

# **Future Memory Research in Soar**

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# Outline

## **1. Retrospective**

- Episodic
- Semantic

## **2. Next Steps**

- Top 3
- Episodic
- Semantic

# Retrospective *Episodic Memory*

Nuxoll (ICCM '04, AAI '07, CSR '12)

- Why is EpMem useful? (cognitive capabilities)
- How to integrate EpMem within a cognitive architecture?

Xu (AAAI '10)

- How can an agent make use of EpMem to develop action models?

Gorski (CSR '11)

- To what degree can an agent learn to use EpMem?

Derbinsky, Li (ICCBR '09, AAMAS '12, AAI '12ab)

- What are efficient & scalable algorithms for EpMem?
- To what extent are they effective and efficient across a variety of tasks over long periods of time?
- To what extent do they facilitate other cognitive processes?

# Retrospective

## *Semantic Memory*

Derbinsky (ICCM '10, AAI '11)

- Architectural integration [Wang; ACT-R]
- How to efficiently retrieve knowledge from large semantic stores?
- How to effectively and efficiently bias ambiguous retrievals?

Li, Derbinsky (AAAI '12)

- To what extent does SMem facilitate other cognitive processes?

# Next Steps

## *Top 3*

### **Episodic**

1. Diverse usage and evaluation
2. Bounded storage – explore interactions with retrievals, recognition, semantic learning, consolidation...
3. Dynamically representing, reasoning about, and learning from events

### **Semantic**

1. Diverse usage and evaluation
2. Automatic encoding – explore interactions with recognition, retrievals, episodic consolidation...
3. Building up and reasoning over hierarchical semantic knowledge

# Next Steps

## *Episodic Memory: Architecture (1)*

### **Encoding**

- How to provide effective episodic capabilities for continuous modalities (e.g. visual)?

### **Storage**

- How to bound episodic-memory growth while maintaining effective retrievals and support for other processes (e.g. recognition, semantic learning)?

# Next Steps

## *Episodic Memory: Architecture (2)*

### **Retrieval**

- Beyond cardinality [and WMA], what are effective indicators of relevance across a variety of tasks (e.g. appraisals, LTI spread)? Efficient support?
- What are effective methods to bound per-decision episodic processing (e.g. heuristic search, anytime)?

### **Integration**

- Long-term spatial-visual memory (SVS)
- Consolidation to semantic memory
- Support for meta-cognitive processes (e.g. recognition)

# Next Steps

## *Episodic Memory: Agents*

### **Reasoning**

- How does an agent learn to utilize and weight retrievals with other sources of [possibly conflicting] knowledge?
  - Meta-knowledge about [possibly flawed] retrieval processes?
- How can an agent build up, reason about, and describe “events” from primitive episodes (could be architecture)?

### **Efficiency**

- What are useful types of episodic queries across a variety of tasks? Better task/cue analysis -> better heuristics/ approximations!



# Next Steps

## *Semantic Memory: Architecture (1)*

### **Encoding**

- What is the source of new LTIs (e.g. environmental/episodic regularities)?

### **Storage**

- Is it useful to forget LTIs?

# Next Steps

## *Semantic Memory: Architecture (2)*

### **Retrieval**

- Besides history of past use, what are effective indicators of relevance (e.g. context)? Efficient support?

### **Integration**

- Support for meta-cognitive processes (e.g. recognition)

# Next Steps

## *Semantic Memory: Agents*

### **Representation**

- What are useful representational paradigms for LTI augmentations?
- To what extent are semantic concepts “grounded?”

### **Reasoning**

- How does agent reasoning lead to hierarchical semantic knowledge?
- What are general-purpose “inference” rule sets would be efficient and useful across a variety of tasks?  
Linguistic rule sets?

# Evaluation

## Nuggets

- EpMem and SMem have come a long way
  - Useful and efficient today!
- There are many opportunities for important progress in these mechanisms

## Coal

- Research takes time