LECTURE 1: Introduction

KD04603 Special Topic in Computer Science

Taken and modified from "An Introduction to MultiAgent Systems"
by Michael Wooldridge, John Wiley & Sons, 2009, COMP310 course of UoL by Terry Payne and "Agent Technology for e-Commerce" by Maria Fasli

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Expected learning outcomes

- Understand the underlying principles of an intelligent agent
- Able to differentiate agents from objects, expert system and AI
- Concepts in agents' environments

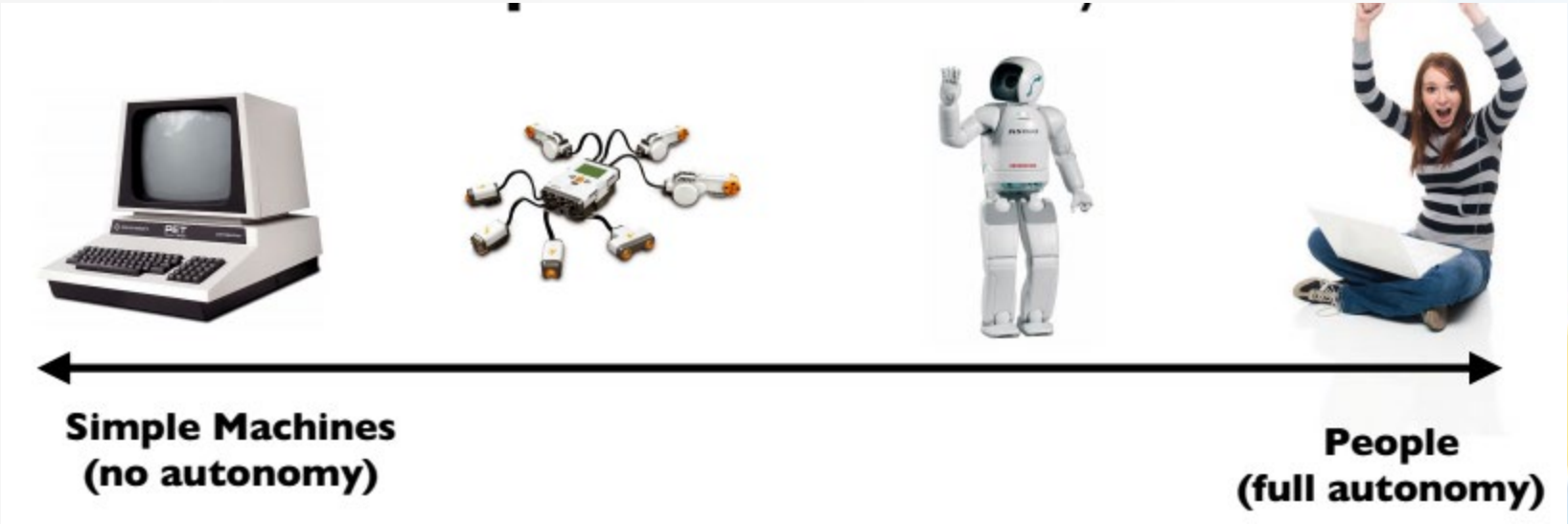
What is an Agent?

- The main point about agents is they are *autonomous*: capable of acting independently
- Thus:

  an agent is ***a computer system*** that is **situated** in some environment + capable of **autonomous** action to meet its design **objectives**

Autonomy

- Spectrum of autonomy



- Absolute autonomy (complete unpredictability) may not be desirable; travel agent may exceed the allocated budget

Agent and Environment

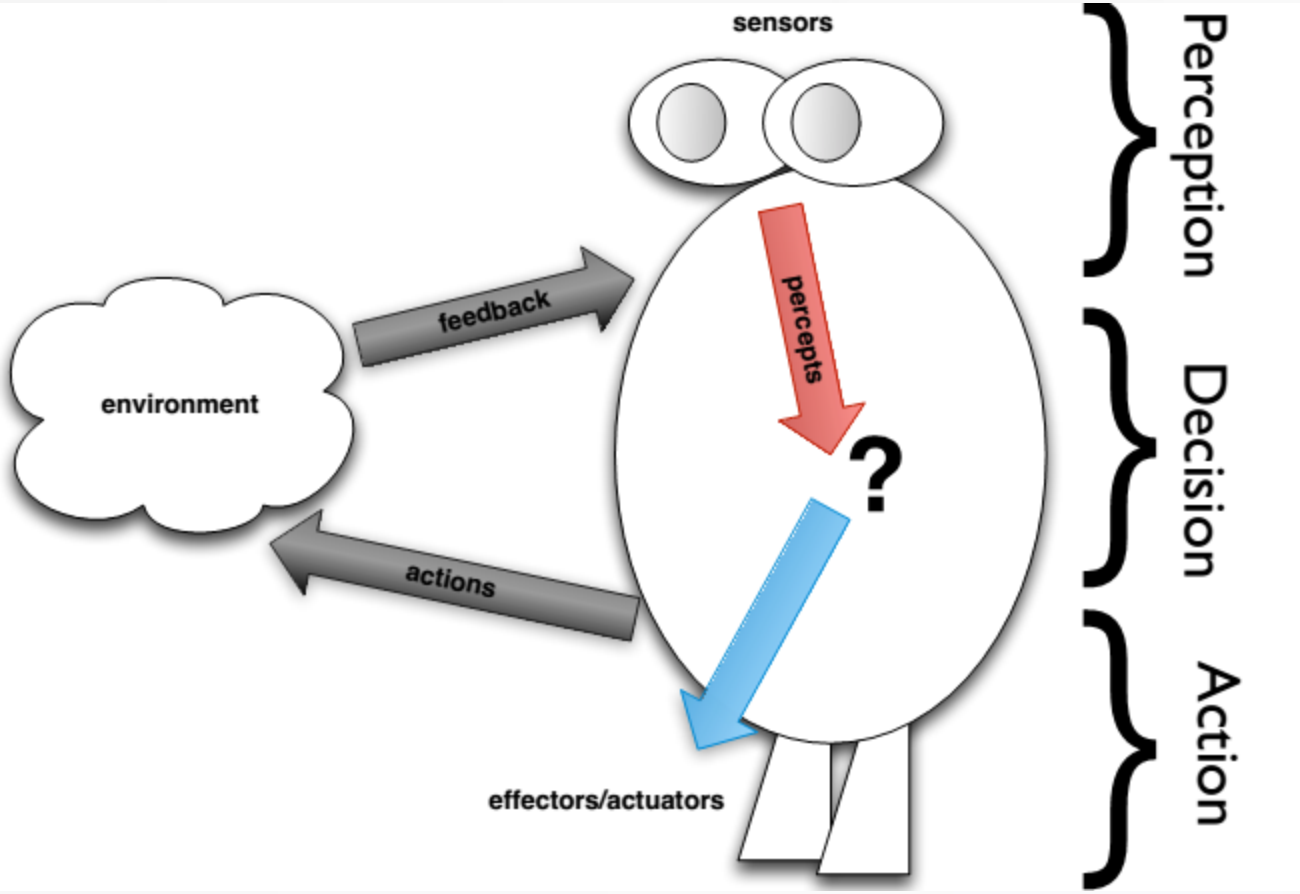


Figure taken from COMP310 Course, UoL, Chapter 2

Trivial (non-interesting) Agents

- Thermostat
  - Goal: to maintain room temperature
  - Actions: heat on/ off
- Unix xbiff
  - Goal: monitor user's incoming email
  - Actions: GUI actions

Taken from https://nest.com

Intelligent Agents

- *An* **intelligent agent** *is a computer system capable of* flexible *autonomous action in some environment*
- By *flexible*, we mean:
  - *reactive*
  - *pro-active*
  - *social*

Reactivity

- If a program's environment is guaranteed to be fixed, the program just executes blindly
  - Example of fixed environment: compiler
  - Most environments are *dynamic* and the information is incomplete
- Software is hard to build for dynamic domains: program must take into account possibility of failure
  - ask itself whether it is worth executing!
- A *reactive* system is one that maintains an ongoing interaction with its environment, and responds to changes that occur in it (in time for the response to be useful)

Proactiveness

- Reacting to an environment is easy
  - e.g., stimulus → response rules
- But we generally want agents to *do things for us*
  - Hence *goal directed behavior*
- Pro-activeness = generating and attempting to achieve goals; not driven solely by events; taking the initiative
  - Recognizing opportunities

Social Ability

- The real world is a ***multi***agent environment: we cannot go around attempting to achieve goals without taking others into account
  - Some goals can only be achieved with the cooperation of others
  - Similarly for many computer environments: witness the Internet
- ***Social ability*** in agents is the ability to interact with other agents (and possibly humans) via ***cooperation***, ***coordination*** and ***negotiation***
  - It means the ability to communicate

Other Properties

- ***mobility***: the ability of an agent to move around an electronic network
- ***veracity***: whether an agent will knowingly communicate false information
- ***benevolence***: agents do not have conflicting goals, and that every agent will therefore always try to do what is asked of it
- ***rationality***: agent will act in order to achieve its goals, and will not act in such a way as to prevent its goals being achieved
- ***learning/adaption***: agents improve performance over time

Bounded rationality

- Making a decision requires computational power, memory and computation takes time
- Agents are resource-bounded and this has an impact on their decision-making process: optimal decision making may not be possible
- Ideal rationality may be difficult to achieve
- Bounded rationality
  - restrictions on the types of options may be imposed
  - the time/computation for option consideration may be limited
  - the search space may be pruned
  - the option selected will be strategically inferior to the optimal one

Agents and Objects

- **Are agents just objects by another name?**
- Object:
  - encapsulates some state
  - communicates via message passing
  - has methods, corresponding to operations that may be performed on this state

Differences between Agents and Objects

- *agents are autonomous:*
  - agents embody stronger notion of autonomy than objects, and in particular, **they decide for themselves** whether or not to perform an action on request from another agent
- *agents are smart:*
  - capable of flexible (reactive, pro-active, social) behavior, and the standard object model has nothing to say about such types of behavior
- *agents are active:*
  - a multi-agent system is inherently multi-threaded, in that each agent is assumed to have at least one thread of active control

Agents are just Expert Systems by another name?

- Expert systems typically disembodied 'expertise' about some (abstract) domain of discourse (e.g., blood diseases)
- Agents are ***situated in an environment***:
  - MYCIN is not aware of the world — only information obtained is by asking the user questions
- Agents *act:*
  - MYCIN does not operate on patients
- Some *real-time* (typically process control) expert systems *are* agents

MYCIN (an example of expert system) knows about blood diseases in humans

It has a wealth of knowledge about blood diseases, in the form of rules

A doctor can obtain expert advice about blood diseases by giving MYCIN facts, answering questions, and posing queries

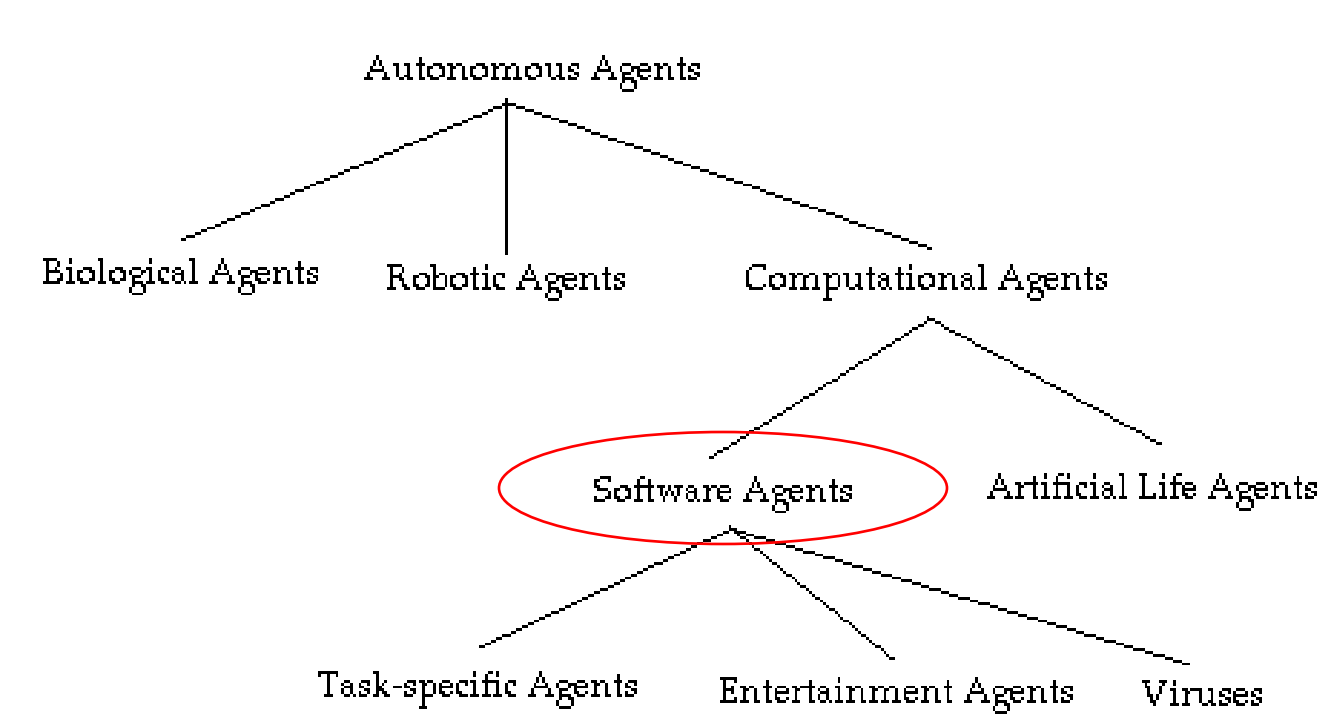
Aren't Intelligent Agents just the AI project?

- AI aims to build systems that can (ultimately) understand natural language, recognize and understand scenes, use common sense, think creatively, etc. — all of which are very hard
- We *do not* have to solve *all* the problems of AI to build a useful agent

Environments

- ***Observable*** (vs. non-observable): obtain complete information
- ***Deterministic*** (vs. non-deterministic): any action has a single effect
- ***Episodic*** (vs. sequential): no influence from the past
- ***Static*** (vs. dynamic): remain unchanged
- ***Discrete*** (vs. continuous): fixed actions and percepts

Agents Taxonomy



Franklin S. and Graesser A. (1997), “Is it an agent, or just a program?: A taxonomy for autonomous agents”.

Multi-agent System

A Multi-Agent System (MAS)

- is a collection of agents co-operating or competing with each other in order to fulfill common or individual goals”

Summary

- Some definition of agents and intelligent agents were described
- We looked at the properties of an intelligent agent and environments it may operates
- **What's next?**
  - Agent development tools