Izmir Institute of Technology

CENG 461 – Artificial Intelligence

Introduction

Introduction

- This course covers a wide range of introductory AI topics.
- You will also have a chance to learn and use Python to implement some of the major AI algorithms.
- Main Textbook:
  - Artificial Intelligence, A Modern Approach by Russel and Norvig, 3rd Edition, (AIMA3Ed).
- Introduction to AI course online:
  - https://www.udacity.com/course/cs271
    - Watching the videos will definitely help with this class!
- Another online course from UC Berkeley
  - https://www.edx.org/course/artificial-intelligence-uc-berkeleyx-cs188-1x

Course Objectives

- This introductory course aims
  - to get you started on major concepts and terminology of AI
  - to gain first hand experience in the application of some AI algorithms
  - to introduce you to scientific programming with Python
- At the end, you will also understand what someone means when he/she says that he/she is interested in
  - Machine Learning, Pattern Recognition, Computer Vision, Robotics, …

Grading

- Midterm Exam - 30%
- Final Exam - 40%
- Homeworks - 20%
  - They are important to understand the discussed algorithms.
  - You can help each other to some extent but you are not allowed to copy the homeworks (we will check this automatically).
  - For homework related issues, please consult to the assistants first.
- Quizzes - 10%

What is Artificial Intelligence?

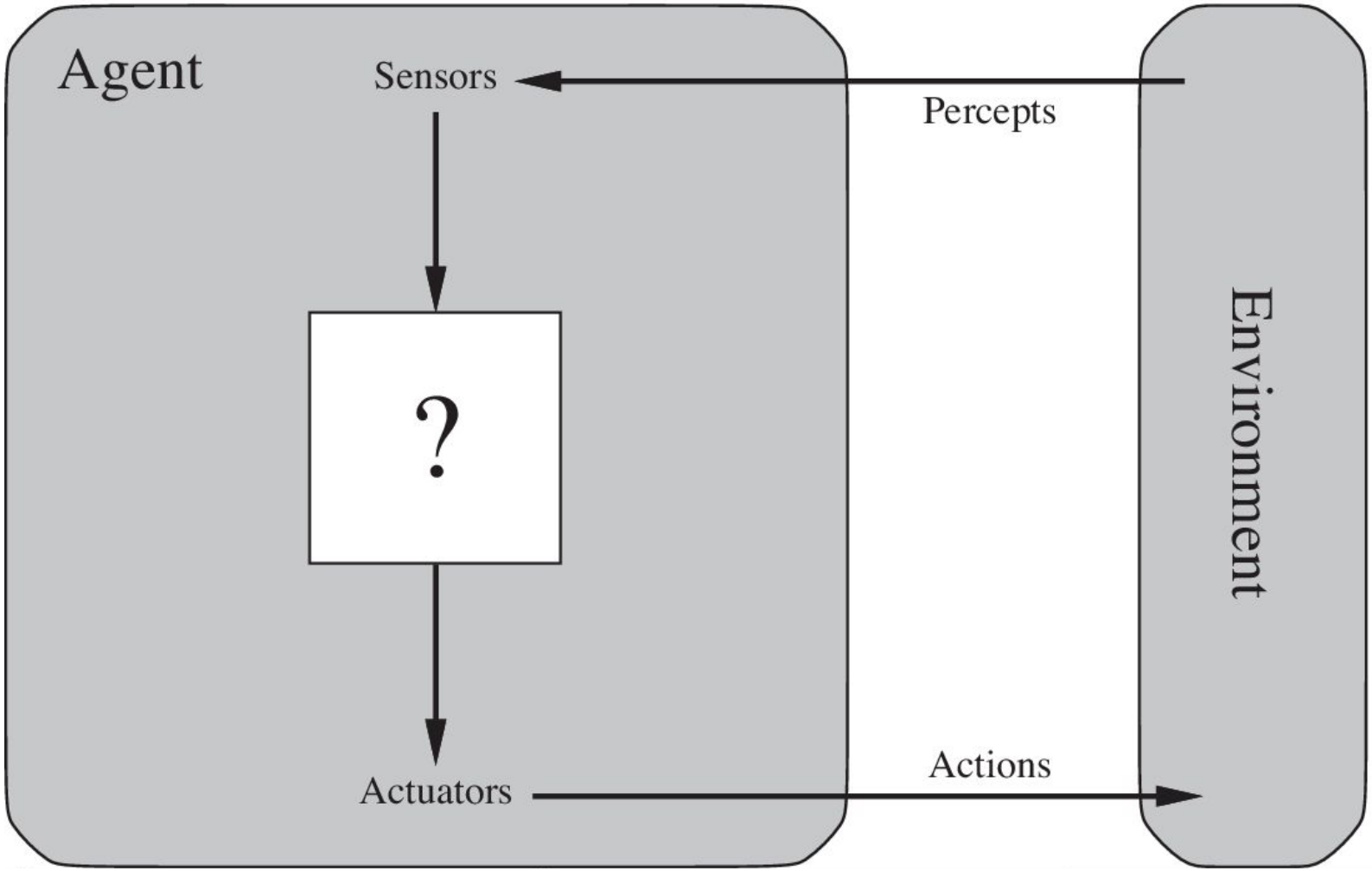
- Human-like Agents:
  - Machines that think like humans
    - Cognitive Science: Observe and try to mimic human thought processes with computational models.
    - Human thought processes are too complex to analyze directly.
  - Machines that act like humans
    - The Turing test: deceive a human to think that he/she is conversing with another human.
    - Hard to formulate, test.
    - Planes do not fly by flapping their wings.
- Rational Agents:

  Rational: based on or in accordance with reason or logic; reasonable; sensible
  - Computers that think rationally
    - Formalize the state and the relations between world objects based on logic.
    - Knowledge is hard to formalize with precision and real-world problems involve dealing with too many variables.
  - Computers that act rationally
    - A rational agent that tries to achieve the best attainable score for a given goal.
    - This is the paradigm that we will follow.

Intelligent Agent

- Rationality can be applied to a wide variety of agents operating in any imaginable environment.
- In this course, we concentrate on a small set of design principles for building successful agents, which we refer to as **intelligent agents**.

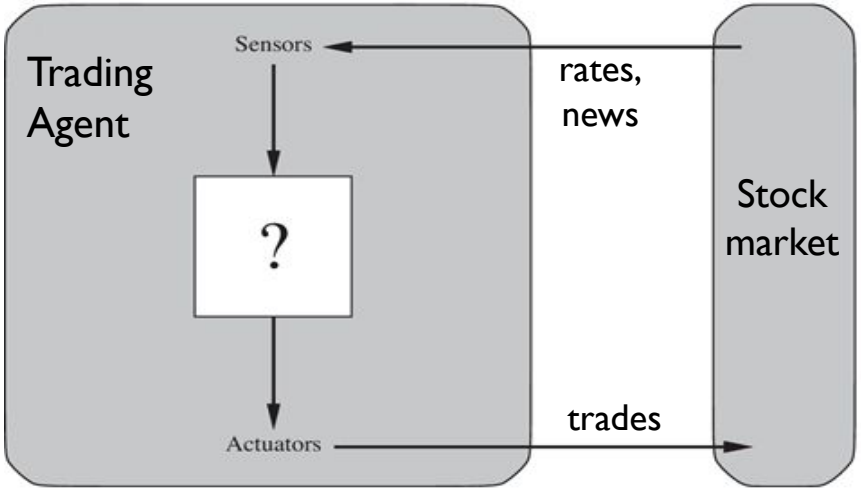
Intelligent Agent: Perception-Action Cycle



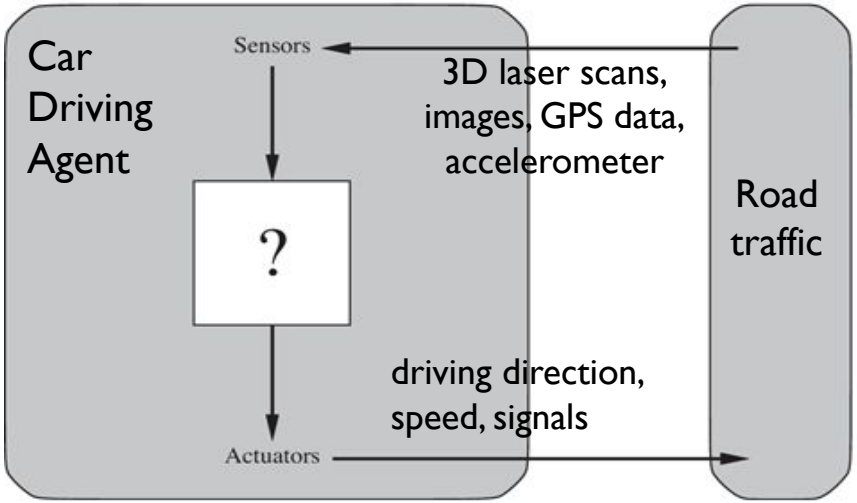
AIMA2Ed: Figure 2.1

Intelligent Agent ..

.. in finance

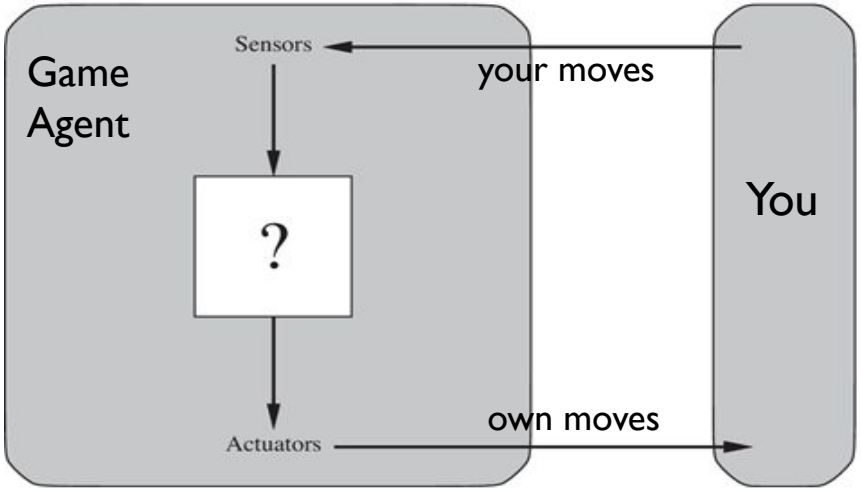


.. in robotics

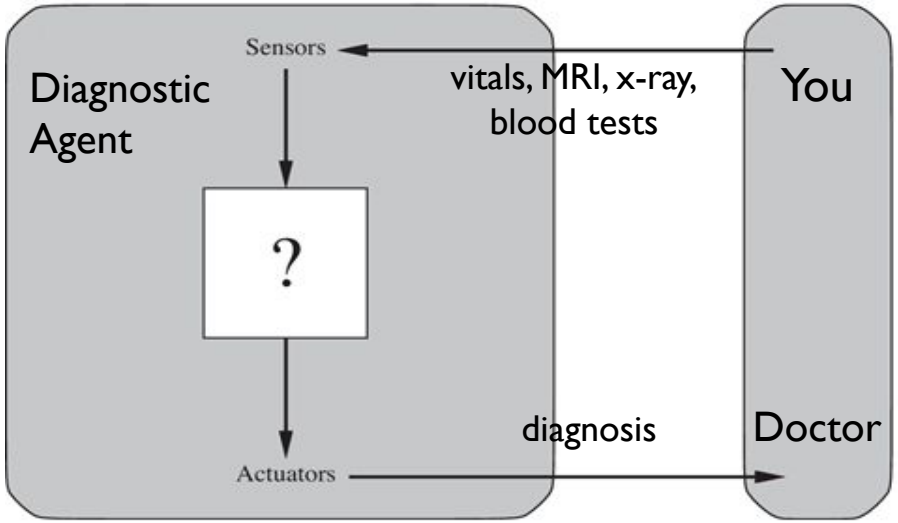


Intelligent Agent ..

.. in games



.. in medicine



Applications of AI

- Games (1992/1994)

https://en.wikipedia.org/wiki/Chinook_(computer_program)

Applications of AI

- Games (1997)

V.S.

http://en.wikipedia.org/wiki/Deep_Blue_versus_Garry_Kasparov

Applications of AI

- Games (2016)

V.S.

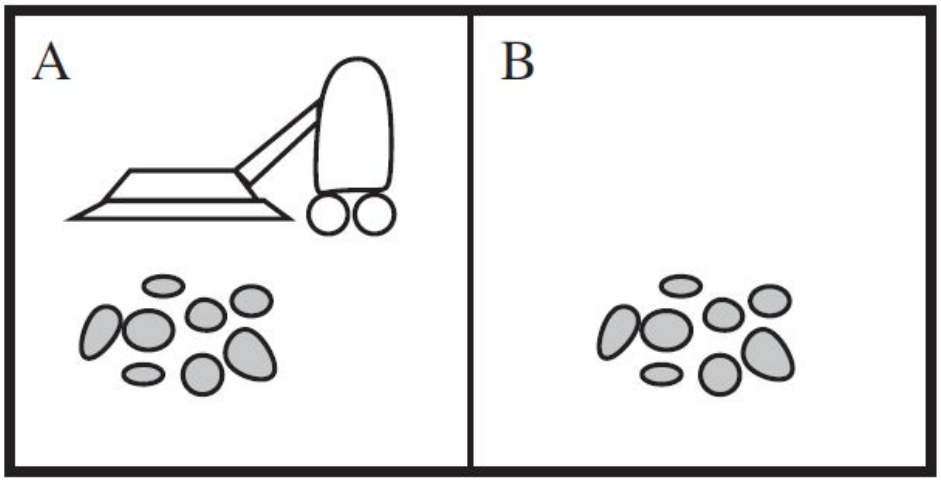
https://en.wikipedia.org/wiki/AlphaGo_versus_Lee_Sedol

Applications of AI

- Autonomous Navigation

Example Agent: A Vacuum-Cleaner

- There are two rooms, A and B. Each room is either *clean* or *dirty*.
- The vacuum cleaner has sensors to perceive which square it is in and if there is dirt in the square.
- It also has actuators to move to *left*, move to *right*, or *suck* dirt.



AIMA2Ed: Figure 2.2

The Goal Function

- We need to define the performance criteria that we can measure. After that, we are able to talk about rationality.
- Example: Maximize the amount of dirt picked up.
  - A rational agent will find a patch of dirt, suck it up, drop it back, suck it up, …
  - Performance is measureable. But it is not a good choice. Your goal function should reflect the intended end result: All rooms are cleaned up.
- Another example: Agent is awarded one point for each clean square at each time step.
  - Once all the dirt is cleaned up, the agent will oscillate needlessly back and forth
  - If the performance measure includes a penalty for each movement to left or right, then the agent would move more reluctantly.

Rational Agent

- A rational agent should select an action that is expected to maximize its performance measure, given evidence provided by the percepts it receives and prior knowledge the agent has.
- A vacuum cleaner agent cleans up the room if it is dirty or moves to the other room otherwise. Is it rational?
  - It depends on performance criteria, geography of the world, whether cleaned up rooms stay clean, what possible actions are, whether its sensor is accurate, whether its wheels can slip, …

Environment

- The environment can be
  - Fully or Partially Observable

    .. if agent's sensors detect all aspects in the environment or not
  - Deterministic or Stochastic
  - .. if the environment is completely determined by the current state and the action executed by the agent or not

note: we ignore uncertainty that arises from the actions of other agents

  - Discrete or Continuous

    .. if there are finite amount of action choices and finite amount of things you can sense (like locations) or not
  - Benign or Adversarial

    .. if the environment has no objective that contradicts to your objective or not

Fully versus Partially Observable

- Chess
- Poker
- Backgammon
- A self-driving car
- An automatic vacuum-cleaner
- Scheduling lectures
- The Rubik's Cube

Deterministic versus Stochastic

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Discrete versus Continuous

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Benign or Adversarial

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Applications of AI

- Language Translation:
  - Many languages to translate!
  - You can either try to build rules of translation for each pair.
  - Or you could take lots of documents with the same content but in different languages and try to learn from them (to find most probable translation).
  - If you have enough data with repeating structure, the second one works pretty well.

Applications of AI

- Given the related table entries from the website of the University of Science and Technology in Beijing, can you figure out the Chinese for "Engineering" and "Science". What about others?

National Key Disciplines	Main Disciplines (4)	Mining Engineering
		Metallurgical Engineering
		Materials Science and Engineering
		History of Science and Technology
	Subsidiary Disciplines (12)	Mining Engineering
		Mineral Processing Engineering
		Safety Technology and Engineering
		Ferrous Metallurgy
		Non-ferrous Metallurgy
		Physical Chemistry of Metallurgy
		Materials Physics and Chemistry
		Materials Processing Engineering

Partial table in English from http://en.ustb.edu.cn/AboutUSTB/ShowArticle.asp?ArticleID=260

国家重点学科	
一级学科(4)	矿业工程、冶金工程、材料科学与工程、科学技术史
二级学科(12)	采矿工程、矿物加工工程、安全技术及工程、钢铁冶金 有色金属冶金、冶金物理化学、材料物理与化学、材料加工工程 材料学、科学技术史、机械设计及理论、热能工程

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工程

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科学

Some of the Subfields of AI

- Natural Language Processing
  - Text In 📬☮ Structure Out
- Computer Vision (CENG608)
  - Image In 📬☮ Structure Out
- Image/Signal Processing (CENG508)
  - Image/Signal In 📬☮ Image/Signal Out
- Data Mining (CENG484, CENG542)
  - Data In 📬☮ Interesting Structure Out
- Information Retrieval (CENG543)
  - Data+Query In 📬☮ Relevant Data Out
- Machine Learning (CENG463)
  - Data+Model In 📬☮ Learned Model Out
- Robotics: Application of the above to mechanical systems.
- For all of the above, 'structure' means any kind of knowledge inferred from the input data