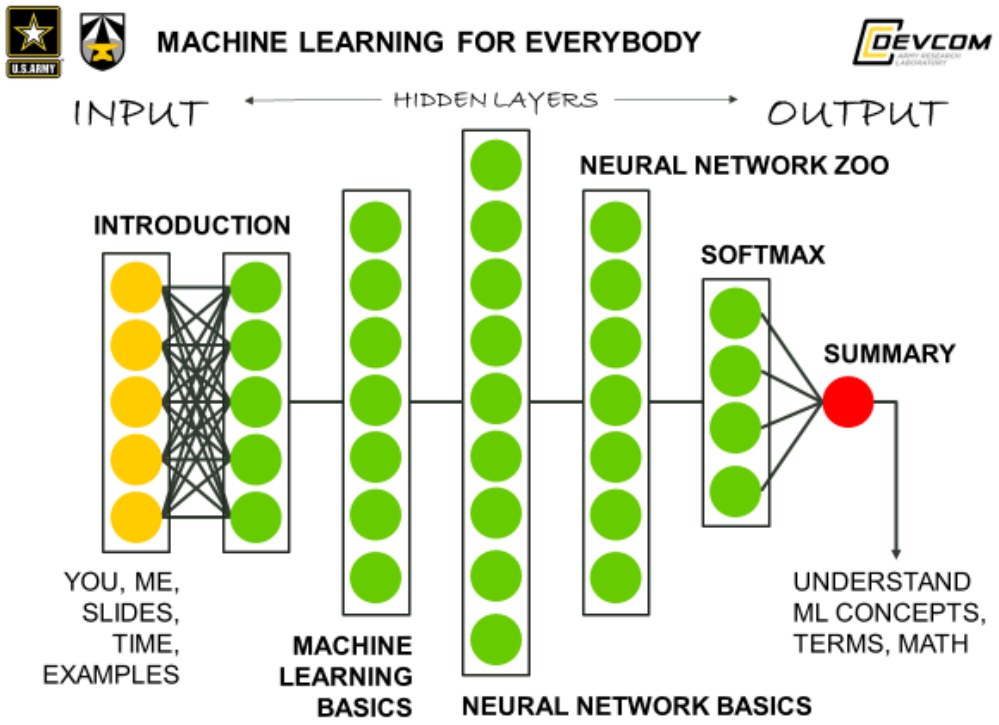
Machine Learning for Everyone!

Bullets, armor, a little math, STAR WARS, and minimal cat examples

Mark Tschopp, US Army Research Laboratory

So, why should I spend time learning ML from someone who just learned about it?

GREAT QUESTION. Thank you for asking! Why learn this from me and not some world-renowned expert? Well, first off, maybe because I was like you a few months back. Some people do not actually remember how they learned machine learning, i.e., the intuition, the concepts, the math just sort of gradually seeped in over the course of their undergraduate or graduate degree. For me, I just learned this, so it is fresh in my mind – what concepts I grasped, which ones were harder to grasp, what are the key concepts that I would tell someone "If you know anything in machine learning, you got to know this." I sat down, I listed what I felt were key concepts: regression, classification, linear regression, logistic regression, regularization, variance-bias tradeoff, loss/cost functions, activation functions, neural networks, dropout, convolutional neural networks, LSTMs, etc. Then, I built a slide deck around them. I was hoping for one slide per concept—I miserably failed. But it is a comprehensive entry point into machine learning. And guess what? Since I am an Army scientist, I chose an Army-related dataset—ballistic penetration of armor. No cat classification datasets or Boston housing price datasets here; just straight up bullets being stopped by armor. (1st spoiler alert – the houses are too expensive in Boston; 2nd spoiler – ok, I did use a few cats… or are they Ewoks? It's hard to tell). I have condensed 7 months of online ML courses into a few sessions (yes, I threw some of it out), with a few Excel-programmed neural networks to boot (you are crazy Mark! ML experts everywhere will unite to overthrow you! …or give you a sad face emoji, at least – because who are we to argue with our AI emoji software). I separated it into 3 modules: machine learning basics, neural network basics, and neural network zoo—then I went back and added a few more. Not everything, but a good start. At least I hope so. Speaking of hope, wasn't that the name of the original Star Wars? Hmm, that gives me an idea. (Cue music: Da-da-da duh... duh... da-da-da duh-duh, da-da-da duh-duh, da-da-da-daaa…)



Machine Learning for Everyone!

"May the […] Be With You" Series

The "Infomercial" pitch version

In world where everyone is harnessing the immense impact of AI and machine learning, you need to understand how it works to know its capabilities. If you don't, technology and opportunities are going to pass you by.

Well, I've got a solution for you.

It's not a do-it-yourself complicated website. It's not a 1000-page book for you to read. It's not a 14 week in-person or online course. It's not even one of these introductory machine learning courses with no details of how the algorithms work.

That's right. I've got a course for you!

It has a proven track record. Hundreds of satisfied customers that gave this course version a ***4.7/5.0*** rating and the instructor a ***4.9/5.0*** rating!

Yippee Ki-yay! *Wow!*

Testimonials are pouring in!

"This course was the best ML/AI I have ever taken."

"If I had to give it a score, I would give it a ***10 out of 9***."

So, how much would you pay for such a course?

$199? $99.99? $49.99? 2 payments of $9.99?

What if I told you that it's *FREE* if you act now.

"Did you just say FREE? I like FREE stuff."

"Yes, I did. FREE, FREE, FREE, FREE, FREE!"

You better act now on this incredible opportunity to lock in your attendance and ward off the dark side of the calendar (meetings!).

So, what are you waiting for? Register now by clicking on the rocket ship to sign up via Microsoft Form. Any questions or problems, email ml101@army.mil

MACHINE LEARNING FOR EVERYONE: STAR WARS EDITION

Agenda (draft) **Machine Learning for Everyone: "May The Fourth" Star Wars Edition**

Time	WED	THU, May 1st	FRI, May 2nd
8-9 CST		ML 101 Introduction & ML Primer	ML 201 AI/ML Successes/Failures
9-10 CST		ML 102 Machine Learning Basics	ML 202 Feature Engineering
10-11 CST			ML 301 – Neural Network Zoo Autoencoders & GANs Multimodal Models
11-12 CST		ML 103 Neural Network Basics	ML 302 – Neural Network Zoo Convolutional Neural Networks
12-1 CST			ML 303 – Neural Network Zoo Sequence Neural Networks Natural Language Processing Transformers
1-2 CST			
2-3 CST	Testing, Testing, 1…2…3… Red is Optional!	Machine Learning in XLS: The Tutorial	
3-4 CST	XLS Essentials for ML Understanding the Functions!		
4-5 CST			

RED ARE OPTIONAL: WEDNESDAY IS JUST FOR TESTING, THU/FRI IS THE COURSE

MACHINE LEARNING FOR EVERYONE: STAR WARS EDITION

- ML101, ML Primer
- ML102, Machine Learning Basics
- ML103, Neural Network Basics
- ML201, AI/ML Failures
- ML202, Encoding Features (may be displaced by new content)
- ML301, Autoencoders & GANs & Multimodal Models
- ML302, Convolutional Neural Networks
- ML303, Sequence Models (RNN, GRU, LSTM) & NLP & Transformers
- Excel examples throughout… including DIY Tutorial sessions
- Breaks when it makes sense!
- Star Wars, other references throughout! Marvel? We'll see…

Star Wars + ***Machine Learning*** =

L1/L2 REGULARIZATION

DEVCOM

So, what is regularization?

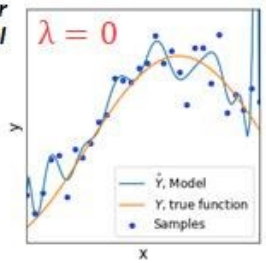
20th Degree Polynomial Linear Regression Model

L2, Ridge Regression

regularizing term

$$J(\theta) = \sum_{i=1}^{n} \left(\hat{Y}_i - Y_i\right)^2 + \lambda \sum_{i=1}^{P} \theta_i^2$$

"Must… regularize… the… parameters…"



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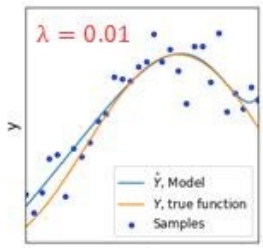
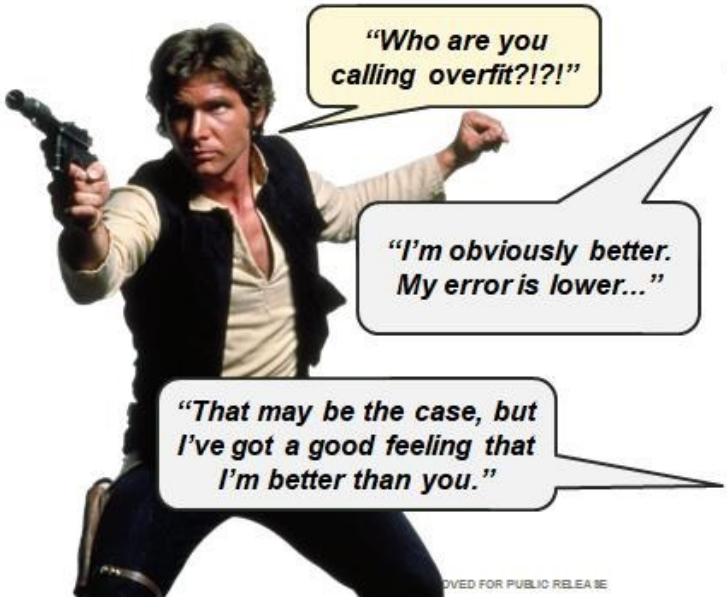


TRAINING, DEV-SET, TEST SET, HUH?

DEVCOM

Assume you don't know what the true function Y looks like…

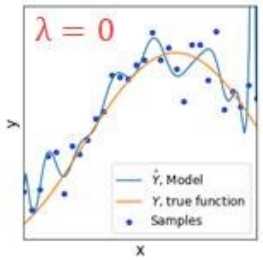
How do you know what model is the best?



"Who are you calling overfit?!?!"

"I'm obviously better. My error is lower…"

"That may be the case, but I've got a good feeling that I'm better than you."



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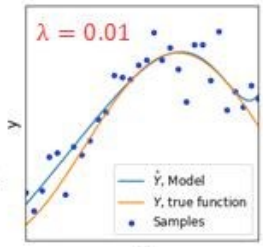
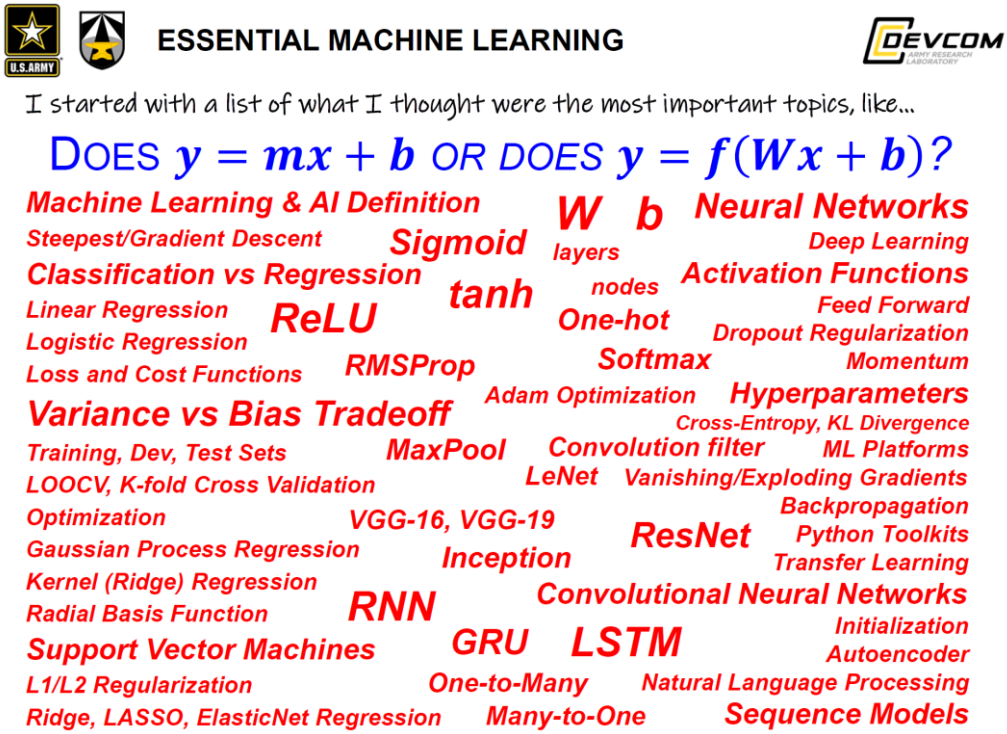


Machine Learning for Everyone: *The Syllabus*

So, here is a rough synopsis of the different algorithms and concepts that I started with for the course.



Machine learning or **ML** allows computers to learn directly from examples, data, and experience via mathematical models that map inputs to outputs, X's to Y's, factors to responses, etc. – a functional approximation of this relationship. **Artificial intelligence** or **AI** can come in a lot of different sizes, but generally it allows machines to perform functions/tasks that normally require human intelligence, like learning and reasoning. Hence, machine learning AI is popular topic where the learning and reasoning for tasks within the AI algorithm uses ML models to accomplish this.

There are generally two classes of supervised machine learning algorithms. **Classification** is a form of ML where the outputs are labels, i.e., in this course "does the bullet go through or not?" (0 or 1 response). **Regression** is a form of ML where the outputs are continuous variables or metrics, i.e., what is the bullet velocity where 50% of the bullets are stopped by the armor.

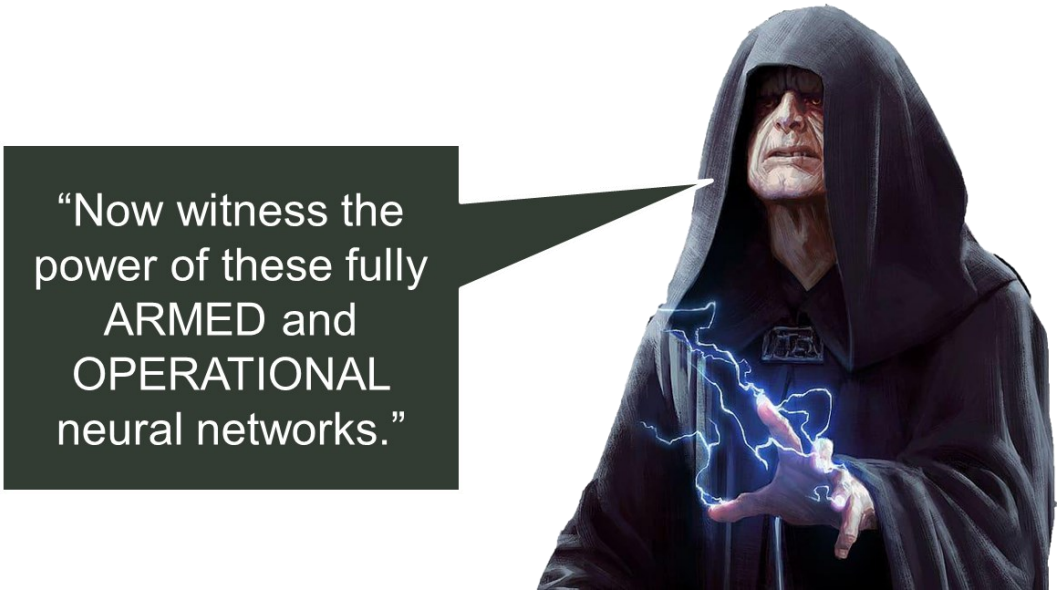
Linear regression is an ML model where the X's are connected to the Y through an equation of the form y=mx+b, i.e., good for regression tasks. **Logistic regression** is an ML model where the X's are connected to the Y through an equation of the form y=1/(1+exp(mx+b)), i.e., good for classification tasks. This equation form is also called the **sigmoid** function, a function that maps the inputs onto a range between 0 and 1, which is why it is good for classification.

Loss and **cost** functions are necessary components for training any supervised ML model. The loss function is a metric that describes how effective the ML model is for predicting one run/experiment, one response. The cost function takes all loss functions and converts them to one metric—a necessary requirement for optimization algorithms that help train the model parameters.

Optimization algorithms modify ML model parameters to minimize (or maximize) an objective, i.e., the cost function. One standard algorithm is **gradient descent**, where each model parameter is iteratively modified proportion to the change in the cost function with respect to the change in that model parameter. The rate at which they are modified is controlled by an additional factor, alpha, which is an example of a **hyperparameter**. Hyperparameters can affect the ML model and how it is trained, but do not affect the ML model's predictions once it is trained.

Variance vs Bias tradeoff is the concept of overfitting (variance) versus underfitting (bias). It is necessary to understand these concepts as it comes to ML models so that they are trained in such a way that they are optimal with respect to over/underfitting. This is often coupled with splitting the available data into **training sets** (as well as **dev/validation/test sets**) to combat overfitting and allow the ML models to generalize well to new data. For simple ML models, using techniques like **Leave-One-Out-Cross-Validation (LOOCV)** and **k-fold Cross Validation** are used to assess the prediction of a trained ML model on new data that was not used in training.

Regularization is a technique used to modify ML model parameters in a way such that they do not overfit the training data. Common metrics applied to model parameters are the **mean squared error (L2)** or **mean absolute error (L1)**, which is added as an additional penalty/constraint within the cost function. A linear regression ML model that uses L1, L2, or L1 & L2 regularization is termed **LASSO Regression**, **Ridge Regression**, and **ElasticNet Regression**.



The **neural network** part is the one that most people identify with machine learning algorithms. Neural networks are built upon the foundation that was just discussed. At its simplest, a one-node neural network is a logistic regression function. For this, **weights W** and **biases B** are used to transform inputs X into an intermediate variable Z, which is inserted into an **activation function** (the sigmoid function is used for logistic regression) to give an output Y. If there are multiple hidden **layers**, this is often termed **deep learning**, but the math does not necessarily change. The activation functions can take on many different forms: **ReLU** or rectified linear unit, **tanh**, sigmoid function, etc. The iterative linear algebra with activation functions are what allow neural networks to take on a variety of nonlinear function approximations.

Now, if only it was not so hard to train the thousands-to-millions of different neural network parameters. The **feed forward model** is relatively easy but optimizing the model parameters in deep neural networks

required **backpropagation**—a scheme for propagating derivatives back through the model so that gradient descent can be used to iteratively update parameters. Gradient descent is not the only optimization method; there is **Momentum** or **RMSProp** or **Adam** optimization or many others. The initialization of the model parameters for a neural network is also important for training. Prior to backpropagation, neural networks suffered from **exploding/vanishing gradients** (and still do, to some extent)—multiple layers would often cause model parameters to go to zero or to infinity (both bad).

When using neural networks to classify, there are a few terms that are common: **one-hot vector** and **softmax**. The one-hot vector is an output label vector that returns 1 for every time it matches the class and a 0 every time it does not. If there are multiple classes, then the softmax function is used. The softmax distributes the outputs between multiple output nodes in such a way that the total for all classes is equal to 1 for each run. In classification, the loss functions used are often **cross-entropy** functions or **KL-Divergence** rather than an L2 (mean squared error).

I usually like to take a break at this point to talk about **AI/ML Successes and Failures**. Aah, who am I kidding? The failures are the far more entertaining topics. Besides, you don't learn much with successes, so failures can be really enlightening!

Also, there sure are a bunch of qualitative features, huh? Different classes, categories, levels… So, how do we transform (or **encode**) them so we can use them in our ML models? **Ordinal encoding**, **target mean encoding**, etc. And, to make it interesting, I'll reach out to Marvel superheroes for some help, and maybe include a Shakespeare-inspired quote to boot.

There are also several different neural network architectures, of which a few are covered. First, **autoencoders** are neural networks where there is an encoder part, a reduced representation, and a decoder part—often used for denoising, compression, or the like. There are **convolutional neural networks**. These are neural networks that make use of **convolution filters** because the spatial relationship between different inputs means something—think pixels in an image and a filter is a grouping of pixels within a neighborhood. Not just filters, there are also activation functions and **MaxPool** operations. All of these are iteratively applied to train model parameters faster and reduce the dimensionality of the input data to something that can be fed into a standard (fully connected) neural network. The convolutional neural network models usually have catchy names like **LeNet** or **ResNet** or **VGG-16** or **VGG-19** or **Inception** ("we must go deeper!") because they use the 80M or so images on Image Net to train the million or more parameters in the model. So, it is often good to just use them, rather than retrain them. But, if there is a new output, it may make sense to lock the parameters in these models and just use them to reduce the input into a feature vector AND THEN insert a fully connected neural network to connect that feature vector to the new inputs. This is called **transfer learning**.

If you aren't confused yet, there is another subset of neural network models called "**sequence models**", meant to operate on sequences of data. One popular use is **natural language processing**, where context (and sequence) matters. For instance, to translate a sentence from one language to another, the entire sentence is necessary; each word is potentially important for comprehending the meaning behind the entire sentence. Some words may impact the word(s) next to it, some words—that occur earlier in a sentence, but the author decides to put an aside statement in between that word and when it is needed—impact the words much further along in the sentence. There are different types: **recurrent neural networks**, **gated recurrent neural networks**, **long/short-term memory neural networks**. These models can take in a lot of inputs to produce one output (**many-to-one**), or one input to produce many outputs (**one-to-many**), or even have different numbers of inputs and outputs. The sequence can be a sentence structure, but could also be a time sequence, or a sequence of letters or notes.

Sprinkled throughout the course are the different types of **ML platforms**. For example, why are so many people interested in **MATLAB** or **Python**? Can you do this in **Excel**? What?!?! Excel? OK, well, the answer to the last one is YES! ***But***… oh well, you will see. Excel does help with the intuitive feel of what the ML algorithms are doing and how they are constructed, because that is what most people are really interested in—can I use this? and can I understand more than just "it's a black box"? A few lines of code in python? There is something unappealing to many when asked to just trust the ML algorithm without knowing how it works. Hence, this course! (Side note: my 8th grader was programming ML facial recognition a few years ago into software platform "scratch" without knowing anything about machine learning! i.e., see definition of "black box"… who am I kidding?! I haven't updated this text in years. He's actually a sophomore in high school now!)

So, if you are "**I know very little about ML**" or if you are "**I am somewhat familiar with ML**", this course was made with you in mind… a rapid introduction to ML starting from the basics, without taking months of online courses, wading through 100s or 1000s of pages in textbooks, or performing your own 'random walk' through online ML content—wading through some good and some not-so-good content. If you are "**I know a lot about ML**" person, you may not be the audience I envisioned but you are welcome to join… it starts with very basic concepts but ramps up in complexity as the course unfolds. You may be surprised at what Excel can do (without accessing the VBA background) … LSTMs and more!

[me] "Thank you, Watcher (from Marvel's 'What If' series). I think I've got this, though. I'll let you know if I need your help."

[Watcher] "OK, but I'll be watching. Don't mess up."

Feedback from "May The […]" ML 101 Course

OK. Now that I have **100+** hours of instruction from **12+** ML short courses, over **3000** people attending the course from organizations around the world, and over **1,000** comments (before and after course), I might be onto something… or something like that.

SURVEY: How familiar were you with the concepts coming into the course? (2.5/5–somewhat familiar)

SURVEY: My overall evaluation of the instructor is excellent. My overall evaluation of the course is excellent. I would highly recommend to others (**4.85/5**–strongly agree, over last year)

"A great demonstration of Army leadership in the field of machine learning, and an incredible job by Mark," said Gen. John M. Murray, (retired) commanding general of the Army Futures Command. "What started as a good idea, some initiative, and a desire to spread knowledge, was met with incredibly positive feedback. His short course showcased not only the challenges associated with building neural networks, but the Army's efforts to harness these capabilities."

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https://www.army.mil/article/246398/army_hosts_global_ai_machine_learning_event

"I thought it was really terrific! An excellent introduction to the entire field of Machine Learning. Probably the best Gov't training that I have ever taken."

"Great course. Learned a thousand percent more about ML than I knew...Give Mark a raise! He is a tremendously valuable asset to our Army!"

"Absolutely great course. We are tremendously grateful for the instructor and his expertise. Awesome learning event."

"I previously found ML, Neural Networking, AI intimidating. Not now. Took notes and will be self-educating. Am currently a research scientist but was an assistant professor at USMA and for the last 11 years as part-time faculty at USNA... from a teaching perspective, this short course was excellent (e.g., the slide containing a type of 'word salad' showing what was to be covered and crossing out subtopics along the way; the concrete example provided on imaging was perfect; examples of activation functions). BLUF - the short course inspired learning (exactly what we tell our students they should be...life-long learners). Thank you."

"Thanks so much for putting it together - it was incredibly helpful!"

"Nice to see samples in something as ubiquitous as excel..."

“The course was great! The use of Excel is far superior to high level programming languages like Python. This method really shows what's going on under the hood. A+”

“The course was excellent! This newest iteration, with the Excel examples provided throughout, really helped me understand those underlying concepts better. Thank you!”

“I really liked how the course made a link between ML and what I typically think of as just stats methods. The visuals were excellent. I was also intrigued to see capabilities in Excel that I didn't know it had.”

“It is an excellent course. AI/ML are great tools to add. Breaking complex forms into simple excel documents is brilliant. One can visualize and understand what is going on.”

“I have background in ML and AI concepts and have never seen a use case in Excel. I'm interested in obtaining the formulas that were covered in the workshop so I can go back and try and analyze myself! Thanks for putting this together!”

“What a great job! Quite detailed and intricate.”

“I actually had to look up tutorials on how to structure the text scrolling animation, so it looked like Star Wars. But now that I have it in a PPT slide deck... the possibilities are endless! Muhahahaha”

“Thanks Mark! Probably the best and most concise presentation of the topic I have seen to date. I really appreciate the extra work with the V50 [ballistic] data. I would love to comb through the xlsx's for kicks and giggles.”

“Bravo! Thanks again Mark!”

“I think you have the vision to see that AI/ML is something that nearly all of us will need to be familiar with, as it will permeate nearly every aspect of our lives (in many ways it already has). Though I was perhaps drawn to AI for various reasons and chose that path early on in my CS course track, every scientist will need to be mindful of AI/ML to do their work within a matter of years.”

“May the course be with you!”

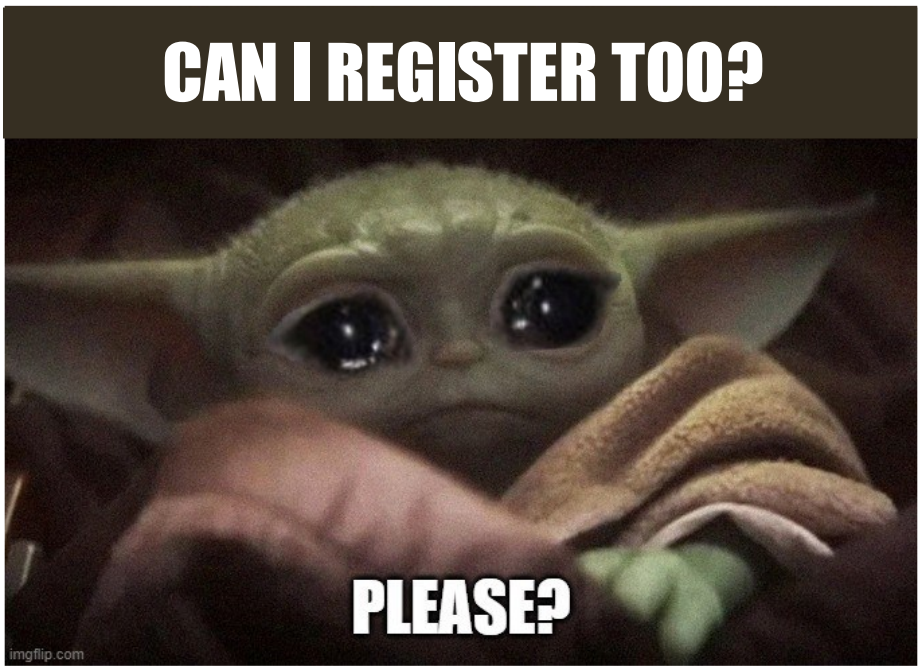
Top 20 Comments:

1. Quite frankly, it was the best and most entertaining presentation on this subject I have ever experienced. Terrific job.
2. This course was the best ML/AI I have ever taken. I do not know anything about Star Wars, but the funny captions, comments and pictures made the training even more enjoyable.
3. The content was intriguing and very eye catchy. The instructor was excellent teacher. The concept was well-presented, very easy to understand at the surface level. Started with literally no background or training in ML, I have learned a lot more than I would ever had thought I can be. Thanks again for the great content and thanks for making me (generalized as someone who doesn't know anything about ML) understand and stay focused throughout the whole course. Thanks!
4. The course tackled an astronomical amount of information, collectively known as machine learning, with well-articulated simplicity and clarity. This one-day course seamlessly presented an overview of ML topics with stimulating visuals and graphics that would normally take hundreds of textbook pages, weeks-long online courses, and entire college semesters to cover!
5. This was so great! If I had to give it a score, I would give it a 10 out of 9. Thank you for putting this material out there and making it approachable for people who don't have backgrounds in linear algebra or other advanced math. The pacing of the material was great and sending out the excel spreadsheets in advance was highly conducive to helping me follow along during the lesson. […] Thanks for making something I once thought was unattainable actually seem much more accessible!
6. I loved the Star Wars theme!
7. “Excellent training! Kept me engaged. Mark has renewed my long-forgotten love for math. I can't wait to learn more about ML!”
8. As a self-proclaimed Star Wars nerd, I was really looking forward to the Star Wars-themed machine learning course. I absolutely loved the way the memes/quotes/references were incorporated in a way that both held my attention throughout the course and made learning the concepts infinitely more enjoyable. Additionally, the instructor's enthusiasm was very contagious! As for the material itself, I really appreciated the way it was presented--especially the Excel-based examples. Often times, ‘machine learning’ is presented as something that requires tons of specialized programming knowledge which makes learning the basics a somewhat intimidating undertaking. It was refreshing to see excel being used for the smaller data sets with an explanation of how python, MATLAB, etc. is needed to larger data sets. To me, that makes the content a lot more ‘relatable.’ I also really liked the ‘Jedi Council’ session at the end. It was a really clever way to put the content in ‘real-world’ context.
9. I thought it was an excellent ML short course. The Star Wars theme added color and interest in the delivery. […] THANK YOU for going out of your way to educate the workforce. This was great.

10. The course and the panel were both fantastic! Thank you so much for offering the course to everyone.
11. There was a lot of math for someone who never took linear algebra, but the very thoughtful and fun Star Wars theme MORE than made up for it. As a new hire in a DoD research lab, this course should be used as a model for how to teach non-experts about your field – I would attend these all the time if they were all half this good!
12. "Truly excellent session! You found the perfect balance between not enough math/theory and too much. Goldilocks level of perfection. I really enjoyed the Star Wars theme too - it made for great levity additions."
13. From the perspective of someone who is just starting to dive into the world of machine learning, I thought this course was great! Mark was knowledgeable, well-organized, and clearly enthusiastic about the material. I appreciate the use of Star Wars to help keep things fun and engaging! I also liked that Mark chose to demonstrate neural network building in Excel rather than Python or MATLAB. It was an intuitive way to visualize the process without getting bogged down by syntax and esoteric functions, even if Excel would not be the most practical way to develop neural networks for a real application. […] Overall, though, this was a great experience, and I would definitely recommend this course to others!
14. Absolutely awesome. The instructor is a "natural teacher", someone who is just born to teach. […] Truly awesome talent, presentation, pedagogy, everything.
15. The course is super! […] The presentation slides are extremely well written and organized. […] The instructor is great! A lot of us benefit from this wonderful course. Thank you!"
16. Wow! Course was fantastic. I was pretty intimidated by the whole idea of machine learning beforehand, but this primer really helped take the edge off. I'm the kind of person who needs to be able to look under the hood of tools before I'm comfortable using them and the way Mark unpacked the equations and approaches used in the various methods was great!
17. Dr. Tschopp was an excellent instructor!!
18. This course was outstanding!
19. The various memes were of course excellent :) Thank you so much for doing this!
20. Overall, a fantastic job at this course, but I feel like it needed more Star Wars references (joking... maybe). I now think that Excel is probably the best/most informative way to represent these algorithms on the smaller scale. I think it improved how easily I understood the concepts.

Most Comedic (OK, I didn’t check that many)

1. "Mark is one with the Force. The Force is with Mark"
2. This material covered in this course reminds me not of drinking from a fire hose, but the ejection pipe at the bottom of a dam!
3. You have spoken. ;-)
4. With this one, the Force is strong.



[me] “ok, baby Yoda. Who can say ‘no’ to you, right? Plus, you know the force, so you can probably force me to do it anyways. Wait, are you using the force on me right now? Is this all part of your plan? Suddenly, I’m feeling compelled to insert a **hyperlink for registering** into this picture…”

TO REGISTER:

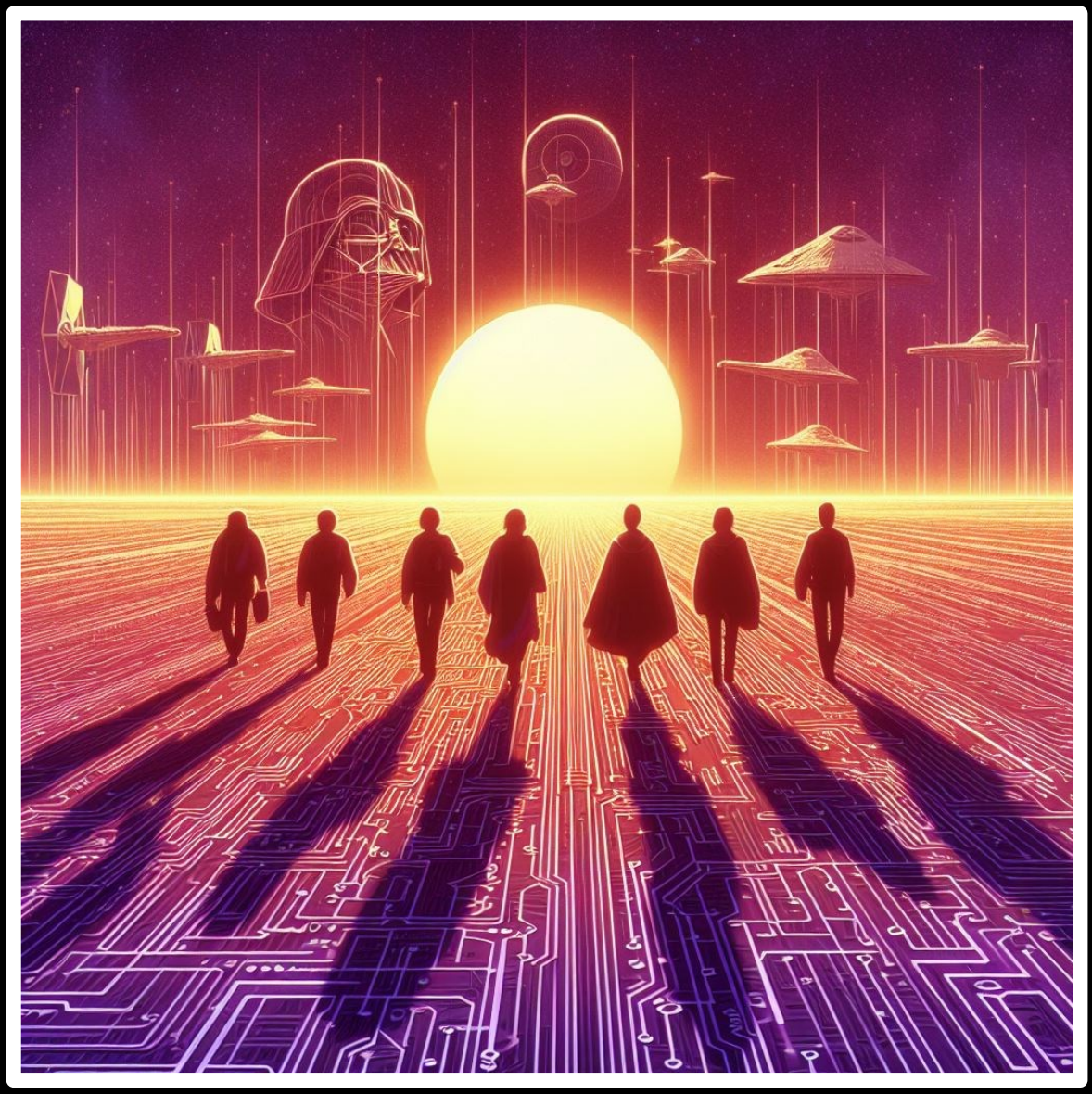
To fill out the Microsoft Forms doc, click on *Grogu* above OR the hyperlinked text OR the Rocket Spaceship below:

Hope to see you there!

Register Now!

Doh! That didn’t work?!?!
Try pasting the link into browser.
Still not working? OK. Try the red rocket ship link above. You may not be able to access materials, though.

Machine Learning for Everyone



Prompt: [Microsoft Bing Image Creator] adult students walking into a serene sunset, their forms outlined in shadow, walking purposefully towards the horizon. The backdrop is a blend of warm oranges and purples, with the sun casting long shadows, and lots of Star Wars references in the distance. However, instead of a traditional landscape, the ground beneath their feet is composed of intricate AI algorithms, neural networks, and lines of code. These digital pathways lead toward the vanishing point, symbolizing their journey into an AI-driven future.

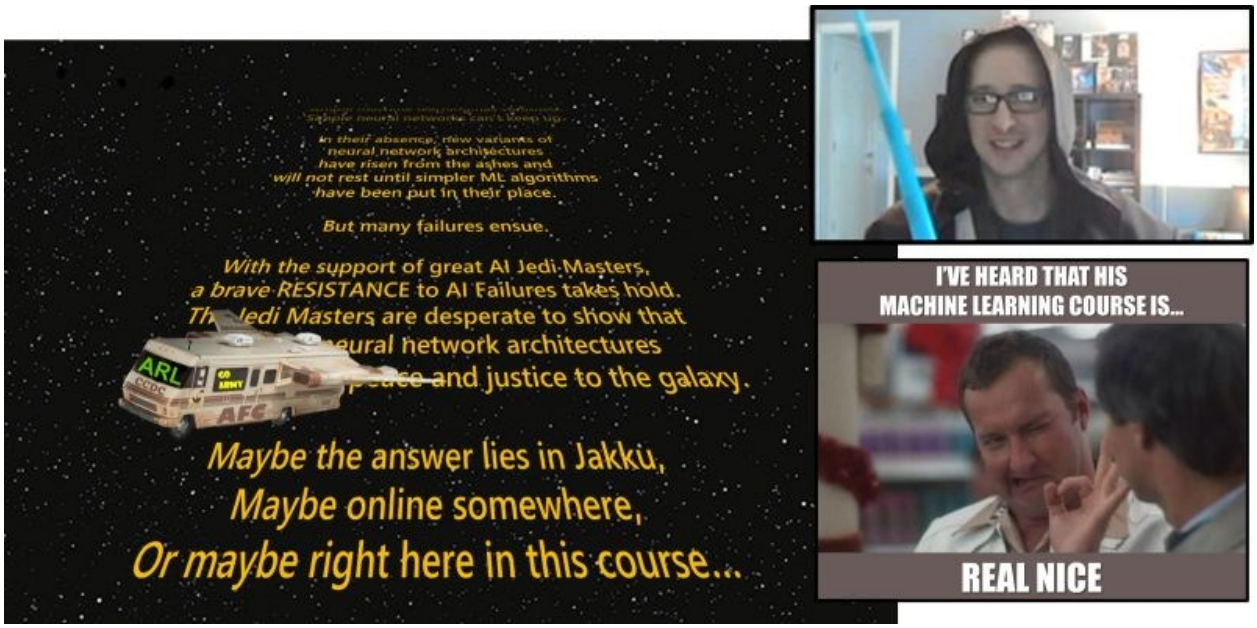
Appendix C. Frequently Asked Questions Document

This appendix appears in its original form, without editorial change.

Machine Learning for Everyone:

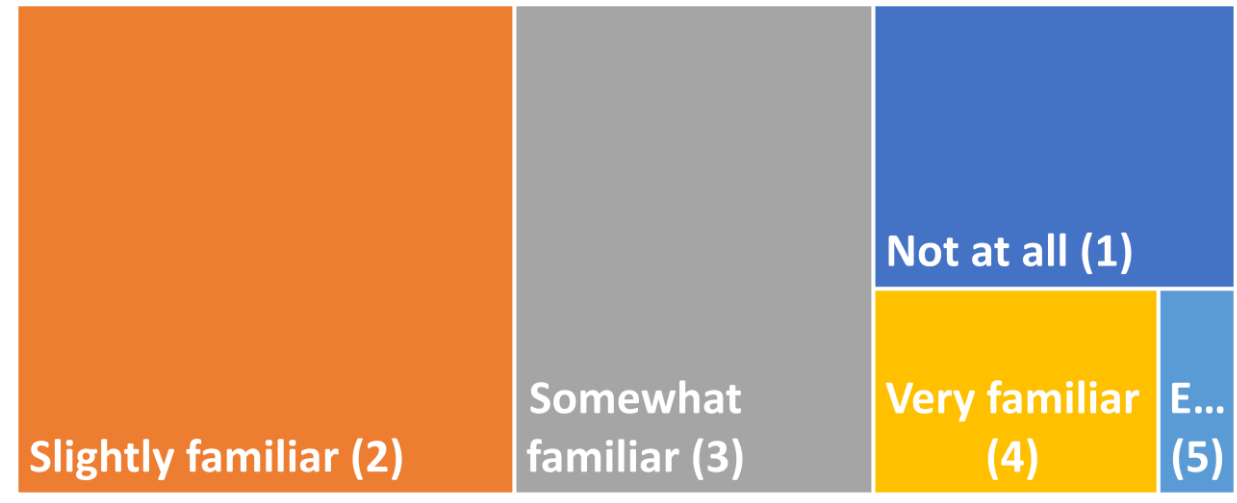
MAY THE FOURTH BE WITH YOU!

MAY 2023 | [Mark Tschopp | LinkedIn]



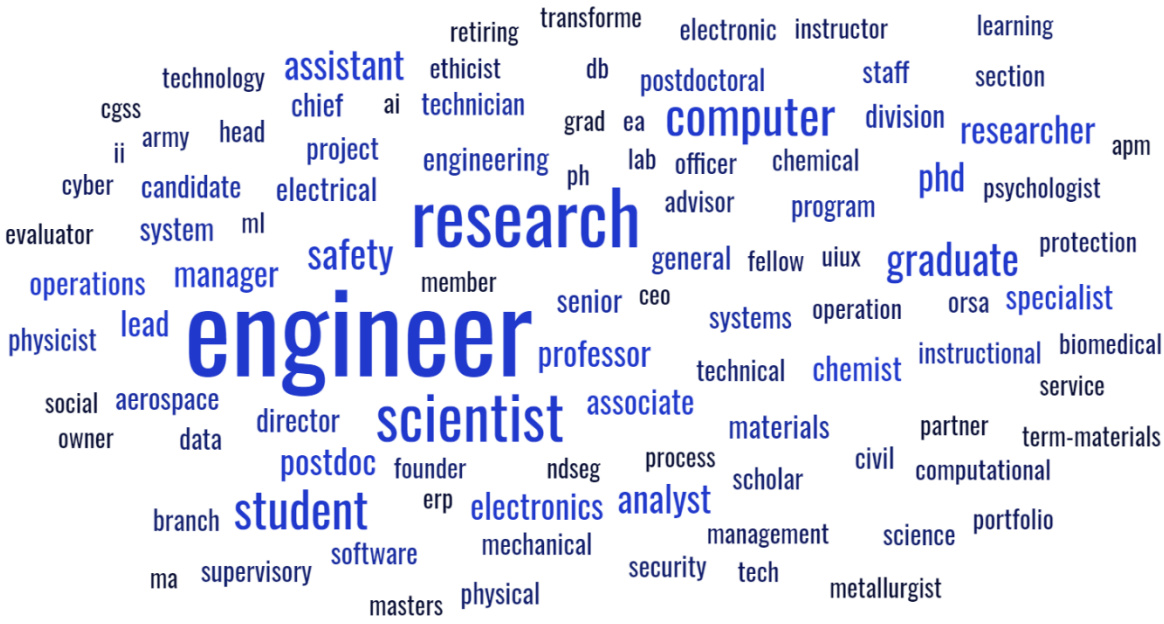
The Audience

The registrants included over 350 people for the May 2023 course. They were asked a host of questions during registration, including “how familiar are you with machine learning?”, i.e.,



The organizational breakdown. >50% of the participants were from the DoD (majority from Army AFC DEVCOM), ~20% from academia, ~10% from other government agencies, ~10% industry. A word cloud of participants:

The participant title/role breakdown. A majority were scientists, engineers, and researchers, but there were a wide range of different positions that attended.



Questions from the Chat – Day 1

Are you recording? If someone missed the primer (Yesterday's Session) would it be possible to get the recording? Is there a recording (or slides) I have access to to catch up? What do i need to do to get the slides and videos for today and tomorrow? Will you also be recording the optional session this afternoon? I am unable to attend but would still like to work through the excel spreadsheet! where are you going to upload the slide and recording? one of my folks is interested in this recording, if you do one. Can these slides be shared with us? Will the slides be shared? slides would be great. if you could share the slides with me as well that would be great!! Are you going to post presentation slides?

*SLIDES/VIDEOS. They're already on Google Drive and on the Army 365 TEAMS "AI/ML 101 Hub". The videos are there, the PPT "show" files are there too (i.e., so you can see movies, embedded Excel videos, and animations in the slides). The videos worked for me from the Google Drive quite nicely without downloading, so fingers crossed. (*Not working? Or requiring you to sign in? Try a different browser, like Firefox.*)*

- *Slides (in PowerPoint Show *.PPSX format, i.e., embedded videos): https://drive.google.com/drive/folders/1TVInuRBxg-bl_hyBFAGLcupk6a3UgFJI?usp=share_link*
- *Videos (available for viewing, not for download [>5 GB]): https://drive.google.com/drive/folders/1AG2nKp-L6yrnmUG3cVTflWhb3jg5kDwu?usp=sharing*
- *Army 365 TEAMS "AI/ML 101 Hub" team: Team Code qgf203d, Look in the Files Tab for the 20230504_MayTheFourth folder. Voila! The slides and videos are on there.*

Which excel file is this? are the example spreadsheets you are showing available to us?

I added the Excel spreadsheets in the Slides folder as well. I sent most of these out before the course, too.

Why can't companies technical support chat AI really help you?

I think it's only a matter of time before the front end for technical support is AI chat supported.

Are we going to talk about AI Alignment/Ethics? Is there a course or discussion group dedicated to this? Any plans to create one?

Since this course is related to machine learning, it focuses mainly on concepts and algorithms associated with machine learning. This course does discuss some of the bias that can develop from data in the AI/ML Success and Failure portion on Day 2 of the course. But many topics related to Ethics and AI are not covered in this course.

So how many gigabytes is this PowerPoint?

From the PowerPoint Show files in the slides folder, the slides for this course come in at about 1 GB total for the 500 or so slides for the course.

Can you give an example of a pre-trained model that could be leveraged for a project? is there a presumption that schema labels match the data inputs?

An example of pretrained models are VGG-16 and VGG-19, both large convolutional neural network models (covered briefly on Day 2). These models have a LARGE number of parameters, i.e., in the case of VGG-16, it has 138 million parameters and was trained on ImageNet to pick up on 1000 classes (or more). Many image models are easily accessible through different Python packages (see here: Keras Applications). In these cases, the inputs have to match the expected input and the output will match what the model is trained to return. Here is an article from the website "Towards Data Science" on how to use a pretrained model like VGG-16:

How to use a pre-trained model (VGG) for image classification | by Dr. Saptarsi Goswami | Towards Data Science.

How do you assess the trustworthiness of pre-trained algorithms?

Run them on labeled data and evaluate their accuracy compared to the ground truth in your data, i.e., labeled data which they have not been trained on, that is.

A few answers in the chat (in red above).

This answer is good. In this case, assume that they used a training set to train the model and that they also used holdout data to perform cross-validation on the model. In many cases, examining the initial paper(s) for the model should show how it did on a test set, or some other standardized test set. The last check would be to apply it to your new data. If it performs well, then use it. If it doesn't perform as well as you would like, one option is to train the final layer(s) on your dataset, a process called transfer learning (covered in Day 2 for convolutional neural networks).

So [this is] a multivariable model?

Yes, when I refer to multiple linear regression or multiple logistic regression, I am referring to a model that uses multiple variables as inputs.

How often do ML models have to be retrained? is it continuous?

It really depends on the application and the value proposition for retraining the model. This part of the machine learning pipeline is not covered in this introduction to ML, but rather is taught through courses that focus on MLOps or Machine Learning Engineering for Production. In these sorts of courses, the machine learning algorithm is just one small piece of a larger engineered end-to-end pipeline that includes monitoring of the input data to detect data drift or data shifting. If the data coming to the ML model starts to deviate from the data that the model was trained on (and trained for), then it may be good to retrain the model. MLOps not only focuses on this part but also provenance (version control) – for not just models, but for data and queries as well. For more information, there is an excellent certificate course on Coursera for ML-Ops by deeplearning.ai which uses TensorFlow Extended (TFX) to lead you through different concepts within the ML production pipeline.

Can you point to which MLOps course in Coursera?

Machine Learning Engineering for Production (MLOps) | Coursera

This is the one I was talking about in the course, although there are others like this on Coursera, Udemy, LinkedIn Learning as well.

On the surprise Ewok example, can you add lines with partial info? Should you?

I'm assuming that what is meant is "can you add more inputs?" Certainly! Should you? Well, it depends. In reality, having more features is usually not a bad thing, as long as you make sure that your model is not overfitting. This was a very simple example just to get you thinking about inputs, outputs, model parameters, and a simple linear regression model.

Are you really going to leave the whole question of the size of an Ewok tail unanswered?

Ewoks are depicted as having short, furry tails in the Star Wars universe. While the exact length of their tails may be up for debate, they are a distinct physical feature of these lovable creatures. In fact, in the movie Return of the Jedi, we can see Ewoks using their tails to help them balance and climb trees in the forest on the moon of Endor. So, it's safe to say that Ewoks do indeed have tails!

QUESTION

Q2. What would happen if my ML algorithm encountered an Ewok?

1. It would classify it as an Ewok.
2. It would classify it as a dog.
3. It would classify it as a cat.
4. It would return an error.

Who/where makes/sells the replica saber you're using?

I got it for Christmas, but I am told it came from Amazon. Here is the company:

Amazon.com: CUSTOM SABER Dueling Light Saber for Adults, Smooth Swing Rechargeable LED Light Saber, 9 Sound Fonts, RGB Infinite Color Changing, Light Saber Support Heavy Dueling for Adults Toy Gift- Black : Toys & Games

Are we going to talk about how to turn a regression model into some kind of classification model?

Yes, as you probably have already realized, one way to turn a regression model into a classification model is about adding an activation function to the output. The binary 0 or 1 response (Y) can be modeled by logistic regression where the output has been run through the sigmoid function, transforming it into a number between 0 and 1 (Yhat). Another way to turn a regression model into a classification model would be to apply a threshold value onto the continuous response (Y) to transform it into a binary 0/1 response or into multiple classes/categories for multiple thresholds/criteria.

Something I've wondered about for a while: how would you differentiate simple y=m*x+b type linear regression from machine learning? Maybe if you don't split the data into training/testing portions it shouldn't be considered ML?

Machine learning algorithms automatically learn patterns and relationships in data. Machine learning can encompass a wide range of techniques, including linear regression, but it also includes more complex methods like decision trees, neural networks, and support vector machines. In many cases, people use machine learning as a synonym for neural networks, but machine learning does in fact encompass simple and *complex algorithms.*

When we do logistic/ordinal regression will we be looking at other cost functions? Maximum likelihood for example?

Per the course, once we made it to logistic regression, we started to minimize the binary cross-entropy loss function between the predictions (Yhat) and the true outcomes (Y), which was equivalent to

$$-Y \cdot log(\widehat{Y}) - (1 - Y) \cdot log(1 - \hat{Y}).$$

Maximum likelihood estimation involves finding the parameters of the model that maximize the likelihood of the observed data, given the model. In other words, MLE seeks to find the values of the model parameters that make the observed data the most probable. While maximum likelihood wasn't mentioned in name, the approach with minimizing the cost function is exactly that.

Are there cases where there are local minima that we would get stuck in depending on our initial guess?

I think you have to add randomness to avoid the local minima.
You will commonly choose many initial starting points and solve all of them for that reason. For detail look into initialization of genetic algorithms.
Momentum or "inertia" parameters along are common initial attempts to remedy with minimal adaptations to your optimization algorithm.

A few answers in the chat (in red above).

These are correct. As the surface of the cost function becomes more complex with local minima as well as the global minimum, there are many different optimization techniques to try to find the global minimum cost function value. To avoid getting stuck in local minima, various techniques can be used, i.e.,

- *randomly initializing the parameters and running the optimization algorithm multiple times, or*
- *using more advanced optimization algorithms that are less likely to get stuck in local minima, such as stochastic gradient descent or Adam (discussed in the neural network section).*

Is gradient descent what the Excel Solver Add-in does?

The Solver Add-in is a tool in Excel that allows you to find an optimal solution for a problem by adjusting the values of input cells to minimize or maximize a specified objective function, subject to certain constraints. The Solver Add-in can use various optimization algorithms to find the optimal solution, including gradient descent, simplex method, and evolutionary algorithms.

ReLU seems to be more popular than the sigmoid function. Is that because the sigmoid calculation is more computationally expensive?

ReLU (Rectified Linear Unit) is generally more popular in deep learning because it is computationally easy, both in the forward propagation as well as in computing the derivative in backpropagation. ReLU is a simple activation function that involves a simple threshold operation that sets all negative values to zero and leaves positive values unchanged (resulting in derivatives of 0 and 1, respectively).

The sigmoid function would be slightly more computationally expensive for the hidden layers but still has its uses, particularly in problems that involve binary classification or probabilities, where the output needs to be between 0 and 1. Sigmoid can also be used in certain architectures, such as in the Gated Recurrent Unit (GRU) and in the Long Short-Term Memory (LSTM) networks, which are commonly used in natural language processing tasks.

Could you explain again what Z is?

Sure! In machine learning, Z often refers to the intermediate state right after applying the linear combination of weights, activations (or inputs) from the layer before, and bias; but right before the activation function. The nonlinear activation function can be represented as $f(Z)$ *and Z can be represented as* $Z = W_i A_i + B$ *where i refers to the nodes in the layer before.*

What is the difference between a parameter and a hyperparameter?

A parameter is a value that is learned by the model during training, based on the input data and the chosen optimization algorithm. Parameters are usually associated with the weights in a neural network, or the coefficients in a regression model. The

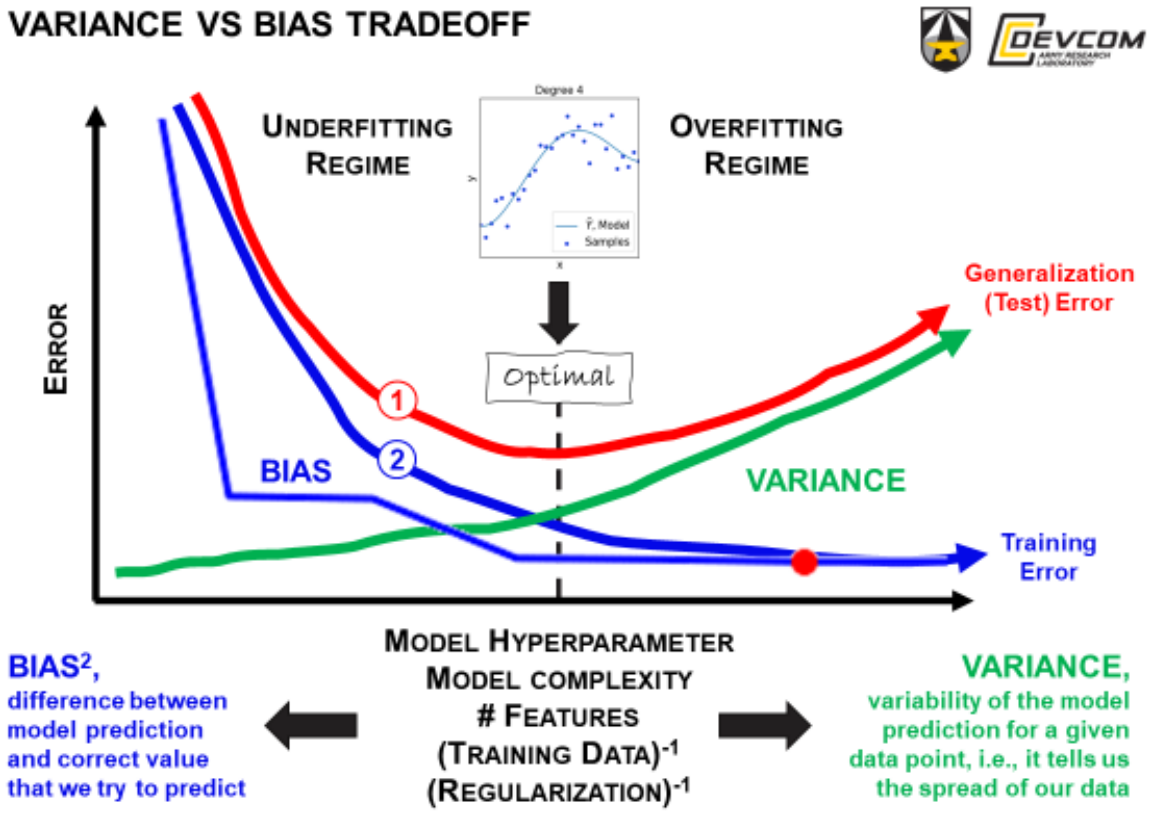
values of these parameters are adjusted by minimizing the difference between the model's predicted output and the actual output (i.e., the cost function).

In contrast, a hyperparameter is a value that is set prior to training and is not learned by the model. Hyperparameters control aspects of the learning process, such as the regularization strength, learning rate, number of hidden layers in a neural network, or the choice of activation function. The values of hyperparameters are typically set manually or through a search algorithm (such as grid search or random search) before the training process begins. The choice of hyperparameters can have a significant impact on the performance of the model, and finding the optimal values for the hyperparameters is often an important part of the machine learning workflow.

Upon execution of the machine learning algorithm, only the parameters affect the prediction; hyperparameters are not a part of the model.

How do you know whether it is overfitting or a good result?

Cross-validation! This question was from a slide leading up to cross-validation. By separating the data into different parts and making sure that a cross-validation technique is used, the model can be tuned such that it does not overfit the data (e.g., through regularization techniques).



Are you using features and attributes interchangeably?

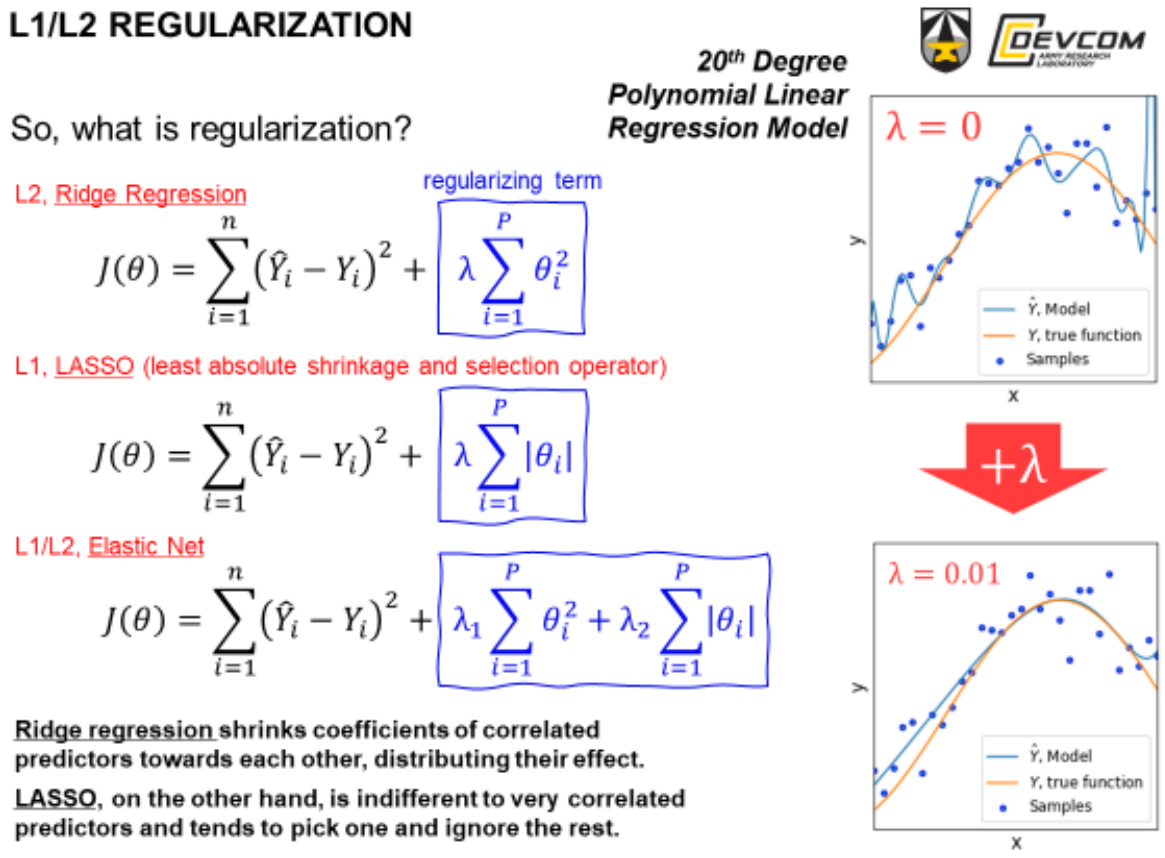
There are a few schools of thought here. One school of thought is that they can be used interchangeably. Another school of thought is that the term "attribute" refers to the raw input data, while the term "feature" refers the input variables after they have been preprocessed in some manner to make them more useable for machine learning models. I try to stick to the latter but may have accidentally used them interchangeably at times.

It seems like you should exclude theta1 from regularization. Is that right?

In linear regression with regularization, it is common to exclude the bias term (theta0) from the regularization term because it does not affect the complexity of the model in the same way as the other weights. It is not necessary or common to remove theta1.

Could you explain Elastic Net?

Elastic Net is a regularization technique that combines L1 (Lasso) and L2 (Ridge) penalties to address the limitations of each technique. It balances feature selection and stability, making it a powerful tool for linear regression models with many input features or highly correlated features. As mentioned, it adds one more hyperparameter and may not give much of a different from L1 and L2 regularization so it may not be used as often.



How do you determine a "good" lambda in regularization? just by looking at the graph?

The value of lambda in regularization is typically chosen using a separate validation dataset or using cross-validation techniques. The goal is to choose a value of lambda that gives the best performance on the validation set. A common approach is to start with a small value of lambda and gradually increase it until the desired level of regularization is achieved.

How do you determine the optimum K in K-fold cross-validation?

In k-fold cross-validation, the value of k is typically chosen based on the size of the available data and the computational resources available. The most common value for k is 10, but other values such as 5 or 20 may also be used. However, it is important to note that increasing the value of k generally leads to a more accurate estimate of the model's performance, but also increases the computational cost of cross-validation. Therefore, the choice of k should be a trade-off between the desire for accurate performance estimates and the available computational resources.

In general, a good practice is to choose a value of k that is large enough to provide a reliable estimate of the model's performance but small enough to be computationally feasible.

Are there tools in (e.g., python) to help with these processes (partition and iterate the Train, Dev, and Test sets)?

Yes, there are several tools in Python that can help with partitioning and iterating the train, dev, and test sets for machine learning tasks. Perhaps the most popular library for machine learning in Python is scikit-learn. Scikit-learn provides a range of functions and classes for data preprocessing, model selection, and model evaluation, including functions for cross-validation and grid search. For example, the train_test_split function in the sklearn.model_selection module can be used to split the data into training and testing sets. For instance, see this page for the documentation and a Python example:

sklearn.model_selection.train_test_split — scikit-learn 1.2.2 documentation

How much data is enough data?

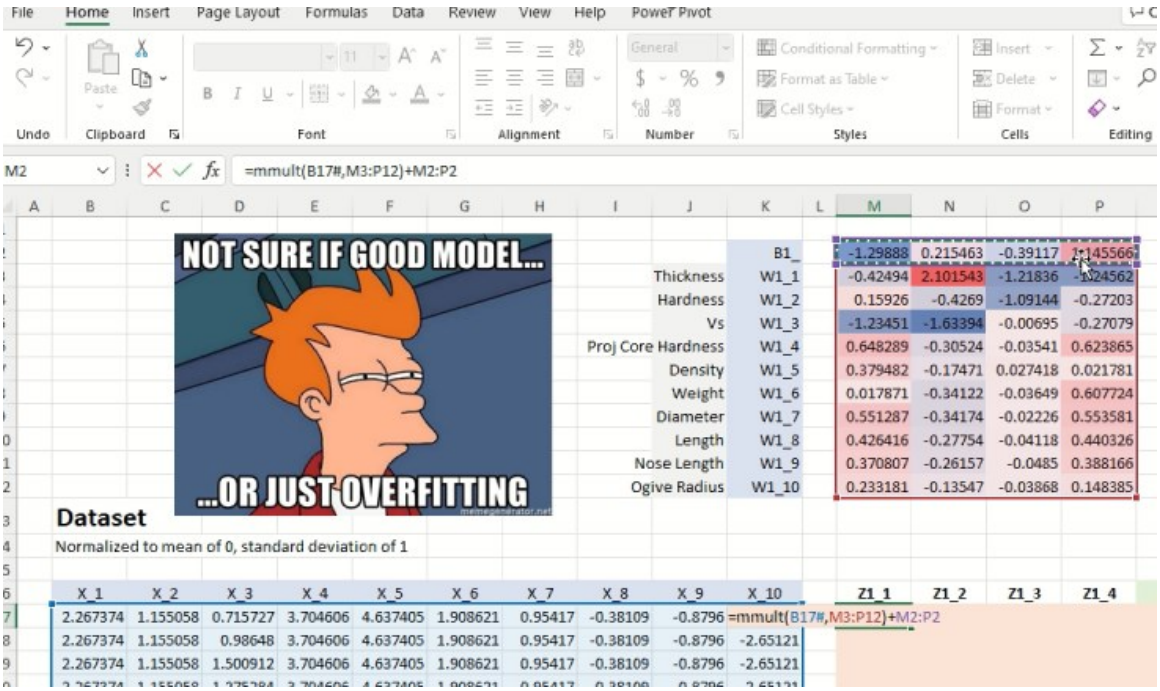
All of it.
To follow-up on my “all of the data” comment from earlier. There are three kinds of data, and you want all of two kinds. The first kind of data is good data, data that is known to be accurate (it can still have noise or bias in it), you want to build your model on this. The second kind of data is bad data, you want the data that is known to be incorrect to test your model against and to verify that generally it is not in your model (your model does not predict the bad data). The third kind of data is data of unknown quality. This kind of data is dangerous and should generally be thrown away as quickly as possible so that no one tries to use it in a model or verify a model with it.

A few answers in the chat (in red above).

Ha ha. Yes, love this answer. Generally, the more "good data", the better. The models can still learn from non-pristine data though also, it just depends on what the data in the real-world application looks like. As you partition into different sets for cross-validation (dev set) and generalization (test set), you want the data in each to reflect the ultimate real-world data. Often, you have a much smaller dataset to begin with – that's ok, it just may mean that the model complexity can't be too great when starting. As more data is collected, the model complexity can be increased to capture more of the response nonlinearity/complexity.

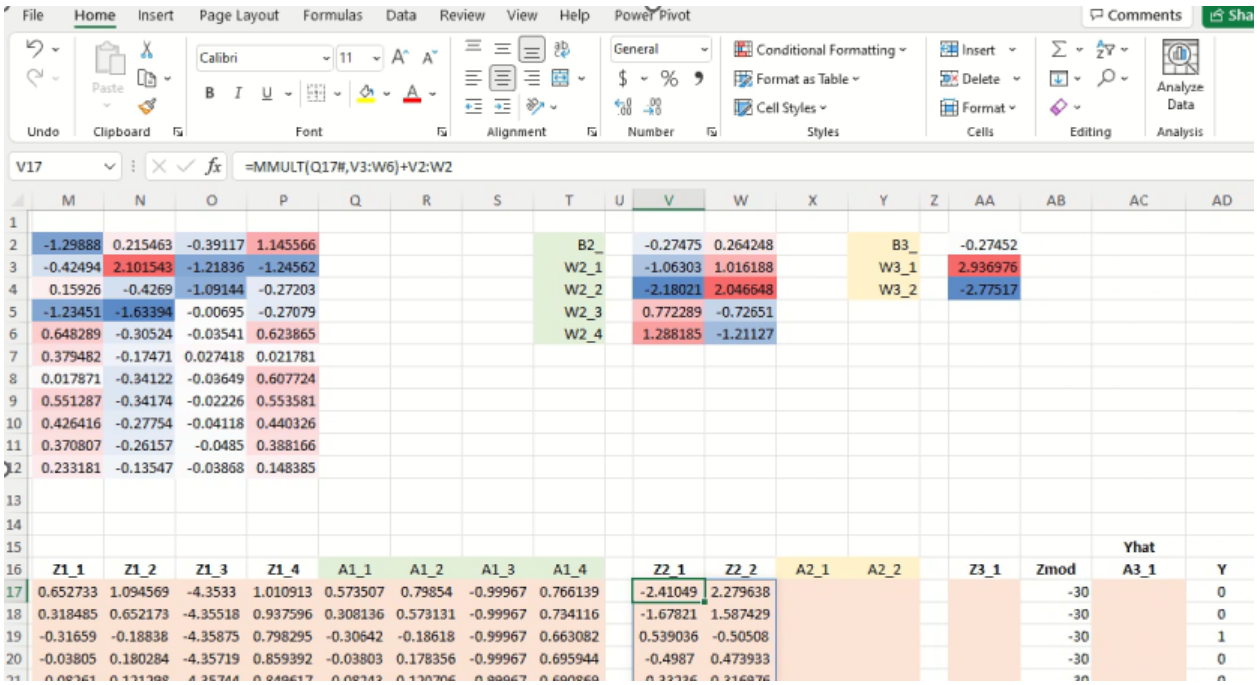
Is A0_0 = B_1?

*In general, the superscript in the model weights W, model bias B, and activations A refers to the layer. So, in my Excel shorthand, A0 refers to the 0^{th} layer, i.e., the inputs. The _0 generally refers to the 0^{th} node, which is usually set to 1 and multiplied by the bias B1_ to return 1*B1_=B1_. Note that in this example, the B1_ means that this 1^{st} layer bias applied to each node. A more accurate label would be B1_1. If there were multiple nodes in the first layer, there would be B1_1, B1_2, B1_3, B1_4, …*



Why do we have two columns of Z2_1?

In the Excel spreadsheet example, the 2 Z2_ columns are because there were two nodes in that layer. The Z2 represents the 2^{nd} layer, the _1 represents the first node and _2 is the second node.



	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD
1																		
2	-1.29888	0.215463	-0.39117	1.145566				B2_		-0.27475	0.264248		B3_		-0.27452			
3	-0.42494	2.101543	-1.21836	-1.24562				W2_1		-1.06303	1.016188		W3_1		2.936976			
4	0.15926	-0.4269	-1.09144	-0.27203				W2_2		-2.18021	2.046648		W3_2		-2.77517			
5	-1.23451	-1.63394	-0.00695	-0.27079				W2_3		0.772289	-0.72651							
6	0.648289	-0.30524	-0.03541	0.623865				W2_4		1.288185	-1.21127							
7	0.379482	-0.17471	0.027418	0.021781														
8	0.017871	-0.34122	-0.03649	0.607724														
9	0.551287	-0.34174	-0.02226	0.553581														
10	0.426416	-0.27754	-0.04118	0.440326														
11	0.370807	-0.26157	-0.0485	0.388166														
12	0.233181	-0.13547	-0.03868	0.148385														
13																		
14																		
15																	Yhat	
16	Z1_1	Z1_2	Z1_3	Z1_4	A1_1	A1_2	A1_3	A1_4		Z2_1	Z2_2	A2_1	A2_2		Z3_1	Zmod	A3_1	Y
17	0.652733	1.094569	-4.3533	1.010913	0.573507	0.79854	-0.99967	0.766139		-2.41049	2.279638					-30		0
18	0.318485	0.652173	-4.35518	0.937596	0.308136	0.573131	-0.99967	0.734116		-1.67821	1.587429					-30		0
19	-0.31659	-0.18838	-4.35875	0.798295	-0.30642	-0.18618	-0.99967	0.663082		0.539036	-0.50508					-30		1
20	-0.03805	0.180284	-4.35719	0.859392	-0.03803	0.178356	-0.99967	0.695944		-0.4987	0.473933					-30		0

When you mentioned high weights may indicate overfitting, do you mean weights compared to each other, or to the bias?

When I mentioned that high weights may indicate overfitting, I meant high weights in comparison to each other within a given layer of the neural network. Biases, on the other hand, are not as prone to overfitting as the weights are, because they typically have fewer parameters and are more constrained in their range of values. However, it's worth noting that biases can still have an impact on the overall performance of the model, so they should not be ignored completely.

Is there some mathematical theorem/proof for the dropout algorithm? It seems like this is try random things to see if they help...

There are almost no proofs or theorems for even physical dampening, no less numerical.

Article: The dropout learning algorithm - ScienceDirect

A few answers in the chat (in red above).

The dropout algorithm is not based on a mathematical theorem or proof, but rather on an empirical observation that has been validated through experimentation and testing. The intuition behind dropout is that it helps prevent overfitting by introducing noise and redundancy into the network, thereby forcing it to learn more robust and generalizable features. This idea has been tested extensively on a wide range of datasets and network architectures and has been shown to be effective in practice.

While there may not be a formal mathematical proof of the effectiveness of dropout, there is a growing body of research that seeks to understand its theoretical underpinnings and to develop more rigorous methods for analyzing its performance.

So, while dropout may have started as an "experimental" technique, it has since become an established and widely used tool in the deep learning toolbox.

What does the # after M17 do?

In Excel, the # refers to a dynamic array. In dynamic arrays, you select the upper lefthand cell, in this case M17, and then add a hashtag, M17#, to utilize the entire dynamic array in a formula. Dynamic arrays are a new feature in Excel that allow a single formula to spill results into multiple cells, instead of just the cell where the formula is entered. With dynamic arrays, Excel can automatically determine the size of the output range based on the size of the input range.

For example, if you have a range of cells containing numbers and you enter a formula to calculate the square of each number, Excel will automatically "spill" the results into the adjacent cells, creating a dynamic array of the same size as the input range.

Where do obtained the Y columns values? are those just given results?

The Y column values are typically the "ground truth" or "target" values that you are trying to predict with your machine learning model. In supervised learning, you usually have a dataset of input features (often denoted by X) and corresponding target values (denoted by Y).

Could you show the binary cross-entropy loss function again?

The binary cross-entropy function is as follows:

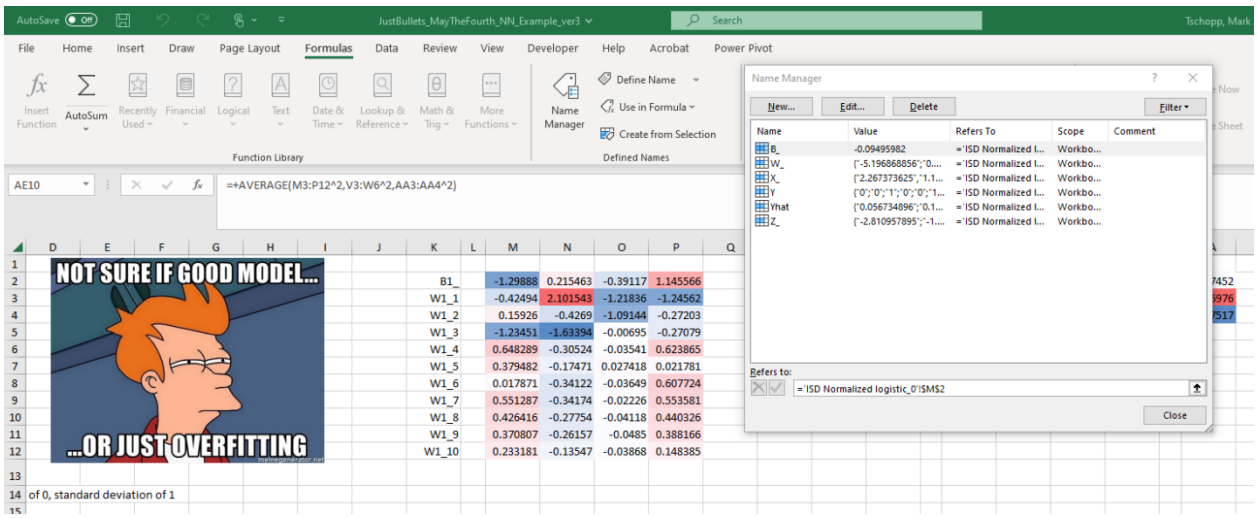
$$-Y \cdot log(\widehat{Y}) - (1 - Y) \cdot log(1 - \hat{Y})$$

If we were starting from scratch all of our weights and the Bias would be zero to start?

When a neural network is initialized, the initial weights and biases are usually not set to zero because doing so can lead to symmetrical neurons that perform the same calculations, which can cause problems with training the network. Instead, the initial values for the weights and biases are randomly set using a specific distribution, such as the normal distribution or the uniform distribution. This randomness helps to break the symmetry and allows the network to learn different features.

Seems like defining Y takes me back to the first page. Is there a good way to undefine the first Y we made?

Go to the Formulas tab, then click on Name Manager. Within the box that comes up, you can make new variables, edit current variables, or delete variables.

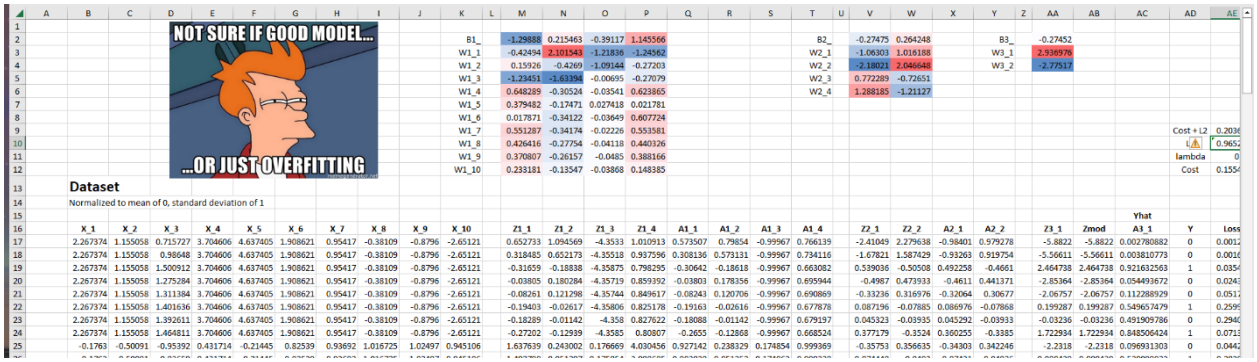


Is the Z2_1 column basically just using the A1_1 and A1_2 as if it's an X_data array?

Yes, although the X input values are often referred to as activations in the 0^{th} layer (and not vice versa in later layers). In this way, for each layer, the Z values are functions of activations from the prior layer, weights for that layer, and biases for that layer.

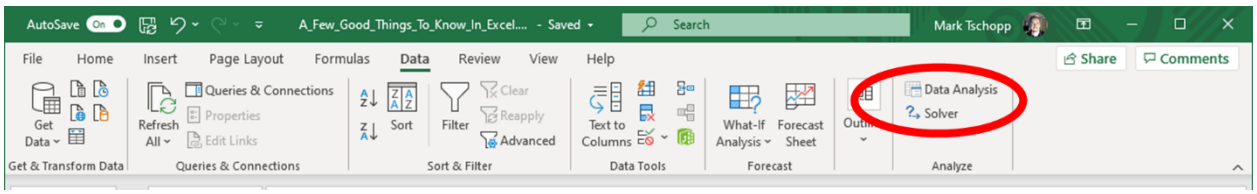
If this is 4 nodes, how many layers there are?

For the example I showed, there are 4 nodes in the first layer, 2 nodes in the second layer, and 1 (output) node in the third layer. So, three layers in all – 2 hidden layers and 1 output layer.



Can you show again how to launch the Excel Solver?

Certainly! Click on Data Tab, look all the way over in the Analyze category.



…follow these steps if it doesn't appear:

- *Go to File*
- *Click on Options (all the way at the bottom)*
- *Click on the Add-ins Tab*
- *Select "Excel Add-Ins" next to "Manage" at bottom of the page*
- *Press Go*
- *Check the box next to Analysis Toolpak*
- *Press OK*

Still not there? Sounds like a Help Desk / IT ticket. Best of luck!

Just the chat – Day 1

Just cuz it's fun:

- May the 4th be with you!!!
- The fourth is strong with us today!
- Your fit is spectacular! May the Fourth Be With you!
- I would've picked Mando armor.
- Does this conflict involve lightsabers?
- I LOVE IT!!
- Love the Sith Office Space reference.
- This is the way.
- My office mate and I are Mando obsessed so we're loving this (Mandalorian theme music)
- awesome intro
- "When you finally finish training your model, but it has Stormtrooper Accuracy."
- That's no moon.
- Thank you, Dr. Kott! Thank you!
- yes, augmenting what we do repeatedly or what we want to delegate to our personal assistant we never had so we can become more creative.
- You found the Droid you were looking for...
- Bard is talking more like a parent!
- Daisy...Daisy...
- The Schwartz
- Din Grogu. Short for Dining Grogu
- nice graphic!
- Also, do you really know it if you can't do it in excel?!
- :D
- that was awesome. Love it! that was great! This is amazing. I'm so happy! This is an awesome experience! This presentation is top quality! This course is gonna be legendary!
- probably would return a *small walking carpet, if the training data were A New Hope
- this will be in my head for the next 13 days (We didn't start the fire)
- love the disclaimer! haha
- Need to watch this every morning.
- You're not on some mercy mission.
- looks like the real thing to me (lightsaber)

- Talk about job satisfaction!
- I need to work at your location.
- It looks like a Saberspro deal or similar… also that's a great way to spend $70-500
- crazy to see an animation of convergence actually executed in Excel!!
- Was Han talking about hyperparameters when he scolded Luke about the precision required to navigate hyperspace?
- Yes, along with the Kessel run in 12 parsecs being a distance optimization.
- very cool. :o
- This approach with Excel is really good, there is no better way to quickly convince people that AI works, to show how, and that it is not too complicated.
- Can't shoot through something that isn't there :P
- gerrymandering
- I love the force transfer of various snacks that's happening in this slide :D
- This reminds me of those videos they play during movie intermissions.
- that's helpful - thanks!
- I love this one!
- I see you have entered hyperparameter-space.
- That's "DAY-TA"
- Jango!
- that assumes storm troopers could actually hit armor.
- Also, perfect timing. GOTG 3 is coming out tonight.
- All these layers and not one Shrek reference :(
- it's a trap!
- Good stuff!
- I just learned how to do this animation trick the other day!
- This is awesome, thank you!!! this is a great course. thank you! Very useful! Thanks! Thank you, Mark. Thank you!! This is great! Really looking forward to tomorrow! Thanks so much! Thanks a ton. Outstanding, thank you. Thank you for putting this on.
- May the 4th be with you!
- Bravo! Wow!
- you may need an intervention...
- thank you! Thank you! Great, thank you! Thank you for running through these examples! Thank you for today! Thanks! thank you! Thank you for the details, very informative. Thanks for your time, Mark!! You are awesome!!! awesome. great class! I've got it, assume others do too! Thanks for recording. beautiful!

Dropping knowledge in TEAMS chat – Day 1

Recording some of the links and info shared in the chat:

- AI Task Force is now called Artificial Intelligence Integration Center (AI2C)
  - Home (crmforce.mil)
  - AI2C is Army...it is one of the centers under AFC...
- The JAIC was replaced by the Chief Digital and Artificial Intelligence Office (CDAO)
  - CDAO - Chief Digital and Artificial Intelligence Office (ai.mil)

- Check out Futurepedia:
  - Futurepedia - The Largest AI Tools Directory | Home
- Re: how often to train. Data Drift and Concept Drift are terms to know.
  - Understanding Data Drift and Model Drift: Drift Detection in Python | DataCamp
  - A Gentle Introduction to Concept Drift in Machine Learning - MachineLearningMastery.com
  - Concept Drift 101 - Introduction to the Machine Learning Problem (opendatascience.com)
- For those who may not be aware, Army civilians currently all have access to Udemy
  - https://armyciv.udemy.com/
  - funded thru ACCMA
- Have you ever watched Because Science's explanation of lightsabers?
  - Because Science "Star Wars Science": Star Wars Science - YouTube
  - Because Science "SURPRISE Lightsaber!": SURPRISE Lightsaber! - YouTube

Questions from the Chat - Day 2

Would you be able to post them somewhere and/or SAFE them to me? How can we access the recordings? Will the rest of the day be recorded? Are the slides going to be available? If not, could you post the links to those courses? How can we access the recordings? hope to get hold of the slides and recordings

> ***SAME RESPONSE AS DAY 1!***
>
> *SLIDES/VIDEOS. They're already on Google Drive and on the Army 365 TEAMS "AI/ML 101 Hub". The videos are there, the PPT "show" files are there too (i.e., so you can see movies, embedded Excel videos, and animations in the slides). The videos worked for me from the Google Drive quite nicely without downloading, so fingers crossed. (*Not working? Or requiring you to sign in? Try a different browser, like Firefox.*)*
>
> - *Slides (in PowerPoint Show *.PPSX format, i.e., embedded videos): https://drive.google.com/drive/folders/1TVInuRBxg-bl_hyBFAGLcupk6a3UgFJI?usp=share_link*
> - *Videos (available for viewing, not for download [>5 GB]): https://drive.google.com/drive/folders/1AG2nKp-L6yrnmUG3cVTflWhb3jg5kDwu?usp=sharing*
> - *Army 365 TEAMS "AI/ML 101 Hub" team: Team Code qgf203d, Look in the Files Tab for the 20230504_MayTheFourth folder. Voila! The slides and videos are on there.*

How does global regulation work?

> Poorly, but mostly through the UN… which gets ignored a lot.
> International regulation has different forms for different areas, e.g., banking, use of spectrum, health care, etc.
>
> *An answer in the chat (in red above) and others in knowledge section.*
>
> *Wow, this is really not in my domain of knowledge. But I can google and there seems to be a growing body of work on global regulation of AI. This has become a very hot topic around the world as AI becomes more prevalent, i.e.,*
>
> Global moves to regulate artificial intelligence: AI news | World Economic Forum (weforum.org)
> global ai regulation - Bing News | global ai regulation - Google Search

It's been almost 20 years since the DARPA Grand Challenge that team successfully completed the first year... Would that be a cakewalk today? And what might be a cakewalk in another 20 years that we can't quite fathom today?

> *20 years is a long time. Not sure about this.*
>
> *The general consensus amongst experts for how long it will take for artificial general intelligence to emerge is somewhere between 5-10 years and never. It's hard to fathom what we can't quite fathom today. ;) Needless to say, such an emergence*

would likely change everything and I don't think we can fathom what that disruption will lead to around the world.

Any ideas on how large the fields of trusted AI or explainable AI are compared to the other AI/ML fields in gov or private industry?

No ideas on this. In some sense, I suspect that this is integrated in with other AI/ML efforts and isn't a distinct team or structure within a government organization, but I am unsure about this.

Do people use different functions instead of (theta1) X + theta0?

Yes! This is only the linear part. The activation functions described within this course (ReLU, tanh, sigmoid, leaky ReLU, etc.) provide the nonlinearity to neural networks.

Vision is hard, researchers have shown that you can generate adversarial images and paste them over highways and stop signs and cause unpredictable behavior. How robust is robust enough when highway safety is the concern?

How robust is robust enough? It depends. The algorithm robustness certainly depends on what the consequences are for a failure. Is it just an inconvenience or is it destruction of property or is it a loss of human life? This may mean in some of these areas where the consequences can be great, that backup systems (human or otherwise) need to be considered as well.

So, now how robust is robust enough when highway safety is a concern? In many scenarios (and maybe this one or maybe not), the bar is "does it do better than a human?" or human-level performance. That could be one criterion. Unfortunately, the potentially adverse outcomes in many situations mean that these algorithms may have an even higher standard placed on them. For instance, autonomous vehicles may be far safer than human drivers based on accidents (per mile), but that still isn't convincing enough for many human drivers. If you are the company, are you liable for any loss of life? If so, this may also enter into your calculus of level of acceptable robustness. As you can see, there are a lot of factors for this question, and it is not an easy one to answer.

Are we going to cover other types of input data for ML/AI? e.g., time series data, or something like a chemical structure ... e.g., using AL/ML to predict chemical properties where a chemical structure is an input rather than discrete numeric measurements?

I've briefly looked into molecular structure + ML. From the papers I've found on polymers, features related to chemical structures can be encoded into matrices of data, which are then fed to ML models. So chemical structures might introduce some preliminary pre-processing of the data, but the machine learning algorithms might not need to be adjusted too much.

That's what I've found as well. There seem to be a bunch of ways to represent molecules as networks (some people even just pass SMILES codes as inputs but that seems to limit what information can be extracted). Just wondering if we're going to cover how to transform different kinds of inputs that aren't numbers and if there are any strategies as to best practices or best ways to ensure you're extracting good features from non-numeric input.

A few answers in the chat (in red above).

In Day 2, we covered different types of encoding for categorical features from the simplest forms (one-hot encoding) to more advanced techniques like target encoding. In the sequence model part, we covered how time series data is handled through the RNN, GRU, and LSTM architectures.

For chemical structure and other domains, there is often architectures for different unstructured data that is domain/applications specific. Per the comments, the SMILES string has evolved to describe the chemical composition in this domain. I uploaded a seminar that an undergraduate researcher gave on machine learning and using SMILES information, i.e., Machine Learning and SMILES Presentation

Were these early computers using data or were they using exhaustive search functions...

ding ding ding! In the early days, it was known that perceptrons (the basic building block of neural networks, i.e., the nodes) were promising to recognize many classes of patterns. It could even be used to recognize the infamous XOR function (although at the time, it was thought by some that they couldn't capture XOR). If they only knew how to train them back in the early days!

Until backpropagation and other machine learning concepts came around, it was not known how to train deep and/or complex neural network architectures. Hence, the most promising way to deal with data at the time was through lookup functions from tables and expert systems (hand-coded rules, like decision trees). Once backpropagation came around and many other discoveries, suddenly the DATA could help parameterize the models.

Would ChatGPT pass the Turing test?

Let's start with "what is the Turing test?" In 1950, Alan Turing proposed the Turing test as a way to measure a machine's intelligence. The test pits a human against a machine in a conversation. If the machine can fool the human into thinking it is also human, then it is said to have passed the Test.

Would it fool humans? I think in some ways it already has fooled some humans, at least. In fact, a quick Google Search contains everything from "no, ChatGPT has not passed the Turing Test in a standardized and scientifically approved manner" to "ChatGPT has passed the Turing test and if you're freaked out, you're not alone".

Are we going to discuss AI bias for a few minutes? how/why does it happen and what is a good example of it?

AI bias refers to the systematic and unfair favoritism or discrimination that can occur in artificial intelligence algorithms. It happens when the training data used to build or train the AI model contains biased patterns or reflects societal biases present in the data. As a result, the AI model can perpetuate and amplify these biases in its predictions or decision-making processes.

There are a few reasons why AI bias can occur:

***Biased Training Data:** If the training data used to train the AI model is biased or unrepresentative of the real-world population, the model can learn and reproduce*

those biases in its predictions. For example, in the Amazon example, if historical hiring data is biased towards certain demographics, an AI-based hiring system trained on that data may unfairly favor candidates from those demographics.

Biased Features and Labels: *Biases can also arise from the features or labels used in the training process. If certain features correlate with specific biases or if biased labels are assigned to the training data, the model can learn and perpetuate those biases. For example, including certain features associated with gender, ethnicity in a credit score model.*

Implicit Human Biases: *AI models are designed and trained by humans, who may inadvertently introduce their own biases consciously or unconsciously into the system. The biases present in the design choices, data collection, or model configuration can influence the outcomes.*

One well-known example of AI bias is facial recognition systems that have exhibited racial and gender biases. As shown in the AI Success / Failures lecture on Day 2, some of these systems have shown higher error rates for people with darker skin tones and women compared to lighter skin tones and men. This bias can lead to discriminatory outcomes, such as misidentifications or false accusations, disproportionately affecting certain groups.

Can that be a result of bias or overfitting the AI?

I forget what "that" refers to, but it is important to address both AI bias and overfitting. These are distinct concepts. Strategies to mitigate overfitting include using regularization techniques, cross-validation, a diverse and representative dataset, etc. Simultaneously, to mitigate AI bias, steps such as careful data collection, bias-aware model training, and continuous evaluation for fairness should be taken.

So, it [an image] looks really good, but as soon as you change something the AI is far off? So hypothetically a malfunctioning pixel could result in a wild misclassification?

Here are some 1-pixel examples, when looking at them it's understandable how an "AI" would be confused. https://www.hindawi.com/journals/wcmc/2021/8891204/

A few answers in the chat (in red above).

Note that when I showed these examples, these studies were five years or so ago (back in 2017?). The whole concept of specially designing noise to try to fool these algorithms into misclassifying objects was new at the time. But knowing how these systems could be fooled was also instrumental for adding in defenses for these algorithms – in most cases, making the algorithms more robust to these sorts of attacks. A lot of work has been done since then to increase the robustness of these models. It makes you appreciate how good humans are at classifying objects in the presence of noise, huh?

Doesn't that also apply to humans? e.g., if I'm good at camouflage and paint a tree on a tank, it will cause the human vision system to misclassify the tank as a tree?

I believe that this question was in response to the 3D printed "adversarial" turtle example. Yes, humans can also be deceived. The novelty of this study back in 2017

was that it caused the AI image system to misclassify the adversarial turtle as a rifle, in a way that no human would be confused in the same manner. So, we have to not only be aware of our AI systems potentially being fooled by traditional methods of camouflage and deception, but also camouflage designed to specifically attack the AI system, and which may be imperceptible to humans.

Google's AI thinks this turtle looks like a gun, which is a problem - The Verge

Does that 1-pixel sensitivity scale with resolution? E.g., would a one-pixel change in a 1280x720 image change the classification result on a 1280x720-trained vision algorithm? Or would a threshold appear such that the "bad pixels" are ignored until they reach a certain ratio of the entire resolution?

For the pixel resolution: it's true that bigger or higher resolution pictures probably would not be as affected. But, for example, if an algorithm thinks "horses can never have purple dots on their body" then it would always misclassify a horse with a purple pixel. So, it certainly depends on how the system is trained. Maybe the lesson is that the programs are great, and very impressive, but that one needs to be careful about making them too restrictive when real world cases have non-idealities. Of course, scientists are supposed to worry about non-idealities...

I suppose it then comes down to an arms race of "who can train in a way that accounts for known and possible adversarial attacks." The data complexity required for minimizing that risk will be huge, so I presume there will have to be a tradeoff of safety that is dependent on the seriousness of the use-case.

A few answers in the chat (in red above).

These answers are great. I imagine that the 1-pixel sensitivity would change with resolution. That being said, the fact that you can specially design noise to adversarially attack the image doesn't necessarily mean that higher resolution leads to better robustness against this attack. It is attacking the model, not the image. It is important to be aware of these attacks and implement defenses against them (i.e., making model more robust to these attacks).

Is that capturing all the features available? e.g., that the last 2 CAL50 projectiles might be similar or have a similar feature (same caliber). Or are features like that reliant on pre-processing by humans to incorporate them?

This section on encoding may not have all features available for use with this dataset – it is just showing how categorical data can be converted to a form where it can be incorporated into the models that were explored on Day 1: linear regression, logistic regression, traditional neural networks, etc. Feature engineering is an area that focuses on specially designing raw data in order to give higher performing models. This can be a really important step in many models. However, deep neural networks can eliminate some of this step by taking raw input data and learning features within the many layers, essentially extracting important encodings necessary for predictions (or in the case of autoencoders, extracting the most important information within the latent space).

Is there a significant difference in computational expense for ordinal vs one-hot encoding?

It depends. For ordinal encoding, each class is mapped to a number and there is only one column. For one-hot encoding, each class is mapped to a binary indicator column.

So, if there are 10 (or N) classes, ordinal encoding has 1 feature, and one-hot encoding requires 10 (or N) features. So, one-hot encoding for many classes can increase the dimensionality of the input dataset, which can impact the number of model parameters, the model performance, and the computational time.

Am I correct that if order "doesn't matter" and you use a label encoding rather than a one-hot encoding, that the order may influence the ML algorithm?

Yes. Exactly! If the order doesn't matter, then label (ordinal) encoding should not be used. The ML algorithm will take those numbers and assume that there is some natural order to them (i.e., the lower or higher the value is tied to some characteristic). If this assumption is not correct, then you don't want to use this with your algorithm and can use something like one-hot encoding instead. Some algorithms may have the ability to handle this (like some tree model implementations), but many of the models that were discussed cannot.

Think about converting red, blue, green, and purple to a feature with values of 1, 2, 3, and 4, respectively. A linear regression model uses a slope term for the effect on the response. But is their really any reason why these colors are arranged in this order?

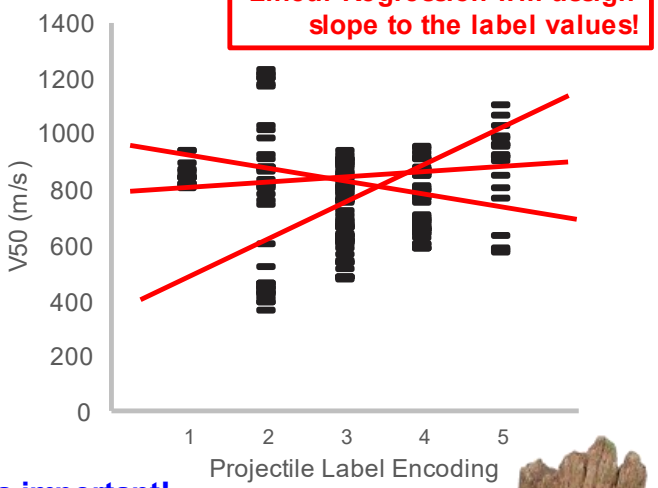
Now think about dissatisfied, neutral, satisfied being mapped to 1, 2, 3. This makes a lot more sense for label/ordinal encoding.

UNCLASSIFIED

LABEL ENCODING | OR ORDINAL ENCODING

Is the Order Important?

Projectile	#
145MMBS41	1
20MMFSP	2
CAL30APM2	3
CAL50APM2	4
CAL50FSP	5



For label encoding, the order is important!
Sometimes called "Ordinal Encoding"
Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree
Very low, Low, Medium, High, Very High

(Translation): ***Some*** (Tree) models automatically handle categorical variables!

Groot!

UNCLASSIFIED

Any comments about mapping the concept of 'degrees of freedom' from statistics to introducing LOTS of parameter columns here?

The concept of "degrees of freedom" in statistics refers to the number of independent pieces of information available for estimating a parameter or making inferences. In the context of encoding categorical variables with a large number of unique categories using one-hot encoding, it's true that the introduction of many parameter columns can ***resemble*** *an increase in degrees of freedom.*

However, it's important to note that the increase in the number of parameters doesn't directly correspond to an increase in the degrees of freedom in the statistical sense. Degrees of freedom in statistical inference refer to the number of independent observations (rows, not columns) or the effective sample size that contributes to the estimation or testing of a parameter.

Are interactions where tensors come into play?

Tensors are often associated with multi-dimensional arrays. So, interactions can be represented by tensors. I didn't go into the concept of tensors and tensor notation, but these can be very useful for representing and manipulating interactions.

If a particular parameter used in creating a NN model has no correlation to any of the other parameters, does the NN automatically cancel it out?

it depends on the training step. For example, in yesterday's excel exercises with Mark, a stronger regularization penalty (larger lambda) would more quickly drive "useless" nodes to a weight of 0. But the larger lambda is, the less accurate the neural network gets, because it also suppresses the useful nodes (just suppresses them less than the useless ones). So, there is a tradeoff.

A few answers in the chat (in red above).

I agree with the answer above, too. If a parameter in a neural network model has no correlation or interaction with other parameters, the network's learning process may assign it a small weight during training. The network will prioritize parameters that have meaningful relationships ***with the target variable****. However, the parameter is not automatically canceled out completely, as it still contributes to the model's predictions, albeit with less influence. Feature selection techniques can be used to explicitly remove irrelevant features from the model (like LASSO regularization from Day 1).*

How does this apply to time series ... e.g., if I have time series data would I want to create a column of data looking at the change from the previous measurement? or the difference from some moving average?

In time series analysis, creating features such as differencing (change from previous measurement) or differences from moving averages can help capture temporal patterns. Differencing removes trends and seasonality, while differences from moving averages identify deviations. Including these features in the model helps capture temporal dependencies and improve predictions. I also showed how a lag feature (or features) can be used as well. The sequence neural networks effectively carry this information through time until it is needed for the model prediction.

This is my first time seeing Yoda outside of the baby Yoda memes. They did a pretty good job making it look a little real. Was Yoda a puppet?

Yes, Yoda was originally portrayed as a puppet in the Star Wars films. In the original trilogy (Episodes IV, V, and VI), Yoda was operated and voiced by puppeteers, primarily Frank Oz. The puppet was meticulously designed and manipulated to bring Yoda to life on screen. Frank Oz's skilled performance brought Yoda to become an iconic and beloved character in the Star Wars universe. More info at: Yoda | Muppet Wiki | Fandom

What happens at the edges of images in convolutional neural networks?

In convolutional neural networks (CNNs), the treatment of image edges depends on the padding strategy employed during convolution. Padding is the process of adding additional pixels around the image before applying convolutional filters.

There are typically three padding options: Valid Padding, Same Padding, and Full Padding (not used). In valid padding, no padding is added. As a result, the convolutional filters are only applied to the valid pixels within the image. Consequently, the output feature map will have smaller dimensions than the input image. In same padding (below), the output feature map should have the same spatial dimensions as the input image. It achieves this by adding an equal number of pixels of padding around the image. The added pixels usually have zero values or replicate the edge values of the image.

To keep the image the "Same" size, we can pad the outside with zeros, i.e.,

0	0	0	0	0	0	0	0
0	1	2	3	4	5	6	0
0	7	8	9	10	11	12	0
0	13	14	15	16	17	18	0
0	19	20	21	22	23	24	0
0	25	26	27	28	29	30	0
0	31	32	33	34	35	36	0
0	0	0	0	0	0	0	0

Now, multiply by filter…

10	4	4	4	4	-16
24	6	6	6	6	-33
42	6	6	6	6	-51
60	6	6	6	6	-69
78	6	6	6	6	-87
58	4	4	4	4	-64

Does this work on 3D images or volumes? Do they use 27 values?

Yes. For a 3D volume with one channel (remember RGB images has 3 channels), the resulting convolutional filter would be 3x3x3 (times the number of channels) or 27 weights. The example shown in class was a 3x3 image (with 3 channels for the RGB image), which also resulted in 27 weight parameters for the filter. But for the case of a 3D volume, a 5x5x5 or other filter size could also be used, and more channels could also be necessary for each pixel.

Is the convolution layer ever done in the Fourier domain for more efficient calculation?

While the Fast Fourier Transform (FFT) convolution can be used to accelerate the computation of convolutional layers, it is not commonly used in most convolutional neural networks (CNNs) for training or inference. The standard practice in CNNs is to perform convolutions directly in the spatial domain using convolutional filters/kernels. This is because the FFT convolution has certain limitations and may not always provide significant speed improvements compared to traditional convolution in the spatial domain. Convolutional operations in the spatial domain are highly optimized and efficient, especially with the availability of specialized hardware (e.g., GPUs) that can perform parallel computations.

…and the pooling layers feels a lot like Wavelet multiscale processing?

Regarding pooling layers, their behavior can indeed resemble certain aspects of wavelet multiscale processing. Pooling layers downsample the spatial dimensions of feature maps, which helps to extract invariant and robust features. Similarly, wavelet multiscale processing involves decomposing an image into different frequency bands, capturing information at various scales.

While there are similarities, it's important to note that pooling layers in CNNs and wavelet multiscale processing are distinct techniques with different underlying principles. Pooling layers focus on downsampling and aggregation, whereas wavelet multiscale processing involves decomposition into frequency bands using wavelet transforms.

Both pooling layers and wavelet multiscale processing contribute to feature extraction and dimensionality reduction, but their specific mechanisms and mathematical foundations differ.

Are the filters used for the training set, or in the prediction, or both?

Filters, or convolutional kernels, are utilized in both the training and prediction stages of a convolutional neural network (CNN). During the training process, filters are learned and optimized through backpropagation and gradient descent. This learning phase enables the network to identify and extract important features from the input data, ensuring that the filters capture relevant patterns and characteristics.

Once the CNN is trained, the learned filters are employed during the prediction phase. When new, unseen data is presented to the network, it undergoes a convolution

operation with the learned filters. This convolution generates feature maps that represent the activations of different filters, highlighting the presence of specific features or patterns in the input. The subsequent layers of the network utilize these feature maps to perform further computations and make predictions based on the extracted features. Therefore, filters play a crucial role in both training and prediction, allowing the CNN to learn and apply relevant feature extraction to new data.

Is there a way to determine which filters are most important for classifying the image?

I think we leave that work to the CNN lol.

I'm wondering if there could be something like a Pareto chart that gives some info about which filters are most important.

A few answers in the chat (in red above).

Yes, there are methods to determine which filters are important. By examining the activations (activation mapping) and visualizing the feature maps (feature visualization), these can provide clues about their importance on classification. If you recall, I discussed the interpretability of the CNN models and included a section on saliency maps. This showed how groups of pixels relate to the final classification – similar to the methods discussed above but tracing the importance all the way back to the image.

Is this an example of how OCR works?

The process of Optical Character Recognition (OCR) involves converting images or scanned documents containing text into machine-readable text. OCR typically involves multiple steps, including image preprocessing, text detection, character segmentation, and character recognition. These steps are designed to handle the specific challenges of recognizing and extracting text from images, such as variations in fonts, sizes, orientations, and backgrounds. While OCR systems can utilize deep learning techniques, they often involve additional components and algorithms tailored for text extraction and recognition.

Is SIFT used much anymore to find features?

While Scale-Invariant Feature Transform (SIFT) was a widely used feature extraction algorithm in computer vision, its popularity has decreased in recent years. This is mainly due to the emergence of more advanced and efficient feature extraction methods, particularly deep learning-based approaches.

Deep learning models, such as convolutional neural networks (CNNs), have shown superior performance in feature extraction tasks, including object recognition, image classification, and image segmentation. These models can learn discriminative features directly from the data, eliminating the need for explicit feature engineering.

SIFT still has uses where scale and rotation invariance are crucial, or when dealing with limited training data. SIFT's robustness to various image transformations and noise makes it suitable for certain real-world scenarios.

In the stormtrooper sheet, how do we see what the value is for each "pixel" spot... can you give us the password to view?

XLS sheet without password:

https://docs.google.com/spreadsheets/d/1h9dFsxgGM7qUwrwgwM11ByRx88f5Dh-M/edit?usp=share_link&ouid=117597268280112898698&rtpof=true&sd=true

The values were 0, 0.25, and 1 for white, gray, and black, respectively.

Could you do this in Excel? (MNIST dataset)

Could you? Yes.

Should you? For 70,000 images? Hmm…

Actually, someone did this by doing gradient descent for optimization in Excel (1 hr video): https://youtu.be/kCL065_0zTY

Is the "skipping" distance an arbitrary value chosen by design, like a hyperparameter, or does ResNet learn what is the best distance to skip?
Remind me what it means for a network to be "fully connected"?

It means that every node has a connection to every node in the next layer
Fully connected is also synonymous with a dense layer

A few answers in the chat (in red above).

Question about ResNet: Is the "skipping" distance an arbitrary value chosen by design, like a hyperparameter, or does ResNet learn what is the best distance to skip?

It is a hyperparameter, since the skipping distance is not used upon execution, just in training of the model. These skip connections, which allow information to bypass intermediate layers and flow directly from one layer to a later layer, are pre-defined in the architecture. Specifically, ResNet is designed to skip over two or more layers at specific distances. This design choice helps mitigate the issue of vanishing gradients and facilitates the training of very deep neural networks. While the skip connection distances are fixed, other parameters in ResNet, such as the weights of individual layers, are learned through training to optimize the network's representation capabilities for the given task and dataset.

In the case of word [embeddings] does similarity of 1=homonym and -1=antonym?

Homonyms, by definition, are words that share the same pronunciation or spelling but have different meanings. The language models can't distinguish the same pronunciations part of homonyms but does have words that are spelled the same but can have multiple meanings. In some models, like GloVe word embeddings, there are not different word embeddings for different meanings. Like shown below for months of the year, "may" looks very different than the other months but "may" can also act as a verb, so its word embedding (based on co-occurrence matrix) can be very different from other months, which are often used in very similar contexts. In some

more complex embedding techniques, they try to generate different word embeddings for the same word based on how it is used (i.e., its context).

select list	Months Of The Year

Any words NOT in the GLOVE dictionary? — *All words in GLOVE dictionary*

dimension	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
average	0.02	0.01	0.01	-0.22	-0.20	0.08	-1.08	0.07	-0.56	-0.60	0.44	-0.53	-0.38	-0.53	1.26	0.22	-1.20	-0.48	-1.58	0.78	1.26	-0.39	0.76	-0.44	-0.62	-1.20	0.47	-0.41	-0.03	0.96	2.87	-0.38	-0.88	-0.42	0.23	-0.71	0.65	0.04	0.06	-0.37	-0.64	-0.47	-0.25	-1.30	-0.44	0.09	-0.22	-0.65	0.07	0.07
stdev	0.23	0.14	0.05	0.12	0.07	0.13	0.26	0.07	0.05	0.15	0.14	0.32	0.14	0.07	0.16	0.26	0.25	0.10	0.30	0.33	0.31	0.09	0.07	0.15	0.20	0.13	0.27	0.05	0.16	0.25	0.20	0.17	0.15	0.17	0.10	0.13	0.11	0.07	0.10	0.07	0.11	0.12	0.13	0.45	0.26	0.07	0.12	0.10	0.06	0.11
word	glove_vector (50-D)																																																	
january	-0.1	-0.1	0.0	-0.3	-0.3	0.1	-1.2	0.0	-0.6	-0.6	0.5	-0.5	-0.4	-0.6	1.3	0.1	-1.4	-0.3	-1.5	0.9	1.3	-0.4	0.8	-0.5	-0.7	-1.1	0.6	-0.4	-0.2	1.2	2.9	-0.5	-0.8	-0.4	0.2	-0.6	0.6	0.1	0.1	-0.4	-0.6	-0.4	-0.3	-1.4	-0.9	0.1	-0.3	-0.6	0.1	0.1
february	-0.2	-0.1	-0.1	-0.3	-0.3	0.1	-1.2	0.1	-0.5	-0.6	0.6	-0.6	-0.4	-0.5	1.3	0.2	-1.2	-0.4	-1.7	0.9	1.3	-0.3	0.7	-0.5	-0.6	-1.2	0.5	-0.4	-0.1	1.2	2.7	-0.6	-0.8	-0.5	0.2	-0.7	0.7	0.0	0.1	-0.3	-0.5	-0.4	-0.3	-1.4	-0.6	0.1	-0.3	-0.7	0.1	0.0
march	-0.1	0.0	0.0	-0.1	-0.1	0.0	-1.0	0.0	-0.6	-0.5	0.2	-0.9	-0.4	-0.5	1.2	0.1	-1.3	-0.6	-1.6	0.7	1.4	-0.4	0.7	-0.5	-0.7	-1.3	0.5	-0.5	0.0	0.8	3.0	-0.2	-1.1	-0.3	0.1	-0.8	0.6	-0.1	0.0	-0.3	-0.8	-0.5	-0.3	-1.4	-0.2	0.1	-0.2	-0.8	0.1	-0.1
april	0.0	0.0	0.0	-0.1	-0.2	0.1	-1.2	0.1	-0.6	-0.7	0.3	-0.7	-0.4	-0.5	1.4	0.1	-1.4	-0.5	-1.7	0.9	1.3	-0.3	0.7	-0.4	-0.7	-1.2	0.5	-0.4	0.0	0.9	2.8	-0.4	-1.0	-0.4	0.3	-0.7	0.8	0.0	0.2	-0.3	-0.7	-0.5	-0.3	-1.4	-0.4	0.2	-0.2	-0.6	0.1	0.2
may	0.7	0.2	0.1	-0.2	-0.1	0.4	-0.3	0.1	-0.5	-0.2	0.5	0.4	0.0	-0.5	0.8	1.0	-0.4	-0.7	-0.6	-0.2	0.3	-0.6	0.9	0.0	-0.1	-1.6	-0.3	-0.4	0.5	0.2	3.4	0.1	-0.7	-0.9	0.3	-0.5	0.3	0.0	0.2	-0.4	-0.5	-0.1	0.0	0.1	0.2	0.1	0.1	-0.4	0.2	0.3
june	0.0	0.2	0.0	-0.1	-0.2	0.0	-1.1	0.0	-0.6	-0.7	0.3	-0.7	-0.4	-0.5	1.4	0.3	-1.3	-0.6	-1.7	0.9	1.3	-0.4	0.8	-0.5	-0.8	-1.2	0.6	-0.4	-0.1	0.9	2.9	-0.3	-1.0	-0.3	0.3	-1.0	0.7	0.1	0.0	-0.5	-0.7	-0.5	-0.1	-1.4	-0.4	0.1	-0.2	-0.7	0.0	0.2
july	0.0	0.3	0.0	0.0	-0.2	-0.1	-1.2	0.1	-0.6	-0.7	0.3	-0.7	-0.5	-0.5	1.4	0.2	-1.4	-0.6	-1.7	0.9	1.4	-0.4	0.8	-0.4	-0.8	-1.1	0.6	-0.4	0.0	0.9	2.9	-0.4	-1.0	-0.3	0.4	-0.8	0.7	0.1	0.1	-0.3	-0.7	-0.6	-0.1	-1.3	-0.4	0.0	-0.1	-0.7	0.1	0.1
august	0.0	0.0	0.0	-0.4	-0.3	0.1	-1.2	0.2	-0.5	-0.7	0.6	-0.6	-0.4	-0.7	1.3	0.1	-1.1	-0.4	-1.8	0.9	1.3	-0.4	0.7	-0.5	-0.6	-1.1	0.5	-0.5	0.0	1.0	2.7	-0.5	-0.8	-0.4	0.2	-0.5	0.6	0.1	0.0	-0.3	-0.5	-0.5	-0.3	-1.6	-0.5	0.0	-0.2	-0.8	-0.1	0.0
september	0.0	-0.1	0.0	-0.3	-0.2	0.0	-1.1	0.0	-0.5	-0.6	0.5	-0.6	-0.4	-0.6	1.2	0.1	-1.3	-0.5	-1.7	0.9	1.4	-0.4	0.7	-0.5	-0.6	-1.2	0.5	-0.4	-0.1	1.1	2.9	-0.4	-0.6	-0.5	0.1	-0.7	0.7	0.0	-0.1	-0.4	-0.7	-0.5	-0.3	-1.4	-0.5	0.1	-0.2	-0.6	0.1	0.1
october	0.0	0.0	0.0	-0.2	-0.3	0.1	-1.2	0.0	-0.5	-0.6	0.6	-0.5	-0.4	-0.6	1.2	0.1	-1.3	-0.4	-1.7	0.9	1.4	-0.4	0.7	-0.5	-0.6	-1.1	0.5	-0.4	-0.1	1.0	2.8	-0.5	-0.8	-0.4	0.2	-0.6	0.7	0.0	0.0	-0.4	-0.6	-0.5	-0.3	-1.5	-0.5	0.0	-0.3	-0.7	0.0	0.0
november	-0.1	0.0	0.0	-0.3	-0.2	0.2	-1.2	0.1	-0.6	-0.7	0.4	-0.6	-0.4	-0.4	1.2	0.2	-1.2	-0.5	-1.6	0.8	1.3	-0.4	0.8	-0.5	-0.6	-1.2	0.5	-0.4	-0.1	1.1	2.7	-0.5	-1.0	-0.6	0.3	-0.8	0.6	0.1	0.0	-0.5	-0.7	-0.5	-0.4	-1.4	-0.6	0.2	-0.3	-0.6	0.2	0.1
december	0.0	-0.2	0.0	-0.3	-0.1	0.0	-1.1	0.0	-0.5	-0.6	0.5	-0.5	-0.5	-0.6	1.3	0.1	-1.2	-0.4	-1.6	0.9	1.4	-0.4	0.8	-0.5	-0.6	-1.2	0.7	-0.4	-0.1	1.2	2.9	-0.5	-0.9	-0.2	0.2	-0.8	0.6	0.0	0.1	-0.4	-0.7	-0.5	-0.2	-1.4	-0.6	0.1	-0.3	-0.6	0.1	0.0

Synonyms and antonyms have the same meaning and opposite meaning from other words, respectively. Since both of these tend to be used in a similar context, they actually are very similar in the embedding space. For example, the 50-D GloVe word embedding shows that the most similar words in the embedding space to "hot" are "cool" and "cold", based on cosine similarity and L2 Euclidean distance.

Word Similarity

type in a word: **hot**

in the XLS GloVe dictionary? ✓ **1**

GloVe Word Embedding

Cosine Similarity

	Top 25 Similar Words	
1	**cool**	**0.861**
2	**cold**	**0.801**
3	**mix**	**0.771**
4	*dry*	*0.756*
5	*soft*	*0.746*
6	*warm*	*0.746*
7	*roll*	*0.743*
8	*ice*	*0.742*
9	*heat*	*0.739*
10	*chill*	*0.726*

L2 Norm - Euclidean Distance

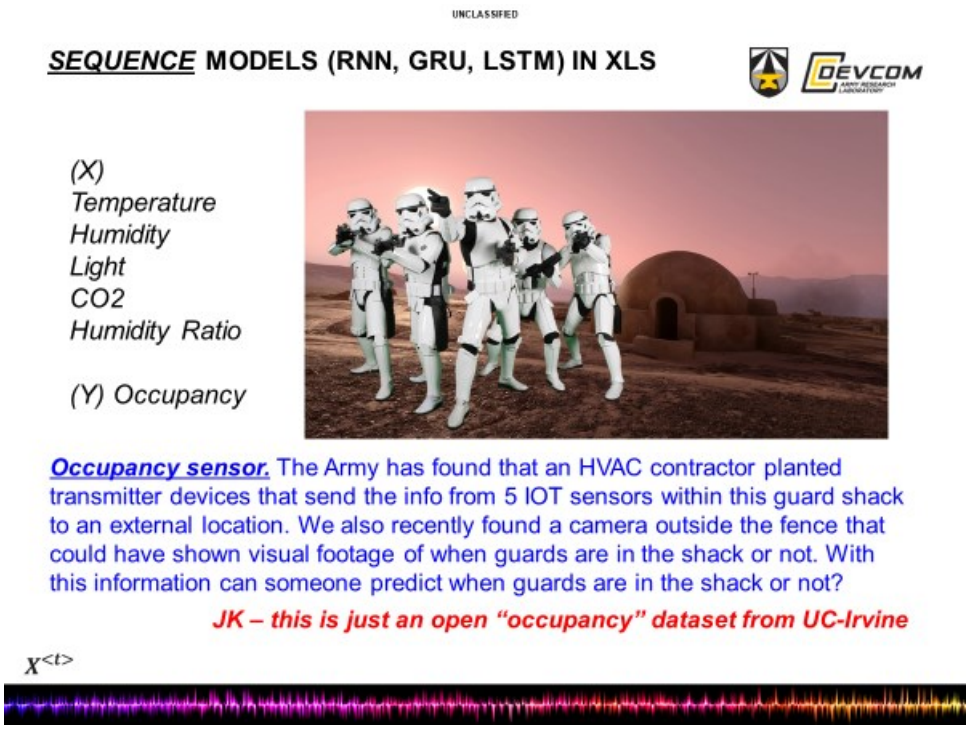
Top 25 Similar Words	
cool	**2.615**
cold	**3.169**
mix	**3.324**
roll	*3.405*
soft	*3.487*
chill	*3.529*
splash	*3.614*
ice	*3.628*
rolling	*3.634*
pack	*3.679*

L1 Norm - Manhattan Distance

Top 25 Similar Words	
cool	**14.65**
cold	**18.32**
splash	**18.93**
mix	*19.16*
filled	*19.80*
snow	*19.87*
soft	*20.01*
chill	*20.11*
dry	*20.45*
whipped	*20.47*

Can you provide an example of when you might want to use RNN, GRU, or LSTM?

Rather than providing an example of natural language processing (which in most cases, these models have been replaced with attention-based models like Transformer architectures), one example that was shown in the course was a simple occupancy sensor dataset where our inputs (X) are IOT sensors that are evolving over time and the response (Y) is the occupancy, a binary response (is there a person in the room? Is there not?). So, in truth, these models can be used with any sequence dataset (e.g., time series).



Just the chat – Day 2

Just cuz it's fun:

- I sent that video to my Star Wars loving family, and everyone loved it!
- Setting the mood with a great rendition of the Mando theme, I see. Love it! Good morning, everyone!
- So cool!
- love the music intro.
- Wow!
- Just beautiful. Thank you for this amazing energy.
- This is the way.
- TALOS!!!! at Ft Belvoir
- Agent Smith?
- It's the sweat...the smell...
- That works great with airplanes.
- I wonder if AI programs are being designed to negate effects of the bad ones.
- I think a global consortium would be necessary to discuss existential AGI risks and benefits.
- If we don't want humanity to end up as a "paperclip factory" because of misaligned AI haha.
- With Chat GPT being quite useful in writing and/or suggesting improvements to code (although it usually takes a few manual tweaks to work correctly for anything that's not really basic), I'm curious how far away we are from a LLM being able to improve its own code and/or write a better version of itself.

    - We are already breaking ground on this with stuff like self-referential weight matrices.
    - Also this is an interesting read about self-improving Pretrained Language Models for Code (PLMCs):
    - https://arxiv.org/abs/2304.01228

- Thanks Brian!
- rut rho
- We can always have ChatGPT write the regulations. Fox guarding the henhouse?
- I am always concerned about the unintended consequences of any new technology especially related to public health.
- There's a reason "Smart Cities" is a thing and "Smart Suburbs" or "Smart Countryside" is not haha. Definitely a revenue problem
- Humans can drive fine with no radar and only a single set eyes which don't even have a great vantage point (inside the car where their vision is obscured by the car itself) ...so it seems like it ought to be possible for an AI to drive without radar ;-)
- just because you can, don't mean you should.
- Lots of great questions and posting of papers, thanks!
- All the talk of regulation... I think the Imperial senate is the right background.
- the MS Teams noise reduction AI algorithm is on it.
- SOUND!
- Hooray!
- success!
- yay!!
- yesss
- Teams couldn't handle the powerful Mandalorian theme. Now it is broken forever.
- Good Job!!!
- it works!
- I find your lack of faith disturbing.
- This is the May.
- I vote "louder."
- the galactic senate rejected our motion to play audio.
- I can hear the theme in my head ... just like reading a Yoda speech bubble in Yoda's voice.
- must be the dark force.
- The Disney copyright AI bot is overruling you.
- Determined, you are.
- It's Skynet taking over and keeping us from having nice things.
- why is Microsoft still around. UNIX sure screwed up a long time ago.
- Oh man, Alpha Go is such a good documentary.
- WHAT A MOVIE!
- Cade Metz's book provided some interesting insights of the event. (Genius Makers)
- One time, ChatGPT responded so slowly that I was almost convinced someone was typing it out on the fly.
- is it weird that I see the armadillo?
- Midichlorian counts.
- Mickey Mouse dressed as Deadpool.

- YouTube has since began requiring all upload to be marked as "for kids" or "not for kids" and I'm guessing they do some checks on it now...?
- I guess it comes down to are you trying to get the AI to mimic a human or get the AI to ID stuff regardless of paint ... if I'm using AI to see if my camouflage works I kinda want it to make the same mistakes a human does.
- It just has to be significantly better than the human's judgement. Kind of a low bar IMO
- Fatigued and negligent drivers still make the same mistakes, but the public outcry when it happens isn't as big as when a computer does it.
- That is the dilemma, but who do you trust more in the other car?
- Obvious Army application: Ears and tails add-ons that make adversary AI misclassify a tank as a cat or dog. Wouldn't fool a person, just the security system/drone watching long enough to maneuver.
- Enjoy your dollhouse, Mark!
- This would be a definite place where a lesson learned database would be beneficial. Like all safety precautions, incidents (including fatal ones) are beneficial.
- sounds like The Onion?
- It worked in RoboCop!
- steps are the best way to defeat robots and Daleks.
- Will Smith was saved instead of little girl in I Robot because the little girl would never have slapped Chris Rock?
- Man that is tough to watch... I actually feel bad for this guy!
- oh noooo
- Do you need a CV in Fast food industry?
- That is a fantastic question! We tend to think of training it with data that is unsoiled by "us"...
- "Garbage in garbage out" is a saying as old as programming!
    - Unfortunately, in this case, we (humanity) are the garbage!
- "Emotional contagion"
- "I'm sorry Dave, I'm afraid I can't do that." - HAL
- Open the pod bay doors HAL!
- thanks Mark
- K-Fold Cross Validation
- best show!
- What If was awesome!
- Excellent
- Like how it folded into Dr. Strange / Multiverse
- You really wanted that one stuck...
- "noooooooooo!"
- -vader quote
- Grogu would be hungry by now.
- sounds good!
- My kids love this one.
- OMG - the thing you don't expect to take away from ML101.
- Talk about something I won't get out of my head all weekend...
- it looks better than the CGI baby Yoda.
- except the backpack part which was kinda funny
- Jim Henson was just that good...
- baby Yoda is mostly puppeted in the show!

- Very neat to have all of those filter examples!
- Convolution Layer 2 looks like what individual animal eye neurons are currently believed to do, if I'm not mistaken.
- That is a strangely octopus shaped eel.
- lol mislabeled dataset!
- do or do not...
- A lot of it could be in error.
- where waldo is (finally)
- Could be neat to capture likelihood of aggressive behavior in a person given their posture.
- tie fighter present?
- can we identify the distance between labeled object as an input?
- would distance use image metadata ... e.g., lens/focal length?
- Best one yet lmao
- It's better live...
- that's awesome!
- Weird Al is a national treasure.
- R2 is chaotic good.
- machine learning biased toward machines?
- he got Greedo right.
- Princess Leah is the only female!
- Simpson's Yoda LOL
- Interesting. I previously tried asking the Bing AI chatbot about which was cuter between some animals, and it replied that cuteness is subjective but that many people find both of those animals cute (which I thought was appropriate). But the ChatGPT bot is a bit less careful, I suppose.
- Needs more Jar-Jar
- We obviously see the bias toward "cute" = "good"
- But that's likely a realistic bias.
- I think it's severely under estimating Grogu.
- He eats people's kids.
- that is helpful, thanks!
- Huey Lewis sang it.
- Maybe it's Monica Rambo
- March is a verb.
- I guess that "March" is not used as a verb often in general society, whereas may is used in its non-month form often in general society.
- March the month and march the verb are fairly similar, especially compared to may the month and may the (whatever part of speech that is)
- Based on the values though March should have ranked somewhat lower than the other months
- Frequency in parts of speech you're describing? My first thought is in Imperial March if it is used as a verb.
- Fascinating
- The look on my dog's face right now hearing this is priceless...
- I like it. Where do you get those, and do you need a green screen behind you? LOL
- Sending the autoencoder video would be great.
- So humble!
- I wonder how logistic would work if it had access to "data from time before" for each point.

- A long and again educational day! The time series circuits are hard. All of your excel sheets are really impressive and informative.
- Addition of NLP especially the visualization part is awesome. Very Interesting concepts.
- Excellent Job! Thank you, Mark. Thank you very much for an excellent course! Thanks Mark! thanks...great course! Thank you so much! Thank you, Mark. Thank you, it was great! Mark, outstanding job, very informative. Thank you very much. Thank you very much... Thanks Mark. May the 4th be with you. Go rest your voice! Thank you! Mark Awesome, thank you! Thanks so much Mark. Great course! Thank you! You did an amazing job! thank you for the informative course. very nice class-Doc! loved it! See you on LinkedIn! Awesome course! Thank you, Mark. thanks for such an amazing tutorial!

Dropping knowledge in TEAMS chat – Day 2

Recording some of the links and info shared in the chat:

- I recommend following Missy Cummings about autonomous vehicles research & facts
    - (4) Missy Cummings | LinkedIn
- Stanford AI links
    - https://hai.stanford.edu/research/ai-index-2023
    - https://hai.stanford.edu/news/2023-state-ai-14-charts
- NPR had a piece this morning on a study done at a call center where the staff was using an AI chat tool to respond to questions...turns out it benefited the least skilled people the most (16% productivity increase) and got them up to a higher skill level more quickly...the staff got the AI generated response but had the choice of using it or not...
- Agents and LLMS:
    - 2304.03442.pdf (arxiv.org)
- Policies typically govern the application of the technology (like aerospace, or weapons) and not the development. For instance, you can develop killer robots, but there are policies on US use of robots or autonomous systems to implement killing actions...
- Chat-based search flunks the "show your work" test.
    - https://www.axios.com/2023/05/03/chat-based-search-citations-accuracy-research
- Self-supervised learning can be applied to large models, so they can be improved on the fly so to speak.
- There was significant pushback with seatbelt regulations; I'm sure this would be manyfold if you were to threaten the "right" to drive. I'd leave it elective--if it works, people will use it. Who wouldn't want to relax, watch a movie, read a book, or crochet a sweater on their morning commute?
- Driverless cars:
    - On driverless cars, actually humans don't drive all that well, because in the US we have > 30,000 fatalities yearly! The funny tradeoff is this: Would you accept all driverless cars and give up your right to drive, if the death rate reduces to, say, 3,000 per year?
    - Driverless cars, part 2: It's a grand challenge to do this with purely passive sensing (vision). But, if we add active sensing (like radar), can we do better than human drivers? Hopefully the answer is yes! Then we can bring down the annual death rate on our highways.

    - Driverless cars, part 3: Yes, using a NN for vision can be fooled, poisoned, etc. So, the answer is a systems design that is robust, redundant, and therefore safe. So, you can use the NN in general, but you should have some safety checks. Example: Your NN "sees" a stop sign, so now independently verify that it's red, has the right shape, the right text, etc. Note that this verification is not part of the NN.
    - Driverless cars, part 4: Adoption and acceptance in society depends on our trust and appreciation of the technology. The psychology is interesting. Classic example: a person may choose to smoke because they discount the long-term effects, but on the other hand they won't fly because they have to give up control, even though flying is **far** safer than driving to the airport is.
- Tesla has gone to all cameras. They took away the ultrasonic sensors.
- It varies between manufacturers, Honda and Toyota both use radar and LiDAR in their systems for multi-car ahead detection and tracking for example.
- NIST publication on Adversarial Machine Learning:
    - https://nvlpubs.nist.gov/nistpubs/ai/NIST.AI.100-2e2023.ipd.pdf
- there are some examples showing how putting a couple of dots on faces etc. fools AI into not recognizing a human. But my view is just that means that the AI is not trained robustly enough. Just like training a human, we need to train for all kinds of contingencies.
- This is a bit of a plug, but NIST has some resources talking about Trustworthy & Responsible Artificial Intelligence:
    - https://airc.nist.gov/Home which includes an AI Risk Management Framework which dives into many of the risks and issues for a trustworthy AI system:
        - https://airc.nist.gov/AI_RMF_Knowledge_Base/AI_RMF
- For adversarial AI, there's the example of KataGo (beat AlphaGo 100 to 0), being beat by an amateur 14:1 since it can get distracted by random noise plays.
    - "If you know the enemy and know yourself, you need not fear the result of a hundred battles." - Sun Tzu
- A summary of major AI events
    - https://www.youtube.com/watch?v=Sqa8Zo2XWc4
- For the pixel-based attacks and other types of adversarial inputs, there is work on-going called "Certifiable Robustness".
    - Certified Adversarial Robustness via Randomized Smoothing (arxiv.org) and
    - 1905.12105.pdf (arxiv.org) are examples.
- McDonald's opens its first robot automated restaurant in Texas:
    - https://www.youtube.com/watch?v=FPFc0FvAN18
- I use Positive/Negative Disagreements/Agreements instead of False Negative, False Positive etc. because we don't know if either are right or wrong, only if they agree or not.
- Stephen Wolfram had an excellent post about ChatGPT:
    - What Is ChatGPT Doing … and Why Does It Work?—Stephen Wolfram Writings
- Singular Value Decomposition is SVD
    - Singular value decomposition - Wikipedia

Thank you! May the Force be with You!

Appendix D. Frequently Asked Questions

The following section contains questions and answers about ML concepts, based on a fraction of questions asked within Appendix C.* This shows the types of questions that participants were curious about as they were taking the course. The following questions were compiled in a conversational dialogue using Google Gemini's model from the https://genai.mil/ website. The initial queries were often detailed and situational, while the answers were insightful but informal and candid. To make this appendix a valuable reference, each entry has been processed in a two-step refinement.

First, the user's original, verbose question was distilled into a direct and concise query. The goal was to capture the core of the inquiry so a reader can immediately understand the topic. For example, a detailed situational question like:

> I was able to learn from you how to build a NN and train it on combinations of parameters and outputs (X's and Y's). But could a NN be used in an optimization sense? For example, if I have a set of X's and Y's already, but I am looking for the best set of X's to produce a certain Y value (that I already know), can a NN find that best set?

. . . was refined into the more direct question: "Can a trained neural network be used to find the best input parameters (X) to achieve a specific output (Y)?"

Second, the original, often stream-of-consciousness answer was edited to provide a structured explanation, while preserving the original answer's logic. As with most language models, it converted what were initially paragraph-form answers into itemized lists, for ease of reading. For instance, an initial answer to the question of AI degrading human skills was as follows:

> Hmm. I don't know. Why do we need to do calculations by hand if our trusted calculator can do it for us? Uh oh, if they take away our calculators, can we compute the hypertangent of 30 degrees? I think there are studies that show that people may start to trust the machine too much, and that may be a problem. How do you know when the machine

*There were hundreds of questions asked and answered both within these documents as well as in the course. This appendix section tried to curate some of the common questions that arose or the common concepts. All questions pertaining to "Where do I find files?," "Are you going to release videos?," etc. have been removed so that the general ML questions about concepts remain.

is wrong? On the other hand, calculators are awfully convenient, and aren't we really just talking about more massive calculators (ok, not quite, but close).

This was then refined into the final version seen here, which starts with a direct answer but keeps the original analogy: "Yes, this is a significant concern known as 'automation bias,' where humans can over-trust automated systems. Think of a calculator: while it's an invaluable tool, overreliance on it can atrophy one's ability. . . " This approach aims to provide clear, helpful answers without losing the unique and valuable perspective of the original conversation. Last, these questions and answered were formatted into various colored boxes (no meaning assigned to colors) for ease of reading.

How do I know how many layers and nodes I need for a given problem? Is there some kind of "rule of thumb?"

I think rules of thumb come with experience. I would try out multiple layers, multiple node constructs, and use the validation set to tell you which is best for your dataset. You might be surprised at how few nodes you need to capture the pattern in your data.

Can a trained neural network be used to find the best input parameters (X) to achieve a specific output (Y)?

Yes, this is a powerful application of a trained model. Once your network is trained and validated on your data, it effectively becomes a high-speed mathematical surrogate for the real-world system. You can then use this surrogate model with optimization algorithms to efficiently search for the optimal set of input parameters (X) that produces your desired output (Y), a process often called **inverse design** or **optimization**.

Are there dangers to using synthetically generated data?

Nope. I can't see any problems with making up data to train mission-critical models with.

(Joking aside, the dangers are significant.) The core challenge is ensuring the synthetic data possesses identical mathematical and statistical properties to the real-world dataset it represents. If the synthetic data is a true proxy, it's a powerful tool. However, if it fails to capture the true underlying distributions, correlations, and outliers of the real data, any model trained on it will be fundamentally flawed, leading to poor generalization and unreliable performance on real-world problems.

Does reliance on AI/ML models risk degrading human decision-making skills?

Yes, this is a significant concern known as **automation bias**, where humans can over-trust automated systems. Think of a calculator: while it's an invaluable tool, over-reliance on it can atrophy one's ability to perform mental arithmetic. Recent findings on LLMs suggest a similar effect, showing users engage certain parts of their brain less when the model provides an answer.

In a military context, this is critical. A leader who cedes judgment to an AI risks degrading their own tactical intuition and decision-making capabilities. The crucial principle is to use AI as a powerful analytical tool that provides input, but never as a replacement for human experience and final command authority.

What is the purpose of the intercept or bias term, and why add a column of ones to the input data to handle it?

The **intercept** b (a term from linear regression, $y = mx + b$) is called the **bias** in a neural network. Its purpose is to provide an independent offset, allowing the model's activation function to shift left or right. Without a bias, the model is forced to pass through the origin (0,0), which can severely limit its ability to fit the data.

Adding a column of ones to your input matrix is a computational trick to handle this bias elegantly. You have two mathematically identical options:

1. Calculate the weighted sum of inputs and then add the bias separately.
2. Augment your inputs with a column of ones and add the bias to your list of weights. Now, you can get the same result with a single, clean matrix multiplication.

In short, the bias itself is fundamentally important for model flexibility. The column of ones is simply a convenient programming method to fold that bias calculation into the main matrix multiplication, making the code simpler.

Are hyperparameters similar to locally scoped variables in programming?

A better analogy is that hyperparameters are like settings in a configuration file that you define before training begins. They are the high-level rules that control the learning process itself.

Common examples include the following:

- The learning rate
- The number of hidden layers and nodes
- The choice of activation function (e.g., ReLU)

The model's internal **parameters** (its weights and biases) are what get optimized during training, guided by these rules.

Can you explain the concepts of Bias and Variance in machine learning?

Bias and Variance are two competing types of error that dictate model performance. The goal is to find a balance in their trade-off.

High Bias Error from a model that is too simple, leading to **underfitting**. It fails to capture the underlying patterns in the data. (Analogy: Consistently missing the target in the same spot).

High Variance Error from a model that is too complex, leading to **overfitting**. It learns the noise in the training data, not just the signal. (Analogy: Shots are scattered randomly all over the target).

Regularization seems like just massaging an overfit model. Why not just build a good model from the start?

You've described the process well. The standard workflow is often to first build a model complex enough to intentionally overfit, then use regularization to **methodically** reduce its complexity. This is generally easier than trying to fix an underfitting model.

The search for a "better" model from the start is the training process—experimenting with different architectures guided by your validation set. While the validation metrics are objective, the initial choices of what to try are subjective, which is why subject matter expertise is so valuable.

Why do we need a separate test set? Why not just use the validation set?

The validation set is used to select the model type and tune its hyperparameters. Because you make design choices based on this set, the model becomes biased to perform well on it, leading to overconfidence.

The test set is a final, unseen check. It provides an unbiased measure of how the model performs on completely new data, which is the true test of its ability to generalize. Think of it as the real exam after studying with practice tests (the validation set).

Why not use all the data for training and then predict?

In one word: **overfitting**. A model trained on all the data might perfectly memorize that specific dataset, including its noise, but then perform terribly on new data.

Without holding back some data for validation and testing, you are "flying blind." You have no way to know if your model is overfit, underfit, or genuinely useful for predicting on unseen data. These holdout sets are your only check on the model's true performance.

How is accuracy calculated in classification tasks?

Accuracy is the number of correct predictions divided by the total number of predictions.

Since a model's raw output is a probability, we convert it to a class prediction first.

- **Binary (Two Classes):** The output probability is rounded to the nearest integer (0 or 1).
- **Multiclass (More than two):** The class with the highest predicted probability is chosen as the prediction.

We then count how many of these predictions match the true labels in the dataset to calculate the accuracy.

How are the initial weights for a model chosen?

Initial weights are typically set to small random numbers. This is crucial for breaking symmetry, ensuring that different nodes in the same layer learn different features.

- For simple models like linear regression, setting weights to all zeros or simple random numbers is often sufficient.
- For deep neural networks, more advanced random initialization methods like **Xavier** or **He initialization** are standard. These methods are carefully designed to set the initial variance of the weights, which helps prevent issues with gradients vanishing or exploding during training.

What strategies are used for hyperparameter tuning? Is it just a random search?

Yes, your analogy of searching an n-dimensional space (where n is the number of hyperparameters) is correct. Several strategies exist to find the best combination:

- **Grid Search:** Exhaustively tests every combination on a predefined grid of values. Can be computationally expensive.
- **Random Search:** Randomly samples points within the hyperparameter space. It is often more efficient than grid search at finding good combinations.
- **Latin Hypercube Sampling:** A more advanced sampling method that ensures the search points are more evenly spread across the space, making it more efficient than pure random search.
- **Automated Methods:** Advanced approaches (like Bayesian Optimization) that use the results of past trials to intelligently decide where to search next.

How do you choose the number of nodes in the hidden layers?

The number of nodes is a hyperparameter, so you let the data guide your choice. There's no magic formula.

The standard approach is to experiment. Train several models with different numbers of nodes (e.g., 5, 10, 20) and see which one performs best on your validation set. The architecture that results in the lowest cost (or highest accuracy) is the one you select for your final model.

Can a neural network have multiple outputs to represent confidence levels, not just the final category?

Yes, a network can have multiple outputs. Your question touches on the concept of a model's confidence in its own predictions.

Standard classification networks already do this indirectly: the output probabilities (e.g., 70% for Class A, 30% for Class B) represent a form of confidence. However, a more advanced approach is **Uncertainty Quantification**. Special models can be designed to provide two outputs: the predicted class, and a separate, explicit measure of the model's certainty in that prediction.

How does the bias of an AI algorithm compare to human bias?

Human bias is cognitive. AI bias is a direct reflection of the data it's trained on. An AI is not inherently biased, but if its training data contains biases from human decisions or historical inequalities, the AI will learn and reproduce them.

The critical difference is scale. A biased human makes one bad decision at a time. A biased AI can make millions of flawed decisions automatically, amplifying the original human bias. The advantage, however, is that AI bias can sometimes be systematically audited and corrected by adjusting the data or algorithm, which is much harder to do with human cognition.

How do for-profit models influence the "moral" development of AI?

This points to a fundamental conflict of interest. AI systems built for profit are often designed to optimize simple metrics that correlate with revenue, such as user engagement or watch time.

The ethical dilemma arises when an algorithm discovers that the most effective way to maximize its goal is by promoting morally questionable content—like outrage or misinformation. This raises a key question: is the negative outcome an intentional choice by the developer, or an unintended consequence of the AI ruthlessly optimizing its programmed goal? The true moral test is what a company does to correct these harmful emergent behaviors once they are discovered.

When should I use a single model for multiple categories versus separate models for each?

A single, multicategory model can be advantageous, as it often has a **regularizing effect** and promotes knowledge transfer. It's especially useful in two scenarios:

- **Sparse Data:** When some categories have very little data, the model can apply patterns learned from data-rich categories to improve predictions for the data-poor ones (a form of transfer learning).
- **Noisy Data:** A single model may generalize better by learning the overarching trends across all categories, ignoring noise that might mislead smaller, individual models.

However, if each category has abundant, high-quality data, training separate models can perform just as well or better, as each can specialize on its own unique patterns.

How do you determine what patterns a model has learned?

The primary method is by examining the model's **latent space**. This is the compressed, internal representation where the model distills the most important information it has learned from your input data.

By analyzing this space, you can discover what the model found important. The most common technique is to correlate the variables in the latent space back to your original input features. This reveals which features (or combinations of features) the model learned to associate with certain outcomes, effectively showing you the patterns it discovered.

Is the main idea of an autoencoder to replace many features with fewer features to train another model faster?

Yes, that is a primary use of autoencoders, known as **dimensionality reduction**. An autoencoder is trained to compress the input data into a smaller, dense representation (the latent space) and then reconstruct it. This compressed representation can then be used as a highly efficient set of features for training a different model.

However, autoencoders have several other powerful applications, including:

- **Denoising:** Training an autoencoder to reconstruct a clean image from a noisy one.
- **Anomaly Detection:** Anomalies often have high reconstruction error, as the model struggles to recreate data it has not seen before.
- **Data Imputation:** Filling in missing values in a dataset.

Can you use an autoencoder for sequential data, like time series or text?

Yes. This is typically done using an **autoencoder architecture built with recurrent neural networks (RNNs)** or their more advanced variants, like LSTMs or GRUs.

The structure is:

- The **Encoder** is an RNN/LSTM that reads the input sequence step-by-step and compresses it into a single, fixed-size vector representing the latent space.
- The **Decoder** is another RNN/LSTM that takes this vector as its initial state and generates the output sequence.

This encoder-decoder model is the foundation for many sequence-to-sequence tasks, most famously in machine translation, where a sentence in one language is encoded into a latent vector and then decoded into another language.

Is output from a Generative Adversarial Network (GAN) trained on copyrighted data a copyright violation?

This is one of the most complex legal questions in AI today. The answer depends on two main issues that are being actively litigated in courts:

- **The Training Data:** AI companies often argue that ingesting copyrighted material for training constitutes **fair use**. Content creators and copyright holders argue it is mass-scale infringement. This is the central question in several major lawsuits.
- **The Generated Output:** The legality of the output hinges on whether it is "substantially similar" to a specific copyrighted work. If a GAN produces an image that is nearly identical to a copyrighted photo, it is likely an infringement. If it produces a completely novel image that merely learned the **style** of the training data, it is likely not.

In short, while the act of training is being challenged, the output is a violation only if it is a recognizable copy of an existing copyrighted work.

Is there a preference for using prime numbers (e.g., 3, 5, 7) for convolutional neural network (CNN) filter dimensions?

No, the preference is not for prime numbers, but for **odd numbers** for convolutional filters and **even numbers** for pooling filters.

- **Convolutional Filters (e.g., 3×3, 5×5):** These filters are almost always odd-dimensioned. This ensures the filter has a clear central pixel, which is necessary for the sliding window operation to be symmetric and aligned with the input feature map.
- **Max-Pooling Filters (e.g., 2×2):** These filters are typically even-dimensioned. Their purpose is to downsample or reduce the dimensionality of the feature map, and a 2×2 filter with a stride of 2 perfectly halves the height and width, which is a very common and efficient operation.

(Convolutional Layer) Where does the output channel depth come from?

The depth of the output volume is determined by the number of filters you use in that convolutional layer.

Each filter scans the input and produces its own single-channel output map. Therefore, if you define 10 filters for that layer, the output volume will have a depth of 10 channels, with each channel representing the features detected by one of those filters.

Can a CNN be used on data structured like an image (e.g., a 2D grid) if it represents simulation outputs instead of a visual image?

Yes, absolutely. A CNN is fundamentally a pattern detector for grid-like data; it does not care if the values represent pixel colors, temperatures, pressures, or any other output from a simulation. If there are spatial patterns in your data (i.e., neighboring points are related), a CNN is an excellent tool for analysis.

The separate challenge you mentioned—using simulation data to predict on real-world data—is a problem of **domain adaptation**. For that to work, you must ensure the statistical distribution of your simulated data is nearly identical to the distribution of the real-world data.

Is optimization in neural networks driven by backpropagation?

Yes. Backpropagation is the algorithm used to calculate the gradient (the direction of steepest descent) of the loss function with respect to each weight in the network. An optimizer then uses this gradient to update the weights and minimize the loss.

This is true for all network types, but sequential models like RNNs, long short-term memories (LSTMs), and gated recurrent units (GRUs) have a special consideration:

- They use a version called **Backpropagation Through Time**, where the error is propagated backward through the sequence. This can lead to the **vanishing/exploding gradient problem** on long sequences.
- Architectures like LSTMs and GRUs were specifically designed with **gates** to better control the flow of the gradient, allowing them to capture long-term dependencies that are lost in simple RNNs.

Can AI/ML be used to clean data?

Yes, it's a powerful and growing application. While data cleaning is often seen as a prerequisite for machine learning, AI can be used to automate the cleaning process itself.

Some common techniques include the following:

- **Anomaly Detection:** Training models to identify and flag outliers or erroneous data points that do not fit expected patterns.
- **Data Imputation:** Using models like autoencoders or regression to intelligently fill in missing values based on other features.
- **Automated Correction:** Building classifiers to automatically correct misspelled or inconsistent categorical labels (e.g., standardizing "USA" and "United States").

As you noted, specialized tools and companies are now emerging that offer these AI-powered data cleaning services.

Are correlated input variables a problem for a model?

Generally, no. A model can learn to handle correlated variables. However, the degree of correlation matters:

- **Perfect Correlation ($R = 1$ or -1):** You should remove one of the variables. It's redundant and provides no new information.
- **High Correlation:** This can be a symptom of overfitting. The model might assign very large, unstable weights (thetas) as it tries to use the tiny differences between the variables to make predictions.
- **The Solution: Regularization** is the perfect tool for this. By penalizing large weights, it stabilizes the model and prevents it from overfitting to highly correlated features.

How should outliers be handled?

Handling outliers requires careful judgment. You must first ask: is it a true error or just an extreme, but valid, data point?

- **Legitimate Extremes:** If the outlier is a rare but real event that your model should expect to see in the wild, removing it will damage the model's performance when that event occurs.
- **Data Errors:** If you can confirm the outlier is due to a known mistake (e.g., a sensor failure or data entry typo), then you have a valid reason to remove it.

Never remove an outlier simply because it's an outlier; first, determine its cause.

Must the activation function be the same in every layer?

No, they can be different. While you could technically assign a unique activation function to every node, it's rarely done.

In practice, a single activation function (like **ReLU**) is used for all hidden layers for simplicity and consistency.

The one layer that almost always has a different activation function is the **output layer**. The choice here depends entirely on the type of problem you are solving:

- **Sigmoid** for binary classification.
- **Softmax** for multiclass classification.
- **Linear** (i.e., no activation) for regression.

Are CAPTCHAs used to train pattern recognition AI?

Yes, this was a primary function of Google's reCAPTCHA system for many years. When you solve a CAPTCHA, you are acting as a human labeler for data that a machine finds difficult to interpret.

The process has two parts:

1. The system shows you a known image/word that it can already solve to verify you are human.
2. It simultaneously shows you a new, unknown image/word that Google's AI is uncertain about. By correctly identifying it, you provide a high-quality label for their training datasets.

This system was originally used to digitize books by identifying scanned words that optical character recognition software could not read. It then evolved into identifying objects like street signs, cars, and storefronts to improve Google Maps and train self-driving car models.

Does the smooth latent space of a Variational Autoencoder make it resistant to adversarial attacks?

That's a great intuition, but surprisingly, Variational Autoencoders are still highly vulnerable to adversarial attacks.

Even though the latent space is globally smooth, a small, carefully crafted perturbation to an input can push its representation off the learned data manifold into an "empty" area of the latent space. When the decoder attempts to reconstruct an image from this unfamiliar point, it often produces a completely nonsensical output.

This vulnerability has become an active area of study. Defenses are being developed to make the models more resistant to these attacks.

Are CNNs automatically invariant to scaling and rotation, or only translation?

This is a key insight into how CNNs work. Standard CNNs are inherently robust to **translation** due to their sliding filters and pooling layers. However, they are not automatically robust to other transformations like rotation or scaling. To a standard CNN, a rotated object can look like a completely new object.

To make your model handle rotation and scaling, the most common and effective technique is **data augmentation**. Before training, you artificially expand your dataset by creating copies of your images with random rotations, scales, shears, and flips applied. This teaches the model that a rotated object is still the same object.

While more advanced architectures exist that attempt to build this invariance into the network itself, data augmentation is the most common and practical approach.

How do optimizers handle problem spaces with many local minima?

This is a core challenge in deep learning. While there is no guarantee of finding the absolute global minimum, several strategies are used to find a "good enough" local minimum:

- **Global Optimization Algorithms:** Methods like particle swarm optimization or genetic algorithms are designed to explore the entire search space. However, they are often too computationally expensive to be practical for training high-dimensional neural networks.
- **Advanced Gradient Descent Optimizers:** This is the standard approach in deep learning. Optimizers like **Adam**, **Adagrad**, or **Momentum** modify standard gradient descent. They incorporate a "memory" of past updates, which helps the optimizer build momentum to **roll past** shallow local minima and settle into deeper, more effective ones.

The goal is not necessarily to find the single best solution, but to use these advanced optimizers to consistently find a very good one.

What is the purpose of regularization?

Regularization is a technique used to prevent **overfitting** by making a model "simpler."

It works by adding a penalty to the loss function that discourages the model's weights (parameters) from growing too large. A model with smaller weights is less sensitive to the noise in the training data. The result is a model that is just right—it sacrifices some performance on the training set to achieve better, more reliable performance on new, unseen data.

What is the difference between the validation and test sets?

Think of the validation set as the tool for hyperparameter optimization. The two sets serve distinct but equally critical roles:

- **Validation Set:** Used during development to make decisions. You test your model against it repeatedly to tune hyperparameters and select the best model architecture.
- **Test Set:** Used only once at the very end. After all training and tuning are complete, this pristine holdout set provides the final, unbiased measure of how well your model generalizes to new, unseen data.

Reporting performance from the validation set would be misleadingly optimistic, as the model has been indirectly tuned for it. The test set provides the true performance score.

After using cross-validation to test multiple models, what comes next? Which one is the final model?

Cross-validation is the process you use to select the winning combination of model architecture and hyperparameters. It does not produce the final model itself.

The standard practice is as follows:

1. Use cross-validation to identify the best-performing model configuration (e.g., a specific neural network architecture with an optimal learning rate).
2. Once you have the winning configuration, you typically retrain that single model from scratch on the entire combined training and validation dataset.
3. This newly trained model is your final model. You then evaluate its performance one last time against the completely unseen test set to get the final, unbiased performance score.

What does poor performance on the test set suggest?

Poor performance on the test set is a critical warning flag. The next step depends on how it compares to your other sets:

- **If performance is poor across all sets** (training, validation, and test), it suggests your model is **underfitting**. It's too simple or the wrong type for the data. Re-examine your model architecture and hyperparameters.
- **If performance is good on training/validation but poor on the test set**, it points to a **data distribution mismatch**. Your test set contains data or patterns that your model was never trained on. The ideal is for all three datasets to have the same distribution; a mismatch here indicates the model has failed to generalize.

How do you determine the optimal size of a mini-batch?

Batch size is a hyperparameter, so you should let your validation set guide the choice. The standard method is to experiment with different sizes (e.g., 16, 32, 64) and select the one that results in the best performance (lowest cost or highest accuracy) on your validation data.

The goal is to find the sweet spot:

- **Small batches** are computationally fast per iteration but provide a noisy estimate of the gradient, which can slow overall convergence.
- **Large batches** provide a more accurate gradient but are computationally expensive and can sometimes lead to poorer generalization.

The optimal size is one that best approximates the true gradient of the full dataset with a fraction of the computational cost.

Is there a hard limit on how many nodes can be dropped in a layer? What if all nodes are dropped?

There is no hard limit coded into the dropout function, but there are practical consequences that make it a poor strategy for small layers.

It is possible (though statistically unlikely with large layers) for the random dropout mask to select all nodes in a layer to be dropped. If this occurs:

- The output of that layer becomes all zeros for that specific training step.
- The forward pass will complete without error.
- However, backpropagation will stop at that layer, as the gradient cannot flow through the zeroed-out nodes. No weights in any preceding layers will be updated in that step.

This does not crash the model, but it makes training extremely inefficient. Therefore, if you have layers with very few nodes, a high dropout rate is not recommended. Other methods, such as **L2 regularization**, are a better choice in that scenario.

How does the multidimensional output of the convolutional layers get collapsed into one dimension for the final classification?

This is done by a dedicated layer called a **Flatten** layer.

Its sole purpose is to take the multidimensional output volume from the final convolutional or pooling layer (e.g., a $5 \times 5 \times 16$ tensor) and reshape it into a single, long 1D vector (e.g., $5 \cdot 5 \cdot 16 = 400$ elements). This vector then serves as the input to the first fully-connected (Dense) layer, which performs the final classification.

How do you assess the trustworthiness of a pretrained model?

You should always verify a pretrained model's performance on your own problem. A good workflow is as follows:

1. **Check the Source:** Review the original paper or documentation. The authors should report the model's accuracy on standard benchmark test sets, which gives you a baseline for its general performance.
2. **Validate on Your Data:** The most important step. Test the model's performance on your own labeled data (a holdout set it has never seen). This tells you how well its learned patterns generalize to your specific problem.
3. **Use Transfer Learning if Needed:** If the model performs poorly out-of-the-box, do not give up. The most common strategy is **transfer learning**. Freeze the early layers of the network and retrain only the final layer(s) on your dataset. This fine-tunes the model to adapt its general knowledge to your specific data.

How often do machine learning models need to be retrained?

The retraining frequency depends entirely on the application. This process is managed by a discipline called **Machine Learning Operations (MLOps)**.

The primary trigger for retraining is a phenomenon known as **data drift** or **concept drift**. This happens when the live data your model sees in production starts to differ from the data it was trained on.

An MLOps pipeline continuously monitors the live input data for this drift. When a significant deviation is detected, the pipeline automatically triggers a retraining process on the new, more relevant data to ensure the model's performance does not degrade. Beyond retraining, MLOps also handles version control for your models, data, and code to ensure the entire system is robust and reproducible.

How much data is enough data?

The flippant answer is: "All of it."

The practical answer is that the amount of data you have dictates the complexity of the model you can build. The goal is to have enough high-quality data to accurately represent your real-world problem, including its noise.

- **If you have a small dataset,** start with a simple model. A complex model trained on too little data will almost certainly overfit.
- **As you collect more data,** you can justify increasing the model's complexity to capture more intricate patterns.

It's also about data quality. Focus on collecting "good" data. Data known to be incorrect can be useful for testing what your model does not learn, but data of unknown quality should be discarded.

Appendix E. Jane's International Defense Review Interview

The questions and responses included in this report were prepared for a feature article in Jane's *International Defence Review* (November 2025) and reflect the context, priorities, and information available at that time. They have not been updated to reflect subsequent changes, in order to preserve the original context and provide an accurate representation of the interview content as it was prepared.

Question 1: Could you outline the background to the course that took place earlier this year—was this the first such version of this course? Did it build on previous courses? If so, how?

The "AI for Soldiers" course emerged from a request by the AFC to expand the Strategic Broadening Seminar (SBS) series with a dedicated AI curriculum. What made this course unique within the SBS program was that it was developed and taught internally by Army researchers—a departure from the typical academic, industry, or think-tank led SBS courses. ARL had been conducting various AI-related training initiatives, including a popular introductory Machine Learning course, and we leveraged that expertise to create a comprehensive two-week program in 2024. It was a significant team effort, involving nearly 100 personnel. The feedback was overwhelmingly positive, with participants noting the course felt remarkably polished for a first iteration. This year, at the direction of Army G-3/5/7, we streamlined the course to one week, focusing on core concepts and maximizing impact. Interestingly, participant feedback improved with the condensed format, suggesting a focused approach resonated well.

Question 2: What technologies were in focus (i.e., convolutional layers, generative adversarial networks, transformer models) – could you talk about why it was important to focus on these technologies?

The course dedicated a day to essential AI concepts—its history, different approaches, and the basics of building a simple AI model. We then delved into Machine Learning, starting with simpler models to establish a strong conceptual and mathematical understanding before progressing to more complex neural networks and deep learning architectures. Specifically, we focused on Convolutional Neural Networks (CNNs), Generative Adversarial Networks (GANs), Autoencoders, and Transformer models. These architectures are the building blocks of most current AI technologies, and our goal was to "pull back the curtain" and reveal how these systems actually work. Uniquely, we demonstrated these algorithms even in tools like Excel, allow-

ing participants to directly interact with and understand the underlying principles. Ultimately, understanding algorithms is key to grasping the capabilities and limitations of AI.

Question 3: More broadly, what are the key technological priorities in AI training?

Key technological priorities in AI training center around fostering a deep understanding of both the capabilities and limitations of these systems. It's not enough to simply know what AI can do; Soldiers need to understand how it works—how algorithms are trained, the data they rely on, and potential biases they may exhibit. A crucial objective is to equip them with the "language of AI," enabling informed discussions with developers and industry partners. Beyond the technical aspects, we prioritize exposing them to cutting-edge applied research, allowing them to anticipate future technologies and contribute to their development. This isn't a one-time learning event but rather establishing a foundation for continuous learning and increasing AI literacy within their units. Perhaps most importantly, we aim to cultivate a mindset of critical inquiry, encouraging Soldiers to approach AI with curiosity and a discerning eye.

Question 4: How was the course delivered? What was the mix of seminars, lectures, tours, demonstrations, etc.? How did you decide on the particular mix of different elements?

The course was intentionally structured as a 50/50 blend of traditional seminar and lecture-based instruction with hands-on laboratory tours and direct interaction with our scientists. We divided the curriculum into two main sections: "Foundations of AI" and "Applied AI." The "Foundations" portion focused on the tactical, core concepts, while the "Applied" section featured strategic insights from senior leaders, officers, and scientists. We found that inviting talks from these senior personnel were particularly valuable in Year 1, providing a broader perspective on the implications of AI. The course was designed to be inclusive, showcasing AI and Machine Learning applications across a wide range of Army domains: from natural language processing and image recognition to robotics, bioscience, and tactical networks. A key objective was to raise awareness of the Army's extensive research and development capabilities within ARL and the broader AFC DEVCOM enterprise. Participant feedback was overwhelmingly positive, with many expressing surprise at the breadth and depth of the Army's science and technology efforts.

Question 5: How were attendees selected for the recent course? (Why mid-career officers?) Is AI useful in all roles, or in particular areas?

Attendees for the recent course were selected by Army G357 through a competitive application process distributed to major commands. The intent was to assemble a diverse cohort representing a range of ranks, branches, and experience levels, including officers, NCOs, and warrant officers. While often described as "mid-career," the participant pool spanned from Captains to Colonels, Warrant Officers from WO1 to CW4, and NCOs up to Sergeant Major. This broad representation reflects the belief that AI has the potential to transform the Army across all functional areas, and that preparing future leaders – regardless of their current rank – is critical. While AI is broadly applicable, its impact will be particularly significant in areas involving data analysis, decision support, autonomous systems, and intelligence, surveillance, and reconnaissance (ISR). However, fostering AI literacy across the entire force is essential to ensure effective integration and responsible implementation.

Question 6: Were there any particular challenges of teaching the course (and more generally, in educating students on AI)? How were they overcome?

A significant challenge in delivering this course stemmed from the diverse backgrounds of the attendees. Participants ranged widely in their prior experience with computer science and mathematics, leading to varied feedback – some requesting more technical depth, others preferring a more conceptual overview. This diversity also extended to preferred learning styles and desired levels of practical application, with some wanting more coding exercises and others finding even a week of instruction too lengthy. To overcome these challenges, we prioritized instructors who could effectively translate complex concepts into accessible terms, often utilizing analogies, e.g., framing AI systems as analogous to a car with its engine, fuel, and environmental factors. We also recognized the importance of practical relevance by demonstrating algorithms not only in Python but also in tools readily available to Soldiers, such as Microsoft Excel, addressing the need to apply these concepts to existing workflows.

Question 7: Could you give me a broad overview of ARL's work in training for AI? How long has ARL focused on the area, and why is AI an important training focus for the laboratory?

As the Army's corporate research and development laboratory, ARL's core mission is to operationalize science for transformational overmatch. We pursue fundamental AI research, both internally and through extramural collaborations, working closely with the Futures Command to translate concepts into future capabilities. While not explicitly a training-focused organization, ARL's engagement in AI training has evolved as a natural byproduct of our long-standing expertise in the field. We've been conducting AI-related research for many years, and as AI's importance has grown, we've recognized the value of sharing that expertise. AI is now a pervasive element across the entire laboratory, as nearly every research program generates and analyzes data. The future operational environment will be characterized by an abundance of data, and AI is critical for harnessing that information to provide a decisive advantage to our Soldiers. This training initiative represents one avenue through which ARL can extend its impact beyond its core research mission, leveraging our talent and expertise to benefit the broader Army.

Question 8: How has this training evolved? For example, has it become a larger focus in recent years?

The training program has demonstrably evolved between Year 1 and Year 2, primarily driven by the rapid advancements across the entire field of AI. The course timeline has been condensed to reflect this accelerated pace of innovation. While the emergence of ChatGPT in November 2022 was certainly an influential milestone—and has led to increased incorporation of how large language models function—this course encompasses a much broader range of AI topics. This mirrors the growing interest among students, many of whom have experience with or have heard of these tools. Current AI trends, particularly generative AI and multimodal models that combine images and language, now play a greater role in the curriculum than in the past. We are sensitive to the constantly changing landscape of AI and actively seek to integrate the latest developments into the course, ensuring its continued relevance and value to the Army.

Question 9: What are the current limitations of AI and how do you teach students about those limitations?

Understanding the fundamental concepts behind machine learning is crucial for recognizing both the strengths and limitations of AI models. For example, a model trained on data from a specific environment may perform poorly when applied to

a significantly different one. Similarly, if the training data contains inherent human biases, the model will inevitably learn and perpetuate those biases. To illustrate these limitations, we utilize real-world examples of AI failures documented in resources like the AI Incidents Database, which catalogs instances where deployed AI systems have caused harm. This database serves as a cautionary tale, demonstrating that even large corporations have experienced setbacks when rushing to deploy AI technologies. There's often a competitive drive to be the "first mover" in AI, but this can come at the cost of thorough testing and safety considerations. Within the Army context, where critical decision-making and Soldier's lives are at stake, a cautious and rigorous approach to AI safety, testing, and evaluation is paramount. We emphasize that while AI will undoubtedly transform numerous domains, responsible implementation requires a clear understanding of its inherent limitations and potential risks.

Question 10: Many companies in the defense industry are also making use of AI – is it important for army personnel to be capable of communicating with industry representatives on areas related to the technology? How do you train them to do this?

Absolutely. It is critically important for Army personnel to be capable of communicating effectively with defense industry representatives regarding AI technologies. Numerous companies are currently developing and offering AI solutions to the Army, and understanding AI concepts is essential for having deliberate and informed conversations about their potential applications. The goal of this course is to equip Soldiers with that knowledge, enabling them to ask insightful questions, assess vendor claims critically, and identify opportunities for AI integration. Student feedback has been overwhelmingly positive, with participants reporting that the course has empowered them to ask smarter questions of vendors, proactively prepare for an AI-driven future by focusing on data collection and curation, and identify specific areas within their organizations where AI can provide valuable assistance. This feedback reinforces the value of the course and its impact on the Army's ability to leverage AI effectively.

Question 11: Is there anything coming up for you in AI training that you would highlight? (New courses for instance). How do you envision AI developing as a focus for training in the coming years more broadly?

We are pleased to announce an expansion of the "AI for Soldiers" course to two Strategic Broadening Seminar offerings in Fiscal Year 2026, effectively doubling the number of Soldiers we can reach with this critical training. This expansion indicates the growing recognition of AI's importance and the need to prepare the Army and DoD workforce for an AI-driven future. More broadly, AI will continue to be a central focus for training initiatives in the coming years. However, it's important to emphasize that this effort is a collaborative one. Our work is a byproduct of the larger mission to accelerate AI adoption within the Army, and we see ourselves as one piece of a larger puzzle. Key partners in scaling AI know-how include other Army agencies, such as the AI Integration Center within Army Futures Command and Army University. At the DoD level, the Chief Digital and Artificial Intelligence Office (CDAO) is also playing a crucial role, offering a range of AI courses through both digital and in-person modalities. A coordinated, multiagency approach is essential to ensure the Army and DoD are fully prepared to leverage the transformative potential of AI.

Question 12: Do you have anything to add?

Just to reiterate, the Army recognizes that AI is not simply a technological advancement, but a fundamental shift in how we will operate in the future. Our focus isn't just on teaching Soldiers about AI, but on equipping them with the critical thinking skills to evaluate AI solutions, understand their limitations, and integrate them responsibly into our operations. We are committed to a deliberate and ethical approach to AI adoption, prioritizing safety, security, and alignment with our values. This training program is a key component of that commitment, and we're encouraged by the positive feedback and the growing demand for this type of education across the force. We see this as a continuous process of learning and adaptation, and we're committed to staying at the forefront of AI development while upholding the highest standards of military professionalism.

Appendix F. Participant Roles and Titles

The following list enumerates all individual position roles and titles collected from course registration data prior to aggregation. Titles reflect the variety of roles held by participants across Army, DoD, and other affiliated organizations. For readability, the list is presented in alphabetical order, with the number of participants holding each title indicated in parentheses.

1. Accountant Staff (1)
2. Acquisition & Contracting Career Manager (1)
3. Acquisition Officer (1)
4. Acquisition Program Analyst (1)
5. Acquisition Program Manager (1)
6. Acquisition Subject Matter Expert (1)
7. Action Officer (1)
8. Additive Manufacturing Lead (1)
9. Additive Manufacturing Research Engineer (1)
10. Advanced Electronics Branch Chief (1)
11. Advisor (1)
12. Aerospace Engineer (23)
13. Aerospace Research Engineer (1)
14. Aerospace Technology Materials Researcher (1)
15. AI Evaluator (3)
16. AI Technician (1)
17. Airdrop Systems Tech (1)
18. Airworthiness Engineer (1)
19. All Source Analyst Security Manager (1)
20. All-Source Intelligence Analyst (1)
21. All-Source Intelligence Technician (1)
22. Analysis Branch Chief (1)
23. Analyst (7)
24. Analyst Officer (1)
25. Analytical Chemist (1)
26. Army Engineering & Technical Manager (3)
27. Army Financials Systems Convergence & Unification Tool SCoUT Engineer (1)
28. Army Instructor (1)
29. Assistant Chief of Staff for Communications IT (2)
30. Assistant Fire Chief (1)
31. Assistant Professor (5)
32. Assistant Program Manager (1)
33. Assistant Program Manager Materials Science (1)
34. Assistant Research Professor (2)
35. Assistant Research Scientist (1)
36. Associate Counsel (1)
37. Associate Director Executive Officer (1)
38. Associate Division Chief (1)
39. Associate for Systems Engineering Integration (1)
40. Associate Professor (4)
41. Associate Professor Cognitive Scientist (1)
42. Associate Research & External Engagement (1)
43. Associate Researcher (1)
44. Atmospheric Scientist (1)

45. Attack & Aviation Systems Branch Chief (1)
46. Attorney (2)
47. Audit Liaison (1)
48. Auditor (1)
49. Automation Specialist (1)
50. Automation Team Lead (1)
51. Autonomous Sensor Exploitation & Dissemination Subject Matter Expert (1)
52. Autonomy Test & Evaluation Portfolio Manager (1)
53. Aviation Maintenance Officer (1)
54. Basic Research Portfolio Director (1)
55. Battalion Commander (1)
56. Battalion Intelligence Officer (1)
57. Battalion Operations Officer (1)
58. Battalion Standardization Pilot (1)
59. Battle Officer (1)
60. Bioanalytical Chemist Project Lead (1)
61. Bioinformatician (1)
62. Biologist (6)
63. Biomechanical Engineer (1)
64. Biomedical Engineer (6)
65. Branch Associate (1)
66. Branch Chief (15)
67. Branch Chief Logistics Civilian Augmentation Program (1)
68. Branch Chief Medical Simulation Research (1)
69. Branch Manager (1)
70. Brigade Assistant Intelligence Officer (1)
71. Brigade Chaplain Observer Coach Trainer (1)
72. Budget Analyst (5)
73. Building Science Manager (1)
74. Business Associate (1)
75. Business Communications Specialist (1)
76. Capability Development Directorate Director (1)
77. Career Program Manager (1)
78. Cavalry Branch Doctrine Writer (1)
79. Chair (1)
80. Chaplain Corps Observer Coach Trainer (1)
81. Chemical Engineer (17)
82. Chemist (14)
83. Chemist Operational Toxicology Branch (1)
84. Chemist Surety & Protection Office (1)
85. Chief (11)
86. Chief Academic Operations (1)
87. Chief BioTesting Division (1)
88. Chief Business Operations Division (1)
89. Chief Cavalry Doctrine Branch (1)
90. Chief Civilian Personnel Analytics Office (1)
91. Chief Communications & IT (1)
92. Chief Cybersecurity & Program Protections Branch (1)
93. Chief Disruptive Technology Branch (1)
94. Chief Embedded Systems (1)
95. Chief Engineer (2)

96. Chief Executive Officer Founder (1)
97. Chief Field Artillery Proponent Office (1)
98. Chief Financial Management Division (1)
99. Chief Futures Officer (1)
100. Chief Human Capital (1)
101. Chief Information Officer (1)
102. Chief Innovation (1)
103. Chief Learning Requirements Division (1)
104. Chief Logistics Engineering Branch (1)
105. Chief Network Systems Branch (1)
106. Chief Operational Power & Energy Analysis Branch (1)
107. Chief Operations (1)
108. Chief Operations Division (1)
109. Chief Plans Exercises & Theater Security Cooperation (1)
110. Chief Program Analysis & Integration (1)
111. Chief Protection Division Force Protection (1)
112. Chief Radar Systems & ID Division (1)
113. Chief Scientist (2)
114. Chief Signals Security Intelligence (1)
115. Chief Software Engineering (1)
116. Chief Standardization & Evaluation (1)
117. Chief Tactical Missile System Safety Division (1)
118. Chief Technologist (1)
119. Chief Technology Officer (2)
120. Chief Technology Transfer (1)
121. Chief Test & Evaluation Division (1)
122. Chief Unmanned & Fixed Wing Branch (1)
123. Chief Weapon Propulsion Science Branch (1)
124. Chief Weapons Branch (1)
125. Civilian Aide Secretary Army (1)
126. Cognitive Scientist (1)
127. Collection Manager (1)
128. Combat Analyst (1)
129. Combat Operations Analyst (1)
130. Command Chief Engineer (2)
131. Communications & Information Systems Officer (1)
132. Communications & IT Officer (7)
133. Communicator (1)
134. Component Branch Chief (1)
135. Composites Engineer (1)
136. Computational Biologist (1)
137. Computational Fluid Dynamics Researcher (1)
138. Computational Materials Engineering (1)
139. Computational Scientist (1)
140. Computer & Electrical Engineer (1)
141. Computer Analyst (1)
142. Computer Engineer (62)
143. Computer Engineer Computer Scientist (1)
144. Computer Scientist (94)
145. Computer Scientist Test Engineer

(1)
146. Computer Software Engineer (1)
147. Computer Specialist (1)
148. Computing Platforms Contractor (1)
149. Concept Developer (1)
150. Concept Writer (1)
151. Concepts Branch Chief (1)
152. Concepts Project Officer (1)
153. Configuration Management (2)
154. Consultant (3)
155. Contractor (15)
156. Contractor Senior Scientist (1)
157. Contractor Team Lead (1)
158. Corporate Policy Officer (1)
159. Cost Analyst (1)
160. Counterintelligence Instructor & Trainer (1)
161. Counterintelligence Sergeant (1)
162. Counterintelligence Technician (1)
163. Country Desk Officer (1)
164. Crisis Response Communications & IT Officer (1)
165. Cryptologic Linguist (1)
166. Curriculum Lead (1)
167. Cyber Analyst (2)
168. Cyber Engineer (2)
169. Cyber Intelligence lead (1)
170. Cyber Operations Officer (1)
171. Cyber Operations Researcher (1)
172. Cyber Planner (1)
173. Cyber Risk Assessor (2)
174. Cyber Security Analyst (1)
175. Cyber Signal Officer Career Manager (1)
176. Cyber Threat Intelligence (1)
177. Cybersecurity Analyst (4)
178. Cybersecurity Chief (1)
179. Cybersecurity Officer (1)
180. Data & Operations Officer (1)
181. Data Analyst (8)
182. Data Architect (1)
183. Data Engineer (1)
184. Data Governance Lead (1)
185. Data Governance Officer (1)
186. Data Management Officer (2)
187. Data Operations Lead (1)
188. Data Scientist (12)
189. Data Systems Engineer (1)
190. Data Team Lead (2)
191. Database Administrator (1)
192. Deputy Branch Chief (1)
193. Deputy Chief Communications & IT (1)
194. Deputy Chief Geospatial Intelligence (1)
195. Deputy Chief Information Officer (1)
196. Deputy Chief of Staff (1)
197. Deputy Chief of Testing (1)
198. Deputy Commander (1)
199. Deputy Directing Editor (1)
200. Deputy Director (3)
201. Deputy Director Chief (1)
202. Deputy Director Internal Audit (1)
203. Deputy Director Workplace Culture & Equity (1)
204. Deputy Division Chief (1)
205. Deputy Division Director (1)
206. Deputy Program Manager (1)

207. Deputy Strategic Readiness Division (1)
208. Deputy to Chief CTO Program Budget Data Management Division (1)
209. Deputy Vice Provost Army Digital Education (1)
210. DevOps Security Team Lead (1)
211. DevOps Team Lead (1)
212. Digital Services Analyst (2)
213. Director (16)
214. Director Chief (1)
215. Director Deputy (2)
216. Director Executive President (1)
217. Director Financial Management (1)
218. Director Future Plans (1)
219. Director Graduate Studies Associate Professor (1)
220. Director Office of Reference Materials (1)
221. Director Operations (1)
222. Director Portfolio (1)
223. Director Specialty Engineering (1)
224. Director Technical (1)
225. Director Technology (2)
226. Division Chief (2)
227. Division Chief Ground Systems Cyber Engineering (1)
228. Division Chief Systems Assessment (1)
229. Division Director (1)
230. Division Operations Research Systems Analysis Officer (2)
231. Division Targeting Officer (1)
232. Division Technical Advisor (1)
233. Doctoral Student (1)
234. Doctrine Branch Chief (1)
235. Doctrine Team Chief (1)
236. Doctrine Writer (1)
237. Drill Sergeant (1)
238. Economist (1)
239. Educational Outreach Program Manager (2)
240. Electrical Engineer (20)
241. Electrical Engineer & Research Computer Scientist (1)
242. Electrical Engineering (1)
243. Electronic Engineer Systems Engineer (1)
244. Electronic Security Technician (1)
245. Electronic Technician (1)
246. Electronic Warfare Officer (1)
247. Electronics Computer Engineer (1)
248. Electronics Engineer (53)
249. Electronics Software Engineer (1)
250. Emergency Action Controller Officer (1)
251. Emerging Technologies Lead (1)
252. Energetic Materials Research Engineer (1)
253. Energy Engineer (1)
254. Energy Sciences Competency Fellow (1)
255. Engineer (56)
256. Engineer Branch Chief Missile Defense System of Systems (1)
257. Engineer Data Analyst (1)
258. Engineer Modeling & Simulations (1)
259. Engineer Team Lead (2)

260. Engineer Technology Developer (1)
261. Engineering Analyst (1)
262. Engineering Lead Specialty Engineering (1)
263. Engineering Psychologist (3)
264. Engineering Technician (5)
265. Entrepreneur (1)
266. Environmental Geochemical Engineer (1)
267. Epidemiologist (2)
268. Ergonomist (1)
269. Executive Assistant (2)
270. Executive Deputy Director SES (1)
271. Executive Officer (2)
272. Executive Officer Budget Analyst (1)
273. Executive Staff Assistant (1)
274. Explosive Safety Specialist (1)
275. Exports Technology Protection (1)
276. Faculty (18)
277. Faculty Research (1)
278. Field Artillery Advisor (1)
279. Field Service Representative (1)
280. Finance Consultant (1)
281. Financial Analyst (2)
282. Financial Management Analyst (4)
283. Financial Specialist (1)
284. Fires Branch Chief (1)
285. First Sergeant (1)
286. Flight Chief (1)
287. Flight Chief Medical Operations (1)
288. Force Integrator (1)
289. Force Management Analyst (1)
290. Foreign Intelligence Officer (1)
291. Forester (1)
292. Formulation Chemist (1)
293. Founder (1)
294. FPGA Hardware Engineer (1)
295. Full Spectrum Targeting Project Manager (1)
296. Full-Motion Video Operations Officer (1)
297. Fusion Deputy Chief (1)
298. General Engineer (22)
299. General Engineer Lead (1)
300. General Engineer Strategic Partnerships Office (1)
301. General Engineer Surveillance (1)
302. Geographer (1)
303. Geospatial Intelligence Analyst (1)
304. Geospatial Intelligence Officer (1)
305. Geospatial Intelligence Subject Matter Expert (1)
306. Geospatial Intelligence Technician (2)
307. Google Developer (1)
308. Graduate Research Assistant (8)
309. Graduate Student (38)
310. Group Leader (2)
311. Group Leader Program Manager (1)
312. Guest Researcher (3)
313. Guest Researcher Electronics Engineer (1)
314. Hardware Cybersecurity Scientist (1)
315. Health Information Systems Officer (1)
316. Health Scientist (1)

317. Helios Developer (1)
318. Help Desk (1)
319. High School Student Researcher (1)
320. HPC Application Engineer (1)
321. Human Factors Engineer (1)
322. Human Protections Coordinator (1)
323. Human Resources Analyst (1)
324. Human Resources Assistant (1)
325. Human Resources Officer (1)
326. Human Resources Technician (1)
327. Human Subjects Protection Scientist (1)
328. Imagery Analyst (1)
329. Industrial Engineer (3)
330. Information Protection Tech (1)
331. Information Security Specialist (1)
332. Information Services Technician (1)
333. Information Systems Engineer (1)
334. Information Systems Officer (1)
335. Information Systems Security Manager (1)
336. Information Systems Security Officer (6)
337. Information Technical Specialist Army University Library System (1)
338. Information Technology (1)
339. Information Technology Specialist (2)
340. Information Warfare Officer (1)
341. Innovation Analyst (1)
342. Innovation Officer (1)
343. Installation Emergency Manager (1)
344. Institutional Review Board Chairman (1)
345. Instructional Systems Specialist (4)
346. Instructor (3)
347. Integration Branch Chief (1)
348. Intelligence & Sustainment Company Commander (1)
349. Intelligence Advisor (1)
350. Intelligence Analyst (2)
351. Intelligence Observer Coach/Trainer (1)
352. Intelligence Officer (7)
353. Intelligence Operations Specialist (1)
354. Intelligence Planner (1)
355. Interagency Liaison (1)
356. Intern (3)
357. IT & Information Security Specialist (1)
358. IT Business Analyst (1)
359. IT Project Manager (1)
360. IT Specialist (17)
361. IT Specialist Application Developer (1)
362. IT Specialist APPSW Internet (1)
363. IT Specialist Data Manager (1)
364. IT Specialist KM (1)
365. IT Specialist Networking (1)
366. IT Specialist System Analysis (1)
367. Journeyman Fellow (1)
368. Junior Software Developer (1)
369. Kinesiologist (1)
370. Knowledge Management Director (1)

371. Knowledge Management Officer (1)
372. Knowledge Management Specialist (3)
373. Knowledge Manager (2)
374. Lab Manager (2)
375. Laser & Directed Energy Protection Branch Deputy (1)
376. Lead (1)
377. Lead Analyst (1)
378. Lead Budget Analyst (1)
379. Lead Engineer (2)
380. Lead General Engineer (1)
381. Lead IT Specialist (1)
382. Lead Metallurgist (1)
383. Lead Power & Energy Applications Team (1)
384. Lead Power & Energy Generation Team (1)
385. Lead Power & Energy Team (1)
386. Lead Program Specialist (1)
387. Lead Quality Assurance Specialist (1)
388. Lead Research Chemist (1)
389. Lead Research Risk Protection (1)
390. Lead Software Architect (1)
391. Lead Software Engineer (1)
392. Lead Systems Safety Engineer (1)
393. Lead Systems Engineer (2)
394. Lead Visual Information Specialist Multimedia (1)
395. Leader (1)
396. Learning Analyst (1)
397. Lethality Engineer (1)
398. Liaison Engineer (1)
399. Liaison Officer (1)
400. Librarian (1)
401. Life Cycle Software Engineering (1)
402. Lifecycle Analysis & Policy Division Chief (1)
403. Live Virtual Constructive Training Integrator (1)
404. Live Virtual Constructive Training Integrator Technical Operations Lead (1)
405. Logistics Engineer (1)
406. Logistics Management Specialist (7)
407. Logistics Officer (4)
408. Machine Learning Engineer (3)
409. Management Analyst (2)
410. Manager (1)
411. Manager Aberdeen Research Operation (1)
412. Manpower Analyst (1)
413. ManTech Sustainment Lead (1)
414. Market Research Intern (1)
415. Master Operations Research Analyst (1)
416. Masters Student (3)
417. Materials Engineer (10)
418. Materials Research Engineer (1)
419. Materials Scientist (5)
420. Mathematical Statistician (3)
421. Mathematician (7)
422. Mechanical Engineer (42)
423. Mechatronics Engineer (1)
424. Medical Readiness Specialist (1)
425. Metals Branch Chief (1)

426. Metereologist (1)
427. Metrics & Analytics (1)
428. Microbiologist (1)
429. Military (1)
430. Military Analyst (3)
431. Military Evaluator (2)
432. Military Instructor (1)
433. Military Intelligence Analyst (1)
434. Military Plans Analyst (1)
435. Mission Element Lead (1)
436. Mission Partner Network Interoperability Branch Chief (1)
437. Modelling & Simulation Analyst (1)
438. Modernization Officer (1)
439. Network Engineer (1)
440. Network Operations Administator (1)
441. Network Portfolio Director (1)
442. Network Security (1)
443. Network System Admin (1)
444. NeuroImaging Scientist (1)
445. Occupational Safety & Health Mannager (1)
446. Office Administrator (1)
447. Officer (41)
448. Officer Research Psychologist (1)
449. Officer Speechwriter (1)
450. Operation Research Analyst (1)
451. Operations (1)
452. Operations Desk Officer (1)
453. Operations Manager (1)
454. Operations Officer (8)
455. Operations Planner (2)
456. Operations Research (1)
457. Operations Research & Systems Analysis Officer (2)
458. Operations Research & Systems Analyst (17)
459. Operations Research & Systems Analyst Data Scientist (1)
460. Operations Research Analyst (45)
461. Operations Security & Privacy Officer (1)
462. Operations Sergeant (1)
463. Operations Specialist (1)
464. Optical Scientist (1)
465. Owner (1)
466. Pararescue Staff Sergeant (1)
467. Partner (1)
468. Personnel Officer (2)
469. Physical Research Scientist (1)
470. Physical Science Technician (2)
471. Physical Scientist (13)
472. Physical Scientist Science & Technology Advisor (1)
473. Physicist (14)
474. Physicist Project Leader (1)
475. Pilot (1)
476. Planetary Program Analyst (1)
477. Plans & Systems Manager (1)
478. Plans Officer (2)
479. Portfolio Director (2)
480. Portfolio Lead (1)
481. Portfolio Manager (2)
482. Postdoctoral Fellow (2)
483. Postdoctoral Researcher (51)
484. Predictive Logistics Analyst (1)
485. Predictive Logistics Team Lead (1)
486. Presidential Management Fellow

Prize Challenge Specialist (1)
487. Principal Airworthiness Program Lead – Contractor (1)
488. Principal Data Scientist (1)
489. Principal Engineer (3)
490. Principal Software Engineer (1)
491. Principal Statistician (1)
492. Principle Programmer Analyst (1)
493. Process Engineer (1)
494. Procurement Analyst (1)
495. Producer (1)
496. Product Data Management Division Chief (1)
497. Product Manager (2)
498. Product Quality Manager (1)
499. Product Support Branch Manager (1)
500. Production Machinery Mechanic (1)
501. Professor (1)
502. Program Analyst (10)
503. Program Engineer (1)
504. Program Integrator (1)
505. Program Manager (20)
506. Program Manager Chemical Engineer (1)
507. Program Specialist (1)
508. Programmer Analyst (1)
509. Project Engineer (4)
510. Project Leader (2)
511. Project Management (2)
512. Project Manager (6)
513. Project Officer (2)
514. Psychologist (1)
515. Public Affairs Specialist (3)
516. Python Developer (1)
517. Quality Assurance Analyst (1)
518. Quality Assurance Instructional Systems Specialist (1)
519. Quality Assurance Officer (1)
520. Reactor Engineer (3)
521. Reactor System Engineer (1)
522. Readiness Officer Program Manager (1)
523. Regional Integrator (1)
524. Regional Lead (2)
525. Regulatory Research Scientist (1)
526. Reliability & Risk Analyst (1)
527. Reliability Engineer (6)
528. Remote Sensing Scientist (1)
529. Remotely Piloted Aircraft Team Lead (1)
530. Requirements Developer (2)
531. Research & Analysis Group Manager (1)
532. Research Agronomist (1)
533. Research Area Coordinator (1)
534. Research Assistant (4)
535. Research Assistant Professor (2)
536. Research Associate (4)
537. Research BioEngineer (1)
538. Research Biologist (3)
539. Research Chemical Engineer (2)
540. Research Chemist (26)
541. Research Civil Engineer (7)
542. Research Computer Engineer (3)
543. Research Electrical Engineer (2)
544. Research Electronics Engineer (1)
545. Research Engineer (15)
546. Research Environmental Engineer

(1)

547. Research Ethicist (1)
548. Research Ethics & Compliance Officer (4)
549. Research General Engineer (3)
550. Research Geographer (1)
551. Research Hydraulic Engineer (4)
552. Research Material Scientist (1)
553. Research Materials Engineer (3)
554. Research Mathematician (6)
555. Research Mechanical Engineer (8)
556. Research Oceanographer (1)
557. Research Physical Scientist (6)
558. Research Physicist (13)
559. Research Physicist Statistics (1)
560. Research Physiologist (2)
561. Research Policy (1)
562. Research Professor (4)
563. Research Protections Ethicist (1)
564. Research Psychologist (8)
565. Research Scientist (23)
566. Research Software Engineer (1)
567. Research Structural Engineer (1)
568. Research Team Lead (1)
569. Researcher (18)
570. RF Systems Engineer (1)
571. Risk Team Lead (1)
572. Rotorcraft Flow Simulation Engineer (1)
573. Safety Engineer (20)
574. Safety Engineer & Cybersecurity Action Officer (1)
575. Safety Specialist (1)
576. Science & Technology Analyst (1)
577. Science & Technology Associate (1)
578. Science & Technology Lead (2)
579. Science & Technology Manager (2)
580. Science & Technology Operations Human Machine Integration (1)
581. Science Advisor (2)
582. Scientist (44)
583. Section Chief (1)
584. Section Head (3)
585. Section Manager (1)
586. Security Officer (1)
587. Security Specialist (4)
588. Senior AI Policy Advisor (1)
589. Senior Airworthiness Engineer (1)
590. Senior Analyst (3)
591. Senior Army Fellow (1)
592. Senior Associate (1)
593. Senior Chemist (1)
594. Senior Computer Engineer (1)
595. Senior Computer Scientist (1)
596. Senior Concept Developer (1)
597. Senior Cyber Media Analyst (1)
598. Senior Cybersecurity Manager ISSM (1)
599. Senior Engineer (3)
600. Senior Geospatial Intelligence Analyst (1)
601. Senior Geospatial Intelligence Technician (1)
602. Senior Intelligence Analyst (1)
603. Senior Knowledge Management & Common Ops Pct Spt (1)
604. Senior Materials Development Engineer (1)
605. Senior Materials Engineer (1)

606. Senior Mechanical Engineer (1)
607. Senior Model Based Engineer (1)
608. Senior Observer Coach Trainer (1)
609. Senior Operations Research Analyst (3)
610. Senior Physicist (1)
611. Senior Project Manager (1)
612. Senior Project Officer (1)
613. Senior Reactor Engineer (1)
614. Senior Reactor Systems Engineer (1)
615. Senior Reliability & Risk Analyst (1)
616. Senior Religious Affairs Officer Observer Coach Trainer (1)
617. Senior Researcher (1)
618. Senior Research Engineer (1)
619. Senior Research Materials Engineer (1)
620. Senior Research Physicist (1)
621. Senior Science & Technology Advisor (1)
622. Senior Science & Technology Manager (3)
623. Senior Scientist (9)
624. Senior Security Engineer (1)
625. Senior Software Engineer (2)
626. Senior Software MBSE Engineer (2)
627. Senior Staff Engineer (1)
628. Senior Staff Scientist (1)
629. Senior Systems Engineer (1)
630. Senior Systems Security Engineer (2)
631. Senior Technical Advisor (1)
632. Senior Technologist (1)
633. Sign Language Interpreter (1)
634. Signal Instructor (1)
635. Signal Officer (1)
636. Signature Management Technician (1)
637. Silicon Design Engineer (1)
638. Simulation Lead (1)
639. Small Caliber Ammunition Manager (1)
640. Social Scientist (1)
641. Software Airworthiness Support Contractor (1)
642. Software Analyst (1)
643. Software Application Development Portfolio Deputy (1)
644. Software Developer (3)
645. Software Engineer (13)
646. Software Engineering Consultant (1)
647. Software Engineering Lead (1)
648. Software Quality Engineer (1)
649. Software Safety (1)
650. Software Safety Engineer (1)
651. Software Safety Subject Matter Expert (1)
652. Software Safety Test Officer (1)
653. Software Systems Engineering (1)
654. Software Test Engineer (1)
655. Software Test Lead (1)
656. Software Testing Chief (1)
657. Space Capabilities Program Administrator (1)
658. Special Assistant (1)
659. Spectrum Manager (1)

660. Staff Accountant (3)
661. Staff Chief Technology Officer (1)
662. Staff Scientist (4)
663. Staff Training Specialist (1)
664. Statistician (2)
665. Statistician & Operations Research Analyst (1)
666. Strategic Analyst (1)
667. Strategic Intelligence Analyst (1)
668. Strategic Planner (1)
669. Strategic Program Integrator (1)
670. Strategic Workforce Planning Lead (1)
671. Strategist (1)
672. Strength Manager (1)
673. Structural Materials Lead (1)
674. Student (73)
675. Student Co-op (1)
676. Student Trainee Computer Science (1)
677. Subject Matter Expert (1)
678. Supervisory Computer Engineer (1)
679. Supervisory Customer Engagement Manager (1)
680. Supervisory Electronics Engineer (2)
681. Supervisory Engineer (2)
682. Supervisory Engineer Reliability Engineering (1)
683. Supervisory Engineering Technician (1)
684. Supervisory General Engineer (1)
685. Supervisory Management & Program Analyst (1)
686. Supervisory Management Analyst (1)
687. Supervisory Operations Research & Systems Analyst (1)
688. Supervisory Operations Research & Systems Analyst Branch Chief (1)
689. Supervisory Operations Research Analyst (2)
690. Supervisory Plans Specialist (1)
691. Supervisory Program Analyst (2)
692. Supply & Logistics Officer (1)
693. Supply & Logistics Specialist (1)
694. Sustainment Operations Officer (1)
695. System Administrator (1)
696. System Analysis Database Administrator (1)
697. System Analyst (1)
698. System Engineer (2)
699. System Engineer Architecture Lead (1)
700. System Evaluation (1)
701. System Information Assurance Administrator (1)
702. System Safety Engineer (2)
703. Systems & Logistics Officer (1)
704. Systems Administrator (2)
705. Systems Analyst Cyber Technology (1)
706. Systems Engineer (17)
707. Systems Engineer Lead (1)
708. Systems Integration Officer (1)
709. Systems Integration Team Lead (1)
710. Systems Safety Engineer (2)
711. Tactical Network researcher (1)
712. Targeting Observer Coach Trainer

(1)
713. Targeting Officer (2)
714. Tax Accountant (1)
715. Team Lead (7)
716. Team Lead Command Post Concepts (1)
717. Team Lead Electrical Engineer (1)
718. Team Lead Turbine Power Research (1)
719. Team Leader (8)
720. Technical & Core Mission Support (2)
721. Technical & Engineering Support Branch Chief (1)
722. Technical Advisor (2)
723. Technical Assistant (1)
724. Technical Coordinator (1)
725. Technical Director (2)
726. Technical Expert Engineer Robotics (1)
727. Technical Lead (4)
728. Technical Lead Future Technology Integration (1)
729. Technical Lead Modeling & Simulation (1)
730. Technical Program Manager (1)
731. Technical Project Manager (1)
732. Technical Specialist (2)
733. Technical Support Officer (1)
734. Technical Ventures Director (1)
735. Technology Advisor (1)
736. Technology Manager (1)
737. Technology Protection Officer (1)
738. Technology Representative (1)
739. Test Lead (1)
740. Test Manager (2)
741. Test Officer (2)
742. Test Officer Electronics Engineer (1)
743. Toxicologist Computational Systems Biologist (1)
744. Traffic Management Specialist (3)
745. Trainer (2)
746. Trainer Human Dimensions Branch (1)
747. Training & Education Analyst (1)
748. Training & Education Specialist (2)
749. Training & Exercises Officer (1)
750. Training Manager (1)
751. Transportation Manager (1)
752. UIUX Lead (1)
753. UIUX Researcher (1)
754. University Instructor (1)
755. User Support Services (1)
756. Vehicle Security Researcher (1)
757. Vice President (1)
758. VVUQ Analyst (1)
759. Web Developer (1)
760. White House Facility Manager (1)
761. Wireless Digital Signal Processing Engineer (1)
762. Writer Editor (1)
763. X-ray CT Scientist (1)

Appendix G. Participant Motivations

The following provides a curated selection of participant responses to the question "Motivation – Why are you taking this course?" Responses are organized into three categories: enthusiastic responses, representative motivations, and unconventional or creative responses. This selection illustrates the diversity of interest and engagement in the course.

Some participants conveyed their excitement through exclamation points or emphatic phrasing, highlighting their eagerness to engage with the material:

1. I love learning. I am becoming familiar with the terminology and trying to learn (re-learn) most of the mathematics on my own. I think this course will be perfect for me. Thank you for offering it!
2. Awareness, general direction of advancements in tech, highly-reviewed!
3. I hear about ML all the time- I want to understand it so I can maybe use it!
4. I want to have a better general understanding of "Machine Learning" as a whole in order to decide when to use it (and when to not!).
5. Always found Machine Learning to be extremely interesting. I like to watch Sentdex, Code Bullet, and Jabril's Neural Network videos on YouTube. Also been heavily considering going to Georgia Tech for the OMCS Machine Learning degree, so this would be an amazing course for me. Thanks!
6. Dr. Tschopp and his team are the best at explaining ML/AI concepts!
7. Job scope now includes AI/ML systems!
8. The PDF was very moralizing! But also colleagues of mine from Office of the Provost ArmyU are participating and I wish to bolster my organization VPDE.
9. I need to know! XD
10. To learn new concepts!
11. AI/ML is growing rapidly and as AI/ML is being used and deployed in the Army on various systems, it is important to have a strong foundation and understanding on these technologies. Also, the Star Wars theme is super fun!
12. Because over 2500 people have taken the course, it's gotta be good! J/K Interested in learning more about this topic.
13. Need to get smarter on this!
14. Will be working on a ML based project and would like to have a basic understanding of the algorithms/concepts!
15. Would like to have a revision of the concepts I know and to learn something new!

16. Task Manager highly recommended on attendance due to workload path. Also, i am always up to learning new things!
17. Learn more/get better!
18. I enjoy math, and love analytical work!!
19. Am using machine learning for my thesis project!
20. Deepen my understanding!
21. Learn about machine learning!
22. Hoping to learn something!
23. Continue my data literacy, AI, ML upskill journey!
24. My current field of studies is related to AI/ML and GANs. Always looking to learn more!
25. I want to learn!
26. ML is an interesting topic and I love that you just learned it as well so we're in the same position so hopefully you don't speak above my head!
27. I enjoy learning new concepts and especially tech related topics. Great opportunity to stay in the know and current on the most up to date technologies. The future depends on AI; AI depends on ML!
28. I had attended your course in the past (I think last year) but missed a lot of content. Re-signing up to see what's new!
29. I'm trying to learn everything I can about AI and have heard great reviews about this course!
30. I want to learn something new. I know AI is going to be our future, so to learn more about it will be beneficial for me!
31. I want to learn something new!!
32. ML is the new buzz word(s) that needs more understanding!
33. It sounds fun!
34. Practical applications!
35. There is always more to learn and I love ML!
36. ML is the future, I'm excited that it is being taught in Excel and Python, and I think it will be directly applicable to my work. And I love Star Wars!
37. ML is used in several parts of my portfolio. I took the class 2 years ago and it was great! Want to see what updates there are.
38. I've finished my optical bench setup and am now collecting a bunch of lab data for my postdoc project, yay. And then I'm supposed to apply ML to it, but I've never done that before!

39. This sounds like a fantastic way to hone my machine learning skills with a themed understanding. Cannot wait!
40. Wanting more information and to get smarter with ML, AI, etc! Help me help myself :)
41. Learn more about AI!
42. Interested to learn more about ML and Star Wars is awesome!
43. I would like to start using AI/ML in tribology research. It is just starting to catch on in a few talks at conferences, and there is so much potential!
44. I'm very familiar with newer neural network things, but actually missing some foundational stuff. Hoping to see a good bit of that on day 1!
45. To learn and be better at my job!
46. Machine learning is the future! Want to learn as much as possible!
47. It's machine learning! Why wouldn't I be interested?!? I'm honestly offended that you would have to ask that question! Ok, fine. People throw around the term like it's confetti. I want to understand it rather than just accept it.
48. AI/ML is or will be part of everything we do!
49. I have made it through parts of your course each time I have tried but never all of it!!... this time I will complete it!
50. I'm an old dog, this looks like a new trick!
51. To learn the parts I don't know, and to review the parts I do know!
52. It seemed like a fun advertisement, and I wanted to get involved !
53. So the force can be with ME!
54. Attended in 2022, would like to review everything again/ get even more familiar... and see what's new!
55. Dr. Tschopp is teaching the course!!
56. I'm a clinical neuroscientist and more ML/AI skills is a must!

Many participants provided straightforward explanations, often linking the course to professional roles, research needs, or skill development:

1. ML and AI is becoming much more relevant so I want to learn as much as possible.
2. I want to see how I can take ML and implement it into my workflow and research.
3. ML is a common buzzword that is referenced most technical areas in recent times. I would like to gain a better understanding of what processes and functions this area encompasses and its corresponding strengths and weaknesses.

4. I need to become more familiar with machine learning concepts, for possible future application to rotorcraft simulations.
5. I am interested in obtaining a broader understanding of the field so we can better identify areas where AI/ML would be beneficial for our mission, as well as better our ability to judge & interpret proposals utilizing these technologies.
6. I would like to become familiar with ML concepts so that I have a general idea as to what it's all about.
7. I am interested in how machine learning can be incorporated into collection management and intelligence processes.
8. I am learning python and I am currently struggling finding practical uses and I believe this course will help me connect the dots better.
9. I need to have a clue when the researchers in my division talk about their work
10. I would like to understand how it works and also how to apply it to my work on soft matter, active matter, self-assembly
11. Machine learning technology is being incorporated into more applications as time passes, and I would like to gain some basic knowledge about how the technology works.
12. Applying ML to data analysis is common in multiomics research today; I need to become more familiar with its concepts as ML becomes more relevant in my field.
13. My lab utilizes some machine learning techniques with the data that we collect and I would like to grow my understanding.
14. Have taken some machine learning classes, and would like to expand my knowledge on the subject for further career opportunities and apply it to a couple of projects I am currently working on.
15. To gain a deeper appreciation for these tools as we are increasingly trying to utilize them for training simulations.
16. Computer science is such a hot topic, and I would like to improve my data analysis ability.
17. I am trying to do as much learning as possible. There is a lot of talk about AI/ML in our directorate so I would like to get smarter.
18. I am interested in getting a deeper understanding of ML in an effort to assist with development of Synthetic Data
19. I want to learn how to integrate ML concepts into my workflow to enhance analytical efficacy and efficiency.

20. I am interested in getting a simple primer to ML that breaks it down simply enough for me to ascertain whether or not I would like to delve deeper into it.

A smaller number of participants shared witty, unusual, or detailed comments, illustrating the variety of motivations for taking the course:

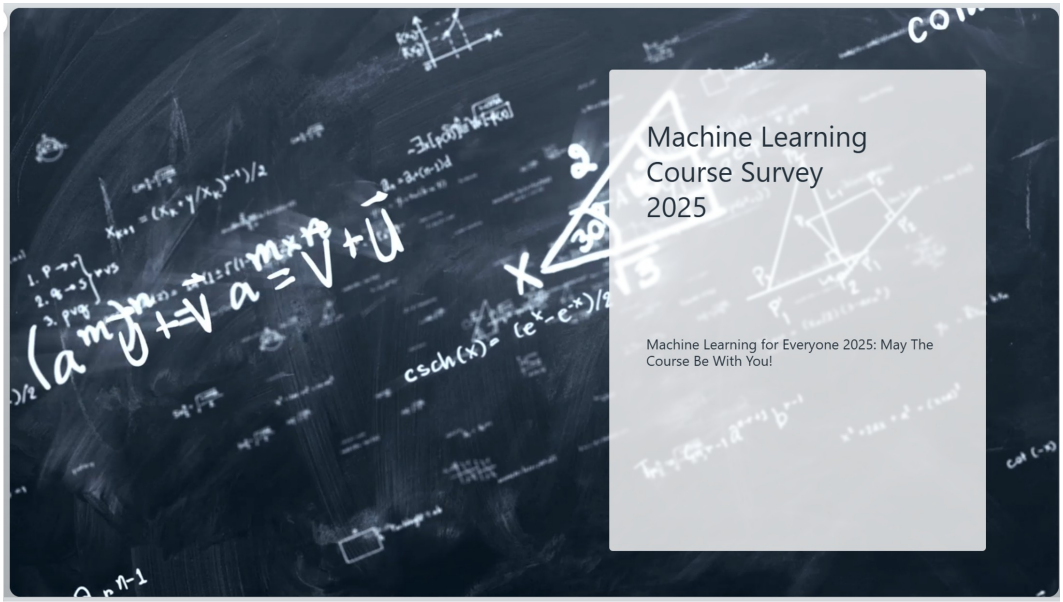
1. I supervise people developing and implementing AI and ML on autonomous robots. Waned, my skills have. I want to stay fresh and current on what is AI and ML so I can be a better manager and leader.
2. Our changing curriculum & PME demand data literacy and data tools for making sense of today's information-saturated OE. Descriptive and diagnostic analysis need to iteratively evolve into prescriptive [and eventually predictive] data sets for decision making... I want to be a part of all of this change, to include using AI and ML tools.
3. The drive to keep learning—especially the "dark side" of ML, like its hidden biases and ethical challenges. And since I know every Jedi needs to understand both sides of the Force, I'm here for the full journey :)
4. I like turtles... I mean programming. I have a MS in Computer Science and want to use opportunity as continuing education.
5. Because over 2500 people have taken the course, it's gotta be good! J/K Interested in learning more about this topic.
6. Want to be prepared for the day Skynet takes over.
7. ML is the dark side so I have to know how to fight it... just kidding. Always curious.
8. It's something I'd be interested in learning about especially in a fun Star Wars related way
9. Saw rave reviews about it.
10. I love Marvel and Star wars movies (just kidding, I really do) but also an ongoing learner, interested in an easy to grasp course, with notes I can go back and reread a (like a "ML for Dummies" version) so I can possibly connect the dots to my work.
11. I think it's a professional travesty I know more about Star Wars [and by some fan standards probably don't know enough about Star Wars either] than computer learning. Considering computer learning and AI are concepts my organization is asking the analytic cadre to become familiar with ASAP; I should and will make more of an effort, starting with this course. :)

12. I have tried to use Bayesian statistics concepts before in research, which resulted in me reading the first 2 chapters of an Introduction to Machine Learning textbook... and I got very, very lost in the ML (admittedly, without a good project or the time to digest the concepts) but very, very interested in how it can be made more accessible to those with relatively weak CS backgrounds so we can apply basic versions as appropriate.
13. As a "somewhat familiar," I'd like to learn "the very basics of linear regression to some of the more complex and relevant ML algorithms, using Excel to show some of the underlying algorithms." The class comes highly recommended by someone who's attended before. I'm all about learning and this is right within my wheelhouse.
14. ML is the future, I'm excited that it is being taught in Excel and Python, and I think it will be directly applicable to my work. And I love Star Wars!
15. I am currently an ORSA working on statistical tasks, but my dream job is to become a data scientist. I am extremely interested in aspects of AI/ML, computer vision, and what this technology means for the DoD, as well as where in the Army we are currently using it.
16. I started a new job helping to award ML and AI research contracts, and although I have a strong business background in Army contracts, I have limited technical knowledge in ML and AI, but it would be quite beneficial for my new role to learn more about them.
17. I would like to increase my familiarity level to "Slightly Familiar" or higher.
18. To protect myself from our future robot overlords by convincing them I'm on their side. Besides, ML + Excel...
19. (1) I have an insatiable natural curiosity for topics like this. (2) Understanding the capabilities, limits, and risks of electromechanical systems is relatively easy. Understanding the capabilities, limits, and risks of traditional software is challenging. Understanding the capabilities, limits, and risks of machine learning or "stochastic parrots" or "pixie dust," whatever you want to call it, makes me want to cry. I need to wrap my head around this.
20. Highly motivated... I am using anything and everything I can get my hands on. I've also written some information papers on the direction I think the Army should take.
21. I took the course last year and know I missed a lot of good stuff...
22. Fill in the blanks, and hear Mark's version.

23. Already know this is a good course. I'm looking for ways to better communicate with Everyone about ML. This course already has done that and a refined curriculum to learn how to improve messaging.
24. ML and AI are hot topics for DoD and beginning impact SW development and implementation for Army Aviation and Missile systems. As a SW safety engineer we are working to develop safety guidance for the usage of ML on new and existing Army programs. A greater understanding of ML would help develop better guidance.
25. I've been using a variety of AI based tools to enhance my work, and have been requested to give trainings to other strategic planners on how to use these tools (CamoGPT, NotebookLM, Gemini, ChatGPT, NIPRGPT, etc.). I try to include overviews of deep learning/machine learning/narrow AI but lack the fundamental basics to really drive those points home.
26. We are at the forefront of next generation digital world. ChatGPT and AI rendered graphics are impressive, yet it is just the beginning of AI. The potential of AI is fascinating to me.
27. Refresher – I took this course a few years ago and with AI creeping into Army missile systems, it is important to re-align my thoughts... from a safety perspective, on potential impacts to the Army and US warfighter.
28. I am diving face first into the topics of ML, AI, and other areas that are on the rise for productivity. Honestly, I just think it's cool. I'm interested in learning how it works from a technical perspective, so that I can be an early adopter of the technology coming down the pipeline. For me, it's easier to learn something when I can understand the Why/How. So while I'm beginning my exploration into how I want to best use Generative AI, I'm trying to pick up all of the knowledge I can.
29. I am going to be studying Machine Learning algorithms for my Masters. And Star Wars.
30. The Excellent advertising and to see if machine learning will be useful in my area of expertise.
31. I am a nuclear engineer and have used ML in my research. However, I generally approach ML problems in a naive way—I almost always use the most basic neural network architecture to solve a variety of problems. I'm curious about other model types—it will be nice to know what's out there so I can select architectures more thoughtfully in the future.

32. ML/AI is coming to Army Aviation platforms. Part of airworthiness certification is certification of the software. I need to understand ML/AI in order to: 1) develop certification processes; and 2) understand what risk is being introduced/accepted.
33. Most documents written with the words "AI" or "ML" that I see could replace the phrase with "Elvish Magic" and the document's meaning would not change in the least.

Appendix H. Course Survey



Section 1

First, a bit about you...

THIS COURSE THRIVES ON FEEDBACK! What do you think after going through the course? The good and the bad! This doesn't get better without paying attention to the tremendous feedback that has been received in the past, and also what you can provide after attending this "MAY THE COURSE BE WITH YOU" course. As Yoda would say, "do or do not, there is no try." So, take a few minutes. Click on some short disagree/agree/strongly agree statements and let me know from your perspective how this went - the comments section is your opportunity to be candid so please speak up! "Help me attendees, you are my only hope!" I set it up to be anonymous, so it won't collect email/name. It should only take a few minutes.

1. How familiar are you with Machine Learning concepts coming into the course? (not at all, slightly familiar, moderately familiar, very familiar, extremely familiar) *

	Not at all	Slightly	Somewhat	Very	Extremely
How familiar are you with machine learning?	○	○	○	○	○

2. What organization are you with? *

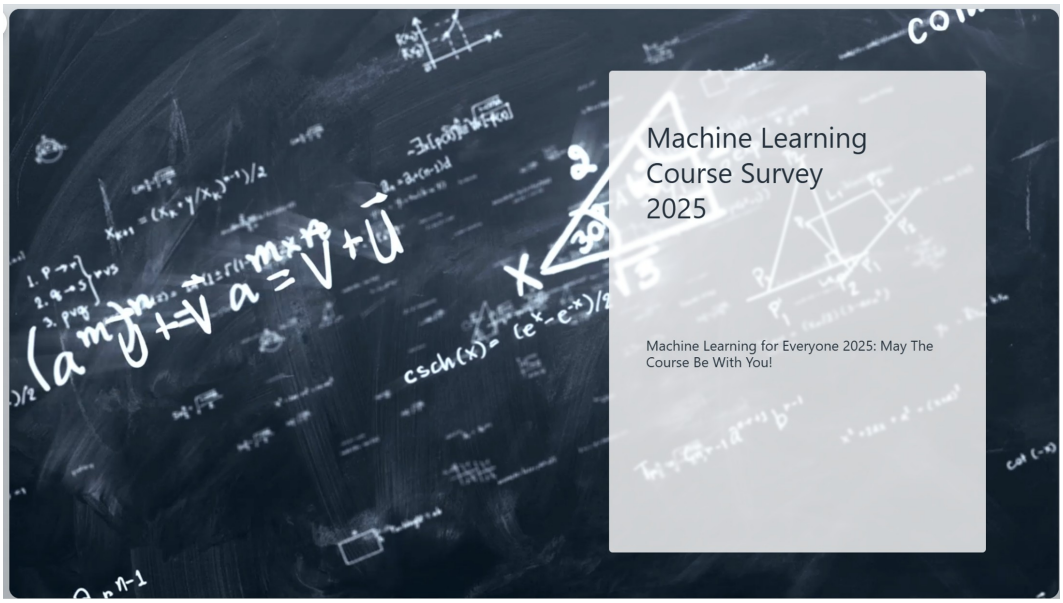
Enter your answer

3. What is your role in your organization? (CIV, CTR, MIL, Scientist/Engineer/Researcher, Leadership/Management, Business/Administrative, other) Multiple answers are ok *

- ☐ CIV
- ☐ CTR
- ☐ MIL
- ☐ Scientist/Engineer/Researcher
- ☐ Leader/Manager
- ☐ Business/Administrative
- ☐ Other

Figure H-1. Machine Learning for Everyone course survey for gathering participant information from participants.

Course Survey



Section 2

Now, a bit about the course...

THIS COURSE THRIVES ON FEEDBACK! What do you think after going through the course? The good and the bad! This doesn't get better without paying attention to the tremendous feedback that has been received in the past, and also what you can provide after attending this "MAY THE COURSE BE WITH YOU" course. As Yoda would say, "do or do not, there is no try." So, take a few minutes. Click on some short disagree/agree/strongly agree statements and let me know from your perspective how this went - the comments section is your opportunity to be candid so please speak up! "Help me attendees, you are my only hope!" I set it up to be anonymous, so it won't collect email/name. It should only take a few minutes.

4. Statements about the course. Please answer your agreement (or disagreement) with the statements below, i.e., strongly disagree, disagree, neither, agree, strongly agree (1-5 scale). *

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The presentations and course materials were well organized	○	○	○	○	○
The presentations and course materials explained the course concepts effectively	○	○	○	○	○
The presentations and course materials were interesting	○	○	○	○	○
The course gave me confidence to do more advanced learning (or understand more advanced concepts) in the area.	○	○	○	○	○
The instructor was enthusiastic and knowledgeable about the course material.	○	○	○	○	○
My overall evaluation of the course is excellent.	○	○	○	○	○
My overall evaluation of the instructor is excellent.	○	○	○	○	○
I would highly recommend this course to others.	○	○	○	○	○

Figure H-2. Machine Learning for Everyone course survey for gathering quantitative and qualitative (long answer) feedback from participants.

Appendix I. Course Feedback Comments

In the course surveys, there was the following long text question at the end.

What did you think of the course? Anything else that you wish to add?

Here are the responses over the years. The content has changed slightly over the years, so some feedback may have already been corrected. Participant feedback was overwhelmingly positive, indicating that the course was valuable and made an impact on people's understanding of ML.*

1. "AWESOME!"
   1.00 **0.99** **0.97** **Key Strength**
2. "Thank you! Course was excellent"
   1.00 **0.99** **0.98** **Key Strength**
3. "This is the best class I've ever had."
   1.00 **0.99** **0.98** **Key Strength**
4. "Great course!"
   1.00 **0.99** **0.96** **Key Strength**
5. "Great opportunity to see the details inside of the ML environment! Great course!"
   1.00 **0.99** **0.98** **Key Strength**
6. "It is an excellent ML course. I am going to review videos again. I have recommend my coworker to take it. Thank you!"
   1.00 **0.99** **0.98** **Key Strength**
7. "The course is excellent and well presented."
   1.00 **0.99** **0.97** **Key Strength**
8. "Great use of examples!"
   1.00 **0.99** **0.96** **Key Strength**

*The author discloses the use of AskSage to identify and remove comments that 1) complain about math after being warned about the mathematical content prior to the course, 2) are dismissive or disrespectful in tone, 3) question the premise of the course, 4) focus on personal challenges ("hard to follow along while caring for a toddler"), or 5) could be seen as unprofessional criticism. The number of removed comments amounted to only a small fraction of the total number of comments anonymously submitted.

9. “I loved it! Great Teacher!”
   0.93 **0.99** **0.98** **Key Strength**

10. “Very good”
    0.91 **0.99** **0.88** **Key Strength**

11. “Unabashedly nerdy... but I loved it! Bravo”
    0.87 **0.99** **0.97** **Key Strength**

12. “I loved the Star Wars theme!”
    0.87 **0.99** **0.98** **Key Strength**

13. “Loved the Star Wars theme!”
    0.87 **0.99** **0.98** **Key Strength**

14. “Great course. Had me thinking of math that I have not used or seen in decades.”
    0.80 **0.99** **0.95** **Key Strength**

15. “the course was really great with the context and all the YouTube videos added for our understanding.”
    0.80 **0.99** **0.97** **Key Strength**

16. “Great course. Honored to be selected to attend. I hope this course will be geared to O-3 commanders and 1SGs/SGMs.”
    0.80 **0.99** **0.98** **Key Strength**

17. “Great course. Look forward to seeing this course evolve if the the course is allowed to continue”
    0.80 **0.99** **0.97** **Key Strength**

18. “Great course and I plan to review the recordings”
    0.80 **0.99** **0.98** **Key Strength**

19. “Great course”
    0.80 **0.99** **0.91** **Key Strength**

20. “It was a great course”
    0.80 **0.99** **0.96** **Key Strength**

21. “I thought it did a great job of explaining the math and implementation of ML. As a 101, I would not add anything else.”
    0.80 **0.99** **0.92** **Key Strength**

22. “I think this is a great introduction for non experts which is the target audience. I don’t have any suggestions.”
0.80 **0.97** **0.78** **Area for Improvement** **Key Strength**

23. “a great overview of what’s what in machine learning that will let you know what you should know to be in the field of machine learning”
0.80 **0.99** **0.78** **Key Strength**

24. “Wonderful introduction to ML, Mark was very engaging and thorough”
0.76 **0.99** **0.98** **Key Strength**

25. “Favorite Part: The videos Additional Comments: Mark did a great job!”
0.75 **0.99** **0.98** **Key Strength**

26. “This is a great course. I feel like the pieces are coming together for me and I’m already planning my own application. The tips and chatter from the attendees were great too. Learned a lot about where ML/AI is applicable and how to get the solver add-in running.”
0.73 **0.99** **0.98** **Key Strength**

27. “It was a great course! The Excel examples helped me understand things better. Something I think would be good to add is example applications (maybe a list) for each neural network you talked about.”
0.73 **0.99** **0.96** **Key Strength**

28. “Great course, I would love to share it... but also I’m going to need to watch it again for myself!”
0.71 **0.98** **0.98** **Key Strength**

29. “Absolutely great course. We are tremendously grateful for the instructor and his expertise. Awesome learning event.”
0.71 **0.99** **0.98** **Key Strength**

30. “Favorite Part: It was a very good intro course. Lots of topics were discussed and presented in an easy to understand way. Additional Comments: Great class. Mark is also a very good instructor.”
0.71 **0.99** **0.98** **Key Strength**

31. “I absolutely love this course! Content is spot on for those of us in the audience unfamiliar with AI/ML. I went from having zero sum knowledge to

working knowledge of AI/ML applications and parallels between coding languages used and usage of Excel spreadsheet. It is more than plentiful to pique interest from the layperson, but more so to continue to expand on learned knowledge in a formal certification program or degree program. Hats off to Mark! Intent met!!"
0.70 **0.99** **0.97** **Key Strength**

32. "Great course! Really liked the pop culture references to keep the material interesting."
0.70 **0.99** **0.98** **Key Strength**

33. "A GOOD REFRESHER"
0.70 **0.99** **0.77** **Key Strength**

34. "Good Course"
0.70 **0.99** **0.84** **Key Strength**

35. "The course was well laid out and provided good foundational knowledge. I'd like to see the incorporation of practical exercises (via Excel sheets that can be done with/along side the instructor), as I believe that would help with the application of the knowledge gained."
0.70 **0.99** **0.91** **Key Strength**

36. "I am very glad you added the intro part. The Excel examples were great in understanding how the math works. I now feel like I understand my data scientist's research a lot better, and the implications!"
0.69 **0.99** **0.95** **Key Strength**

37. "It was great with no issue. More hands-on in AI applications."
0.65 **0.80** **0.98** **Key Strength**

38. "Great job with the course! It filled in many gaps for me..."
0.63 **0.99** **0.98** **Key Strength**

39. "Please leave a bit more time for lunch! 30 minutes minimum—if I wasn't teleworking I couldn't have managed the 15–20 minute lunches."
0.62 **0.99** **0.57** **Area for Improvement**

40. "Great course. Learned a thousand percent more about ML than I knew...Give Mark a raise! He is a tremendously valuable asset to our Army!"
0.61 **0.99** **0.98** **Key Strength**

41. “What a great job.. Quite detailed and intricate.”
0.60 **0.99** **0.97** **Key Strength**

42. “I think this was a great introduction. This is relevant to understand something that is being pushed as needed for a lot of projects.”
0.60 **0.99** **0.95** **Key Strength**

43. “Excellent course! I’ve walked away with a better understanding of what ML is and how to set it up. The course made me realize how elementary some of my questions were and how I should try to answer them.”
0.60 **0.99** **0.91** **Insight/Learning** **Key Strength**

44. “A very well thought out course and excellent instruction!”
0.60 **0.99** **0.97** **Key Strength**

45. “Great course. Learned a lot. Now it is on me to continue learning. Will definitely use the course material as a baseline reference. Excellent job on delivery of information.”
0.60 **0.99** **0.98** **Key Strength**

46. “Nice to see samples in something as ubiquitous as Excel for the introduction....”
0.60 **0.99** **0.93** **Key Strength**

47. “Truly excellent session! You found the perfect balance between not enough math / theory and too much. Goldilocks level of perfection.

    I really enjoyed the Star Wars theme too—it made for great levity additions.”
0.58 **0.99** **0.98** **Key Strength**

48. “Great course! Highly recommend for ALL ranks, grades, and MOS.”
0.58 **0.99** **0.98** **Key Strength**

49. “Mark is one with the Force. The Force is with Mark

    Excellent training! Kept me engaged. Mark has renewed my long-forgotten love for math. I can’t wait to learn more about ML! I had to step away during a portion of the training and I cant wait to get access to the recording so I can watch what I missed. If there is ever an intermediate or advanced class from Mark, I would love to know about it.

I would have preferred to had taken this training in a two-half-day format, but I understand the complexities of scheduling things these days. Overall, excellent!"
0.57 **0.99** **0.96** **Key Strength**

50. "You did a great job with the course Mark. I appreciate your knowledge and enthusiasm. The course provided a nice primer to focus my next AI/ML competency building steps. Keep up the good work!"
0.56 **0.99** **0.98** **Key Strength**

51. "Great intro to ML. I liked when you played the Excel recordings and narrated over them but think it could be beneficial to have some hands-on tutorials within the training. I wasn't able to attend the after-class session on the first day but maybe there could be a mandatory component of this sort. Again, thank you for the training!"
0.55 **0.99** **0.95** **Key Strength**

52. "An incredibly enlightening course with an instructor who does a great job making the content approachable and understandable to the uninitiated."
0.55 **0.99** **0.97** **Key Strength**

53. "Excellent organization and well developed."
0.55 **0.99** **0.96** **Key Strength**

54. "Not related to the class. It was excellent. However, with respect to the Excel spreadsheets, I think many of them could have used a Freeze pane just below the headers of the longer lists to hold the headers in place while scrolling. I think that would help for newbies to the material, like myself. Thanks again for the excellent examples, and explanations!"
0.54 **0.79** **0.89** **Key Strength**

55. "Keep Reggie and Mark teaching! Having some more time at Graces Quarters where we get to see the robotics in action on the terrain would be awesome."
0.53 **0.99** **0.95** **Key Strength**

56. "Favorite Part: Great Star Wars references. Futuristic like AI. Additional Comments: Super interesting training."
0.53 **0.99** **0.98** **Key Strength**

57. “The course is great foundation for AI and ML. Thank you so much!”
0.52 **0.99** **0.98** **Key Strength**

58. “Great course, thanks for taking the time to put it together!”
0.52 **0.99** **0.97** **Key Strength**

59. “Would have liked to learn a bit more regarding how the data collected/accessed for machine learning impacts the privacy and confidentiality of individuals when for example PHI is used and how is this mitigated. Overall the course was an excellent window for me into what machine learning and neural networks are and how they operate.”
0.52 **0.99** **0.75** **Key Strength** **Insight/Learning**

60. “Amazing course. I program in Python, but did appreciate showing steps in Excel to eliminate the focusing on code. Mark is super motivated, and a great speaker, instructor who has a true passion for this material.”
0.52 **0.99** **0.96** **Key Strength**

61. “I enjoyed the course very much (a lot of material/concepts were covered). You’re a great instructor. Thank you.”
0.52 **0.99** **0.98** **Key Strength**

62. “Overall the course was excellent. Mark is very knowledgeable and did a great job explaining the concepts. For an audience that does not have an engineering background it would be more effective to talk conceptually about the process with diagrams or figures rather than getting into the math.”
0.51 **0.99** **0.93** **Key Strength**

63. “More examples using Pythons would be helpful like today’s examples, with explanations of each parameter is very helpful. Showing a bit more of the input parameters to the Python program are nice to see as well. It is a great course taught by an outstanding instructor.”
0.51 **0.99** **0.95** **Key Strength**

64. “Dr. Tschopp was an excellent instructor!! and he prepared a lot.

    This course was intensive (which means nice introduction for general).

    I hope there will be more detailed courses with Python.”
0.51 **0.99** **0.98** **Key Strength**

65. “Love the Star Wars references :)”
0.50 **0.99** **0.98** **Key Strength**

66. “I would have an emphasis on a distance learning course for beginners and the in-person course for those with more experience.”
0.50 **0.98** **0.76** **Key Strength**

67. “Favorite Part: The video clips and discussion of recommended articles/books to read”
0.50 **0.99** **0.87** **Key Strength**

68. “Favorite Part: I have to pick a favorite session??? I was intrigued with the whole thing! Improvements: It worked via TEAMS but I truly feel that this training would serve everyone better as a face-to-face training. Mark was a great speaker and being through TEAMS did not serve him justice! Additional Comments: With the talk of AI and Machine Learning, the two day course would be beneficial. Thank you so much for the information you provided today, Mark!”
0.50 **0.96** **0.97** **Key Strength**

69. “This topic might not apply to most positions, however, I would need to learn the concepts to know if it can be applied.”
0.50 **0.99** **0.80** **Area for Improvement**

70. “I thought it was really terrific! An excellent introduction to the entire field of Machine Learning. Probably the best government training that I have ever taken.”
0.50 **0.99** **0.98** **Key Strength**

71. “I now know what machine learning is. I can’t perform the math, however, I’m glad I know what it is.”
0.50 **0.76** **0.72** **Key Strength** **Insight/Learning**

72. “I know there was a lot of material to cover. But more and longer breaks would have been helpful.”
0.50 **0.99** **0.65** **Key Strength**

73. “Thank you for all your efforts! I really enjoyed this course in machine learning. I learned more than I anticipated.”
0.50 **0.99** **0.99** **Key Strength**

74. “This course was the best ML/AI I have ever taken. I do not know anything about Star Wars but the funny captions, comments and pictures made the training even more enjoyable. I want to know more about the test and evaluation of the AI, thanks a lot for all the effort!”
0.50 **0.99** **0.97** **Key Strength** **Insight/Learning**

75. “Thanks for making this available–a great introduction to the technique.”
0.50 **0.99** **0.97** **Key Strength**

76. “I think this topic requires attending more class meetings.”
0.50 **0.99** **0.82** **Key Strength**

77. “definitely worthwhile”
0.50 **0.99** **0.88** **Key Strength**

78. “Really great work! The only part I was hoping to get a bit more detail on was autoencoders, and specifically variational autoencoders.”
0.50 **0.86** **0.95** **Key Strength**

79. “This was an excellent and well-structured course. Having demonstrations in Excel made it more accessible. I wish there had been more time to work with some of the hands on demonstrations. Also, the information on the last day was quite dense – and I felt like I may have missed a connection somewhere, in order to truly understand it.”
0.47 **0.93** **0.94** **Key Strength**

80. “Very enlightening course that helped us build foundational knowledge about AI. Loved that I can tell how enthusiastic the instructors were and appreciated how patient they were with my questions and lack of knowledge about AI. This course motivated me to find opportunities to increase my competency in this field.”
0.47 **0.99** **0.97** **Key Strength**

81. “wonderful job! This was a great course not only in content but also getting researchers excited to learn and move into this new area!”
0.46 **0.99** **0.98** **Key Strength**

82. “You did an outstanding job Mark! Very much appreciated! Thank you!”
0.46 **0.99** **0.98** **Key Strength**

83. “Thanks so much for putting it together—it was incredibly helpful!”
0.46 **0.99** **0.98** **Key Strength**

84. “It would be better to practice while learning the concepts. The ML with Excel is interesting but could not pace with the presentations to learn by doing.

    I hope I will learn more with your presentation if the recorded version is available. I kindly request to provide the link to the recording of the presentation, if possible.

    I appreciate your effective and energetic teaching till the end.

    Thank you!”
0.46 **0.99** **0.52** **Key Strength**

85. “This was honestly one of the best virtual trainings I have attended. The instructor was very enthusiastic and knowledgeable. The content was very interesting and presented in an engaging way. We did not touch much on Reinforcement Learning (which happens to be my personal ‘favorite’) but that’s ok. I would definitely recommend this course to my colleges.”
0.46 **0.99** **0.98** **Key Strength**

86. “Favorite Part: The entire presentation was great. The speaker kept the information presented entertaining and interesting.”
0.46 **0.99** **0.98** **Key Strength**

87. “1. It would be good to provide resources to take online introductory classes for AI. 2. More breaks in between sessions. It felt like two hours of lecture is a bit much without a break in between. It could be a quick 5-7 minutes to standup and stretch. 3. Use feedback to provide how service members could benefit from AI in their daily positions. For each warfighting function, how can AI help them. 4. Share best practices of applied technique on a portal that people can reach.”
0.45 **0.99** **0.68** **Insight/Learning**

88. “Favorite Part: Learning how machine learning operates. Improvements: Yes. Additional topics: applications of machine learning with vantage Additional Comments: Fantastic course”
0.45 **0.99** **0.97** **Key Strength**

89. “This was a very informative day! I am new to ML, and the hands-on Excel examples were incredibly helpful. I might suggest using a 1/2 hour break to let people fill in a (simple) worksheet after the first part of the course, then go over it so they can check their own understanding.

    Great course!”
    0.44 **0.99** **0.97** **Key Strength**

90. “Well-rounded and very informative course taught with great enthusiasm. It contained interesting real world examples and made the topic of machine learning more approachable.”
    0.44 **0.99** **0.98** **Key Strength**

91. “Absolutely awesome. The instructor is a “natural teacher,” someone who is just born to teach. I would recommend that he find a regular venue to practice and develop his teaching abilities. I would also recommend that he pursue formal instruction in the art of teaching, in order to raise his teaching skill to a professional level. Truly awesome talent, presentation, pedagogy, everything.”
    0.44 **0.99** **0.97** **Key Strength**

92. “Great primer. My math isn’t advanced as some of the neural network stuff, but it was still useful for my purposes to help me understand the broader topic better. Thanks Mark for doing this.”
    0.44 **0.99** **0.91** **Key Strength**

93. “Quite frankly, it was the best and most entertaining presentation on this subject I have ever experienced. Terrific job.”
    0.43 **0.99** **0.98** **Key Strength**

94. “It was a good introductory course on ML. Follow-up assignments and online course ideas will be useful. This can be separated into either: 1. Additional, more in-depth ML techniques; and, 2. Applications of the ML concepts covered in the course. Thanks!”
    0.43 **0.99** **0.96** **Key Strength**

95. “It was a good overview of ML. It put me in a position to explore further on my own.”
    0.43 **0.99** **0.95** **Key Strength**

96. “This was a great course, I think anyone involved in research would benefit from it. I would love to see more courses like this offered in the future. I also really enjoyed hearing about some of the projects ARL is working on and how they are applying ML to exciting and cutting-edge technologies.”
0.43 **0.99** **0.98** **Key Strength**

97. “Exceptional instructor and material organization, yet too much to absorb in one day.”
0.43 **0.92** **0.85** **Key Strength**

98. “With this one the Force is strong.”
0.43 **0.99** **0.86** **Key Strength**

99. “The course was great! The use of Excel is far superior to high level programming languages like Python. This method really shows what’s going on under the hood. A+”
0.43 **0.99** **0.98** **Key Strength**

100. “The content was intriguing and very eye-catchy. The instructor was excellent teacher. The concept was well-presented, very easy to understand at the surface level. Started with literally no background or training in ML, I have learned a lot more than I would ever had thought I can be. Thanks again for the great content and thanks for making me (generalized as someone who doesn’t know anything about ML) understand and stay focused throughout the whole course. Thanks!”
0.42 **0.99** **0.98** **Key Strength**

101. “Excellent, the use of Excel to break out the functions of the ‘black box’ in R or Python Tools”
0.41 **0.99** **0.84** **Key Strength**

102. “This was a very valuable and understandable course! It turns out I already knew more than I thought, because people always describe ML as magic.”
0.41 **0.99** **0.97** **Key Strength** **Insight/Learning**

103. “Favorite Part: Learning the history of AI Improvements: Incorporate a quick interactive AI exercise for students.”
0.41 **0.99** **0.93** **Key Strength**

104. “It was great. The order and flow was good. More pretext would help in that, hey this is the math that is tough, but when you understand this level, it will help you understand the next levels of how it becomes easier. As I mentioned, connectivity would have been great so we could do some instructor led practical work in Excel, Python, or GPT. Just to reinforce the lessons taught and break up some of the overwhelming (at times) power points. I want to dig in and try it myself.”
0.41 **0.99** **0.91** **Key Strength**

105. “I definitely enjoyed the Star Wars theme. For me many of the concepts were easy to understand, but I do have a BS, and Master’s course work in the area of mathematics. Some of my other colleagues did not understand the mathematics as much. Overall I thought that the presentation of the course was great, understandable, and serves as a great way to introduce and educate others on machine learning.”
0.41 **0.99** **0.94** **Key Strength**

106. “I really enjoyed the course. I am so glad I took it. I found it very interesting and useful. I am sure it will help me in future decisions.”
0.40 **0.99** **0.98** **Key Strength**

107. “Course was very good but I think it could still use a little more introductory information. Maybe in the form of read-aheads or a pre-recorded lecture.”
0.40 **0.99** **0.83** **Key Strength**

108. “Honestly, this was one of the best courses I’ve taken in my professional career! It was a really good overview, but I felt like it still had enough depth to be very useful. I’ve recommended that all my coworkers take future versions of this class.”
0.40 **0.99** **0.98** **Key Strength**

109. “It had a good flow from basic to the more advanced.”
0.40 **0.99** **0.94** **Key Strength**

110. “Great short course!”
0.40 **0.99** **0.96** **Key Strength**

111. “Great course for folks who have solid linear algebra skills and want to learn more about how the mechanics of how ML works. I would definitely recommend clarifying this up front, but even for someone to whom neither of

those applies, the course was interesting to participate in and I took away some relevant insights. That said, it would be great to have a course that covers these topics for people who would benefit from the applications of ML, but would not be working directly with the ML tools/training/etc; from an application perspective, I found it valuable to learn more about some of the techniques and challenges of training algorithms, selecting tools, dealing with the amount/type/quality of data available, etc."
0.40 **0.98** **0.91** **Key Strength**

112. "Would be great to have notes in the PowerPoint with key info discussed and examples"
0.40 **0.89** **0.84** **Key Strength**

113. "Valuable information and techniques were shared demonstrated. Real world application and suggestions of how to use it we shared effectively."
0.40 **0.99** **0.86** **Key Strength**

114. "I am inspired to apply more machine learning to my research. Thanks for the Star Wars theme :-)"
0.40 **0.99** **0.98** **Key Strength**

115. "So far so good. I use MATLAB but it is instructive to see it in Excel—I would never know how (or want) to do that."
0.40 **0.99** **0.73** **Area for Improvement** **Key Strength**

116. "Very well done. Rather than diving into math-heavy notations and jargon right from the beginning, this course got into it gently and talked about the concepts with many examples. I thought that was a great approach."
0.39 **0.99** **0.92** **Key Strength**

117. "I thought the course was fantastic, it was a very knowledge rich course and having Star Wars incorporated was a good way to make it fun."
0.39 **0.99** **0.98** **Key Strength**

118. "It was a good course. If I had done the Excel practice beforehand, it would have been more fruitful to me. Because I did not, it was difficult to keep up. I recommend everyone do the Excel before coming into the course. Loved the break slides!"
0.39 **0.95** **0.92** **Key Strength**

119. “Favorite Part: Mainly, the context of the training. Very informational Improvements: No improvement required at my level Additional topics: AI in Project Management is desired. Additional Comments: More of this kind of teaching.”
0.39 **0.98** **0.93** **Key Strength**

120. “I knew that parts of statistics were considered machine learning (i.e. classification, clustering, SVM, etc.) but I did not quite understand how they related. I previously heard of neural networks but wasn’t sure what they were. This course was great at filling in my gaps of knowledge and has made me want to learn more. I personally loved seeing the math since it helped me understand what ML is and how it works.”
0.38 **0.99** **0.64** **Key Strength** **Area for Improvement**

121. “Some of the calculations were too quick for me to follow along in my sample spreadsheet. I’d like to spend more time going through the equations to better understand the spreadsheet. Sharing a completed spreadsheet would be helpful. Overall, I enjoyed the workshop and have a better understanding of what ML is all about.”
0.38 **0.87** **0.50** **Key Strength**

122. “it was really great and already have many at my unit who are interested in attending the next one”
0.38 **0.99** **0.98** **Key Strength**

123. “The course was fabulous and it demystified ML for me! The instructor was extremely knowledgeable regarding ML. This is one of the best courses I have taken. A ton of material was presented and the instructor made it understandable and interesting. The Star Wars examples made the class fun as well :-) The instructor provided many references and tips on where to find additional information regarding our future ML endeavors. Many thanks to the instructor for all the time and effort put in and to offer this course.”
0.38 **0.99** **0.98** **Key Strength**

124. “Dr. Tschopp and Dr. Hobbs were phenomenal. The Major and the DAC were great moderators and they lent a lot of perspective during the entire course. BG Ahern was very personable and sincerely listened to the feedback of the students. I loved the course and it was encouraging to know that we have 1600

researchers pioneering the way ahead for the armed forces. With the outlook, skills, and knowledge gained from the course I have a significantly better understanding of the capabilities and limitations of AI. I intend to educate my organization and eventually build an 'Intro to AI in the Armed Forces' presentation at some point to build a shared understanding with rest of the brigade. Thank you, I am very thankful for the opportunity to participate in this course."
0.38 **0.99** **0.97** **Key Strength**

125. "Great overview and a cool way to present it."
0.38 **0.99** **0.97** **Key Strength**

126. "I truly enjoyed the course though I did not not realize there was so much math! I did learn cool stuff on AI and images which is fascinating. I also enjoyed the opening brief. Thank you."
0.38 **0.99** **0.98** **Key Strength**

127. "for the manager :-) could've used less math more emphasis on vocabulary. more high level discussion of what is happening in Neural Nets. really enjoyed it, learned some new Excel stuff and am very interested in learning more. course slides/ notes/biblio would be welcome"
0.37 **0.99** **0.95** **Key Strength**

128. "The instructor was entertaining. That help keep students interested and engaged."
0.37 **0.99** **0.96** **Key Strength**

129. "Instructor made it fun, but there was still a lot of material over my head!"
0.37 **0.98** **0.81** **Key Strength**

130. "The course was excellent! I had skimmed through the recordings of the first iteration of your ML 101 Part 1, but still had trouble truly understanding some of the concepts at their core. This newest iteration, with the Excel examples provided throughout, really helped me understand those underlying concepts better. Thank you!"
0.37 **0.99** **0.89** **Key Strength**

131. "This was a very good course, with good explanations of the different concepts. I thought the use of Excel for demonstrations is very original, and the

instructor is excellent. I am not much of an Excel user, but it was interesting to see some of the more advanced capabilities of Excel.

References are made to other online material. One I would mention as a really great introduction to the various concepts for people that do not know anything about machine learning, composed of conveniently short videos, is by 'deeplizard': deeplizard

I found it useful to have gone over that course first and then have attended this course."

0.37 **0.64** **0.92** **Key Strength**

132. "I'm fairly new to the field of AI and ML. This course really inspired me to dig deeper into the field. The use of Excel was very interesting to show what's going on under the hood and it helped me understand those underlying concepts better."

0.37 **0.99** **0.95** **Key Strength**

133. "As a statistician, it is always great to get a refresher of the basics. Even if it is perhaps not the most exciting, I know an ounce of effort now is worth a pound of debugging later. Many thanks."

0.37 **0.99** **0.96** **Key Strength**

134. "I loved the course. There was never a time when I was bored, which is saying a lot because I can never set through 6 hour lectures. Dr. Tschopp did very good with explaining the topics, having many breaks, and making the content fun to learn. I loved how he is so conscious of time and attention spans. I learned so much more about machine learning. I would like to add a lab to this course. Maybe like homework in between days to practice ML. Other than that I really enjoyed this course!"

0.37 **0.99** **0.96** **Key Strength**

135. "From the perspective of someone who is just starting to dive into the world of machine learning, I thought this course was great! Mark was knowledgeable, well-organized, and clearly enthusiastic about the material. I appreciate the use of Star Wars to help keep things fun and engaging! I also liked that Mark chose to demonstrate neural network building in Excel rather than Python or MATLAB. It was an intuitive way to visualize the process without getting bogged down by syntax and esoteric functions, even if Excel would not be the

most practical way to develop neural networks for a real application. My only criticism is that the material was covered very quickly, and some topics were not explored quite as thoroughly as others. It was a lot to take in all at once. Someone more experienced in machine learning topics might disagree, but for a beginner, it was a bit overwhelming at times to keep up with everything being conveyed. Instead of covering everything in one day, I feel like it would be more effective to go at a slightly slower pace and spread the material out over two or more days. I also would have liked the course to be done in a more interactive format (e.g. sharing the Excel examples ahead of time and having the audience follow along with Mark instead of just watching him). Perhaps a different medium would be better for a more hands-on approach? Overall though, this was a great experience, and I would definitely recommend this course to others!"

0.36 **0.99** **0.96** **Key Strength**

136. "Favorite Part: Seeing the very formal Linear Algebra and neural logic that provided the complexity of AI and ML Improvements: Perhaps some greater emphasis of how very complex these ideas are. One of my favorite words has been in 'Incidental' and it applies to this very large set of entertaining presentation material that showed Dr. Tschopp's skill in his use of the graphics and features of PowerPoint and in AI. Additional topics: Would like to see more on AI and ML. And also some better emphasis on the facilities that suffered a bit with how the facilities were able to handle the media that was used. It seemed like getting kicked out of the Wheeler Conference Room was distracting a bit. Additional Comments: Was completely impressed with General Anderson's visit and discussions of how AI is helping with some of our tools that have been honed in our use of munitions identifying targets. The chance to see Mr. John Campbell was indeed an unexpected pleasure."

    0.36 **0.99** **0.86** **Key Strength**

137. "Wow! Course was fantastic. I was pretty intimidated by the whole idea of machine learning beforehand but this primer really helped take the edge off. I'm the kind of person who needs to be able to look under the hood of tools before I'm comfortable using them and the way Mark unpacked the equations and approaches used in the various methods was great!

    My only comment is that it would be nice to have a "cheat" sheet of sorts

that summarizes the equations for each approach, particularly for the Bullets worksheets.

Also, more Futurama please!"
0.36 **0.87** **0.91** **Key Strength**

138. "I thought the course was great—content, pace (built in breaks), platform, instructor. I left with a greater appreciation of what ML has to offer. I still feel overwhelmed with what was presented but plan to look back at the resources provided to gain a better understanding over the content as time goes on. Thank you."
0.36 **0.96** **0.96** **Key Strength**

139. "I am familiar with the content, though not a practitioner. This could be split into two days for different audience. For people who know nothing about the topic and for people who are familiar and want to learn the advanced topics.

    I learned some capabilities of Excel. I am impressed at how good Excel is, but as the instructor pointed out, it is not for large problems. I am not sure how many actually use Excel for anything like this.

    Overall, excellent intro."
0.35 **0.99** **0.68** **Key Strength** **Area for Improvement**

140. "I thought that the use of Excel was a great idea. It really allowed me to get a good handle on how the pieces connected at a basic level, and I have never seen Excel used for this. That said, the course covered a lot of ground very quickly and it is a lot to take in within a short amount of time. But I guess that is just the nature of a one-day intensive!"
0.35 **0.92** **0.90** **Key Strength**

141. "Excellent course! My only suggestions would be to maybe break it up into smaller bits over more days—by the afternoon I had a hard time retaining things because my brain hurt :) and I would love to see some more Python examples in there. Thank you for all the work you put into this and for your humor and enthusiasm!"
0.35 **0.99** **0.94** **Key Strength**

142. "The amount of learning and fun was pretty balanced, definitely a lot more jokes and fun than I was expecting. Some of the advanced material was gone

through quite quickly but I understand there was a lot of material, so it was needed. Overall good experience and it would give people more confidence to start learning on their own with this foundation."
0.35 0.99 0.96 Key Strength

143. "It is a long day but a great course from end to end. I think the message conveyed was strong—especially when it comes to appropriate application. That is something I have had to learn on the job coming from school. I also thought Excel was an effective way to teach the mechanics of machine learning especially when it comes to breaking down the underlying math piece by piece (something I wanted to learn/understand more). I do all my work and was taught in R/Python but I think this approach of teaching in Excel might be more effective in school/training!"
0.35 0.99 0.95 Key Strength

144. "I appreciated the Excel files, but I was hoping to keep up with what you were doing on screen better than I was able to. This was probably the result of you having less time to work with us than you typically would.

    Recommend adding inserting a 'that's no moon... it's a space station' reference. :P

    Tesla's Autonomy day video from 2019 might have some good examples for you to screenshot or reference if someone asks about how machine learning relates to self-driving cars. Here is a video that jumps to where that part starts: https://youtu.be/Ucp0TTmvqOE?t=6725

    Overall, I really appreciate you providing me with a base-level understanding of what's happening in the background of machine learning and neural nets. The Excel approach was great for this, and your slides and videos were very well done! I love the Star Wars theme and appreciate all the effort and passion you put into this. :)"
0.35 0.99 0.48 Key Strength

145. "Star Wars theme was very relaxing and witty."
0.35 0.99 0.98 Key Strength

146. "Since this is the second time I have taken this course, it was good to see the expanded data discussion relating to performance and trust."
0.35 0.99 0.95 Key Strength

147. “understanding the scale and the magnitude of going from model to full operational is still a challenge”
0.35 **0.91** **0.66** **Insight/Learning**

148. “Fun and engaging”
0.35 **0.99** **0.93** **Key Strength**

149. “Loved the class. Struggled a bit on day 2 with keeping up, but now have some confidence to go do independent learning.”
0.35 **0.99** **0.95** **Key Strength**

150. “Good initial overview of Machine Learning.”
0.35 **0.99** **0.91** **Key Strength**

151. “The course and the panel were both fantastic! Thank you so much for offering the course to everyone.”
0.35 **0.99** **0.98** **Key Strength**

152. “This was so great! If I had to give it a score, I would give it a 10 out of 9. Thank you for putting this material out there and making it approachable for people who don’t have backgrounds in linear algebra or other advanced maths. The pacing of the material was great and sending out the Excel spreadsheets in advance was highly conducive to helping me follow along during the lesson. Also very grateful for all the additional resources you pointed out. Now it’s time to go devote way too much time on 3blue1brown. Thanks for making something I once thought was unattainable actually seem much more accessible!”
0.34 **0.99** **0.96** **Key Strength**

153. “The first half (intro to ML concepts) and the intro to neural nets was interesting and more digestible as a new-comer to the field. I thought the afternoon was quite heavy on the NN and I lost the plot on a lot of it. From my experience level I would have benefited more from more information on the classical ML models and best practices—things like: how to evaluate the model, feature engineering, dealing with missing values, etc. but I understand that the ‘basics’ may not be of interest to others that are more experienced in the field. The Excel approach was quite interesting and I thought it was a nice way to ‘visualize’ what was going on. Loved your enthusiasm and endurance to cover that much material in one day! Really appreciate the effort you put in

to offer/deliver this course and I feel like I now know some of the questions to be asking when jumping off for further learning. Thanks!!"
0.34 **0.94** **0.78** **Key Strength**

154. "I would recommend to break the session in two days. After 4–5 hours of session it becomes exhaustive to follow such a dense topic. Other than data , the session was very helpful and touched strong points for both beginners and more advanced users in the field. Great work preparing this event. Congrats!"
0.34 **0.99** **0.93** **Key Strength**

155. "Mark's depth of knowledge and research of the topic was impressive.

    Mark is a tremendous asset to the ARL team and I'm sure would be welcomed on almost anyone's team.

    The 8 hour block spends a good amount of time in thee weeds—might recommend a "Machine Learning 001" vice "101" that addressed the general concept and components of ML and what role they played in the process—but pull back from specifics on formulas and spreadsheets. The "001" version would be a great overview for non-technical folks and a short EXSUM for managers and leaders to become more familiar with the overall model.

    I'd be careful recommending to ALL others—many yes—but many would be well served with the "001" model addressed above."
0.34 **0.99** **0.89** **Key Strength**

156. "As a self-proclaimed Star Wars nerd, I was really looking forward to the Star Wars-themed machine learning course. I absolutely loved the way the memes/quotes/references were incorporated in a way that both held my attention throughout the course and made learning the concepts infinitely more enjoyable. Additionally, the instructor's enthusiasm was very contagious!

    As for the material itself, I really appreciated the way it was presented–especially the Excel-based examples. Often times, "machine learning" is presented as something that requires tons of specialized programming knowledge which makes learning the basics a somewhat intimidating undertaking. It was refreshing to see Excel being used for the smaller data sets with an explanation of how Python, MATLAB, etc. is needed to larger data sets. To me, that makes the content a lot more "relatable." I also really liked the "Jedi

Council" session at the end. It was a really clever way to put the content in "real-world" context."

0.34 **0.99** **0.97** **Key Strength**

157. "Good Morning Mark- Good job on day 1 explaining the basic concepts. Would have liked to see more time spent on Day 2 going through the application process. Maybe walk through one or two use cases in detail. Understand time is limited, but getting an understanding of real-world application is important."

0.34 **0.97** **0.90** **Key Strength**

158. "As the instructor noted, the course involves a lot of material to cover in one day, and I admit my attention waned in the afternoon. I think this was more a result of the schedule than the instructor, and perhaps the material could be spread out over multiple shorter sessions. Overall, I appreciated the instructor's enthusiasm, well-organized presentations, and Excel examples which helped to understand the concepts without requiring specialized programming software/knowledge. Thank you for an excellent job!"

0.34 **0.99** **0.63** **Key Strength**

159. "Favorite Part: I enjoyed the section that discussed the past failures of AI. It put in perspective the extent of how AI and Machine Learning, from an outward view, is seen as something simple but in reality, is not how we think it is. There are many moving parts and not a one size fits all approach. Additional Comments: I really loved this course! I have already recommended it to just about everyone I have spoken to, haha!"

0.33 **0.99** **0.64** **Key Strength**

160. "I love the Excel examples. Some might claim they are repetitive, for me, the repetition and slow build up of capabilities helped my understanding.

    The panel session was fine but the course was much better. My first thought was to use the panel time to do more of the course.

    As I think more though, it might be even better to just push the panel to shorten their laundry lists of all the wonderful things they do and have them do examples from their work that repeat/show examples of things taught in the course. Yes it's important to show that the simplified things in the course lead to the cutting edge but really everyone taking the course knows that. To

me the course is all about showing the steps to get there. If the panel could go over the simplest examples of things they do (maybe to extend the Python already covered) to illustrate the simpler level of 'intermediate' ML, even if they have to pull those examples from their grad school work 10 years ago, that process would help me see 'how to get there' in my own work.

Anyway, Great Job! Thanks"
0.33 **0.88** **0.91** **Key Strength**

161. "My only critique is of the amount of math that was presented. I very much enjoyed the material and am thankful for the opportunity to meet so many of the staff that work with the technology every day."
0.33 **0.99** **0.97** **Key Strength**

162. "Can clarity be added to math portion of instruction? It's been awhile since I've been exposed to anything beyond simple algebra and additional sources to be brought up to speed might reduce the overall learning curve. WONDERFUL COURSE! THANK YOU!"
0.33 **0.99** **0.88** **Key Strength** **Insight/Learning**

163. "I really enjoyed this course, but it was a lot of information to take in at one time. It may be better in the future to split the course over two days."
0.33 **0.79** **0.97** **Key Strength**

164. "The course is super! I would like to see two things to happen:

    1. The recording of the course is available so that we can go back to it later. I really feel the need to go back for at least some parts of the course.

    2. The presentation slides are extremely well written and organized. If the slides (or some of them) can be made available, that would be wonderful.

    The instructor is great! A lot of us benefit from this wonderful course. Thank you!"
0.33 **0.99** **0.94** **Key Strength**

165. "The use of Excel to explain the working of ML algorithms is unique and very appropriate for a short course like this. However, I think that giving a little bit more exposure to some real ML platforms (e.g. TF), will make the course even more attractive. Maybe creating some examples (preferably the

same Excel ones) in Google Colab and just introducing them to the attendee could be a good idea.

Inviting young ARL researchers to the panel is an excellent idea. It was nice to hear what those young researchers are working on.

Thank you very much, Mark, for all your hard work on putting things together."
0.33 **0.99** **0.88** **Key Strength**

166. "Very well done. The examples in Excel and PowerPoint really helped me understand the concepts better. I would recommend doing the "ML Primer" before the "Intro to ML for Cyber" talk since some of the concepts would be introduced first before they are discussed in the cyber domain. Additionally, more examples for the Cyber talk would be beneficial, as well as a slower pace."
0.33 **0.93** **0.94** **Key Strength**

167. "Favorite Part: Learning the possibilities of what AI, and how Machine Learning can change the battle space as well as the Civilian uses, both pro and cons. Improvements: I would like to see more real life examples of how AI and ML effects everyday life as well as what we can use it for and even in warfare. Additional topics: More of AI and ML, how its changes and its effects in future warfare. Additional Comments: Great Class, 10/10 recommended"
0.32 **0.99** **0.76** **Key Strength**

168. "I appreciate Mark offering this course and sharing his advanced knowledge of Machine Learning concepts and models to educate Army personnel on this important topic. One issue that makes presenting this material more difficult is the differing backgrounds of personnel attending the course. Personnel attending the course who do not have a great deal of background in statistical techniques and advanced data analysis will generally struggle to understand many of the statistical formulas Mark discusses during the course. It may be worthwhile to offer a more basic course focusing primarily on conceptual aspects of Machine Learning for personnel who do not have a background involving statistical techniques / advanced data analysis and a more advanced version of the course delving into actual statistical techniques and formulas for personnel who do have this type of background."
0.32 **0.90** **0.54** **Key Strength**

169. “I really liked how the course made a link between ML and what I typically think of as just stats methods. The visuals were excellent. I was also intrigued to see capabilities in Excel that I did not know it had. I’d like to know how to label variables in Excel, as that seems incredibly useful. Also curious about the + being used before entering Excel formulas instead of =”
0.32 **0.99** **0.96** **Insight/Learning** **Key Strength**

170. “Very educational”
0.32 **0.99** **0.93** **Key Strength**

171. “Distribute Original Files Examples, and then Final File Examples, not everyone is as proficient in MATLAB/Python/Excel and can replicate the equations effectively and efficiently.”
0.32 **0.95** **0.72** **Area for Improvement**

172. “This course was outstanding! A huge amount of material was presented and, therefore, it is extremely helpful that the presentations and spreadsheets are made available because they allow to repeat part of the course when needed.”
0.32 **0.99** **0.98** **Key Strength**

173. “It is an excellent course. AI/ML are great tools to add. In my experience as a researcher in Materials Engineering, the data points are not as huge as most of these tools are typically designed for. Excel serves the purpose. Breaking complex forms into simple Excel documents is brilliant. One can visualize and understand what is going on. As we talked during the class, adding a instructions “dummies guide” tab will be helpful with key formulae or other reference info. Also adding “plots” will be “cool” to visualize the data optimization curve fitting.”
0.32 **0.99** **0.93** **Key Strength**

174. “Great course Mark. Thank you very much for offering this and taking the time to make it fun and exciting and easily received. I think the Star Wars aspect really makes it more approachable and engaging, especially for the fans. I definitely think the course was well laid out and well organized. I think it was hard for some like myself to commit to a 2 day training without taskers in between, no fault of yours though. I liked the breaks in between and ad hoc as well but it would have been good to put out a more refined agenda if possible so we could catch up or follow along where we left off. If slides

could be provided ahead of time as well, that could be beneficial for some folks to catch up, take notes, etc. Additionally the videos/recordings would be good if there was a linkage to the slides/sections in shorter segments but having them is better than none. Thanks again."

0.32 **0.99** **0.96** **Key Strength**

175. "Favorite Part: Graphics, audio and videos. Relevant present day examples and practical applications. Additional Comments: This course was way above my head, and I was only able to understand the overview and basic concepts/principles/examples/practical applications. The advanced math/calculus and Excel formulas would best be suited for an intermediate or advanced course on AI and ML."

0.32 **0.99** **0.81** **Key Strength**

176. "The presentation was very good and the content interesting, but I wish we had spent more time covering the "pre-course" material. I had no background in machine learning and felt that this could have been more effective for people with some working knowledge of machine learning. I am familiar with calculus and logistic regression but not so familiar with linear algebra, so I found the matrices a bit overwhelming. The day was also long, even with breaks. I might recommend breaking this into two 4-hour sessions maybe with some 'homework' for people to complete between sessions. I felt that the pre-assigned work was quite easy, but I wish there would have been some practice for neural networks since we spent so much time on it. I also was under the impression that we would be going through the "JustBullets" file together during the session and was disappointed to learn that that was not the case. Overall, I think the course was good and would recommend it to others with the caveat that they should have knowledge of calculus and some knowledge about machine learning or related concepts. I also really liked the themed materials. Great touches to the slides! Mark was great. Glad we will receive a recording as there are several sections I'd like to go back and review."

0.31 **0.88** **0.89** **Key Strength** **Area for Improvement**

177. "MANY THANKS FOR YOUR EXCELLENT PRESENTATION. I had to drop out in the afternoon, so can you share a video or the slides of the whole thing?

You started out with material that I already knew, so it was slow at first, but then you moved into new stuff, and the pace was good. However, I did not need as many breaks as you had. I appreciate your friendly and unpretentious style of presentation, but it became clear that you know your stuff and made considerable effort to make it understandable to the intended audience."
0.31 **0.99** **0.93** **Key Strength** **Insight/Learning**

178. "The course was awesome, but extremely long and a lot of information to absorb in a single day. Having a recording to review is an essential component in my opinion, so that people can go over it at a more leisurely pace and make sure that they get everything."
0.31 **0.99** **0.94** **Key Strength**

179. "I loved it! I wish it was two weeks. I would have liked more 'hands-on' with the material. Also, a little more in depth on what is currently out there and how they work, ChatGPT, Deepseek, etc. I am sure there is much more available than we realize. Already thinking of ways how we can experiment here at the CORPS and working with the data team to see what is feasible and what is not. Being able to get Commercial (or privately owned computers onto the network) would be beneficial as well, so we can use the other tools, like ChatGPT, etc."
0.31 **0.98** **0.95** **Key Strength**

180. "Favorite Part: The logical way we walked through the different models and their complexities. Improvements: Allow more time for the discussion of transformers."
0.31 **0.99** **0.82** **Key Strength**

181. "While I'm sure you gave the correct answers to all 40 pre-test questions, I missed the 'foot stomp moment' for many of them. The parts of the course that were most useful centered on 'here's how to do it' versus 'here's what it is.' That Excel file might be extremely useful for standing up a minimalist model in one of these environments they won't allow us to install Python in. Any other points of empowerment we can take to air-gapped networks is greatly appreciated."
0.31 **0.97** **0.59** **Key Strength**

182. "Excellent. I think that it would have been great to go even more in depth on some topics, but at that point we might as well make it Coursera! I think it is

very nice that you gave us some links and suggestions for external learning resources. I think the course is appropriate in rigor for beginners. There were, in my view, a couple of minor technical details that were slightly wrong on the slides, but not worth worrying about since you have so much to worry about in getting the bulk of the main content across to beginners! I do think it was good that you largely ignored the chat messages until breaks, and let the bunch of us answer each other's questions, since that helped the course move along effectively!"

0.30 **0.99** **0.93** **Key Strength**

183. "I was deeply impressed. You guys put a lot of thought into this course. It was interesting and fun, and I think you had fun doing it. It also helped cement technical terms in my memory. I'm pretty much self-taught in Machine Learning, so I have a measure of self-doubt. Your course increased my confidence. The use of Excel was great, because it demystified ML. The visuals were vivid, clear and interesting.

    One teeny tiny suggestion: Make many small pauses, so that there are moments of silence, so participants can digest what they just heard. (It's a LOT of non-stop talking.)

    Thank you so much!!"

    0.30 **0.99** **0.96** **Key Strength**

184. "This was just what I needed to get beyond the many 'intro to' online courses which dumbed things down too much and I lost interest. The level of detail was great and left me with a better understanding of what questions I still have to ask."

    0.30 **0.96** **0.57** **Area for Improvement** **Key Strength**

185. "The material presented was not what I expected (through no fault of Mark).

    Mark did a great job.

    For a 1-day course, I would have rather seen more concrete examples of AI/ML regression applications.

    For me, the deep dive into Excel was good to see, but just could not expend the energy to follow all the equations. And, since I have no plans to ever use Excel in this context...

For an example from the presentation that worked well was the discussion on parameter training and the methods to do so.

Would like to have seen more theoretical discussion on partial derivatives, gradients, breaking symmetry."

0.30 **0.90** **0.48** **Key Strength** **Area for Improvement**

186. "The modified format focusing more on concepts combined with the pre-workshop spreadsheet demonstrating needed Excel functions was much easier to follow compared to the previous version where we tried to keep up to real-time Excel work. Providing a spreadsheet (like the pre-workshop one where it shows equations and explanations) with more types of examples would also be appreciated. Overall, the content was very helpful. Great job, and thank you!"

0.30 **0.99** **0.79** **Key Strength**

187. "The instructor covered a significant amount of areas in machine learning. I would have liked to complete the example that was sent out prior to the course. I think there is merit in walking through a solution with the instructor. However, I understand we needed to cover all the planned material.

Overall, it was a great course. Thanks!"

0.30 **0.99** **0.60** **Key Strength**

188. "Overall, a fantastic job at this course, but I feel like it needed more Star Wars references (joking... maybe). I now think that Excel is probably the best/ most informative way to represent these algorithms on the smaller scale. I think it improved how easily I understood the concepts. I would really like to take an expanded series of courses from this instructor in this format; although, I most likely wouldn't be able to attend."

0.30 **0.98** **0.95** **Key Strength**

189. "I wish the fundamentals parts went a tad slower? I missed a minute on Day 1 and it was hard to catch up – NOT the instructor's problem, just my only thought. i thought the course was great and glad I was able to participate. I'll definitely be watching the videos again and trying some of the Excel stuff on my own"

0.30 **0.88** **0.52** **Key Strength**

190. “The topic area is vast. The instructor and materials did a great job to provide understanding. I would like to know what POCs are available to us in the Army for future collaboration.”
0.30 **0.99** **0.94** **Insight/Learning** **Key Strength**

191. “More Python examples/ Do the course on Python completely”
0.30 **0.55** **0.80** **Key Strength**

192. “It was surprisingly fun.”
0.30 **0.99** **0.97** **Key Strength** **Insight/Learning**

193. “I think that the course is important to educate our workforce to the challenges ahead. I learned through the NDIA AI Conference this year, that AI and ML need to be at the forefront to bring the U.S. to the Global Leader position. In order to do that we need to strive as teams to accomplish this goal. I am an Engineering Psychologist and attempting to define how our group may be able to feed data into AI/ML programs.”
0.30 **0.97** **0.72** **Key Strength**

194. “Given the course time constraints, I think it would have been a worthwhile trade-off to sacrifice some of the advanced concepts to show a simple Python implementation of the v50 (yes, the code).”
0.30 **0.99** **0.74** **Key Strength**

195. “I have no foundational knowledge of machine learning concepts. However, I felt engaged with the presentation and became interested in learning more about the topic by the end of the session. My perspectives shifted on day two with the breadth of information presented regarding AI and social engineering. This course covered so much information that I had never even considered before, and I want to know more about the topics covered.”
0.29 **0.79** **0.90** **Insight/Learning**

196. “I have organized a few all day workshops—Mark maintained energy and engagement with a virtual audience all day long. Doing that without being able to read the audience is a challenge. Mark’s energy and ability to communicate the concepts was impressive, ... most impressive.

    Looking back, I realized I went into that training as a MATLAB snob. Mark used Excel in a way that made the linear algebra tangible. “Data” is a matrix, coefficients are values in a table—which is very different than a matrix

variable in RAM. I think your approach of using Excel made me see the process far better than any linear algebra scripts implemented in MATLAB or Python. Outstanding teaching style. Now I need to go do my homework to see if it stuck. I learned a lot and am inspired to try more. Too bad more DoD training isn't like this workshop."

0.29 0.95 0.91 **Area for Improvement** **Key Strength** **Insight/Learning**

197. "Favorite Part: Just getting "dumbed down" information on AI and ML, it lessens the amount of intimidation I have about AI and ML Improvements: It was a lot of information to try to absorb so quickly. I think it would have been better to do a 2 day session."

0.29 0.99 0.53 **Key Strength**

198. "Favorite Part: The humor he would add in to keep the subject interesting. Additional topics: shorter, refresher classes on updates on how AI will impact our work environment. Additional Comments: I enjoyed the class and it was way in depth. Makes me have a new respect for those working with AI"

0.29 0.99 0.94 **Key Strength**

199. "The course was great to learn about how ARL is approaching and using AI in research. I do wish that there was more tools that we can bring back to our commanders. However, the knowledge and resources gained in this course will be used in forming guidance on how to prepare for producing realistic expectations and guidance to the unit."

0.29 0.72 0.91 **Key Strength**

200. "I know we had a lot to cover but it went just so quickly through concepts. I liked the idea of having prep material available to us before the course but it was sent the very night before the course so I did not have much time to get through it. I would have liked to have had it earlier than that and maybe have it cover some of the basic mathematics concepts."

0.29 0.99 0.59 **Key Strength**

201. "When giving an opportunity for the audience to participate in labs, repeat the instructions. Otherwise people will be lost pretty quickly and give up on the lab."

0.29 0.99 0.53 **Key Strength**

202. “This is my second time to take the course. This time, I did more preparation before the course. I went though the Excel files. These are truly helpful. They help me understand the concepts and work flow of ML so much better this time. The first day is especially helpful to me because the contents are all about basic foundation you need to grasp before you can move on to more advanced topics. The second day contents are helpful too but they require more advanced knowledge to understand fully. The NLP part is relevant to my work and the addition of it this year is spot on. The examples and visualization of word embeddings are well chosen to educate audience in this area even if they don’t have prior experience on it. You need to understand the basic fundamentals before you can really dive into ML. It’s not always easy to achieve that. This course is exactly about getting you the basics covered in a way that translates abstract concepts into something audience can relate in real world and thus easier to understand. It’s a wonderful course.”
0.29 **0.99** **0.95** **Key Strength**

203. “- I’d like to download the video so I can replay some portions that I did not quite follow

    - The course goes fast—which is good. The pace was just about right. I had to pay full attention to keep up; the benefit is that we see the whole picture, in an affordable amount of time.

    - There were a couple of points that I did not quite keep up, but that probably is more my fault than in the way the course was presented.

    - Thank you Mark, well done. To quote someone that has a lot of experience in ML “this course distills down what is buried deep in ML/AI books, and most folks aren’t able to draw the key insights that are given freely here.””
0.29 **0.88** **0.75** **Key Strength**

204. “This was a great introductory course to AI/ML for someone with math/science background and experience working with Excel. I did not expect to take away much from the course, as I was intimated by the materials, but once we started discussing and using real world examples, I was surprised how much confidence I had in the basic building blocks and benefits/pitfalls of AI/ML, as applied in Excel. Looking forward to more advanced and domain specific courses in the future, to see if I can use AI/ML to my benefit, too! Thanks

again, this was an excellent course and I've highly recommended it to my organization."
0.28 **0.99** **0.96** **Key Strength**

205. "Great course. Great presentation. Kudos to Dr. Tschopp for presenting such complex subjects in a simple easy to understand format."
0.28 **0.99** **0.98** **Key Strength**

206. "Just for illustration, it would be nice to be pointed to real world examples where the major methods have been applied."
0.28 **0.97** **0.68** **Key Strength**

207. "I wasn't really able to participate as I was double booked today, but from the portions that I was able to "pop-in," I thought the content was valuable and interesting. I have background in ML and AI concepts and have never seen a use case in Excel. I'm interested in obtaining the formulas that were covered in the workshop so I can go back and try and analyze myself! Thanks for putting this together!"
0.28 **0.99** **0.90** **Key Strength**

208. "It gave me a better foundation for being able to read about and understand what others are doing with ML. There were definitely concepts that I probably should have been more familiar with coming into the course to be able to get more out of it, though. The morning was more useful for me than the afternoon, the afternoon material got really dense and complicated quickly and I was pretty lost. The Excel examples did help me get more of a practical understanding of the concepts, although it's also clear that using Excel only allows the very basic level of modeling. I thought Mark did a great job being engaging all day, and at the very least, I came away with a sense of where I need to do more learning!"
0.28 **0.99** **0.74** **Key Strength**

209. "Great pilot effort. This type of material needs to be incorporated into Army PME in a condensed space to provide general awareness to future leaders."
0.28 **0.98** **0.90** **Key Strength**

210. "I like that the Excel portion was optional as a lot of the required add-ons are blocked on my government laptop and it would have been hard to follow along. I liked how the instructor was able to convey the basics of ML and

quickly get to neural networks. The Star Wars theme was a blast and made it more memorable! There was a lot of background and a recap of the current state of the art which I appreciate. I feel inspired to keep learning and check out some of the Coursera courses on ML and deep learning!"
0.28 **0.99** **0.73** **Key Strength**

211. "I understand you are trying to reach a broad audience, but I would have preferred a course with more math included."
0.28 **0.99** **0.73** **Key Strength**

212. "I thought that the course gave a great initial high level overview of the concepts—especially to me where I had no previous ML experience officially. I very much appreciate it, and really liked how you linked it to relatable data sets. I also liked how you were able to show using Excel. I think the Excel uses helped me to better understand what was going on 'behind the scenes' so that once you started showing the Python code, it made so much sense. Also, your linkages to other principles helped me to grasp the material better, and helped me to realize that I knew some of this stuff already—just under a different category.

    I understand that you covered a lot of material to cover in one day. I thought you did a great job! I could tell that it was a lot by the end of the day. And, I was starting to get tired. I think the 'Jedi Council' at the end was a nice change of pace and a helpful re-invigoration.

    Thanks again! I very much enjoyed it, and could tell that you put a lot of work and effort to make it a fun learning experience. Plus, I like all the fun Star Wars stuff :) "
0.28 **0.99** **0.95** **Key Strength**

213. "Favorite Part: Initial Excel examples Improvements: More examples, to include relevant coded examples Additional topics: Machine Learning within Army parameters such as Army Vantage Additional Comments: N/A"
0.28 **0.98** **0.69** **Key Strength**

214. "It helped fill in a lot of holes in my understanding. Double edge sword thought with folks like me with a SW background the Python would make a lot more sense as the math part was so much as last calculus/linear Algebra I used was in collage like 35 years ago LOL Maybe link the two? Show

the math but how easy Python makes it? Mike did that in part I recall. Its in part why AI/ML has come more to the masses, you don't need to be a math genius.

But overall worth my time and thank you very much for doing such."
0.27 **0.99** **0.79** **Key Strength**

215. "Well done! Would love to see a Python-based intro course about how to work with PyTorch and/or TensorFlow to create, train, quantize, and test models! I am trying to do this my own YOLO model in Python and it has proven tough."
0.27 **0.95** **0.94** **Key Strength**

216. "The course was laid out and executed very well. Would like to take the course again and recommend it to all involved in AI/ML. Even if you don't understand the math/science, it introduces concepts in an easy to understand manner. They will help in any AI/ML conversation. Thank you, really appreciate your time and the course."
0.27 **0.99** **0.97** **Key Strength**

217. "I know what all the hype is about! This was a fantastic course, even if you don't get all the math. Doing the pre-work really helped me to keep up and I thought the explanations and walkthroughs helped with cementing the learning. Highly Recommend! Mark makes learning fun."
0.27 **0.99** **0.98** **Key Strength**

218. "Great intro to AI/ML and having the Excel examples really helps to make topic relatable. Star Wars and other references definitely makes the class entertaining."
0.27 **0.99** **0.97** **Key Strength**

219. "Great course and material. I will need to watch the recording and look through the slide deck/Excel sheet to review some of the concepts and follow along in the examples better. The Excel examples are great in showing what is actually going on under the hood, but I had difficulty trying to plug in the equations while you were and also absorb the information. That part would have had to be slowed down 2x for me to actually follow along. Hoping you will post the final Excel sheet and the slide decks for the revised courses. Thanks!"
0.27 **0.96** **0.87** **Key Strength**

220. “A job well done. I certainly need to brush up more on the concepts. Main feedback is I’m sure the first 25% of the course could be tailored for a day long tutorial for beginners. I’m sure you’ve heard already, but the Excel sheets you were showing would help the audience to do live demos during your presentation. Or do a few mini-live demos, like doing a logistic regression problem for instance. Overall I thought it was great!”
0.27 **0.99** **0.92** **Key Strength**

221. “It balances the need for details without getting the weeds quite well. It may be useful to have a one-slide or table listing the types of ML capabilities (categorization, binary yes/no, LLM, etc.) and give an example of uses in the DoD. This would be just one more tool to communicate with local leaders to help them understand what we ask for other than just “can we use AI on this?” Great course, highly recommend to others if they get the opportunity.”
0.27 **0.96** **0.55** **Key Strength**

222. “This course was very informative and was well presented with the amount of information covered. It would be nice to have a follow up class that could cover even more of this topic with more examples of the functions and how they apply to Python i.e cheat sheets for common commands used in coding an AI. On a fun note, defiantly needs more Marvel references to include Ultron, Jarvis, and other AIs’ in the MCU.”
0.27 **0.99** **0.95** **Key Strength**

223. “I would highly recommend this course, but would be vary careful about who I would recommend the course to. This course was very focused on practitioners with a good mathematics background. There are a few members in my organization that would benefit from the course but would likely be lost in the math and miss the concepts. Absolutely loved the course and it provided an excellent starting point to delve deeper. Thank you so much!”
0.27 **0.99** **0.94** **Key Strength**

224. “The Star Wars theme and preludes into our training each morning.... so good..... I felt my mind was loose and limber after watching all the videos and memes and ready to go when you started the training. I enjoyed the course and yes, there were times when the math was deeepppp, too deeeeep for my gray matter even so I tended to zone out during those times.... but overall I did learn more about how the algorithm’s work in AI. I also appreciate the

brevity of the course allowing my mind rm to breath and not burnt and then everything after that becomes just an overwhelming blur."
0.27 **0.99** **0.95** **Key Strength**

225. "Course was a good and entertaining introduction for a beginner. I will likely watch recordings before attempting any other courses."
0.26 **0.99** **0.94** **Key Strength**

226. "I think this was a really great course and I am glad I took it. It remained interesting throughout the entire duration, it included relevant topics, it was presented in a steady and easy to understand format. I really appreciated the instructor providing us with multiple sources where we can continue learning about the subject. I have done a lot of trainings during my first year and a half here and I believe this course has been the most enjoyable and motivating so far."
0.26 **0.99** **0.98** **Key Strength**

227. "Thank you for offering the Machine Learning course. I knew very little about machine learning going into the course and now feel like I have a very very basic understanding of machine learning and the underlying mathematics. The things that I found most valuable from the class are (1) the examples of where machine learning can/has been used and its successes and failures and (2) the introduction to the mathematics underlying machine learning algorithms.

    Prior to my current position in DEVCOM, I spent 20 years teaching undergraduate chemistry at a state university. Theses are my recommendations from one teacher to another. (1) Please provide more context to the Excel examples that you distribute prior to the course. I could follow your instructions and understand linear algebra, but I had no context or idea why I was doing the math that I was doing. I recommend sharing a video or some type of documentation along with the spreadsheets. I think that I would have gotten more out of the class and more out of the Excel exercises if I had more context up-front. Students always want to know why they are doing something, and I want to know if the answers that I got were reasonable or not. I had no clue about any of this when I ran through the Excel examples prior to class. (2) The more you teach a course and the more the field grows and changes, the more you want to add to a course. Think about the essentials of what you

want to teach and don't try to add more and more content. Two days to introduce machine learning to people from a variety of different backgrounds is a challenge. Don't lose people by going through a ton of material super fast. (3) It might be helpful to provide the class with an article or two about machine learning prior to the start of the class.

Thank you for teaching the course. It was a good introduction."
0.26 **0.97** **0.84** **Key Strength**

228. "I ultimately think it's impossible to reach a subject matter like this, and all the pre-requisite knowledge, in a single day so with that in mind the instructor did an incredible job at tackling this topic. I loved the incorporation of Star Wars themes to engage the audience that much more. I'm a Machine Learning novice having never 'done' the calculations myself so I would've benefited a lot with a slower pace and really spelling the concepts out more gradually. Thanks for running this course, it was very interesting!"
0.26 **0.99** **0.94** **Key Strength**

229. "It is lot of material and I will cover little by little watching through recording if it is sent to me. I may use the material on my own example data set to see what it gives me the insight that is not visible or how I can articulate the concept and course material for my own use though we are successfully using computer codes of different languages a lot. but trying machine learning / AI won't hurt."
0.26 **0.58** **0.69** **Key Strength**

230. "Excellent one-day course! Truly enjoyed all content. Thank you very much for organizing this event. Hope to attend the next workshop if it is planned.

It would be great to see more Python hands-on examples instead of Excel (especially some of the complex examples using multilayers). As you've shown that Excel is poor at handling activation functions (tanh if I remember correctly)."
0.26 **0.74** **0.95** **Key Strength**

231. "- I thought it was an excellent ML short course on. The Star Wars theme added color and interest in the delivery. There could have been more breaks, although I took advantage of the pause function of the recording (but felt a

little stressed out about being behind). It wasn't clear where all of the questions were being posted. I only saw the Moderated questions and responses. I think I would have liked to see the live stream of Q&As.

- I hope the slide deck will be available for download at some point. I'd like to follow-up on some of the other ML courses and resources.

- I did not stay to listen to the Panelists. They may have covered it, but it would have been useful to see more applications of ML.

THANK YOU for going out of your way to educate the workforce. This was great."

0.25 **0.99** **0.83** **Key Strength**

232. "It seemed that regression/numerical predictions as opposed to classification were mainly hit during the early portions on machine learning. It would be interesting to see how neural networks could be used for these types of regressions as opposed to only classification. For example, if we are trying optimize a value using NN, can we still use functions like tanh and then normalize the predicted outputs so that our possible optimum values are less than 1? If so, what normalization factors would be useful especially when considering that we would like to predict something better than our current best value in the training set?"

0.25 **0.99** **0.78** **Insight/Learning**

233. "I came in with prior institutional experience in machine learning/deep learning and the course was excellent. While most of the material was a great refresher, I did get an introduction to decision trees and random forest for the first time. I was surprised that popular classification algorithms like KNN, K-means, and SVM were not covered. Additionally, the introduction of PCA and SVD might have been extremely beneficial for those looking to gain an understanding of how features are obtained. However, I completely understand that time was limited and this may have been too much information for some folks to digest. Perhaps another follow-on course (ML201?) that has more applicability would be beneficial for those folks that already have an understanding of the topics to get an idea of how the Army uses machine learning."

0.25 **0.98** **0.93** **Insight/Learning** **Key Strength**

234. “I found this course fun and interesting however I still don’t really understand what the course objective was.

I am better informed about AI/ML and I will defiantly advocate for ARL. If that was the objective that was a success.”
0.25 **0.96** **0.44** **Area for Improvement** **Key Strength**

235. “First, let me say you did a wonderful job and your efforts will benefit the Army for years to come. The area I rated the lowest in this survey was related to material organization. It was NOT that you were unorganized... that was certainly not the case, but more to do with how to, perhaps, more effectively reach the different populations within your audience.

Based on the class discussions, you have analysts who are actively working with ML and those, like me, who are team leads and maybe higher that are trying to understand how ML can be used to better support Army analyses. I am an engineer but the last time I looked at matrix multiplication was likely back in the mid-80s. haha My point is that you have a very difficult task reaching the two, if not more, very disparate groups within your class.

My suggestion would be to make Day 1 (or some initial stage of appropriate length) focused more on the ‘leadership’ folks by explaining what ML is and isn’t, and how it is being used today to solve the world’s toughest problems. During the second day of class, you noted several examples of ML (both good and bad), that portion would have been best up front, IMHO, to set the stage for how and why ML is being used. So, for this first portion you are making the argument, to leadership, as to why ML matters and why they should consider ML when building their year-to-year work programs. After this initial segment you would then transition from the leadership folks to the active performers (or wanna be performers) of ML to describe techniques that could support their efforts.

For the most part, what I describe above would not require additional material development, but more along the lines of rearrangement of your existing material (although I would expect the leadership portion would need some expansion to make the case for why ML should be important to them).

In any event, nicely done. I think you are doing some great work and, again, I truly appreciate the effort helping all of us to support Army analyses. Oh, the Star Wars stuff was great! :-)”

0.25 **0.86** **0.81** **Key Strength**

236. “Machine Learning is mostly way above my head but I enjoyed this course in outside the box thinking.”
0.25 **0.99** **0.92** **Key Strength**

237. “Favorite Part: Going over real-life examples of how these models have evolved over the years and where they began. Improvements: Incorporate actual Star Wars examples into the training, rather than some spliced images off to the sides. Additional topics: Hands-on learning with building a model as a classroom participation”
0.25 **0.99** **0.78** **Key Strength**

238. “Favorite Part: How to using different number pattern to convey colors and shades. Improvements: Show example of how information is validated for federal government use. Additional topics: Yes”
0.25 **0.99** **0.82** **Key Strength**

239. “Favorite Part: Visual and interaction of the presentation.”
0.25 **0.99** **0.95** **Key Strength**

240. “Thank you! This was exactly the sort of introduction I needed. It gave me the foundational knowledge I needed to make sense of the literature”
0.25 **0.99** **0.96** **Key Strength**

241. “Wow. Given the amount of content, the organization required, the Excel demos, and the breadth of the topics, this was fantastic. Well done.”
0.25 **0.99** **0.97** **Key Strength**

242. “I appreciate the presenter’s energetic explanations. The course is also well organized and informative. A key word note may be helpful for the listener. Thank you again.”
0.25 **0.99** **0.97** **Key Strength**

243. “You have spoken.’ ;-)”
0.25 **0.99** **0.65** **Key Strength**

244. “Previously found ML, Neural Networking, AI intimidating. Not now. Took notes and will be self-educating. Am currently a research scientist at APG (ctr) but was an assistant prof at USMA (math department) ‘97–‘00 and for

the last 11 years, part-time faculty at USNA... from a teaching perspective, this short course was excellent (e.g., the slide containing a type of 'word salad' showing what was to be covered and crossing out subtopics along the way; the concrete example provided on 10/16—imaging—was perfect; examples of activation functions). BLUF—the short course inspired learning (exactly what we tell our students they should be... live-long learners). Thank you."

0.24 **0.99** **0.64** **Key Strength**

245. "I liked the Star Wars theme – it lightened the mood and did not drag the dense material into the dark side. Plus, one of my pandemic activities has been to watch all the Star Wars movies in chronological order (never seen them before.) Now only have Episode IX left to watch. So I actually got most of the references.

    I really got a lot out of all the terminology that was introduced. It is very dense. Introducing the concepts via Excel, and then showing the Python scripts made a lot of sense to me. Jumping straight to Python would not have been as helpful (says someone who will probably never write a Python script ever.)

    There was a lot of math – unavoidable for this topic. However, it was presented in a logical way. Sending the Excel spreadsheets out ahead of time helped, in that I could look it over and "get" the Excel functions that were being used.

    The bullet example was relevant to Army, which was great. Would have liked a few more Army examples, maybe one from each of the Directorates, e.g., vehicles, human-performance, sensors/electronics. More on understanding the data needed. The bullet example was straight forward – wonder if all other examples would be as straightforward?

    I really enjoyed the panel—a nice mix of applications and personnel.

    All in all, I got a lot out of it, although I will probably never actually calculate anything using a ML algorithm. But vocabulary and process understanding was very useful.

    Thanks for all the work you put into it."

    0.24 **0.98** **0.88** **Key Strength**

246. "This was one of the most thoughtfully planned courses I've ever taken and

I appreciate the instructor's dedication to make learning something complex into a very fun course."
0.24 **0.99** **0.98** **Key Strength**

247. "I thought the course was very interesting. The instructors were very knowledgeable and passionate about the AI technology. The material was easy to digest even with no background on coding and AI. I think the course can be better if we had some practical exercises. Maybe assigning small homework each day."
0.24 **0.98** **0.96** **Key Strength**

248. "I absolutely loved this course!!! I think Mark is an excellent instructor. For someone that is completely new to ML, I learned a lot. My only criticism (and this could very well be just because of my inexperience of the material) is that the transition from day 1 to day 2 was a little difficult for me. I was able to follow along day 1 no issue, but when CNNs were introduced, I started feeling a little lost. Overall, this was an amazing course and thank you so much!!!"
0.24 **0.99** **0.97** **Key Strength**

249. "Favorite Part: It was all very interesting! The instructor was very knowledgeable. Great class and info. Additional Comments: Informative class but a little scary too as far as AI as a whole."
0.24 **0.99** **0.96** **Key Strength** **Area for Improvement**

250. "The course was a great experience—I feel considerably more comfortable with the concepts and nomenclature of machine learning than I did before, and I can already see how some of the simpler tools could be implemented to aid in my own data analysis (and I am more confident that I can now pick out well-thought-out neural networks from less well-thought-out ones). If there was one drawback, there was a whole lot of information presented in one day, and it was unfortunate that the most complex concepts were given at the end of hours of instruction (I understand the constraints that require this to be a very short course; I wonder whether a two-day format might not be the happiest medium between scheduling convenience and coverage of material). I sincerely appreciated Mark's enthusiasm, both in general and for the concepts he presented—it helped to keep 6+ hours of nearly uninterrupted material engaging and fresh. Thank you!"
0.23 **0.99** **0.93** **Key Strength**

251. “The one-week AI/ML course was exceptionally well-organized. The curriculum provided an excellent overview of fundamental concepts and practical applications in artificial intelligence and machine learning. Overall, it was a valuable and insightful experience that significantly enhanced my understanding of the subject matter.

A key highlight was visiting the Army Research Laboratory (ARL) and engaging directly with the scientists. I recommend establishing an AI/ML Student Alumni network—like “S1NET”—where ARL leaders can connect with military, DoD civilian, and contractor personnel across the enterprise. Such a platform would enable the force to disseminate more efficient information, tools, and resources.

Thank you to everyone who contributed to the success of this course. Special thanks to MG Ahern—your leadership presence was truly invaluable. I also want to recognize the ARL team for their seamless coordination and support throughout the week.

Dr. Reginald Hobbs and Dr. Mark Tschopp delivered the content in a clear, digestible manner that made science and math approachable without being overwhelming. Their delivery greatly contributed to the effectiveness of the course.”
0.23 **0.99** **0.96** **Key Strength**

252. “It was a fantastic experience, and I wish that you had been my instructor when I was learning this material during my Ph.D. (to gripe about my Ph.D. experience: if the word ‘introduction’ appears anywhere in your course title, then you should not have THAT MUCH new mathematical notation appear at the same time)!

I do wish that you had the time to expand this into a full-blown course series though, one that was able to dive further down into the details. E.g., how are the neural networks designed? Are there design choices, or are people just slapping together architectures and then seeing how well they work afterwards? If it’s the latter, why aren’t we using genetic programming to design the architectures? Humans can then focus on designing better metrics to optimize over, which is something that computers can’t decide for us.

Anyways, it was a great course, I hope that you keep offering it!”
0.23 **0.76** **0.90** **Key Strength** **Insight/Learning**

253. “A work-a-long document would be very helpful throughout the seminar (unless I missed it). There seemed to be a lot of examples but it’s hard to grasp the concept without working side by side. Even just a pdf with a lot of lecture/concept stuff with some fill in the blank would help keep focus for that long of a time period.

    I also think that some check-in concept questions during each break would be nice to have. Don’t need to submit anything, just questions and then go over answers.

    There were a lot of resources listed, a summary of the resources would be nice (in case people did not write them down).

    Commitment to the bit was superb.”
    0.23 **0.98** **0.51** **Key Strength**

254. “I pretty much knew nothing at the start. I can’t say I know a whole lot now, but taking the course has de-mystified some of the concepts and lingo. Definitely worth a day’s time.”
    0.23 **0.99** **0.65** **Insight/Learning** **Key Strength**

255. “I highly recommend that we implement a smaller scale course at the Army school houses for our young leaders, who can take this information to their squads/platoons/companies and get real feedback on implementing tools or new uses for the tools. I think it would also inspire knowledge and excitement that we are investing in these leaders with emerging technology, that usually only is given to select units.

    The instructors were fantastic. They brought interest into every concept and found a way to bring us back to the ‘so what’ of how learning the algorithms and math and concepts would better assist us in using AI/ML. I also enjoyed the guest speakers and field trips to Grace’s Quarters and the labs. I thought it was a good mix of classroom time and seeing the real products.

    One week was sufficient for my learning and I feel comfortable in going back to my unit and explaining what I learned.”
    0.23 **0.99** **0.87** **Key Strength**

256. “Mark did a great job simplifying the complex concepts. The material was presented in a fun way that kept me engaged throughout the entire day. The

read-ahead and do-ahead material was helpful and the videos of the examples were useful for furthering my understanding. Thank you!"
0.23 **0.99** **0.97** **Key Strength**

257. "The course was very informative. It gave me a better understanding of how AI works and how to approach AI systems in the future."
0.23 **0.99** **0.94** **Key Strength**

258. "I was so surprised to learn that Excel can be effectively used for ML. The explanations were so simple."
0.23 **0.97** **0.94** **Insight/Learning**

259. "Well as a CS major and SW dev for like 30 years and now a Branch Chief that oversees staff doing ML this is very helpful and insightful. Biggest issue is its been almost half a century (ok only 40 years :)) since I did calculus and linear algebra. And honestly was not sure at the time why I needed to do all this math other than was a weed out class's for the CS majors. Now I see why just wish was more fresh as would have understood the math you where going over and how it applied better. But I guess when programming Python as you said 40 line of code to do a lot of it LOL thus the complexity is largely hidden from you"
0.23 **0.84** **0.60** **Key Strength**

260. "Great course. I will admit some of the topics did dig a little deep for someone with no background but I'm sure others with a little more background knowledge appreciated it."
0.23 **0.99** **0.97** **Key Strength**

261. "First, I believe you are extremely knowledgeable in the subject matter and glad we have you. Overall, I felt parts 1 and 2 were a bit overwhelming for the novice S&E with somewhat familiarity. The first 70% of part 1 I was able to follow, but then it got harder to follow. The first 40% of part 2 I understood, I had some experience with neural networks many, many years go plus boxcar and band pass filtering techniques in image editing. But the last part of part 2 was a bit overwhelming, to be honest my head actually hurt at the end. Since the bars are closed here it was like having a mathematical hangover. Parts 1 and 2 could be a 3–5 day mini course with examples showing the flow of data from input to output, six total hours was to compressed. Using the ballistic

data reference was very good to have since we could relate to it. More actual examples, especially when applied to 2D imagery, would also be useful."
0.23 **0.94** **0.68** **Key Strength**

262. "The initiative to offer this course was masterful. Providing some level of understanding about the world's technological advancements will prepare everyone for the future of mankind and its robotics friends. As an individual without any knowledge of ML concepts prior to the course, my only suggestion would be to increase the duration of the course by another half day so that the more advanced concepts could be better explained and demonstrated. Overall, Kudos to you for bringing this course to the Army. Thanks for sharing knowledge!"
0.22 **0.99** **0.95** **Key Strength**

263. "I thought the course was great. I began with just a little knowledge of the concepts because I never took the time to understand the math that makes ML work. This course introduced me to the ML vocabulary and got me over the threshold of starting to learn the concepts. Before this course, I did not know where to start to learn this material and I couldn't justify spending too much to immerse myself in the material as this is not a concentration area for my job function. This course was a good primer to enter this subject and the examples provided in the course helped reinforce the concepts."
0.22 **0.99** **0.85** **Key Strength** **Area for Improvement**

264. "I would highly recommend this course to other non-experts in ML; I would probably not give as strong a recommendation to ML experts unless they were curious of your approach, which I found a refreshing perspective/approach. On that note, the level of math content was on point for me, an M.S. Aeronautical Engineer with some familiarity of ML concepts, and A LOT of education in advanced math. I really appreciated how you exposed the mathematical principles and operations without diving too far into theory (let's save that for the universities!). I found your use of Excel effective in visually reinforcing the linear algebra—much more illustrative than a few lines of Python code. For what can be a very dry technical topic, your delivery was engaging and had a great flow. The material was broken down into manageable chunks with well-spaced breaks. However, I was quite fatigued by the last 2–3 hours and did not seem to learn as much then due to overload—it will be great

to go back and revisit the material, so thanks for that! My suggestion there would be perhaps breaking the course down into two 1/2 days. The panel was excellent and I much appreciated hearing the diverse perspectives and practical uses of ML for relevant problems! Also great that you set up follow-up times for attendees to ask questions. I will not be attending those however, as I'm quite busy and will probably not be using ML in the immediate future. Again, much appreciate you providing all the course materials and recording for future reference—it will certainly be used! Thanks for a great ML 101 course!"

0.22 **0.99** **0.91** **Key Strength**

265. "Great course, this was my second time taking it. I went through the MIT 6.S191 videos and while that went pretty deep into the technical side of things, your course helped me better understand the 'why' behind a lot of it. Also, love your enthusiasm and the Star Wars everywhere!"

0.22 **0.99** **0.96** **Key Strength**

266. "Two suggestions: 1. Consider scheduling in the time you take for lunch in the schedule (it was hard to have lunch in 15 minutes when I had to take the class from the office). 2. Even for someone with some ML background, I found that the pace was getting quicker to the point that I think introductory people might not find it accessible. Overall, great job."

0.22 **0.99** **0.48** **Key Strength**

267. "I loved it- a great intro to ML and covered many areas. My only complaint would be that we did not have access to the Excel document that was worked through in the lecture. I would have learned a lot better if I could have interactively followed along. I tried to follow along in the similar bullet examples, but the differences meant that I couldn't keep up fast enough.

    Thanks! I would like to take this class again next year, I think I need a second go-around to retain everything."

0.22 **0.98** **0.82** **Key Strength**

268. "Even though I haven't used advanced math in decades, I truly liked this course. It was only when you explained detailed methodology using linear algebra and calculus that I had to remind myself to stay focused. However, I understood everything you were talking about and how to achieve results. Excellent job!

My area of expertise is in communication and my current position is technical writer-editor. I enjoy taking complex information and presenting it in its appropriate simplicity for a wide variety of audiences (E-1 to GEN). I know the subjects of ML, AI, and NNs will cross my desk in the near future and want to be ready!"

0.21 **0.99** **0.94** **Key Strength**

269. "This was an incredible amount of material to cover in less than 2 days, well done! One comment I could make is to explain the mathematical underpinnings of yhat=1/(1+EXP(-Z)) and loss=-y*LOG(yhat)-(1-y)*LOG(1-yhat), where y=target_values. Not that you need to derive these but you could explain that they are used to say model, for example, a Gaussian distribution and that "Loss" is the effective error measure equation. Admittedly, I did have some distractions going on at this time, peeking at a concurrent Zoom presentation (explaining how they miscalculated/misappropriated MD 529 Prepaid College funds), so perhaps I missed your explanation. Actually, I'm not sure where these equations originate or even if a Gaussian is involved (since exponential term is not squared), just guessing from maybe something I saw 35 years ago (yep, I'm an old-timer not really working in this area, currently coding microcontrollers and test equipment control in NI LabVIEW). I would like to complement your use of MS Excel in explaining how basic ML works and optimizing parameters using measured data. There were certainly a number of tricks I was unfamiliar since I rarely work on matrices in Excel. It helped me understand the material and upgrade my Excel skills at the same time! Great job overall!"

0.21 **0.83** **0.65** **Area for Improvement** **Key Strength**

270. "I definitely got lost by the time the neural networks came around. I had trouble understanding why certain functions were used in the NN, do you have to pick certain ones for a certain reason? Overall the course is very entertaining and engaging. It definitely helps to have taken in 2x now to refamiliarize myself with some of the concepts. I'd also like seeing how to use some basic commands in Python to carry out these functions more easily. Thank you!"

0.21 **0.99** **0.53** **Key Strength** **Insight/Learning**

271. "My purpose of taking this course was to become more familiar with ML in

general. It's doubtful that I will perform this myself, but i feel more in touch with the parameters, set up and vocabulary surrounding ML set up and execution. You are very good at explaining concepts step by step and I love that you showed how to handle small data sets in Excel. Building off of what is familiar to most is a great way to conquer the entropy mountain of learning a new language. the It's great how you recently learned this information yourself and you have taken the time to organize the info and teach it to so many others. That's such a valuable thing to do. As you know, we have a different perspective on newly learned material than something we've known for decades. We tend to forget where the 'aha' moments and pit falls lie. Anyhoo, you talked about math for 8 hours and you were interesting the entire time. That is an award winning ability! I mean really, who can do that?!? I was mostly lost after the first hour or two, but despite that this course completely served my purpose. So if you're like me you do want negative feedback too. I only have one little nit for you and it's that you tend to say 'you know' quite a bit. But hey, if that's the worst you've got that's not too shabby. Thank you again for sharing the enthusiasm. You're pretty awesome."
0.20 **0.99** **0.84** **Key Strength**

272. "Favorite Part: There were many parts within this session that were great however none really stuck with me other than current and possible AI development. Improvements: Further emphasis on machine learning both current and in development."
0.20 **0.98** **0.97** **Key Strength**

273. "The course was great (and quite fun for a May the Fourth event)—thank you! Definitely made ML look less scary for someone not familiar with it. Also made me realize that some easier things which used to just be known as 'modeling' can now be renamed as ML. Although I started to lose traction after we started getting into the advanced neural networks, it was still great to get familiar with the terms. This will definitely help when it is brought up in discussion with others in my organization that are more familiar with ML."
0.20 **0.99** **0.96** **Key Strength**

274. "Python and/or Jupyter notebook examples would be nice for those not familiar with Excel."
0.20 **0.98** **0.54** **Key Strength**

275. “Excellent course overall—thank you. Slightly larger slide size would be good: it was little hard to see text when typing commands/functions in Excel. (Slides only took a portion of the presentation area in the center of the screen, could use more space; something like a “presentation” mode in power point could help)”
0.20 **0.93** **0.87** **Key Strength**

276. “I thought the course was very informative and provided me information regarding what AI does and doesn’t do and how AI ‘learns’ and progresses.”
0.20 **0.71** **0.78** **Key Strength**

277. “Advanced stuff for those of us who don’t work with data or coding regularly. A one-sheeter or Barney style tutorial might be helpful for us before diving into the course.”
0.20 **0.97** **0.59** **Key Strength**

278. “Favorite Part: Everyday examples of how AI is being used. Also, I enjoyed some of the current geopolitical discussion.”
0.20 **0.99** **0.96** **Key Strength**

279. “Very well done.”
0.20 **0.99** **0.94** **Key Strength**

280. “very intuitive”
0.20 **0.99** **0.59** **Key Strength**

281. “Very informational and somewhat helpful for someone with no experience with machine learning”
0.20 **0.99** **0.82** **Key Strength**

282. “Very informative. The instructor demonstrated some novel ML approaches that I had not seen before.”
0.20 **0.99** **0.97** **Key Strength**

283. “Favorite Part: The Excel brief toward the end. Improvements: maybe some financial machine learning examples. Additional Comments: Thanks so much. You make Sheldon Cooper and the Scorpion crew look like middle school kids. Many thanks.”
0.20 **0.99** **0.94** **Key Strength**

284. “Course was good. My intellectual capacity has decreased with the years. I did follow along longer than I thought I would, but there were times when my eyes glossed over. I cannot keep up with the kids at work, but I will try playing with a Jetson Nano at home so I can have some hands on understanding what is going on. AI might be of help for those in declining years.”
0.20 **0.73** **0.43** **Key Strength** **Area for Improvement**

285. “Favorite Part: day 2 making the leap from linear regression into multidimensional arrays, regularization, k-fold validation, dropout regularization Improvements: I feel like the strongest use of AI will be things like scanning huge amounts of X-ray and MRI data for early detection in cancer. Its slow/ hard/ expensive for error prone doctors to review these, but this could help millions of people. More examples like this or what is being done, where it is going. I really did not see a lot of application focused topics. Also, how deterministic is some of your examples, especially with respect to generative AI, and multiple prompts that are exactly the same (like if you asked 10 people to draw a Jedi dog you’d get 10 unique pictures, will AI do the same?). Will Smith eating spaghetti, some of the cursed AI videos that are newly floating around that are crazy dreamlike randomness. Additional Comments: Probably one of the best multiday presentations in terms of keeping engaged and I think a lot of it had to do with the quirky nerd humor throughout, but day 3 felt really dry and I’m not sure if was the slides or the content or we were just burnt out. The GloVe stuff was pretty interesting but I feel like day 3 might be a good time to do the real-world application stuff like cancer scanning.”
0.19 **0.98** **0.76** **Area for Improvement** **Key Strength**

286. “Overall, my impression of the course is that it was well done, hitting many of the basics of Machine Learning and some more complex examples. What I would recommend is a little less ARL sales pitch / class reception during the intro and something on day one that leads into day 2. While logistic reg is a good lead in to more complex ML concepts, it left more to be desired for that first day. I believe the Cyber specific examples (decision tree, etc) would have been a better close out for day two after the more in depth examples.”
0.19 **0.99** **0.83** **Key Strength**

287. “The course was great. It was drinking from the firehose, but done in such a way that I was grasping around and trying to collect more. I know these

things are difficult to cover so much in 2 days. But you did a great job, giving someone a good general fill for things. The examples were just getting to the point were, if a person was attentive they know was the next step in the process was going to be (i.e. it time to apply the sigmoid function or tanh, etc.). You gave a great broad overview. I know I need to go back through the slides and examples several times, but I have good confidence that this is a skill that I can pick up on, and do useful work and examples. I know the expert 'feel' for things is some thing that can only come after seeing tons of examples, problems, troubleshooting etc, but this feels doable. I have 3Blue1Brown cued up and saved in a YouTube watch later list. You presented path that gives a beginner hope of how to further access this material. It is hard for me to know what you could add. I would say more hands on stuff, but hard to know what exactly. Maybe the side by side for those that do have an anaconda environment set up, or at least know what that means, they could do some simple stuff in side-by-side fashion between Excel and Python, to see under the hood with Excel, and then what this will look like 'practically' on a day to da basis. Overall, Great job and thank you again. I need to keep this momentum going. I know how easy it is to start saying I will get to it. And other priorities always get in the way."
0.19 **0.58** **0.92** **Key Strength**

288. "The bite-sized module structure mixed with pop culture bits was great, as were all the real-world examples of AI/ML uses (and fails). Length was just about right, shouldn't be longer. I think a couple of timed intermission slides appeared more than once, so maybe a few more of those to mix it up."
0.19 **0.51** **0.88** **Key Strength**

289. "Dr. Tschopp's course was one of the rare courses that teaches an incredibly complex subject effectively to a diverse audience from PhDs to old engineers like me 22 years out of college (25 out of linear algebra!). Outstanding job!"
0.19 **0.99** **0.96** **Key Strength**

290. "The modules in the first two days seemed heavy, and I was initially thinking the deep dive into math could have skipped. I thought all we needed was an appreciation of the concepts behind AI. I appreciate the math review now and am glad we got it, but would recommend instructors better explaining, up front, why this information is important.

We sort of just dove right into those modules with no context. MAJ Work helped provide some context, some "so what," and I think these modules would have been served with some scene setting to help the class understand why we're starting with such fundamental concepts and why that information is important. Most modules would have been better served with some context."

0.19 **0.99** **0.53** **Key Strength**

291. "As a laboratory chemist I was not sure what to expect to get out of this. After attending I think the awareness of the audience made it so worthwhile. Like the presenter said, I don't have time to spend a week or two doing trainings on this. This day long course allowed me to familiarize with the concepts and see 'under the hood' a bit to see where the strengths and weaknesses of ML are. It was well worth it to me to get this fundamental understanding so I can meet and collaborate with data scientist in the future. I think because I may never do lots of ML myself it was nice to see the Excel calculations even though I appreciate that it is not a good medium for that, but I am not fluent in Python or MATLAB so I likely would have found the lines of code unreadable and logged off in the middle of the day. There was a lot of math for someone who never took linear algebra, but the very thoughtful and fun Star Wars theme MORE than made up for it. As a new hire in a DoD research lab, this course should be used as a model for how to teach non-experts about your field—I would attend these all the time if they were all half this good!"

0.19 **0.99** **0.67** **Key Strength** **Area for Improvement**

292. "I really enjoyed this workshop. The speaker made some difficult concepts very easy to follow for a chemist like myself. "

0.18 **0.99** **0.97** **Key Strength**

293. "It was interesting to see that some basic examples of ML can be performed in Excel. This really help to understand the general picture of ML."

0.18 **0.99** **0.94** **Key Strength**

294. "Extremely insightful and worthwhile."

0.18 **0.99** **0.97** **Key Strength**

295. "Thank you for providing an informative presentation, keeping it interesting and including material that can be reviewed later. There were several in-

stances were I backed up the video to watch it again to capture the steps and supporting calculations."
0.18 **0.99** **0.96** **Key Strength**

296. "I love the May the 4th theme... kept things nice and light, and kept me engaged. The only suggestion I would have is to approach the RNN stuff from a problem set viewpoint. For example, you want to predict the next word or the next time step in a time series. You don't want to throw away past information because that will help you predict the future (or the next word). Now, how does the architecture of an RNN help you do that? Overall, an absolutely excellent course. I will recommend that our scientists attend any future classes too. Could you send out a schedule of when you plan to do it again?"
0.18 **0.99** **0.93** **Key Strength** **Insight/Learning**

297. "Great survey with some real meat in it! I ranked myself "4" on prior familiarity but really it's more like 3.5; so I definitely learned some things. Going from ideas to specific examples – with the actual methods in Excel – was an inspired model. Very unusual in a survey like this. Does it really need to be over one and a half days? Well, yeah, but you probably know that. (Or else cut some things, e.g., less about CNNs for vision and RNNs/LSTMs for NLP would still work.)

    The panel at the end was great too. I wasn't aware of the range of work in AI at ARL, and the folks who presented were sharp and articulate."
0.18 **0.99** **0.96** **Key Strength**

298. "Dr. Tschopp is extremely knowledgeable in terms of Machine Learning and is the right instructor for this course! This material was right at the skill level needed to start coding. The build up to Neural networks was important and the inclusion of ethics and Training Data sets should be sustained as critical."
0.18 **0.99** **0.96** **Key Strength**

299. "Yes, a video link explaining the true and false answers for the quiz maybe 2 weeks after the class as a nice refresher"
0.18 **0.98** **0.77** **Key Strength**

300. "May the course be with you if you were the Jar Jar Binks of data science? So much for comic relief, I have limited knowledge of machine learning (ML) and still found the course outstanding for improving my understanding of key

concepts. I followed along at the beginning of each segment, however, was quickly overwhelmed by the math or programming details. No issue with the instructor or course and rated this course 5 out of 5 in all areas. Some of us are not in tune with either the dark or light side of the ML force. I'll keep 'trying' to understand, Yoda can go jump in a swamp."
0.18 **0.94** **0.86** **Key Strength**

301. "Overall the course was very good. Especially the Excel examples help us have a grips on what happens in "black box."

    I only have one suggestion. I would prefer if instead of detailed discussions in the afternoon session on the convolutional neural networks and sequential models, the instructor spend more time on the basics of neural network (maybe example on how having different layers and different node numbers change the NN model predictions)"
    0.18 **0.99** **0.83** **Key Strength**

302. "I thoroughly enjoyed the course. Some of the material was over my head but I learned something new from every section. I want to rewatch a couple sections to glean more. I may have talked to AI about a few things during the lessons to better understand without having to ask and waste valuable time. Overall, I learned a lot. Most importantly, I learned how to use Excel to do ML since I can't figure out how to access Python (which is how I know to do ML). Thank you so much for your hard work and dedication to putting out this course, Mr. Tschopp!"
    0.17 **0.99** **0.97** **Key Strength**

303. "I enjoyed the course's aim in covering many different topics in a short time period. It's clear that the instructor is very knowledgeable about the subject matter and is also extremely enthusiastic about teaching others in an approachable way. I felt it would've been helpful to have the instructor's example sheet on hand while watching the presentation. Some of the material was covered quickly, so it was difficult to keep up at times. Having the same example sheet would've made it easier to follow along and be able to practice with the presentation. The practice sheet provided (which had different content) could then serve as homework!

    It was unfortunate that the video feed came through blurred at times (not sure if this was a universal issue), which only magnified the difficulty in following

along. I do plan on watching the recording at a slower pace to learn more as the presentation covered a lot of good content. The various memes were of course excellent :)

Thank you so much for doing this!"
0.17 **0.64** **0.93** **Key Strength**

304. "Thank you so much for offering this course. It was super helpful and it gave me an overall framework for understanding ML."
0.17 **0.99** **0.98** **Key Strength**

305. "Favorite Part: The seamless merging of real-world results with Sci-Fi and the history behind this starting in the 50s and 60s, etc. Additional topics: A deep dive class of this same topic. Additional Comments: This was a great overview class – it sounds like there's a longer one available?"
0.17 **0.98** **0.86** **Key Strength**

306. "The course was well presented and engaging. This was probably the most engaging course I've ever had, especially for such a complex and technical topic. You well exceeded expectations coming in. You should teach a course on how to build engaging courses, because a lot of people could use some help."
0.17 **0.99** **0.97** **Key Strength**

307. "The course was a nice balance of demystifying AI/ML without putting a huge 'we've already done that' negative spin on the future potential. I expect those that have taken the class will have more realistic expectations about what is likely to be possible across a diverse set of topics without having to invest nearly as much time into many potentially redundant available online courses."
0.17 **0.98** **0.66** **Key Strength**

308. "This course was able to form my understanding of AI/ML at the foundational level. Having the ability to briefly understand the models and functions, will help me justify required capabilities or concepts for its future use."
0.16 **0.99** **0.81** **Key Strength**

309. "I like how the course started at the foundation and introduced the mathematical side of what machine learning is and how these concepts were referred

to in later ‘Episodes’ periodically. I appreciate the time and effort put into the course materials and the creativity of the slides. I can’t ask for more without this class going over the two days.”
0.16 **0.99** **0.93** **Key Strength**

310. “A clever way to hold a students attention on line with interjecting Star Wars theme”
0.16 **0.99** **0.82** **Key Strength**

311. “I appreciate the time and effort the instructor has dedicated to this course. This does make the subject better understood. My regret is that I needed to be exposed to and smarter about this material about 10 years ago when an Army project was using these concepts within a sensor detection algorithm.”
0.16 **0.60** **0.73** **Area for Improvement** **Key Strength**

312. “I liked the course. My only suggestion would be for the neural networks, I think it might help to provide the general architecture within a png, i.e., how many inputs there are how many neurons there are in each hidden layer, what each hidden layer is (I believe GNNs CNNs or deep learning algorithms sometimes have alternative layers) and then the output layers etc.”
0.16 **0.74** **0.80** **Key Strength**

313. “Great course. You condensed a lot of far flung materials in to a concise, here is what you need to get started and actually start doing things with AI-ML that are useful. Thank you very much for that.

    As a busy first line manager at NRC, I had to break away several times during the day. I did so hoping that you meant what you implied. That is, a note was there that said this session is being recorded. It was indicated a few times during the course that you would make the streams available for a while at least so that I can go through them step by step. I am not fast enough to run my Excel and do the exercises you did on the fly. I need time to study them and work my way through them. The video is very helpful because in several cases you actually showed us how to run Excel to accomplish some little side task. I need the video for this. I promise to use the video privately for my own learning and to not pass it on to anyone. I will send them to you if they want access. So anything you could do to make the course available (as if it were on YouTube or in the stream you sent today would be appreciated.)”
0.16 **0.85** **0.91** **Key Strength**

314. “The course most definitely met my immediate goals. Thank you so much for your time and effort to prepare and deliver. I’ve had no formal training in AI/ML and no hands-on experience to speak of. Your course expanded my familiarity with and understanding of the basic technical concepts and will facilitate my pursuit of more extensive introductory training, such as some of the online courses that you mentioned. Thanks again!”
0.16 **0.99** **0.96** **Key Strength**

315. “Favorite Part: Getting some of the background behind data analytics and the history of how it began. Improvements: I would recommend providing less of the exact way things are mapped and more how we can anticipate using it in our field. Additional topics: How JMC projects to use data analytics in the near future to better our business.”
0.16 **0.74** **0.76** **Key Strength**

316. “It was a great refresher for someone who known a little bit theory about what is going on in the background. Did few audit courses last year. This was very useful in bringing back all the concepts, in such a concise manner. As you mentioned during the course, GRP topic may have been given some more time.

    Here is a suggestion that may be helpful. Make it 1.5 days.

    1. Extend a little bit more on the basics (such as adding more discussion on GPR, random forest, gradient boosting)

    2. Move the NN zoo topic on day two. 1 hr each for CNN and RNN. The basic RNN was clear, but LSTM/GRU got a little bit confusing, may be because of the time. The graphics were great however. May be focus a little bit more on intuition of RNN, before showing the diagrams. I think the ‘Cell’ concept in LSTM did not come across very cleanly.

    But overall, great job Mark. When I was learning these concepts last year, I was thinking, may be one day I will enough understanding to teach it the way you did to AFRL colleagues. Now, I don’t need to :) You did amazing job. When I get the video links, I will revisit it again every half a year.”
0.16 **0.99** **0.82** **Key Strength** **Area for Improvement**

317. “The course was informative, and I would highly recommend others to take this course.”

0.16 0.99 0.98 **Key Strength**

318. “The subject matter is quite mathematical, and some people simply aren’t comfortable with that; that is the only hesitation I have recommending the course to just anyone.

     Yet the mathematical content is what made this course so incredibly good, so don’t dumb it down any more than you already have! The math was the right speed for someone (me) who has been away from the topic for many, many years. And I appreciated learning the current terminology.

     I was a little lost on the second day. It felt a little like a grab bag compared to the first day. ‘Zoo’ was a good analogy. I just did not catch the map to this zoo. But I’m going to go back and watch the second day on video. I expect that will help greatly. Thanks for recording and making video available.

     Sir, you are the Chosen One when it comes to communicating this topic at this level!”
     0.15 0.99 0.39 **Key Strength**

319. “As a course billed as a “101,” more time should be dedicated to concepts, qualitative descriptions. While the read-ahead materials were very well done, folks that have not taken advanced mathematics are left behind, especially younger attendees who may be considering an advanced degree in these areas.

     Nonetheless, the course is very well done, and it cannot be stated enough it took a lot of dedication, courage and forethought to put the course together in the first place.

     Thank you”
     0.15 0.99 0.66 **Key Strength**

320. “Maybe an option for doing the course over more days where you did one section per day and there was a chance for people to review, work with the spreadsheets a little and start the next section with a Q&A. I guess that the videos provide some of that, but hearing a discussion of what others keyed in on might be useful.”
     0.15 0.99 0.79 **Area for Improvement**

321. “Great course. I especially like the variance versus bias (underfit/overfit) slide on Day 1.

When working in Excel, I suggest manually adjusting your thetas one or two times to show the effect on the loss and accuracy before running the solver. Also, maybe provide a guess for thetas as a starting point and explain why you chose those values versus always starting them equal to 0.

Really enjoyed the two days. I admit I zoned out at the end of the last day, but only because I was munging data in order to try out some stuff I learned earlier in the course. I will review those videos.

Thanks for teaching, Mark. I appreciate all the effort you put into the course."
0.15 **0.99** **0.90** **Key Strength**

322. "I am very grateful for this course. It's obvious you have done a lot of work and care about ML. Thanks!"
0.15 **0.99** **0.98** **Key Strength**

323. "This material covered in this course reminds me not of drinking from a fire hose, but the ejection pipe at the bottom of a dam! I thought the course was well organized and gave a comprehensive overview. While I am no fan of Excel, I think it really helped me understand the inner workings without getting bogged down in the math. The Python coding classes are always lacking because they tell you everything that happens in the 3 lines of code, but it just doesn't sink in.

    I felt the course made me more comfortable with the topic and offered great suggestions for outside material/learning. I would love to have a recommendation about how to stage classes to build complexity, say from Coursera or via the academic YouTube videos.

    It was a long day and my brain felt it. This made layered NN and CNN topics hard to follow. No fault of the instruction, the complexity builds fast!

    One recommendation I would have could be to have more a materials/mechanics focus in the NN. The image based is the bread and butter, but I see the recent work from Buehler at MIT and others regarding fracture or strength. It is hard to make that connection. At least at the level I am performing at now, which is pre-K.

    Thanks again. It was definitely a good experience and I look forward to working the examples. Let me know if you have any questions on my feedback.
    "

0.14 0.95 0.66 Key Strength

324. “I mainly took this course for improving my background knowledge rather than assuming I would be able to apply machine learning. However, as a novice I would have appreciated some more concrete ‘where to now?’ discussion, such as examples of ML from around the DoD (to see what is possible), next step courses for different disciplines, and what tools are typically used (executing these models in Excel is extraordinary but it does feel unrealistic for actual applications given my background). Overall this was a great and engaging course for some very dense material, and the enormous work that you clearly put in to keep people’s attention and pace the material correctly really pays off.”
0.14 0.99 0.56 Key Strength

325. “Highest marks. I would love to see this turned into a few day workshop because it got to be a little overloading near the end but it was fantastic. Would be interested in to talking to someone about machine learning in the life sciences.”
0.14 0.99 0.97 Key Strength

326. “I appreciate the organization and preparation, and the Star Wars theme definitely makes it more relatable to others. I wish there had been a little more time spent on the demonstration of recurrent/LSTM networks. Also, would it be possible to do some Python examples in PyTorch? I feel like a sizable amount of Python ML developers use PyTorch instead Tensorflow. Thanks!”
0.13 0.96 0.92 Key Strength Insight/Learning

327. “It would be helpful to distribute the PowerPoint slides in advance of the presentation so that attendees could flip back to earlier slides occasionally during the lectures to better understand the material. There was a large amount of material, so longer breaks between sessions would be helpful. The first and last sessions could be shortened to accommodate this. I think it would also be helpful to have students work some of the examples during the course (recognizing this would be a challenge in the current virtual delivery format, but working problems at the same time as the instructor would improve learning outcomes). The panel discussion might be better situated as a break in the middle of the course, perhaps as a brown bag lunch event.”
0.13 0.99 0.62 Key Strength

328. “I don’t think a person could gain a complete understanding in one day, but this was a great “deep dive” to cover the fundamental concepts and see examples in action. This course will give me insight into evaluating and designing projects that use ML. Thanks for extending the opportunity and for all your hard work to organize and present the material!”
0.12 **0.99** **0.94** **Key Strength**

329. “So, a number of comments here on this really good short course:

1) I think that beginning with linear regression with the most basic case being $y = mx + b$ is both the right way and a great way to start getting into it. I think that it’s very helpful to understand what linear regression is first.

2) The level of math was just about right. Not too detailed or overly complex, but with enough basics to get a mathematical sense of what the neural networks are doing. I think, at least for me, that it’s very informative to know the basic math that the input layer, output layer, and layers in between in a NN are using for its calculations. Doesn’t need to be gory detail but showing the basic important and/or critical equations and math makes it concrete so that you essentially know what the NN is physically doing.

3) This next thing is part a little about me—two things in my past helped me going into this course. One, my MS was in nuclear/high energy particle physics and linear algebra (e.g., matrix manipulation) is used a lot. Inverse matrices, transpose matrices, matrix multiplication and determinants (which also show up in quantum mechanics). I’m simplifying but basic particle classification and interaction can be described by a lot of matrix math. Two, decades ago in the late 80’s and early 90’s (yes, I am that old!!) when I got into image processing of fluoroscopic x-ray data I remember digging into image convolution matrices and the actual math of what they did. So, I have seen this before and I’ve been doing x-ray computed tomography for years and years now. This background helped me out. A lot of people in the class probably already understood matrix multiplication, but some probably did not. My comment/suggestion is that it might be worthwhile to spend just a few or five minutes on the math of basic matrix multiplication and drive home that both the linear regression and NNs are doing a WHOLE LOT of matrix multiplication. Of course, convolution of two matrices is related but not exactly the same thing. I’m just thinking something like the rule that a $[M \times N]$

matrix times a $[N \times O]$ matrix is a $[M \times O]$ matrix, and that N dimension has to be the same, otherwise you can't multiply them. Just something simple like that.

4) Well, I really liked the course and I thought that you did a great job. I definitely understand a ton more about NNs than I did before the course. And I think what you prepared and provided beforehand, especially the Excel spreadsheet stuff, was really helpful and useful—I went through some of that before the course. I don't know and never used Python, and we use third party software apps to use NNs in our image processing work.

5) Thanks—great course!!"

0.12 **0.95** **0.87** **Key Strength**

330. "Thank You. It is obvious that a lot of work went into this course and it was very well done. The Star Wars references were well done and helped keep it fun. Some of the math went over my head, I got a basic understanding of why you were doing it but could not initiate it myself. The panel made it very interesting at the end. I know it was time limited but I would like to have seen information on what equipment is necessary to run the programs based on complexity and data size (not just an Excel example). How many programs are available as plug and play, the subject seems ripe for this, a GUI that lets you select the hidden layers of a neural network from drop down menus, you customize the two ends for your data set."

0.12 **0.99** **0.93** **Key Strength** **Insight/Learning**

331. "Overall the course was very in-depth and provided a ton of information on how to build an AI/ML function. As an intro to AI/ML course, I would have benefited from more explanations as to the "why and what" for the lessons and less time on building AI/ML programs in Excel. It seemed to jump straight into building out AI/ML functions in Excel without defining what the variables were or where they (the data) come from. An intro into this AI/ML is used to do "x,y,z" the outputs are "user/function" defined (?) and a result nearer "1" indicates ___ while "-1" or "0" indicates ___. Classification vs categorization was helpful to understand, but the jump into functions without defining them up front left me trying to figure out what/why we were building towards something."

0.12 **0.99** **0.68** **Key Strength**

332. “Well done, Jedi Master. Wow, that’s a lot of info... I thoroughly enjoyed the course... definitely reconnected some long unused pathways but the underlying concepts are still the same but lots evolved... You really did a fantastic job.

    If there was an area for improvement, I’d say it was in the pre-course slides– this is really a nuts and bolts session... loaded with practical examples of what is actually going on inside the black box... several people joined thinking it was ‘Machine Learning for Everyone!’ and were lost, and dropped out– researchers, program officers, data manipulators, department chairs with in-depth background, etc... but ‘everyone’ is reaching a little too far.

    Thanks again for doing it... it was well worth the time.”
    0.11 **0.99** **0.90** **Key Strength**

333. “A personal preference: one full day is a lot and smaller chunks would have been easier to both schedule and digest.”
    0.11 **0.99** **0.63** **Key Strength**

334. “Acknowledging the budget restrictions, this course should certainly be 2 weeks. Additionally, it would be cool to collaborate with the Army Applications Lab (even remotely) to show how basic research manifests into applied research!”
    0.11 **0.84** **0.81** **Key Strength**

335. “Since I am new to machine learning, some of the information was over my head. But I did enjoy the course, and I am taking a few AI classes.”
    0.11 **0.57** **0.74** **Key Strength**

336. “There was a lot of technical data that really did not make sense. Split the course into two groups based on knowledge and experience with this information.”
    0.10 **0.99** **0.81** **Area for Improvement**

337. “Weaving in the Star Wars theme was VERY creative and well-done, and I recognize must have taken considerable time to prepare. I’ll note that I have not been a Star Wars follower over the years, and so, personally, I found the time devoted to the Star Wars references to be excessive. Also, at times, additional time was needed to get the A/V to play properly.”
    0.10 **0.59** **0.75** **Key Strength**

338. “The material was good, but it would be helpful to go a bit slower (or add the equations somewhere that we can copy) when going through the examples in Excel. It was difficult to keep up with the speaker while entering the equations.”
0.09 **0.99** **0.50** **Key Strength**

339. “The course tackled an astronomical amount of information, collectively known as machine learning, with well-articulated simplicity and clarity. This one-day course seamlessly presented an overview of ML topics with stimulating visuals and graphics that would normally take hundreds of textbook pages, weeks-long online courses, and entire college semesters to cover! Mark remained highly enthusiastic through hours of dense content, always bringing the concepts back to the larger picture. The various elements of neural networks were further demonstrated with easy to follow Excel worksheets. The course is additionally helpful in pointing participants to further readings, websites, videos, and courses. I appreciate the plugs for Andrew Ng, fast.ai, MIT 6.S191, deeplearning.ai, and especially 3Blue1Brown! I would add to those recommendations: Martin Görner’s “Tensorflow and deep learning—without a PhD,” François Chollet’s “Deep Learning with Python,” Lex Fridman’s podcast, and “Machine Learning Zero to Hero” from Google I/O’19. Thank you!”
0.09 **0.99** **0.91** **Key Strength**

340. “Very well done making a complex topic accessible for many without a hard science background. I appreciate the care put into the course organization from the meal options to field trips to SME engagements. Thank you for this investment in our professional development.”
0.09 **0.99** **0.95** **Key Strength**

341. “The only issue was the video/sound glitches which still provided entertainment. Might want to change the course name to ‘ML for everyone who has some math background.’ I could easily foresee some folks getting lost if they were expecting a less practical class.”
0.08 **0.99** **0.69** **Key Strength**

342. “Translating the problems to DoD-specific topics was a great idea.

Instructing ML with Excel is very helpful. It reminded me a lot of the book ‘Data Smart’ but with a bigger focus on DNN. It really de-mystified some of

what is going on in the black box. With that said, I personally think it may be helpful to dial back some breadth in a 101 course and focus on having people work through the problems in Excel with you. The presentation later got awfully in-depth for a one-day 101 course and it can be a lot to digest. The course was fantastic but if there's one suggestion I could make, it would be to sacrifice some of the breadth for more hands-on type of experience during the lecture. Maybe it would be helpful to send out the example data and Excel workbooks prior to attending."

0.08 0.88 0.73 **Key Strength**

343. "I joined peers of mine in the DoD who are responsible for compliance of research involving human subjects. Please note that all IRBs are increasingly reviewing more AI research while struggling to understand it and the concomitant risks for human subjects. While I have some background in the field (undergraduate degree in physics), my colleagues were lost. Most of my colleagues have nearly zero math background (little to no calculus decades ago, no linear algebra, a few had some statistics). To reach "everyone" likely to be interested in this topic, recommend creating a shorter, more conceptual course, like a 3blue1brown-type of course but sadly, requiring even less math background. Honestly, if someone could create a course that focused on the risky aspects of AI-research (risky from the perspective of people whose data is collected and whose lives will be affected through poor or biased algorithms (e.g., embedded bias within training data), or methodologies that may lead to non-generalizeable results unbeknownst to the researchers, etc.) that would be really helpful for our field."

0.08 0.99 0.69 **Area for Improvement**

344. "This is my second time taking the course. I took it a few years ago and decided to retake it this year to brush up on my knowledge, and I'm so glad I did. The course structure and content delivery were absolutely fantastic. The instructor's enthusiasm for the topic makes it so much more enjoyable! The term "artificial intelligence" can seem intimidating (totally not referring to the fact that the first suggestion in google for "is artificial intelligence" is "a threat to humans?") but this course does a great job of not only explaining the basics, but also contextualizing machine learning (and artificial intelligence) in terms of beneficial real-world applications."

0.08 0.99 0.98 **Key Strength**

345. “I loved the course, very informative. I learned so much! I think that the instructor, at times, explains topics very fast. Not the worst thing ever though, because slides and recordings are provided. thank you!”
0.08 **0.99** **0.98** **Key Strength**

346. “I know there were time limitations, but work along wit the examples would be great. This would allow the Excel calls and formatting to sink in. Also, would like this broken up a little more—maybe 4 hours a day. It was hard to devote the time with so much other stuff going on. Thanks!”
0.07 **0.69** **0.52** **Key Strength**

347. “Fantastic Course. Thank you for all the foundational knowledge to catch up with how the field has changed over the past 10 years.”
0.07 **0.99** **0.98** **Key Strength**

348. “As someone with essentially no experience using or building AI tools, I felt some of the course content was difficult to understand at the pace it was presented. I understand that time constrained the amount and type of content and the pacing, but I felt I had only barely grasped the differences between types of models and how each operates after the lecture concluded. It felt as though we were sprinting through the slides without ample time to take notes on and digest the displayed content. However, I found the subject matter fascinating and feel I’ve inched closer to understanding how various types of AI models function. I also enjoyed meeting the scientists working at ARL and having exposure to up-and-coming Army technology utilizing AI and machine learning elements.”
0.07 **0.98** **0.54** **Key Strength**

349. “Very enjoyable mode of presentation! I wish the transition from Excel into neural networks had been a bit clearer, although I know this is difficult to do considering that once we start moving into multiple layers Excel starts to break down in its ability to represent... I think if a very explicit connection between which part of the graph representation matches up with which part of the Excel spreadsheet would help.”
0.07 **0.94** **0.89** **Key Strength**

350. “Mark does a great job of encapsulating a LOT of info into a short course. I’ve taken several longer courses in ML, but there were a few things that I’d remembered wrong, or I’d forgotten about. I enjoyed the class.

He also deserves kudos for staying "on" for the full day! I know I was tired!"
0.06 0.93 0.82 Key Strength

351. "Have to send the survey the second time. In my previous submit, I requested the recording of the course and presentation slides. I found all the presentation slides in the google drive. My bad.

    Thanks again for the great work!"
    0.06 0.99 0.63 Key Strength

352. "I wish that there was enough to to have specific breakout sessions with the ARL competency of your choice to get a deeper understanding of AI subject matter with respect to the competency of interest. Additionally, I would have enjoyed each competency being represented during the course, especially weapon systems."
    0.06 0.75 0.54 Key Strength

353. "Working in a field of Aviation & Missiles for the Army with a major push towards higher level autonomy of our weapon systems, this course is very beneficial for this old dog to better understand to processes, which helps me consider these systems in a less frightening manner. It allows me to ultimately understand what these systems are doing, what they may or may not be capable of and so that I can ensure Soldier Safety during the design, manufacturing and development of technical manuals for soldiers utilizing these systems."
    0.06 0.99 0.63 Key Strength

354. "I want to thank the instructor for putting together this one day course. It has a lots of information and concepts. Some of the slides were excellent. I learned quite a few things. I have the following comments to make this course better in the future:

    1. The Excel spreadsheets that were sent ahead of the start of the course were helpful. However, the students should have been provided with the actual files that were used during the instruction. I will appreciate receiving a copy of the slides and the spreadsheets for my personal learning.

    2. It was very difficult to read the spreadsheets during the instruction in this remote setting and so, I could not follow them very closely.

    3. The pace of the course was not even. The first few sessions were good. However, the pace picked up midway in the course and it was very difficult

to follow the contents without the actual files in hand. The instructor spent a lot of time in the last segment. This could have been shortened.

4. The panel discussion was not particularly helpful in this context. I would have liked to see each person present an actual AI/ML example in detail describing the entire process from start to finish clearly.

5. The instructor should be commended for his dedication and enthusiasm."
0.05 **0.99** **0.95** **Key Strength**

355. "I was following along pretty well and getting into the first half of the course. The second half of the course, after lunch, went out of my grasp and I did not really understand what was going on. I feel like I started to gain confidence about the material, then had less and less confidence as the course progressed. I did not like the unscheduled, impromptu breaks, I would rather know when breaks are happening precisely, specifically lunch break. I did like the use of Excel and also the explanation and walk through of Python code, it helps to demystify the process."
0.04 **0.98** **0.56** **Area for Improvement**

356. "The only recommendation I can give is that in the second half of the course it became a lot less visual and intuitive (can be just because it was harder concepts and it was more in depth) but I felt a little lost at times. After reviewing my notes and some google searches I feel confident in the material now"
0.04 **0.86** **0.50** **Area for Improvement**

357. "The course provided valuable foundational knowledge on AIs theoretical aspects, its potential applications, and future implications within the force. However, for future iterations, I would recommend incorporating a more in-depth exploration of current and evolving AI applications that could affect the force in the next four to eight years. We have to start small getting each and every leader and soldier involve of the impacts of AI and build that trust between leaders and AI capabilities."
0.03 **0.98** **0.53** **Key Strength**

358. "I feel like I'll need to take it or similar again because it is a lot of information quickly. I might suggest a longer lunch break, or, at least, preparing attendees for a short one."
0.00 **0.99** **0.71** **Key Strength**

359. “Improvements: Instructor went a little fast in some areas. May have been because he was used to this be a 2 day class.”
0.00 **0.97** **0.67** **Insight/Learning**

360. “Thank you for providing such an in-depth exposure to AI/ML. I’ve never seen a course like this in the Army.”
0.00 **0.99** **0.95** **Key Strength**

361. “The course was overall well put together and should continue”
0.00 **0.99** **0.95** **Key Strength**

362. “I would recommend everyone in my organization to attend this course.”
0.00 **0.99** **0.90** **Key Strength**

363. “I did a refresh on my linear algebra after the course. I wish I had done that ahead of time.”
0.00 **0.99** **0.54** **Key Strength**

364. “Have examples of solution variations based on NN type or of a given NN type with different parameters. Optional homework of implementing NN on several textbook problems.”
0.00 **0.75** **0.88** **Key Strength**

365. “Including an example where the ML doesn’t work well might be helpful to counterbalance the pitch that ML will solve all the problems”
0.00 **0.99** **0.52** **Key Strength**

366. “Having the slides in advance so I can take notes on them would be helpful.”
0.00 **0.99** **0.55** **Key Strength**

367. “Thank you for the opportunity.”
0.00 **0.99** **0.96** **Key Strength**

368. “I appreciate you running this course!”
0.00 **0.99** **0.97** **Key Strength**

369. “I strongly believe that this course should be offered at least twice annually to educate the force. Promoting awareness will be crucial to guarantee success within the force while implementing AI. I recommend keeping the business casual attire for the course.”
0.01 **0.99** **0.79** **Key Strength**

370. “Various examples were given on how the ML learning algorithms produce confidence in the outcome, but not enough was provided on the data sets (or how/what is needed to know about the data sets) that it will train the ML with confidence across the operating environment/use case. For example, the example of using the HVAC sensors output to predict/detect the presence of persons in the guard shack. Does the data set include or should it include off nominal values and the missing inputs of collected sensors to help train the system? This was alluded to in the discussion after the class with the pane and their projects. Also what should be around the high confidence trained algorithms in the software to guard against an output which is considered high confidence by the algorithm, but is wrong because it wasn’t trained on the condition/value presented by the sensor?”
0.06 **0.99** **0.83** **Area for Improvement** **Insight/Learning**

371. “I would like to see a read ahead or “cheat sheet” of the various functions that lays out what they are typically used for”
0.08 **0.99** **0.84** **Key Strength**

372. “I would add small practice exercises to the course. If time was an issue, offer them as optional homework. Keeping the practice exercises under 1 hour but adding an opportunity for feedback from an instructor the next day.”
0.12 **0.54** **0.77** **Key Strength**

373. “Teacher made a difficult subject quite educational. Reduce “cultural” references that interrupt logic flow. Define terms and concepts before usage. Spreadsheets were difficult to see.”
0.16 **0.99** **0.48** **Key Strength**

374. “There is a lot of in depth information presented in the course, for this reason I think that there should be at least 5 minutes breaks on the hour at a minimum.”
0.30 **0.84** **0.56** **Key Strength**

List of Symbols, Abbreviations, and Acronyms

A	Activation(s)
AC	Armaments Center
AFC	Army Futures Command
AI	Artificial Intelligence
AMC	Army Materiel Command
AMSC	Army Management Staff College
ARL	Army Research Laboratory
ASC	Army Sustainment Command
AvMC	Aviation and Missile Center
B	Bias
BERT	Bidirectional Encoder Representations from Transformers
C5ISR	Command, Control, Computers, Communications, Cyber, Intelligence, Surveillance, and Reconnaissance
CBC	Chemical Biological Center
CDAO	Chief Digital and Artificial Intelligence Office
CESL	Continuing Education for Senior Leaders
CNN	Convolutional Neural Network
CS	Computer Science
CW	Chief Warrant (Officer)
DAC	Data and Analysis Center
DEVCOM	U.S. Army Combat Capabilities Development Command
DOC	Department of Commerce

DoD	Department of Defense
DOE	Department of Energy
DoW	Department of War
EOFY	End of Fiscal Year
FAQ	Frequently Asked Questions
FCC	Futures and Concepts Center
GAN	Generative Adversarial Network
GloVe	Global Vectors for Word Representation
GPT	Generative Pretrained Transformer
GRA	Graduate Research Assistant
GRU	Gated Recurrent Unit
GVSC	Ground Vehicle Systems Center
HQ	Headquarters
HQDA	Headquarters, Department of the Army
ISR	Intelligence, Surveillance, and Reconnaissance
JMC	Joint Munitions Command
L1	L1 Regularization (also known as Lasso Regression)
L2	L2 Regularization (also known as Ridge Regression)
LLM	Large Language Model
LSTM	Long Short-Term Memory
ML	Machine Learning
MLOps	Machine Learning Operations
NASA	National Aeronautics and Space Administration

NCO	Noncommissioned Officer
NIST	National Institute of Standards and Technology
NLP	Natural Language Processing
NN	Neural Network
NRC	Nuclear Regulatory Commission
ORSA	Operations Research/Systems Analyst
RC	Row-Column
ReLU	Rectified Linear Unit (an activation function)
RIA	Rock Island Arsenal
RNN	Recurrent Neural Network
RoBERTa	A Robustly Optimized BERT Pretraining Approach
SBS	Strategic Broadening Seminar
SC	Soldier Center
TRADOC	United States Army Training and Doctrine Command
VAE	Variational Autoencoder
VBA	Visual Basic for Applications
W	Weight
WO	Warrant Officer
X	Input
Y	Output
Z	Preactivation Value

1 (PDF)	DEFENSE TECHNICAL INFORMATION CTR DTIC OCA
1 (PDF)	DEVCOM ARL FCDD RLB CI TECH LIB