Soar Tutorial Introduction
[15 min]

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Thanks to these agencies for support this research.

- 1.45-1.50: Welcome (both)
- Introductions, download software
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- 1.50-2.05: Overview (JEL)
- Cognitive architecture as an area of research, Soar [in context]
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- 2.05-2.50: Basics (JEL)
- Working memory, rules, decision cycle, operators, preferences; random eater (have them copy from the slides?) + debugger walk-through
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- 2.50-3.10: Reinforcement Learning (ND)
- Architectural integration, examples (left-right, eater -> RL)
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- 3.10-3.30: Impasses/Substates (JEL)
- Types+uses, results/resolution, example agents (eater "move" operator)
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- -- Coffee Break (3.30-4.00; deal with any software issues, maybe offer SML via Eclipse?) --
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- 4.00-4.20: Chunking (JEL)
- What it does, idea of deliberation->reaction, integration with RL for value-function initialization
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- 4.20-4.40: Semantic Memory (ND)
- Architectural integration, example agents (eater "move" + "evaluate" via SMem + "record", WordNet)
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- 4.40-4.50: Episodic Memory (ND)
- Architectural integration, example agent (eater "move" + "evaluate" via EpMem), scales in a variety of tasks to long time frames
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- 4.50-5.00: SVS (ND)
- Capabilities, architectural integration
-
- 5.00-5.10: SML (ND)
- Overview, example environment (Eater)
-
- 5.10-5.30: Summing Up (JEL)
- Rosie (uses full architecture + learns), resources (book, manual, tutorials, e-mail list, supported software)
-
- 5.30-5.45: Q&A (both)

Tutorial Outline

1. Cognitive Architecture
2. Core Soar
3. Reinforcement Learning
4. Substates and Impasses
5. Chunking
6. Semantic Memory
7. Episodic Memory
8. Interface to other software: SML

Requirements for Intelligent Autonomy

1. Ongoing existence
2. Pursue many different goals/tasks
3. Integrate with perception and motor control
4. Maintain rich relational representations
5. Make decisions based on current situation and goals in real-time
6. Support complex, deliberate reasoning and problem solving
7. Use large bodies of knowledge
8. Communicate and coordinate with humans and other agents
9. Online learning about all aspects of behavior

Newell's Time Scale of Human Action

Scale (sec)	Time Units	System	Band	
10^{7}	months			
10^{6}	weeks		Social	
10^{5}	days			
10^{4}	hours	Task		
10^{3}	10 min	Task	Rational	
10^{2}	minutes	Task		System 2
10^{1}	10 sec	Unit task		
10^{0}	1 sec	Compositional	Cognitive	
10^{-1}	100 ms	Deliberate act		System 1
10^{-2}	10 ms	Neural Circuit		
10^{-3}	1 ms	Neuron	Biological	System 0 Implementation
10^{-4}	100 µs	Organelle		

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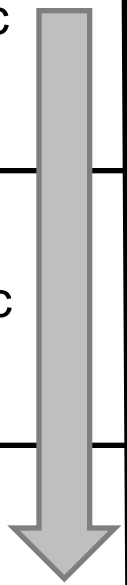
Cognitive Band

Time Units	System	Cognitive Capabilities
10 sec	Unit tasks	Complex Reasoning Analogy Planning Meta Reasoning Theory of Mind
1 sec	Compositional acts	Simple Reasoning Mental Imagery Access Language Processing
100 ms	Deliberate acts	Reactive Decisions Skilled Behavior Primitive Internal Actions Access Long-term Memories

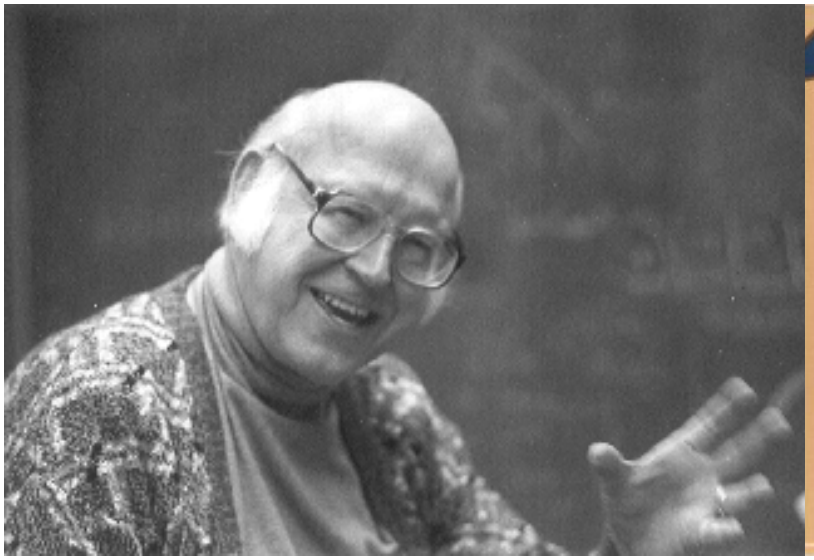


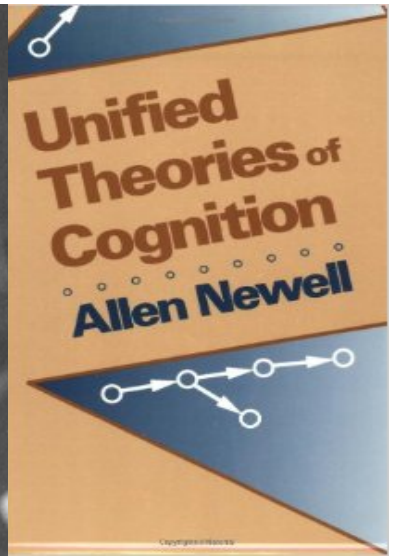
- Promiscuous intermixing of cognitive capabilities.
- Ubiquitous learning: automatic and continuous.
  - "Compiles" System 2 to System 1.

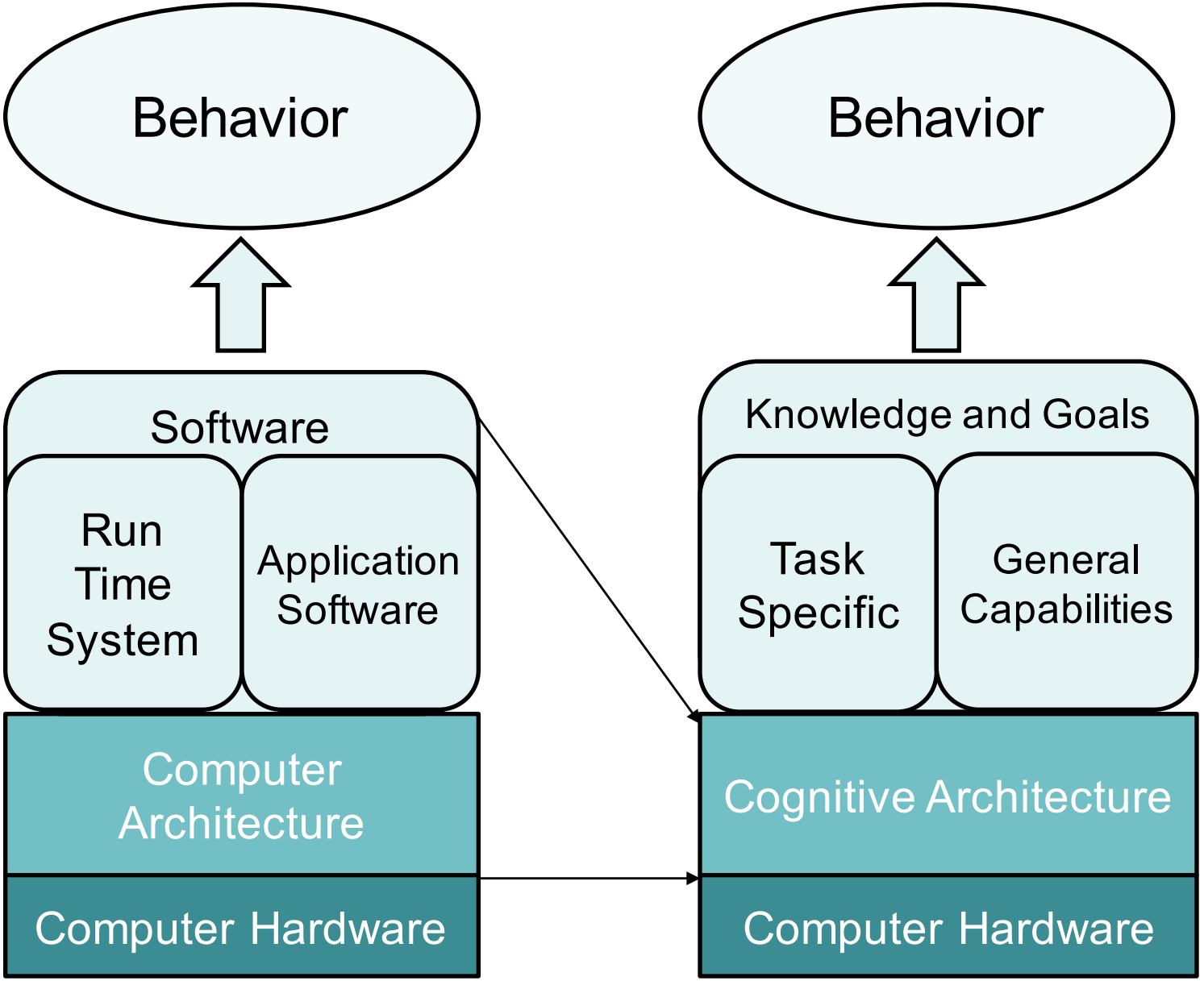
Hypothesis

Systematic regularities at the 50ms level define the *cognitive architecture.*

- Complex behavior (cognitive capabilities) arises from fixed computational building blocks and knowledge:
  - Retrievals from different memories, storing to memories, fixed decision process, multiple learning mechanisms
- Supported by decades of work in cognitive psychology and cognitive architecture research






Behavior
Behavior
Software
Run Time System
Application Software
Computer Architecture
Computer Hardware
Knowledge and Goals
Task Specific
General Capabilities
Cognitive Architecture
Computer Hardware

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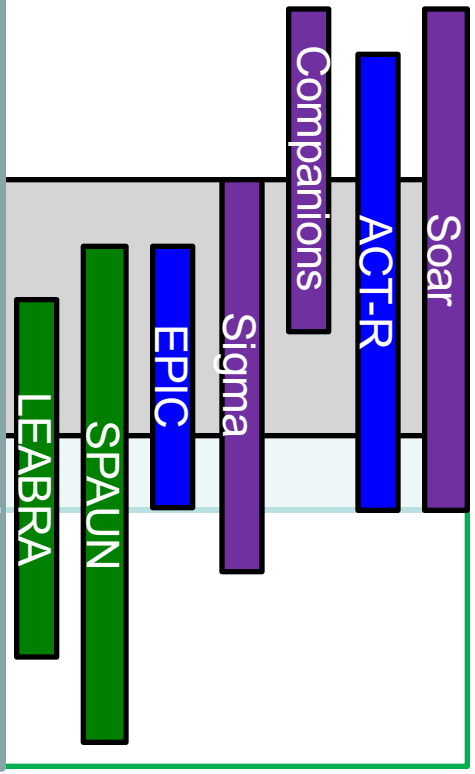
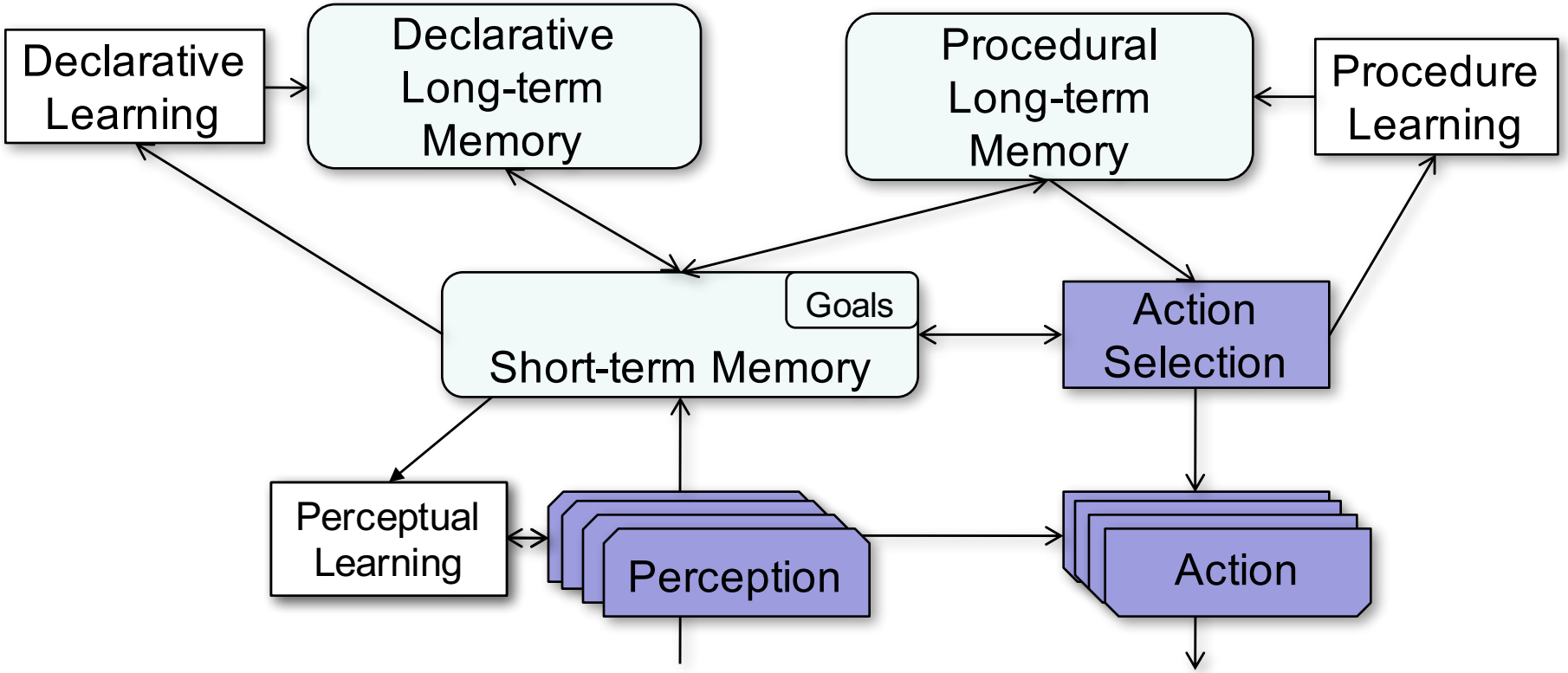


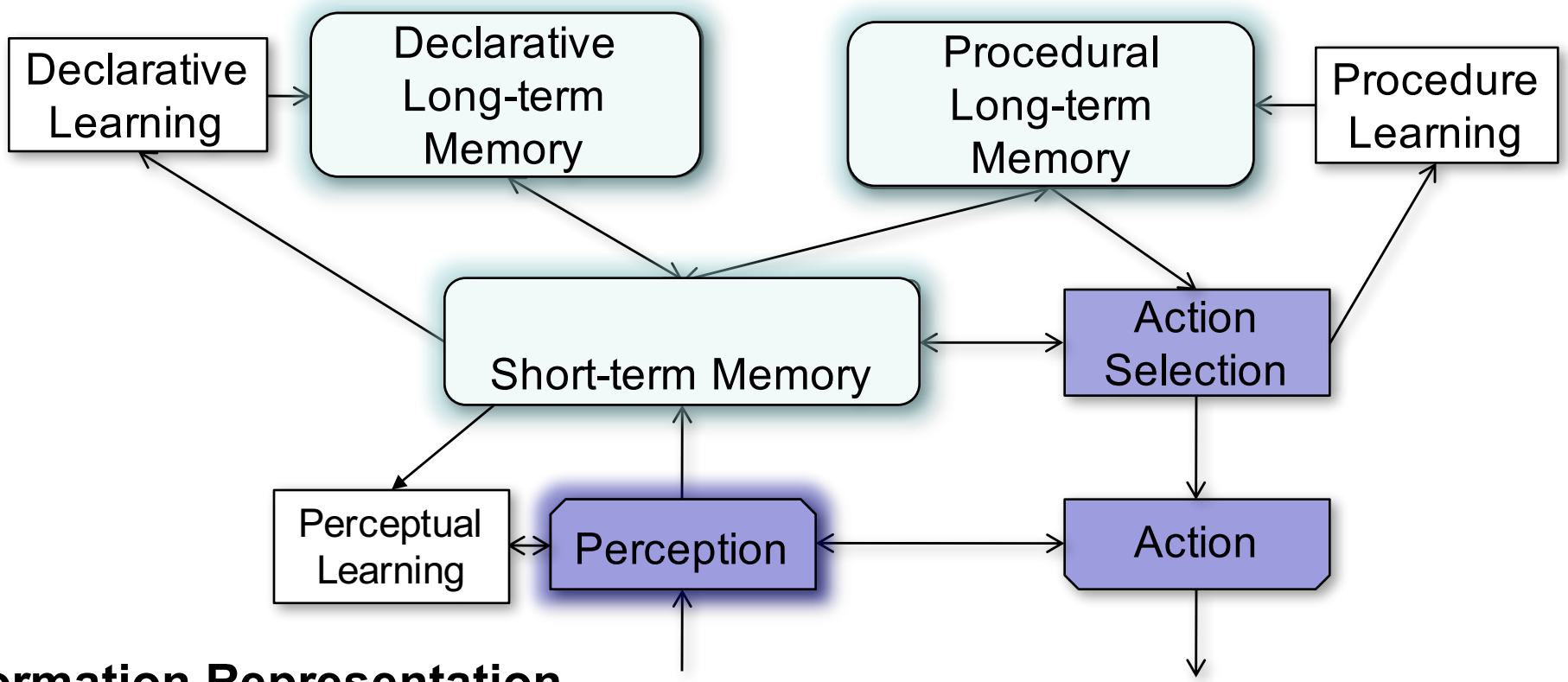
Standard Model of Cognitive Architecture



Organization

- Task-independent modules:
  - memories, learning, decision, perception, motor, …
- Task-dependent content:
  - knowledge
- Architectural metadata not accessible to task knowledge

Standard Model of Cognitive Architecture



Information Representation

- Perceptual data:
  - Probabilistic/statistical converted to symbolic
- Short-term memory:
  - Symbolic relational structures with statistical metadata
- Long-term declarative memories:
  - Symbolic relational structures with statistical metadata
- Procedural memory:
  - Symbolic rules with statistical metadata

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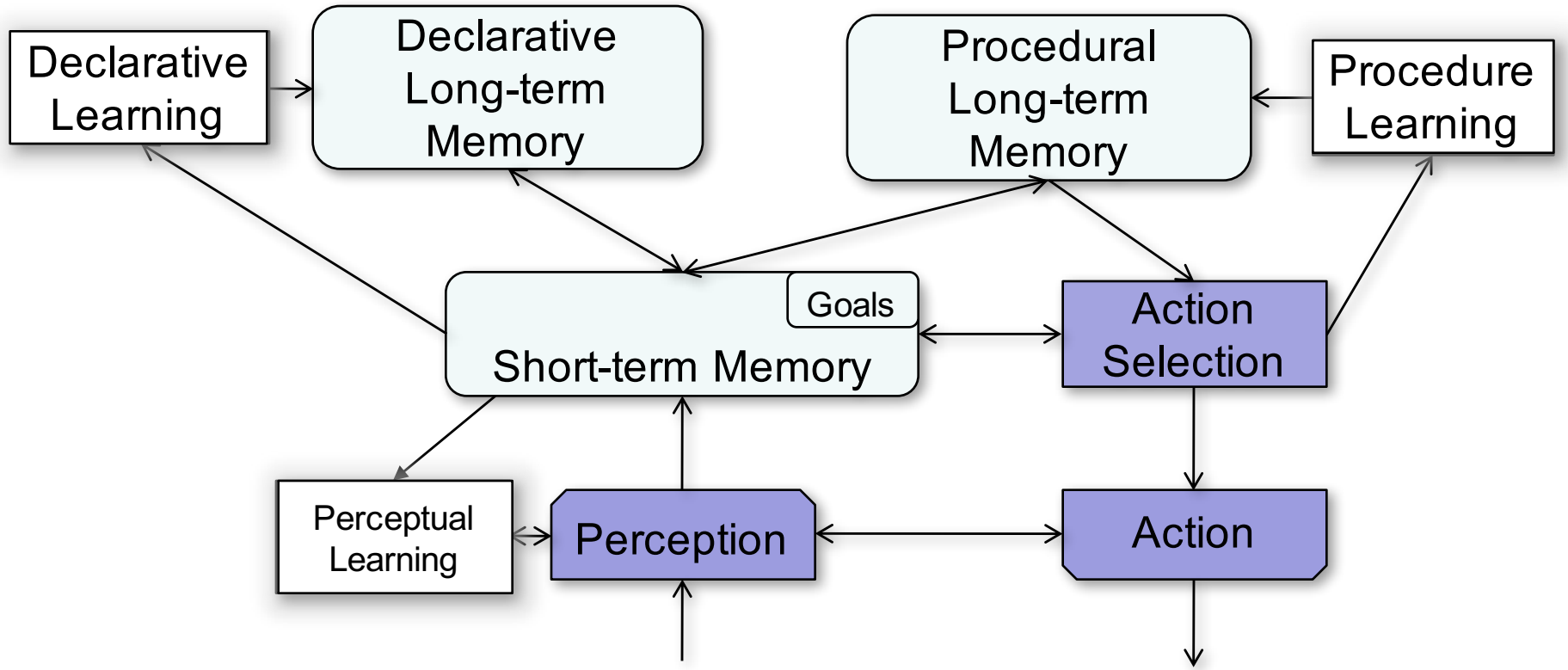

Processing

- Long-Term Memory Access: Associative asynchronous retrieval
- Performance: Single thread of decisions that are controlled by procedural memory
  - 50msec cycle time to model human cognition
  - Complex behavior arises from sequences of simple decisions
- Learning: Multiple, memory-specific algorithms that are on-line and incremental
  - Skill learning, declarative learning, reinforcement learning, activation tuning, …

Expanded Architecture