

Implementing the Mind Cognitive Architectures

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Overview

- Cognitive architectures, UTC
- Soar
- ACT-R
- Comparison
- Conclusion
- Questions?
- Assignment
- (if we have any time left, a quick Soar demo)



Cognitive architectures

- Unified Theories of Cognition (Newell, 1987)
 - Rooted in psychology:
 - systems for prediction and simulation of human/intelligent behaviour
 - integrate separate microtheories
 - modular design
 - Soar as candidate architecture
 - ACT-R as 'unworthy alternative'
 - (a plea for multiple CA's...)
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Unified theories of cognition

- What does a UTC need to cover?
 - Problem solving, decision making, actions
 - Memory, learning, practice
 - Perception, motor behavior
 - Language
 - Motivation, emotion
 - Imagining, dreaming, social behavior etc...
 - *“Best is the enemy of the good”*
 - Unify existing understanding of cognition, but not overnight
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Why should I care?

- Unification is good! (always an aim in science...)
 - Behavior can't be studied separately
 - Many constraints, more cooperation/reuse, practical applications etc...
 - (UTC written for psychologists, but CA's are of course AI systems)
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Soar: *architecture for general cognition*

- (Laird, Rosenbloom, Newell, 1983)
 - “State, operator and result”
 - Goals (stack-based)
 - Knowledge: Symbol system
 - Reasoning: Productions -> rules
 - Use of problem spaces
 - Learning: chunking (stores derived knowledge, generalizes)
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Chunking



- A, B and C are valid, but no goals can be reached. What now?
 - Use subgoals to derive extra information, ex:
 $A + B \sim > D$
 $B + C \sim > E$
 - If $A + C + E$ solve goal, A, C, E are conditional part of new chunk that leads to goal: chunking!
 - (yes, D is thrown away)
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ACT-R: *Atomic Components of Thought – Rational / Adaptive Control of Thought*

- ACT Theory (Anderson, 1976)
 - Knowledge: Semantic memories / net
 - Declarative & Procedural
 - Reasoning: Activation based (hence: ACT)
 - Working memory has high activation with certain Declarative/LTM nodes
 - Learning: new knowledge gets high activation, but temporary becomes permanent through practice
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ACT-R (2)

- Procedures with highest activation strength are executed
- Strengths increase and decrease depending on success of production in past



Comparison



- Essentially symbolic vs. connectionistic, and all the arguments that go with it...
- Both learn from experience: Soar by chunking, ACT-R by adjusting weights to nodes...
- ACT-R learns also by practice: more realistic



Conclusion

- No perfect cognitive architecture
 - ACT-R wins from psychological / biological point of view
 - Soar better grounded in AI theory and many existing projects, tutorials
 - Both projects under active development, both free
 - Modularity? Could be better
 - Biggest hurdle: more AI developers!
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Pfew...

Questions?



Assignment



- Homework:
play around with Soar and/or ACT-R!
(after next monday you have 2 months off, so no excuses... :-)
 - Do you agree with Newell on what a UTC should cover? What would your priority list be?
 - Do you think Soar or ACT-R is a more likely candidate for your papers topic?
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