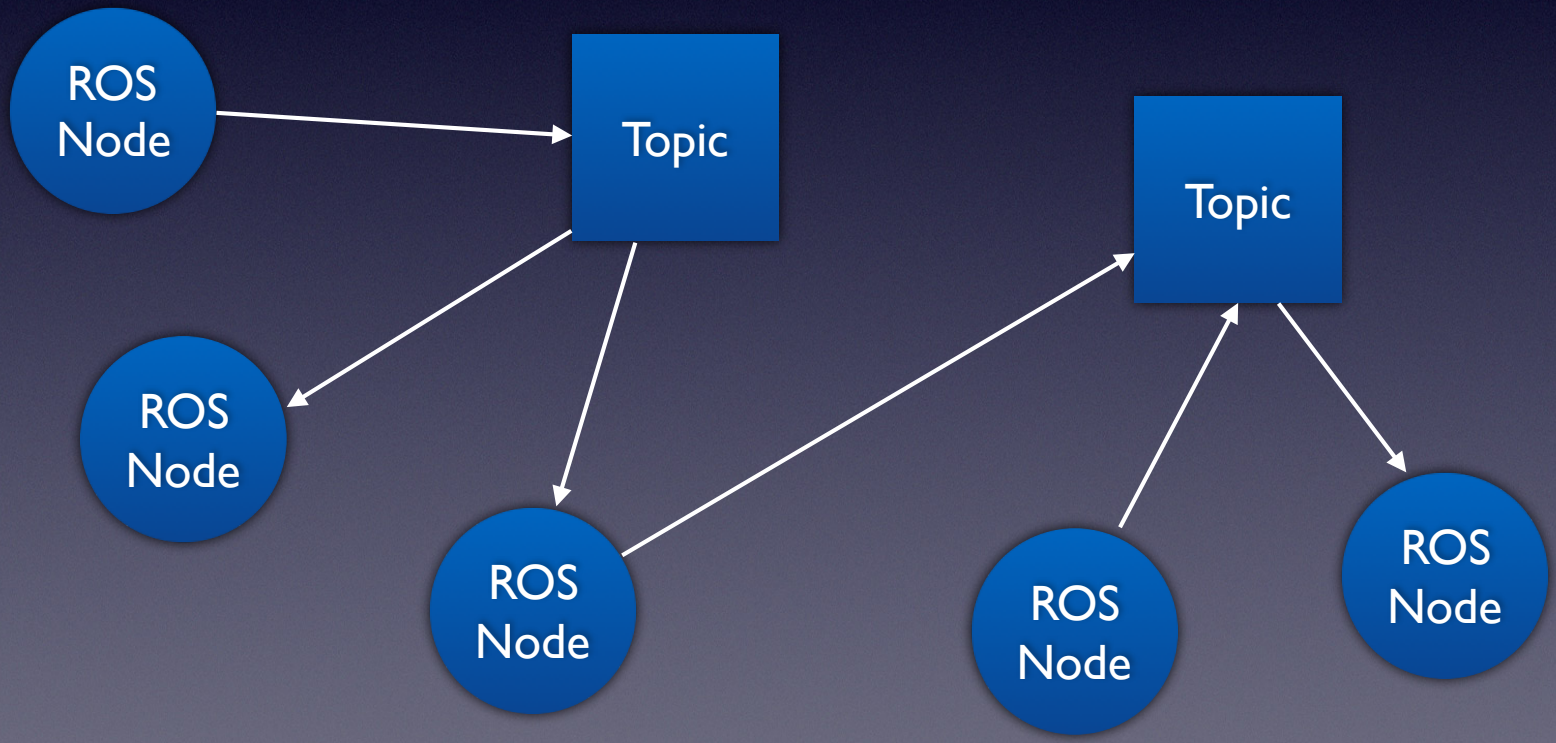
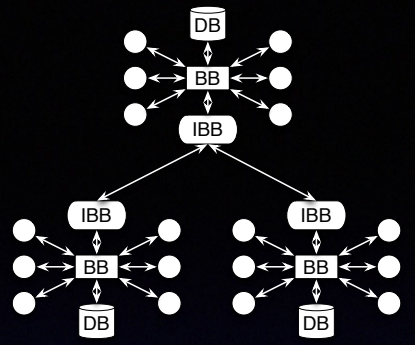
Software vs Cognitive Architectures

Robot Operating System (ROS)



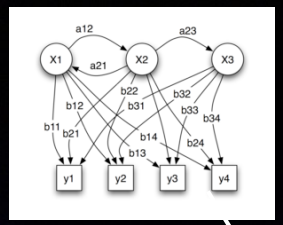
Blackboards



- Agents communicate by posting objects to blackboard
- Objects are timestamped and logged to a database
  - enables introspection and learning
- An agent subscribes to objects of specified types
- Agent is activated when object of the right type is posted

audio input

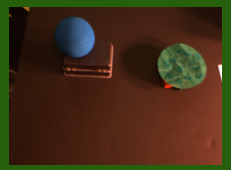
speech recognition



natural language processing

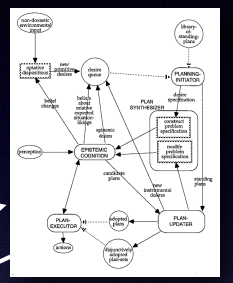
```
<postal-address> ::= <name-part> <street-address>
<name-part> ::= <personal-part> <last-name> <opt-jr>
<personal-part> ::= <first-name> | <initial> "."
<street-address> ::= <opt-apt-num> <house-num> <street>
<zip-part> ::= <town-name> "," <state-code> <ZIP-code>
<opt-jr-part> ::= "Sr." | "Jr." | <roman-numeral> | ""
```

stereo camera



“pick up the green ball”

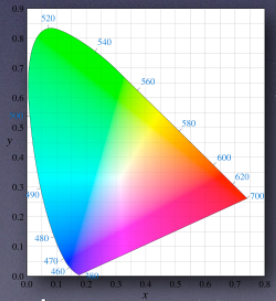
pickup(B)



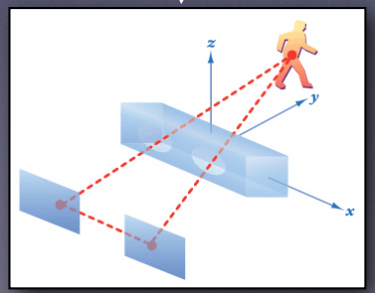
planner

move(..)

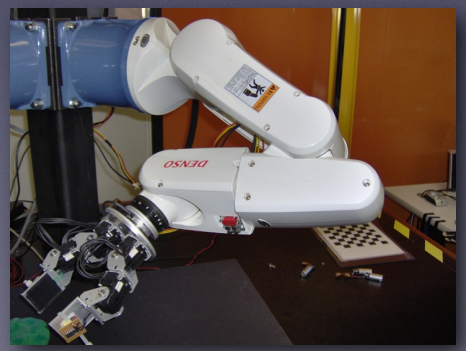
tactile sensors



colour recognition



depth analysis

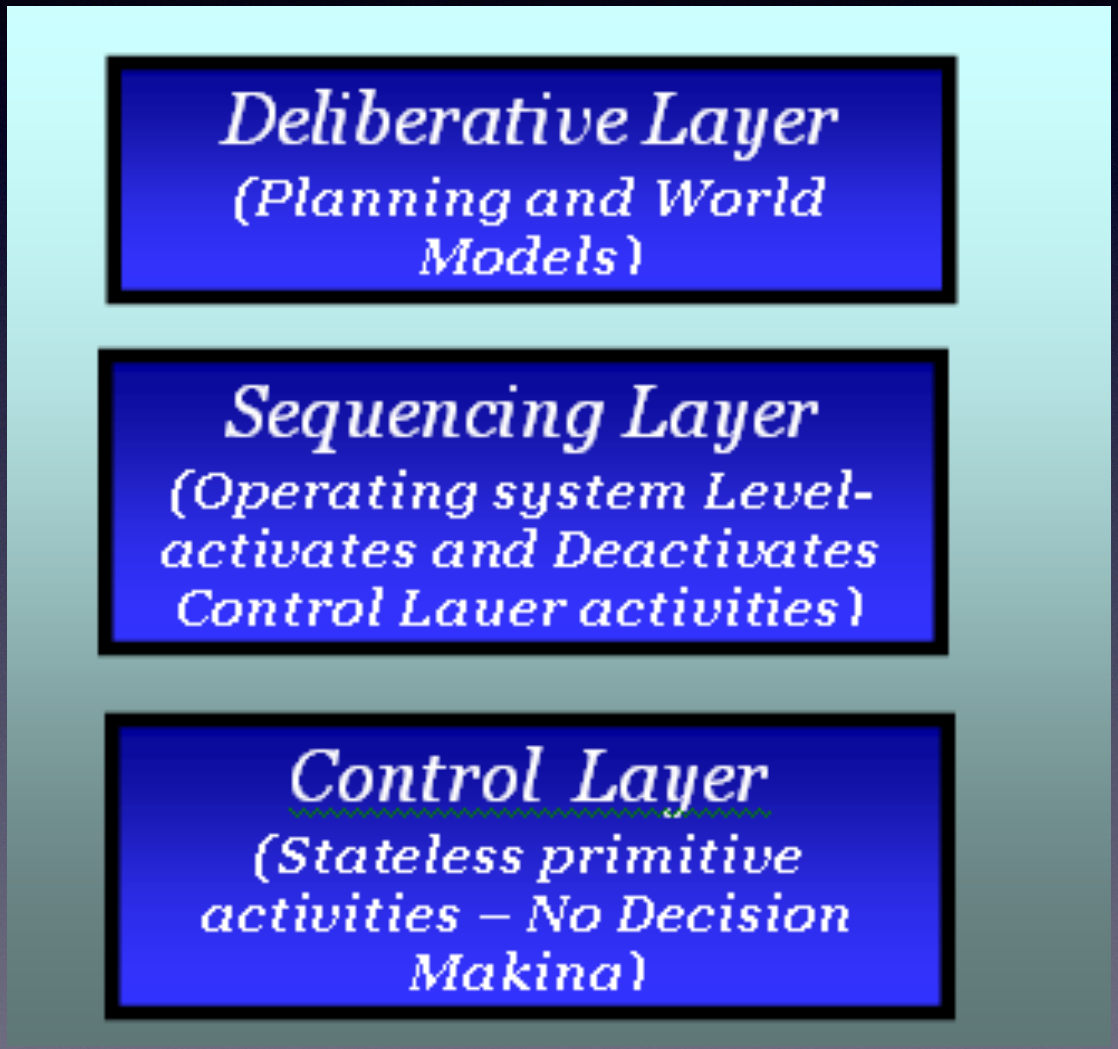


motor actions

Robot software architectures

- Most robot systems are ad hoc combinations of components
- Supported by software architectures (e.g. ROS)
- No principled way of combining components
- No principled way of extending system or components through learning

Three-Layer Architecture

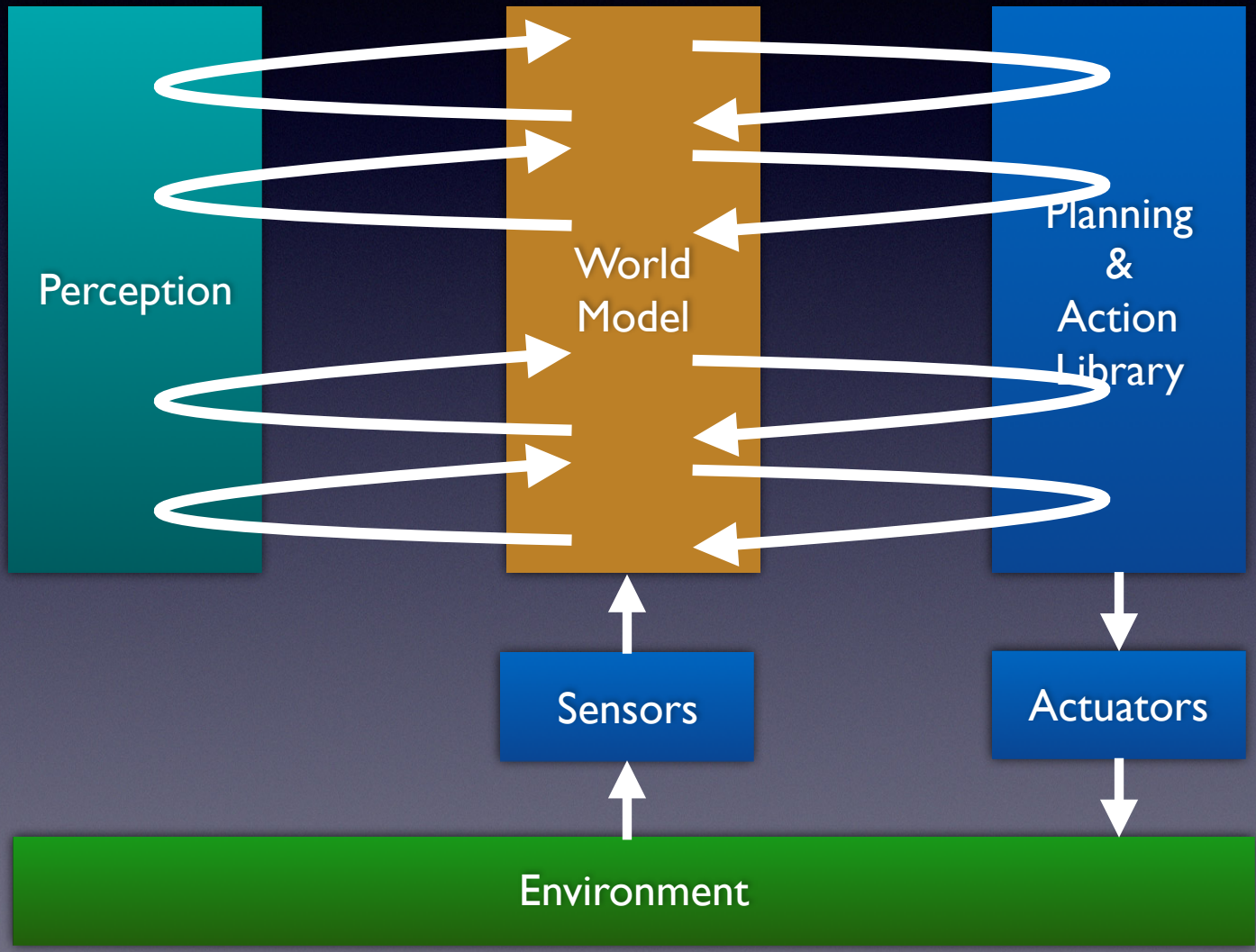


Gat (1992)

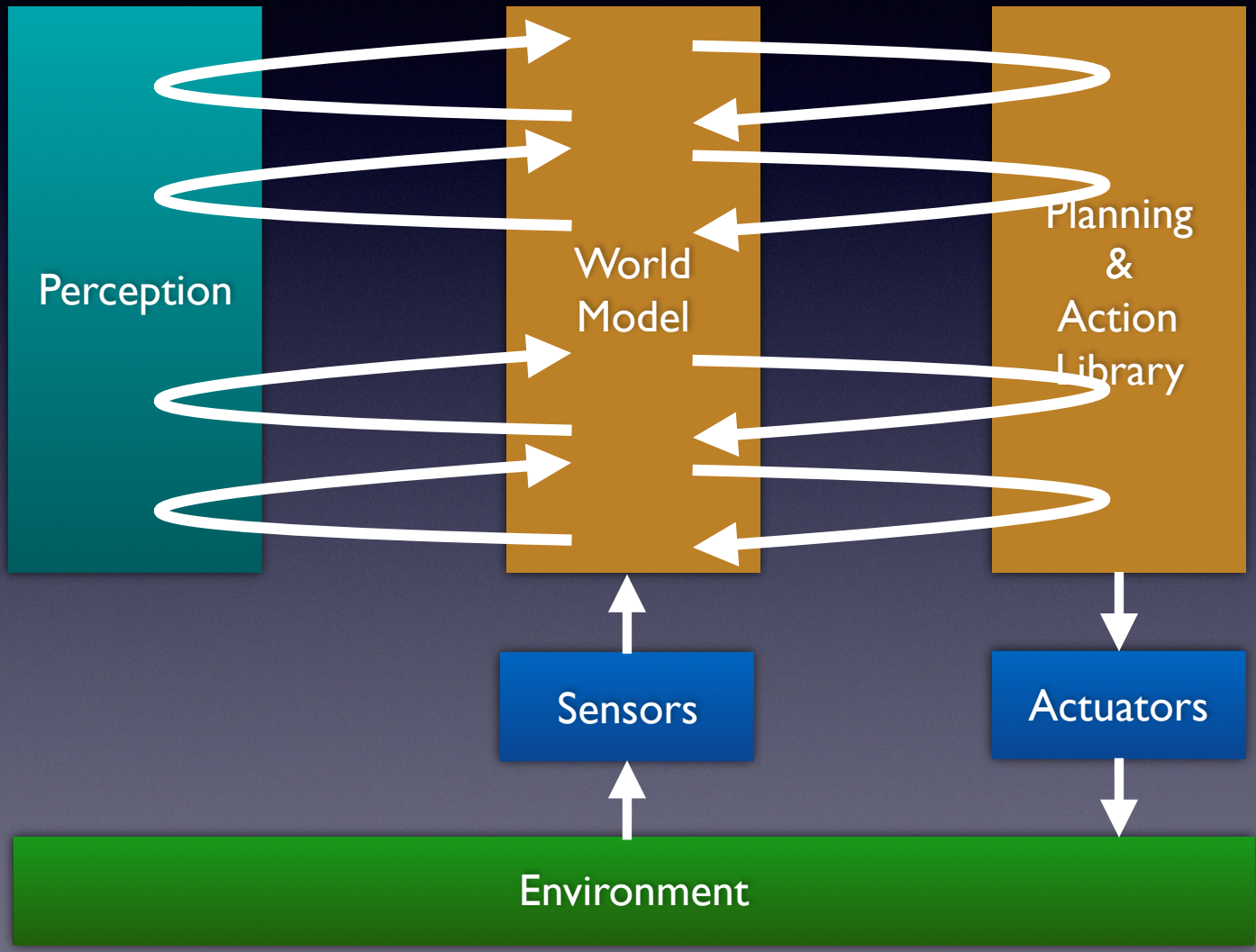
Scales in the Hierarchy

- General, deterministic, persistent, slow, human readable
- Specialised, stochastic, transient, fast, unreadable

Nilsson's Triple Tower

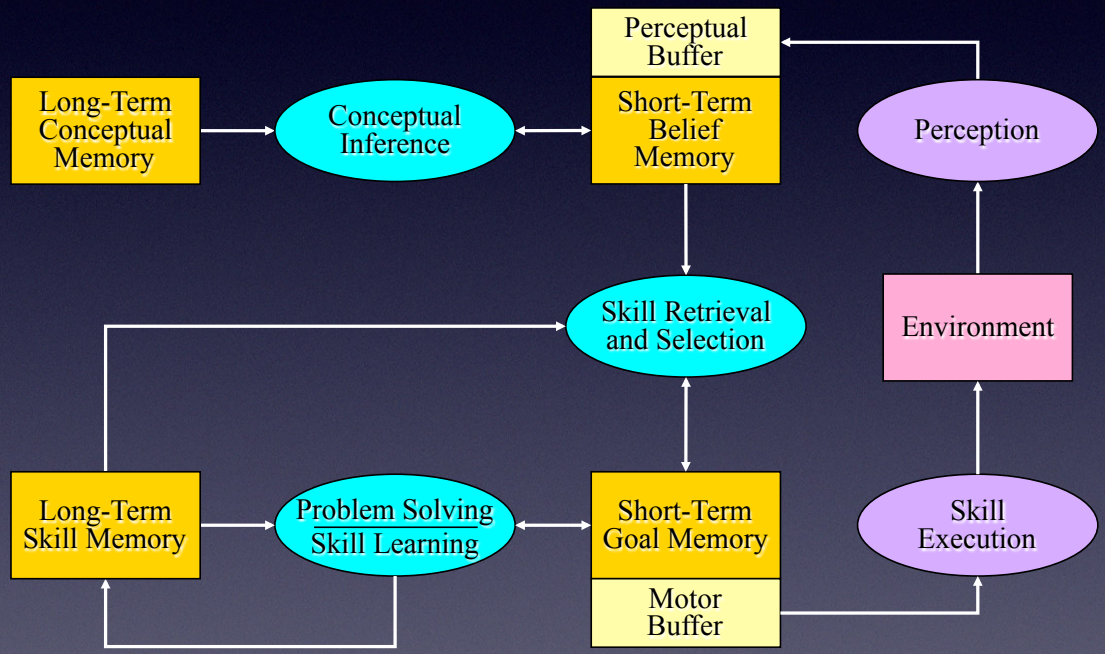


Nilsson's Triple Tower



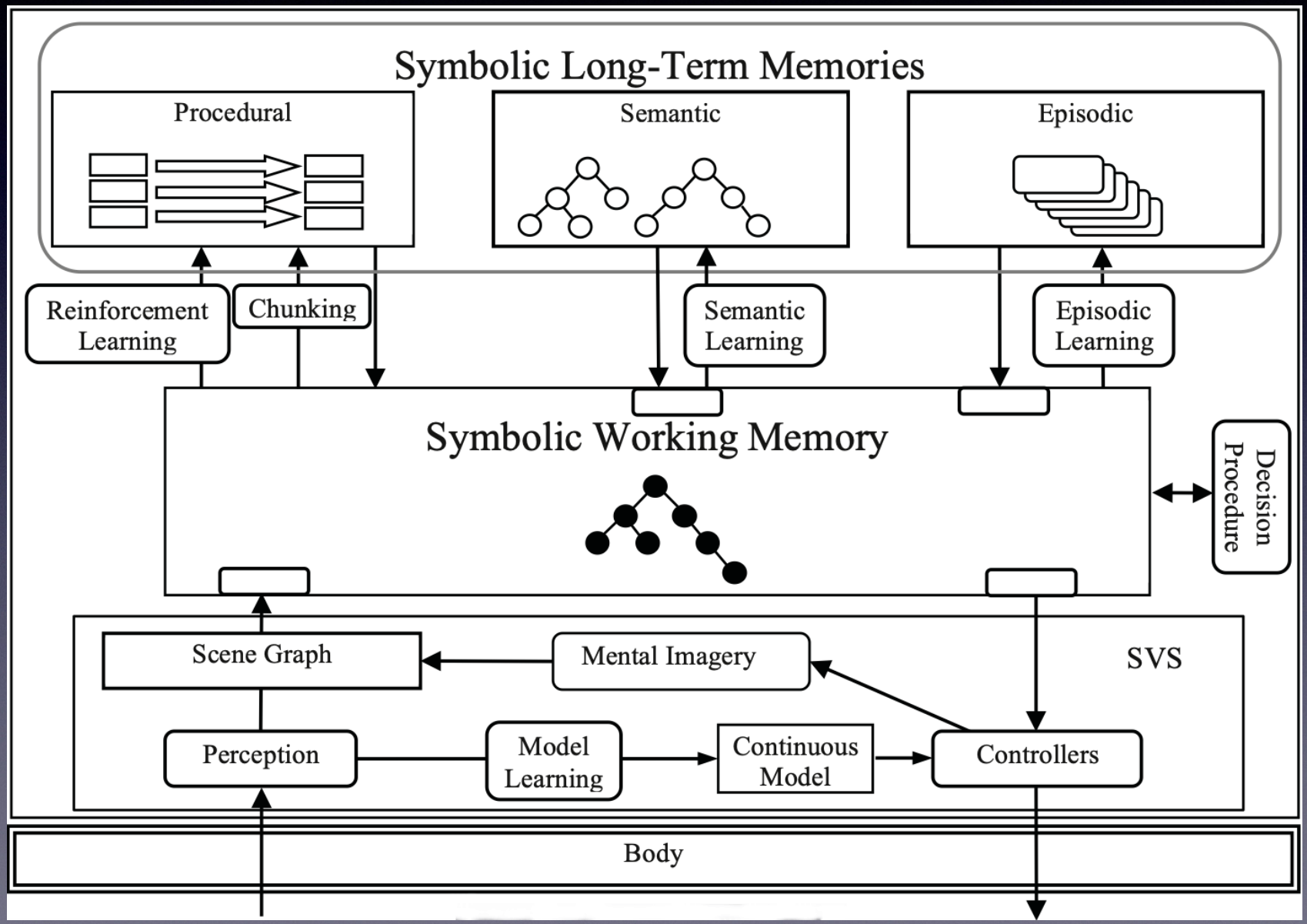
Cognitive Architectures for Robots

- How to integrate these specialised components?
- What is an appropriate architecture?

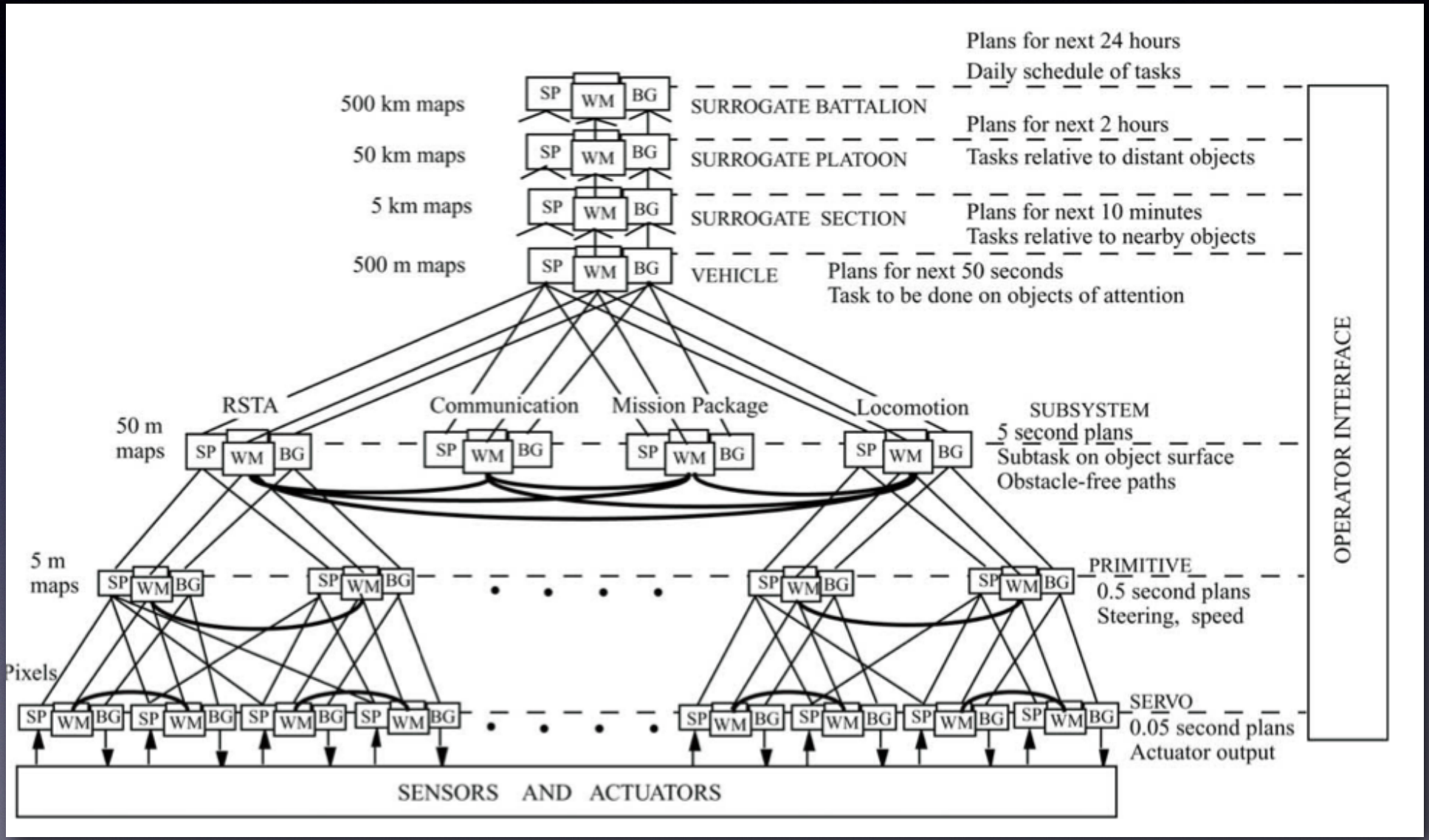


Icarus – Langley

SOAR


Symbolic Long-Term Memories
Procedural
Semantic
Episodic
Reinforcement Learning
Chunking
Semantic Learning
Episodic Learning
Symbolic Working Memory
Decision Procedure
Scene Graph
Mental Imagery
SVS
Perception
Model Learning
Continuous Model
Controllers
Body

RCS (Albus)


Plans for next 24 hours
Daily schedule of tasks
500 km maps
SURROGATE BATTALION
Plans for next 2 hours
50 km maps
SURROGATE PLATOON
Tasks relative to distant objects
5 km maps
SURROGATE SECTION
Plans for next 10 minutes
Tasks relative to nearby objects
500 m maps
VEHICLE
Plans for next 50 seconds
Task to be done on objects of attention
RSTA
Communication
Mission Package
Locomotion
50 m maps
SUBSYSTEM
5 second plans
Subtask on object surface
Obstacle-free paths
5 m maps
PRIMITIVE
0.5 second plans
Steering, speed
Pixels
SERVO
0.05 second plans
Actuator output
SP
WM
BG
SENSORS AND ACTUATORS
OPERATOR INTERFACE