Introduction to Robotics

Lecture 12

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Technical Aspects of Multimodal Systems

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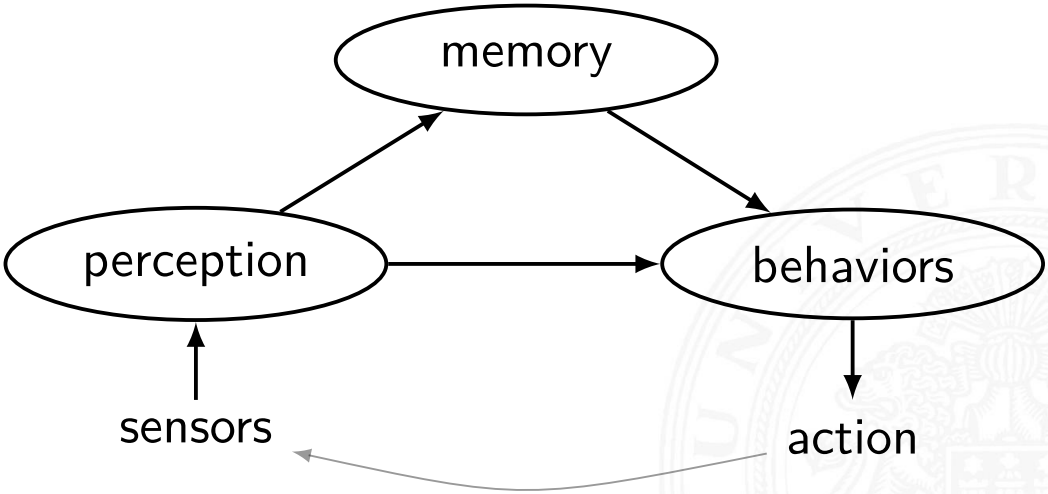
Outline

Outline (cont.)

Overview

- Basic behavior
- Behavior fusion
- Subsumption
- Hierarchical architectures
- Interactive architectures

The Perception-Action-Model with Memory



CMAC: `Cerebellar Model Articulation Controller`

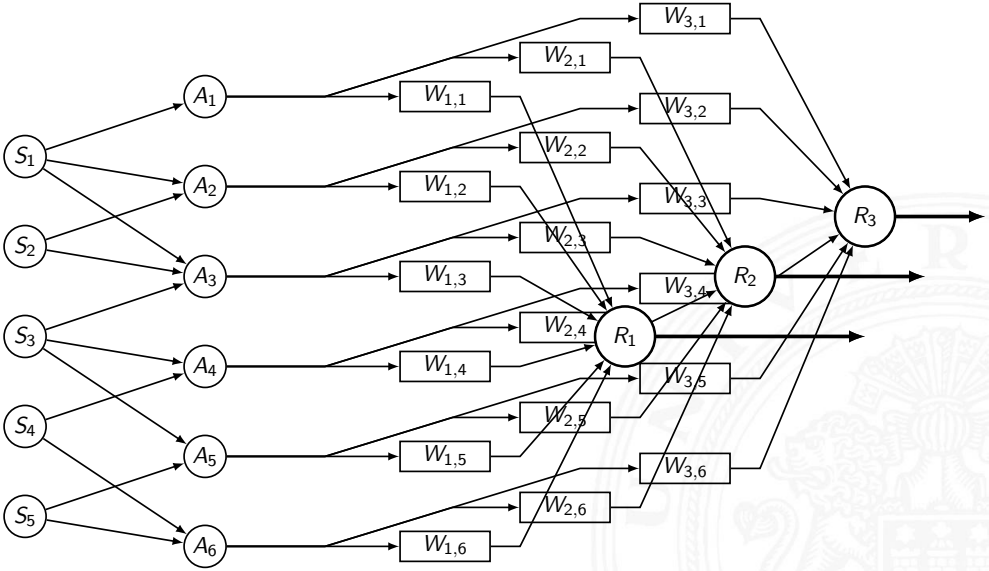
- **S** sensory input vectors (firing cell patterns)
- **A** association vector (cell pattern combination)
- **P** response output vector ($\mathbf{A} \cdot W$)
- W weight matrix

The CMAC model can be viewed as two mappings:

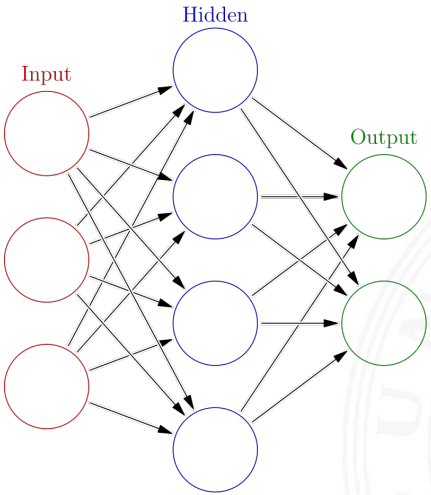
$$f : \mathbf{S} \longrightarrow \mathbf{A}$$

$$g : \mathbf{A} \xrightarrow{W} \mathbf{P}$$

CMAC-Model (cont.)

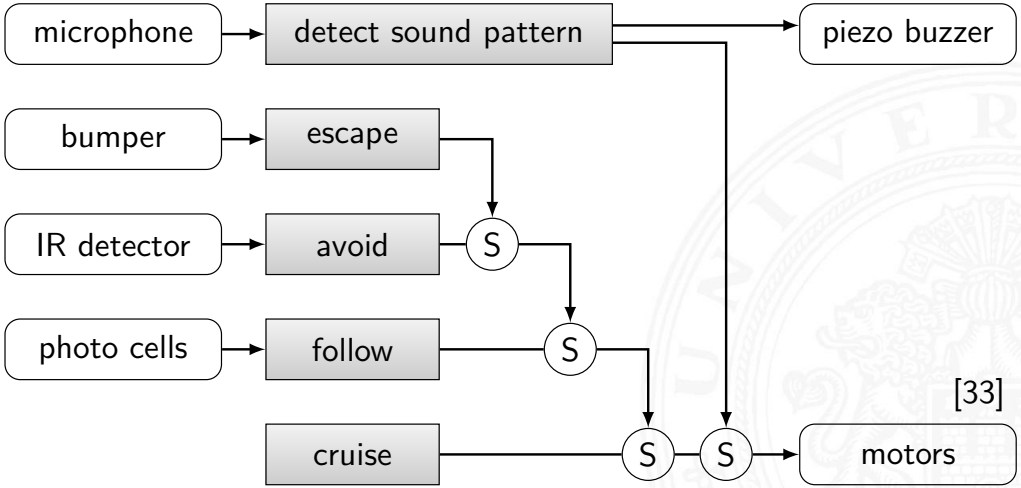


Artificial neural networks (ANN) or connectionist systems are computing systems vaguely inspired by the biological neural networks that constitute animal brains.



The Subsumption Architecture

- hierarchical structure of behavior
- higher level behaviors subsumpe lower level behaviors

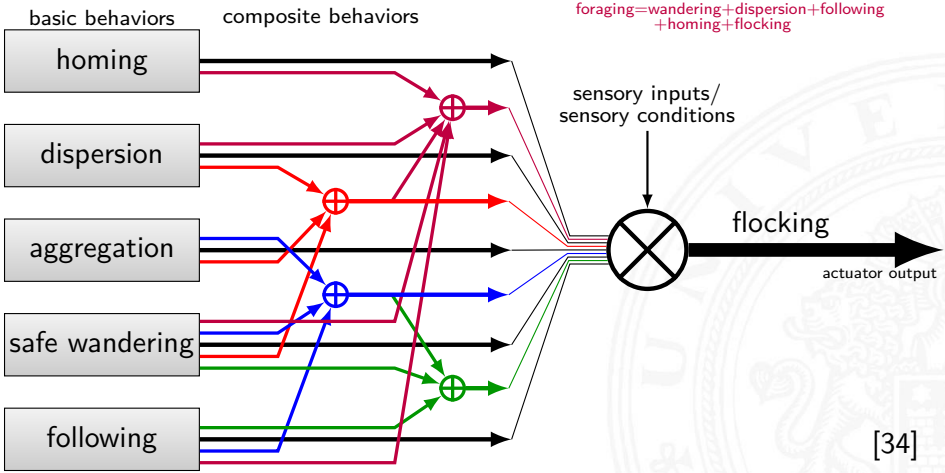


[33]

Foraging and Flocking

- multi-robot architecture
- basic behaviors are sequentially executed

flocking=wandering+aggregation+dispersion
surrounding=wandering+following+aggregation
herding=wandering+surrounding+flocking
foraging=wandering+dispersion+following +homing+flocking



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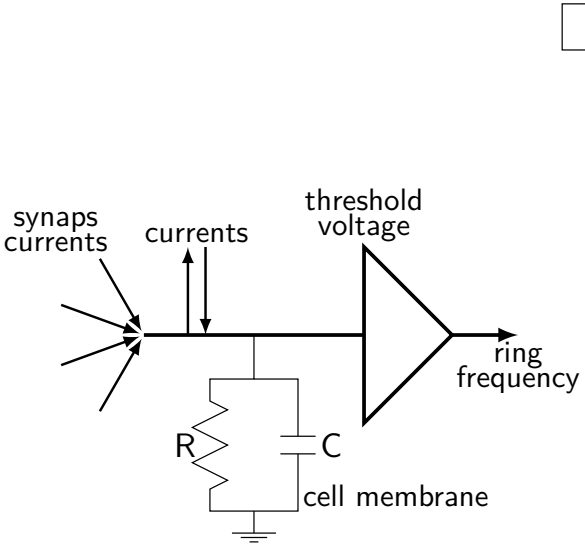

SENSORS
BEHAVIORS
mouth tactile
mouth chemical
antenna chemical
antenna
ingestion
finding food
edge following
wandering
synaps currents
currents
threshold voltage
ring frequency
R
C
cell membrane

Control and information flow in artificial fish

Perception sensors, focuser, filter

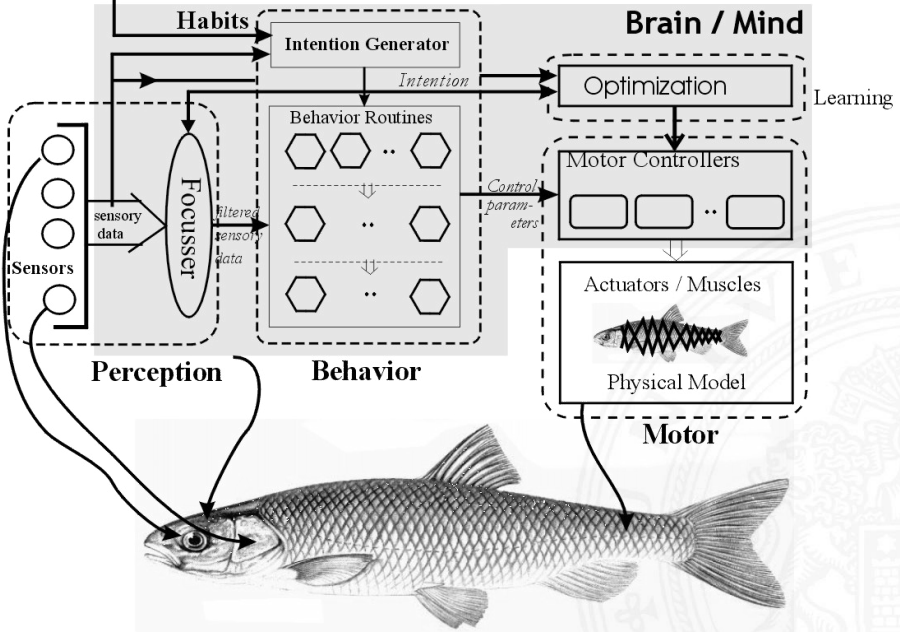
Behaviors behavior routines

Brain/mind habits, intention generator

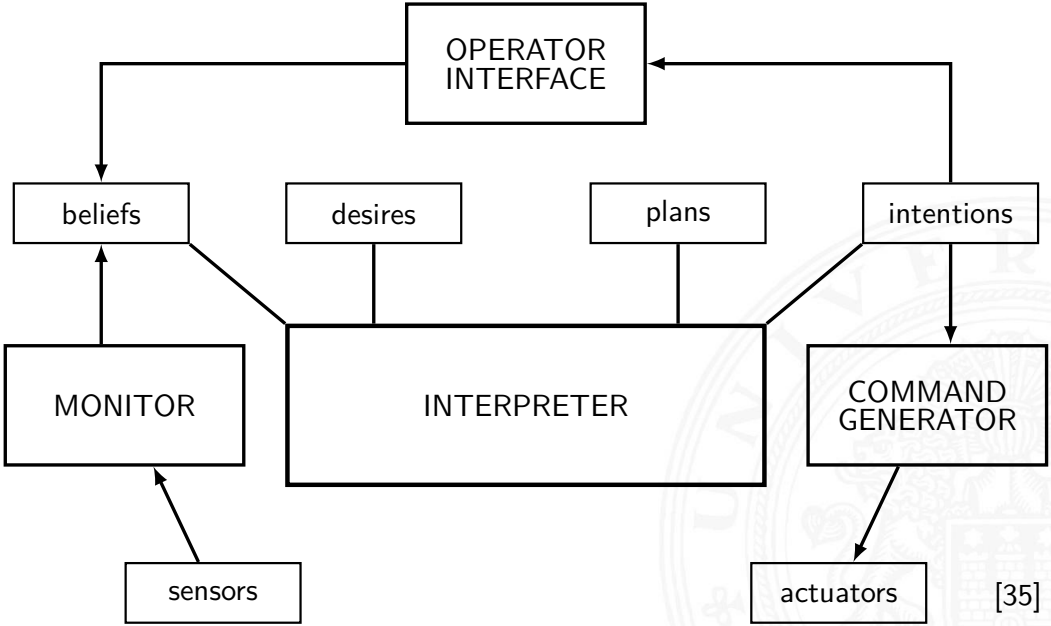
Learning optimization

Motor motor controllers, actuators/muscles

Control Architecture of a Fish (cont.)



Procedural Reasoning System



[35]

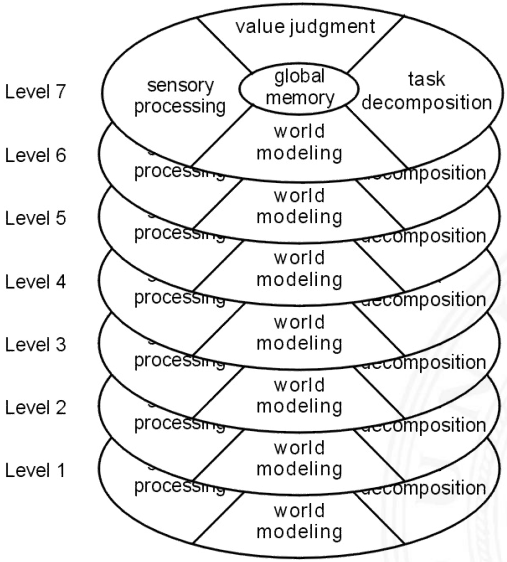
Real-Time Control System (RCS)

- RCS reference model is an architecture for intelligent systems.
- Processing modes are organized such that the BG (Behavior Generation) modules form a command tree.
- Information in the knowledge database is shared between WM (World Model) modules in nodes within the same subtree.

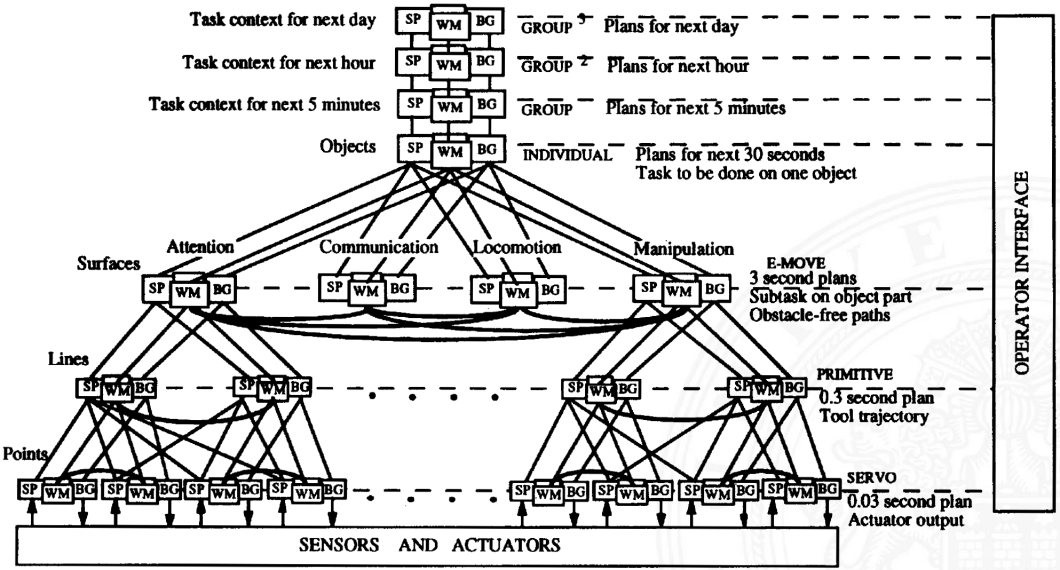
[36]

Examples of functional characteristics of the BG and WM modules:

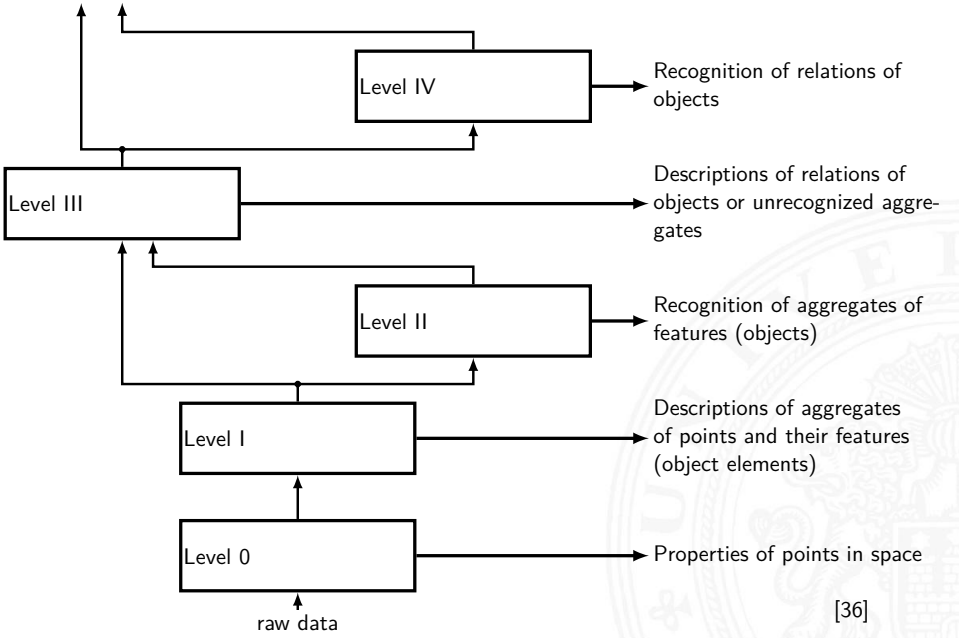
Hierarchy (cont.)



Hierarchy (cont.)

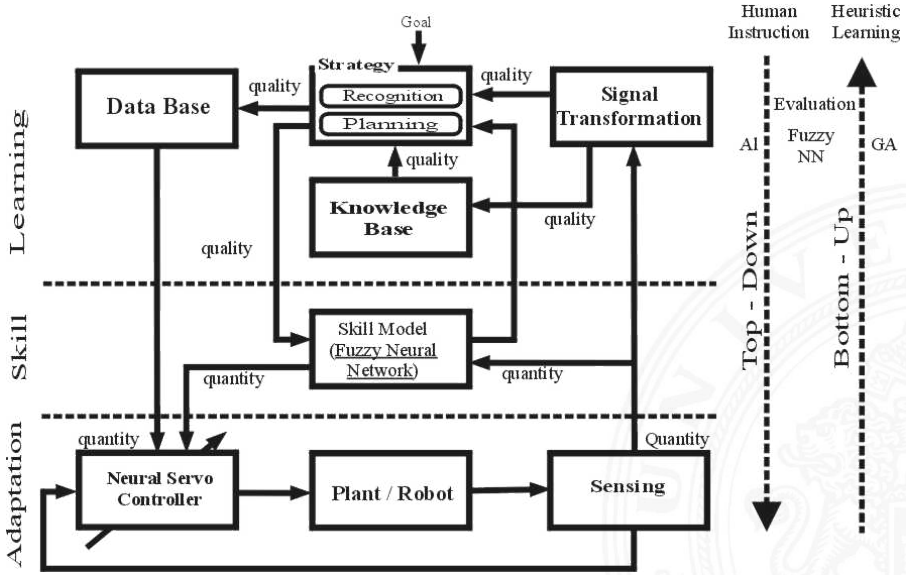


Sensor-Hierarchy



[36]

An Architecture for Learning Robots



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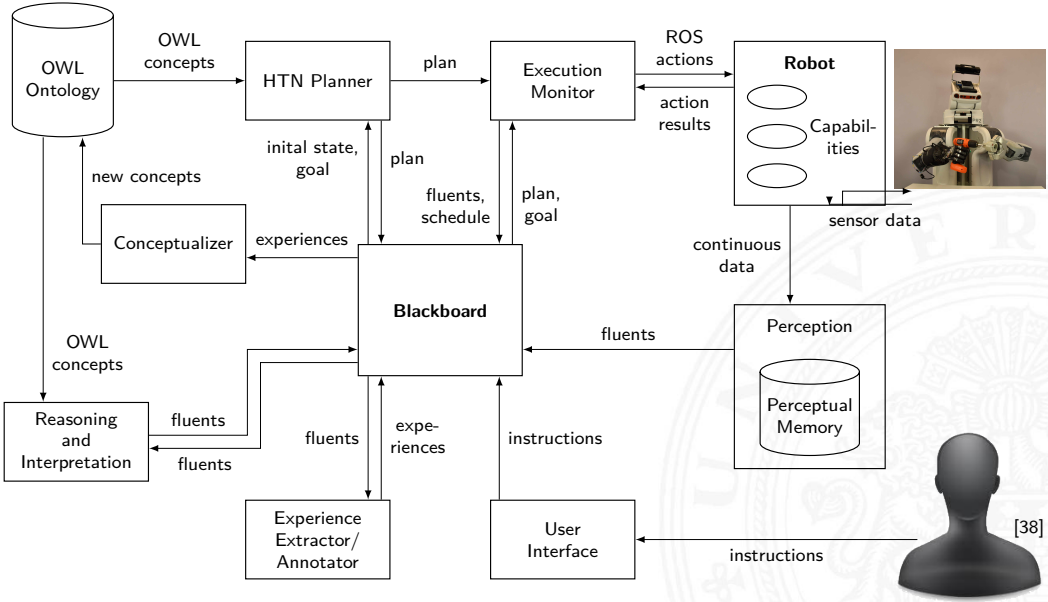
OWL Ontology
OWL concepts
HTN Planner
plan
Execution Monitor
ROS actions
action results
Robot
Capabil-ities
new concepts
inital state, goal
plan
fluents, schedule
plan, goal
Conceptualizer
experiences
Blackboard
sensor data
continuous data
Perception
Perceptual Memory
fluents
OWL concepts
Reasoning and Interpretation
fluents
fluents
fluents
expe-riences
instructions
Experience Extractor/ Annotator
User Interface
instructions
[38]

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