Creating and Capturing Expertise in Mixed-Initiative Planning

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Why capture expertise?

“By three methods we may learn wisdom:
First, by reflection, which is noblest;
Second, by imitation, which is easiest;
And third, by experience, which is bitterest.”

- Confucius

Capture, Develop, Provide Experience

- Challenge: Is it really possible to institutionalize the thought processes of a military commander?
  - Prior efforts attempted to model and recreate the *reasoning* of military decision makers.
  - However, many of the decisions made by human thinkers are founded in *intuition* and not readily modeled.
- Our Answer: Augment the same recognition processes used by humans.
  - Mixed-initiative decision-making:
    - Both the humans and the system are driving the process.
  - People and machines learn from each other.
  - Perform at a higher level of expertise together.

Case-Based Reasoning

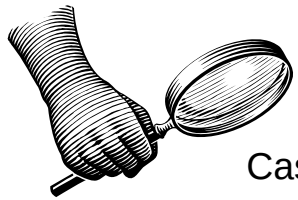
1

"I have a situation…"

user case

User enunciates objectives and situation

2



Case base

Most similar case is retrieved from past experiences

similar case

3

Case is reused and revised, adapted to the present

4

new plan

The new plan is then implemented

5

The experience is retained for future use

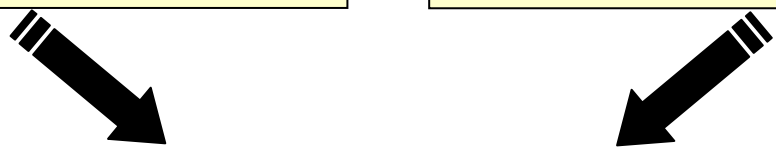
DEEP.

Distributed Episodic Exploratory Planning in one sentence:

DEEP enables planners to cooperate with other Air Operations Centers by using the experience of the past adapted to present situations, allowing for intuition-like mixed-initiative planning.

- New AOC ConOps
  - **Smaller, separate AOCs**
  - **Supporting/ed relationships**
  - **Complex, ever-evolving ops environment**

- Technology
  - **Black Board Systems**
  - **Episodic Memory**
  - **Multi-Agent Systems**



DEEP

Plan. Learn. Together.

Our Focus: Capturing Experience

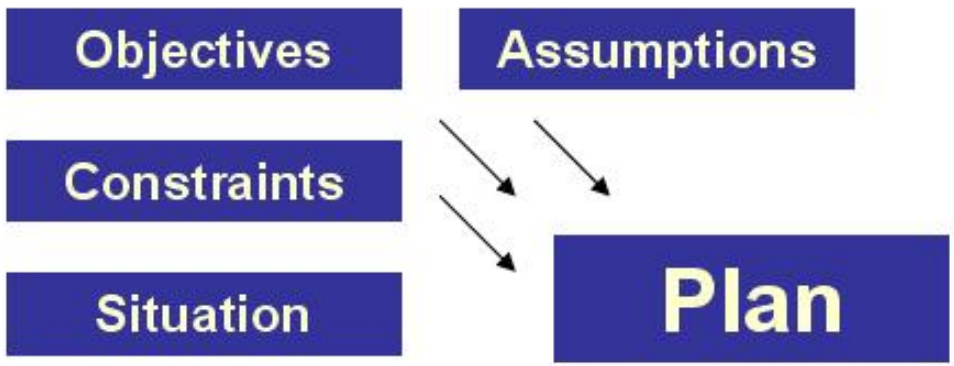
- How do we collect experience in a way that is:
  - Understandable by a computer?
  - Amenable for mixed-initiative planning?
  - Supportive of drawing conclusions from knowledge?

Three Main Areas…

- *Context* of the situation
- *Decision* made by planner
- *Outcome* of that decision

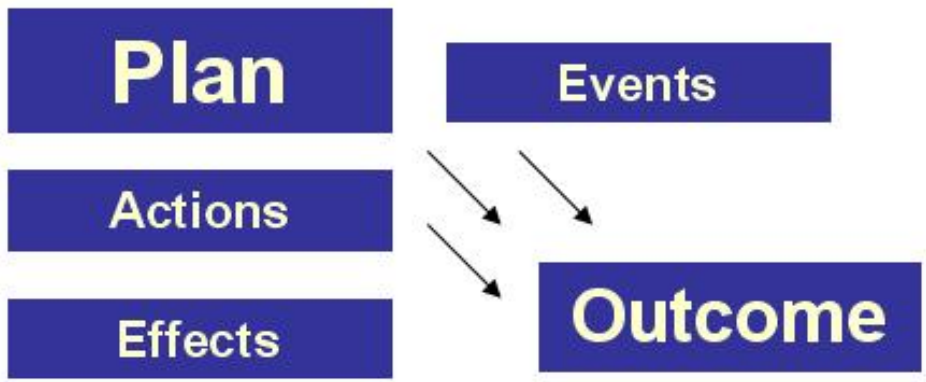
The Context.

- We need to capture:
  - What needs to be accomplished (Objectives)
  - Details about the world (Situation)
  - How that space is bound (Constraints)
  - Assertions based on evidence (Assumptions)
- With this information, a decision (Plan) can be formed…



The Experience.

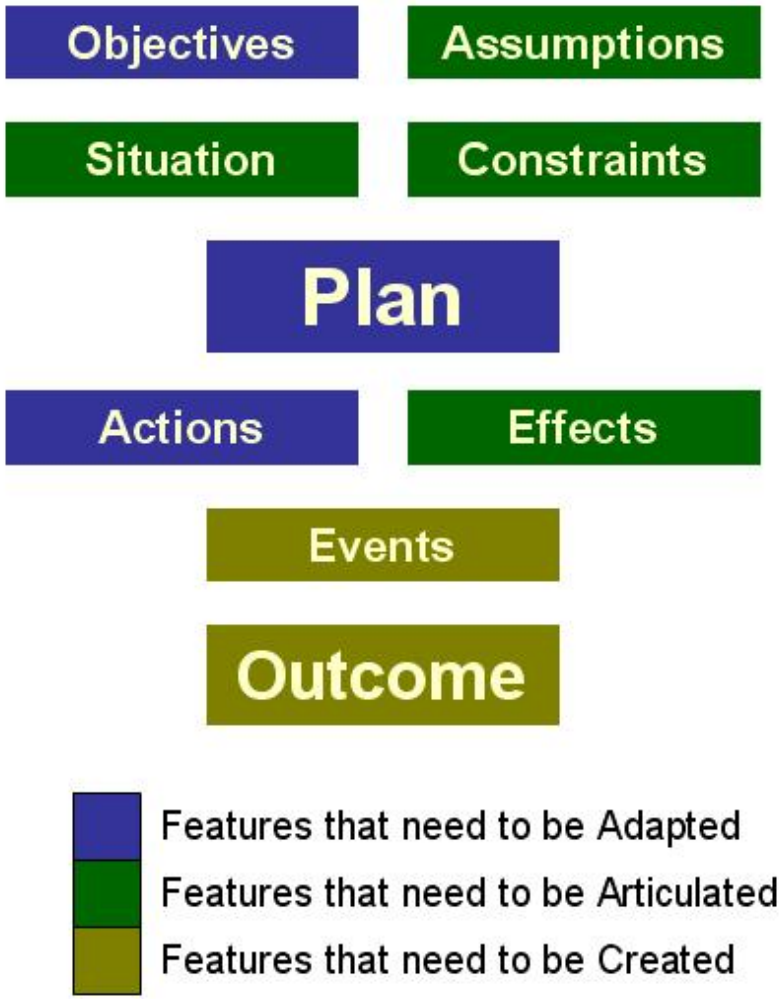
- Based on the decision (Plan), capturing the implementation of that decision requires:
  - What was done to realize the decision (Actions)
  - What was done by others in the environment (Events)
  - How both of those affected the situation (Effects)
- Now we can ask: are our Objectives met? (Outcome)



Developing Experience

- In order to encapsulate this knowledge within a computer, we can adapt previous research in plan representation
  - **Core Plan Representation**, developed by the ARPA Rome Lab Planning Initiative (APRI).
  - Site: **http://projects.teknowledge.com/CPR2/Reports/CPR-RFC4/**
- However, CPR was designed to represent *plans*, not whole experiences.

From Plans to Experiences



Adapting CPR

- Event
  - What really happened when we tried the plan?
- Assumption
  - What if something's very existence is assumed?
- Outcome
  - How do we know if we are successful?
- Cost
  - How do we measure the value of what is expended?
- Location
  - Is the question 'where?' always geospatial?

Forming Analogies with Experience

- Some Approaches…
  - K-Nearest Neighbor: are there characteristics that are very similar? How many?
  - Semantic Similarity: is there a meaning that is very similar? What taxonomy/ontology will answer that?
  - Structural Mapping: are there higher-order relationships at work that form an analogy? Is there 'systematicity'?
  - Many are Called, Few are Chosen: will a first pass with feature matching allow for deeper analysis?
  - Multi-Constraint Theory: are the features, relationships, and purpose of these items the same? Is it 'coherent'?

Summary and Future Work

- DEEP seeks to provide intuition-like planning by utilizing experience in a mixed-initiative environment.
- Future efforts will include:
  - Episodic Memory rather than Case-Based memory
  - Semantic and Structural analogy algorithms
  - Measuring trust/confidence in assumptions using CBR
  - Capturing a world state with enough richness for analogies
  - Capturing ‘war stories’ and lived history for new cases