Intelligent Agents

This is the name used for an artificial intelligence program. However in a typical application several intelligent agents achieve very complex activities through **communication** and **coordination**. An intelligent agent knows one aspect of the problem, but together they are capable of understanding the whole problem.

Agents and Rational Agents

Agents: perceives its environment through **sensors** and acts upon the environment through **actuators**.

E.g., a robot may have a camera to gather visual data, may have sensors to received information about the altitude, temperature, size, etc.

The term **percept** is used to refer to the agent's perceptual inputs at any given instant. The **percept history** is the complete history everything the agent perceived.

At any given time the agent's choice of **actions** depend on the entire percept sequence. Observed to date.

The agent's **behavior** is described mathematically by a function that maps any given percept sequence to an action. This mathematical function is concretely implemented by an **agent program**.

There is a limit to how many percepts an agent can receive. So there is a limit on the type of sensors and data that can be collected.

An agent **acts intelligently is:**

a) Does what is expected in each circumstance
b) It is flexible to changing environments
c) It learns from experience
d) It makes appropriate choices give its percepts sequence

Computational agents are those whose actions can be explained in terms of computations (primitive steps that can be implemented using a physical device).

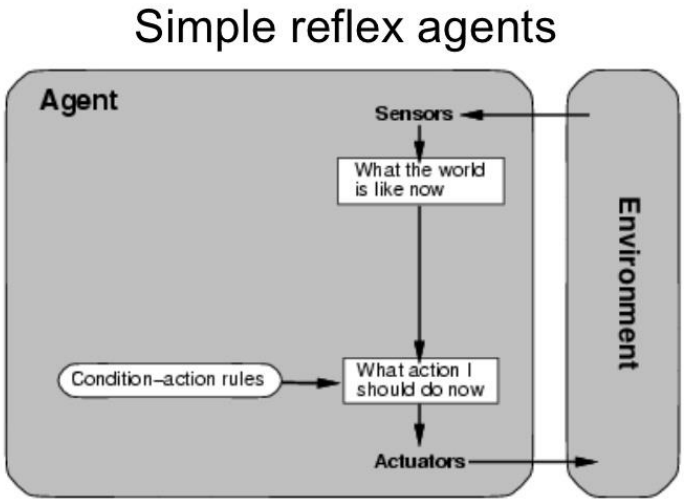
In this course we are mainly interested in computational intelligent agents.

The scientific goal of AI is:

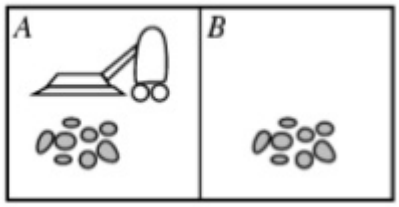
1) The analysis of natural and artificial agents
2) Formulating and testing hypothesis about what it takes to construct intelligent agents
3) Designing, building and experimenting with computational agents

What an agent does depends on:

A) Prior knowledge
B) History of interactions with the environment (observations, past experiences)
C) Goals
D) Abilities



Example (Norvig book p. 36) The Vacuum Cleaner Agent



The robot (vacuum cleaner) moves between two rooms represented as two squares. The robot can perceive in which rooms it is and whether the square is dirty. It can perfrom the following actions:

- Move left
- Move right
- Suck up the dirt
- Do nothing

If the current square is dirty, then suck otherwise move to the other square.

PERCEPT SEQUENCE	ACTION
[A, Clean] [A, Dirty] [B, Clean]	Right Suck

[A, Dirty] [A, Clean],[A, Dirty] ….	

A **rational agent** is one that does the right thing all the time.

But what does it mean to do the right thing?

Typically this is defined as being 'what is expected of the agent' at any given moment. This needs to be specified clearly.

What is 'rational' depends on the following things:

- The performance measure that defines the criteria of success
- The agent's prior knowledge of the environment
- The actions that the agent can perform
- The agent's percept sequence to date.

Definition of a rational agent: For every possible percept sequence a rational agent should select an action that is expected to maximize its performance measures.

In the example above with the Vacuum cleaner, the performance measure could award a point for every clean square at each given step. It could also include penalties for unnecessary moves back and forth between the squares.

An agents may find:

The optimal solution: the best solution according to some measures of optimality.

A Satisficing Solution: a good enough solution according to some measures od adequacy.

A Probable solution: one that it is likely to be a solution not an exact solution.

> False positive error rate: the proportion of the actions taken by the agent that are not correct
>
> False-negative error rate: the proportion of the answers/actions not given by the agent that are correct.

In Section 2.2.2 there is a discussion on what Omniscience, autonomy and learning may mean in the context of an intelligent agent. I am not including that discussion in the notes.

Task Environment

This refers to 5 performance measures (PEAS): Performance, Environment, Actuators, Sensors

Agent Type	Performance Measures	Environment	Actuators	Sensors
Automated Taxi Driver	Safe, fast, legal, comfortable trip, maximize profits	Roads, other traffic, pedestrians, customers	Steering, accelerator, brake, signal, horn, display	Cameras, sonar, speedometer, GPS, accelerometer, odometer, engine sensors, keyboard
Robot- moving parts in a warehouse				
Web Softbot to scan the internet to find new useful sources of information about Malawi and post adverts on those sites				
Medical Diagnosis System				

We classify environments in terms of the following characteristics. Please refer to the previous set of notes and Norvig p. 43.

A) **Fully vs Partially Observable**: A task environment is fully observable is the agent's sensors collect all aspects that are relevant to the choice of action.

B) **Single-vs Multiple agent**. In multiple agents environment we can talk about **cooperative** and **competitive** environments.

C) **Deterministic vs Stochastic**: If the next state of the environment is completely determined by the current state and the agent's actions, then we say that the environment is deterministic. **An environment is uncertain** if it is not fully observable **or** not deterministic.

D) Episodic vs sequential: In an episodic environment the agent's experience is divided in episodes; in each episode the agents receives percepts and then performs a single action. The actions in an episode do not depend on the actions taken in the previous episode. E.g., a robot on a manufacturing line detecting defects.
In a sequential environment the current decision affects all future decisions. Eg. Chess and taxi driving are sequential.

E) **Static vs Dynamic:** If the environment can change while the agent is taking a decision then we say that it is dynamic. If the environment does not change but the score/ performance of the agent changes we say that the environment is **semi-dynamic.**

Question 1: Is the environment in chess dynamic?

F) Discret vs Continuous: Chess has a discret set of percepts and actions. Autonomous taxi driver has a continuous set of percepts and actions.

G) Known vs unknown: This refers to the knowledge that the agent has about the environment and any applicable laws. Ina known environment, the outcomes for all actions are known/given.

E.g., in the game of solitaire the environment is known but it is partially observable.

Question 2: Give an example of an agent that has an unknown and fully observable environment.

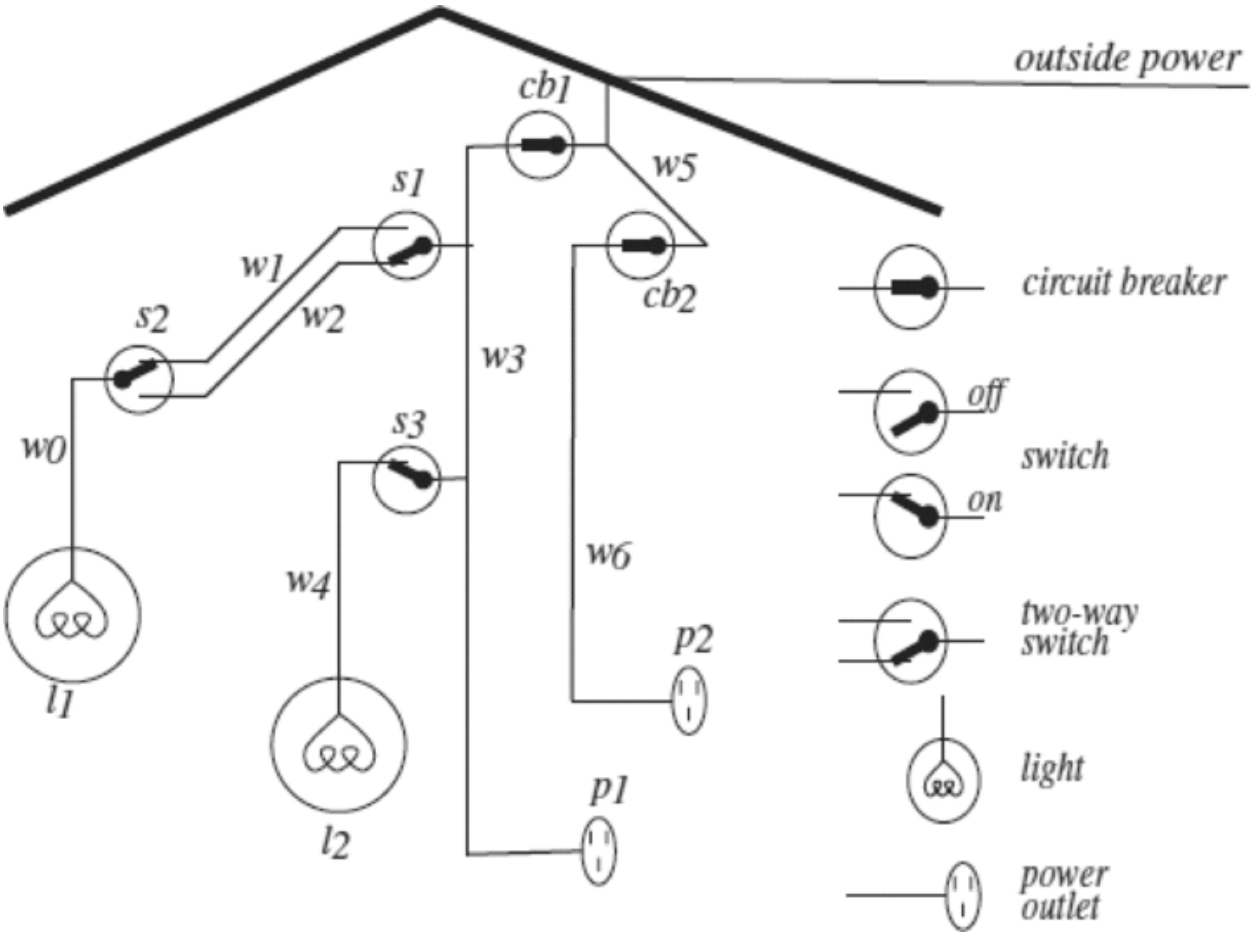
Task Environment	Observable	Agents	Deterministic	Episodic	Static	DIscrete
Chess with a clock	Fully	Multi	Deterministic	Sequential	Semi	Discrete
Image Analysis						
Bao						

Automatic Text Translator (English-Chichewa)						
Automatic Speech Translator (English-Chichewa)						
An autonomous delivery robot around a building						

Question 3: Fill in the above table.

Detailed Examples

Figure below shows a depiction of an electrical distribution system in a house. In this house, power comes into the house through circuit breakers and then it goes to power outlets or to lights through light switches. For example, light l_1 is on if there is power coming into the house, if circuit breaker cb_1 is *on*, and if switches s_1 and s_2 are either both up or both down. This is the sort of model that normal householders may have of the electrical power in the house, and which they could use to determine what is wrong given evidence about the position of the switches and which lights are on and which are off. The diagnostic assistant is there to help a householder or an electrician troubleshoot electrical problems.



(**Source: Artificial Intelligence by Alan K. Mackworth, David L. Poole)**

Next Lecture

Agent Architecture

Knowledge Representation

Some Revision Questions

1. What is Artificial Intelligence?
2. Explain how AI is used in a domain of your choice.
3. Give example of and explain two difficulties that the pioneers of AI faced.
4. What is a Theorem Prover?
5. What is an agent program?
6. What is an intelligent agent?
7. What is a rational Agent?
8. Give example of an agent whose environment is deterministic, partially observable and sequential.

	True/False	Support
An agent that senses only partial information about the state cannot be perfectly rational.	False	The vacuuming cleaning agent is rational, despite it having no information about the other square.
There exist task environments in which no pure reflex agent can behave rationally.	True	A reflex agent reacts to the current percept, but if memory is needed then a pure reflex agent might behave irrationally.
There exists a task environment in which every agent is rational.	True	If every action results in the same result.
The input to an agent program is the same as the input to the agent function.	False	The agent program and function are different entities. The program contains history percepts and the function is only the current percept.
Every agent function is implementable by some program/machine combination.	False	A reflex agent will only act to certain variables.
Suppose an agent selects its action uniformly at random from the set of possible actions. There exists a deterministic task environment in which this agent is rational.	True	Eventually one of the random selections will be the correct one.
It is possible for a given agent to be perfectly rational in two distinct task environments.	True	Only if those environments are similar in a way.
Every agent is rational in an unobservable environment.	False	A GPS mapping system that doesn't record its findings.
A perfectly rational poker-playing agent never loses.	False	There is always a chance that its opponent will be dealt better cards.