CSE-411
Fundamentals of Artificial Intelligence

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Success in creating AI might be the biggest event in human history. Unfortunately, it might also be the last, unless we learn how to avoid the risks.

Stephen Hawking

Outline

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What is Artificial Intelligence?

- Starting with the famous definition from **Alan Turing**:
  - Actions that are indistinguishable from a human's.
- One of my favorite definition is from **Elain Rich**:
  - Artificial Intelligence (AI) studies how we can make the computer do things that humans can still do better at the moment.
- And a more technical definition from **David Marr**:
  - AI is the study of complex information processing problems that often have their roots in some aspect of biological information processing. The goal of the subject is to identify solvable and interesting information processing problems, and solve them.

Skills Needed for Artificial Intelligence

- A combination of the following skills would be needed for a machine to exhibit AI:
  - Perception
  - Language Understanding
  - Motor Skills (if the machine is a hardware device)
  - The ability to learn
  - Inference (both logical and statistical)
  - Emotion

Types of Artificial Intelligence

- Artificial Narrow Intelligence (ANI) / Weak AI
- Artificial General Intelligence (AGI) / Strong AI
- Artificial Super Intelligence (ASI)

Three Main Approaches to Solve AI

- Search
- Logic
- Machine Learning

Outline

Agent, Intelligent Agent, and Computational Agent

- Agent:
  - An agent is something that acts in an environment.
- Intelligent Agent:
  - What it does is appropriate for its circumstances and its goals, taking into account the short-term and long-term consequences of its actions
  - It is flexible to changing environments and changing goals
  - It learns from experience
  - It makes appropriate choices given its perceptual and computational limitations.
- Computational Agent:
  - A computational agent is an agent whose decisions about its actions can be explained in terms of computation.

Agent's Description using EAGPSP

- An Agent can be described using its EAGPSP description:

Environment:	its work-area
Activities:	the set of possible actions it can perform
Goals:	what it wants, its values,...
Prior Knowledge:	what it comes into being knowing, what it doesn't get from experience,...
Stimuli:	what it receives from the environment *NOW* (observations, percepts)
Past Experience:	what it has received in the past

EAGPSP Description - Autonomous (Driverless) Car

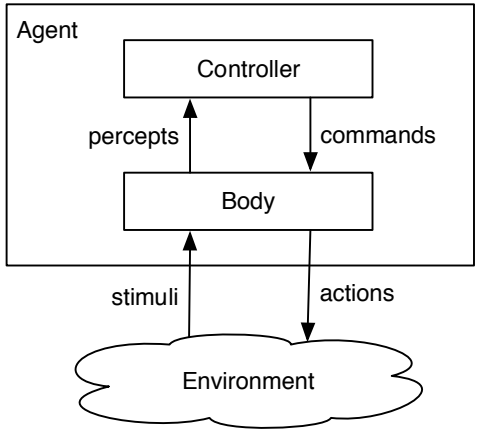
Environment:	Road
Activities:	steer, accelerate, brake
Goals:	safety, get to destination, timeliness ...
Prior Knowledge:	street maps, what signs mean, what to stop for ...
Stimuli:	vision, laser, GPS, voice commands ...
Past Experience:	how breaking and steering affects direction and speed ...

EAGPSP Description - Teacher

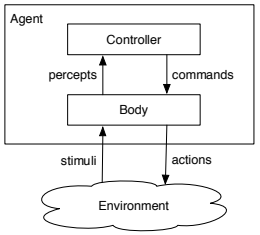
Environment:	Classroom
Activities:	explain concepts, present new concepts, prepare questions, take exams
Goals:	disseminate knowledge, develop skills
Prior Knowledge:	subject materials, teaching strategy
Stimuli:	test result, facial expression, error, focus
Past Experience:	prior test result, effects of teaching strategy

Agent System Architecture

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



Agent System Architecture Details



- The body is made up of **sensors** that interprets stimuli, and **actuators** that carry out actions.
- A controller is the **brain** of the agent.
- Agents are situated in time, they receive sensory data 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.

Outline

Simplifying Assumptions Made in Building an AI System

- Building an agent needs several simplifying assumptions along several dimensions of complexity. Some of these dimensions are:
  - Modularity
  - Planning Horizon
  - Representation
  - Computational Limits
  - Learning
  - Uncertainty
    - Sensing Uncertainty
    - Effect Uncertainty
  - Goal / Preference
  - Number of Agents
  - Interaction with the environment

Dimension of Complexity

Dimension	Values
Modularity	flat, modular, hierarchical
Planning Horizon	non-planning, finite stage, indefinite stage, infinite stage
Representation	states, features, relations
Computational Limits	perfect rationality, bounded rationality
Learning	knowledge is given, knowledge is learned
Sensing Uncertainty	fully observable, partially observable
Effect Uncertainty	deterministic, stochastic
Preference	goals, complex preferences
Number of Agents	single agent, multiple agents
Interaction	offline, online

Dimension of Complexity Example: Human

Dimension	Values
Modularity	flat, modular, **hierarchical**
Planning Horizon	non-planning, finite stage, **indefinite stage**, **infinite stage**
Representation	states, features, **relations**
Computational Limits	perfect rationality, **bounded rationality**
Learning	knowledge is given, **knowledge is learned**
Sensing Uncertainty	fully observable, **partially observable**
Effect Uncertainty	deterministic, **stochastic**
Preference	goals, **complex preferences**
Number of Agents	single agent, **multiple agents**
Interaction	offline, **online**

Dimension of Complexity Example: State Space Search

Dimension	Values
Modularity	**flat**, modular, hierarchical
Planning Horizon	non-planning, finite stage, **indefinite stage**, infinite stage
Representation	**states**, features, relations
Computational Limits	**perfect rationality**, bounded rationality
Learning	**knowledge is given**, knowledge is learned
Sensing Uncertainty	**fully observable**, partially observable
Effect Uncertainty	**deterministic**, stochastic
Preference	**goals**, complex preferences
Number of Agents	**single agent**, multiple agents
Interaction	**offline**, online