T11

Cognitive Systems

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cognitio

PSI 3560 – COGNITIVE SYSTEMS

class T11

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COGNITIVE ARCHITECTURES

Cognitive Architectures

Session T11

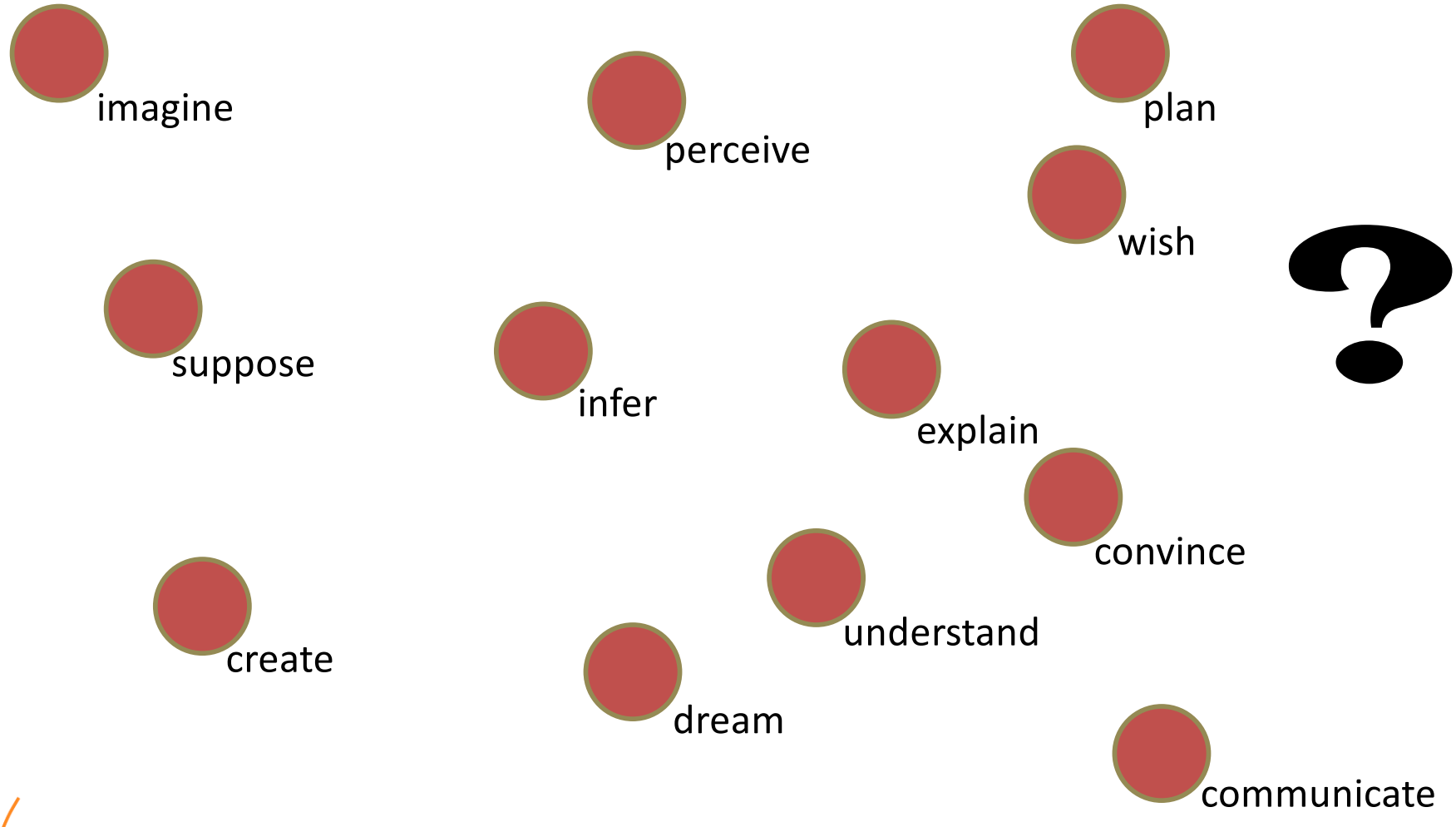
Cognitive architectures

- Architectures of Cognitive Systems
  - Contain cognitive modules
  - Stablish their relationships

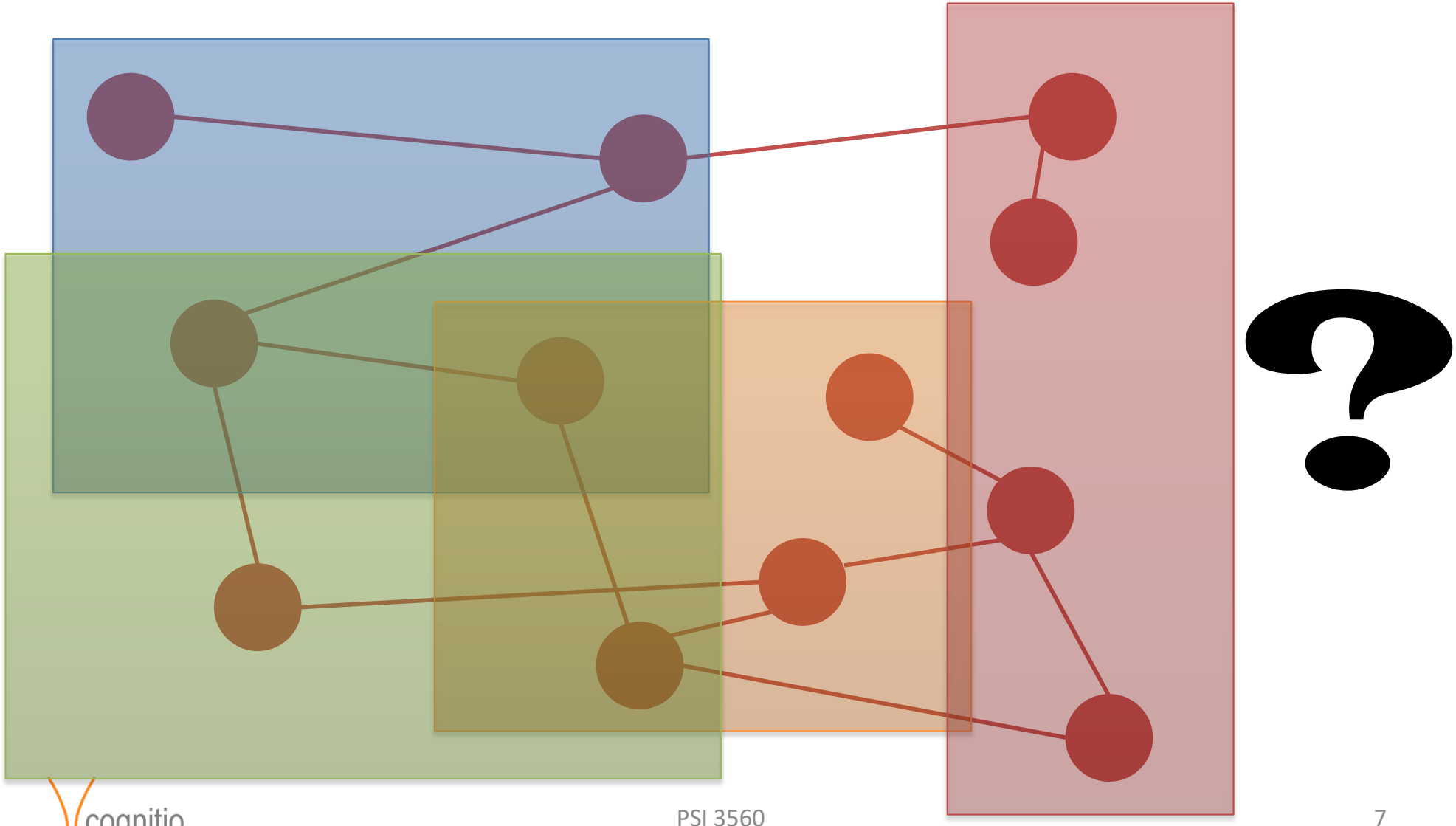
- Typical modules
  - Perception
  - Reasoning
  - Communication
  - Action
  - Learning
  - Memories

SECTION 1

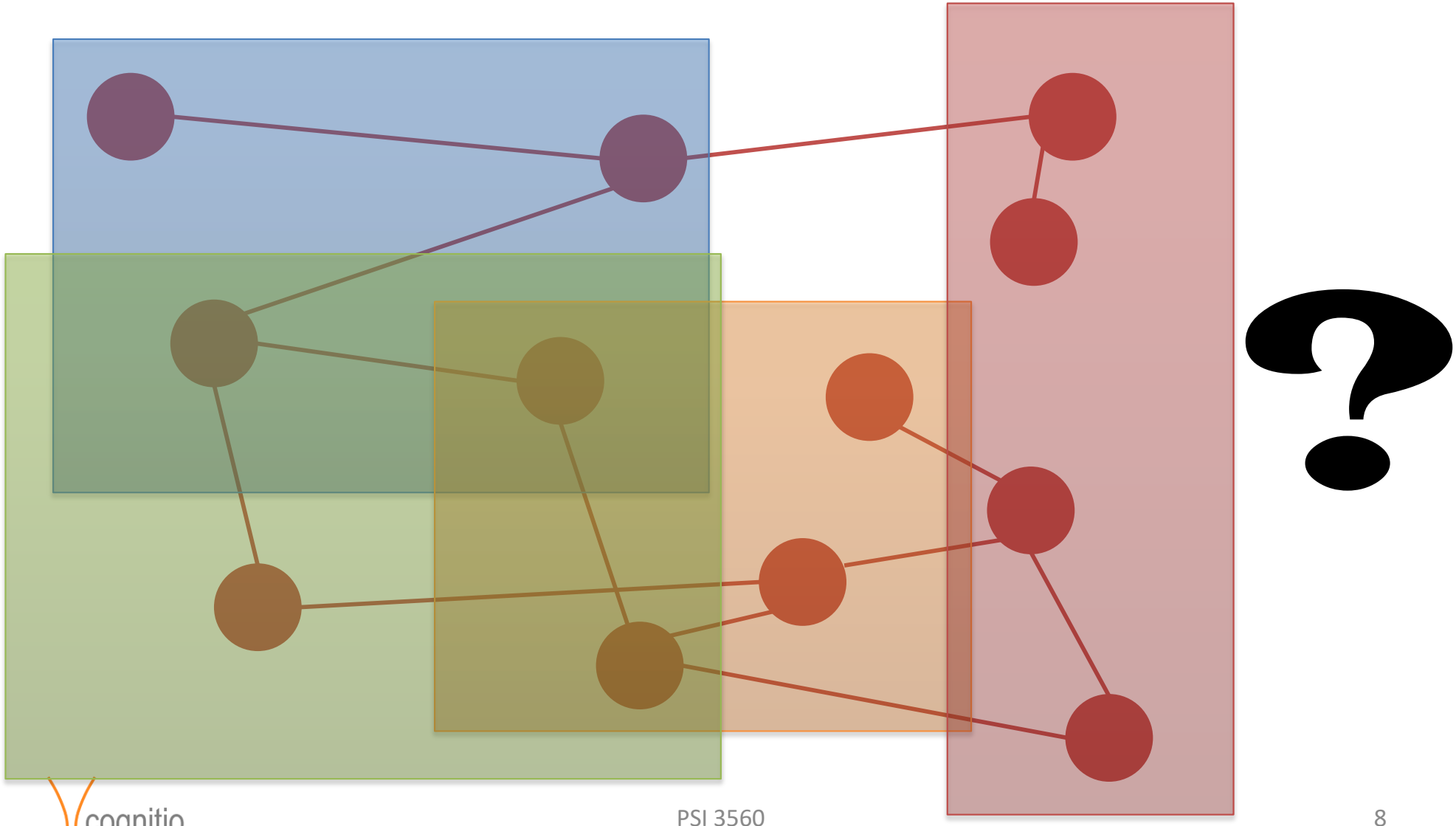
Cognitive Architecture which are cognitive *faculties?*



Cognitive Architecture how are they clustered?



Cognitive Architecture
how are stablished the relationships?



Cognitive Architecture cognition theory*?*

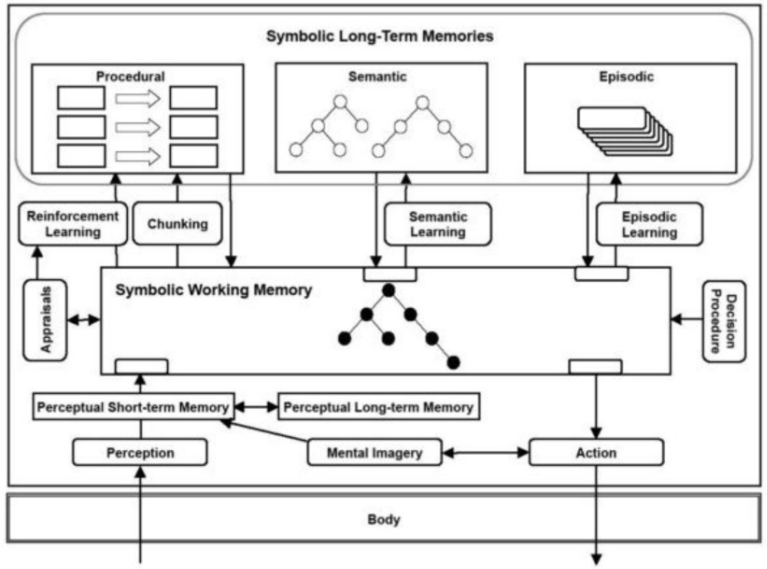
- In particular, a cognitive architecture represents any attempt to create what is referred to as a unified theory of cognition. This is a theory that covers a broad range of cognitive issues, such as attention, memory, problem solving, decision making, and learning.

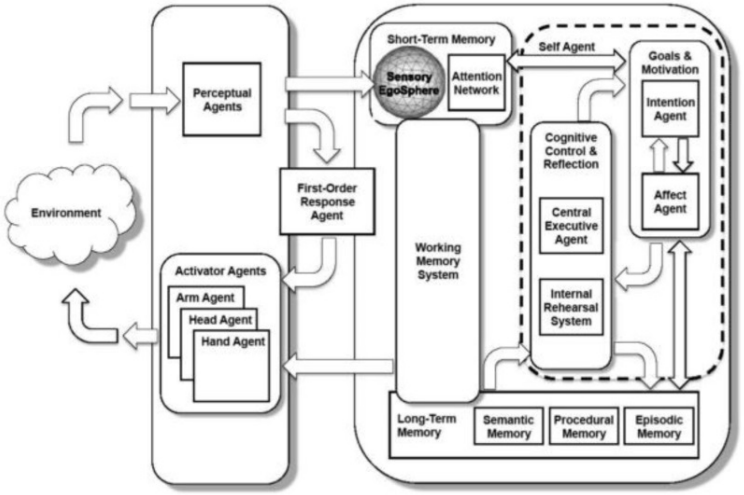
David Vernon. Artificial Cognitive Systems (MIT Press) Kindle

Cognitive Architecture

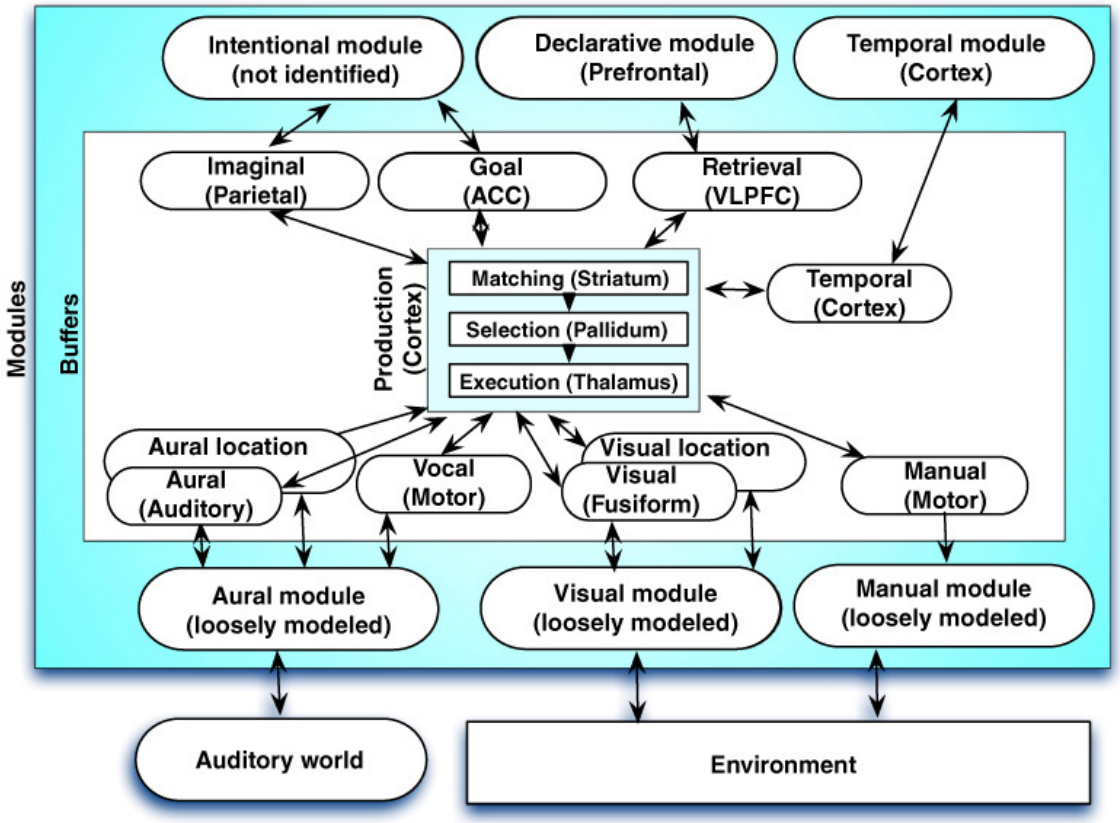
- Typical candidates for unified theories of cognition.
- Approaches
  - Cognitivism
    - Allen Newell's and John Laird's Soar architecture
  - Emergent
    - John Anderson's ACT-R5 architecture
  - Hybrid
    - Ron Sun's CLARION architecture

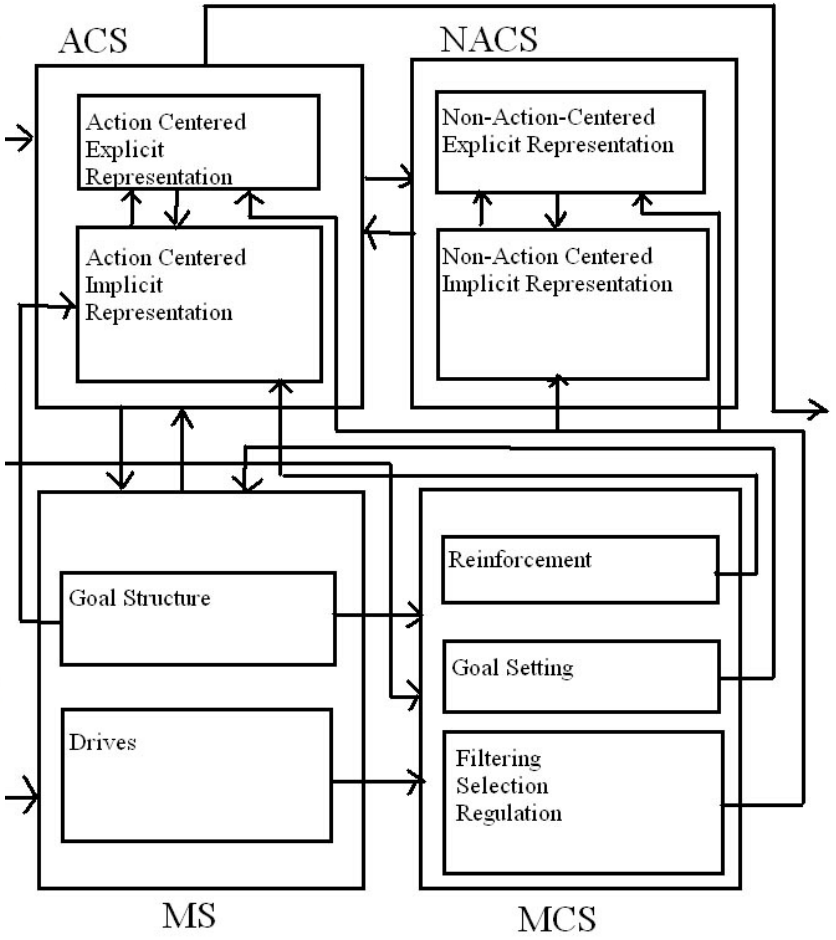
Cognitive Architectures
SOAR (cognitivism) & ISAC (hybrid)





Cognitive Architectures
ACT-R (emergent) & CLARION (hybrid)





Clarion Cognitive Architecture

SECTION 2

Cognitive Architecture

- Processor architecture
  - How tasks are organized and performed
- Data / Information / Knowledge Architecture
  - How data is organized and transformed, acquiring progressively higher value
- How to mix both?

Cognitive Architecture

- "a cognitive architecture is a broadly-scoped domain-generic computational cognitive model, capturing the essential structure and process of the mind, to be used for broad, multiple-level, multiple-domain analysis of behavior."

David Vernon. Artificial Cognitive Systems (MIT Press) Kindle.

Cognitive Architecture

- Behavioral Characteristics
- Cognitive Characteristics
- Functional Capabilities

Cognitive Architectures
Functional Capabilities

- 1. Recognition and categorization
- 2. Decision making and choice
- 3. Perception and situation assessment
- 4. Prediction and monitoring
- 5. Problem solving and planning
- 6. Reasoning and belief maintenance
- 7. Execution and action
- 8. Interaction and communication
- 9. Remembering, reflection, and learning

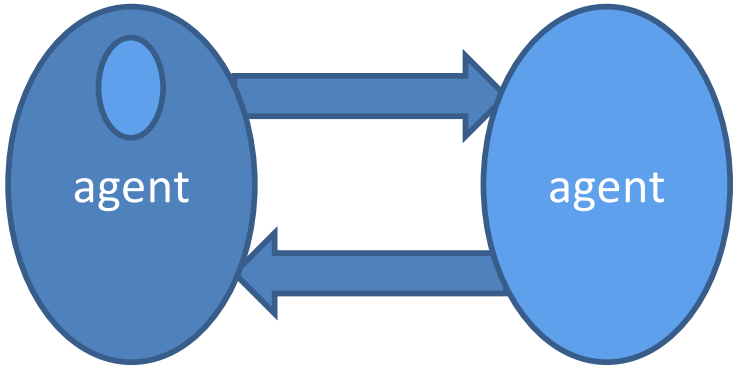
David Vernon. Artificial Cognitive Systems (MIT Press) Kindle.

Cognitive Architecture

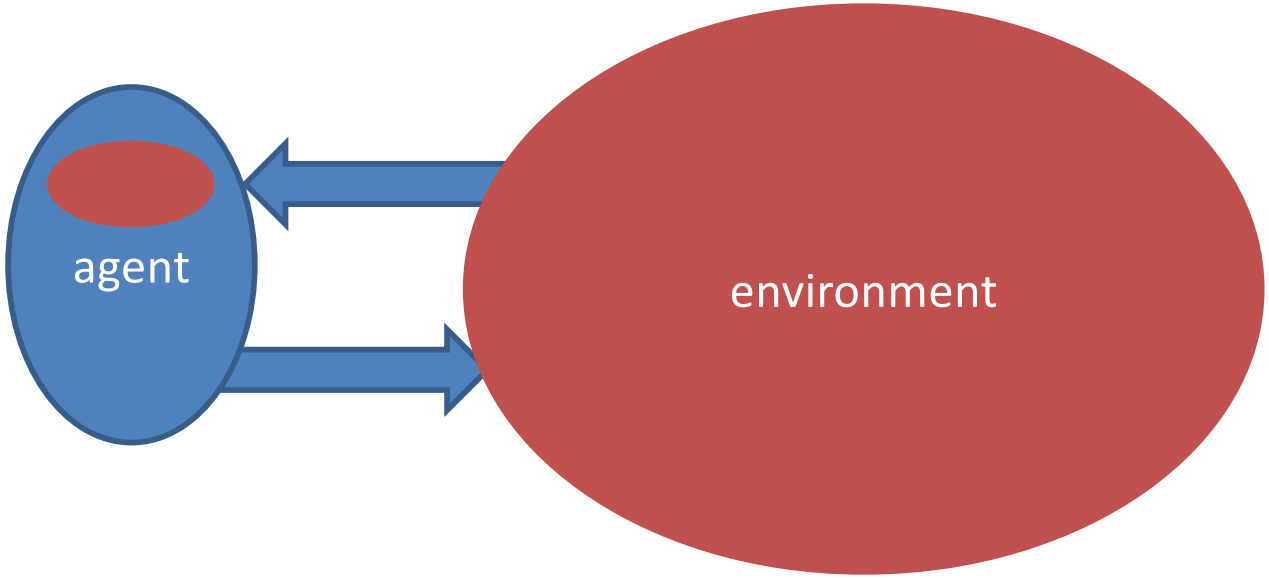
- Presume knowledge handling abilities
  - Producing knowledge (from previous knowledge)
  - Transferring knowledge
  - Refining knowledge
  - Acting by properly using knowledge

Cognitive Architecture

Inter-agent
relationship
Communication



Agent Environment
Relationship
Perception & Action



Cognitive Architecture

- A way of describing a cognitive system
  - Structure (components, modules, parts & connections)
  - Properties / Features
  - Functionalities
  - Abilities (What / When / Where / How)

- Proposing how
  - Information is handled
  - The system evolves acquiring and refining its own view of the living environment

SECTION 3

Cognitive Architecture

- What is unique on a cognitive system?
  - Its autonomy and survival sense
  - The way it learns from the surroundings
    - The environment and other beings/agents
  - How it performs the embodiment of acquired knowledge
  - How it re-organizes itself as consequence of these achievements (learned)

Cognitive Architecture

- Considering the expectations for the cognitive system
- We should propose a way to make them happen
- A good architecture should be flexible and complete to allow the manifestation of all expected things

Cognitive Architecture

- A cognitive system is typically a changing / adapting system

- This turns the conception task of a GS more difficult, but more challenging / interesting

Cognitive Architecture

- We need to find a way to combine multiple components allowing them to act on different data in various forms, dynamically and adaptively producing more and more meaningful data

- A system with such abilities should be closer to a cognitive one, able to understand and react properly to the environment it lives

Cognitive Architecture

- We need to identify (by some criteria) a minimal set of basic components, that together may share contributions to perform the cognitive tasks
- And to search for finding mechanism to connect them all, allowing them to collaborate in such quest
- Recognizing the dynamicity of the system, and the fact that things may be achieved in different forms (combinations or sequences of actions, performed by different components)

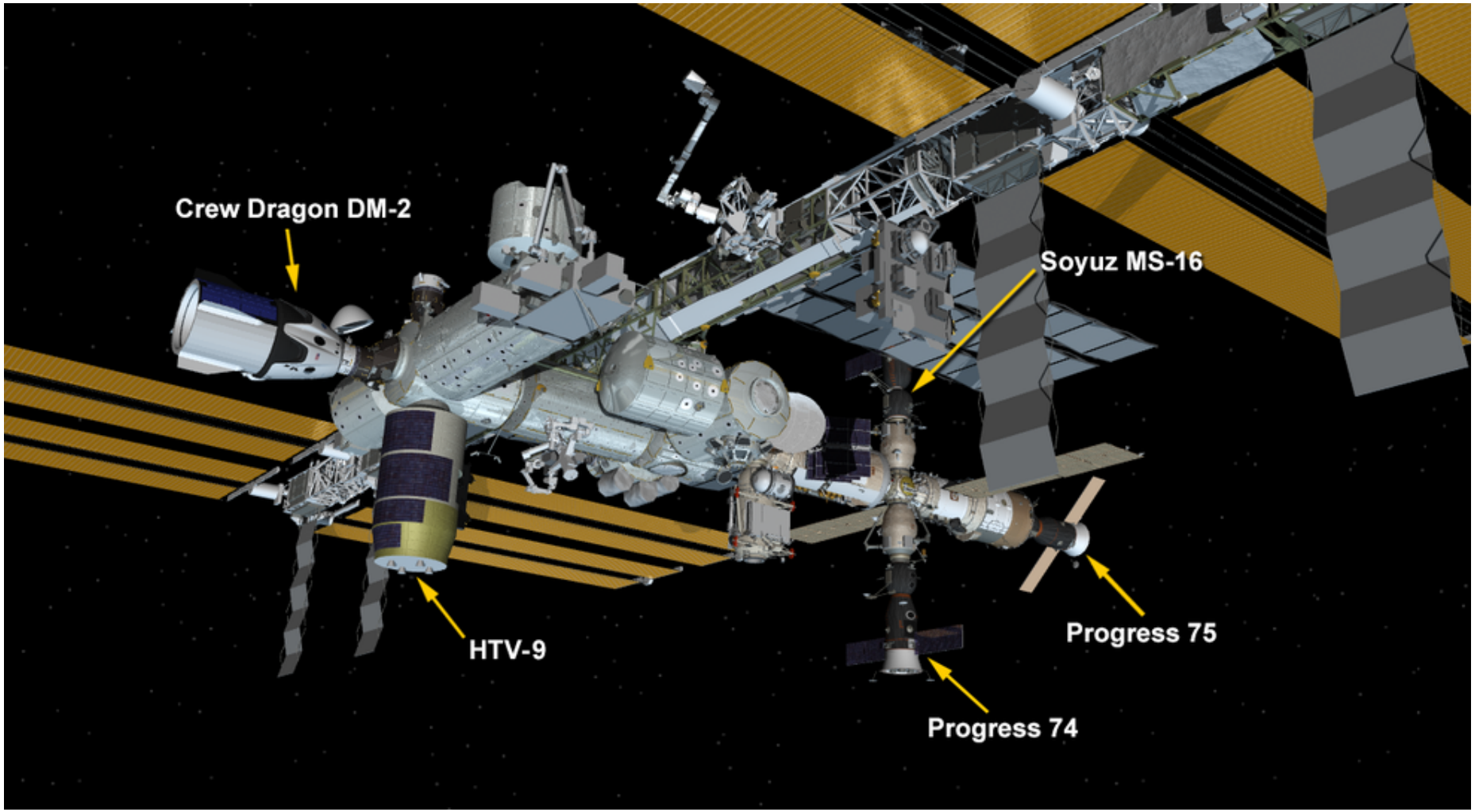
Cognitive Architecture

- As the real biological cognitive system, an organic characteristic should be expected in the artificial one

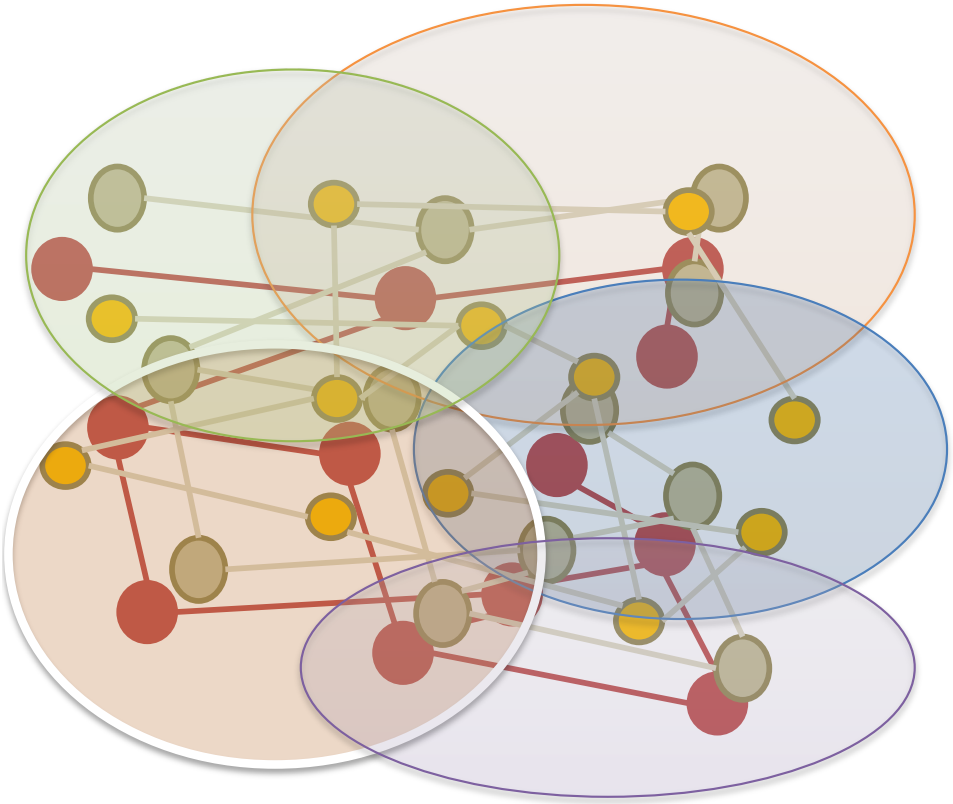
- By organic I refer to structural and functional features and properties (plasticity in opposition to rigidness)

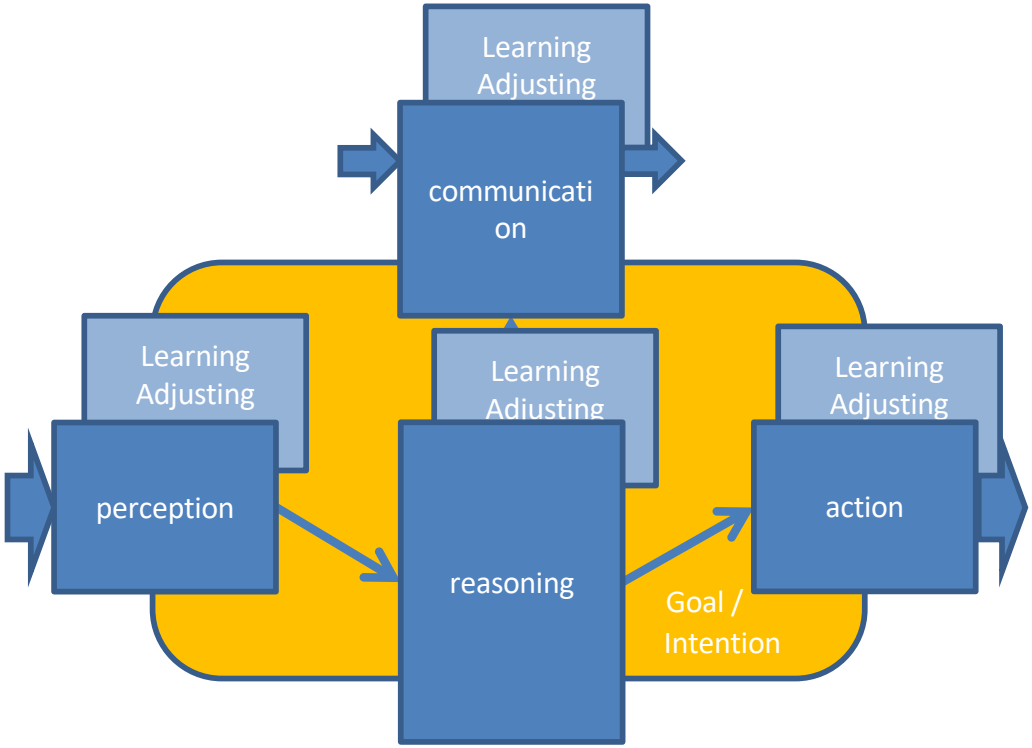
SECTION 4

Complex Engineered Systems
International Space Station - ISS



Cognitive Architecture
how are stablished the relationships?





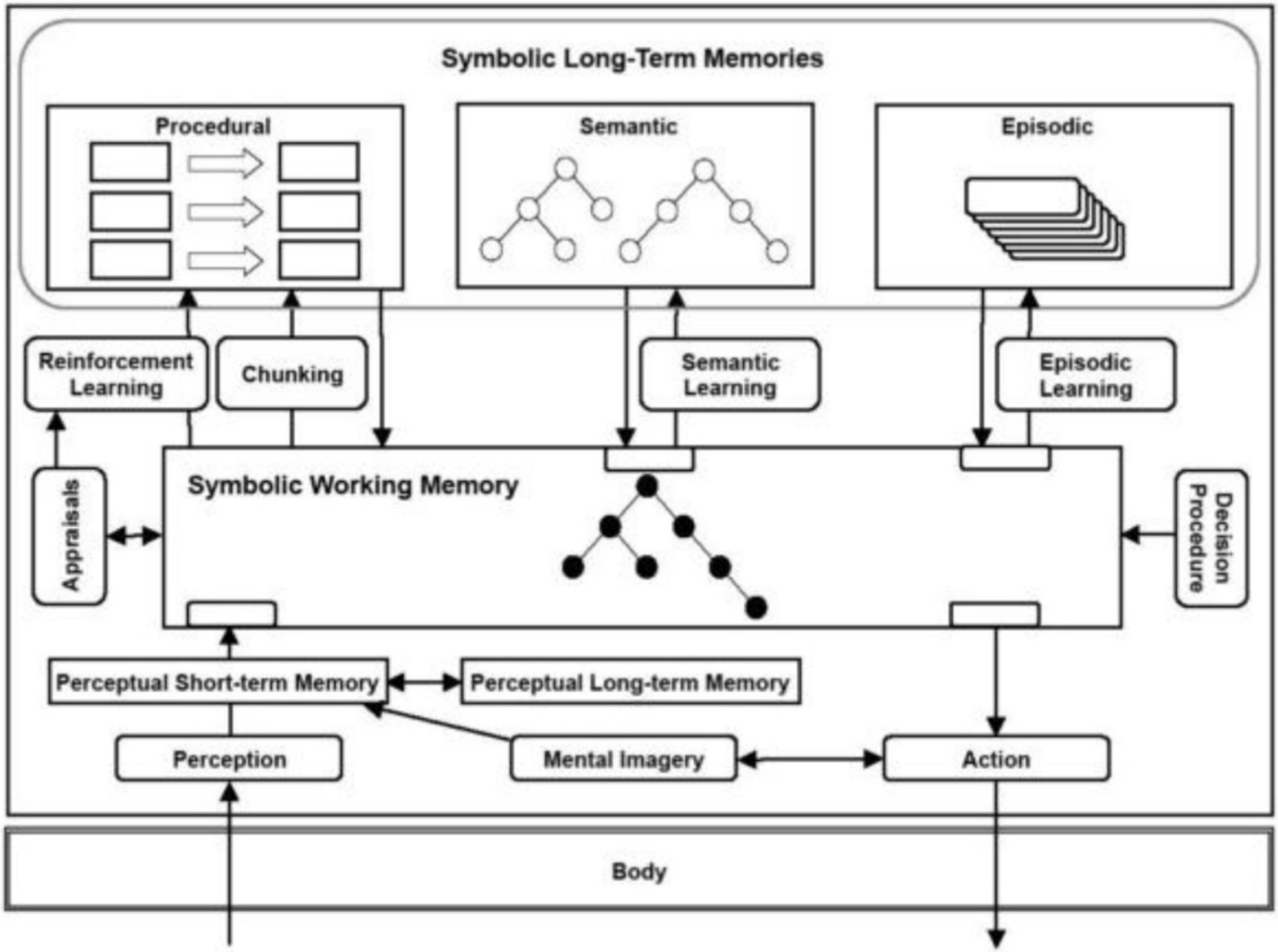
Cognitive Architecture learning (embedded in all modules)

- Pervasive feature of cognitive systems
- At different (all) cognitive modules
- At different scales (spatial and temporal)

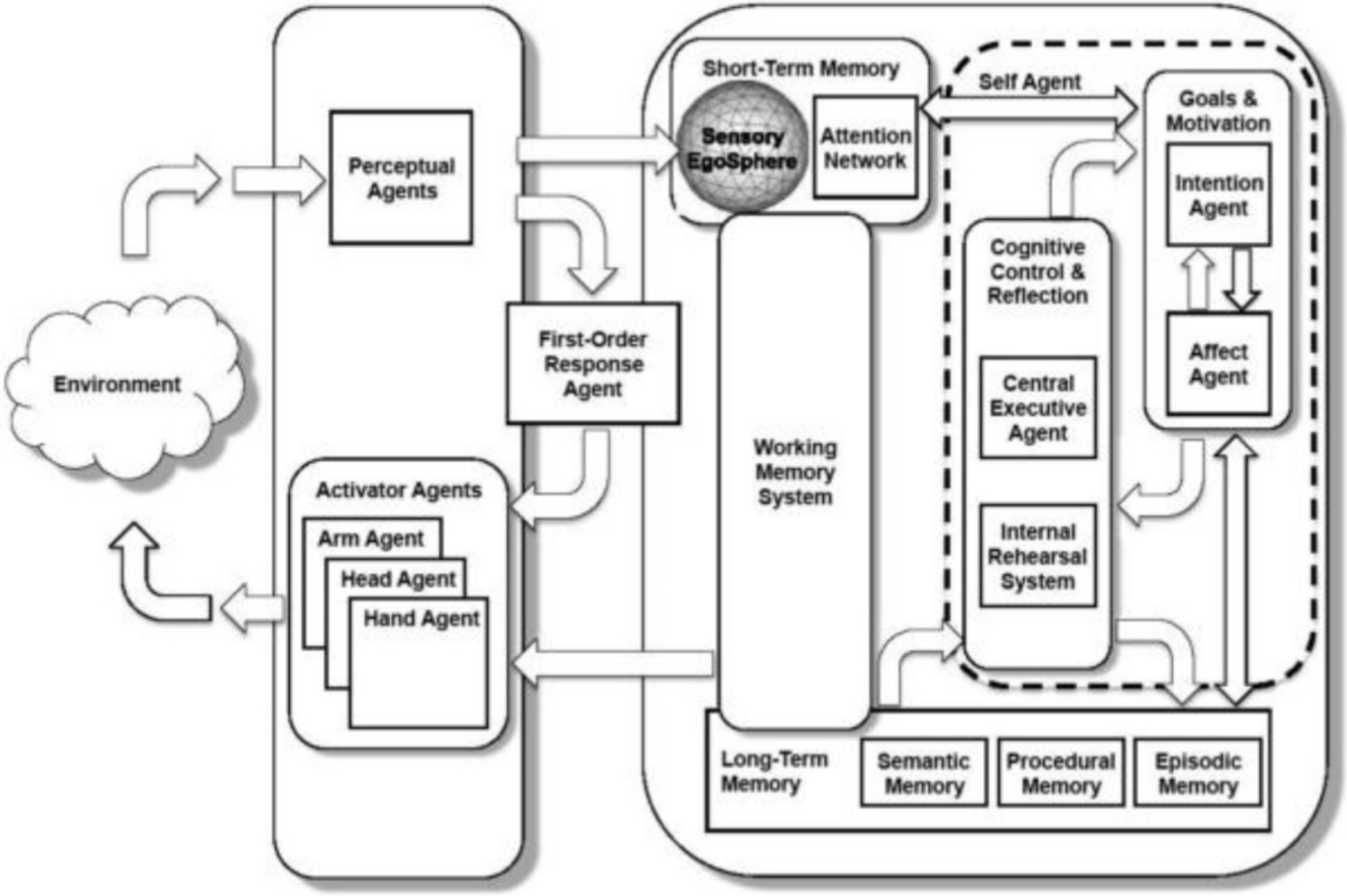
Cognitive Architecture

- Top-Down
  - Cognitivism
  - Engineered
- Bottom-Up
  - 4E: embodied, embedded, enacted, extended
  - Emergent

Cognitive Architecture: Soar



Cognitive Architecture: ISAC



Cognitive Architecture

- Some reflections
  - In fact all proposed architectures have been conceived by us, and so are engineered
  - Even those exploiting emergent concepts (as Woxbot) are also engineered.
  - Although engineered solutions impose some limitations, these can be weaker once we add learning and self adaptive features to the conceived system

Cognitive Architecture

- There is a huge open area to be exploited
- Take the chance and make your contributions

This is all for today.

See you next week !