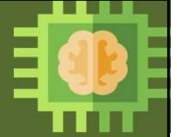**Elective Course**
Course Code: CS4103
Autumn 2025-26

Lecture #01

Artificial Intelligence for Data Science

Week-1: INTRODUCTION TO ARTIFICIAL INTELLIGENCE (AI)
AI Introduction, Brief history
Course Details

Course Instructor:

Dr. Monidipa Das
Assistant Professor
Department of Computational and Data Sciences
Indian Institute of Science Education and Research Kolkata, India 741246
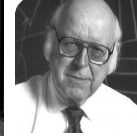

AI Introduction

- What is AI?
- Definition of AI
- Typical AI Problems
- Key Topics of AI
- Foundations of AI
- Applications of AI
- Ethical and Societal Concerns with AI

What is AI?

- **Artificial Intelligence**
  - Term coined by **J. McCarthy** in **1956**
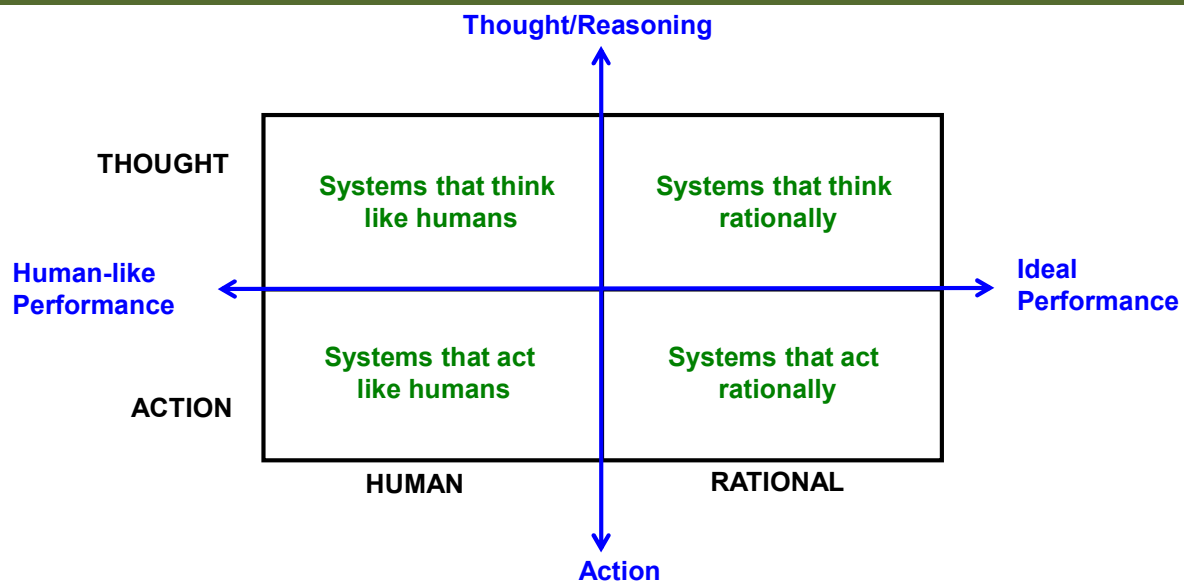 - Concerned with the design of intelligence in an artificial device

- **What is Intelligence?**
  Intelligence is defined by some general characteristics:
  - **Perception:** Manipulation and interpretation of data.
  - **Action:** Control and use of effectors to accomplish a variety of tasks.
  - **Reasoning:** Deductive (logical) inference, inductive inference.
  - **Learning:** Adapting behavior to better cope with changing environments, discovery of patterns, learning to reason, plan, and act.
  - **Communication** with other intelligent agents including humans using signals, signs, icons, etc.
  - **Planning:** Formulation of plans - sequences or agenda of actions to accomplish externally or internally determined goals.

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Definitions of AI

Thought/Reasoning

THOUGHT

| Systems that think like humans | Systems that think rationally |

Human-like Performance ← → **Ideal Performance**

| Systems that act like humans | Systems that act rationally |

ACTION

HUMAN   **RATIONAL**

Action

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Systems that act like humans: **Turing Test** 5

- You enter a room which has a computer terminal. You have a fixed period of time to type what you want into the terminal, and study the replies. At the other end of the line is either a human being or a computer system.

- If it is a computer system, and at the end of the period you cannot reliably determine whether it is a system or a human, then the system is deemed to be intelligent.

  - *"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990)*
  - *"The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)*

Human

AI SYSTEM

Human Interrogator
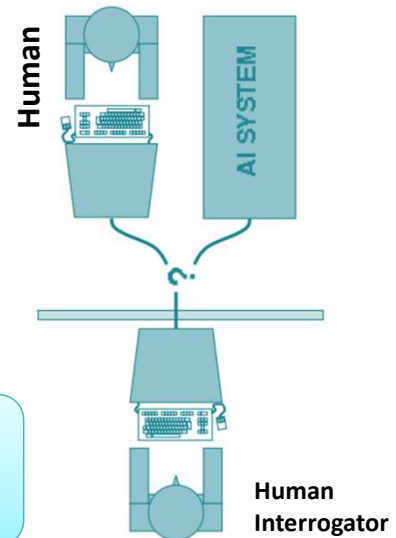
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Systems that think like humans: **Cognitive Modeling** 6

- **Cognitive Science**
  There are three ways to do this:
  - through introspection—trying to catch our own thoughts as they go by;
  - through psychological experiments—observing a person in action;
  - through brain imaging—observing the brain in action.

  - *"The exciting new effort to make computers think . . . machines with minds, in the full and literal sense." (Haugeland, 1985)*
  - *"[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978)*

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Systems that think 'rationally': **Laws of Thought**

- Humans are not always 'rational'

- Logic can't express everything

- Logical approach is often not feasible in practice

> - *"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985)*
> - *"The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)*

Systems that act rationally: **Rational Agents**

- **Rational Agents:**
  - They operate autonomously,
  - perceive their environment,
  - persist over a prolonged time period,
  - adapt to change
  - create and pursue goals

> - *"Computational Intelligence is the study of the design of intelligent agents." (Poole et al., 1998)*
> - *"AI …is concerned with intelligent behavior in artifacts." (Nilsson, 1998)*

Typical AI Problems

❑ The intelligent agents or entities need to be able to do both mundane tasks and expert tasks

❑ **Mundane Tasks**
- Planning Route
- Recognizing (vision)
- Communicating (though natural language : Understanding, Generation, Translation)
- Navigating

❑ **Expert Task**
- Playing Chess
- Medical Diagnosis
- Mathematical Problem Solving

- *It has been very hard to mechanize many tasks that lot of animals can do very easily.*

"I went to the grocery store, I saw the milk on the shelf and I bought it."
What did I buy?
• The milk?
• The shelf?
• The store?

An awful lot of reasoning abilities and knowledge of the world is needed to answer simple questions like this one
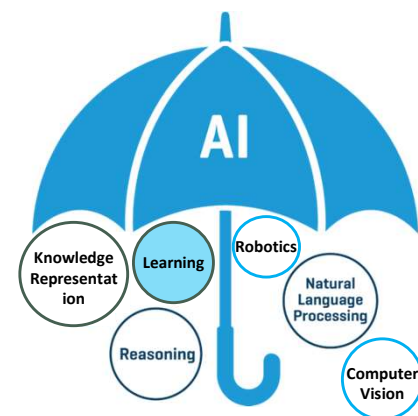
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Fundamental Topics in AI

Artificial intelligence can be considered under a number of headings:
▪ Search Techniques
▪ Constraint Satisfaction Problems
▪ Genetic Algorithms
▪ Representing Knowledge and Reasoning with it
▪ Probabilistic Reasoning
▪ Learning
▪ Expert Systems
▪ Planning
▪ Interacting with the Environment
▪ Natural language processing
▪ Fuzzy Systems

AI
Knowledge Representation
Learning
Robotics
Natural Language Processing
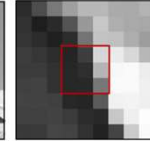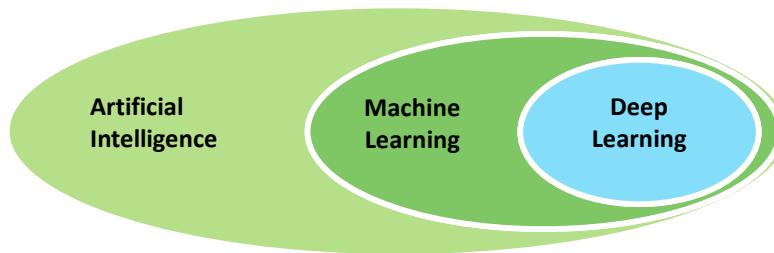Reasoning
Computer Vision

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Fundamental Topics in AI: Learning

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- **Machine Learning:** "field of study that gives computers the ability to learn without explicitly being programmed"
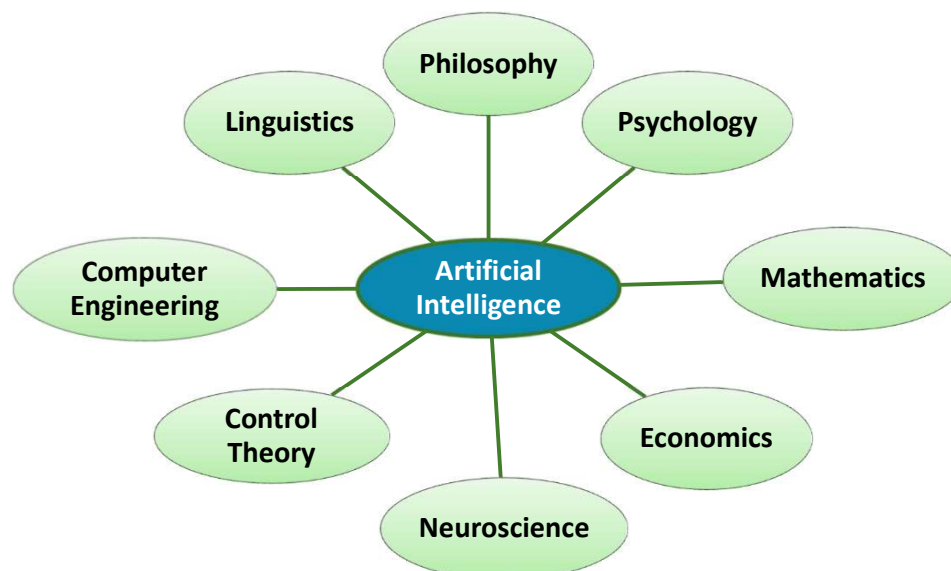

Source: https://hsu.reclaim.hosting/GSP/

- **Deep Learning:** "computational models that are composed of multiple processing layers to learn representations of data with multiple levels of abstraction."

Foundations of AI

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Applications of AI
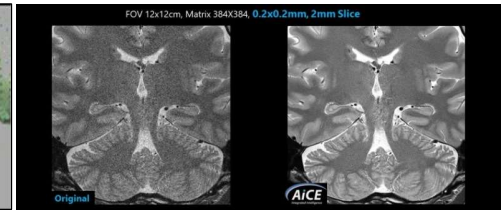

- **Medicine**
  - Image guided surgery
  - Image enhancement
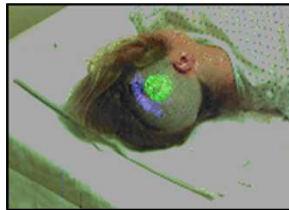
Source: http://www.ai.mit.edu/projects/medical-vision/surgery/surgical_navigation.html

Source: https://healthcare-in-europe.com/en/news/1-5t-mr-system-receives-fda-clearance-for-ai-based-image-reconstruction-technology.html

- **Transportation**
  - Autonomous car
  - Pedestrian Detection

https://www.mdpi.com/2078-2489/14/2/123

Lexus RX450h retrofitted as a Google driverless car

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Applications of AI [contd.]

- **Games**

https://itsourcecode.com/

https://edejesus196.medium.com/

- **Entertainment Agents**

- **Internet Agents**
  - Monitors users task,
  - seek required information, Learns

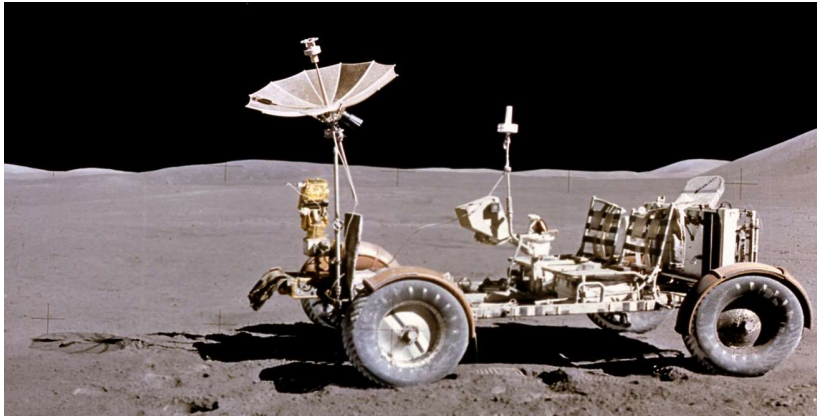https://electronics.sony.com/

https://www.genesis-toys.com/

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Applications of AI [contd.]
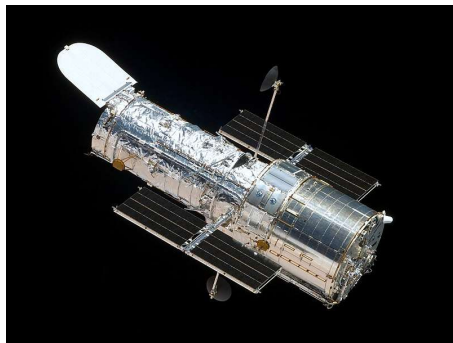
- Autonomous Planning & Scheduling:
  - Autonomous rovers

Source: https://simple.wikipedia.org/

Applications of AI [contd.]

- Autonomous Planning & Scheduling:
  - Telescope scheduling

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

Hubble Space Telescope. Public domain image, NASA

Applications of AI [contd.]

Other application areas:

- Bioinformatics

- Text classification, document sorting

- Video, image classification

- Music composition, picture drawing

- Natural Language Processing

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Ethical Concerns and Societal Impacts of AI
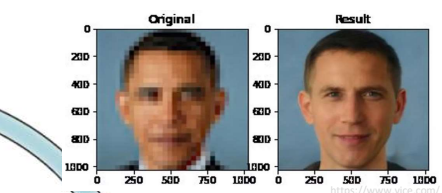
Privacy, Security

Ethical and societal implications of AI

Employment and Workforce

Bias, Fairness, Transparency, Accountability

Human Autonomy

INPUT ➔ ? ➔ OUTPUT

BLACK BOX

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Course Details

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- Course Structure/Syllabus

- Course Materials

- Course Evaluation/Tests

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Course Structure/Syllabus

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Syllabus	
Timeline	**Topics to be Covered**
Week 1	**INTRODUCTION TO AI:** Artificial Intelligence Introduction, Brief History, Intelligent Agents, Types of agents *Python Primer for AI*
Week 2-4	**PROBLEM SOLVING BY SEARCH:** Problem formulation, Concept of state space search Introduction to Uninformed Search Techniques: *Breadth First Search, Depth First Search, Depth First Search with Iterative Deepening, Uniform Cost Search* Introduction to Informed/Heuristic search techniques: *Greedy Best First Search, A* search, Hill Climbing search, Simulated Annealing search* Introduction to GA, GA Operations: *Selection, Crossover, Mutation* *Solving N-Queen Problem using GA* Adversarial Search: *Minimax algorithm, Alpha-Beta Pruning* *Building a bot to play tic-tac-toe/Building 8-puzzle solver*
Week 5	**CONSTRAINT SATISFACTION PROBLEM (CSP):** Introduction to CSP, Constraint Graph, Binary and Higher order CSP, Backtracking Search, MRV heuristic, Degree heuristic, Least Constraining-value heuristic, Forward Checking, Arc Consistency, Min-Conflicts Algorithm *Solving map coloring problem, Solving puzzle*

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Course Structure/Syllabus

Syllabus	
Timeline	**Topics to be Covered**
Week 6-7	**INTRODUCTION TO KNOWLEDGE REPRESENTATION AND LOGIC:** Propositional Logic (PL) and Reasoning with PL, Concept of Forward and Backward chaining, First Order Logic (FOL) and Reasoning with FOL, Rule-based systems *Parsing family tree using logic/Solving puzzle using logic*
Week 8	**PROBABILISTIC REASONING:** Introduction, Probabilistic reasoning with Bayesian Network *Disease diagnosis using Bayesian Network (or other domain specific application)*
Week 9-11	**MACHINE LEARNING (ML):** Introduction to the concept of learning, k-Nearest Neighbor (k-NN), Decision tree (DT), Naive-Bayes (NB), Support Vector Machine (SVM), Neural Network (NN) Models *Building ML models for Steel Plate Fault detection* *Building ML models for predicting Aquatic Toxicity (or other domain specific application)*
Week 12	**Buffer**

Course Materials

- **Text Book:**
  - ❑ **Artificial Intelligence A Modern Approach**, by S. Russell. Norvig,PHI, Third Edition

- **Reference Books:**
  - ❑ **A First Course in Artificial Intelligence by Deepak Khemani**, McGraw Hill Education (India), 2013.

  - ❑ **Artificial Intelligence** by Kevin Knight, Elaine Rich, Third Edition

  - ❑ **Artificial Intelligence: Foundations of Computational Agents** by David L. Poole, Alan K. Mackworth

  - ❑ **Machine Learning** by Mitchell, Tom M., Indian Edition

  - ❑ **Introduction to Machine Learning with Python:** A Guide for Data Scientists by Andreas C. Müller, Sarah Guido

Evaluation/Tests

- Distribution of Marks:

  ✓ **Mid-Sem Exam:** (converted into **out of 30** marks)

  ✓ **End-Sem Exam:** (converted into **out of 50** marks)

  ✓ **Quiz Test:** (converted into **out of 20** marks)
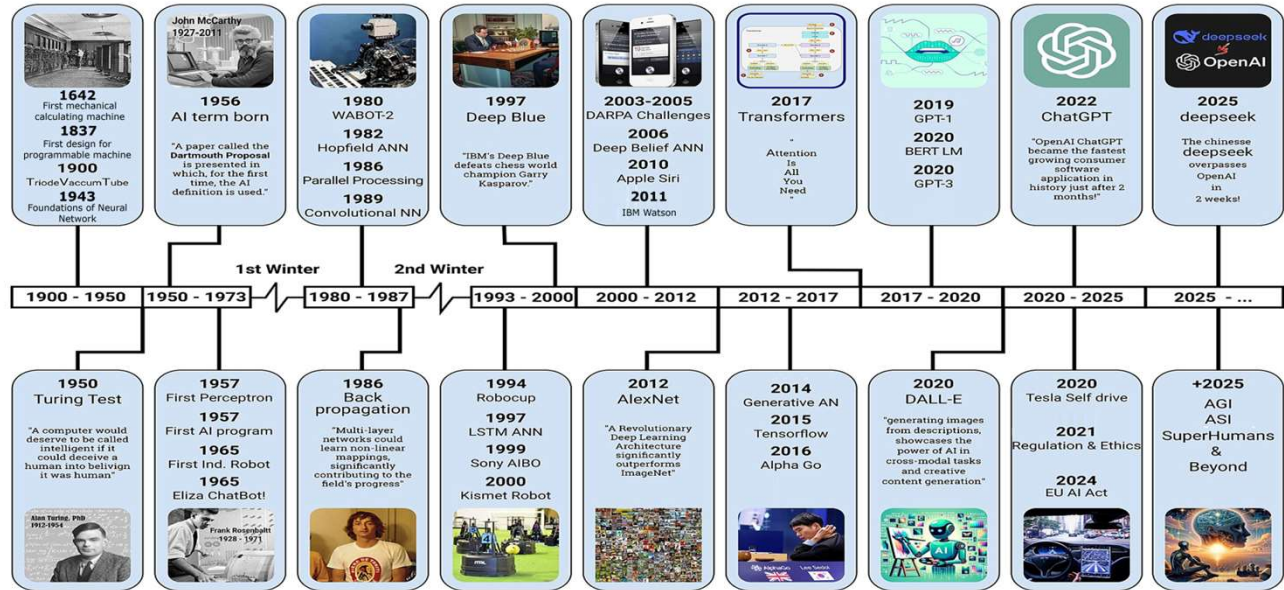 Tentative dates: **12-SEP-2025 (Quiz-1) , 14-NOV-2025 (Quiz-2)**

Brief History of AI

History of AI

Questions?