



Artificial Intelligence

Chapter 1

What is Artificial Intelligence?

Intelligence : the ability to learn and solve problems

AI Defined

- AI may be defined as the branch of computer science that is concerned with the automation of intelligent behavior
- Other definitions:
 - The exciting new effort to make computers think ... machines with minds
 - The automation of activities that we associate with human thinking (e.g., decision-making, learning...)
 - The art of creating machines that perform functions that require intelligence when performed by people
 - The study of mental faculties through the use of computational models
 - A field of study that seeks to explain and emulate intelligent behavior in terms of computational processes
 - The study of how to make programs/computers do things that people do better

What is Artificial Intelligence?

- **Some Definitions**

- *Weak AI*: AI develops useful, powerful applications.
- *Strong AI*: claims machines have cognitive minds comparable to humans.

What is Artificial Intelligence?

- **Operational Definition of AI**
(Turing Test):

In 1950 Turing proposed an operational definition of intelligence by using a Test composed of :

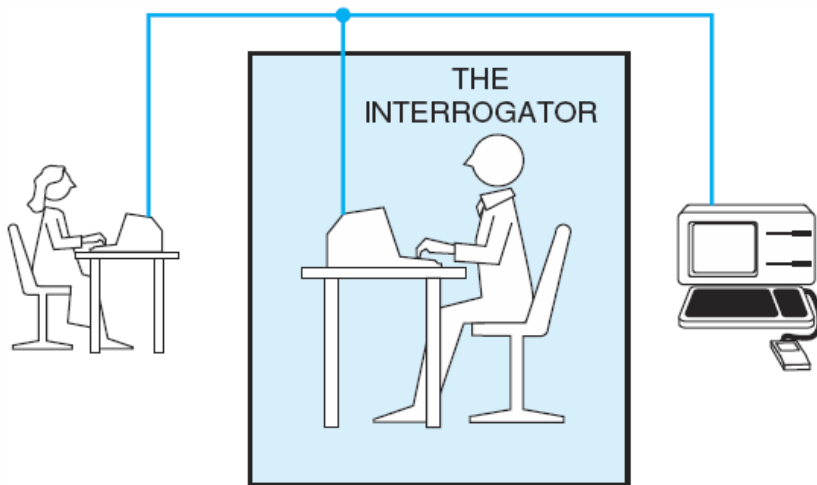
- **An interrogator (a person who will ask questions)**
- **a computer (intelligent machine !!)**
- **A person who will answer to questions**
- **A curtain (separator)**



Alan Turing

Turing Test

- Mathematician **Alan** Turing devised a test for defining artificial intelligence:
 - an interrogator poses questions to two entities, a human and a computer



- If the interrogator cannot tell which is the human and which is the computer, then the computer passes the Turing Test and should be considered intelligent
 - Turing first called this the Imitation game but has since been renamed the **Turing Test** – a test for machine intelligence

What is Artificial Intelligence ?

Goals of AI:

AI began as an attempt to understand the nature of intelligence, but it has grown into a scientific and technological field affecting many aspects of commerce and society. The main goals of AI are:

- **Engineering:** solve real-world problems using knowledge and reasoning. AI can help us solve difficult, real-world problems, creating new opportunities in business, engineering, and many other application areas

What is Artificial Intelligence ?

Goals of AI (cont'd)

- **Scientific**: use computers as a platform for studying intelligence itself. Scientists design theories hypothesizing aspects of intelligence then they can implement these theories on a computer.

Even as AI Technology becomes integrated into the fabric of everyday life. AI researchers remain focused on the grand challenges of automating intelligence.

What is Artificial Intelligence ?

Examples of AI Application systems:

- **Game Playing**

- *TDGammon*, the world champion backgammon player, built by Gerry Tesauro of IBM research
- *Deep Blue* chess program beat world champion Gary Kasparov



What is Artificial Intelligence ?

- **Natural language processing (NLP)** gives machines the ability to read and understand the languages that humans speak.
- **Natural Language Understanding**
 - *AI Translators* – spoken to and prints what one wants in foreign languages.
 - *Natural language understanding* (***spell checkers, grammar checkers***)

What is Artificial Intelligence ?

Examples of AI Application Systems:

- **Expert Systems:**

- **Expert System:** An expert system is a computer system that emulates the decision-making ability of a human expert. Expert systems are designed to solve complex problems by reasoning about knowledge, like an expert, and not by following the procedure of a developer as is the case in conventional programming.

- **Diagnostic Systems**

- **Pathfinder**, a medical diagnosis system (**suggests tests and makes diagnosis**) developed by Heckerman and other Microsoft research
- **MYCIN system** for diagnosing bacterial infections of the blood and suggesting treatments

What is Artificial Intelligence ?

Examples of AI Application Systems:

- **Expert Systems:**

- **Financial Decision Making**

- Credit card providers, banks, mortgage companies use AI systems to detect fraud and expedite financial transactions.

- **Configuring Hardware and Software**

- AI systems configure custom computer, communications, and manufacturing systems, guaranteeing the purchaser maximum efficiency and minimum setup time.

What is Artificial Intelligence ?

Examples of AI Application Systems:

- **Robotics:**



- **Robotics becoming increasingly important in various areas like: games, to handle hazardous conditions and to do tedious jobs among other things. For examples:**
 - **automated cars, ping pong player**
 - **mining, construction, agriculture**
 - **garbage collection**

What is Artificial Intelligence ?

Examples of AI Application systems:

- **Other examples:**

- Handwriting recognition (US postal service zip code readers)
- Automated theorem proving
 - use inference methods to prove new theorems
- Web search Engines

Notes

- **Machine learning** is the study of computer algorithms that improve automatically through experience and has been central to AI research since the field's inception.
- **Unsupervised learning** is the ability to find patterns in a stream of input.
- **Supervised learning** includes both classification and numerical regression.
- **Classification** is used to determine what category something belongs in, after seeing a number of examples of things from several categories.
- **Regression** is the attempt to produce a function that describes the relationship between inputs and outputs and predicts how the outputs should change as the inputs change.
- **In reinforcement learning** the agent is rewarded for good responses and punished for bad ones.

Voice Recognition

- In computer science, voice recognition (VR) is the translation of spoken words into text.
- It is also known as “automatic speech recognition”, “ASR”, “computer speech recognition”, “speech to text”, or just “STT”. Some SR systems use “training” where an individual speaker reads sections of text into the SR system

Artificial Intelligence – Vision

- Computer vision is a field that includes methods for acquiring, processing, analyzing, and understanding images and, in general, high dimensional data from the real world in order to produce numerical or symbolic information, *e.g.*, in the forms of decisions

Questions

State whether the following statements are true or false:

1. Natural language processing (NLP) gives machines the ability to read and understand the languages that humans speak.
2. Unsupervised learning includes both classification and numerical regression.
3. Voice recognition (VR) is also known as “automatic speech recognition” or “speech to text”.
4. Robots are one of the applications of AI.
5. AI can be defined as “the science and engineering of making intelligent machines”.
6. Artificial Intelligence has no branch.
7. Banks use artificial intelligence systems to organize operations, invest in stocks and manage properties.
8. AI deals with the types of problem-solving and decision-making that humans continually face in dealing with the world.

AI Programming Languages

- General programming languages such as C++ and Java are often used because these are the languages with which most computer scientists have experience. There also exist two programming languages that have features that make them particularly useful for programming Artificial Intelligence projects
- PROLOG
- LISP

AI Topics:

- Problem solving by searching
(Uninformed search, heuristic search ...)
- Knowledge-based systems
(expert systems ...)
- Machine learning
(neural networks, RL ...)
- Artificial Life <Modern AI>
(cellular automata, GAs ...)

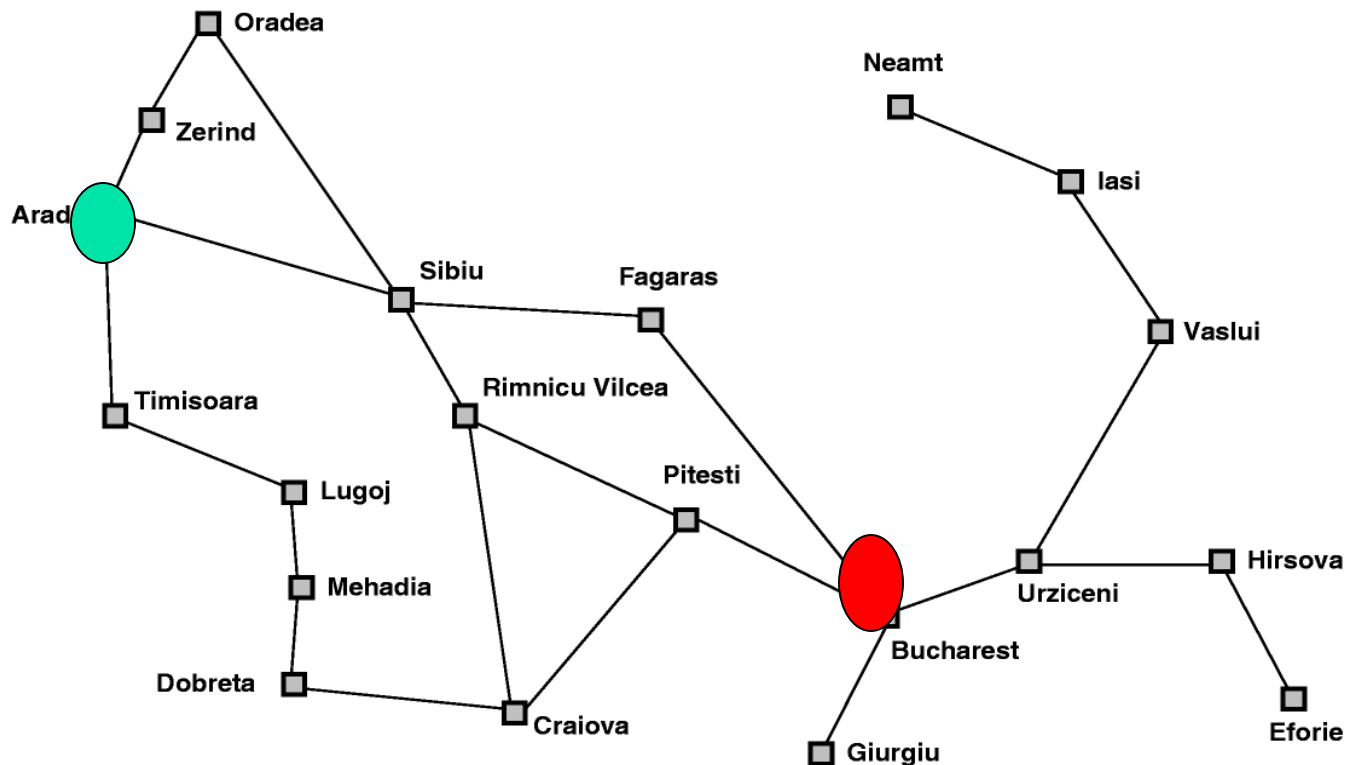
Problem Solving by Searching

Why search ?

- **Early works of AI was mainly towards**
 - proving theorems
 - solving puzzles
 - playing games
- **All AI is search!**
 - Not totally true (obviously) but more true than you might think.
 - Finding a good/best solution to a problem amongst many possible solutions.

Classic AI search problems

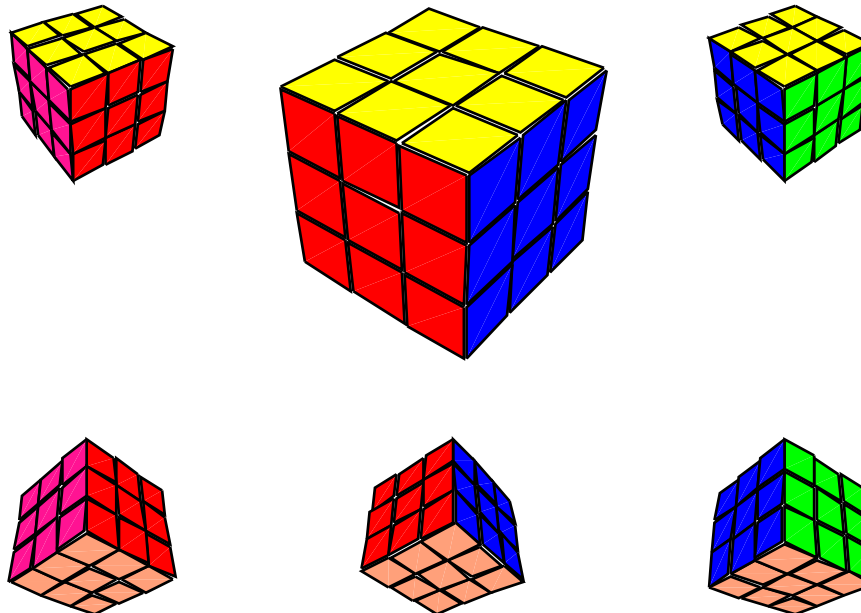
- Map searching (navigation)



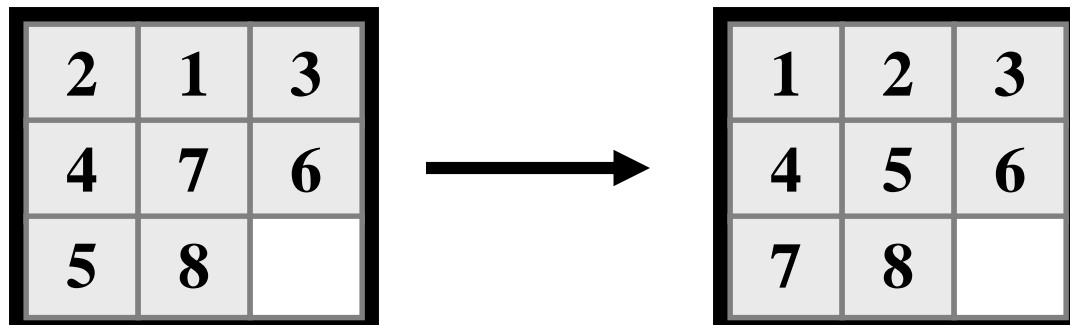
Problem definition

- Initial State : Arad
- Actions(state) :
- Results (state , action)
- Goal test
- Path cost ($s_1 \rightarrow s_2, \dots, s_n$)
- Note that:
- Step_Cost: (s, a, s')

- 3*3*3 Rubik's Cube



- 8-Puzzle



Knowledge-based system

- expert system (**or knowledge-based system**): **a program which encapsulates knowledge from some domain, normally obtained from a human expert in that domain**
- **components:**
 - Knowledge base (KB): repository of rules, facts (productions)
 - working memory: (if forward chaining used)
 - inference engine: the deduction system used to infer results from user input and KB
 - user interface: interfaces with user
 - external control + monitoring: access external databases, control,...

Knowledge-based system

- Why use expert systems:
 - **commercial viability: whereas there may be only a few experts whose time is expensive and rare, you can have many expert systems**
 - **expert systems can be used anywhere, anytime**
 - **expert systems can explain their line of reasoning**
 - **commercially beneficial: the first commercial product of AI**
- Weaknesses:
 - **expert systems are as sound as their KB; errors in rules mean errors in diagnoses**
 - **automatic error correction**, learning is difficult (although machine learning research may change this)
 - **the extraction of knowledge from an expert, and encoding it into machine-inferable form is the most difficult part of expert system implementation**

Questions

Is Artificial Intelligence a branch of computer science or an alternative to computer science?

Why is Artificial Intelligence a worthwhile subject to study?

Explain the difference between strong and weak methods in Artificial Intelligence. Explain how this dichotomy differs from the difference between strong and weak AI.

Why are PROLOG and LISP so well suited to Artificial Intelligence research? Do you think languages such as C++ and Java could also be used for such research?