**SYDE 556/750**

# Simulating Neurobiological Systems
# Lecture 11: The Semantic Pointer Architecture

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March 24 & 26, 2020

UNIVERSITY OF WATERLOO | FACULTY OF ENGINEERING

# Administrative Notes – Remaining Deadlines

- **Assignment 4** – Due Tuesday, Mar. 24* (today!)
  - Worth 10% of the final mark
- **Interim Project Report** – Due Thursday, Apr. 2* (no late submission!)
  - One to two pages maximum; see the website for instructions
  - Not marked; either 0% (not submitted) or 100% (reasonable document submitted)
  - Worth 10 marks (25% of the final project) of the final project
- **Final Project** – Due Wednesday, Apr. 15*
  - Worth 40% of the final mark

* All deadlines are 11:59pm EDT

# Shallow Versus Deep Semantics

TREE

0x54 0x52 0x45 0x45

*Shallow semantics (relational)*

$$\forall x \, \mathbf{is\_a}(x, \texttt{PINE}) \rightarrow \mathbf{is\_a}(x, \texttt{TREE}) \wedge \mathbf{has}(x, \texttt{NEEDLES}) \wedge \mathbf{is}(x, \texttt{EVERGREEN}),$$

$$\forall x \, \mathbf{is\_a}(x, \texttt{TREE}) \rightarrow \mathbf{is\_a}(x, \texttt{PLANT}),$$

$$\forall x \, \mathbf{is\_a}(x, \texttt{PLANT}) \rightarrow \mathbf{is}(x, \texttt{ALIVE}).$$

*Deep semantics ("subjective experience")*

# Deep Semantic in Perception: Visual Processing Hierarchy

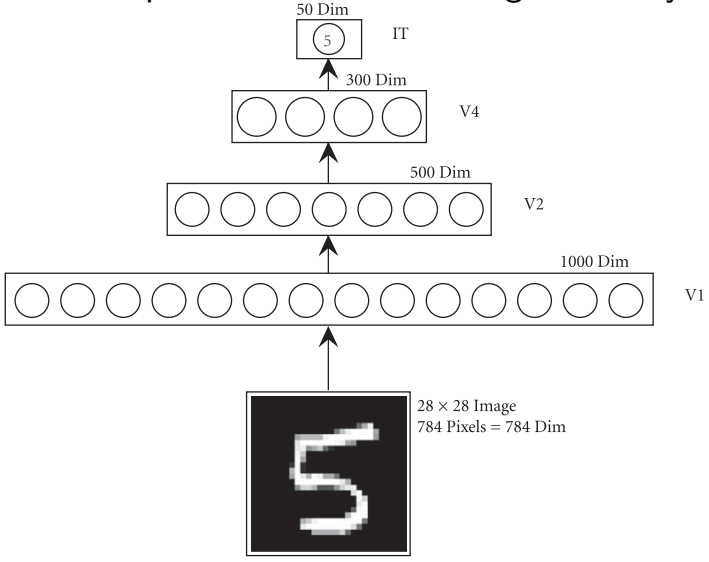



**Image Sources.** Eliasmith, "How to Build a Brain", 2013, Figure 3.4

# Deep Semantic in Perception: Dereferencing

A.

B.

C.

D.

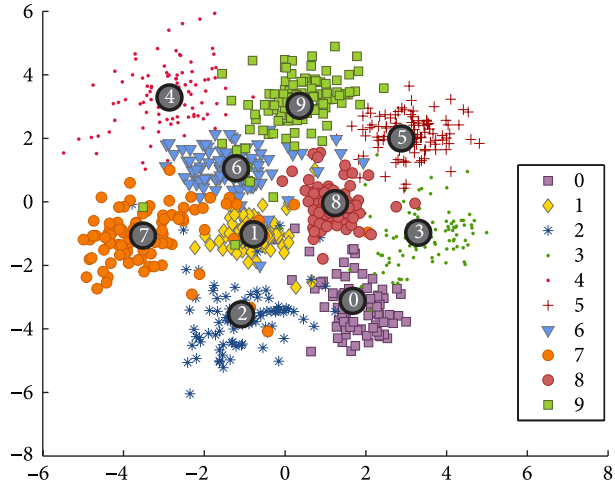
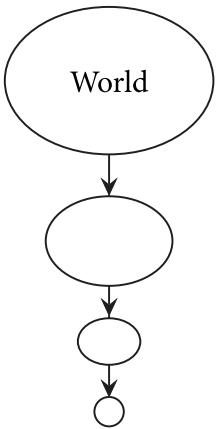



**Image Sources.** Eliasmith, "How to Build a Brain", 2013, Figure 3.7

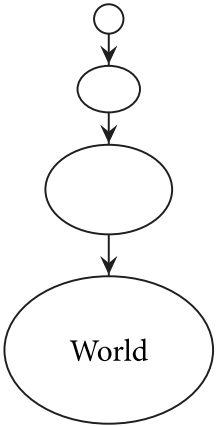
# Perception vs. Action

Perception



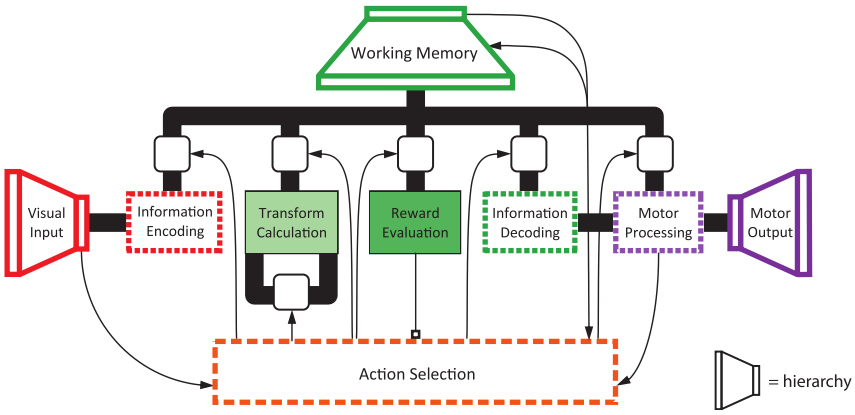

World → Representation

Motor Control

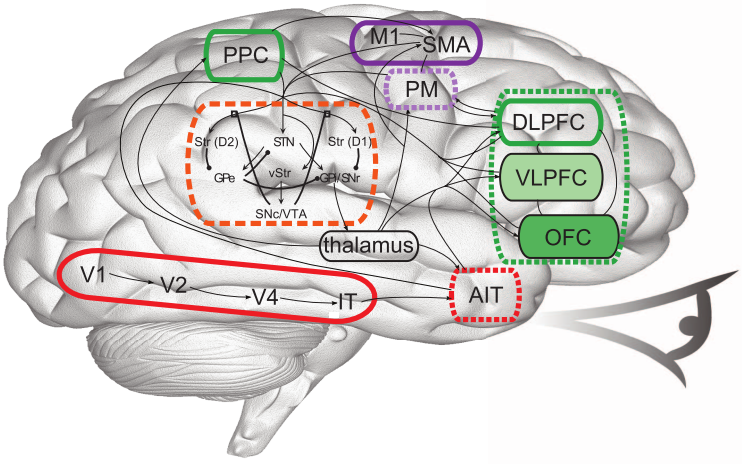



Representation → World

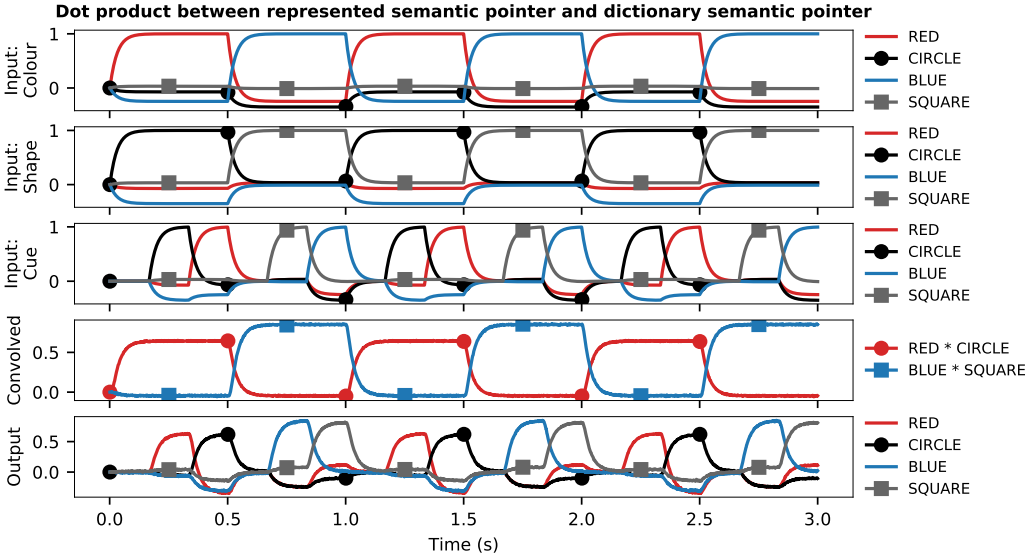
# Spaun – Semantic Pointer Architecture Unified Network (I)



# Spaun – Semantic Pointer Architecture Unified Network (I)



# Nengo SPA Example



# Recency and Primacy Experiment

**Experiment:** Remember this list

# Recency and Primacy Experiment

**Experiment:** Remember this list

1. robot

# Recency and Primacy Experiment

**Experiment:** Remember this list

2. teflon

# Recency and Primacy Experiment

**Experiment:** Remember this list

3. kettlemaking

# Recency and Primacy Experiment

**Experiment:** Remember this list

4. big-league

# Recency and Primacy Experiment

**Experiment:** Remember this list

5. troubleshooter

# Recency and Primacy Experiment

**Experiment:** Remember this list

6. conglomerates

# Recency and Primacy Experiment

**Experiment:** Remember this list

7. waxberries

# Recency and Primacy Experiment

**Experiment:** Remember this list

8. electrograph

# Recency and Primacy Experiment

**Experiment:** Remember this list

9. overjoyous

# Recency and Primacy Experiment

**Experiment:** Remember this list

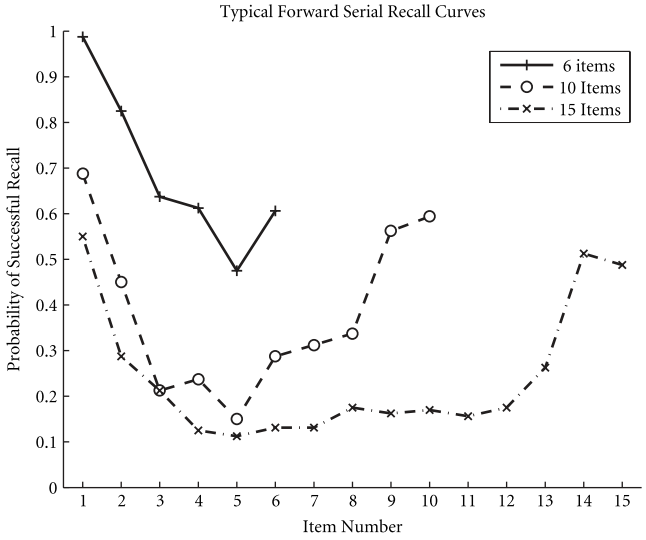
10. unquailing

# Recency and Primacy Experiment

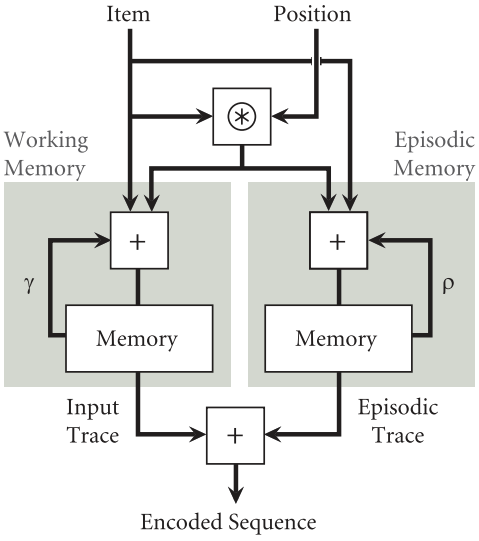
**Experiment:** Remember this list

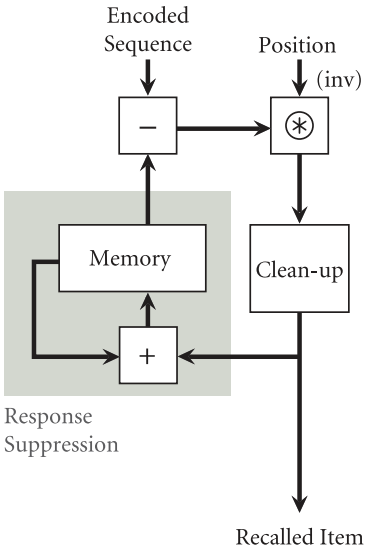
1. robot
2. teflon
3. kettlemaking
4. big-league
5. troubleshooter
6. conglomerates
7. waxberries
8. electrograph
9. overjoyous
10. unquailing

# Recency and Primacy Data

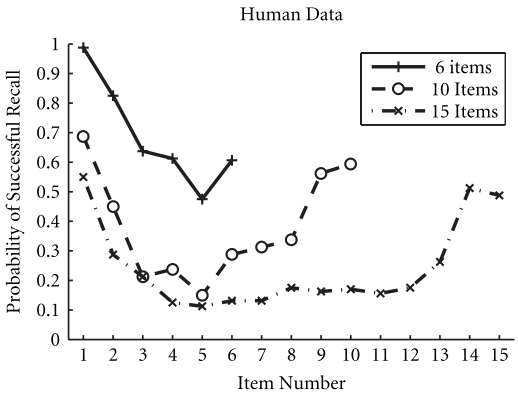


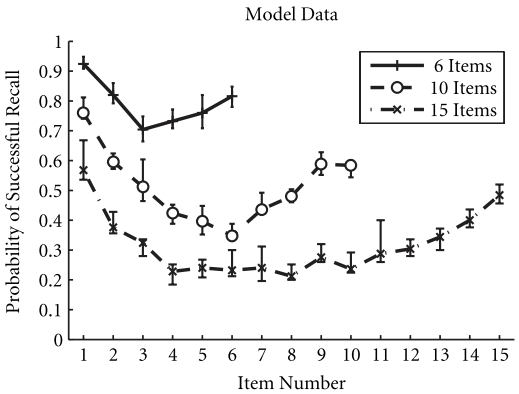
# Ordinal Serial Encoding (OSE) Model



# Ordinal Serial Encoding (OSE) Model: Experiment



# Image sources

**Title slide**
*Librarian (In a library)*, between 1850 and 1866, Georg Reimer Wikimedia.