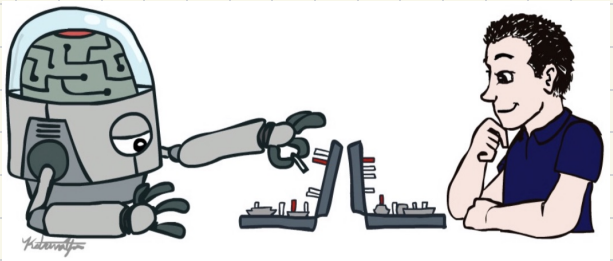
Artificial Intelligence

BCSE306L

lec 01



Introduction

by

Dr. Durgesh Kumar

Assistant Professor (Senior)

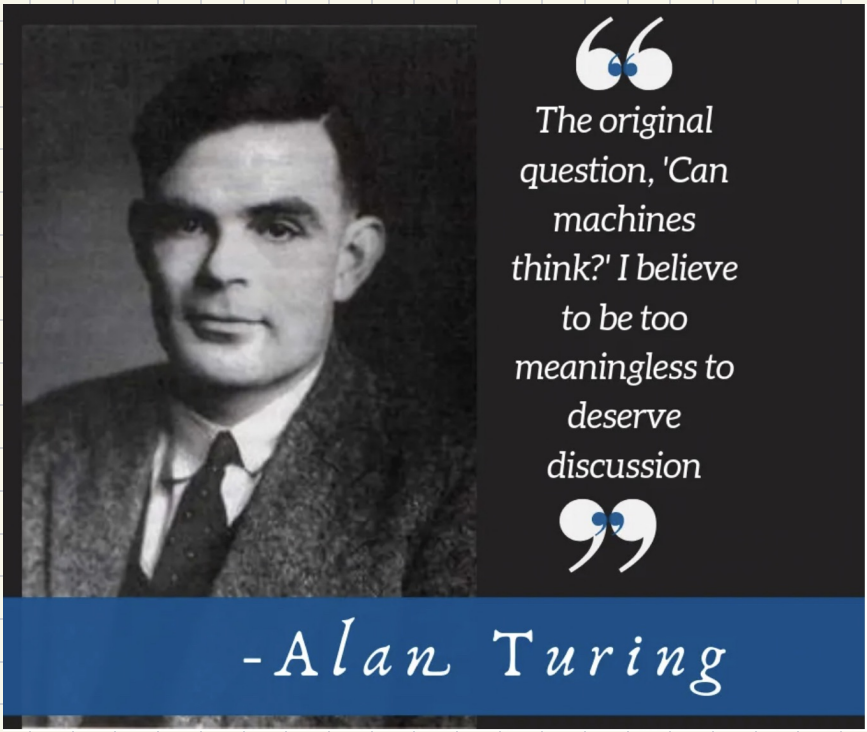
SCOPE, VIT VELLORE

Lecture Outline

- What is AI?
  - definition
  - different types of AI

What is AI ?

Artificial Intelligence



What is AI ?

- a machine mimicking human intelligence

=> It refers to the simulation of human intelligence in machines, enabling them to perform tasks that typically require human intelligence such as learning, problem-solving, reasoning, and decision making.

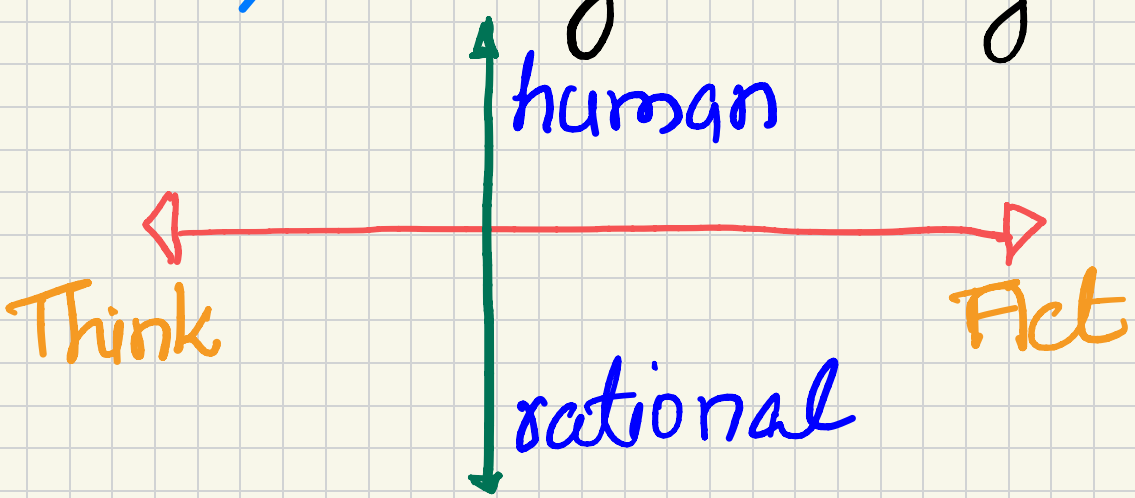
AI systems can analyse data, recognise patterns, make predictions, understand language, and interact with humans or other systems.

Other definition/types of AI

- Some have defined Intelligence in comparison to human performance where others have defined in terms of abstract definition of intelligence called rationality

- rationality - "doing right thing"
  loose meaning

- 2 dimensions:-
  i) human vs rational
  ii) Thinking vs Acting



Types of AI

1.2 Thinking Humanly

- introspection
- psychological experiments
- Brain imaging

human

1.1 Acting humanly

- NLP, ML
- knowledge representation
- Automated reasoning
- Total turing test
- Computer vision, Robotics

Think

1.3 Thinking Rationally

- logic
- probability
- syllogism

Act

1.4 Act Rationally

- Agent, rational agent
- Do the right thing
- standard model,
- limited rationality

rational

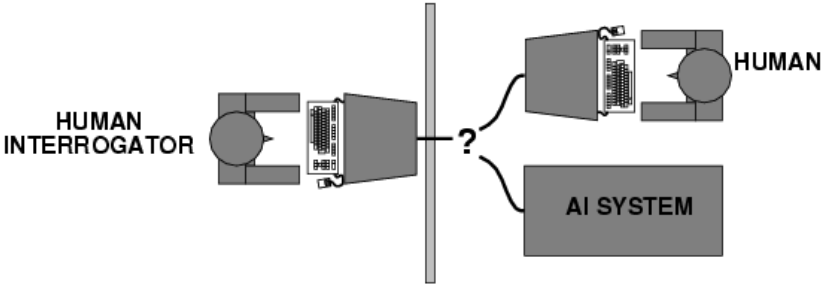
1.5 Beneficial machines

Thinking humanly

- Cognitive science: the brain as an information processing machine
  - Requires scientific theories of how the brain works
- How to understand cognition as a computational process?
  - Introspection: try to think about how we think
  - Predict and test behavior of human subjects
  - Image the brain, examine neurological data
- The latter two methodologies are the domains of cognitive science and cognitive neuroscience

Acting humanly

- Turing (1950) "Computing machinery and intelligence"
- The Turing Test



- What capabilities would a computer need to have to pass the Turing Test?
  - Natural language processing
  - Knowledge representation
  - Automated reasoning
  - Machine learning
- Turing predicted that by the year 2000, machines would be able to fool 30% of human judges for five minutes

Turing Test: Criticism

- What are some potential problems with the Turing Test?
  - Some human behavior is not intelligent
  - Some intelligent behavior may not be human
  - Human observers may be easy to fool
    - A lot depends on expectations
    - *Anthropomorphic fallacy*
    - Chatbots, e.g., ELIZA
  - Chinese room argument: one may simulate intelligence without having true intelligence (more of a philosophical objection)
- Is passing the Turing test a good scientific goal?
  - Not a good way to solve practical problems
  - Can create intelligent agents without trying to imitate humans

Thinking rationally

- Idealized or “right” way of thinking
- **Logic:** patterns of argument that always yield correct conclusions when supplied with correct premises
  - “Socrates is a man; all men are mortal; therefore Socrates is mortal.”
- Beginning with Aristotle, philosophers and mathematicians have attempted to formalize the rules of logical thought
- ***Logicist* approach to AI:** describe problem in formal logical notation and apply general deduction procedures to solve it
- Problems with the logicist approach
  - Computational complexity of finding the solution
  - Describing real-world problems and knowledge in logical notation
  - A lot of intelligent or “rational” behavior has nothing to do with logic

Acting rationally: Rational agent

- A rational agent is one that acts to achieve the best expected outcome
  - Goals are application-dependent and are expressed in terms of the **utility of outcomes**
  - Being rational means **maximizing your expected utility**
  - In practice, utility optimization is subject to the agent's computational constraints (*bounded rationality* or *bounded optimality*)
- This definition of rationality only concerns the decisions/actions that are made, not the cognitive process behind them

Acting rationally: Rational agent

- Advantages of the “utility maximization” formulation
  - Generality: goes beyond explicit reasoning, and even human cognition altogether
  - Practicality: can be adapted to many real-world problems
  - Amenable to good scientific and engineering methodology
  - Avoids philosophy and psychology
- Any disadvantages?

AI Connections

Philosophy	logic, methods of reasoning, mind vs. matter, foundations of learning and knowledge
Mathematics	logic, probability, optimization
Economics	utility, decision theory
Neuroscience	biological basis of intelligence
Cognitive science	computational models of human intelligence
Linguistics	rules of language, language acquisition
Machine learning	design of systems that use experience to improve performance
Control theory	design of dynamical systems that use a controller to achieve desired behavior

Computer engineering, mechanical engineering, robotics, …

Where is AI today?

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
- NASA's Remote Agent software operated the Deep Space 1 spacecraft during two experiments in May 1999
- In 2004, NASA introduced the MAPGEN system to plan the daily operations for the Mars Exploration Rovers

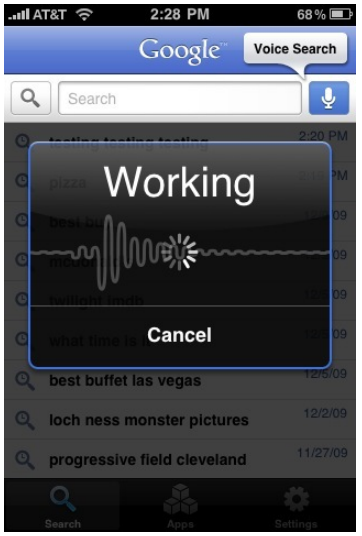
Math, games, puzzles

- In 1996, a computer program written by researchers at Argonne National Laboratory proved a mathematical conjecture (Robbins conjecture) unsolved for decades
  - NY Times story: “[The proof] would have been called creative if a human had thought of it”
- IBM’s Deep Blue defeated the reigning world chess champion Garry Kasparov in 1997
  - **1996: Kasparov Beats Deep Blue**
    “I could feel --- I could smell --- a new kind of intelligence across the table.”
  - **1997: Deep Blue Beats Kasparov**
    “Deep Blue hasn't proven anything.”

- In 2007, checkers was “solved” --- a computer system that never loses was developed
  - Science article

Natural Language

- Speech technologies
  - Automatic speech recognition
    - Google voice search
  - Text-to-speech synthesis
  - Dialog systems
- Machine translation
  - translate.google.com
  - Comparison of several translation systems



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!"

Question answering: IBM Watson

- http://www.research.ibm.com/deepqa/
- NY Times article
- Trivia demo
- YouTube video

Information agents

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

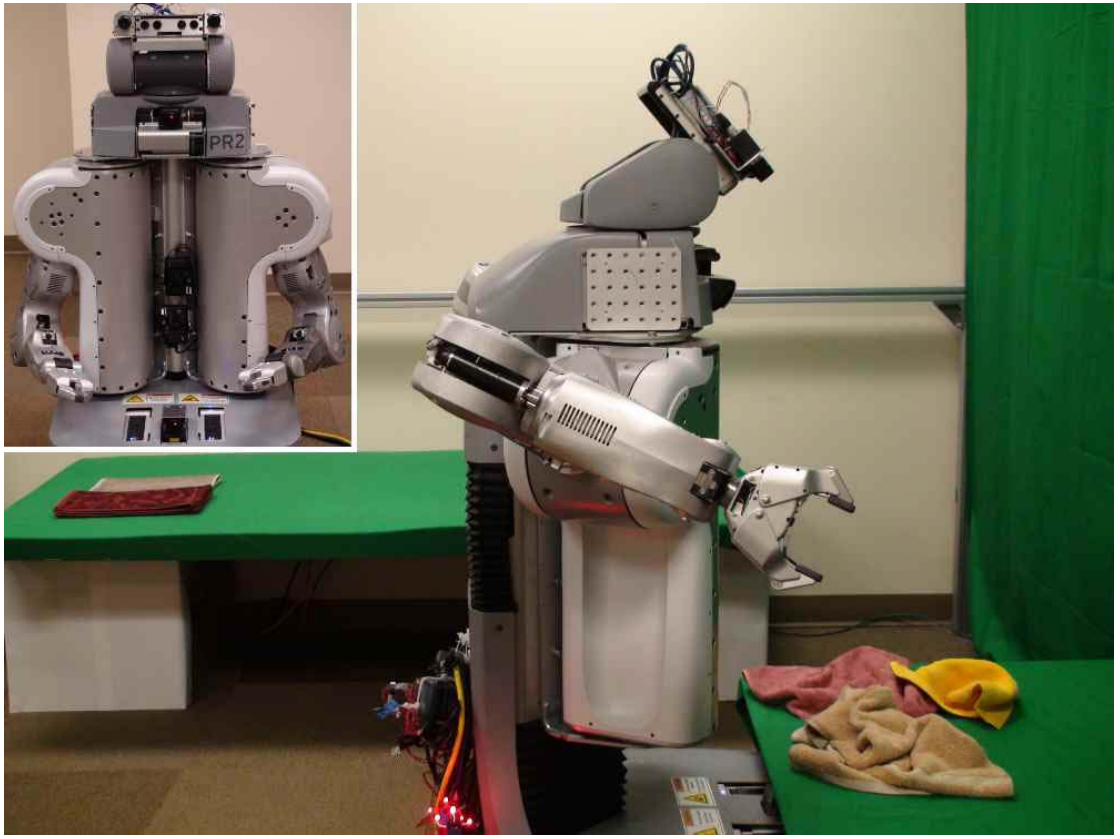
Vision

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

Robotics

- Mars rovers
- Autonomous vehicles
  - DARPA Grand Challenge
- Autonomous helicopters
- Robot soccer
  - RoboCup
- Personal robotics
  - Humanoid robots
  - Robotic pets
  - Personal assistants?

Towel-folding robot



YouTube Video

J. Maitin-Shepard, M. Cusumano-Towner, J. Lei and P. Abbeel, "Cloth Grasp Point Detection based on Multiple-View Geometric Cues with Application to Robotic Towel Folding," ICRA 2010

Course Topics

- Search
  - Uninformed search, informed search
  - Adversarial search: minimax
  - Constraint satisfaction problems
  - Planning
- Logic
- Probability
  - Basic laws of probability
  - Bayes networks
  - Hidden Markov Models
- Learning
  - Decision trees
  - Linear classifiers: neural nets, support vector machines
  - Reinforcement learning

Course Topics (cont.)

- Applications (depending on time and interest)
  - Natural language
  - Speech
  - Vision
  - Robotics

BCSE306L	Artificial Intelligence	L	T	P	C
		3	0	0	3
Pre-requisite	**NIL**	**Syllabus version**			
		1.0			

Course Objectives

1. To impart artificial intelligence principles, techniques and its history.
2. To assess the applicability, strengths, and weaknesses of the basic knowledge representation, problem solving, and learning methods in solving engineering problems
3. To develop intelligent systems by assembling solutions to concrete computational problems

Course Outcomes

On completion of this course, student should be able to:

1. Evaluate Artificial Intelligence (AI) methods and describe their foundations.
2. Apply basic principles of AI in solutions that require problem-solving, inference, perception, knowledge representation and learning.
3. Demonstrate knowledge of reasoning, uncertainty, and knowledge representation for solving real-world problems
4. Analyse and illustrate how search algorithms play a vital role in problem-solving

Module:1	**Introduction**	**6 hours**
Introduction- Evolution of AI, State of Art -Different Types of Artificial Intelligence- Applications of AI-Subfields of AI-Intelligent Agents- Structure of Intelligent Agents- Environments		
Module:2	**Problem Solving based on Searching**	**6 hours**
Introduction to Problem Solving by searching Methods-State Space search, Uninformed Search Methods – Uniform Cost Search, Breadth First Search- Depth First Search-Depth-limited search, Iterative deepening depth-first, Informed Search Methods- Best First Search, A* Search		
Module 3	**Local Search and Adversarial Search**	**5 hours**
Local Search algorithms – Hill-climbing search, Simulated annealing, Genetic Algorithm, Adversarial Search: Game Trees and Minimax Evaluation, Elementary two-players games: tic-tac-toe, Minimax with Alpha-Beta Pruning.		
Module:4	**Logic and Reasoning**	**8 hours**
Introduction to Logic and Reasoning -Propositional Logic-First Order Logic-Inference in First Order Logic- Unification, Forward Chaining, Backward Chaining, Resolution.		
Module:5	**Uncertain Knowledge and Reasoning**	**5 hours**
Quantifying Uncertainty- Bayes Rule -Bayesian Belief Network- Approximate Inference in Bayesian networks		
Module:6	**Planning**	**7 hours**
Classical planning, Planning as State-space search, Forward search, backward search, Planning graphs, Hierarchical Planning, Planning and acting in Nondeterministic domains – Sensor-less Planning, Multiagent planning		
Module:7	**Communicating, Perceiving and Acting**	**6 hours**
Communication-Fundamentals of Language -Probabilistic Language Processing -Information Retrieval- Information Extraction-Perception-Image Formation- Object Recognition.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book

1.	Russell, S. and Norvig, P. 2015. Artificial Intelligence - A Modern Approach, 3rd Edition, Prentice Hall.

Reference Books			
1.	K. R. Chowdhary, Fundamentals of Artificial Intelligence, Springer, 2020.		
2	Alpaydin, E. 2010. Introduction to Machine Learning. 2nd Edition, MIT Press.		
Mode of Evaluation: CAT, Assignment, Quiz, FAT			
Recommended by Board of Studies	04-03-2022		
Approved by Academic Council	No. 65	Date	17-03-2022