What is Artificial Intelligence?

- Artificial Intelligence is the synthesis and analysis of computational agents that act intelligently.
- An agent is something that acts in an environment.
- An agent acts intelligently if:
  - ▶ its actions are appropriate for its goals and circumstances; or
  - ▶ it is flexible to changing; or environments and goals; or
  - ▶ it learns from experience; or
 - ▶ it makes appropriate choices given perceptual and computational limitations.

Examples of Agents

- **Animals** : human, dog, mouse, bird, insect, worm, ...
- **Biological cells** : bacterium, neuron, ...
- **Organisations** : Microsoft, NZ Government, CSSE Department, UC, ...
- **Software and devices** : thermostat, user interface, airplane controller, network controller, game, advising system, tutoring system, diagnostic assistant, robot, Google car, Mars rover, ...

Goals of Artificial Intelligence

- **Scientific goal:** to understand the principles that make intelligent behavior possible in natural or artificial systems.
  - ▶ analyze natural and artificial agents;
  - ▶ formulate and test hypotheses about what it takes to construct intelligent agents;
  - ▶ design, build, and experiment with computational systems that perform tasks that require intelligence.
- **Engineering goal:** design useful, intelligent artifacts.
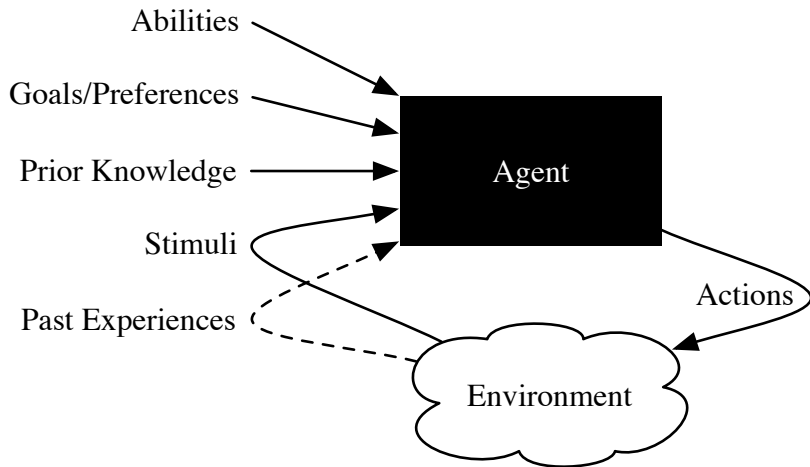
# Inputs to an agent

- Abilities — the set of possible actions it can perform
- Goals/Preferences — what it wants, its desires, its values,...
- Prior Knowledge — what it comes into being knowing, what it doesn't get from experience,...
- History of stimuli
  - (current) stimuli — what it receives from environment now (observations, percepts)
  - past experiences — what it has received in the past

Example agent: autonomous car

- **abilities:** steer, accelerate, brake
- **goals:** safety, get to destination, timeliness,...
- **prior knowledge:** what signs mean, what to stop for
- **stimuli:** vision, laser, GPS...
- **past experiences:** streetmaps, how breaking, steering affects direction..

Domain for Delivery Robot
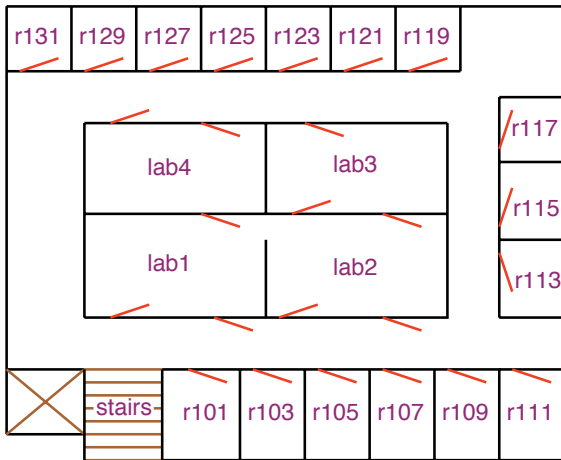
Autonomous Delivery Robot

Example inputs:

- **Abilities:** movement, speech, pickup and place objects.
- **Prior knowledge:** its capabilities, objects it may encounter, maps.
- **Past experience:** which actions are useful and when, what objects are there, how its actions affect its position.
- **Goals:** what it needs to deliver and when, tradeoffs between acting quickly and acting safely.
- **Stimuli:** about its environment from cameras, sonar, sound, laser range finders, or keyboards.

Domain for Diagnostic Assistant in a Smart Home

outside power

circuit breaker

off

switch

on

two-way switch

light

power outlet
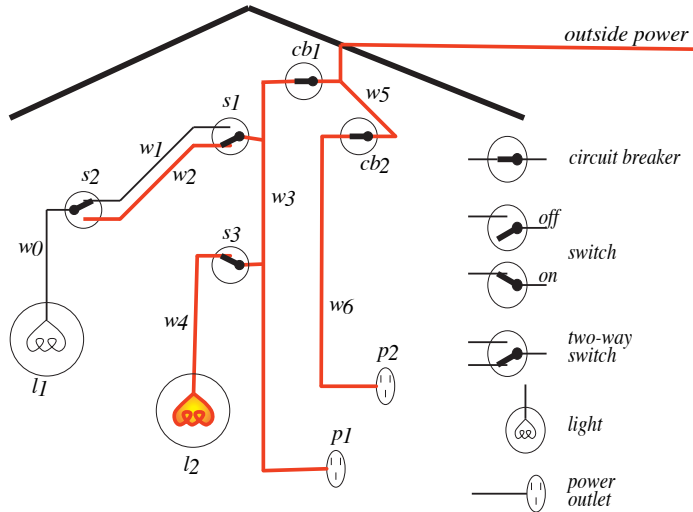
# Diagnostic Assistant

Example inputs:

- **Abilities:** recommends fixes, ask questions.
- **Prior knowledge:** how switches and lights work, how malfunctions manifest themselves, what information tests provide, the side effects of repairs.
- **Past experience:** the effects of repairs or treatments, the prevalence of faults or diseases.
- **Goals:** fixing the device and tradeoffs between fixing or replacing different components.
- **Stimuli:** symptoms of a device or patient.

Common Tasks of the Domains

- **Modeling the environment** Build models of the physical environment, patient, or information environment.

- **Evidential reasoning or perception** Given observations, determine what the world is like.

- **Action** Given a model of the world and a goal, determine what should be done.

- **Learning from past experiences** Learn about the specific case and the population of cases.

Agent System Architecture

An **agent** is made up of a **body** and a **controller** .
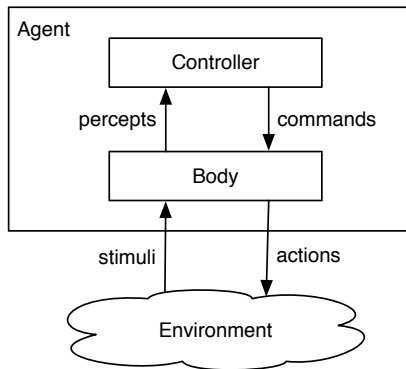
- An agent interacts with the environment through its body.
- The **body** is made up of:
  - ▶ **sensors** that interpret stimuli
  - ▶ **actuators** that carry out actions
- The controller receives **percepts** from the body.
- The controller sends **commands** to the body.
- The body can also have 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.

Controller
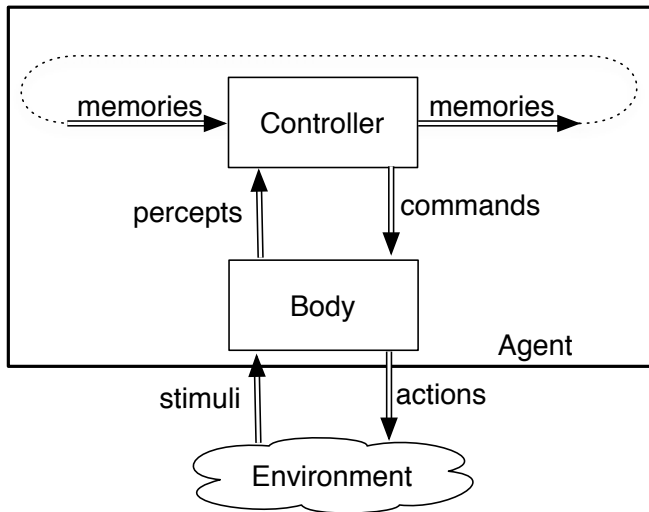
Hierarchical Robotic System Architecture
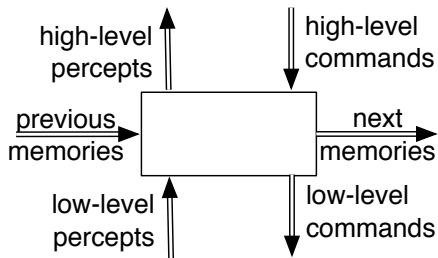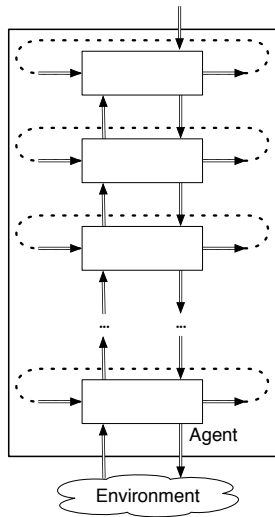
Example: delivery robot

- The robot has three actions: go straight, go right, go left. (Its velocity doesn't change).
- It can be given a **plan** consisting of sequence of named locations for the robot to go to in turn.
- The robot must avoid obstacles.
- It has a single **whisker sensor** pointing forward and to the right. The robot can detect if the whisker hits an object. The robot knows where it is.
- The obstacles and locations can be moved dynamically. Obstacles and new locations can be created dynamically.

A Decomposition of the Delivery Robot