Memory Consolidation: Some Initial Exploration

Mazin Assanie
University of Michigan
33rd Soar Workshop
mazina@umich.edu

Motivation

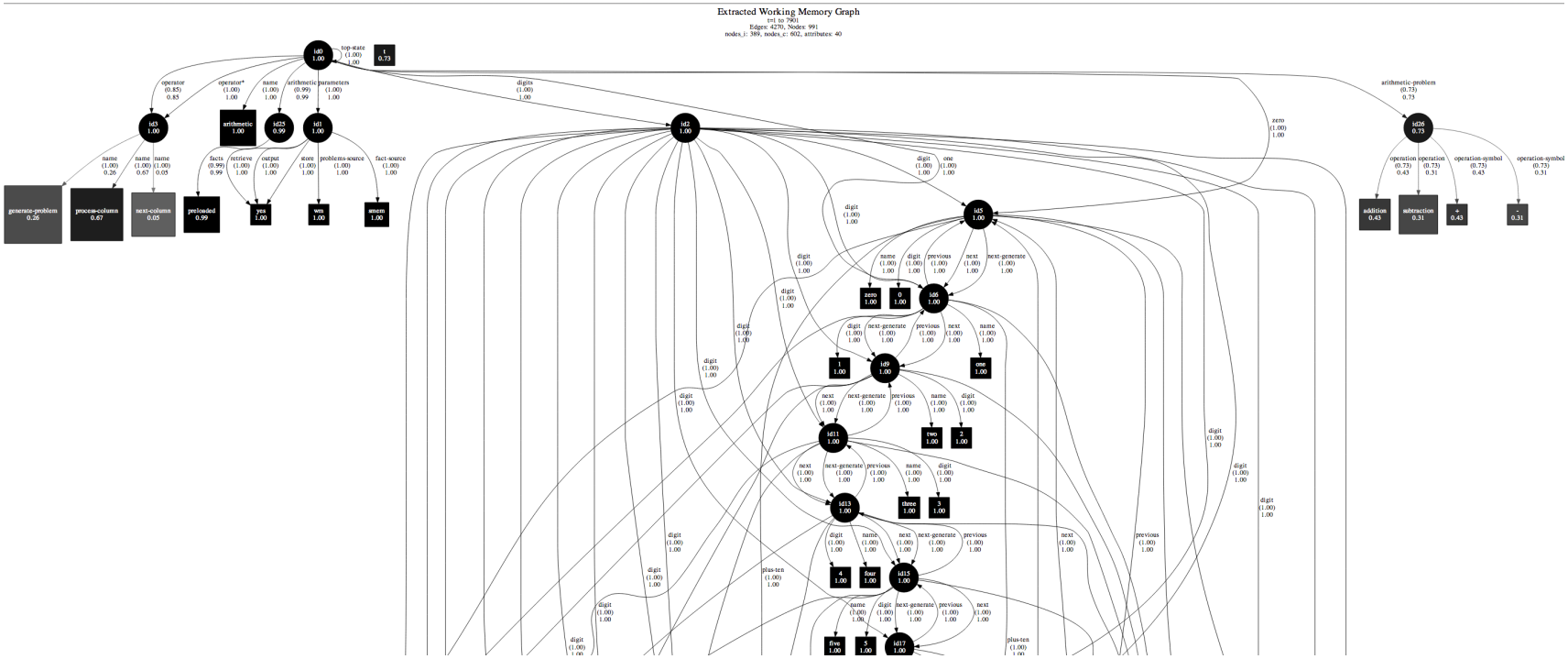
- We do not have a theory on how we gain semantic knowledge
- We don't have an automated mechanism for acquiring semantic knowledge like we do with short-term, episodic and procedural memory.
- There is a lot of potential knowledge in an agent's experience that may be difficult for an agent to deliberately learn.

Hypothesis

- There is implicit structure in an agent's knowledge that, coupled with usage statistics, can be used to automatically extract useful knowledge structures without necessarily requiring deliberate reasoning.

Working Memory Graph

Directed graph representing all working memory elements the agent has ever seen and when it saw them.



Current Status

- We've developed a module within Soar to allow us to run experiments and analyze the working memory graph while running an agent
  1. Calculates statistics on nodes and edges in the WMG
  2. Performs arbitrary filters on the WMG
  3. Results immediately visualized in GraphViz, printed out or stored in semantic memory

MemCon Module

```
% con
========================================
     Semantic Memory Consolidation
========================================
-------------- Strategy ---------------
filter:                      persistence
threshold:                         0.025
episode start:                         0
episode end:                           0
--------------- Output ----------------
output:                              viz


Syntax: consolidate analyze [start] [end]
        consolidate [init|debug|print]
        consolidate [set|get] [filter|threshold|start|end|output]

% con a
MemCon| Using default episode start of 1.
MemCon| Using default episode end of 7901.
============================================
   Running Memory Consolidation Experiment
============================================
---------------- Parameters ----------------
filter:                            persistence
threshold:                               0.025
episode start:                               0
episode end:                                 0
MemCon| Creating wme 1:  0 ^operator* 3 (i-node)
MemCon| Creating i-node 0 (<id0>).
MemCon| Connecting i-node 0 to child i-node 3
MemCon| Adding node 3 to child_i_nodes for i-node 0
MemCon| Creating attribute 1 (operator*)
```

Strategies

- Usage properties of knowledge
  - **Activation**
  - **Persistence**
  - *History of semantic memory queries*
- *Structural properties of knowledge*
  - *Where does a particular structures come from*
    - *Leverage properties we know about that kind of knowledge*
- *Other learning algorithms*

Evaluation

- Accuracy: How closely the structures learned map to structures or concepts in the real world.
  - We know the answers, so easy to measure.
- Utility: How often the agent is able to successfully request and use the semantic knowledge that came from these mechanisms.

Nuggets and Coals

- **Nuggets**
  - Unexplored area. Many possible strategies.
  - Could lead to new, useful architectural learning mechanism
- **Coals**
  - Unexplored area. Many possible strategies.
  - Lots of difficult knowledge types: hypothetical, transient, housekeeping knowledge.
  - May need unified activation.
  - Soar has no sense of time, which may be needed.