Building Situated Robots

Overview:

- Agents and Robots
- Robot systems and architectures
- Robot 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.
- A robot is an artificial purposive agent.

What makes an agent?

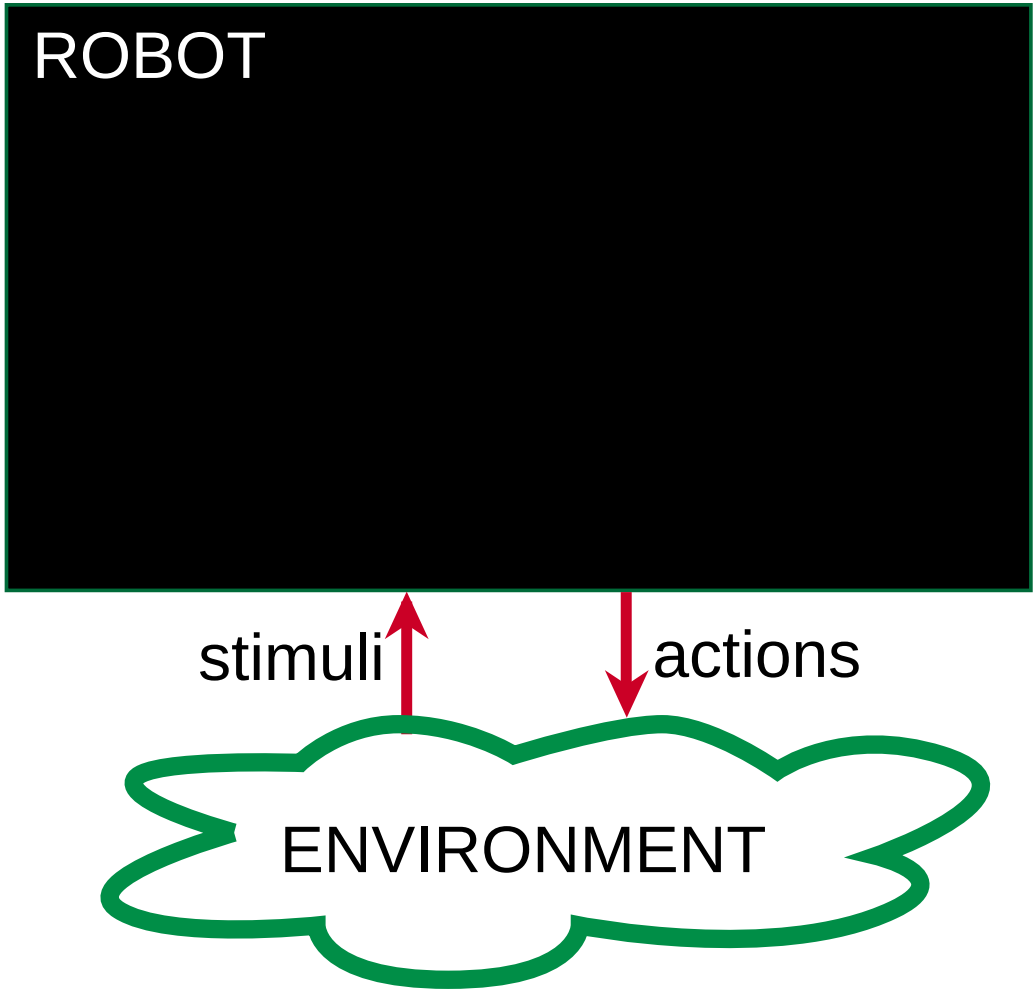
- Agents can have sensors and effectors to interact with the environment.
- Agents have (limited) memory and (limited) computational capabilities.
- Agents reason and act in time.

Robotic Systems

A robotic system is made up of a robot and an environment.

- A robot receives stimuli from the environment
- A robot carries out actions in the environment.

A robotic system

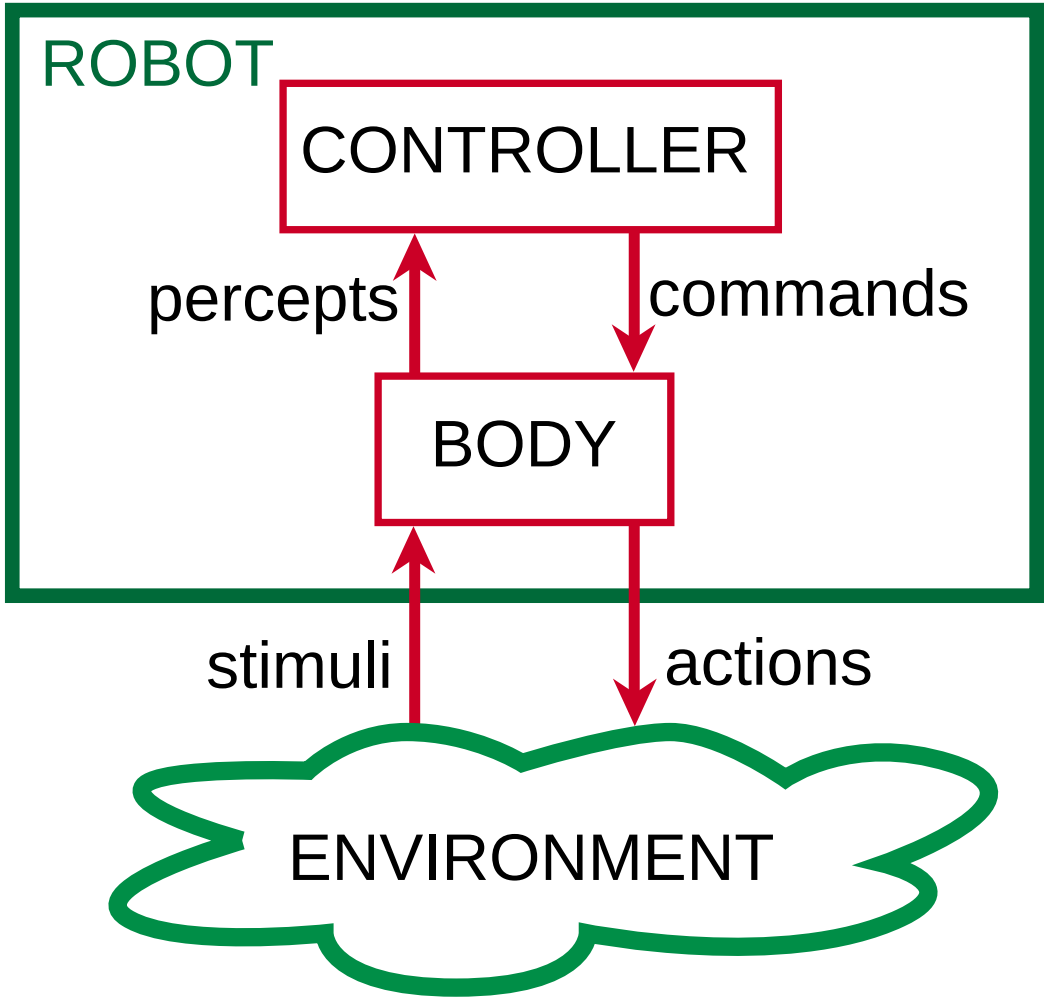


Robot

A robot is made up of a body and a controller.

- A robot 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.

A robotic system architecture



Implementing a controller

- A controller is the brains of the robot.
- Agents are situated in time, they receive sensory data in time, and do actions in time.
- 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 function from T into P, where P is the set of all possible percepts.
- A **command trace** is a function from T into C, where C is the set of all commands.
- A **transduction** is a function from percept traces into command traces that's **causal:** the action trace up to time t depends only on percepts up to t.
- A **controller** is an implementation of a transduction.

States

- A transduction specifies a function from an agent's history at time *t* into its action at time *t*.
- An agent doesn't have access to its entire history. It only has access to what it has remembered.
- The internal state or belief state of an agent at time *t* encodes all of the agent's history that it has access to.
- The belief state of an agent encapsulates the information about its past that it can use for current and future actions.

Functions implemented in a controller

For discrete time, a controller implements:

- a state transition function $\sigma : S \times P \rightarrow S$, where S is the set of belief states and P is the set of possible percepts.

  $s_{t+1} = \sigma(s_t, p_t)$ means that s_{t+1} is the belief state following belief state s_t when p_t is observed.

- A command function $\chi : S \times P \rightarrow C$, where S is the set of belief states, P is the set of possible percepts, and C is the set of possible commands.

  $c_t = \chi(s_t, p_t)$ means that the controller issues command c_t when the state is s_t and p_t is observed.