Spontaneous Retrieval for Prospective Memory

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What is Spontaneous Retrieval?

An automatic, cue-less retrieval from long-term memory

- the original motivation for spreading activation work in Soar

This talk:

- How does spontaneous retrieval work?
- What are the benefits of spontaneous retrieval?
  - Generally?
  - For prospective memory?

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- Instead of “deliberate”, retrieval is “spontaneous” every decision cycle
- Instead of “cued”, retrieval is selected only on base-level and spreading
  - the most activated element is retrieved
- Instead of the SMem buffer... actually, it’s the same the SMem buffer
  - retrieval only occurs when SMem is not in deliberate use

Theoretical Benefits of Spontaneous Retrieval

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Claim Spontaneous retrieval allows an agent deal with:

1. not knowing *what cue to use*
2. not knowing *when time to initiate search*

The Missing Link Puzzle

Find a word that forms compound words with all of the clue words

- Clue (*Stems*): fall, fort, time

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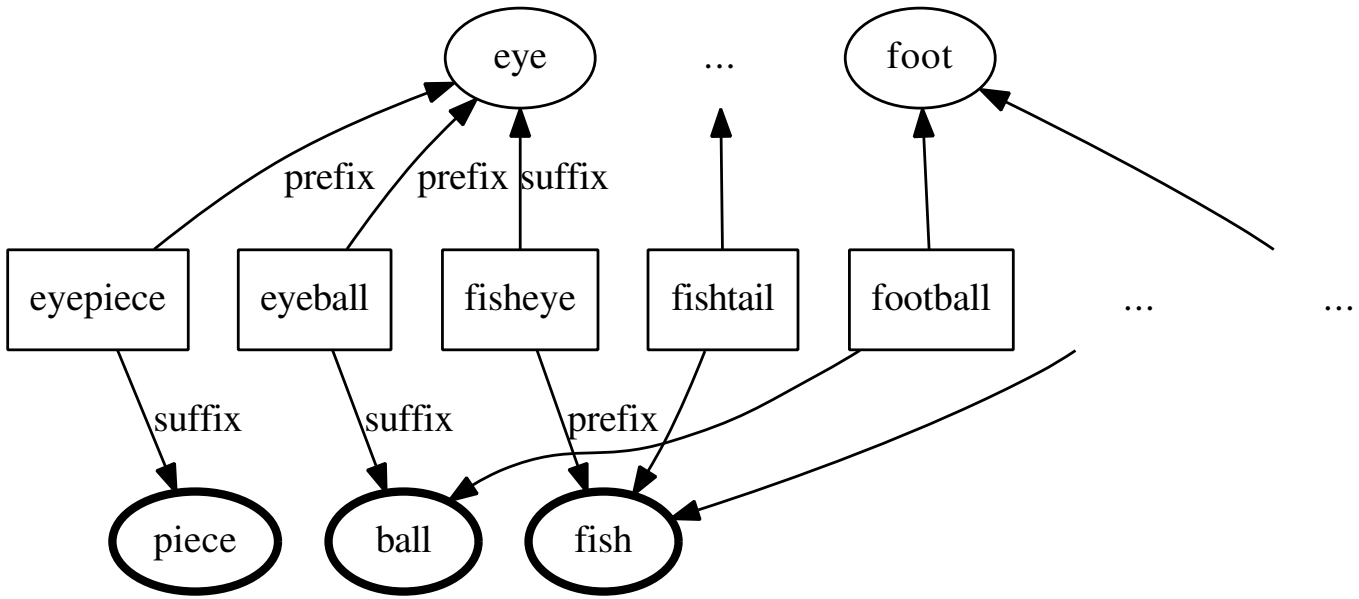
- Stems: ball, fish, piece
- Answer: eye (eyeball, fisheye, eyepiece)

Missing Link Domain



Missing Link Strategy

1. Use *ball* and retrieve all its compound words
   handball, *football*, *eyeball*, ...
2. Use *fish* and retrieve all its compound words
   fishtail, *fisheye*, ...
3. Find common links
   $eyeball \cap fisheye = eye$
4. Check if *piece* also forms a compound word
   $eye + piece = eyepiece$
5. Give answer/Give up

Evaluate based on time taken, not correctness of answer

Unknown Search Cue

What if a puzzle has more than 3 stems?

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Instead of

- Stems: ball, fish, piece

The agent gets

- Stems: ball, boat, fish, land, piece

Unknown Search Cue: Results

What if a puzzle has more than 3 stems?

No. of Distractors	**Decision Cycles**		**Real Time (msec)**	
	Delib.	Spon.	Delib.	Spon.
0	56.1	24.5	2631.6	350.7
1	65.1	26.6	3048.6	341.4
2	70.9	28.2	5752.1	319.4
3	80.8	32.8	3679.1	613.5
4	84.5	40.0	**17591.5**	**840.0**

Unknown Search Initiation

What if not all puzzles are solvable?

Unknown Search Initiation

What if not all puzzles are solvable?

Instead of

- ...
- Stems: fall, fort, time
- Stems: ball, fish, piece
- ...

The agent gets

- ...
- Stems: fall, fort, drop
- Stems: ball, fish, piece
- ...

Unknown Search Initiation: Results

What if not all puzzles are solvable?

Probability Solvable	**Decision Cycles**		**Real Time (msec)**	
	Delib.	Spon.	Delib.	Spon.
1.0	56.1	24.5	2631.6	100.5
0.9	56.1	25.9	2602.9	159.6
0.8	55.5	27.6	2464.0	165.4
0.7	56.0	29.8	2555.8	178.0
0.6	55.9	30.5	2459.8	179.9
0.5	53.9	31.9	2099.2	186.5
0.4	51.4	35.3	1677.9	218.3
0.3	50.3	38.1	1574.2	247.0
0.2	49.5	40.0	1400.6	263.4
0.1	49.0	41.2	1324.1	264.3
0.0	47.8	42.7	**1099.5**	**316.8**

Summary

Spontaneous retrieval is a fallback heuristic when

1. it's unclear which features are relevant
2. it's unclear whether relevant knowledge exists

Positive results in the Missing Link domain support this claim

Prospective Memory

A “fuzzy set” of intuitions around “remembering to *do something* at a particular *moment (or time period) in the future*” (McDaniel and Einstein, 2007)

Five stages in completing a prospective task:

1. **Encoding** - asked to pass a message to John
2. **Retention** - perform other tasks
3. **Initiation** - see John
4. **Execution** - pass the message
5. **Completion** - remove goal from memory

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Key question: How does the agent know that a goal is relevant if the goal is in long-term memory?

Spontaneous Retrieval for Prospective Memory

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Prospective memory has:

- many non-goal-related features
- no indication of when a goal is relevant
- ... or if there is a relevant goal at all

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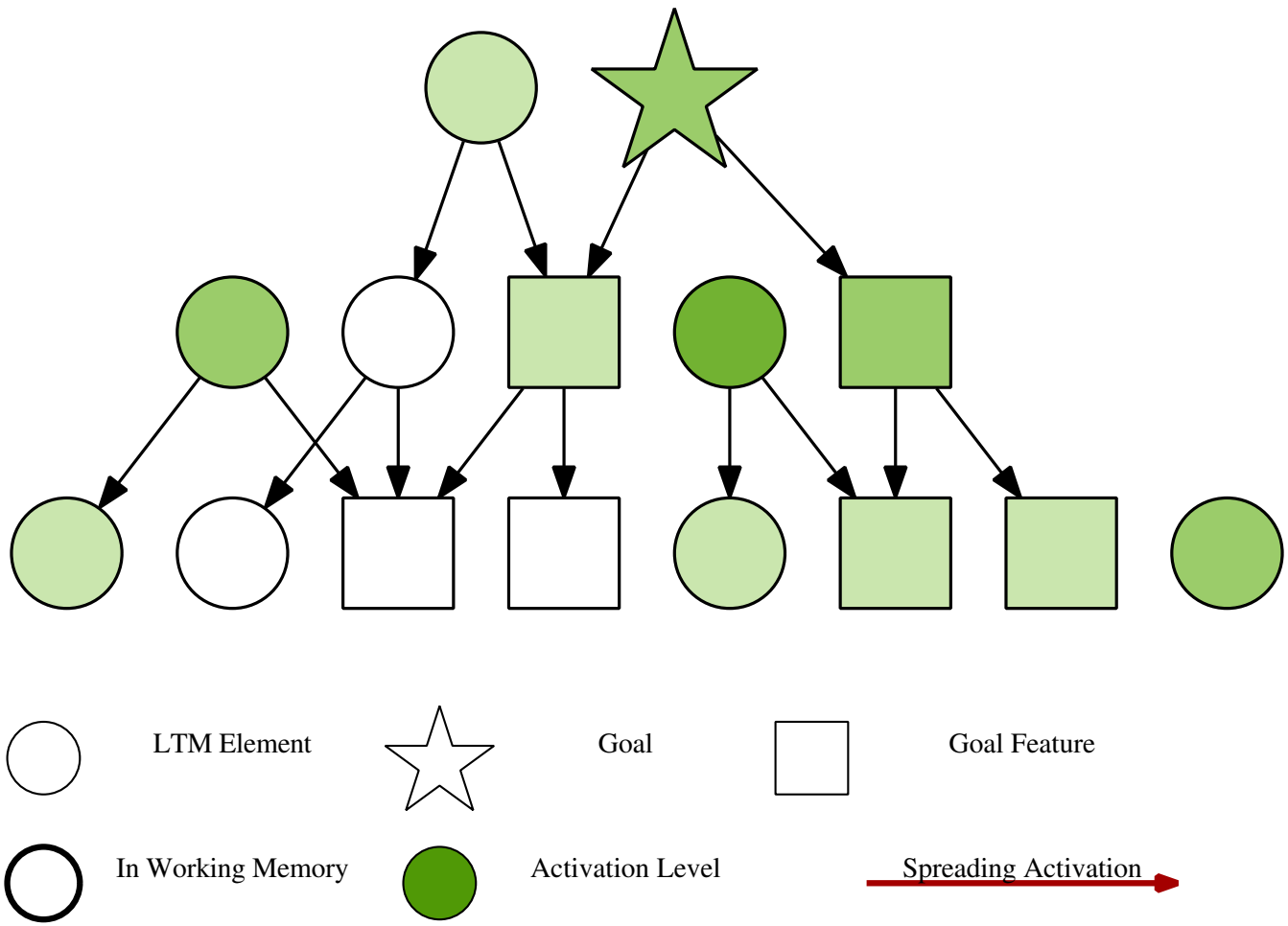
Spontaneous retrieval is good when:

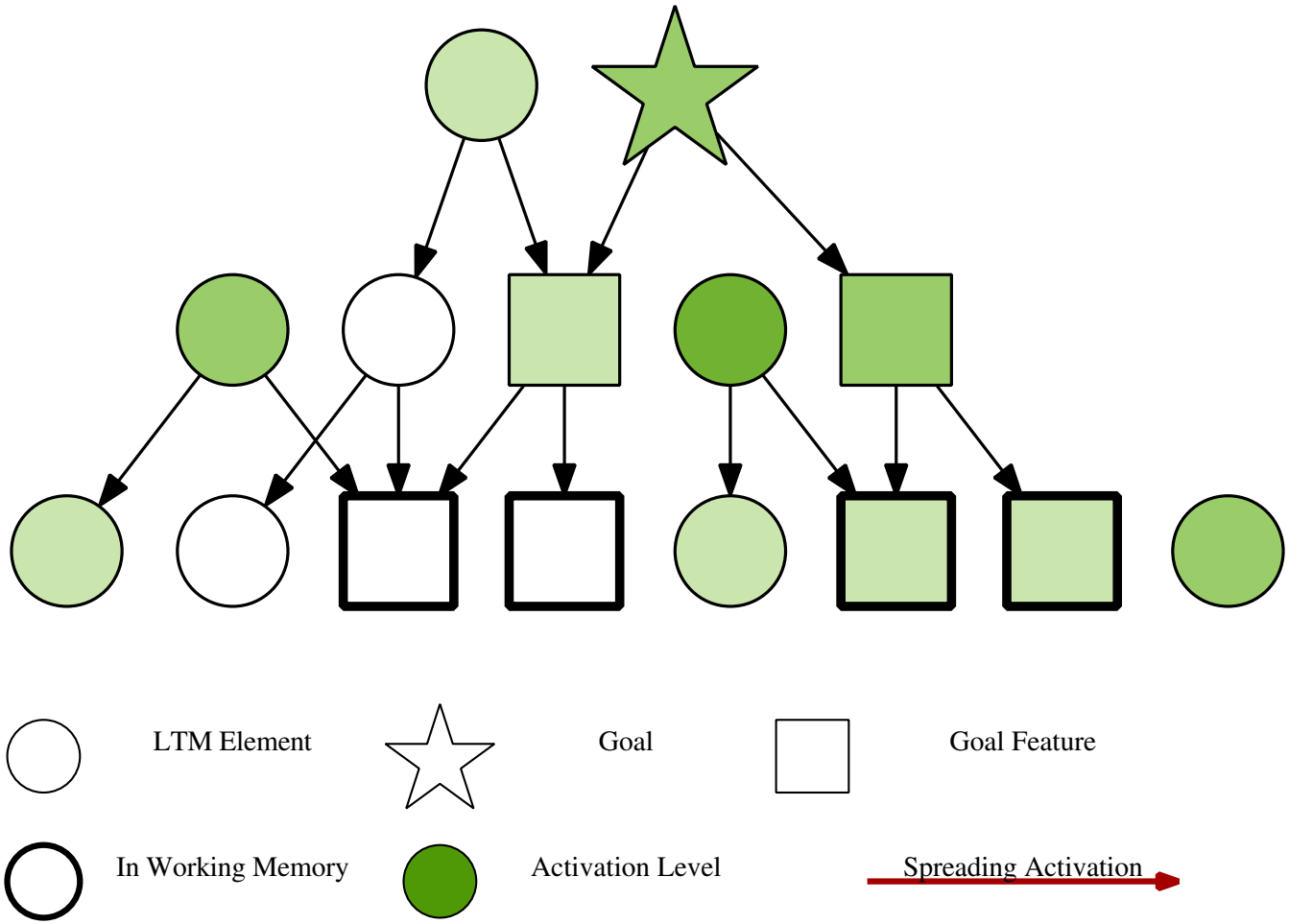
- it's unclear which features are relevant
- it's unclear whether relevant knowledge exists

Spontaneous Retrieval Example



Spontaneous Retrieval Example

Percepts enter working memory, causing activation boost



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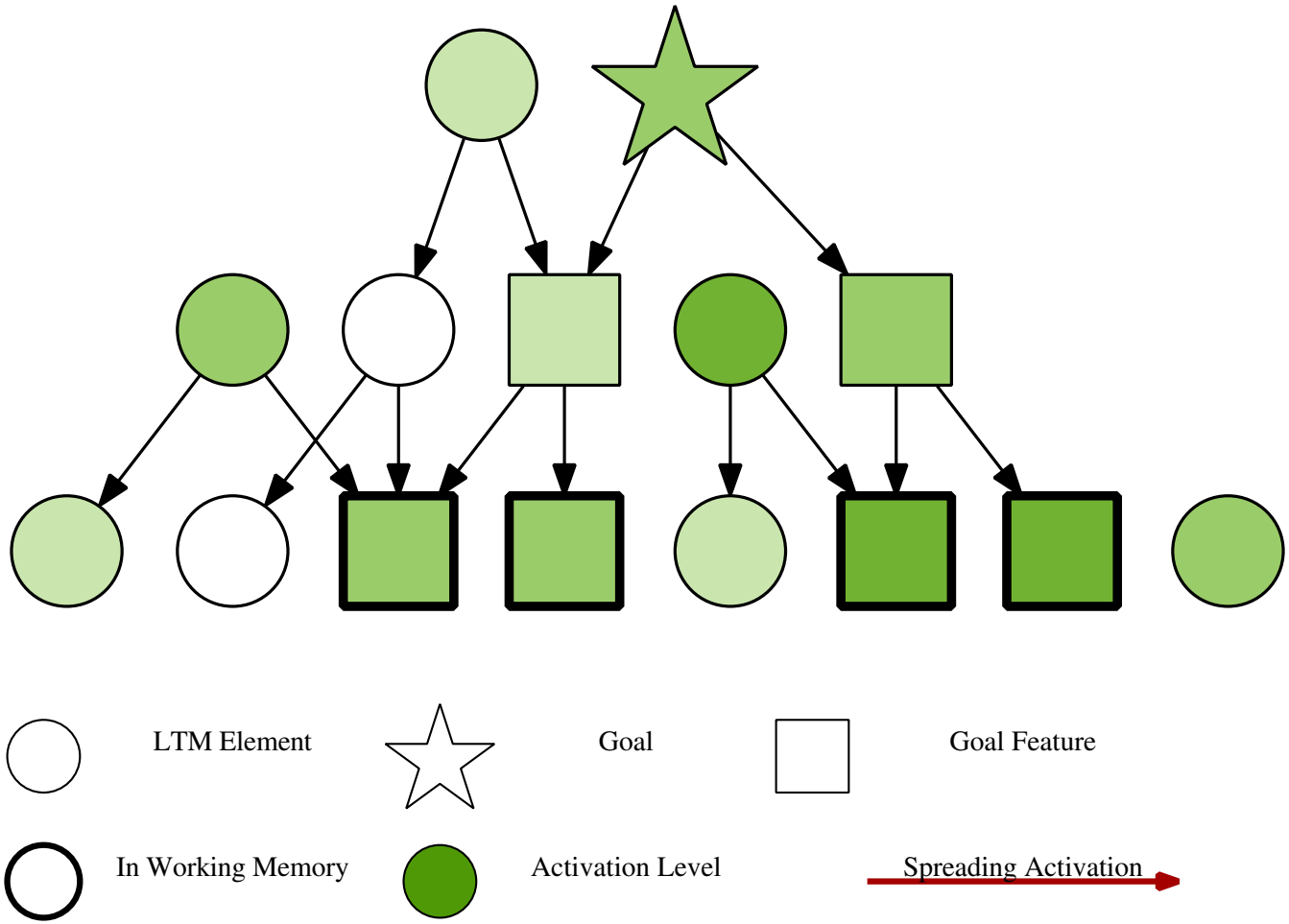

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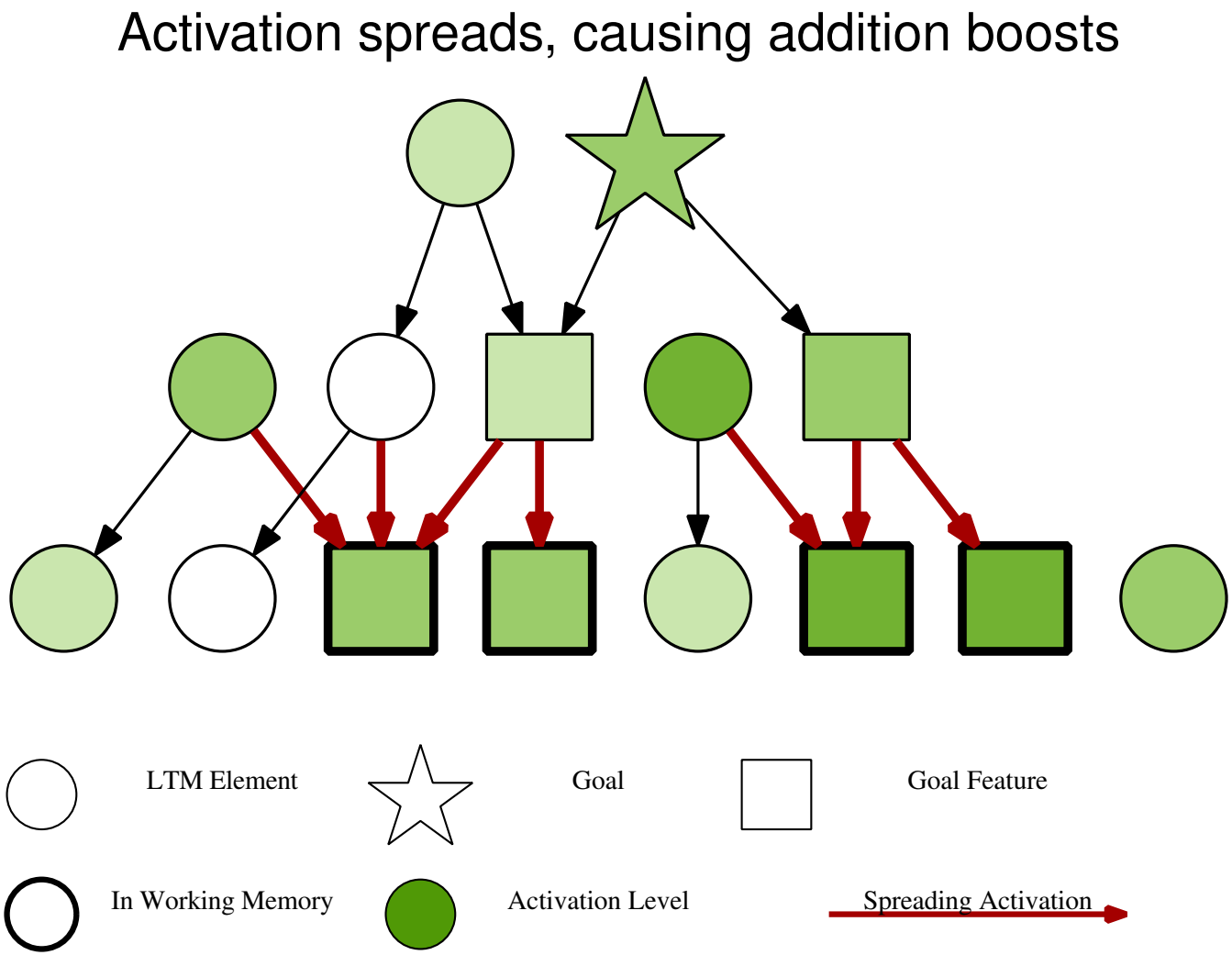

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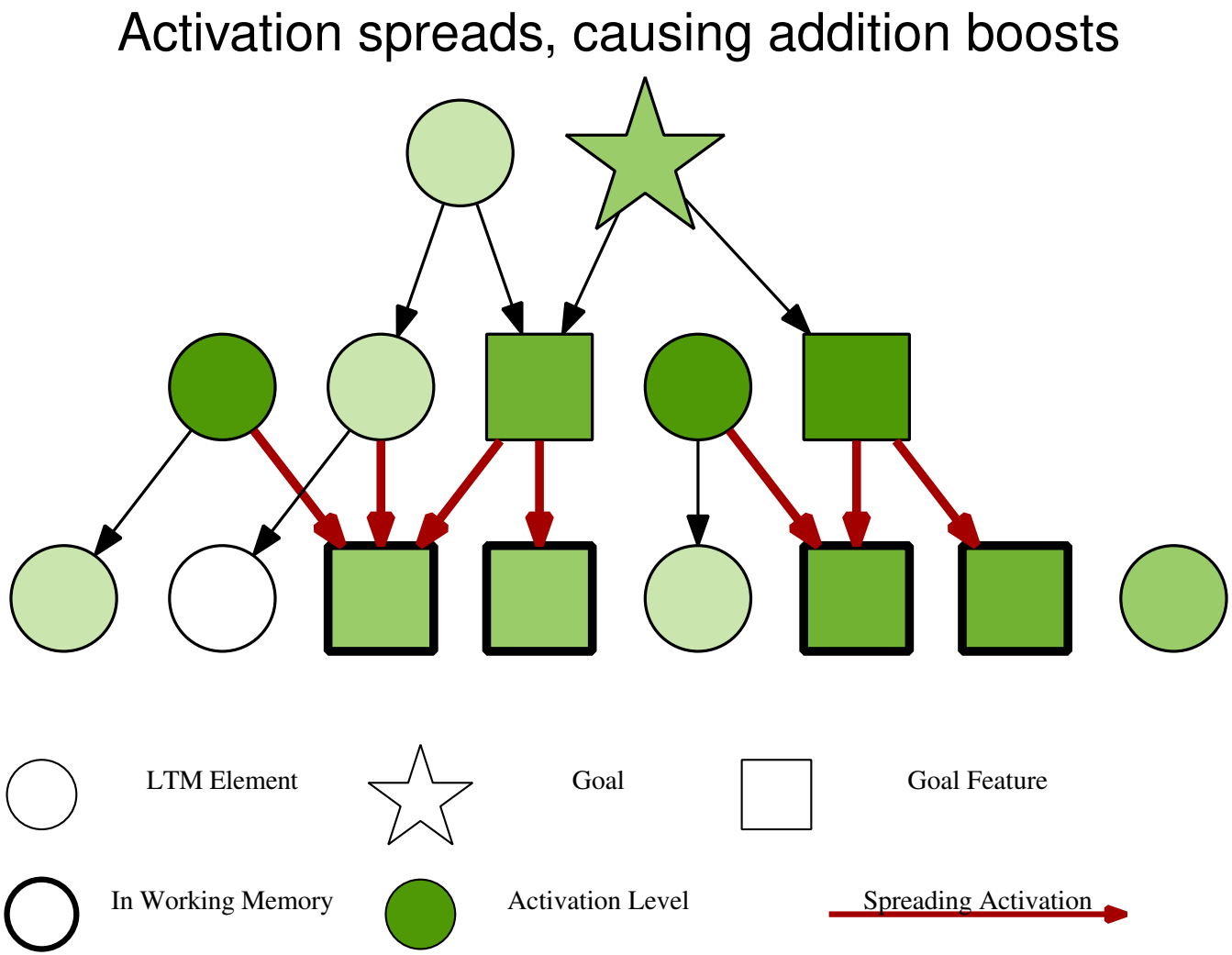

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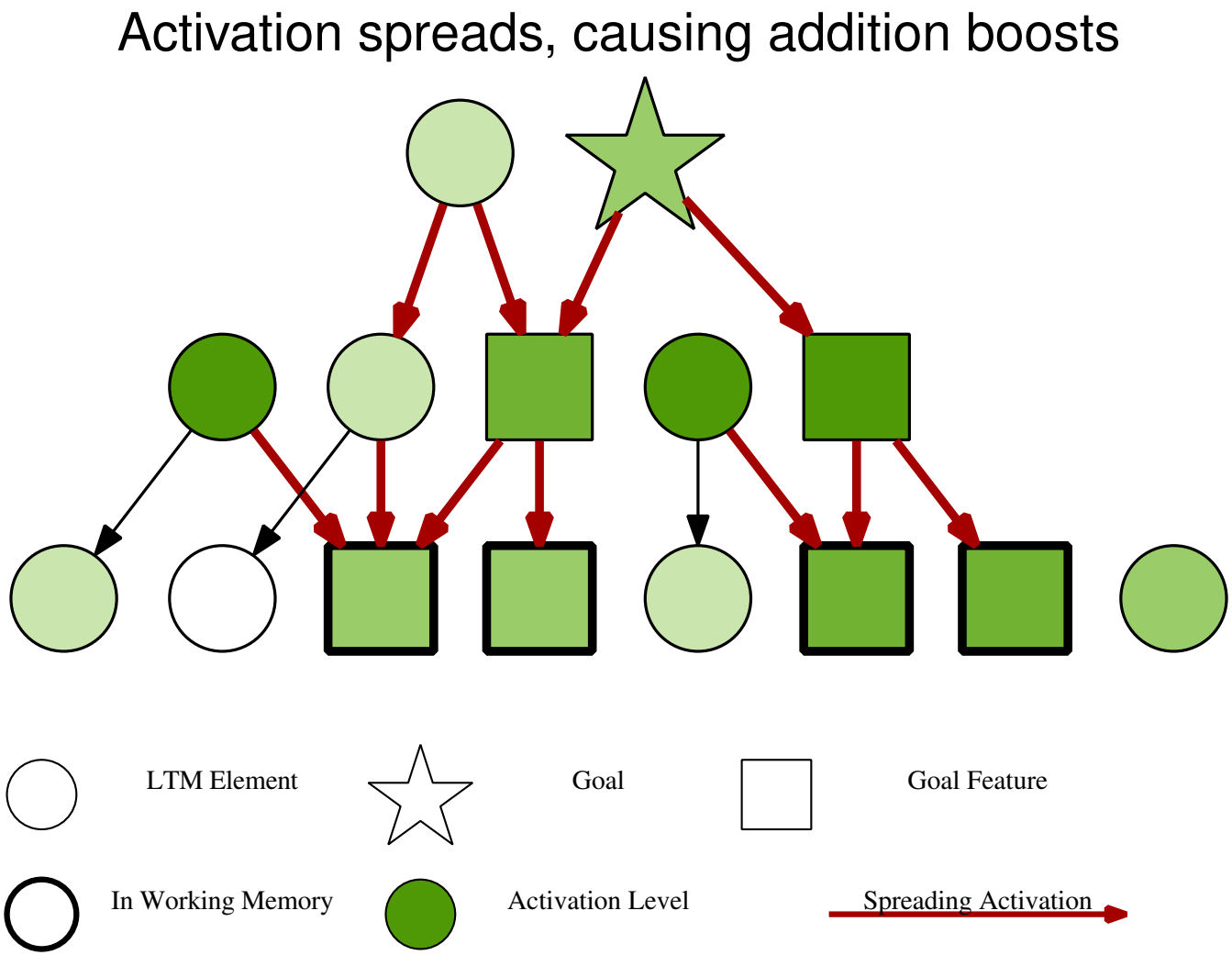

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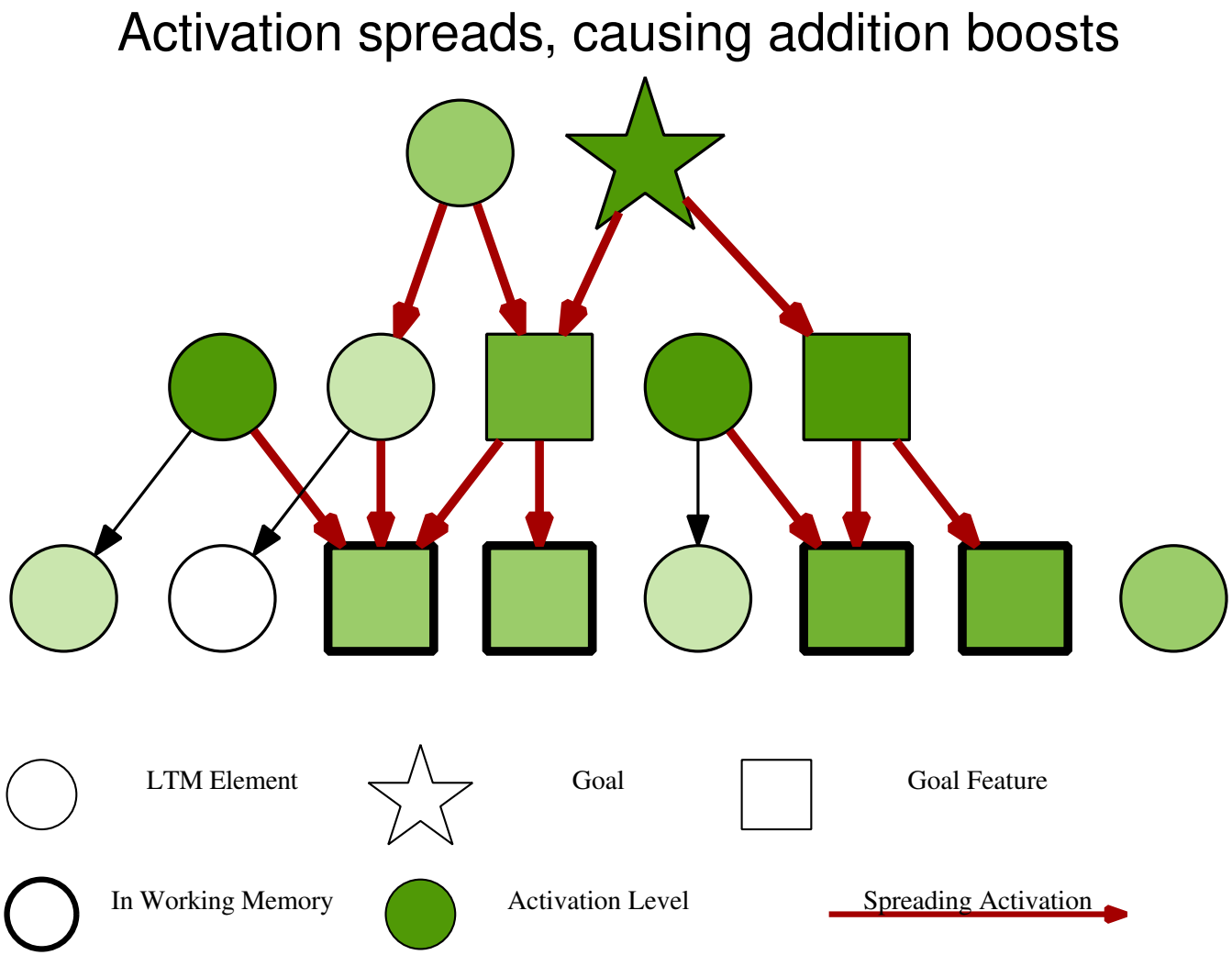
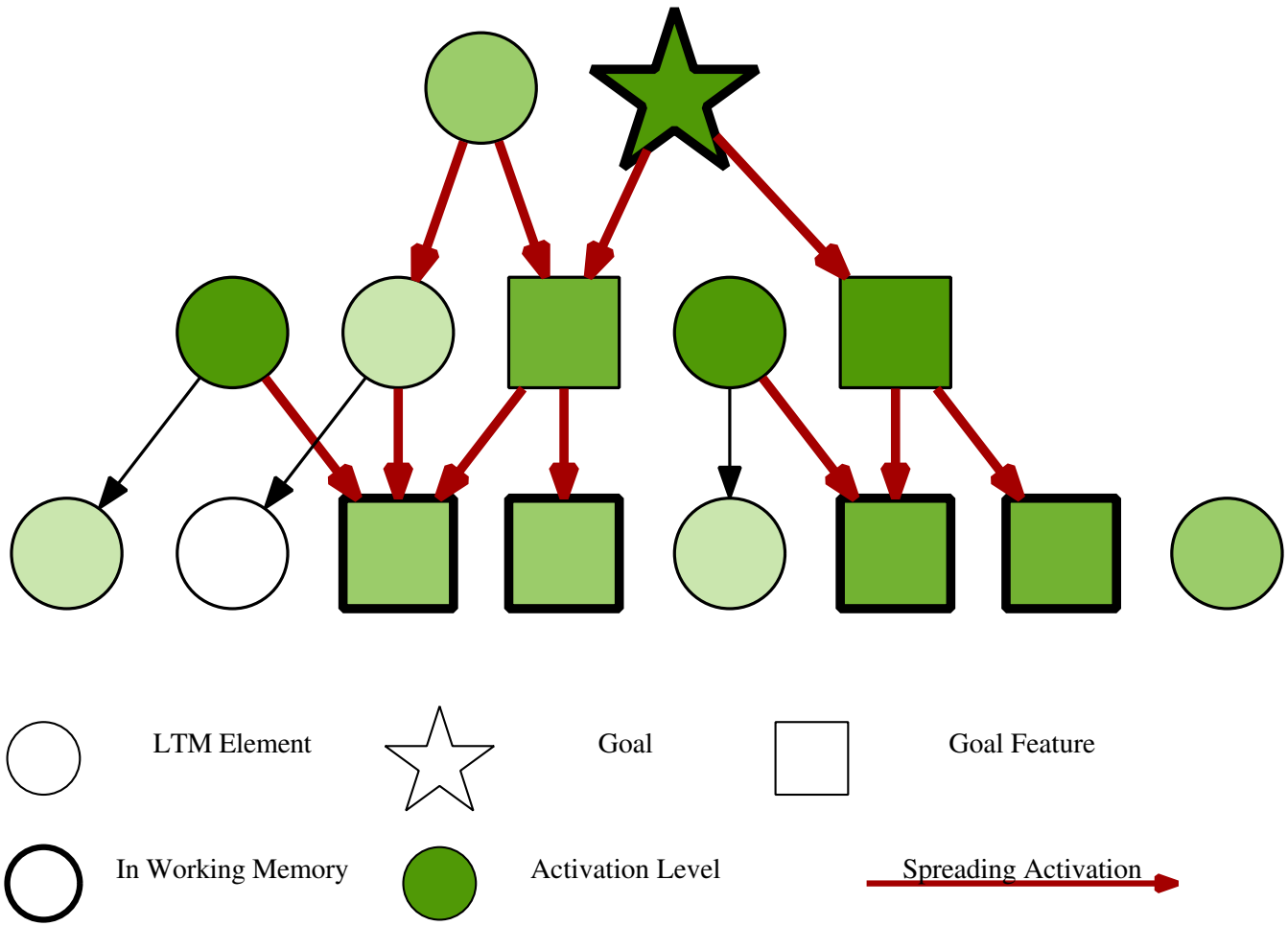


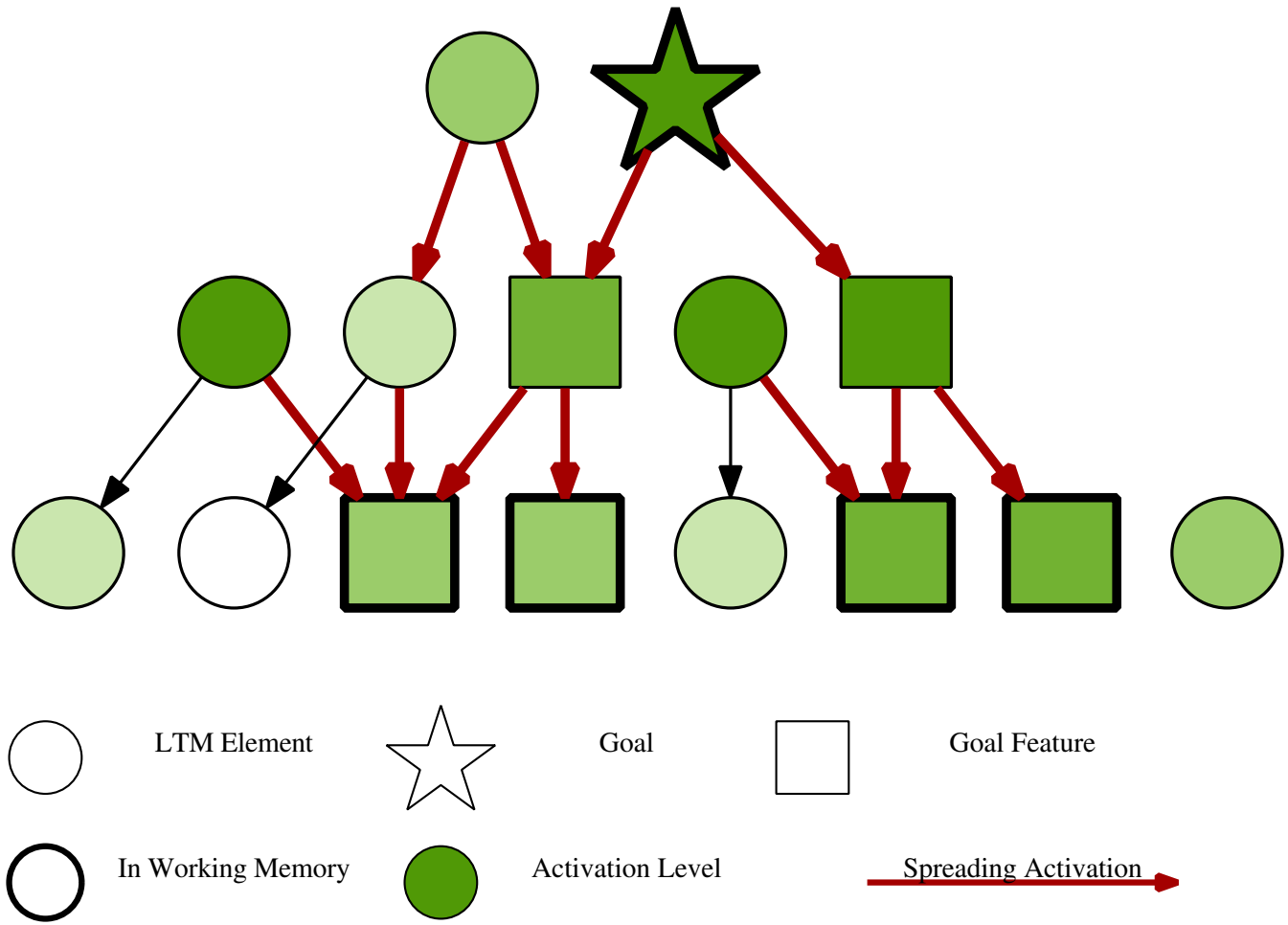
Spontaneous Retrieval Example

The most-highly activated element is retrieved



Spontaneous Retrieval Example

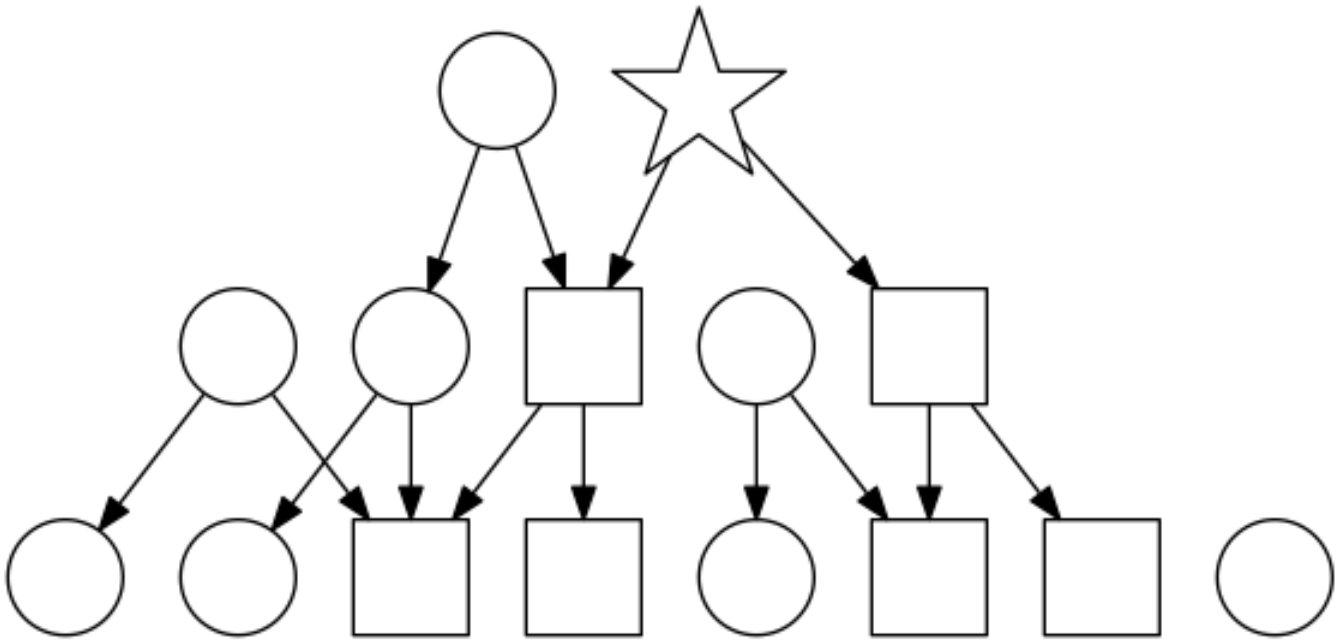
The goal is now in working memory and can be executed



Effects of Encoding Specificity

Encoding specificity: When the cues at encoding matches those at retrieval

What does this mean for the model?



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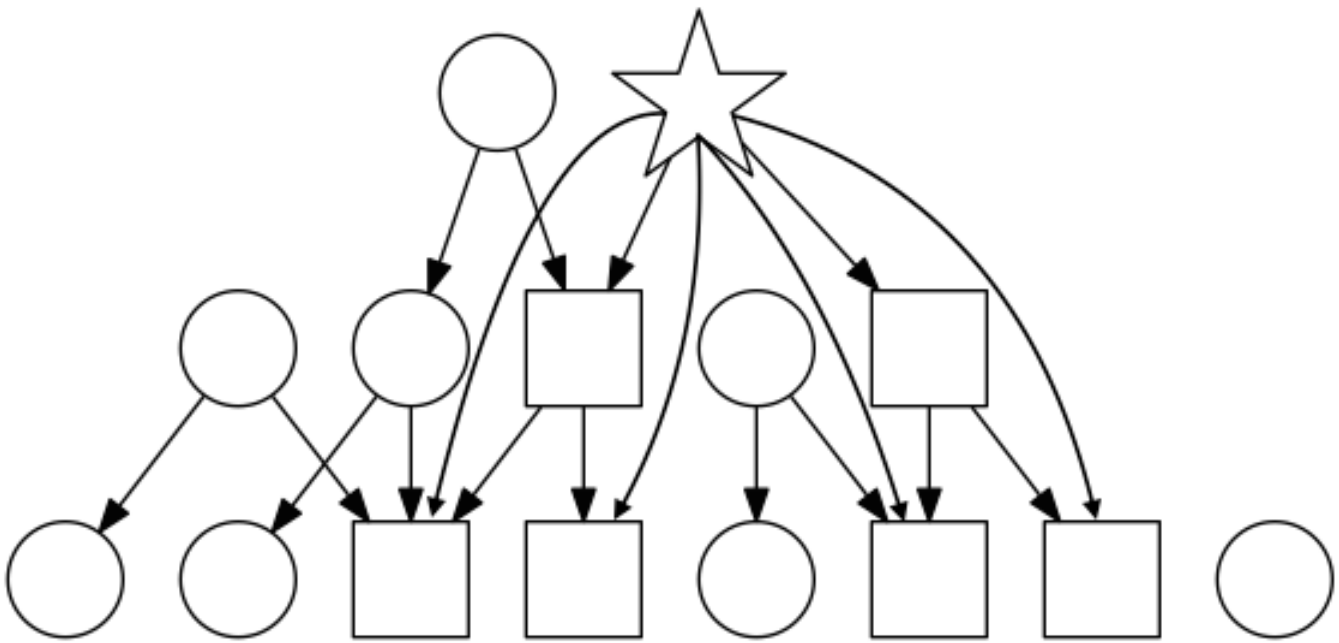

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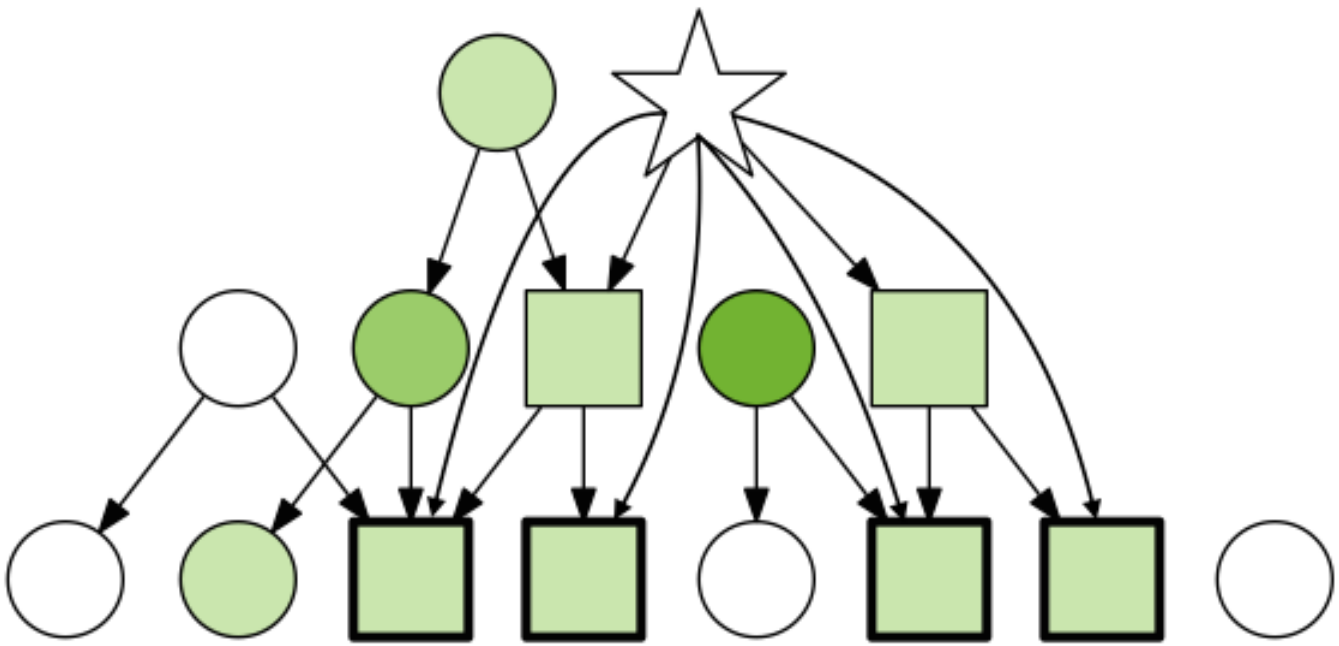

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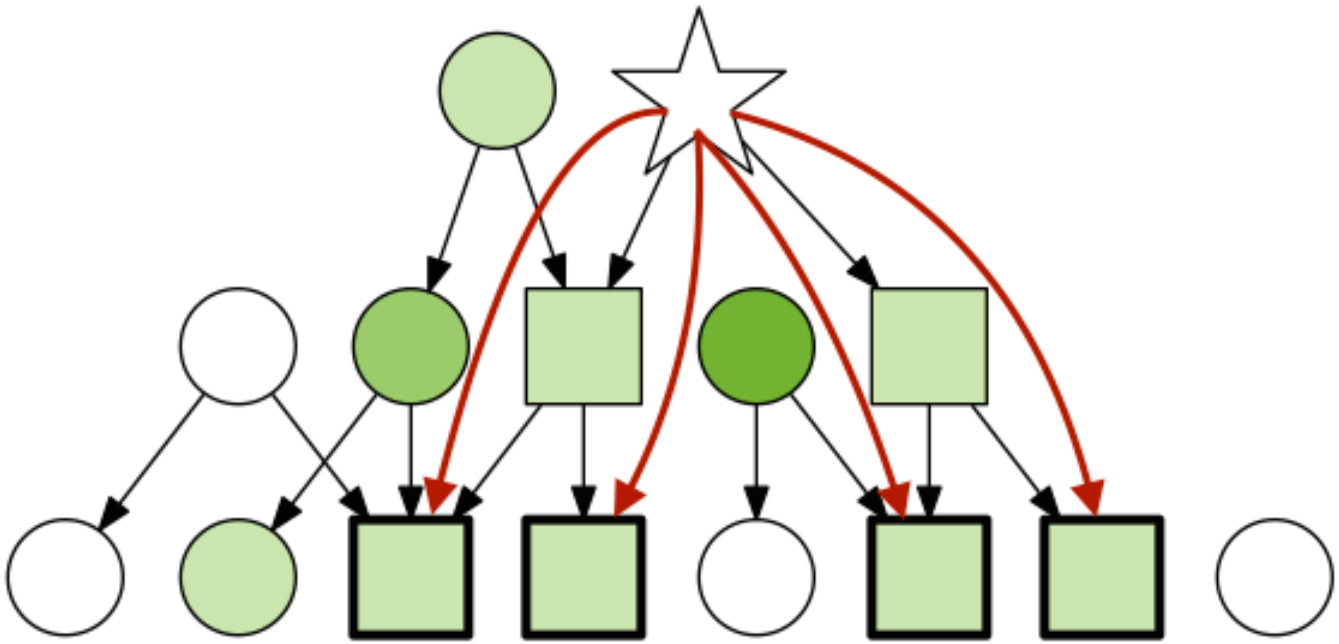

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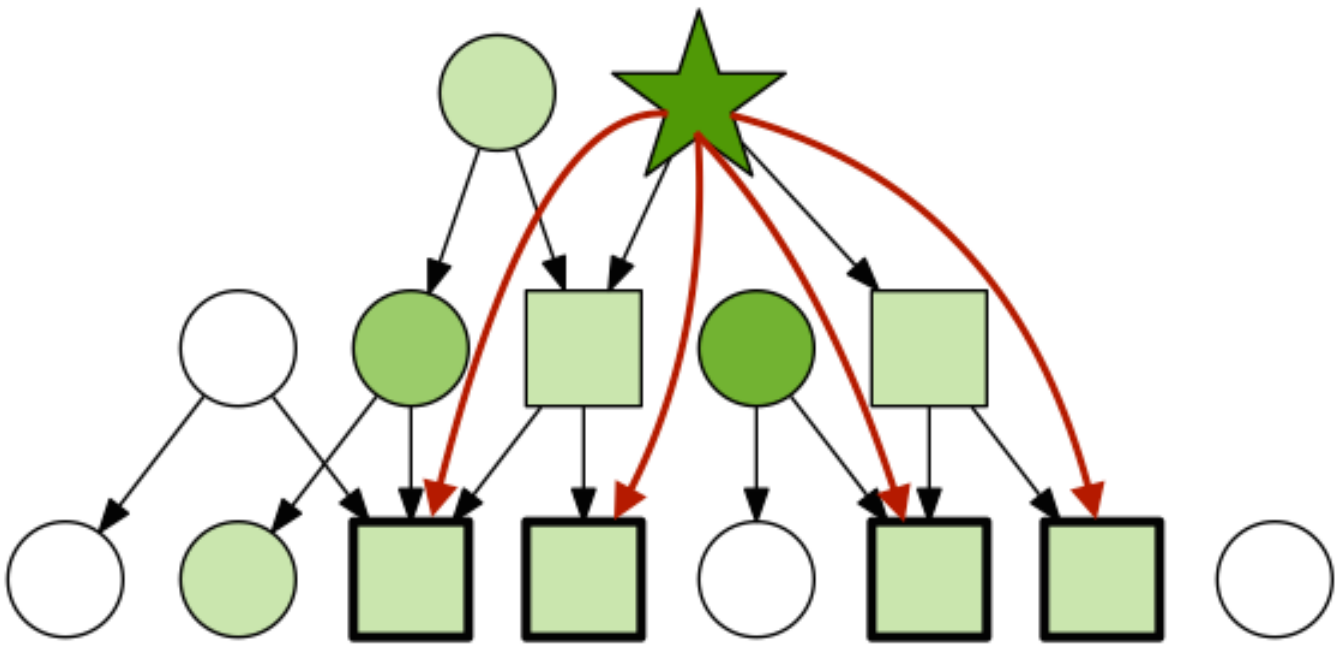

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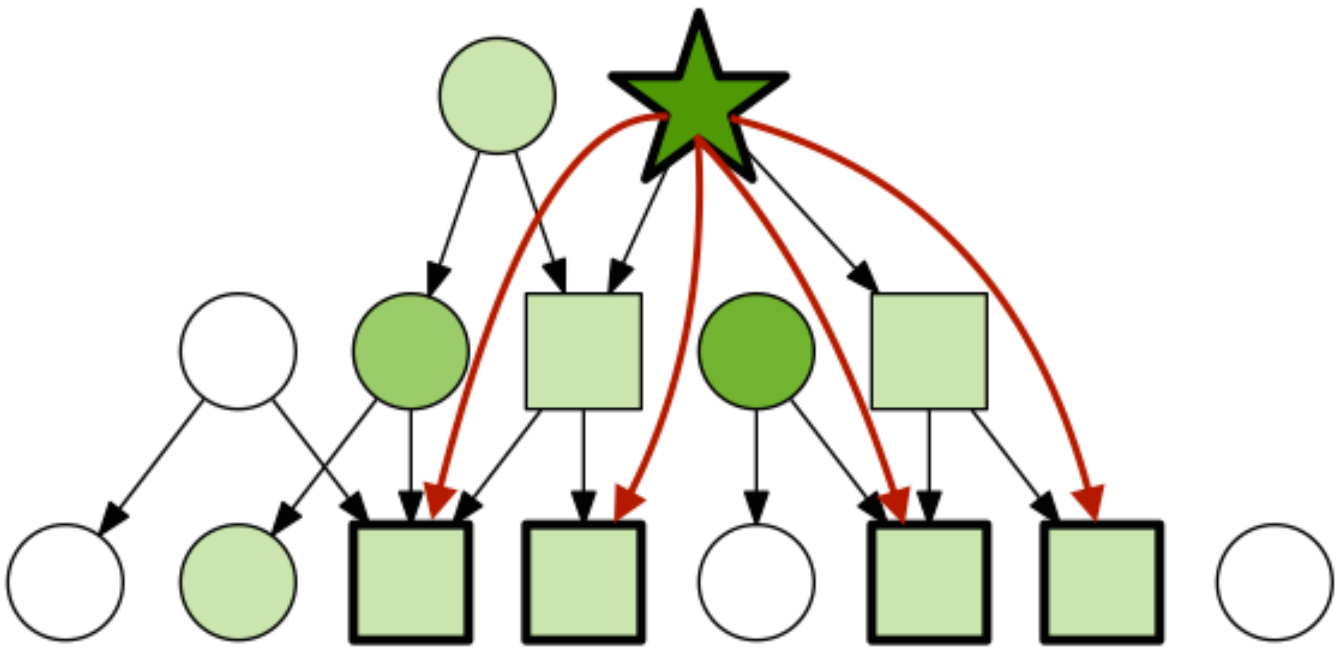
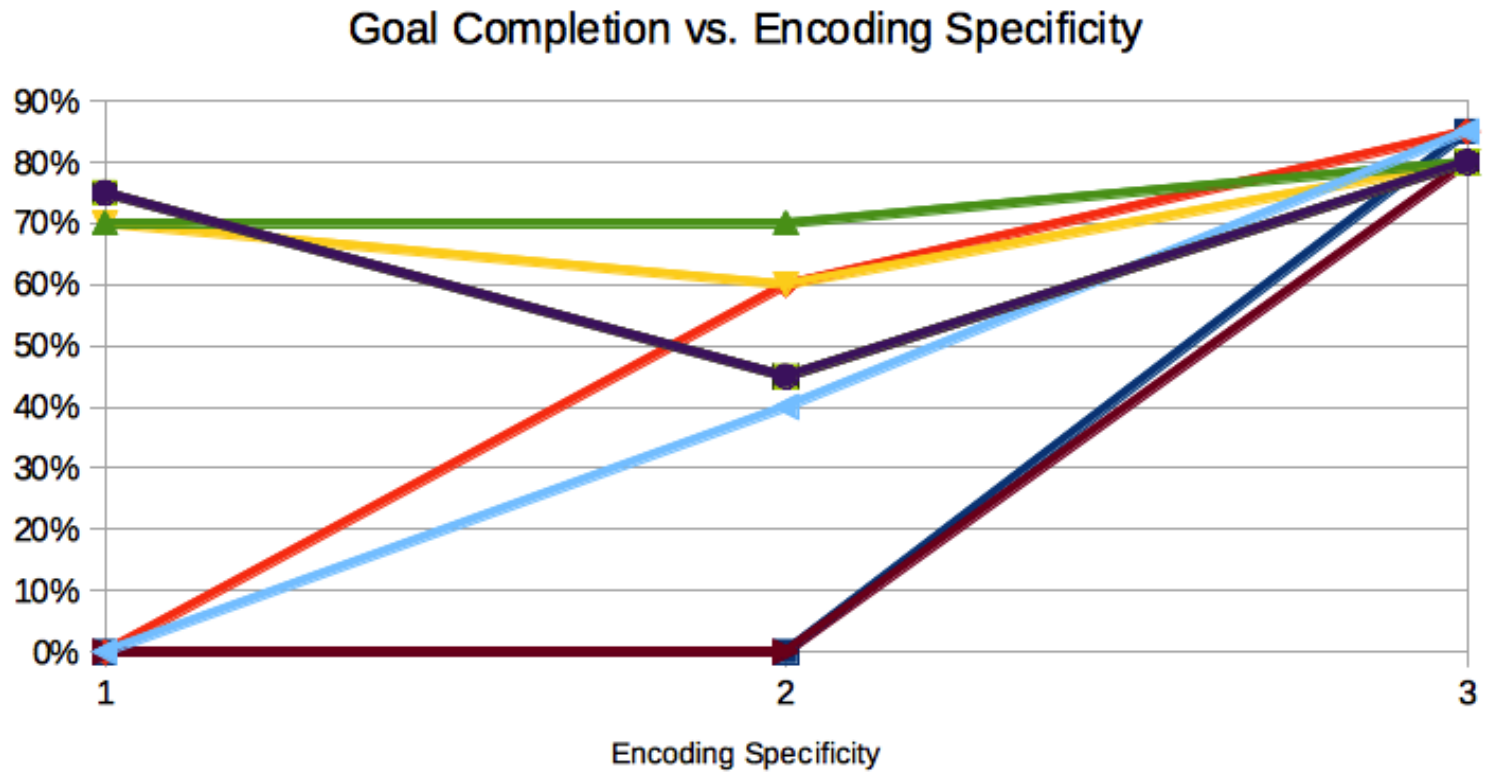


Encoding Specificity Results



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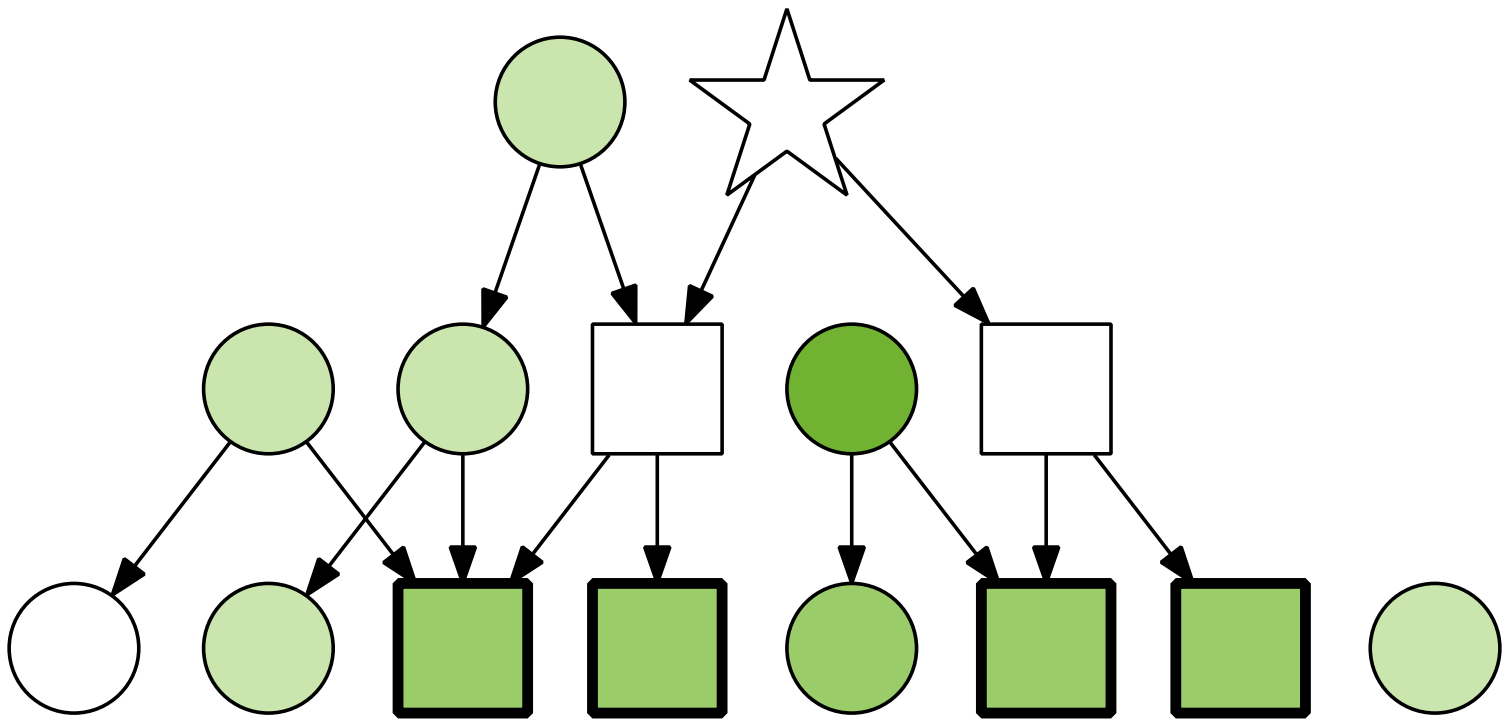
Assumption: goal features are perceived infrequently during retention



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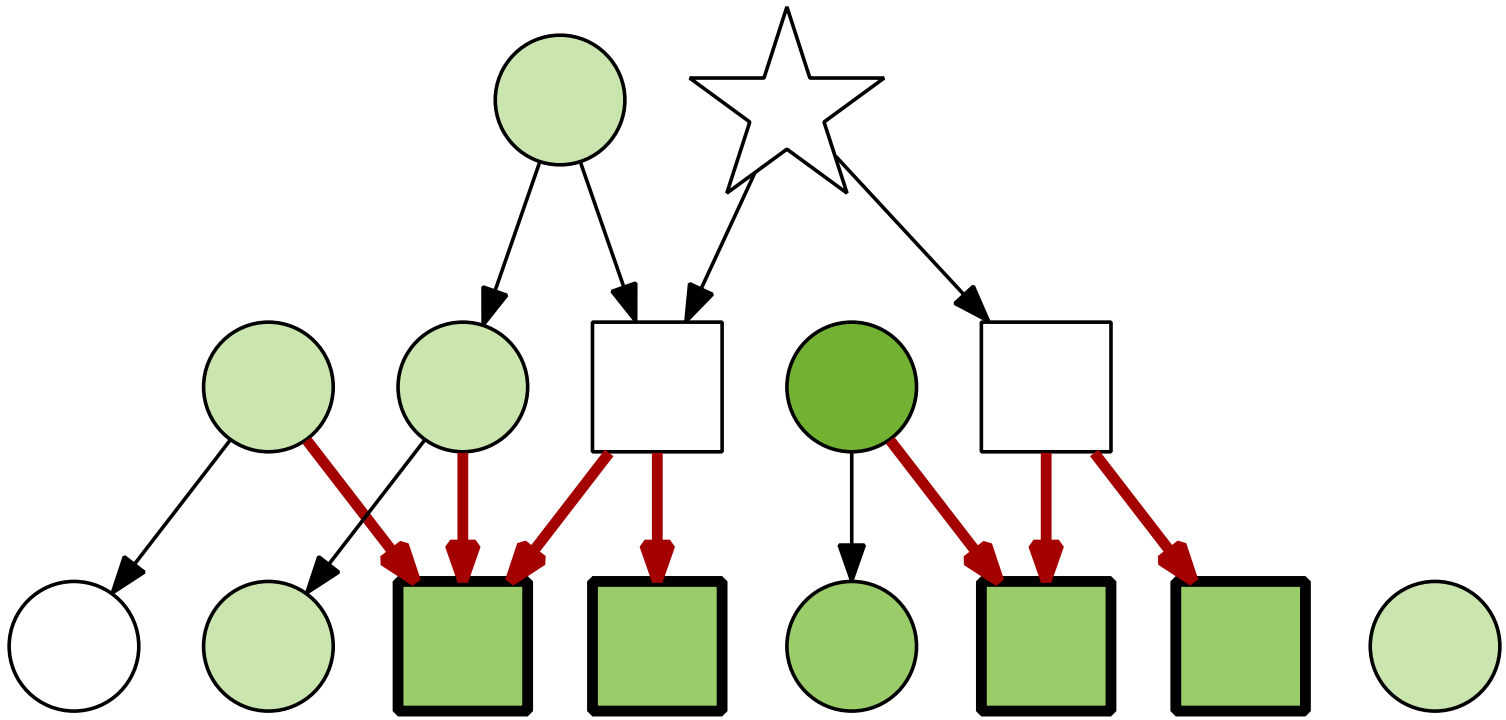

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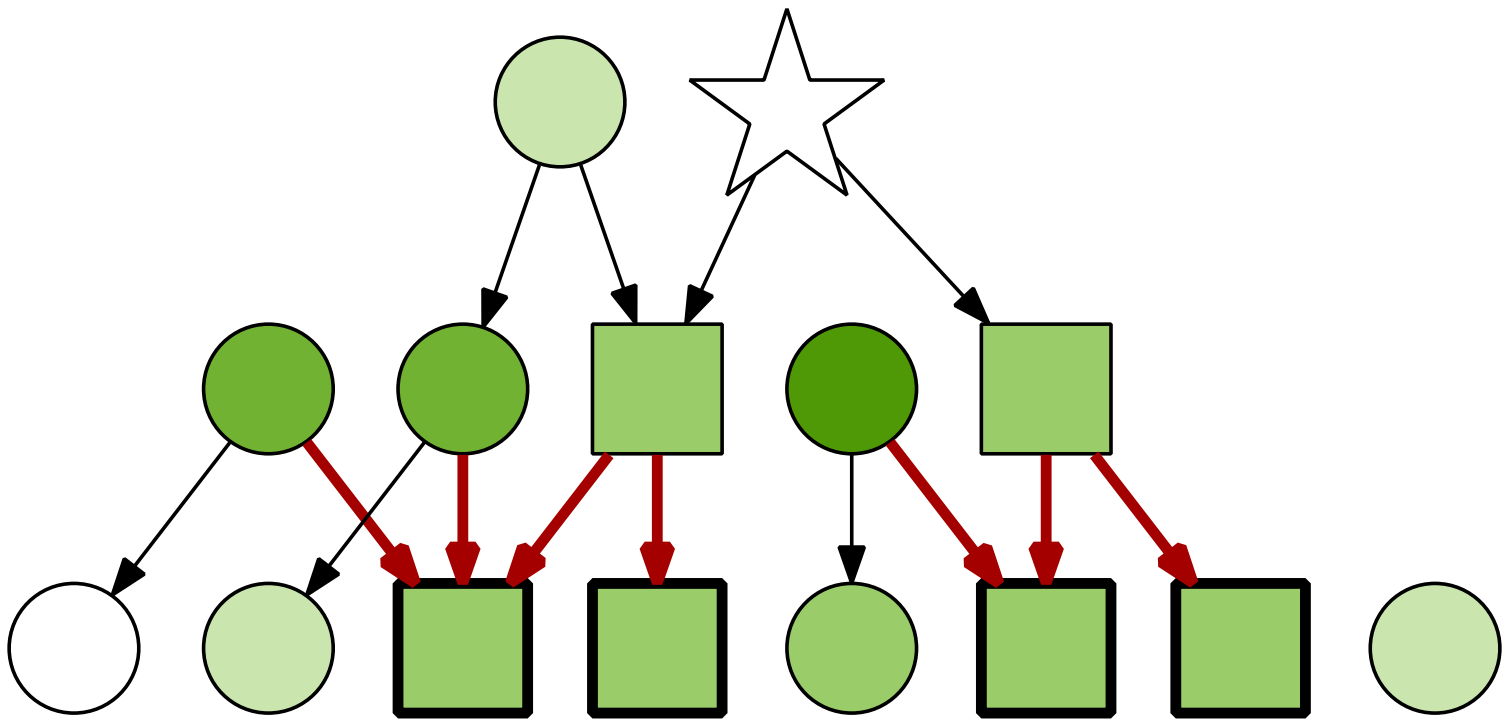

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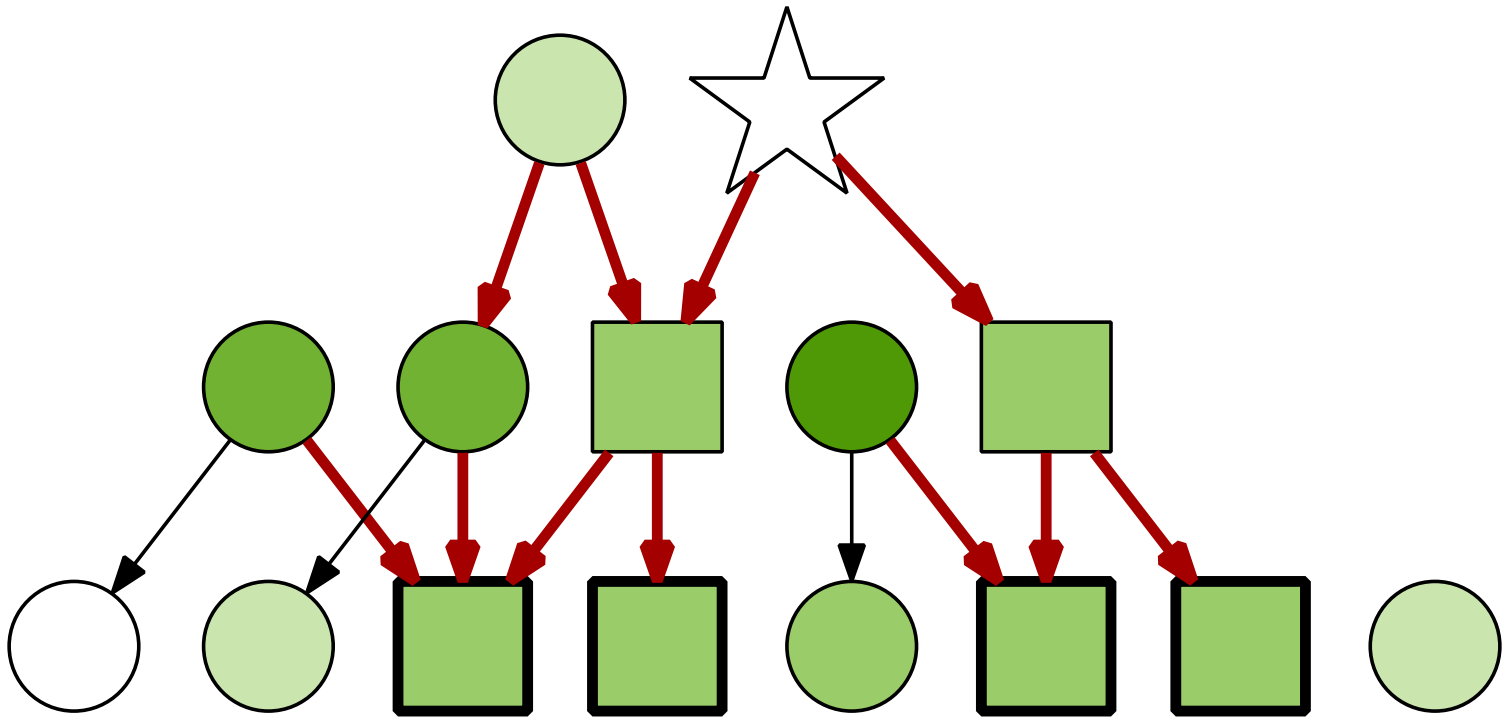

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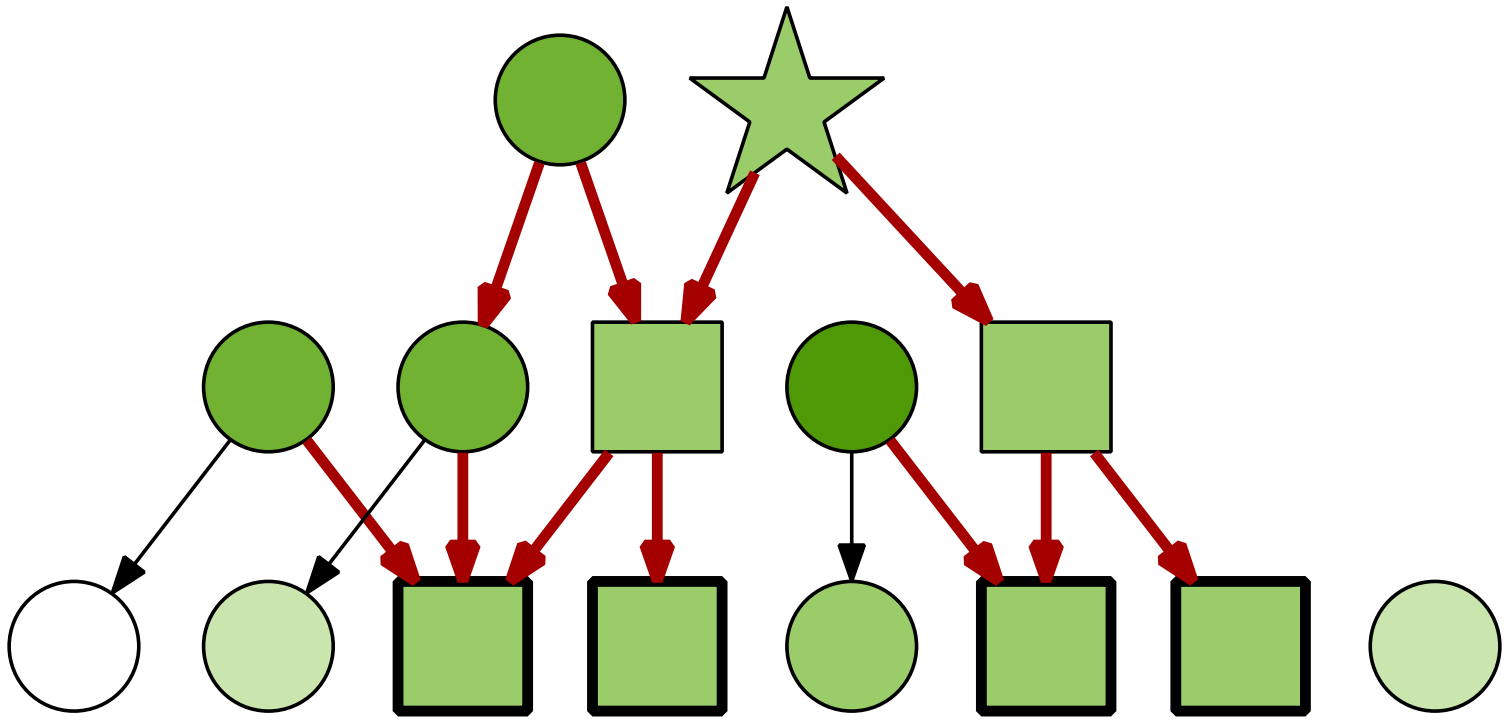

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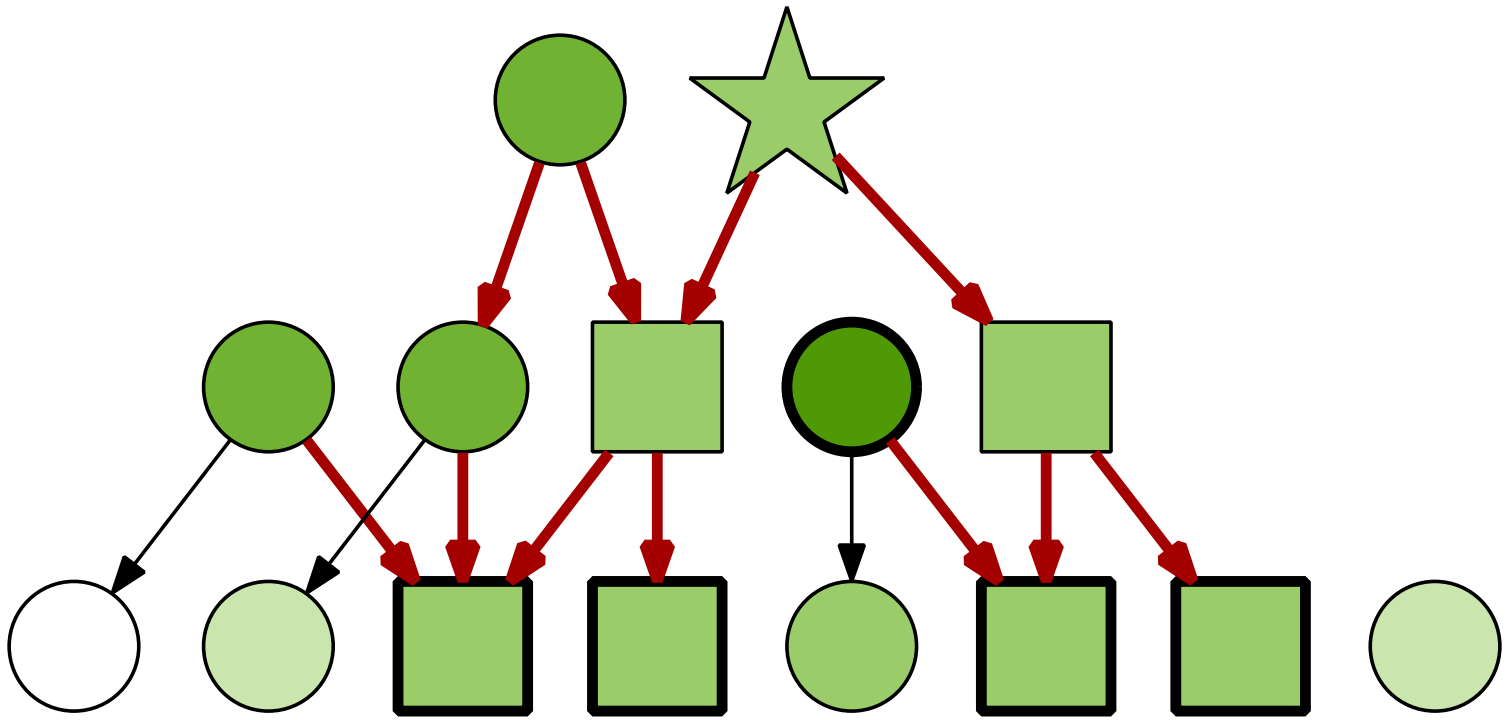
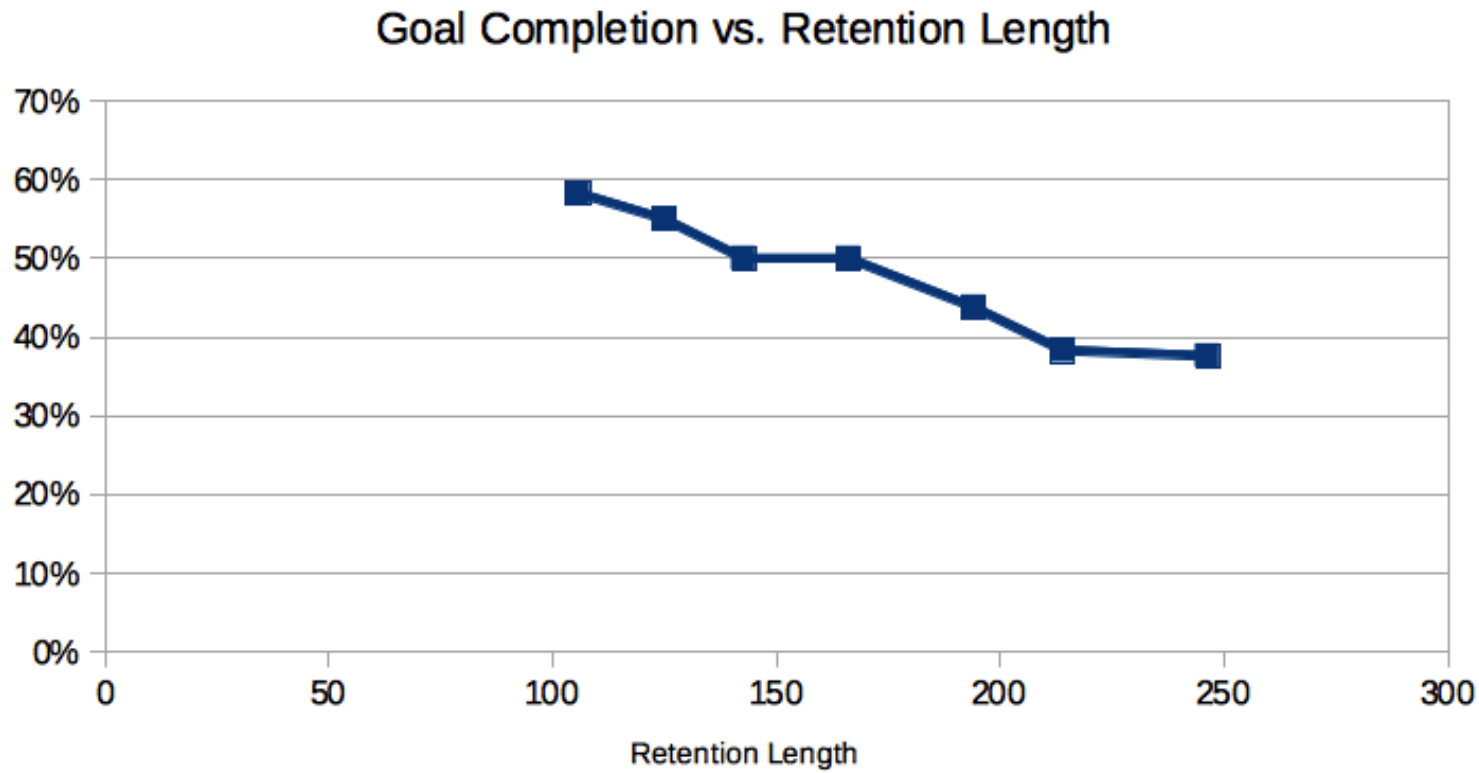


Retention Length Results



Summary

Human prospective memory performance:

- increases with more specific encodings
- decreases with longer retention periods

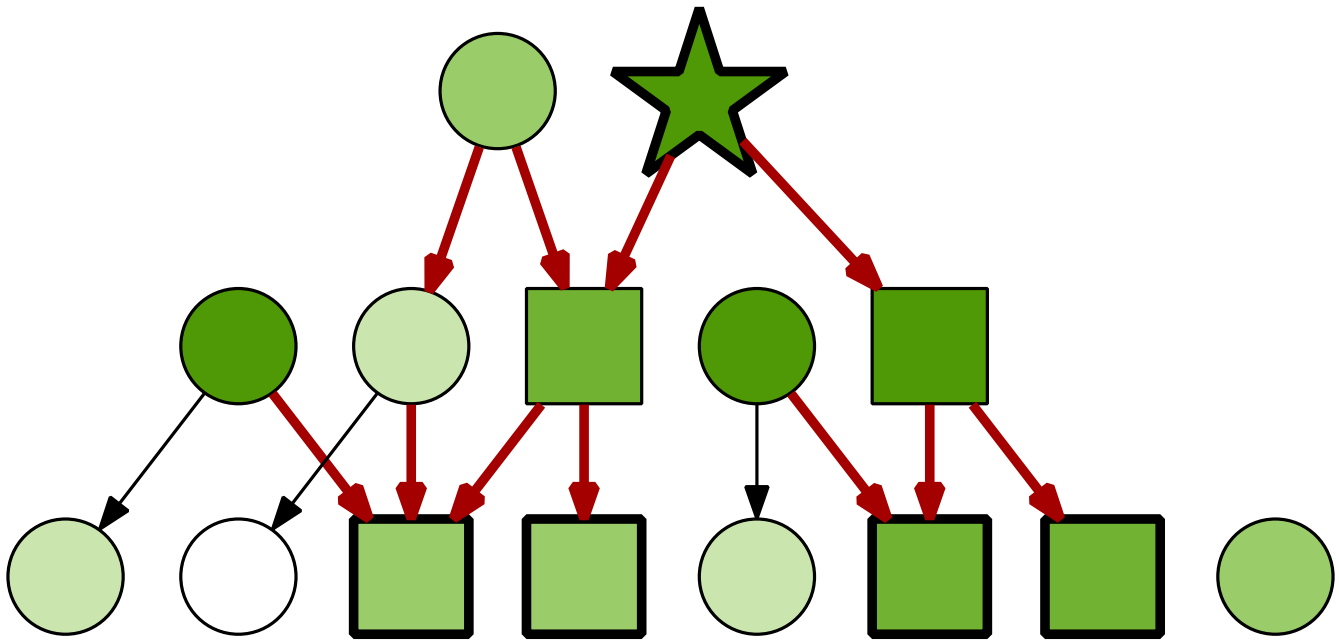
These trends fall out of a spontaneous retrieval strategy that uses spreading activation

Nuggets and Coal

The Good

- Spontaneous retrieval seems useful

The Bad

- Large space of spontaneous retrieval mechanisms
- Lack of real-world domain for prospective memory evaluation

Questions?