Artificial Intelligence
Unit 1-1 Introduction

2021-2022 Odd BE CSE VII semester

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15Z701 ARTIFICIAL INTELLIGENCE

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INTRODUCTION: Artificial Intelligence -History - The State of Art - Intelligent Agents - Structure - Environment. (5)

SEARCH STRATEGIES: Breadth-First Search - Uniform Cost Search - Depth-First Search - Depth-Limited Search - Iterative Deepening Search - Bidirectional Search - Heuristic Search Techniques - A* Search - AO* Algorithm - **Adversarial Search:** Minimax Algorithm - Alphabeta Pruning. (12)

KNOWLEDGE AND REASONING: Representation - First Order Predicate Logic – Inference – Unification - Forward and Backward Chaining - Resolution - Reasoning with Default Information - Truth Maintenance Systems - Acting under Uncertainty - Statistical Reasoning - Probability and Bayes Theorem - Certainty Factors and Rule Based Systems - Dempster-Shafer Theory. (10)

PLANNING AND LEARNING:Planning with State Space Search: Partial Order Planning - Planning Graphs - Examples. **Forms of Learning**: Inductive Learning - Explanation Based Learning - Statistical Learning - Learning With Complete Data. (10)

NATURAL LANGUAGE PROCESSING: Phases - Syntactic Processing - Semantic Analysis - Discourse and Pragmatic Processing. (8)

Total L: 45

TEXT BOOKS:

1. Stuart J Russell and Peter Norvig, "Artificial Intelligence - A Modern Approach", Third Edition, Prentice Hall of India/ Pearson Education, New Delhi, 2015.
2. Elaine Rich and Kevin Knight, "Artificial Intelligence", Tata McGraw Hill Publishing Company, New Delhi, 2014.

REFERENCES:

1. Dan W Patterson, "Introduction to AI and Expert Systems", Prentice Hall of India, New Delhi, 2010.
2. Eugene Charniak and Drew McDermott, "Introduction to Artificial Intelligence", Pearson Education, New Delhi, 2010.
3. Nils J Nilsson, "Principles of Artificial Intelligence", Narosa Publishing House, New Delhi, 2000.

Syllabus

- **COURSE OUTCOMES:**
- Upon completion of this course, the students will be able to
- **CO1:** Apply the fundamental AI concepts to represent and solve real-world problems
- **CO2:** Analyze and solve AI problems using heuristic, non-heuristic and adversarial search strategies
- **CO3:** Employ knowledge representation, logical reasoning and statistical methods to solve AI problems
- **CO4:** Apply planning and learning concepts to solve AI problems
- **CO5:** Apply NLP concepts to analyse and solve real-world problems

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Introduction

- What do we call ourselves? Homo sapiens—man the wise
  - Our intelligence is so important to us (Cogito ergo sum – Rene Descartes)

- For millennia mankind wanted to understand ***how we think***
  - How human brain can __ a world far larger and more complicated than itself?
    - perceive,
    - understand,
    - predict,
    - and manipulate

The field of **Artificial Intelligence** attempts to understand and also to ***build*** **intelligent entities**

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Intelligence

- What is intelligence?
- Examples
  - Mathematician, Painter, Artist, Musician, Chess player, ???
  - Formal tasks: Chess playing, theorem proving, …
  - Generic problem solving?
  - Learning?

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Intelligence – characteristics?

- Thought process and reasoning (Thinking!)?
- Behaviour (Acting!)?
- Measured against
  - Human performance?
  - Defined ideal / rational performance?
- Human centred approach
  - Empirical approach (observations and hypotheses of human behaviour)
- Rational approach
  - Mathematics and Engineering (formal, problem solving)

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What is AI?

Thinking Humanly	Thinking Rationally
"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)	"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)
Acting Humanly	**Acting Rationally**
"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)	"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)

Thought processes and reasoning

Behaviour

Measure success in terms of fidelity to human performance

Measure against an ideal performance measure (**rationality**)

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Acting humanly: Turing test

- On one side a questioner, On the other side (hidden) a computer / a human
- Who answers questions?
  - If questioner cannot find out, computer passes test
- Addresses all major concerns of AI
  - Natural language processing, Knowledge representation, Automated reasoning, Adaptive machine learning
- Total Turing test
  - Add Perception, Object manipulation
  - Computer vision, Robotics

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Acting humanly

- ***Is Turing test a good test?***
- Imitating human / utilize underlying principle

- Think of flying (another difficult task)
  - All bird-like flying failed
  - Aerodynamics and Wind tunnel knowledge succeeded

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Thinking humanly

- Think like human beings
  - Observe humans
  - Emulate human thinking
- Top down: Analyse human beings
  - Cognitive science
- Bottom up: Analyse neuroscience in brain
  - Cognitive neuroscience
- Is a good problem solving model = human thinking? Or vice-versa?

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Thinking Rationally

- **Syllogism**: Formal argument consisting of a major and a minor premise and a conclusion
  - Every virtue is praiseworthy;
  - Kindness is a virtue;
  - Hence kindness is praiseworthy
- Laws of thought; Logic
  - Precise notation for facts
  - Any problem can be solved. (Can it be?)
- Representation is not easy for ALL facts!
  - Number system covers only numbers
- Solving any problem can take very long time!

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Acting Rationally / Rational Agent

- Rational Agent approach
  - Agent that acts so as to achieve the best outcome
  - When there is uncertainty, the best expected outcome
- Actions
  - Operate autonomously
  - Perceive environment
  - Persist over a prolonged time period
  - Apt to change, and create and pursue goals.
- Knowledge representation and Reasoning
  - Inferences (Usually. Running from a lion?)

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Acting Rationally / Rational Agent

- **Turing test allows acting rationally**
- Better than other approaches as
  - Correct inference in laws of thought is just one approach
  - This can be built and tested scientifically

- **Good approach for experimentation**
  - General principles of rational agents
  - Components and construction

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Foundations of AI

- Philosophy
- Mathematics
- Economics
  - Utility theory, Decision Theory, Game Theory, etc.
- Neuroscience
- Computer engineering
- Linguistics
- Many more…

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State of the Art

- Robotic vehicles
  - DARPA grand challenge (Stanford)
  - DARPA urban challenge (CMU)
- Speech Recognition
- Autonomous planning and scheduling (Mars Rover)
- Game playing: Deep blue
- Logistic planning: DART
- Robotics, machine translation, etc.

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Home work - 1

- Which of the following is possible by a rational agent?
  a) Playing a decent game of table tennis
  b) Driving in Coimbatore
  c) Buying a week's worth of groceries on the Web.
  d) Buying a week's worth of groceries at the market.
  e) Discovering and proving new mathematical theorems.
  f) Writing an intentionally funny story.
  g) Giving competent legal advice in a specialized area
  h) Translating spoken English into spoken Tamil (real time).
  i) Performing a complex surgical operation

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References:

- AIMA Book (Artificial Intelligence - A Modern Approach 3rd Edition)

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