AI2002
Artificial Intelligence

Dr. Hashim Yasin

The Course Details

- Course code: AI2002
- Credit Hours: 3+1

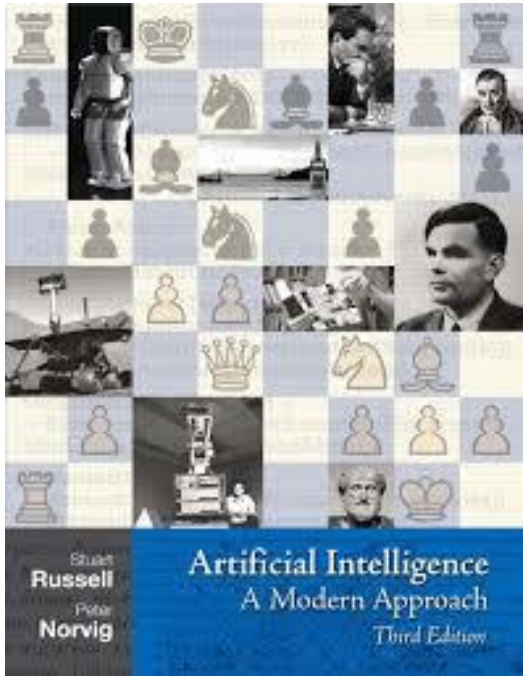
- Focus on general AI techniques that have been useful in many applications

- This course is about designing/implementing rational/intelligent agents.

Tentative Marks Distribution

Items	Marks (%)
Quizzes	10-15
Assignments / Project	10-15
Mid Exam I	15
Mid Exam II	15
Final Exam	40-50

Recomended Books

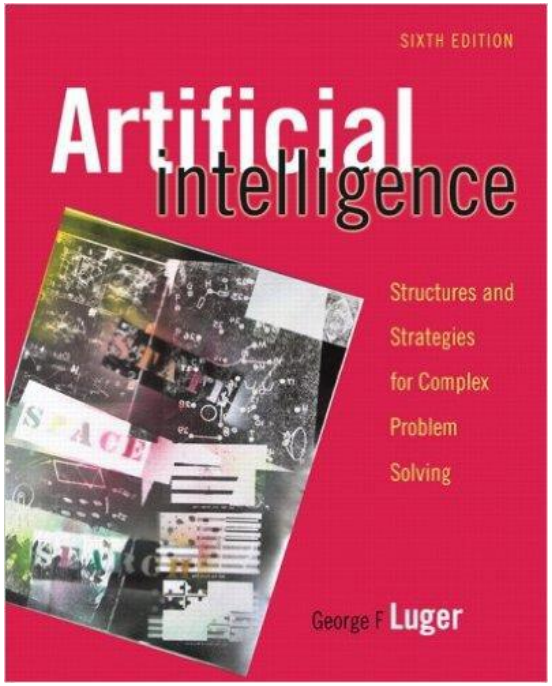


Artificial Intelligence

A Modern Approach

Stuart J. Russell and Peter Norvig

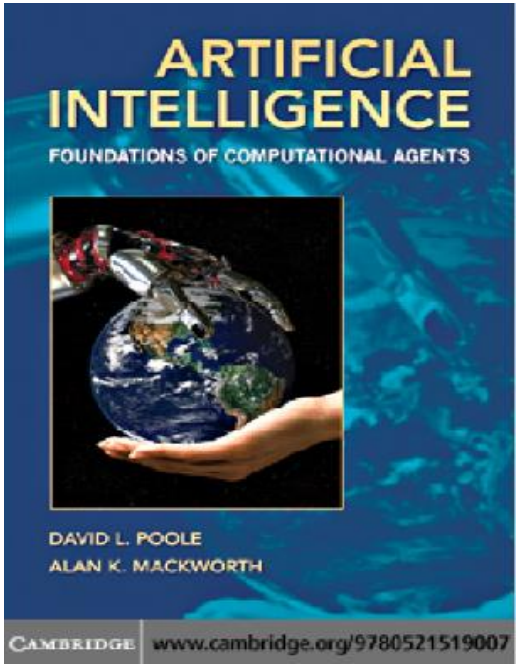
Recomended Books



Artificial Intelligence

George F. Luger

Recomended Books



Artificial Intelligence

Foundation of Computational Agents

David L. Poole

Alan K. Mackworth

Contents

- Agents and its Types
- Problem Solving using Searching Methodologies
  - Uninformed search
  - Informed search
  - Search with Optimization
  - Adversarial search (Game Theory)
- Constraint Satisfaction Problems
  - CSP as standard search
- Constraint Propagation
- Knowledge Representation

Contents

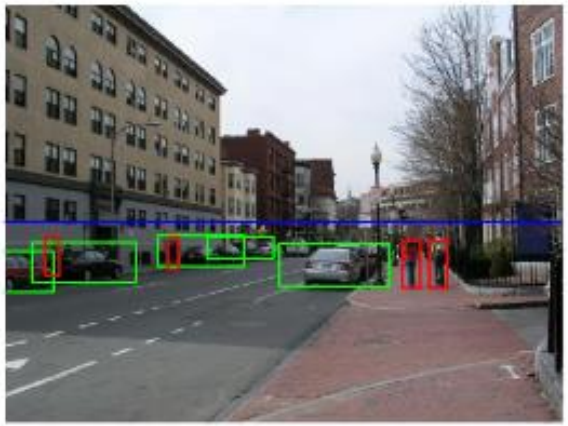
- Reasoning and Logic
  - Propositional Logic
  - First Order Logic
  - Inference in First Order Logic
- Probability in AI
- Learning
  - Unsupervised Learning (clustering)
  - Supervised Learning (ANN)
- Genetic Algorithm
- Classifiers …

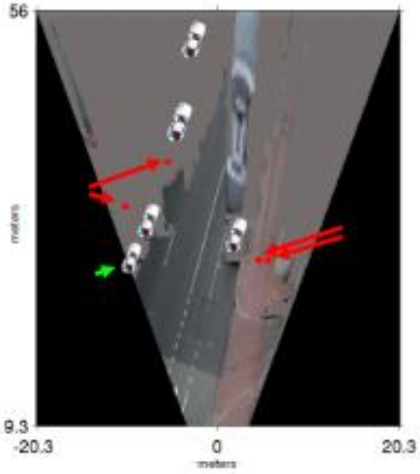
AI Applications

AI Applications

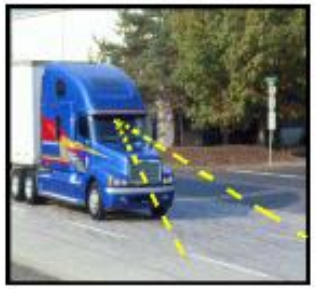
Assisted driving

Pedestrian and car detection





Lane detection

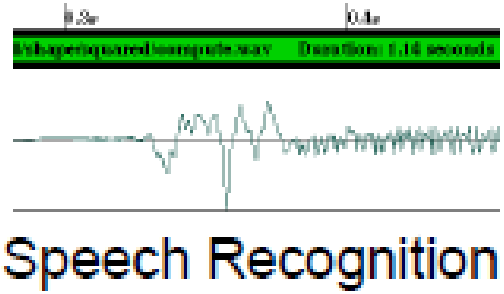


- Collision warning systems with adaptive cruise control,
- Lane departure warning systems
- Rear object detection systems

AI Applications

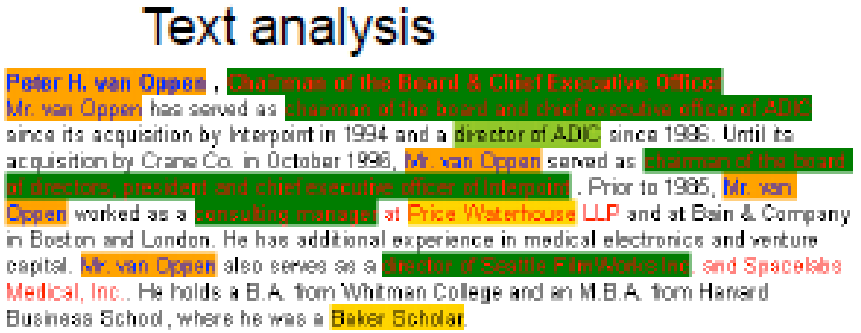
- **Self-drive Cars:**
  - In 2005, a driverless robotic car named **STANLEY** sped through the rough terrain of the Mojave dessert at 22 mph, finishing the 132-mile.
  - Google self-driving car project **WAYMO**, stands for a *new way forward in mobility*.

- **Speech recognition:**
  - A traveler calling United Airlines to book a flight can have the *entire conversation guided by an automated speech recognition and dialog management system*.



AI Applications

- **Autonomous Planning and Scheduling:**
  - NASA's Remote Agent program became the first on-board autonomous planning program to control the scheduling of operations for a spacecraft.
- **Text Analysis and NLP**
  - A computer program automatically translates from Arabic to English.
  - A program analysis the text and execute the summary of the text.



AI Applications

- **Robotics**:
  - **PackBot** it is used to handle hazardous materials, clear explosives, and identify the location of snipers.

- **Spam Detection**
  - Various AI anti-spam techniques
  - Each day, learning algorithms classify over a billion messages as spam, saving the recipient from having to waste time deleting
  - For many users, could comprise 80% or 90% of all messages, if not classified away by algorithms.

AI Applications

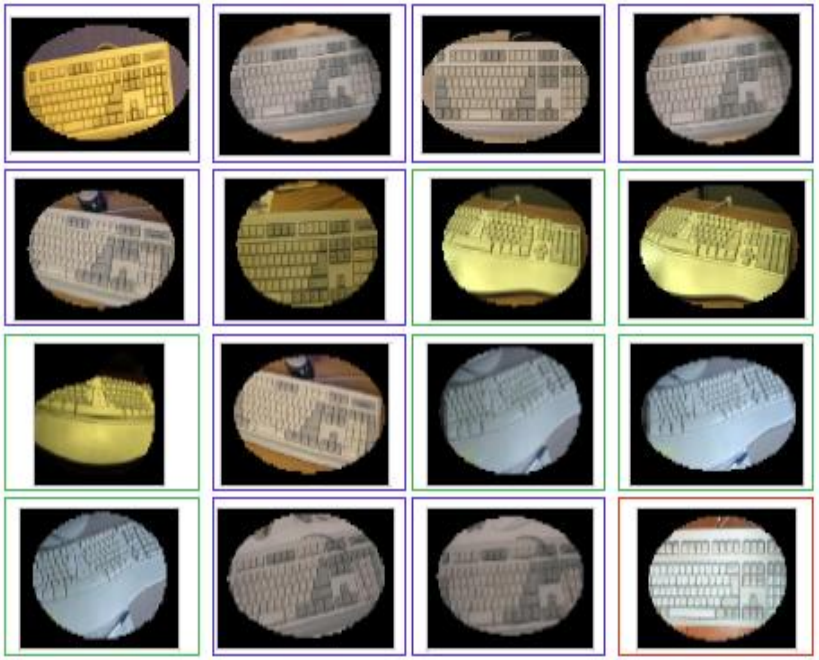
- **Computer Vision**

Action Recognition

AI Applications

- **Computer Vision**

Object detection



What is Artificial Intelligence?

What is an Intelligence?

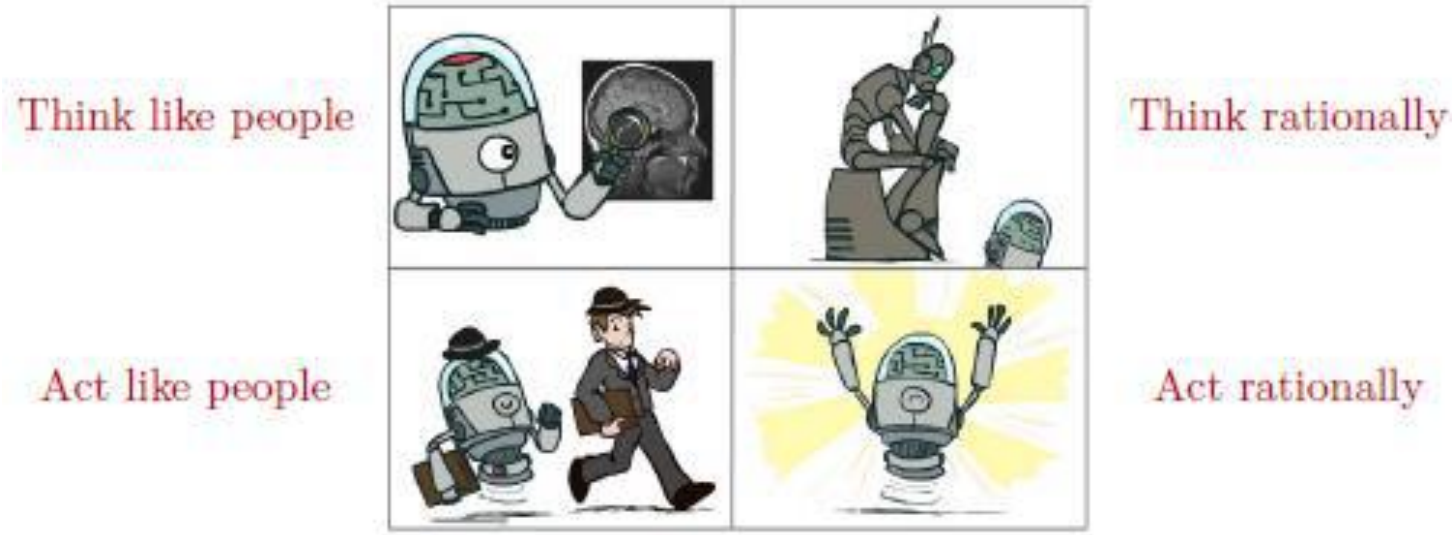
"The ability to learn or understand things or to deal with new or difficult situations." **(Merriam Webster**)

"The ability to learn, understand and make judgments or have opinions that are based on reason." **(Cambridge Advance Learner's Dictionary, 2006)**

"The ability to acquire and apply knowledge and skills." **(Compact Oxford Dictionary, 2006)**

What is Artificial Intelligence?

- AI can be defined with four different perspectives
  - Systems that **think like humans**
  - Systems that **act like humans**
  - Systems that **think rationally**
  - Systems that **act rationally**



What is Artificial Intelligence?

Systems that think like humans

"The exciting new effort to make computers think . . . **machines with minds**, *in the* full and literal sense." (Haugeland, 1985)

Systems that act like humans

"The art of creating **machines that perform functions that require intelligence** when performed by people" (Kurzweil, 1990).

What is Artificial Intelligence?

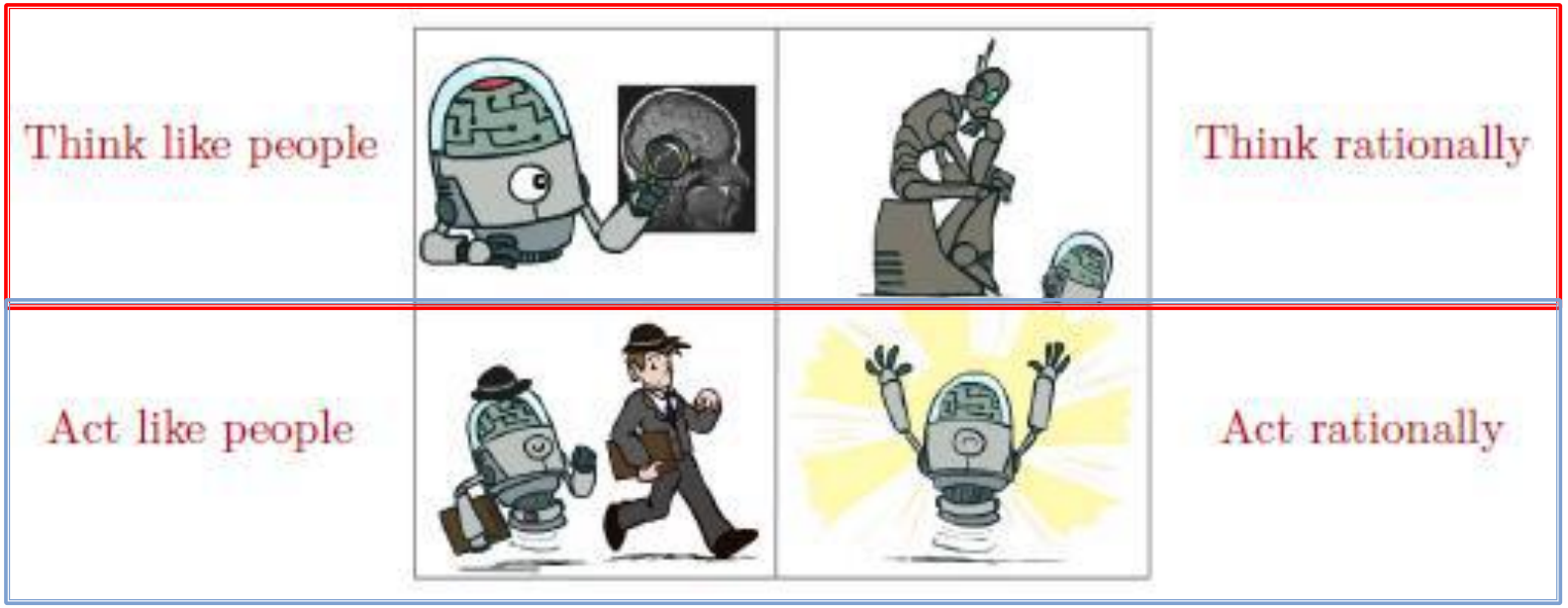
Systems that think rationally

"The **study of the computations** that make it possible to **perceive, reason, and act**." (Winston, 1992)

Systems that act rationally

"Computational Intelligence is the study of the **design of intelligent agents**." (Poole *et al., 1998)*

What is Artificial Intelligence?



- These definitions --- **two main dimensions**
  - *thought processes and reasoning,*
  - *behaviour.*

Act Humanly: Turing Test

"Can machines think?"

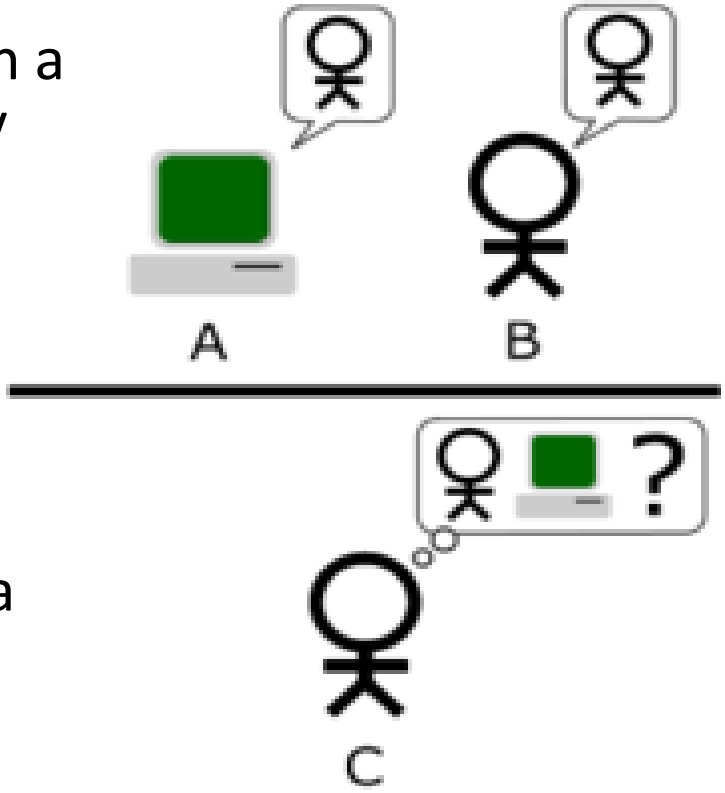
"Can machines behave intelligently?"

Turing Test (1950)

- proposed by **Alan Turing**
- An attempt to provide a satisfactory operational test for intelligent behavior

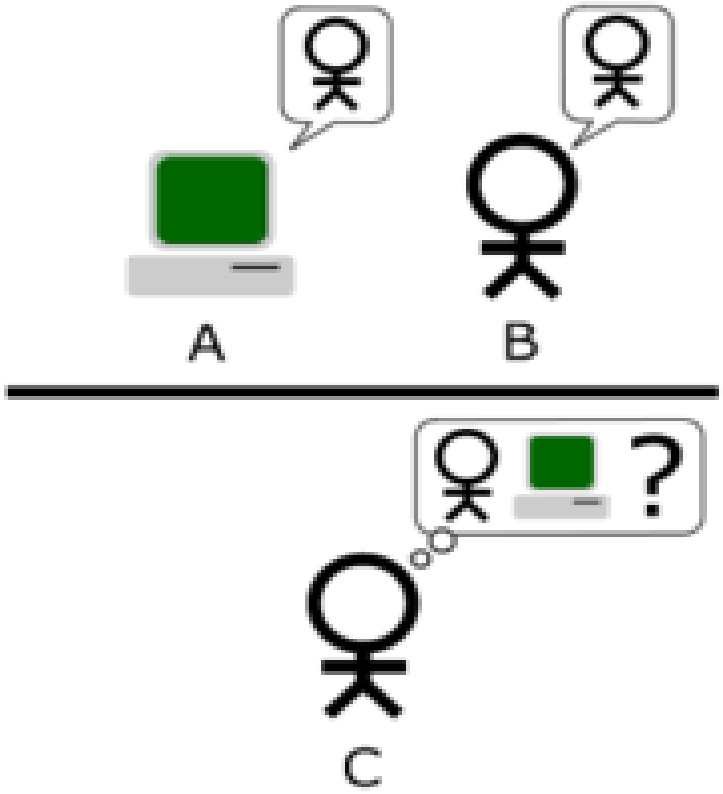
Act Humanly: Turing Test

- **Turing Test ---** An Imitation Game
  - A (Human) judge communicates with a human and a machine over text-only channel,
  - Both human and machine try to act like a human,
  - Judge tries to tell which is which.
  - Predicted that by 2000, a machine might have a 30% chance of fooling a lay person for 5 minutes.



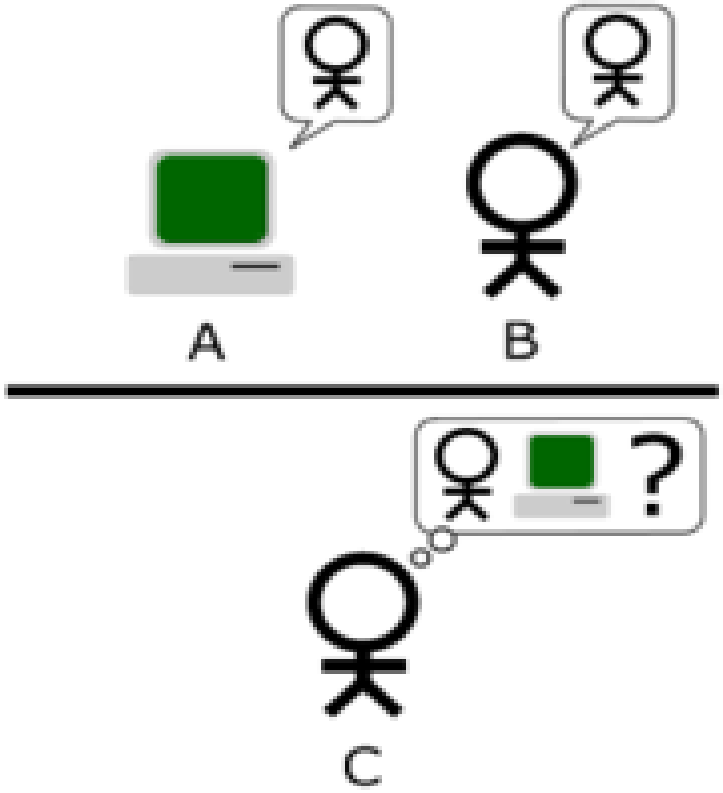
Act Humanly: Turing Test

- **Turing Test ---** An Imitation Game
  - Natural Language Processing
    - To recognize language
  - Knowledge representation
    - To store knowledge
  - Automated reasoning
    - To give answer



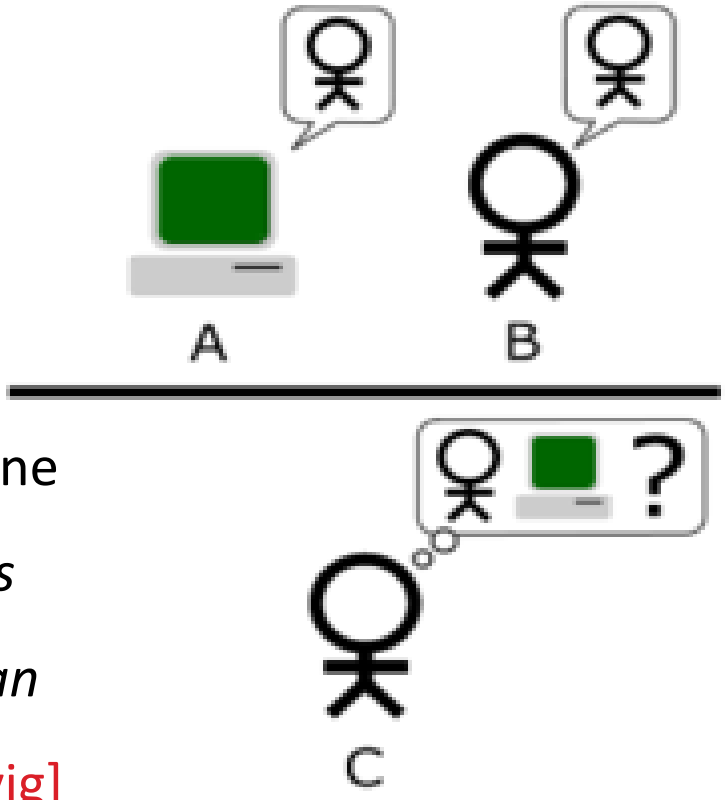
Act Humanly: Turing Test

- **Turing Test ---** An Imitation Game
  - Machine learning
    - adapt to new circumstances
  - Computer vision
    - perceive objects
  - Robotics
    - manipulate objects



Act Humanly: Turing Test

- **Turing Test** --- An Imitation Game



Is Turing Test the right goal?

Aeronautical engineering texts do not define the goal of their field as: *making machines that fly so exactly like pigeons that they can fool even other pigeons*. [Russell and Norvig]

Think Humanly

Cognitive Approach: Three ways to do this:

- Through introspection
  - trying to catch our own thoughts
- Through psychological experiments
- Through brain imaging

Cognitive Science:

- It brings together **computer models from Artificial Intelligence** and **experimental techniques from Psychology**
  - to construct precise and testable theories of the workings of the human mind.

Think Rationally

The "Laws of Thought" approach

- Aristotle was one of the first to attempt to codify "right thinking"
- Initiated the field called **logic**

Socrates is a man; all men are mortal; therefore, Socrates is mortal.

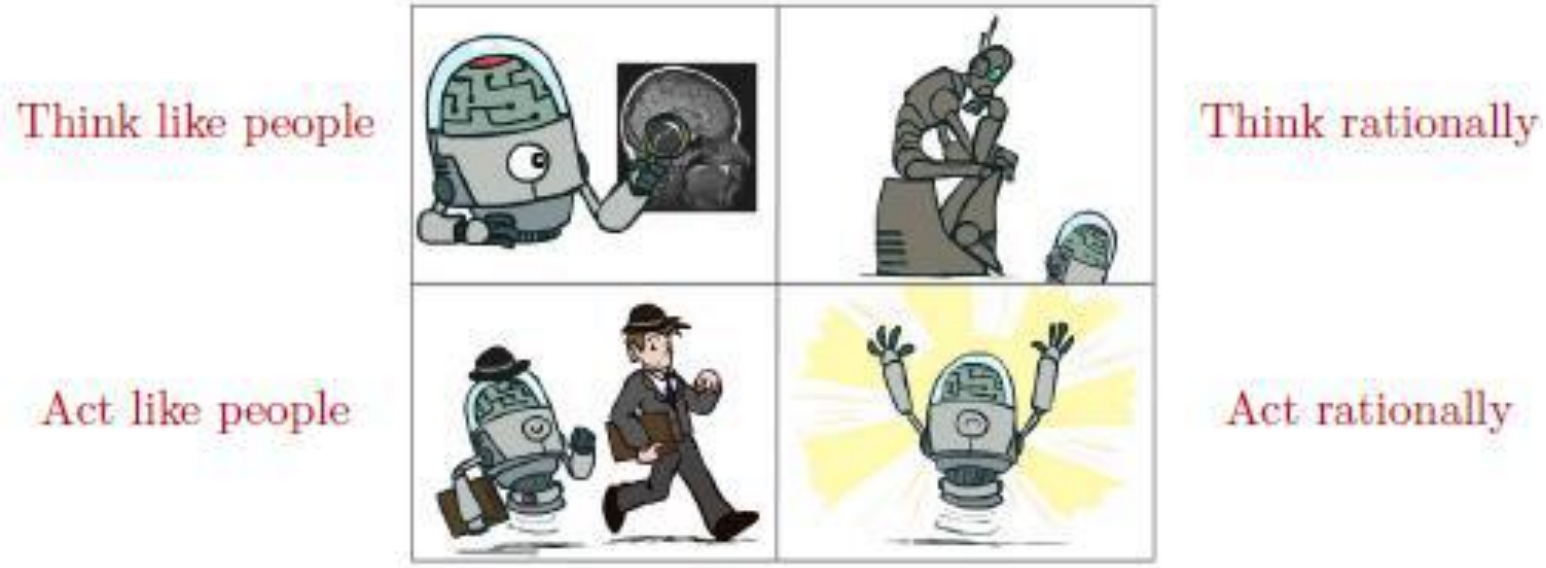
Think Rationally

The "Laws of thought" approach

Two main obstacles:

- Hard to state informal knowledge in the formal terms --- required for logic
- A big difference between problem solving **in principle** and **in practice**.

Act Rationally



- **Act rationally/like a human** presumably requires (some sort of) **thinking rationally/like a human**

- Humans much more rational in complex domains

Act Rationally

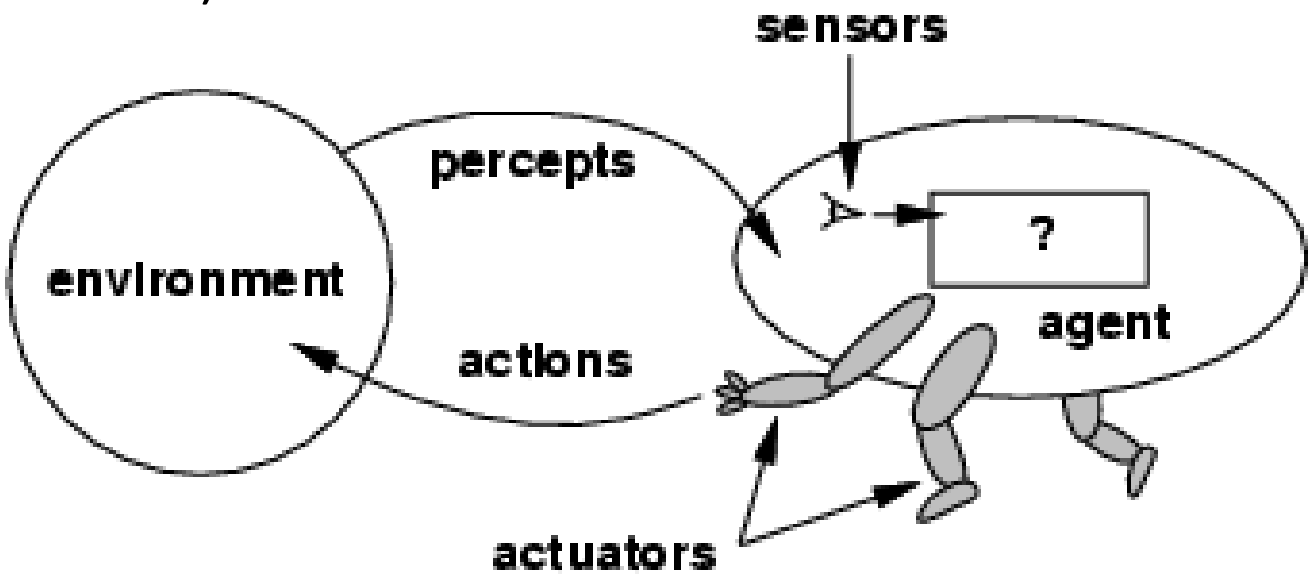
The rational agent approach

- **Rational behavior**: doing the ***right*** thing
- System is rational if it does the right thing.
- The right thing
  - to maximize goal achievement, given the available information
- Doesn't necessarily involve thinking – but thinking should be in the service of rational action

Agent

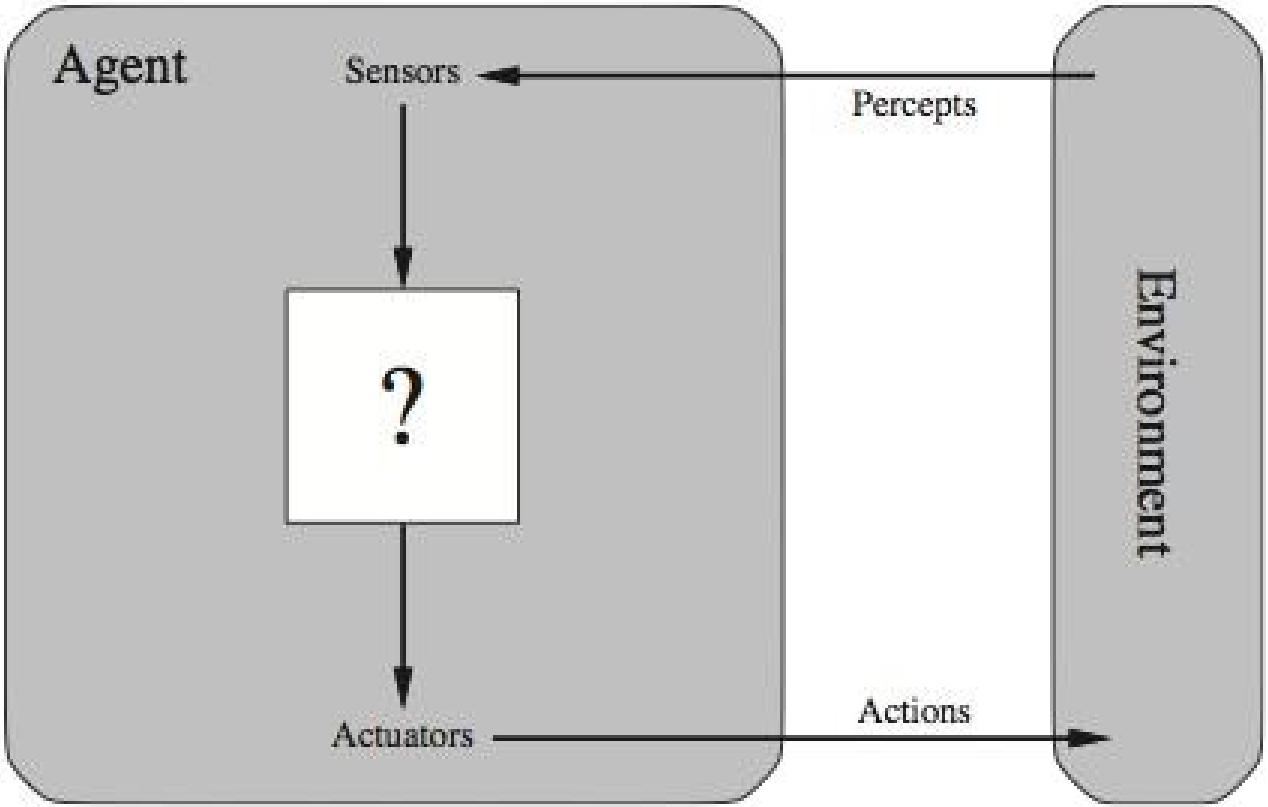
Agent

- An **Agent** is an entity which
  - **perceives its environment** through sensors and
  - **acts upon that environment** through actuators
  - **Assumption:** Every agent can perceive its own actions (but not always the effects)



Agent

Agent with an Environment



Agent

- Abstractly, an agent is **a function which maps percept histories to actions**:

$$[f: \mathcal{P}^{\star} \rightarrow \mathcal{A}]$$

- Internally, the agent function will be implemented by **an agent program** which runs on the **physical architecture** to produce *f*

- agent = architecture + program

Acting Rationally

Agent Examples:

Human agent:

- Sensors --- eyes, ears, and other organs
- Actuators ---– hands, legs, mouth, and other body parts

Robotic agent:

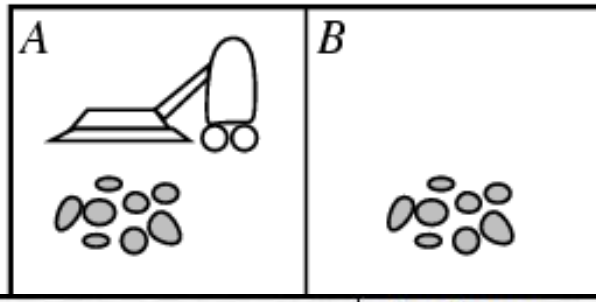
- Sensors --- cameras and infrared range finders
- Actuators ---– various motors for actuators

A software agent:

- Sensors --- Keystrokes, file contents, received network packages
- Actuators ---– Displays on the screen, files, sent network packets

Agent Example

Vacuum-cleaner world



- Two locations: A and B
- **Precepts**
  - location
  - contents

  [A, Dirty]
- **Actions**
  - *Left*
  - *Right*
  - *Suck*
  - *NoOp*

Percept sequence	Actions
[A,Clean]	Right
[A, Dirty]	Suck
[B,Clean]	Left
[B,Dirty]	Suck
[A,Clean],[A,Clean]	Right
[A,Clean],[A,Dirty]	Suck
…	…
[A,Clean],[A,Clean],[A,Clean]	Right
[A,Clean],[A,Clean],[A, Dirty]	Suck

Rational Agent

- A rational agent is one that does the right thing.

How agent should behave?

- **Performance Measure:** As a general rule, it is better to *design performance measures* according to what one actually wants in the environment.

- Performance measure of a vacuum-cleaner agent could be amount of dirt cleaned up, amount of time taken, amount of electricity consumed, amount of noise generated etc.

- Reward the agent for having a clean floor

Acting Rationally

Rationality

What is rational at any given time?

It depends on four things:

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

Reading Material

- **Artificial Intelligence,** A Modern Approach

  Stuart J. Russell and Peter Norvig

  - **Chapter 1 & 2.**