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Information Transfer Model

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14. ABSTRACT
This technical note describes implementation of an information transfer model. In the model, information refers to heterogenous message types. The report also describes implementation of an agent behavior that utilizes the model. The agent behavior has been developed using the Sentry Agents (SAGE) framework.

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1. Introduction

This technical note documents an implementation of an information transfer model and agent behavior that utilizes the model. The agents exchange heterogenous message types with each other. The agent behavior has been developed using the Sentry Agents (SAGE)[1] framework. SAGE is an open-source software developed by the US Naval Research Laboratory; it can be used to create agent-based systems, including custom agents with unique behaviors. With this implementation, the exchange of message types between agents as well as the transition of message types over a period of time, can be observed.

2. Model and Agent Behavior Classes

This section describes the two classes.

2.1 Class 1: MessageTransferModel

This class represents an information transfer model in terms of messages (Table 1). There are four different message types in this class: Pristine, Encoded, In-processing, and Recovered (P, E, I, R).

Table 1 Class 1: MessageTransferModel method summary

Modifier and type	Method and description
void	**MessageTransferModel**（） • This is the constructor that sets the class variables and invokes the executePEIRE method. **Parameters:** • *Pristine_val* - number of pristine messages at model initiation • *Encoded_val* - number of encoded messages at model initiation • *Inprocessing_val* - number of in-processing messages at model initiation • *Recovered_val* - number of recovered messages at model initiation • *total_val* - total number of message types • *bta* - denotes the contact rate between a pristine and encoded message • *gam* - denotes the recovery rate for an in-processing message to become a recovered message • *m* - denotes the rate at which a message is deemed needless • *sig* - denotes the latency rate at which a message is encoded before it gets transformed to in-processing • *omga* - denotes the rate at which a recovered message can become an encoded message again

Table 1 Class 1: MessageTransferModel method summary (continued)

Modifier and type	Method and description
void	**setModelResult** () • This method is used to set the array that holds the current value of different message types. **Parameters:** • *Pval* - pristine messages • *Eval* - encoded messages • *Ival* - in-processing messages • *Rval* - recovered messages • *Nval* - total sum of message types
double[]	**getModelResult()** • This method can be used to access the array holding the current number of different message types. **Returns:** • Array containing the current number of different message types
void	**changePE_Values** () • This method can be used to update the current number of pristine and encoded messages. **Parameters:** • *Pval* - updated number of pristine messages • *Eval* - updated number of encoded messages
void	**runModel** () • This method uses the current values of pristine, encoded, in-processing, and recovered messages as input to the model, resulting in a new number of message types based on model results.
double[]	**executePEIRE** () • This method computes the number of message types based on the model. **Parameters:** • *P* - number of pristine messages as input to the model • *E* - number of encoded messages as input to the model • *I* - number of in-processing messages as input to the model • *R* - number of recovered messages as input to the model • *N* - total number of message types as input to the model **Returns:** • Array containing the computed number of message types
double	**NP** • This method computes the number of pristine messages every second (or any other unit of time). **Parameters:** • *P* - number of pristine messages • *E* - number of encoded messages • *I* - number of in-processing messages • *R* - number of recovered messages • *N* - total number of message types **Returns:** • Computed number of pristine messages

Table 1 Class 1: MessageTransferModel method summary (continued)

Modifier and type	Method and description
double	**NE** • This method computes the number of encoded messages every second (or any other unit of time). **Parameters:** • *P* - number of pristine messages • *E* - number of encoded messages • *I* - number of in-processing messages • *R* - number of recovered messages • *N* - total number of message types **Returns:** • Computed number of encoded messages
double	**NI** • This method computes the number of in-processing messages every second (or any other unit of time). **Parameters**: • *P* - number of pristine messages • *E* - number of encoded messages • *I* - number of in-processing messages • *R* - number of recovered messages • *N* - total number of message types **Returns:** • Computed number of in-processing messages
double	**NR** • This method computes the number of recovered messages every second (or any other unit of time). **Parameters**: • *P* - number of pristine messages • *E* - number of encoded messages • *I* - number of in-processing messages • *R* - number of recovered messages • *N* - total number of message types **Returns:** • Computed number of recovered messages
double	**NN** • This method provides the total sum of pristine, encoded, in-processing, and recovered messages. **Parameters:** • *P* - number of pristine messages • *E* - number of encoded messages • *I* - number of in-processing messages • *R* - number of recovered messages **Returns:** • Total sum of all message types

2.2 Class 2: PEIRE_MSG_TransferWithMultipleAgents

This class represents a SAGE behavior that utilizes the information transfer model transfer of information in terms of heterogeneous message types (Table 2). The model is named after different message types: Pristine, Encoded, In-Processing, and Recovered (PEIRE). In this behavior implementation, agents with specific names ("Agent1," "Agent2," and "Agent3") are referenced in the message exchange.

Table 2 Class 2: PEIRE_MSG_TransferWithMultipleAgents method summary

Modifier and type	Method and description
void	**PEIRE_MSG_TransferWithMultipleAgents ()** • This is a constructor method that initiates the agent. Here, the execution type is set as timed cyclical.
void	**setUp** () • This method is first called when the agent becomes active. In this method, model behavior is attributed to the agent. **Parameters:** • *result* - SAGE result object to carry information about the result of method execution
void	**action** ( ) • This method is called intermittently by the agent after it becomes active. It invokes the callPeirModel and sendPEMessages method to send pristine and encoded messages to other agents. **Parameters:** • *result* - SAGE result object to carry information about the result of method execution
void	**sendPEMessages()** • This method is used to send pristine and encoded messages. The messages are sent to a random active agent. Number of message types exchanged, and the number of message types currently associated with the agent, are also recorded. **Parameters:** • *agentname* - name of the agent that has to send messages
void	**callPeirModel()** • This method is used to access and execute the Message Transfer model.
boolean	**message()** • This method is called each time a message is received by the agent. The message is parsed to extract the sender's agent name and the number of pristine and encoded messages received. These received message types are then used to update the current number of message types associated with the agent and are appropriately recorded. **Parameters:** • *message* - Java class that represents a message sent between SAGE agents for communication • *result* - Java class that represents the outcome of the execution of the message method

Table 2 Class 2: PEIRE_MSG_TransferWithMultipleAgents method summary (continued)

Modifier and type	Method and description
void	**tearDown()** • This method is called when an agent becomes inactive **Parameters:** • *result* - Java class that represents the outcome of the execution of the tearDown method

3. Conclusion

This report has described an initial information transfer model. The model will continue to be augmented so that it can aid with prediction and reasoning capabilities. This document will need to be updated to reflect any new capabilities added in the future.

4. References

1. Naval Research Laboratory. SAGE user guide. Naval Research Laboratory (US); c2022 [accessed 2023 Aug 22]. https://sageframework.com/

1 (PDF)	DEFENSE TECHNICAL INFORMATION CTR DTIC OCA
1 (PDF)	DEVCOM ARL FCDD RLB CI TECH LIB