
ARTIFICIAL INTELLIGENCE & EXPERT SYSTEMS



Introduction

ABOUT THE COURSE

Lecturer : Assoc. Prof. Zeynep ORMAN

E-mail : ormanz@istanbul.edu.tr

Course Notes: aksis.istanbulc.edu.tr

- This will be the primary source of more detailed information, announcements, etc.
 - Check the system often
 - Updates about assignments, clarifications etc. will also be posted on the system.
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TEXT-BOOKS

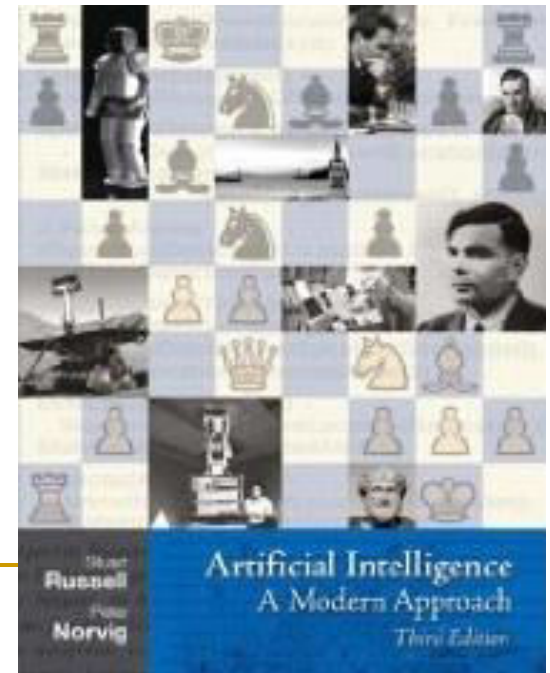
Required:

S. Russell and P. Norvig *Artificial Intelligence: A Modern Approach* Prentice Hall, 2010, **Third Edition**

- This is a good introductory text on AI, well written and with very broad coverage.
- Lecture notes will be posted on line.

Textbook Website :

<http://aima.cs.berkeley.edu/>



ARTIFICIAL INTELLIGENCE & EXPERT SYSTEMS

Grading: Project & Assignments (20%),
 Midterm exam (30%),
 Final exam (50%)

Subareas of AI

- Perception: vision, speech understanding, etc.
 - Machine Learning, Neural networks
 - Robotics
 - Natural language understanding
 - Reasoning and decision making (**our focus**)
 - **Decision making** (*search, planning, decision theory*)
 - **Knowledge representation**
 - **Reasoning** (*logical, probabilistic*)
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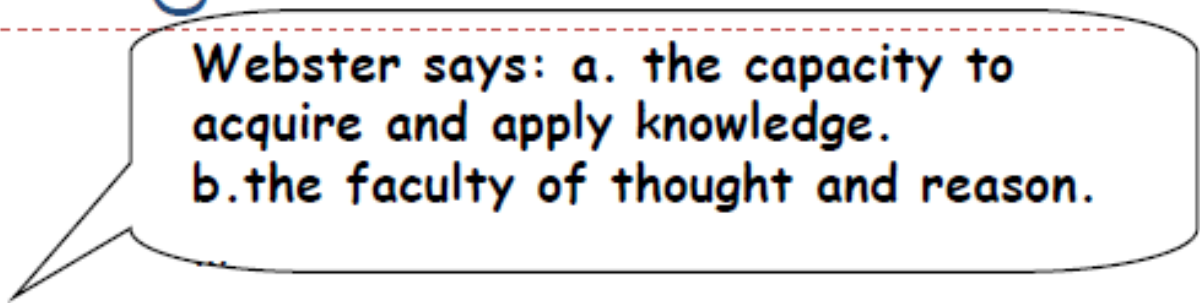
What is AI?

- **Definition 1:** AI is concerned with creating intelligent computer systems.
 - What is intelligence?
 - **Definition 2:** AI is the study of systems that act in a way that to any observer would appear intelligent. [Coppin]
 - Dependent on observer.
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- *Intelligence* is the ability of a system to act appropriately in an uncertain environment, when an appropriate action is that which increases the probability of success, and success is the achievement of behaviour subgoals that support the system's ultimate goal.
 - **Artificial Intelligence** is the part of computer science that attempts to make computers act like human beings
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What is AI?

- **Definition 3:** AI involves using methods based on intelligent behaviour of humans (or animals) to solve complex problems.
- **Definition 4:** AI is concerned with making computers more useful and useable.
 - What's the difference to general CS?
- **Definition 5:** AI is what AI researchers do.



Webster says: a. the capacity to acquire and apply knowledge.
b. the faculty of thought and reason.

What is AI?

- Definitions for AI, vary along two dimensions :
 - thought processes and reasoning
 - behavior
- We can also group these definitions in terms of
 - human performance
 - and
 - rationality

What is AI?

Views of AI fall into four categories:

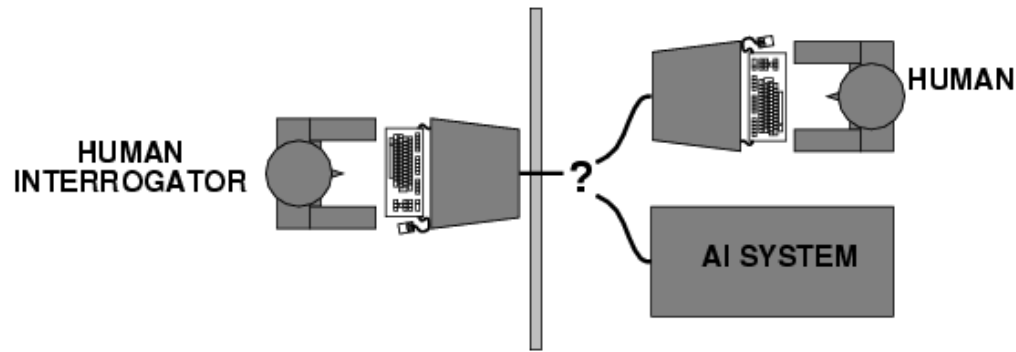
Thinking humanly	Thinking rationally
Acting humanly	Acting rationally

The textbook advocates "acting rationally"

A system is **rational** if it does the "right thing",
given what it knows.

Acting humanly: Turing Test

- Turing (1950) "Computing machinery and intelligence":
- "Can machines think?" → "Can machines behave intelligently?"
- Operational test for intelligent behavior: the Imitation Game



Acting humanly: Turing Test

- An interrogator is communicating with group of people and a computer.
 - The interrogator is not told whether he communicates with a real person or a computer.
 - If 30% of the times the computers are able to fool the interrogator that it's a real person, then the computer passed the Turing test.
 - Predicted that, a machine might have a 30% chance of fooling a person for 5 minutes.
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TURING TEST

The computer would need to possess the following capabilities:

- **natural language processing** to enable it to communicate successfully in English (or some other human language);
 - **knowledge representation** to store information provided before or during the interrogation;
 - **automated reasoning** to use the stored information to answer questions and to draw new conclusions;
 - **machine learning** to adapt to new circumstances and to detect and extrapolate patterns.
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Acting Humanly: The Full Turing Test

■ Problem:

- ❑ 1. Turing test is not reproducible, constructive, and amenable to mathematical analysis.
- ❑ 2. What about physical interaction with interrogator and environment?

■ **Total Turing Test:** Requires physical interaction and needs perception and actuation.

- ❑ includes a video signal so that the interrogator can test the subject's perceptual abilities

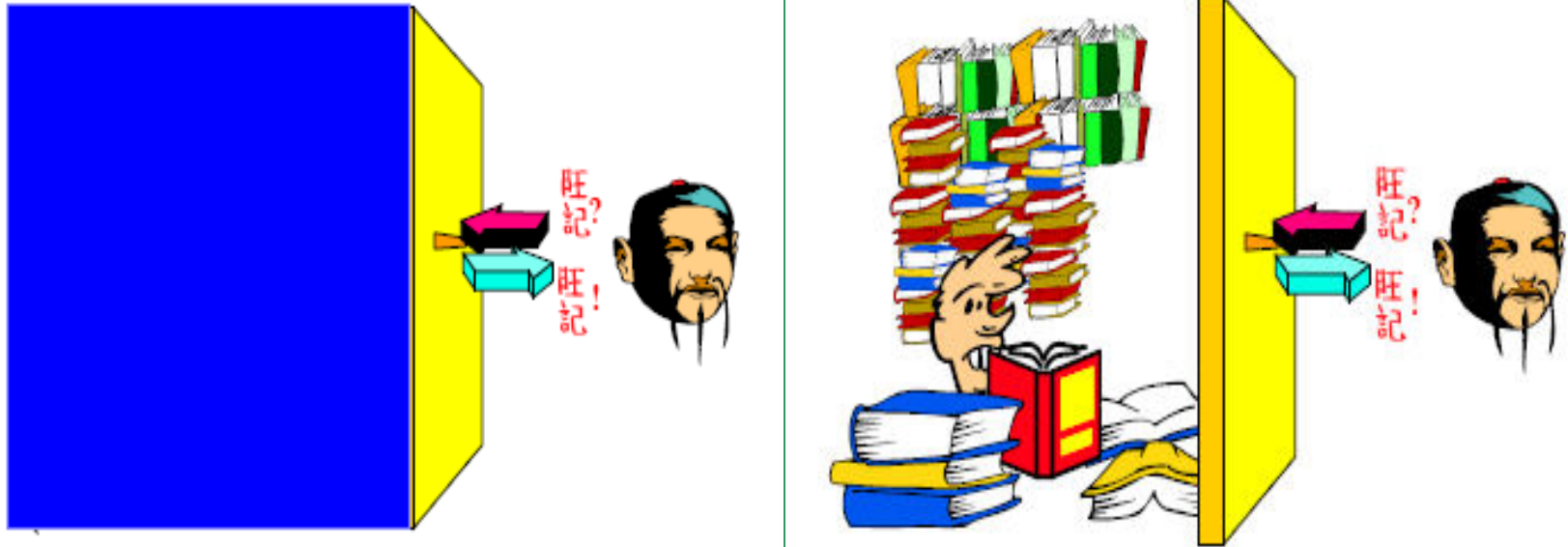
Acting Humanly: The Full Turing Test

- Turing provided some very persuasive arguments that a system passing the Turing test is intelligent.
 - However, the test does not provide much traction on the question of how to actually build an intelligent system.
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The Chinese Room

- A person P1 communicates in Chinese with another person P2 by passing written notes back and forth.
- P2 does not know Chinese.
- P2 has a room full of books that tell him what to do for each character in the note (similar to a Turing Machine program).
- Assuming that all the rules in the books are correct, does P2 speak Chinese?

The Chinese Room



The Chinese room argument comprises a thought experiment and associated arguments by John Searle (1980), which attempts to show that a symbol-processing machine like a computer can never be properly described as having a "mind" or "understanding", regardless of how intelligently it may behave.

Thinking humanly: cognitive modeling

- 1960s "cognitive revolution": information-processing psychology
- Requires scientific theories of internal activities of the brain
- -- How to validate? Requires
 - 1) Predicting and testing behavior of human subjects (top-down) OR
 - 2) Direct identification from neurological data (bottom-up)
- Both approaches (roughly, Cognitive Science and Cognitive Neuroscience) are now distinct from AI

Thinking rationally: "laws of thought"

Aristotle (~ 450 B.C.) attempted to codify “right thinking”

What are correct arguments/thought processes?

e.g., “Socrates is a man, all men are mortal; therefore
Socrates is mortal”

These *laws of thought* govern the operation of mind –
initiation the field *logic*

Several Greek schools developed various forms of *logic*:
notation and *rules of derivation* for thoughts.

Thinking rationally: "laws of thought"

■ Problems:

- 1) Uncertainty: Not all facts are certain (e.g., *the flight might be delayed*).
- 2) Resource limitations:
 - Not enough time to compute/process
 - Insufficient memory/disk/etc
 - etc.

Acting rationally: rational agent

- **Rational** behavior: doing the right thing
 - The right thing: that which is expected to maximize goal achievement, given the available information
 - Provides the most general view of AI
 - Doesn't necessarily involve thinking – e.g., blinking reflex – but thinking should be in the service of rational action
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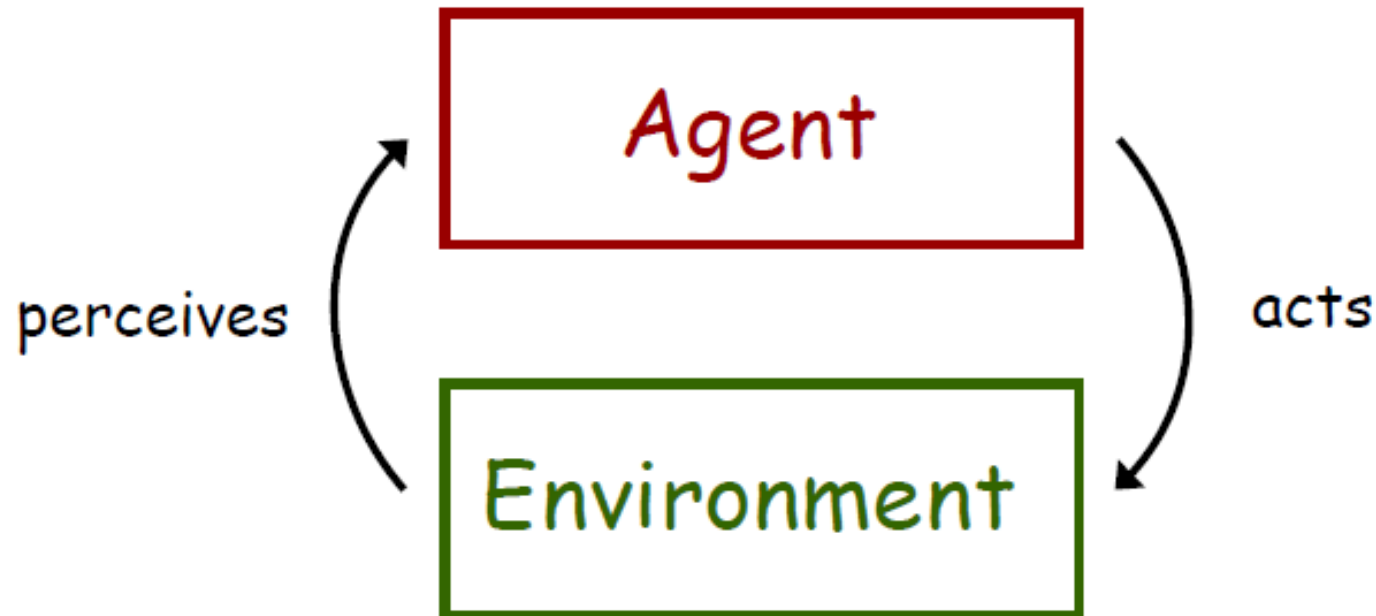
Rational agents

- An **agent** is an entity that perceives and acts
- **This course is about designing rational agents**
- Abstractly, an agent is a function from percept histories to actions:

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

- For any given class of environments and tasks, we seek the agent (or class of agents) with the best performance
- Computational limitations make perfect rationality unachievable
 - design best **program** for given machine resources

Agent Schematic (I)



- This diagram oversimplifies the internal structure of the agent.

Agent Schematic (II)



- Require more flexible interaction with the environment, the ability to modify one's goals, knowledge that be applied flexibly to different situations.