



Improving Software Performance via Human Interaction Learning

Dr. James A. Crowder, Chief Engineer
Intelligence and Information Systems
March 20, 2013

Improving Software Performance through Human Interaction Learning (HIL)

Human Mentored Software (HMS) as an interim solution between operator controlled and autonomously controlled systems

Agenda

- Introduction: Why Human Mentored Software (HMS)
 - Pros and Cons of Autonomy
 - Monitoring vs. Performing
 - Adaptable vs. Adaptive
 - Mentoring Builds Skills and Trust
- HMS High-Level Architecture
- HMS Cognitive Learning Engine
- HMS Automatic Artificial Procedural Memory Learning
- Building Trust in Autonomy through HMS
- Conclusions/Discussion

Introduction – Why HMS?

- Dependency on Automation is a Two-Edged Sword
- Complex Systems Require Complex Control and Monitoring
- Need to:
 - Develop/Train Software to do the Job
 - Preserve the Skills/Knowledge of the Human
 - Provide the Human with a Means to Calibrate Trust of the Software
- Using the Human to Mentor the Automation Provides:
 - Reinforcement of Skills and Knowledge
 - Software with the Benefit of the Operator's Experience
 - Method to Assess Performance and Reliability of Software (Trust)

Human Perception of Automation is Crucial to Acceptance

Automation Pros and Cons

- Pros
 - Augments and Increases Human Capabilities
 - Performs the Activities Humans Can't or Shouldn't
- Cons
 - Could Lead to Higher-Level Errors
 - Reduction in Skills Needed for Trouble-shooting
 - Who's in Control?
- HMS will reduce the cons

HMS Augments Human Capabilities & Reduces Cons

Monitoring vs. Performing

- Automation Helps Us Perform Activities We Otherwise Couldn't
- Changes Role of Operator to Monitor rather than Performer
- Skills and Knowledge Atrophy over Time
- Inappropriate Level of Trust

Operators still needed to monitor tasks

Adaptable vs. Adaptive

- Should Software “Pick up the Load” to Help the Operator?
- Adaptable: Operator Changes the Software Level of Control
- Adaptive: Software Changes Level of Control on its own
- Who Decides?

Autonomous Decision Making is still perceived as Risky

Building Trust

- Humans Must Calibrate their Trust in Software
- Cognitive Heuristics makes the Calibration Difficult
- People can Overtrust or Undertrust Software
- Overtrust can lead to Errors and Dependency
- Undertrust can lead to Inefficiency or not Using the System

HIL can be the bridge between Operator Controlled and Fully Autonomous Systems

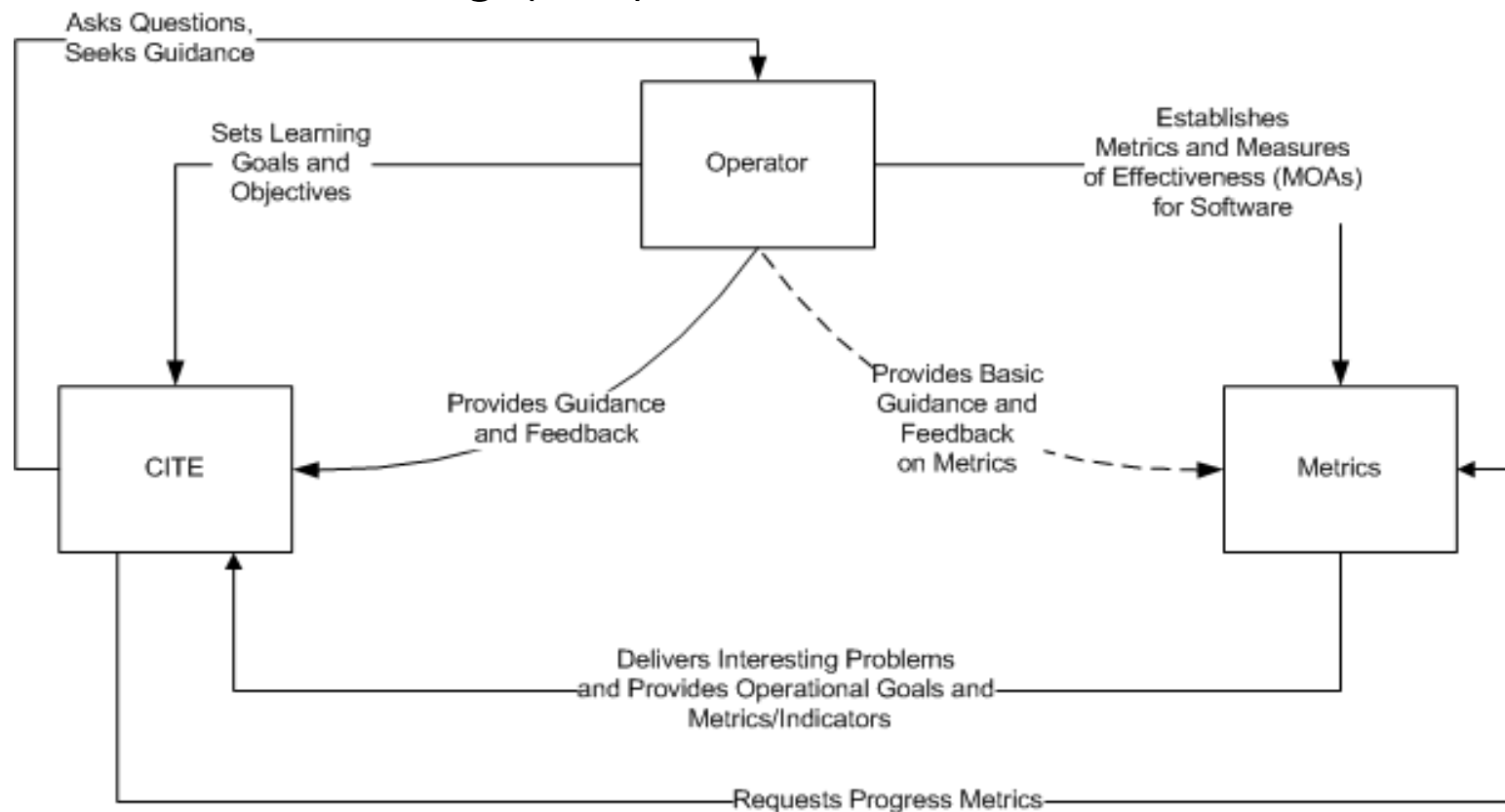
What is Needed?

- Software that will Interact with and Learn From the Operator
- Software that can Demonstrate to the Operator it can Perform its Tasks Well
- Software that will help Maintain the Operators Skill and Knowledge
- Human Mentored Software/Interaction Learning

HIL Allows to Operators to “Teach” the Software their Expertise

HMS High Level Architecture

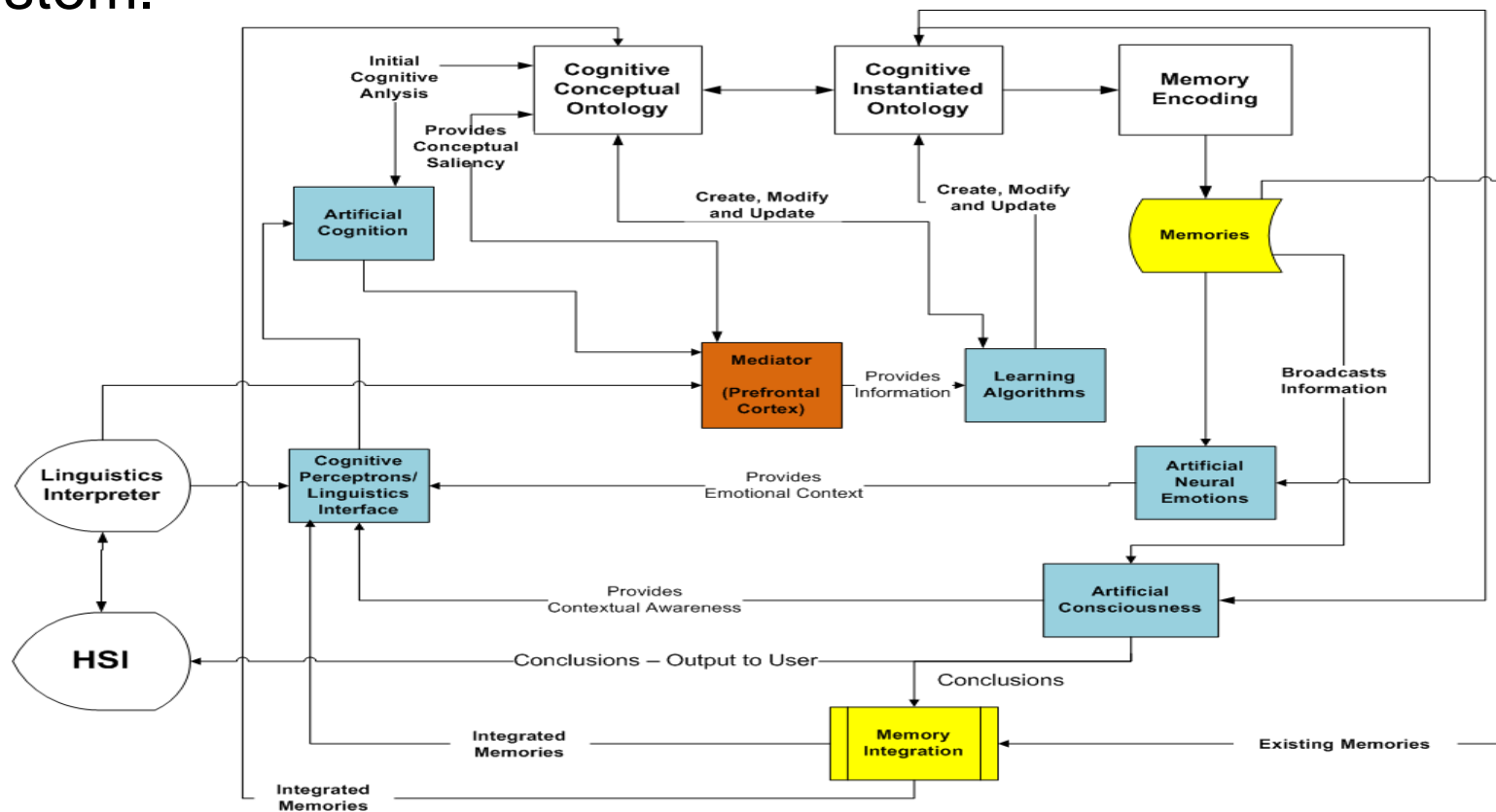
- The Cognitive HMS Framework allows interaction between the Operator and the system to facilitate the Human Interaction Learning (HIL).



HMS provides extensive feedback metrics to allow the software system to “learn” from the human operator

HMS Cognitive Architecture

- The HMS Cognitive Processing Engine interprets inputs from the Operator and uses them to “learn” how to operate the system.

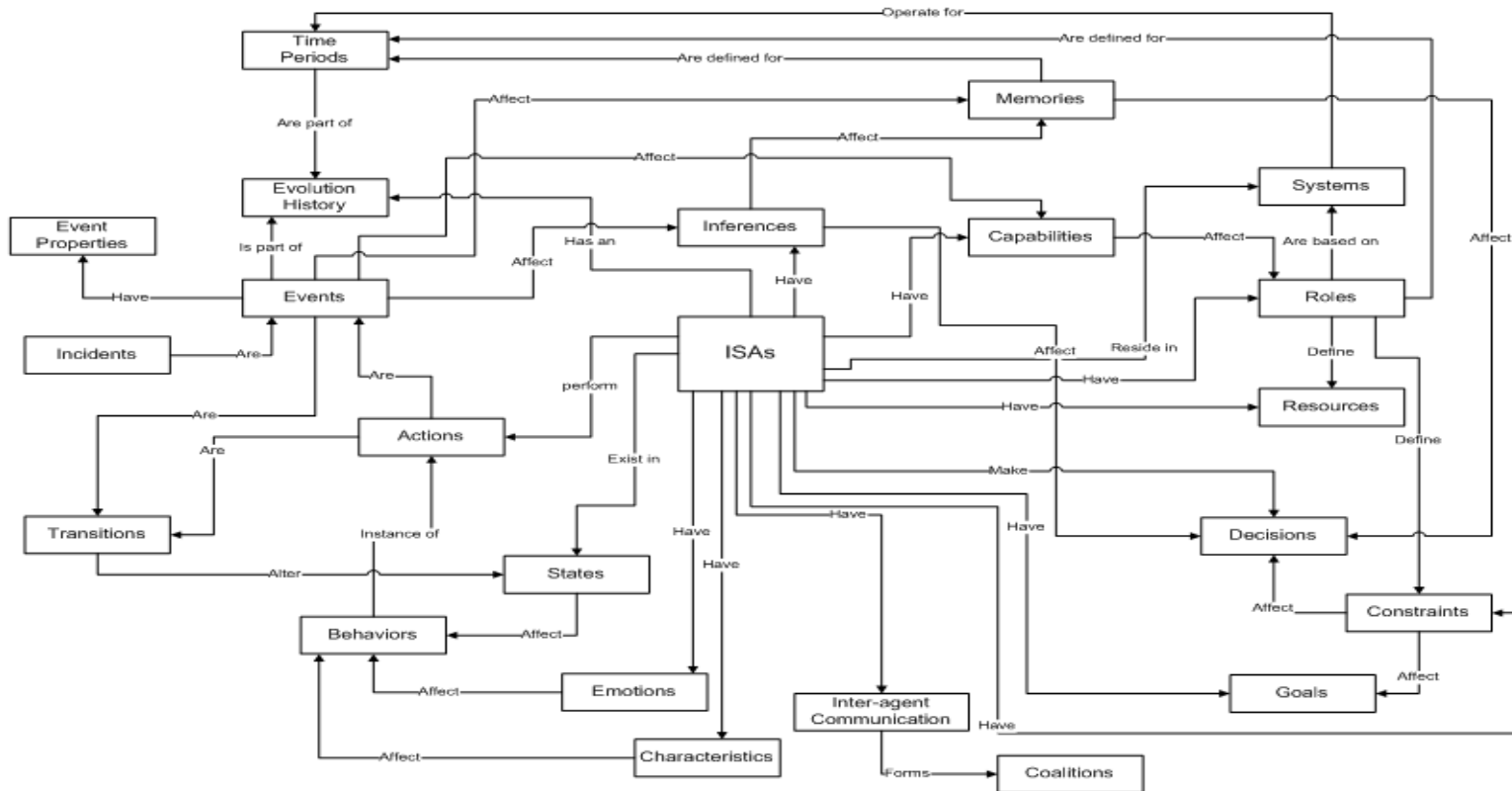


The Cognitive Processor provides multiple learning system to accommodate different types of information and metrics

HMS Cognitive Architecture

- The heart of the Cognitive system are Intelligent information Software Agents (ISAs) that learn, collaborate, and provide information and “intelligence” throughout the system.

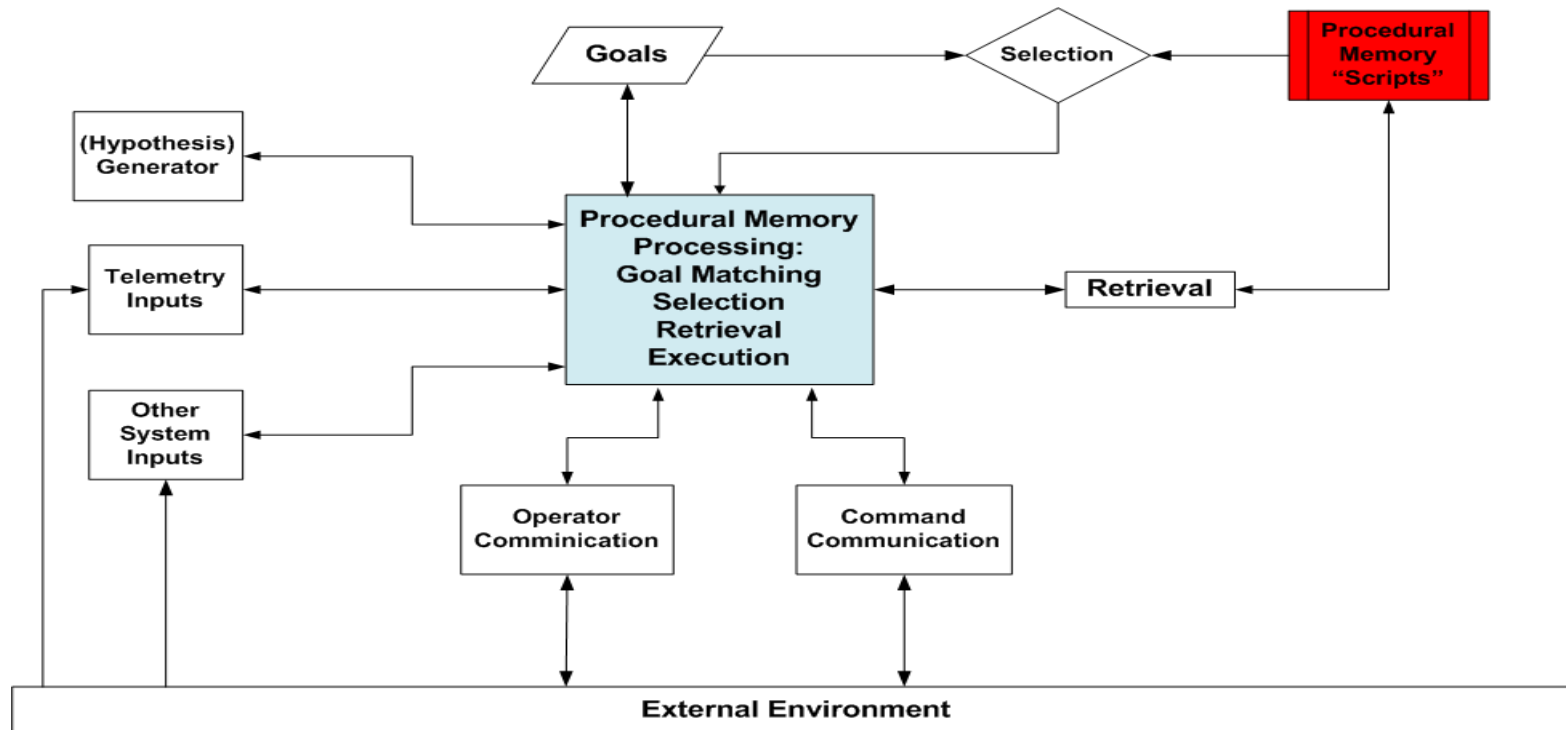
ISA Cognitive Ontology



The Cognitive Processor provides multiple learning system to accommodate different types of information and metrics

HMS Procedural Memory Selection

- The HMS Procedural Memory Selector looks at the system, its goals, and metrics, and looks to see if there is already a Procedural Memory Script in its memories to cover this situation



The Procedural Memory Detector Uses Previously Stored Memory Scripts to Handle Learned Situations

Summary

- Human Interaction Learning provides the methodology for “Operator-Trained” automation software.
- The cognitive processes presented allows the system to develop artificial procedural memories (similar to workflows or orchestrations) that can be used later by the system to perform tasks it has learned.
- Human Interaction Learning provides the ability to create Human Mentored Software that will be the interim solution between completely Operator controlled systems, and completely autonomous system control.

HIL is the transition solution between Operators and Autonomous Systems

Questions?

Biography

- **Dr. James A. Crowder**
 - Chief Engineer, Raytheon Intelligence and Information Systems Advanced Programs Group
 - BS Electrical Engineering
 - MS Electrical Engineering (Signal Processing)
 - MS Applied Math (Applied Probability)
 - PhD Electrical Engineering & Applied Math (Chaos Theory & Stochastic Processing)
 - 90 Publications in Systems Architectures, Signal Processing, and Artificial Intelligence
 - 30 years experience in signal processing algorithms (SIGINT, COMINT, IMINT, and MASINT)
 - 25 years experience as a systems architect
 - 20 years experience in artificial intelligence (neural networks, fuzzy systems, and genetic algorithms)