Artificial Intelligence

Introduction

Instructor:

Dr. Muhammad Shuaib Qureshi

Assistant Professor

muhammad.qureshi@ucentralasia.org

Readings/References

- **Text Book**
  - Artificial Intelligence: A Modern Approach by Stuart Russell and Peter Norvig. 3rd Edition.

- **Reference Book**
  - Artificial Intelligence: Structures and Strategies for Complex Problem Solving by George Luger. 6th Edition, Addison-Wesley.

Course Outline

1. Artificial Intelligence Fundamentals
2. Intelligent Agents
3. AI Search Strategies
4. Knowledge Representation
5. Introduction to Planning in AI
6. Introduction to Machine Learning
7. Selected Topics: Natural Language Processing and Evolutionary Algorithms

Assessment & Evaluation

- Mid Term exam (20%)
- Final exam (30%)
- Quizzes (15%)
- Homework Assignments (15%)
- Class Activities (05%)
- Group Project (15%)

☞ There will be **NO** makeup for exams and/or quizzes without any proper excuse!

AI Fundamentals

- Definitions
- Goals
- Approaches
- Branches
- Applications
- Brief History

What is Intelligence ?

“ability to learn, understand and think”

(Oxford dictionary)

What is Intelligence??? (Cont'd…)

- Intelligence is the ability to learn about, to learn from, to understand about, and interact with one's environment.
- Intelligence is the faculty of understanding
- Intelligence is not to make no mistakes but quickly to understand how to make them good

What is Intelligence??? (Cont'd...)

- Capacity to learn from experience
- Ability to adapt to different contexts
- Capacity of mind, especially to understand principles, facts or meanings, acquire knowledge, and apply it to practice.

What is Intelligence??? (Cont'd...)

- The computational part of the (human) ability to achieve goals in the world
- Intelligent behaviour involves:
  - ability to act in complex environments
  - ability to learn from experience
  - ability to think and reason
  - ability to perceive relations (in the world)
  - ability to use tools
  - (...)
- Varying kinds and degrees of intelligence occur in people, many animals and even in some machines

What is Artificial Intelligence?

- There is no agreed definition of the term artificial intelligence. However, there are various definitions that have been proposed.

- Some will be considered below,

What is Artificial Intelligence? (Cont'd...)

American Association for Artificial Intelligence

The scientific understanding of the mechanisms underlying thought and intelligent behavior and their embodiment in machines.

What is Artificial Intelligence? (Cont'd...)

- AI is the science and engineering of making intelligent machines, especially intelligent computer programs.

What is Artificial Intelligence? (Cont'd...)

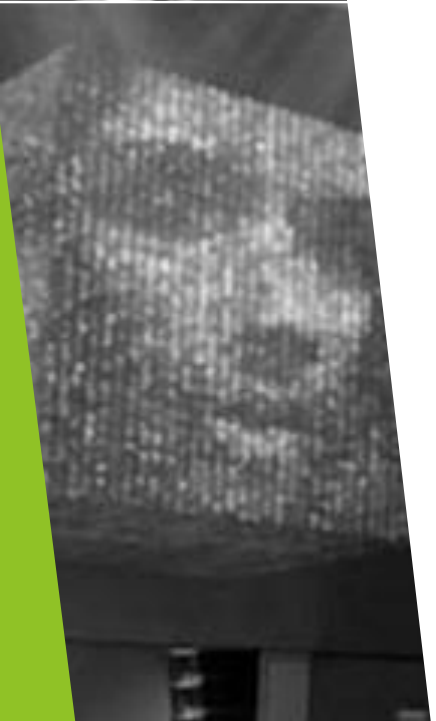
- AI is a study in which computer systems are made that think like human beings. Haugeland, 1985 & Bellman, 1978.
- AI is a study in which computer systems are made that act like people. AI is the art of creating computers that perform functions that require intelligence when performed by people. Kurzweil, 1990.
- AI is the study of how to make computers do things which at the moment people are better at. Rich & Knight, 1991
- AI is a study in which computers that rationally think are made. Charniac & McDermott, 1985.
- AI is the study of computations that make it possible to perceive, reason and act. Winston, 1992.
- AI is the study in which systems that rationally act are made. AI is considered to be a study that seeks to explain and emulate intelligent behaviour in terms of computational processes. Schalkeoff, 1990.
- AI is considered to be a branch of computer science that is concerned with the automation of intelligent behavior. Luger & Stubblefield, 1993.

What is Artificial Intelligence? (Cont'd...)

- The science and engineering of making intelligent machines (John McCarthy)
- The study of ideas that make people intelligent and incorporate those ideas into computers (Patrick Henry)
- The study of making computers do things which, at the moment, people are better. (Elaine Rich)
- Getting computers to do tasks which require human intelligence.

What is Artificial Intelligence? (Cont'd…)

- AI is a multidisciplinary field
  - **Psychology**: To investigate how human mind/brain works
  - **Philosophy**: Theories of reasoning and learning
  - **Mathematics**: Theories of logic, probability, decision making and computation
  - **Linguistics**: The meaning and structure of language
  - **Computer Science**: Makes AI a reality by developing computational models



V.I.K.I : from the movie I Robot 2004

V.I.K.I. part of the story centers around an intelligent computer.

In the movie, V.I.K.I. can

- speak easily
- see and understand the emotions
- navigate automatically
- Diagnose problems
- make life-and-death decisions
- display emotions
- Predict
- Planning

https://youtu.be/b-yxeIcGCwA

Successes of AI today

- In 2017, an AI robot named **Sophia** was granted citizenship by the Kingdom of Saudi Arabia.

https://youtu.be/dMrX08PxUNY

Successes of AI today

- **HUMAN MIND READING:**

Artificial Intelligence translates human thoughts into text.

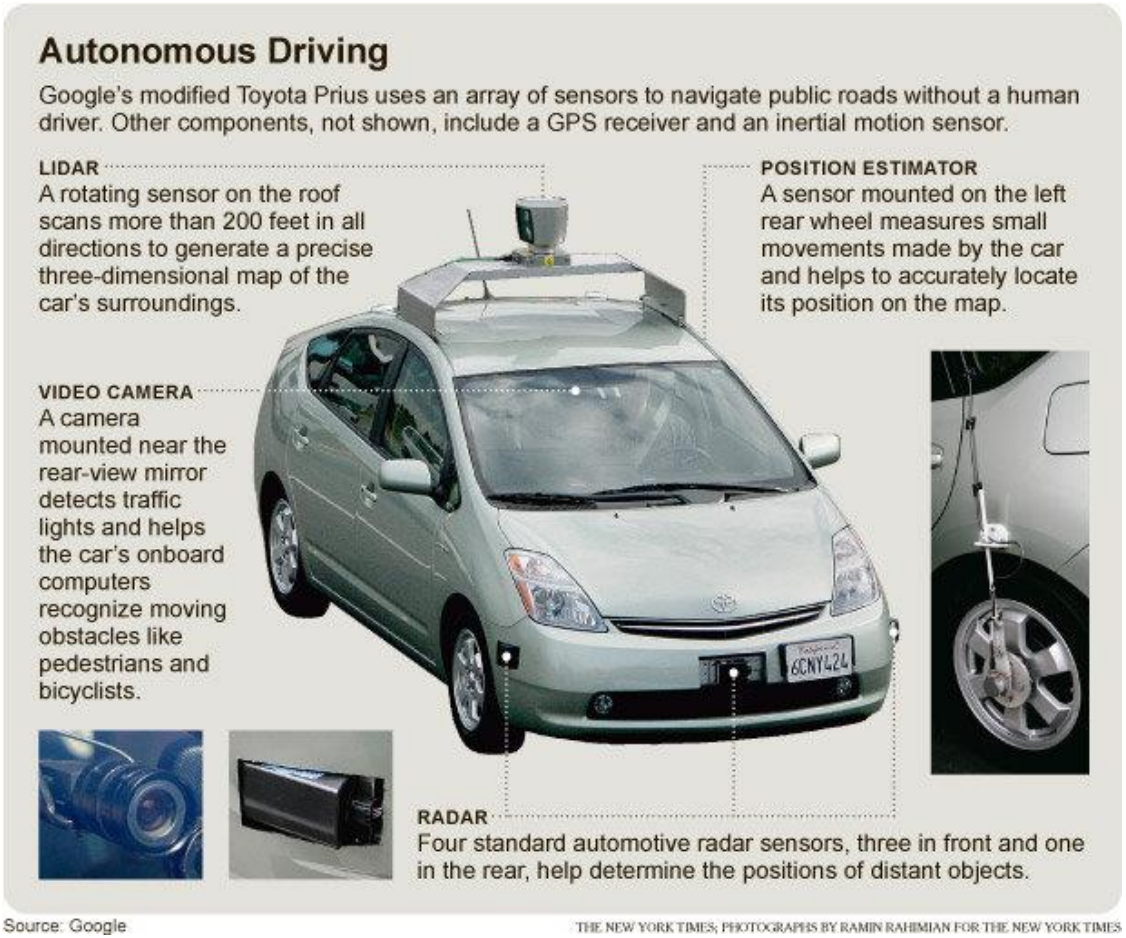
Vision

- OCR, handwriting recognition
- Face detection/recognition: many consumer cameras, Apple iPhoto
- Visual search: Google Goggles
- Vehicle safety systems: Mobileye

Google goggles labs

r Science

Google self-driving cars



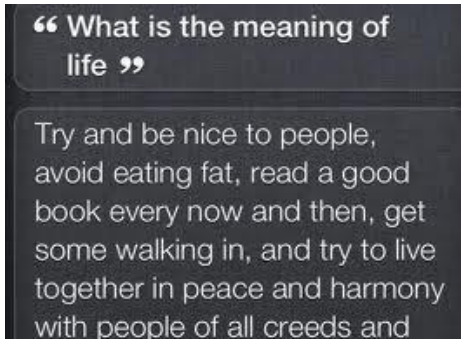
- Google's self-driving car passes 300,000 miles (8/15/2012)

Natural Language

- Speech technologies
  - Google voice search
  - Apple Siri

Machine translation

  - translate.google.com
  - Comparison of human and Google translation



Source	*The Original Text*	*Human Translation*	*Google Translate*
 French "Le Petit Prince" ("The Little Prince") By Antoine de Saint-Exupéry	Le premier soir je me suis donc endormi sur le sable à mille milles de toute terre habitée. J'étais bien plus isolé qu'un naufragé sur un radeau au milieu de l'océan. Alors vous imaginez ma surprise, au lever du jour, quand une drôle de petite voix m'a réveillé. Elle disait: -S'il vous plaît... dessine-moi un mouton!	On the first night, I fell asleep on the sand, a thousand miles from any human habitation. I was far more isolated than a shipwrecked sailor on a raft in the middle of the ocean. So you can imagine my surprise at sunrise when an odd little voice woke me up. It said: "Please ... draw me a sheep." - *Wordsworth Children's Classics, 1995*	The first night I went to sleep on the sand a thousand miles from any human habitation. I was more isolated than a shipwrecked sailor on a raft in the middle of the ocean. So imagine my surprise at daybreak, when a funny little voice woke me. She said: "If it pleases you ... draw me a sheep!"

Math, games

- In 1996, a computer program written by researchers at Argonne National Laboratory proved a mathematical supposition unsolved for decades
  - **NY Times story:** The Computers have found proofs of mathematical assumptions.
  - "[The proof] would have been called creative if a human had thought of it"
- **IBM's Deep Blue defeated the world chess champion Garry Kasparov in 1997.**

Logistics, scheduling, planning

- During the 1991 Gulf War, US forces deployed an AI logistics planning and scheduling program that involved up to 50,000 vehicles, cargo, and people.

- In 2004, NASA introduced the **MAPGEN** system to plan the daily operations for the Mars Exploration Rovers.

Information agents

- Search engines
- Recommendation systems
- Spam filtering
- Automated helpdesks
- Fraud detection
- Automated trading
- Medical diagnosis

Robotics

- Autonomous vehicles
  - Google self-driving cars
- Autonomous helicopters
- Robot soccer
  - RoboCup
- Personal robotics
  - Humanoid robots
  - Robotic pets
  - Personal assistants

Human Intelligence VS Artificial Intelligence

Human Intelligence VS Artificial Intelligence

Pros

Human Intelligence

- Sensitivity, Common sense, Judgement, Creativity, Beliefs etc.
- The ability to demonstrate their intelligence by communicating effectively
- Reasoning and Critical thinking

Artificial Intelligence

- Ability to simulate human behavior and thinking processes
- Capture and preserve human expertise
- Fast Response. The ability to comprehend large amounts of data quickly.

Human Intelligence VS Artificial Intelligence

Cons

Human Intelligence

- Humans are imperfect
- They have limited knowledge bases
- Information processing of serial nature proceed very slowly in the brain as compared to computers
- Humans are unable to retain large amounts of data in memory.

Artificial Intelligence

- No “common sense”
- Cannot deal with “mixed” knowledge
- May have high development costs
- Raise legal and ethical concerns

Artificial Intelligence in Our Life

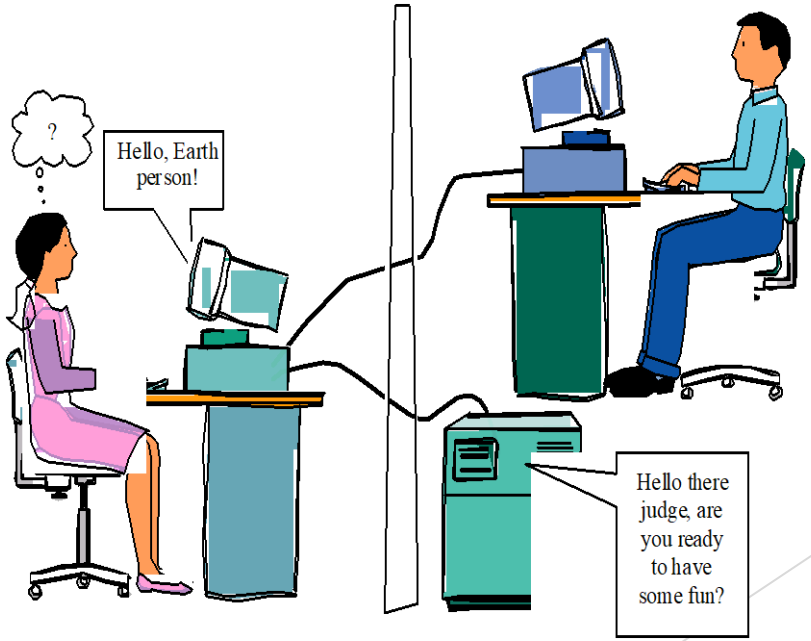
- Virtual Personal Assistants
  - Siri, Google Now: Where is the nearest Italian restaurant?
- Video Games
  - e.g. Far cry & Call of duty
- Smart Cars
  - e.g. Google's self driving car & Tesla's autopilot
- Fraud Detection
  - Credit card fraud detection
- (. . .)

Why Artificial Intelligence?

- Computers can solve some difficult problems much quicker than human
  - Computing GCD of two numbers
  - Solving complex integration problems
  - Computing product of, say, four numbers
- Human can solve some simple problems much elegantly than computers
  - Navigating in a busy street
  - Recognizing voice of a person
- **The first law of AI**
  - **Easy problems are hard and hard problems are easy**

Intelligence Test

- An interrogator communicates with a person and a computer
- The interrogator can't see the person or computer
- The computer tries to fool the interrogator to believe that it is human
- The person also tries to convince the interrogator that it is human
- If the computer succeeds in fooling the interrogator, then it passes the intelligence test – intelligent computer



Intelligence Test Example

- Alice chat-bot acts like human and won the Turing award

  A: I am Daniel.

  B: Nice to meet you Daniel.

  A: Do you know Clinton?

  B: He was the second Impeached President of the United States.

  A: Do you like him?

  B: Sure he has never done anything to me.

Strong vs. Weak AI

- Strong AI refers to the AI research that aims to replicate human intelligence completely
  - Overall intellectual ability of machine is indistinguishable from human
  - Machines can beat human in all respects
- Weak AI refers to the AI research that aims to apply partial human intelligence in specific problem solving
  - Chess playing program – Deep blue

Branches of AI

- Logical AI
- Search
- Pattern recognition
- Knowledge representation
- Common sense knowledge and reasoning
- Learning
- Planning
- Heuristics
- Genetic programming
- (...)

Applications of AI

- Game playing (e.g. chess)
- Natural language processing (e.g. understanding text)
- Speech recognition (e.g. answering machines)
- Computer vision (e.g. face recognition)
- Expert systems (e.g. medical diagnosis)
- (...)

Brief History of AI

- 1943: early beginnings
  - McCulloch & Pitts: Boolean circuit model of brain
- 1950: Turing
  - Turing's Computing Machinery and Intelligence
- 1956: Name coined
  - Dartmouth meeting: Artificial Intelligence by McCarthy et al
- 1956 - 65: Great enthusiasm
  - Newell and Simon: GPS (General Problem Solver)
  - Gelertner: Geometry Theorem Prover
  - McCarthy: invention of LISP (List Processing, a functional language)

Brief History of AI (cont.)

- 1966-73: Towards reality
  - Realization that many AI problems are intractable
  - Limitations of existing neural network methods identified
    - Neural network research almost disappears
- 1969-85: Adding domain knowledge
  - Development of knowledge-based and rule-based systems
    - DENDRAL, MYCIN
- 1986-- Rise of machine learning
  - Neural networks return to popularity
  - Major advances in machine learning algorithms and applications

Brief History of AI (cont.)

- 1990 -- Role of uncertainty
  - Bayesian networks as a knowledge representation framework
- 1995-- AI as Science
  - Integration of learning, reasoning, knowledge representation
  - AI methods used in vision, language, data mining, etc.

Summary

- AI is science and engineering to build intelligent machines
- Strong AI aims to replicate all human capabilities in machines, while weak AI aims to implement partial human capabilities in machines
- Engineering-based AI aims to build intelligent systems, while science-based AI aims to understand intelligent behaviour
- Main AI approaches can be classified as Cognitive science-based approach, Laws of thought-based approach, Turing test-based approach and Rational agent-based approach

Summary

- The main branches of AI include: Logical AI, Search and optimization, Pattern recognition, Knowledge representation, Common sense knowledge and reasoning, Heuristics and Evolutionary Computation
- The main application areas of AI include: Game playing, Natural language processing, Speech recognition, Machine vision, Robotics and Expert Systems