

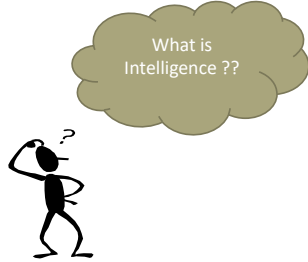
Artificial Intelligence

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Slides material is taken from Prof. Adnan Shahzada and Prof. Mohamed Batouche

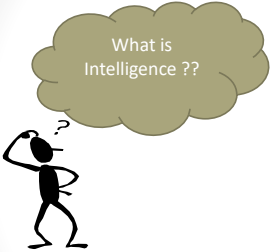
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Artificial Intelligence



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Artificial Intelligence



- Perceive
- Understand
- Remember
- Think
- Reason
- Learn from Experience
- Adapt to the new Situation
- Problem Solving

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Can Machines Think?



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Syllabus

- Recommended Books:**
 1. "Artificial Intelligence Illuminated" by Ben Coppin, Jones and Bartlett illuminated Series, 2004
 2. "Artificial Intelligence: A modern approach" Stuart Russell, Peter Norvig, Prentice Hall, 2003 (new edition 2006)
 3. "Artificial Intelligence – Structures and Strategies for Complex problem solving", George F. Luger, Pearson International Edition, Sixth edition, 2009.
 4. "Artificial Intelligence: A new synthesis" Nils Nilsson, Morgan Kaufmann, 1998

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Syllabus

- Grading**
 - MidTerm 35%
 - Final exam 40%
 - Project %
 - Homework, Quizzes, Attendance 25%

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Humans Vs Machines

| Humans | Machines |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> • Symbolic calculation • Natural language understanding • Not very precise • Knowledge • Generalize from examples • Deal with noisy inputs | <ul style="list-style-type: none"> • Numeric calculation • Machine Language • Precise • Data • Cannot generalize • Cannot deal with noise |

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Artificial Intelligence

“Study of computations that make it possible to perceive, reason and act.”

Patrick Henry Winston

- Branch of *Science* which deals with helping machines to find solutions to complex problems in a more human-like fashion
- In short, putting human intelligence into machines

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Artificial Intelligence

- AI is concerned with the design of intelligence into an artifact.
- Design of computer systems which can exhibit intelligent behaviors
- The term was coined by John McCarthy in 1956

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Why AI?

- **Two main goals of AI:**
 - To create useful “smart” programs able to do tasks that would normally require a human expert
 - To understand human intelligence better as we test theories of human intelligence by writing programs which emulate them

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Approaches to AI

| | |
|---------------------------------------------------------------|-----------------------------------------------------------|
| Systems that THINK LIKE HUMANS Cognitive modeling approach | Systems that THINK RATIONALLY Laws of thought approach |
| Systems that ACT LIKE HUMANS Turing test approach | Systems that ACT RATIONALLY Rational agent approach |

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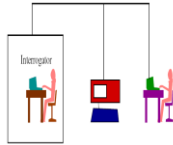
Cognitive Modeling

- We need to understand how humans think
 - Introspection: Trying to catch our own thoughts
 - Psychological experiments
- Requires scientific theories of the internal working of the human brain
- Cognitive science brings together computer models from AI & experiments from psychology to construct theories of the working of the human mind

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Turing Test

- Test by Alan Turing
- Three rooms, connected by a network
 - human interrogator
 - human response (via computer)
 - computer response
- The interrogator has to determine which is the human and which is the computer



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Laws Of Thought

- Date back to Aristotle who attempted to describe irrefutable thought process
- Syllogism provides patterns for arguments structures that give correct conclusions from correct premises, e.g.,
 - Socrates is a man; all men are mortal; so conclude:
 - Socrates is mortal
- Initiated the field of logic
- Emphasis is on correct inference
- Drawbacks
 - Informal knowledge has to be expressed in formal terms by logical notations
 - Problems with just a few dozen facts can require a lot of computations
 - Not all intelligent behavior can be mediated by logical deliberations

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Rational Agents

- Rational behavior: Doing the right thing
- What is the right thing???
 - Maximize the achievement towards a goal given some information
- An agent is something that acts
- Computer agents
 - Operate under autonomous control
 - Perceive their environment
 - Adapt to change
 - Make correct inferences
- Rational agent attempts to achieve the best outcome/best expected outcome
- Doesn't necessarily involve thinking, e.g., reflex actions

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Types to AI

- Weak AI
 - Only simulates human thoughts and actions
- Strong AI
 - Intelligent on their own
- Applied AI
 - Commercially valuable
- Cognitive AI
 - Test Theories about how human mind works

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Disciplines involved in AI

- Many disciplines contribute to goal of modelling intelligent entities:
 - Computer Science
 - Psychology (human reasoning)
 - Philosophy (nature of belief, rationality, etc)
 - Linguistics (structure and meaning of language)
 - Human Biology (how brain works)
- Subject draws on ideas from each discipline

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History of AI

| Event | Year |
|--------------------------------------------------------|--------|
| First electronic computer | 1941 |
| McCulloch & Pitts artificial neuron | 1943 |
| First neural network (Minsky & Edmonds) | 1951 |
| Birth of AI. Coined by McCarthy Dartmouth conference | 1956 |
| Eliza | 1965 |
| Dendral (chemical analysis system) | 1967 |
| SHRDLU (robot arm carried out instructions in English) | 1971 |
| Prolog | 1972 |
| MYCIN (Formally termed first expert system) | 1974 |
| Blackboard model for speech understanding | 1980 |
| Backprop for neural nets | Mid 80 |
| Data mining and virtual reality | 90s |
| Deep Blue AI system beats human chess master | 1997 |

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Typical AI Problems

- Intelligent entities need to perform both **mundane** and **expert** tasks
- **Mundane Tasks:**
 - Planning routes
 - Object Recognition
 - Natural Language Communication
 - Navigating around obstacles
- **Expert Tasks:**
 - Diagnosis
 - Mathematical Problem Solving

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Applications of AI

- Game Playing (AlphaGo, OpenAI Five)
- Computer Vision (Tesla, Waymo, Face ID)
- Natural Language Processing (Alexa, Siri, Google Translate)
- Healthcare and Diagnosis Systems (AI models for cancer, genetic profiling)
- Control Systems (smart grids, Nest thermostats)
- Optimization (supply chain management, stock market analysis)
- Robotics (Amazon Robotics, da Vinci Surgical System)
- Creative Arts (AI-generated music, deepfake technology)
- Customer Service (chatbots, sentiment analysis)
- Education (personalized learning, automated grading)

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Historical Success Stories

Waymo (2009-Present)

- **Autonomous Vehicles**
- **Description:** Waymo, a subsidiary of Alphabet Inc., has been developing self-driving car technology. It became the first company to launch a public self-driving taxi service in 2018.
- **Key Achievements:** Successfully launched and operates an autonomous ride-hailing service in Phoenix, Arizona.

AlphaGo (2016)

- **AI for Board Games**
- **Description:** Developed by DeepMind, AlphaGo is an AI program designed to play the board game Go.
- **Key Achievements:** Defeated world champion Go player Lee Sedol 4-1 in a five-game match, demonstrating the potential of deep learning and reinforcement learning.

OpenAI GPT-3 (2020)

- **Natural Language Processing**
- **Description:** The third-generation Generative Pre-trained Transformer by OpenAI is one of the most advanced language models.
- **Key Achievements:** Capable of generating human-like text, answering questions,

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Tesla Autopilot (2014-Present)

- **Advanced Driver Assistance Systems (ADAS)**
- **Description:** Tesla's Autopilot is an advanced driver-assistance system that offers features such as lane centering, traffic-aware cruise control, self-parking, and automatic lane changes.
- **Key Achievements:** Continuous updates and improvements through over-the-air updates, with millions of miles driven in autonomous mode.

IBM Watson for Oncology (2012-Present)

- **AI in Healthcare**
- **Description:** IBM Watson for Oncology uses AI to help oncologists provide cancer patients with individualized treatment options.
- **Key Achievements:** Assists in the analysis of medical literature, clinical trials, and patient data to recommend personalized treatments.

DeepMind AlphaFold (2020)

- **Protein Folding**
- **Description:** AlphaFold is an AI system developed by DeepMind to predict protein structures.
- **Key Achievements:** Achieved a major breakthrough in predicting 3D models of protein structures with high accuracy, which is critical for understanding diseases and developing drugs.

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AI in your everyday life

Cars

- **Autonomous Driving** (e.g., Tesla Autopilot, Waymo)
- **Real-time Traffic Prediction** (e.g., Google Maps, Waze)
- **Advanced Driver Assistance Systems (ADAS)** (e.g., lane-keeping assist, adaptive cruise control)

Intelligent Games

- **Chess** (e.g., AlphaZero)
- **Real-time Strategy Games** (e.g., DeepMind's AlphaStar in StarCraft II)
- **AI-driven Game Development** (e.g., procedural content generation in No Man's Sky)

Medicine

- **Predictive Analytics for Disease Outbreaks** (e.g., BlueDot's early detection of COVID-19)
- **AI-assisted Radiology** (e.g., Aidoc, Zebra Medical Vision)
- **Personalized Medicine** (e.g., IBM Watson for Oncology, Tempus)

Internet

- **Personalized Recommendations** (e.g., Netflix, Amazon)
- **Virtual Assistants** (e.g., Google Assistant, Siri, Alexa)
- **Fraud Detection in Online Transactions** (e.g., PayPal, Stripe)

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What AI still unable to do?

- **Understanding and Generating Common Sense Reasoning**
- **Generalizing Knowledge**
- **Emotional Intelligence and Empathy**
- **Creativity and Original Thought**
- **Complex Physical Tasks**
- **Understanding and Generating Natural Language**
- **Ethical and Moral Decision Making**
- **Unpredictable Human Behavior**
- **Autonomy and Self-Awareness**
- **Ethical Concerns and Governance**

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AI Topics: A Quick Introductory Overview

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.

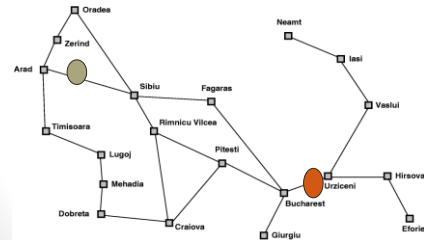
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AI Topics: A Quick Introductory Overview

Classic AI search problems

- Map searching (navigation)



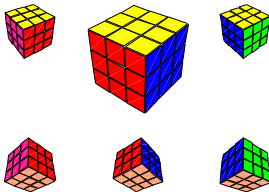
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AI Topics: A Quick Introductory Overview

Classic AI search problems

- 3*3*3 Rubik's Cube



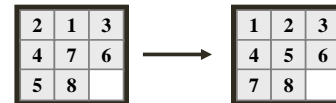
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AI Topics: A Quick Introductory Overview

Classic AI search problems

- 8-Puzzle



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Some Philosophical Questions

!!

- Do you think that the difference between the human brain and a computer is a fundamental one that can never be overcome. Or, is it merely a difference of complexity, one that can be surmounted?
- What are your feelings about the concern that AI would render humans obsolete, or that intelligent machines would turn on their creators?
- If strong AI entity is developed, will it be aware? Why? Also, would we have the right to exploit the labor of sentient artificial beings, or would they deserve the same rights as humans?

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Capabilities ??

- Is it currently possible to design and develop an intelligent system for:
 - Driving a car in the middle of Lahore city
 - Robots handling your housecleaning, yard work and cooking
 - Your groceries are automatically ordered based on preferences and patterns in purchasing.
 - "Smart" search engines that allow you to get your information with more precision to help manage the ever-growing web.
 - Smart AI agents that peruse the web to look for relevant information (new releases, prices, marketing strategies, etc.

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