Agent Architectures and Hierarchical Control

Overview:
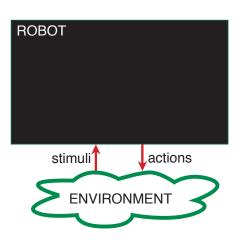
- Agents and Robots
- Agent systems and architectures
- Agent controllers
- Hierarchical controllers

Agents and Robots

A situated agent perceives, reasons, and acts in time in an environment.

- An **agent** is something that acts in the world.

- A **purposive agent** prefers some states of the world to other states, and acts to try to achieve worlds they prefer.

- Agents interact with the environment with a **body**.

- An **embodied** agent has a physical body.

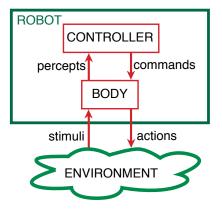- A **robot** is an artificial purposive embodied agent.

Agent Systems

A **agent system** is made up of a **agent** and an **environment.**

- An agent receives **stimuli** from the environment
- An agent carries out **actions** in the environment.

Agent System Architecture

An **agent** is made up of a **body** and a **controller**.

ROBOT

CONTROLLER

percepts | commands

BODY

stimuli | actions

ENVIRONMENT

- An agent interacts with the environment through its body.
- The **body** is made up of:
  - ▸ **sensors** that interpret stimuli
  - ▸ **actuators** that carry out actions
- The controller receives **percepts** from the body.
- The controller sends **commands** to the body.
- The body can also have reactions that are not controlled.

Implementing a controller

- A controller is the brains of the agent.
- Agents are situated in time, they receive sensory data in time, and do actions in time.
- Controllers have (limited) memory and (limited) computational capabilities.
- The controller specifies the command at every time.
- The command at any time can depend on the current and previous percepts.

The Agent Functions

- Let T be the set of time points.
- A **percept trace** is a sequence of all past, present, and future percepts received by the controller.
- A **command trace** is a sequence of all past, present, and future commands output by the controller.
- A **transduction** is a function from percept traces into command traces.
- A transduction is **causal** if the command trace up to time t depends only on percepts up to t.
- A **controller** is an implementation of a causal transduction.
- A causal transduction specifies a function from an agent's history at time t into its action at time t.
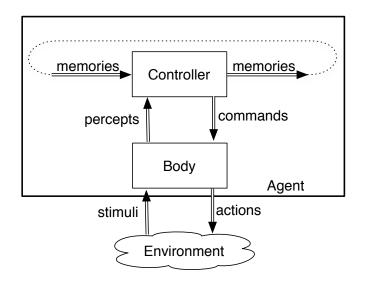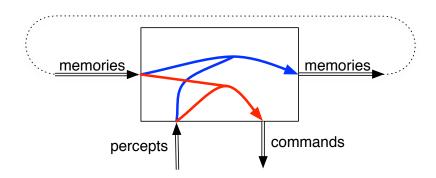
Belief States

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- The memory or belief state of an agent at time t encodes all of the agent's history that it has access to.
- The memory of an agent encapsulates the information about its past that it can use for current and future actions.

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- At every time a controller has to decide on:
  - What should it do?
  - What should it remember?
    (How should it update its memory?)
  — as a function of its percepts and its memory.

Controller

Functions implemented in a controller

For discrete time, a controller implements:

- **memory function** *remember(memory, percept)*, returns the next memory.
- **command function** *do(memory, percept)* returns the command for the agent.