

An Analytical Framework for Agent Architectures

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Overview

- “Heavy” agents
 - Agents with significant amounts of knowledge
 - Contrast with “light” agents
- Variety of existing architectures
 - All are sophisticated
 - All share many conceptual components
 - None completely subsume each other
- Can we identify a subsuming set of architectural principles for heavy agents?

Selected Agent Frameworks

- BDI
 - Inspired by formal logic
 - Formal sense of rationality
 - Focus on logical consistency between beliefs and goals
- GOMS
 - Inspired by psychology
 - Explicit hierarchical task decomposition
 - Explicit pairing of goals with plans
- Soar
 - Inspired by functionality and philosophy
 - Problem-space hypothesis
 - Physical symbol systems hypothesis
 - Focus on minimal but sufficient set of principles

Comparative Framework

- Representational elements
 - Inputs, Justified Beliefs, Assumptions, Desires, Active Goals, Plans, Actions, Outputs
- Design dimensions
 - Representation formalism
 - How is each type of element represented?
 - Commitment strategy
 - Under which conditions do each type of element get selected/activated/instantiated?
 - Reconsideration strategy
 - Under which conditions do each type of element get removed/deactivated/released?

Somewhat supported

Explicitly supported

Comparisons

	Representation	Commitment	Reconsideration
Inputs			
<i>BDI</i>	Input language		
<i>GOMS</i>	Input language		
<i>Soar</i>	Input elements		
Beliefs			
Justified			
<i>BDI</i>	Beliefs	Logic	Belief revision
<i>GOMS</i>	Working memory	Knowledge	
<i>Soar</i>	Transient elems.	Truth maint.	Truth maint.
Assumptions			
<i>BDI</i>	Beliefs	Plan language	Plan language
<i>GOMS</i>	Working memory	Operators	Operators
<i>Soar</i>	Persistent elems.	Operators	Operators
Desires			
<i>BDI</i>	Desires	Logic	Logic
<i>GOMS</i>			
<i>Soar</i>	Proposed ops.	Preferences	Preferences

Somewhat supported

Explicitly supported

Comparisons

	Representation	Commitment	Reconsideration
Active Goals			
<i>BDI</i>	Intentions	Deliberation	Soundness
	Goals/Hierarchy	Operators	
	Beliefs/Impasses	Deliberation	Truth maint.
Plans			
<i>BDI</i>	Plans	Plan lookup	Soundness
	Methods	Selection	
			Interleaving
Actions			
<i>BDI</i>	Plan language	Atomic actions	
	Operators	Operators	
	Operators	Operators	
Outputs			
	Plan language	Plan language	
	Primitive ops.	Conditional ops.	
	Output elements	Truth maint.	

Missing Elements

- Deliberate attention
- Parallel active goals
- Resources and limitations
- Multi-agent/social elements

What Should an Agent Architecture Include?

- It depends
- Tradeoff between flexibility and consistency
 - E.g., no explicit plan representation in Soar
- But all of these elements are necessary for heavy agents
 - The question is whether they are supported implicitly or explicitly
 - They should not be ignored
 - Solutions not provided by the architecture must be provided ad hoc