# Adaptive, Peircean Based Decision Aid

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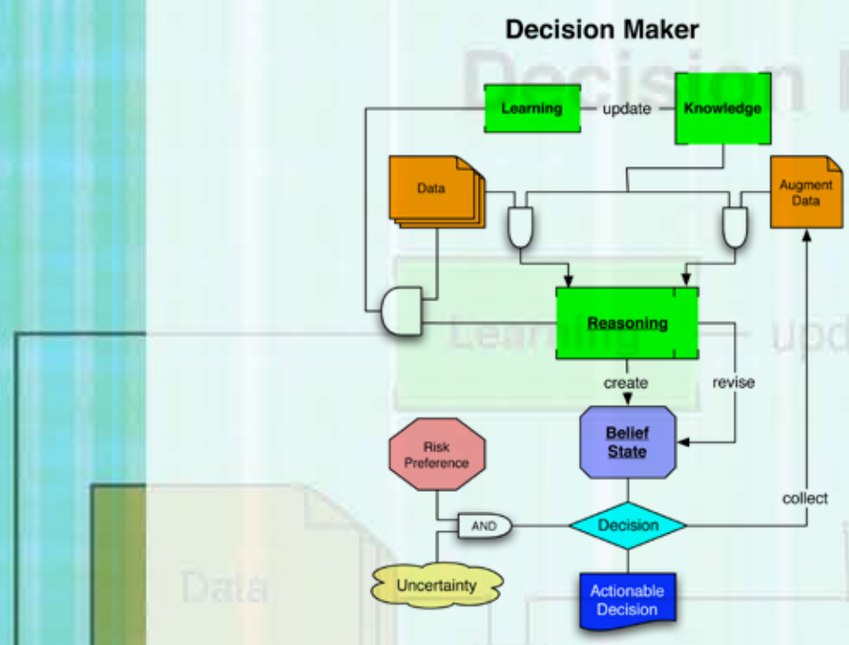
## Decision Aid Design

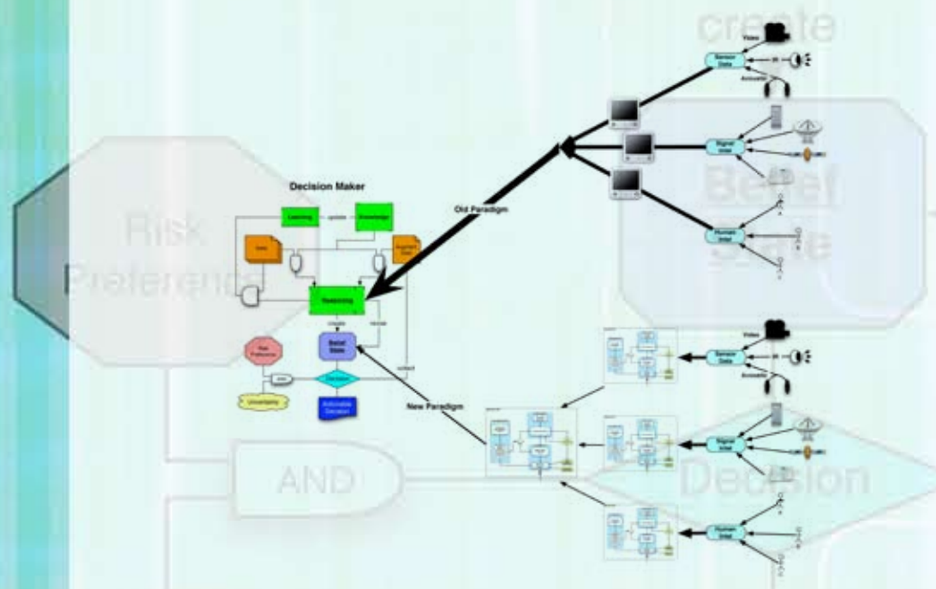
- **Decision Aid Design is flawed.**
  - Minimal or flawed consideration of the decision making process.
  - Minimal consideration of the cognitive loads being imposed on the decision maker.
  - No consideration of the theoretical foundations of information.
    - Modal logic's.
    - Multi-modal Knowledge representation.
  - Failure to include adaptive/learning functionality.
  - 'Information overload' is symptomatic of bad designs.

- **Systems engineering approach requires:**
  - Understand Human Decision Making Process.
    - Data/Information is convolved with knowledge to generate understanding.
    - Understanding constitutes a 'belief state' or situational awareness.
    - Decisions/actions are generated based on that constructed belief state.
    - Uncertainty & risk aversion impact option selection.
  - Understand the functionality of 'Reasoning'.
    - Modal logic's represent heuristics of reasoning.
    - Philosophy (Peircean) defines the core reasoning components.
  - Understand 'data/information' fusion.
  - Understand the mathematics of knowledge representation.
    - The strengths and weaknesses of different technologies.




## Basic Decision Aid Requirements

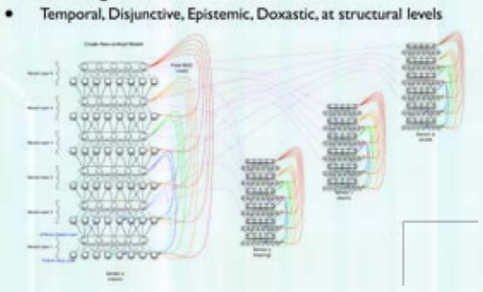
- **Minimize decision maker (DM)'cognitive' load.**
  - Interface to DM "Belief State" not the reasoning functionality.
  - Fuse data and information as close to the sensor as possible.
- **Perform Data / Information fusion.**
  - Knowledge representation to support knowledge capture & re-call.
  - Reasoning algorithms(Peircean) to develop hypotheses & new knowledge.
  - Abduction(including Analogic), Deduction, Induction.
  - Reasoning operators(JSM).
  - Learning engines.
  - Inductive learning to create knowledge.
- **Healthy infusion of "Modal Logic"**
  - Manage knowledge, belief, spacial, and temporal dimensions of information.
  - Temporal, spatial, disjunctive, doxastic, epistemic, ...




## Peircean based Decision Aid Solution

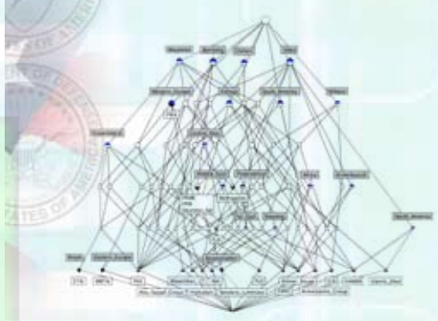

- Initial considerations of a 'real time' hierarchical knowledge structure.
  - Hawkins neo-cortical model.

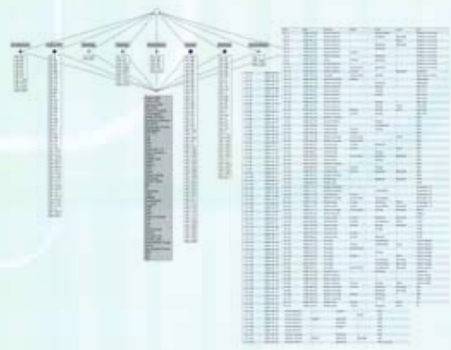
- Knowledge Representation
  - Formal Concept Analysis (Ganter & Wille)
    - Foundations in 'ordered set theory' & 'lattice theory'
- Reasoning
  - C.S. Peirce's 'Method of Scientific Inquiry'
    - Abduction, Induction, & Deduction
- Knowledge Operators
  - J.S. Mills first 2 of 5 canons
- Modal Logic
  - Temporal, Disjunctive, Epistemic, Doxastic, at structural levels



## Peircean DA in an Intel Analyst Scenario

- Raw Information does not clarify a situation even in structured views.





- Processed to Knowledge enables interpretations of newly collected Intel

## Hypothesis Generation

- Single hypothesis:
  - Group is likely to be HAMAS

- Multiple hypotheses
  - Add 'Armed Assault' to information collected

- Hypothesis testing:
  - Deductive - Inductive process
  - Severe Test Constrained (D. Mayo)

## Significance

- Decision aid design that interfaces with a decision makers belief state.
  - Minimizing the cognitive load imposed in a decision maker.
- Decision aid design that is scalable to implementation technology.
  - Main frame for predictive analysis, to PDA for real time applications, to 'post-it' notes in minimalist applications.
- New model of data/information fusion.
  - Fusion model reflects human characteristics and integrates reasoning into the system solution.
- Decision aid design with integrated learning algorithms.
- Concept has implications on sensor and information architecture design.
  - Sensor design with integrated Peircean fusion reduce bandwidth requirements.
    - Mitigating the need for 'mega-pipes' to centralized processing facilities.
- Distributed information architectures that can be structured hierarchically to minimize bandwidth requirements to decision maker/analysts.

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