Towards Improving Soar's Episodic Memory

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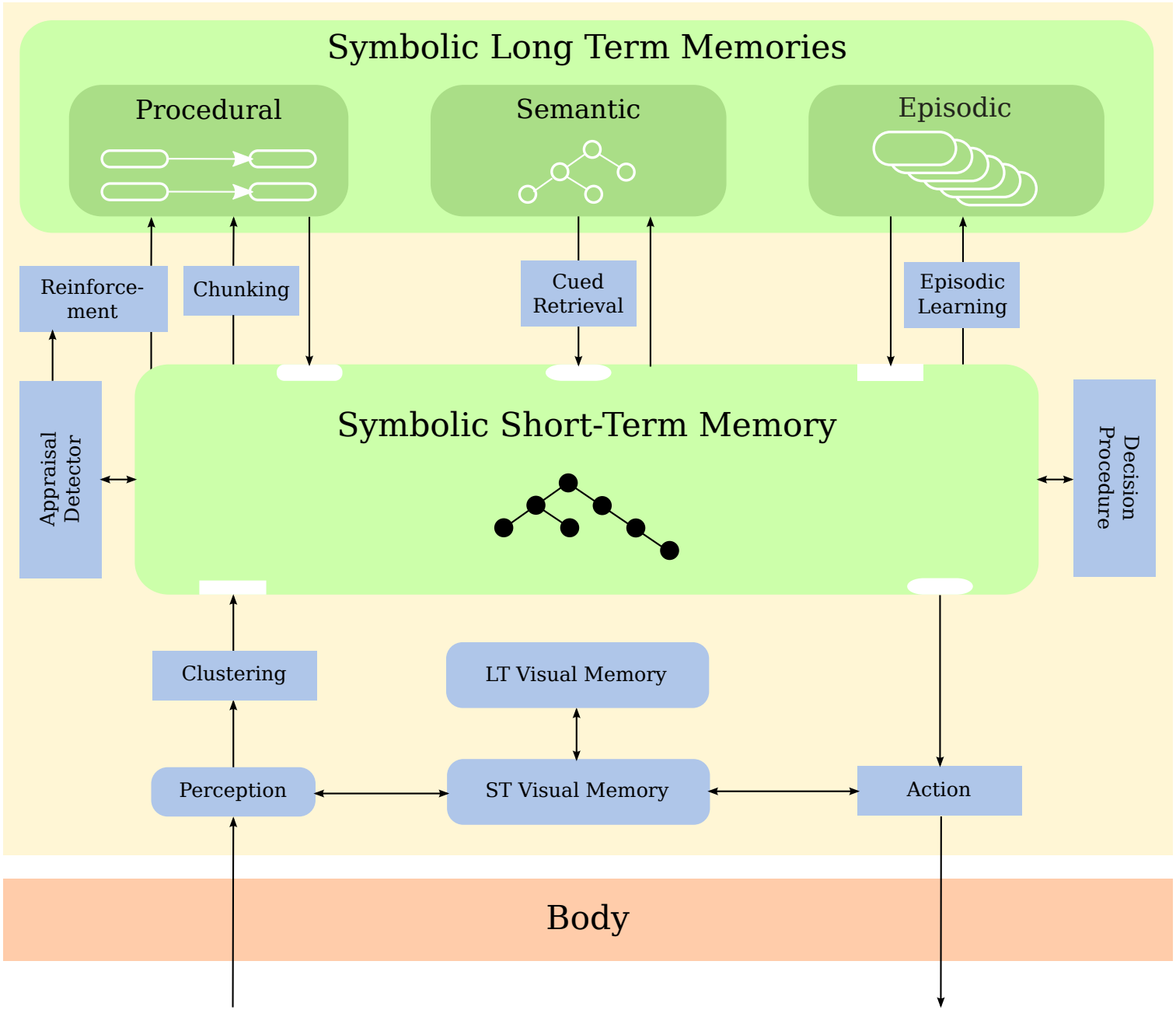
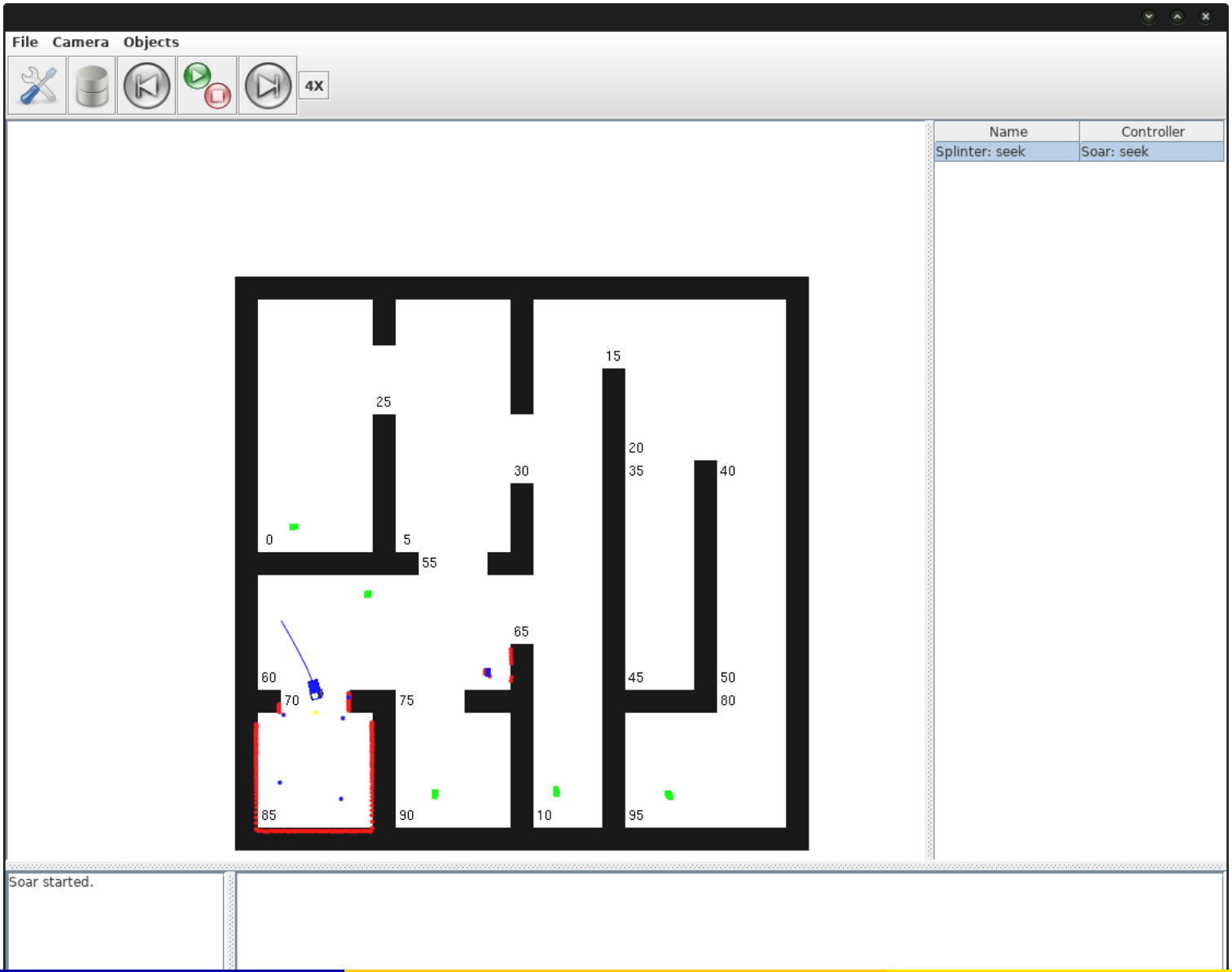

Symbolic Long Term Memories
Procedural
Semantic
Episodic
Reinforce-ment
Chunking
Cued Retrieval
Episodic Learning
Appraisal Detector
Symbolic Short-Term Memory
Decision Procedure
Clustering
LT Visual Memory
Perception
ST Visual Memory
Action
Body

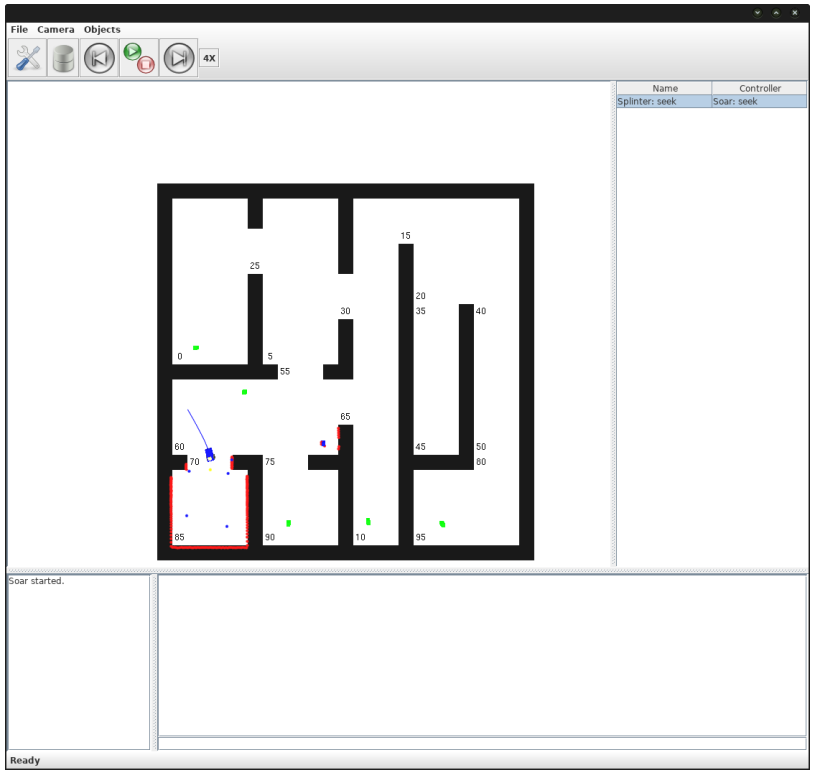
Overview

RoomsWorld Domain https://github.com/SoarGroup/Domains-RoomsWorld



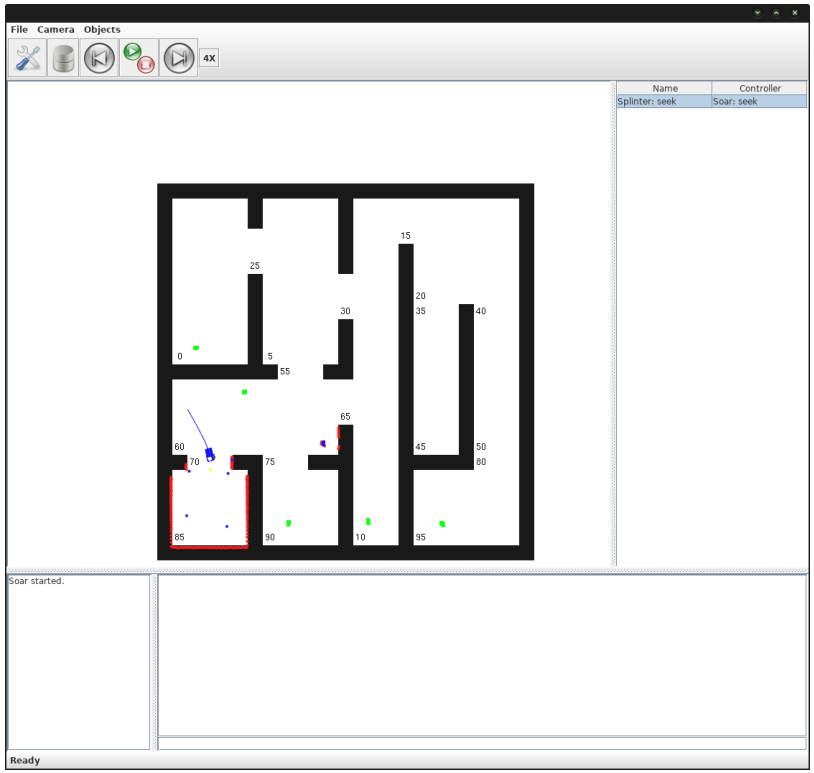
Squirrel Patrol

- Robot goes in circles



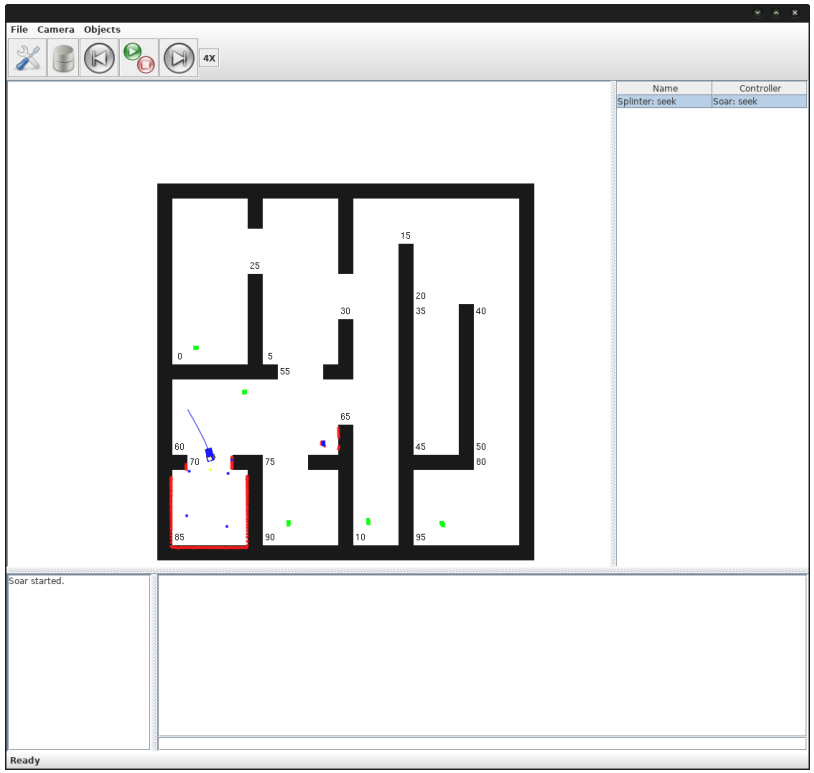
Squirrel Patrol

- Robot goes in circles
- A squirrel runs by



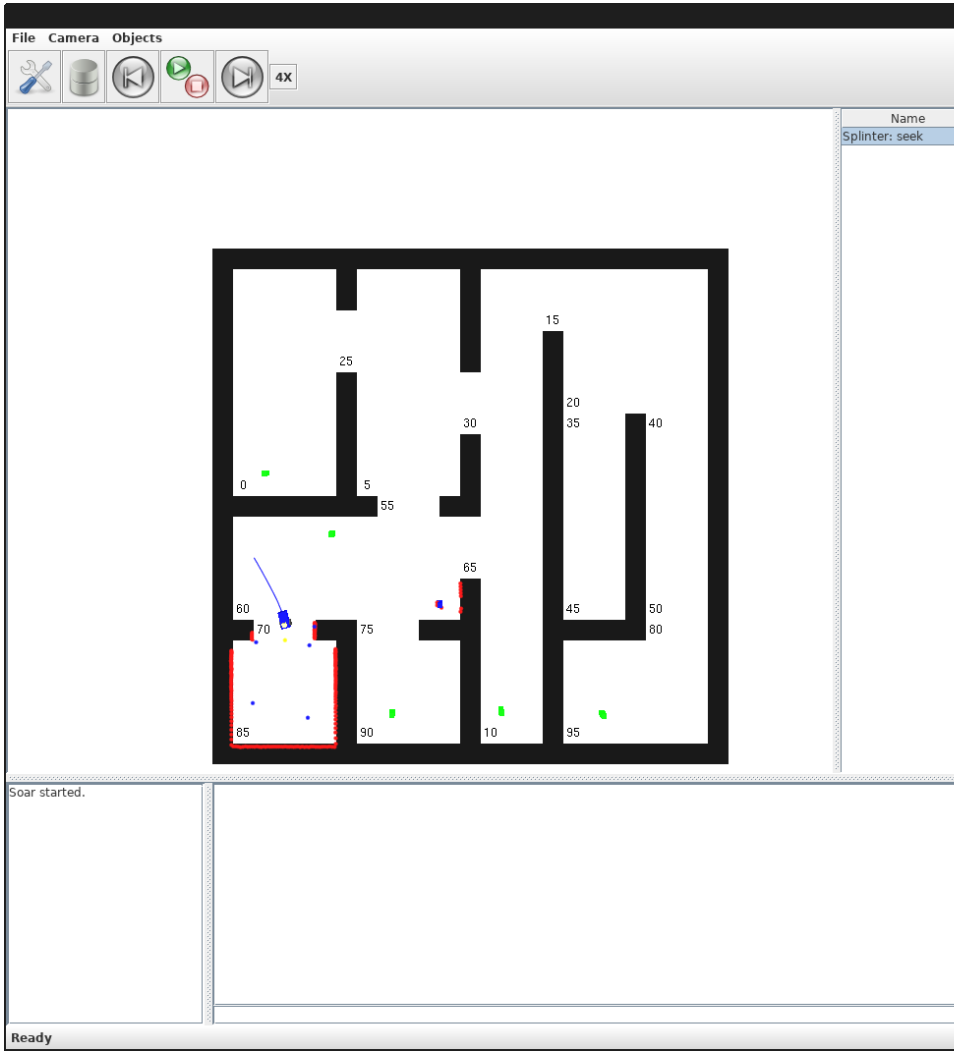
Squirrel Patrol

- Robot goes in circles
- A squirrel runs by
- Soar agent asked to summarize the patrol



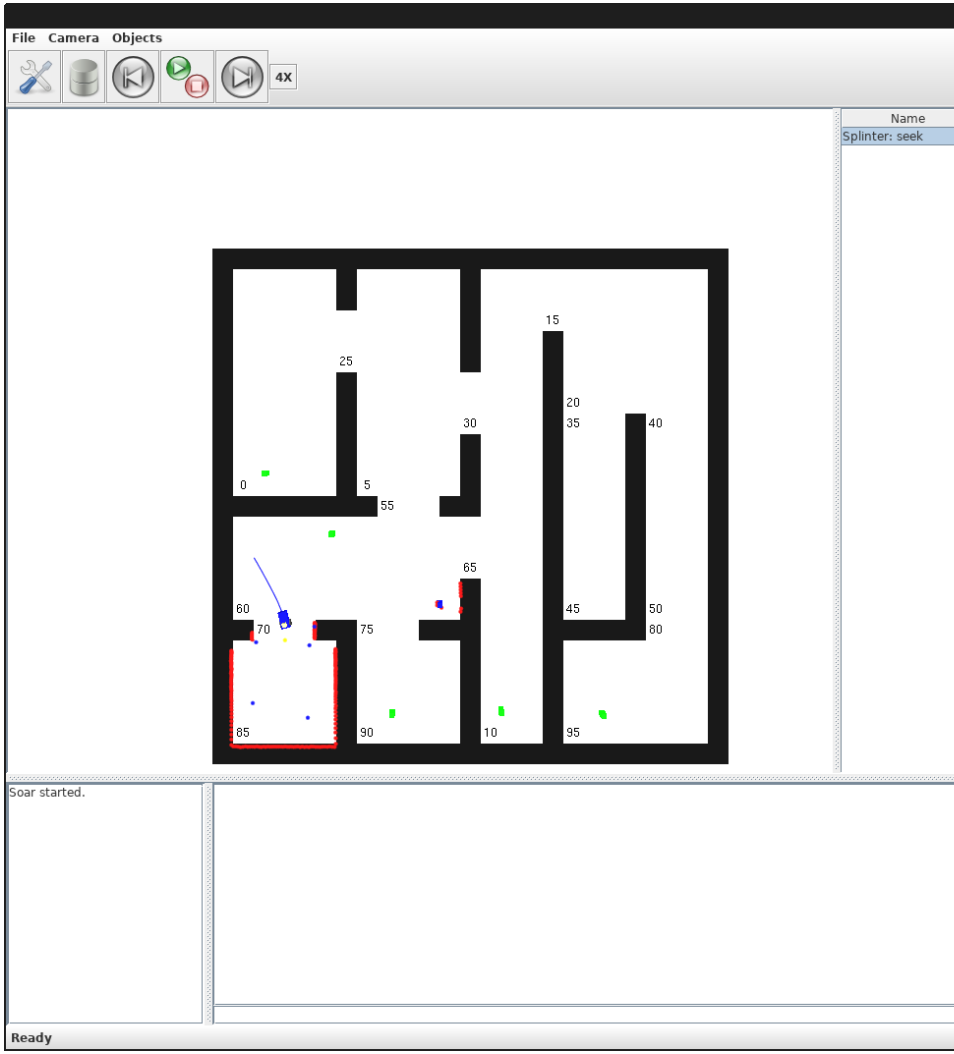
Bored Robot

- Robot is en route to room



Bored Robot

- Robot is en route to room
- Soar is just waiting



Background

Others' Soar Workshop EpMem Ideas

- "Integrated Episodic and Semantic Memory in Robotics" (Furtwangler 2013)
  - retrieve only parts of state
- "Experimental Episodic Memory Features" / "Planned Extensions to Episodic Memory" (Marinier 2014)
  - filtered construction in retrieval
- "Efficient Episode Recall and Consolidation" (Nuxoll 2014)
  - hashing episodes with ever-growing list of features
- "Mining Episodic Memory" (Derbinsky 2015)
  - summary
  - forgetting
  - event recognition
  - spontaneous retrieval
  - elaboration learning

What Could EpMem Be For? (Seems like everything)

- Memory: Encoding, Storage, Recall
- Prediction
- Generalization/Summary
- Anomaly Detection

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Difficult to conceptualize EpMem as distinct from "temporal memory"
Full "heirarchical temporal memory" problem is hard

EpMem for Summary

Summary of the Squirrel Patrol

"What have you done today?" (Assume agent has patrolled before.)

Current Soar:

- First, I issued a command to move towards intersection "A".
- Then, I began waiting until I encountered intersection "A".
- Then, I continued to wait.
- Then, I turned right at intersection "A".
- Then, ...

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Ideal Soar:

- "I patrolled the designated loop three times. On the second loop, a squirrel passed in front of my path."

Speculation: How to change EpMem for Summary?

- New summary mechanism ($\Longrightarrow$ new knowledge)
- New retrieval for data structures created by mechanism
  - Cue type 1: a,b time bounds
  - Cue type 2: last n events
  - Result: hierarchical "episodes" indexed by "next" and "expand"
    - "expand": single symbol representing succession of lower-level episodes

Current Candidate for Summary Mechanism

- Sequitur: turns redundancy into hierarchy
  - sensitive to noise
    - Soar graph states are noisy

EpMem for Prediction

Prediction for Bored Robot

(Robot waiting as it moves towards room)

Current Soar:

- Option 1: wait

Ideal Soar:

Prediction for Bored Robot

(Robot waiting as it moves towards room)

Current Soar:

- Option 1: wait
- Option 2: Manual retrieval for previous room entry episode.

Ideal Soar:

Prediction for Bored Robot

(Robot waiting as it moves towards room)

Current Soar:

- Option 1: wait
- Option 2: Manual retrieval for previous room entry episode.

Ideal Soar:

- Spontaneous retrieval for generalized room entry event

Speculation: How to change EpMem for Prediction?

- New sequence matching mechanism
  - Cue type 1: "none", (spontaneous retrieval based on last "n" states)
  - Cue type 2: agent-specified succession of WM graphs
    - Current EpMem cue structure, but > 1 cue
  - Result: hierarchical episode subsuming the cue.

Current Candidate for Sequence-Matching

- Bioinformatics-style sequence matching[1]
- Match what to what?
  - WMem changes to WMem changes
    - noisy...

[1] inspired by JG Wolff's "SP"

EpMem Input: Stream of WME "change sets"

Each decision cycle: one set of WMEs, noisy

- Similarity measure?
  - nonparametric clustering over all WMem "leaf" values
- Event detection?
  - estimate entropy of WME stream?

Nuggets and Coal

Nuggets

Coal

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Nuggets

- If methods work - prospective episodic memory for Soar

Coal

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- Approaching unified picture for motivating improvement to EpMem

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- Speculative

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Coal

- Speculative
- Lots of new codependent "moving parts" (plenty of room for failure)