Artificial Intelligence Unit-1

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- making computers that think?
- the automation of activities we associate with human thinking, like decision making, learning ... ?
- the art of creating machines that perform functions that require intelligence when performed by people?
- the study of mental faculties through the use of computational models?

- the study of computations that make it possible to perceive, reason and act?
- a field of study that seeks to explain and emulate intelligent behaviour in terms of computational processes?
- a branch of computer science that is concerned with the automation of intelligent behaviour?
- anything in Computing Science that we don't yet know how to do properly? (!)

THOUGHT	Systems that think like humans	Systems that think rationally
BEHAVIOUR	Systems that act like humans	Systems that act rationally

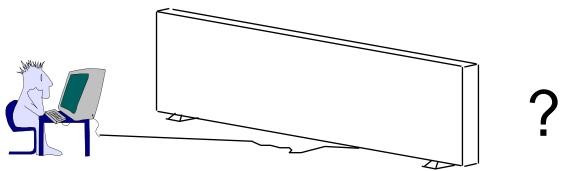
HUMAN

RATIONAL

Systems that act like humans: Turing Test

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

Systems that act like humans



- 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.

Systems that act like humans

- The Turing Test approach
 - a human questioner cannot tell if
 - there is a computer or a human answering his question, via teletype (remote communication)
 - The computer must behave intelligently
- Intelligent behavior
 - to achieve human-level performance in all cognitive tasks

Systems that act like humans

- These cognitive tasks include:
 - Natural language processing
 - for communication with human
 - Knowledge representation
 - to store information effectively & efficiently
 - Automated reasoning
 - to retrieve & answer questions using the stored information
 - Machine learning
 - to adapt to new circumstances

The total Turing Test

- Includes two more issues:
 - Computer vision
 - to perceive objects (seeing)
 - Robotics
 - to move objects (acting)

Systems that think Systems that think **THOUGHT** like humans rationally **Systems that act Systems that act BEHAVIOUR** like humans rationally

HUMAN

RATIONAL

Systems that think like humans: cognitive modeling

- Humans as observed from 'inside'
- How do we know how humans think?
 - Introspection vs. psychological experiments
- Cognitive Science
- "The exciting new effort to make computers think
 ... machines with minds in the full and literal sense"
 (Haugeland)
- "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning ..." (Bellman)

THOUGHT	Systems that think like humans	Systems that think rationally
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HUMAN

RATIONAL

Systems that think 'rationally' "laws of thought"

- Humans are not always 'rational'
- Rational defined in terms of logic?
- Logic can't express everything (e.g. uncertainty)
- Logical approach is often not feasible in terms of computation time (needs 'guidance')
- "The study of mental facilities through the use of computational models" (Charniak and McDermott)
- "The study of the computations that make it possible to perceive, reason, and act" (Winston)

THOUGHT Systems that think Systems that think like humans rationally **Systems that act** Systems that act **BEHAVIOUR** like humans rationally

HUMAN

RATIONAL

Systems that actoration all yright at in a large of the state of the s

- The right thing: that which is expected to maximize goal achievement, given the available information
- Giving answers to questions is 'acting'.
- I don't care whether a system:
 - replicates human thought processes
 - makes the same decisions as humans
 - uses purely logical reasoning

Systems that act rationally

- Logic → only part of a rational agent, not all of rationality
 - Sometimes logic cannot reason a correct conclusion
 - At that time, some <u>specific (in domain) human knowledge</u> or information is used
- Thus, it covers more generally different situations of problems
 - Compensate the incorrectly reasoned conclusion

Systems that act rationally

Study AI as rational agent –

2 advantages:

- It is more general than using logic only
 - Because: LOGIC + Domain knowledge
- It allows extension of the approach with more scientific methodologies

- Artificial
 - Produced by human art or effort, rather than originating naturally.
- Intelligence
- is the ability to acquire knowledge and use it" [Pigford and Baur]

So AI was defined as:

- AI is the study of ideas that enable computers to be intelligent.
- AI is the part of computer science concerned with design of computer systems that exhibit human intelligence(From the Concise Oxford Dictionary)

From the above two definitions, we can see that AI has two major roles:

- Study the intelligent part concerned with humans.
- Represent those actions using computers.

Goals of Al

- To make computers more useful by letting them take over dangerous or tedious tasks from human
- Understand principles of human intelligence

• Philosophy

- At that time, the study of human intelligence began with no formal expression
- Initiate the idea of mind as a machine and its internal operations

- Mathematics formalizes the three main area of AI: computation, logic, and probability
 - Computation leads to analysis of the problems that can be computed
 - complexity theory
 - Probability contributes the "degree of belief" to handle uncertainty in AI
 - Decision theory combines probability theory and utility theory (bias)

- Psychology
 - How do humans think and act?
 - The study of human reasoning and acting
 - Provides reasoning models for AI
 - Strengthen the ideas
 - humans and other animals can be considered as information processing machines

- Computer Engineering
 - How to build an efficient computer?
 - Provides the artifact that makes AI application possible
 - The power of computer makes computation of large and difficult problems more easily
 - AI has also contributed its own work to computer science, including: time-sharing, the linked list data type, OOP, etc.

Control theory and Cybernetics

- How can artifacts operate under their own control?
- The artifacts adjust their actions
 - To do better for the environment over time
 - Based on an objective function and feedback from the environment
- Not limited only to linear systems but also other problems
 - as language, vision, and planning, etc.

- Linguistics
 - For understanding natural languages
 - different approaches has been adopted from the linguistic work
 - Formal languages
 - Syntactic and semantic analysis
 - Knowledge representation

The main topics in Al

Artificial intelligence can be considered under a number of headings:

- Search (includes Game Playing).
- Representing Knowledge and Reasoning with it.
- Planning.
- Learning.
- Natural language processing.
- Expert Systems.
- Interacting with the Environment (e.g. Vision, Speech recognition, Robotics)

Some Advantages of Artificial Intelligence

- more powerful and more useful computers
- new and improved interfaces
- solving new problems
- better handling of information
- relieves information overload
- conversion of information into knowledge

Disadvantages

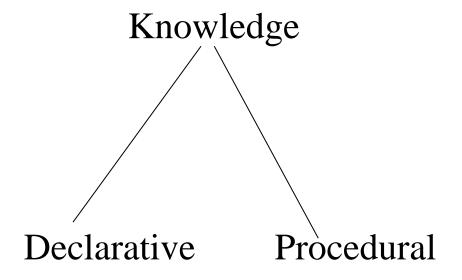
- increased costs
- difficulty with software development slow and expensive
- few experienced programmers
- few practical products have reached the market as yet.

Search

- Search is the fundamental technique of Al.
 - Possible answers, decisions or courses of action are structured into an abstract space, which we then search.
- Search is either "blind" or "uninformed":
 - blind
 - we move through the space without worrying about what is coming next, but recognising the answer if we see it
 - informed
 - we guess what is ahead, and use that information to decide where to look next.
- We may want to search for the first answer that satisfies our goal, or we may want to keep searching until we find the best answer.

Knowledge Representation & Reasoning

- The second most important concept in Al
- If we are going to act rationally in our environment, then we must have some way of describing that environment and drawing inferences from that representation.
 - how do we describe what we know about the world?
 - how do we describe it concisely?
 - how do we describe it so that we can get hold of the right piece of knowledge when we need it?
 - how do we generate new pieces of knowledge?
 - how do we deal with *uncertain* knowledge?



- Declarative knowledge deals with factoid questions (what is the capital of India? Etc.)
- Procedural knowledge deals with "How"
- Procedural knowledge can be embedded in declarative knowledge

Planning

Given a set of goals, construct a sequence of actions that achieves those goals:

- often very large search space
- but most parts of the world are independent of most other parts
- often start with goals and connect them to actions
- no necessary connection between order of planning and order of execution
- what happens if the world changes as we execute the plan and/or our actions don't produce the expected results?

Learning

- If a system is going to act truly appropriately, then it must be able to change its actions in the light of experience:
 - •how do we generate new facts from old?
 - •how do we generate new concepts?
 - how do we learn to distinguish different situations in new environments?

Interacting with the Environment

- In order to enable intelligent behaviour, we will have to interact with our environment.
- Properly intelligent systems may be expected to:
 - accept sensory input
 - vision, sound, ...
 - interact with humans
 - understand language, recognise speech, generate text, speech and graphics, ...
 - modify the environment
 - robotics

History of Al

- Early period 1950's & 60's
 - Game playing
 - brute force (calculate your way out)
 - Theorem proving
 - symbol manipulation
 - Biological models
 - neural nets
- Symbolic application period 70's
 - Early expert systems, use of knowledge
- Commercial period 80's
 - boom in knowledge/ rule bases

History of AI cont'd

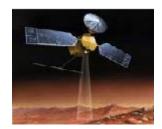
- period 90's and New Millenium
- Real-world applications, modelling, better evidence, use of theory,?
- Topics: data mining, formal models, GA's, fuzzy logic, agents, neural nets, autonomous systems
- Applications
 - visual recognition of traffic
 - medical diagnosis
 - directory enquiries
 - power plant control
 - automatic cars

Symbolic and Sub-symbolic Al

- Symbolic AI is concerned with describing and manipulating our knowledge of the world as explicit symbols, where these symbols have clear relationships to entities in the real world.
- Sub-symbolic AI (e.g. neural-nets) is more concerned with obtaining the correct response to an input stimulus without 'looking inside the box' to see if parts of the mechanism can be associated with discrete real world objects.

- Autonomous Planning& Scheduling:
 - Autonomous rovers.





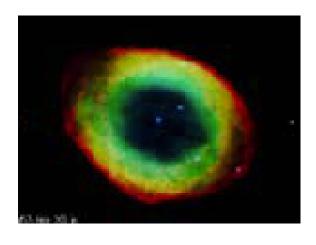
- Autonomous Planning & Scheduling:
 - Telescope scheduling

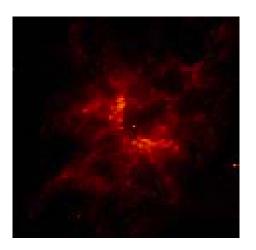




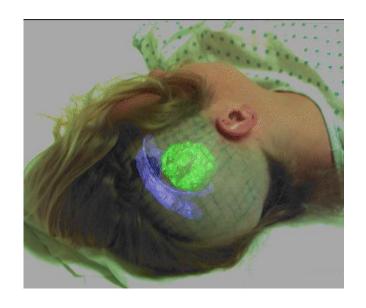
- Autonomous Planning & Scheduling:
 - Analysis of data:

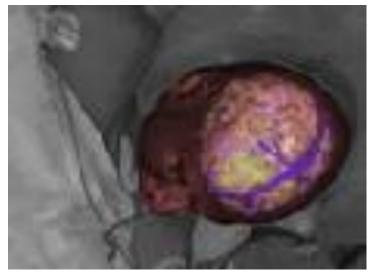






- Medicine:
 - Image guided surgery

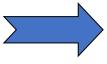




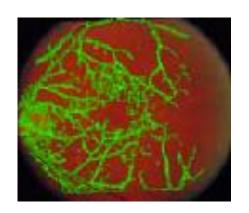
• Medicine:

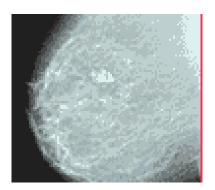
• Image analysis and enhancement



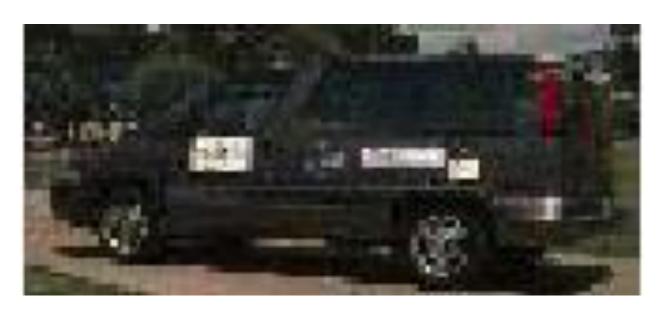








- Transportation:
 - Autonomous vehicle control:



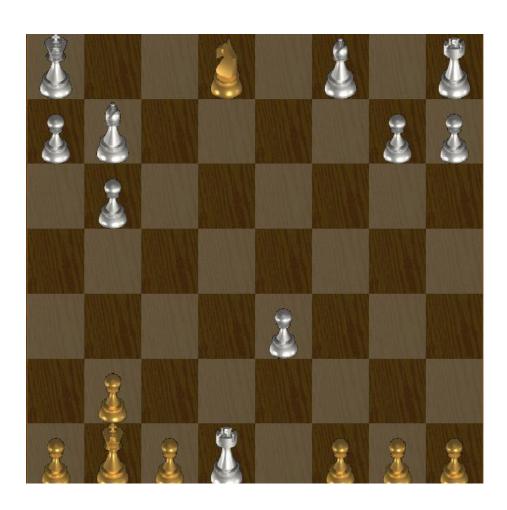
- Transportation:
 - Pedestrian detection:



Games:



• Games:



• Robotic toys:

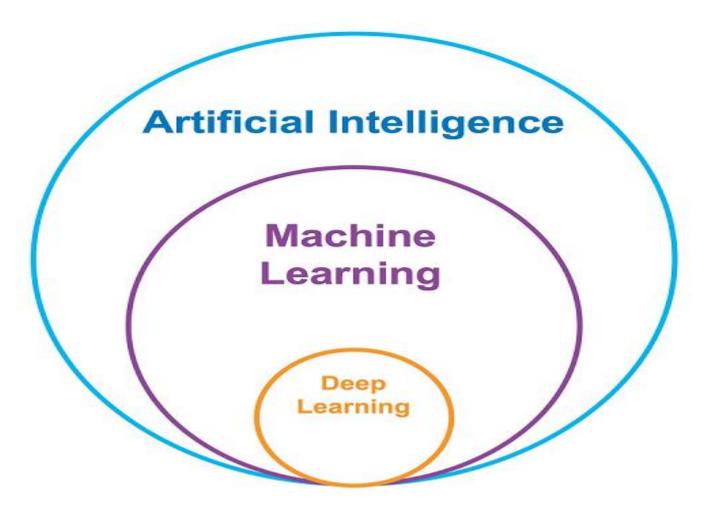




Other application areas:

- Bioinformatics:
 - Gene expression data analysis
 - Prediction of protein structure
- Text classification, document sorting:
 - Web pages, e-mails
 - Articles in the news
- Video, image classification
- Music composition, picture drawing
- Natural Language Processing ©

- ArtMi,cial Intelligenietch percoaches ses many different approaches ranging from top-down knowledge representation to bottom-up machine learning.
 - There are three related concepts that have been frequently used in recent years: AI, machine learning, and deep learning.
 - In general, AI is the broadest concept, machine learning is a sub field in AI, and deep learning is a special type of machine learning.



Relations among AI, machine learning, and deep learning

Artificial Intelligence Approaches

- Based on the ways the machines behave, there are four types of Artificial Intelligence approaches –
- Reactive Machines
- Limited Memory
- Theory of Mind and
- Self-awareness.

Reactive Machines

- These machines are the most basic form of Al applications.
- Examples of reactive machines are games like Deep Blue, IBM's chess-playing supercomputer. This is the same computer that beat the world's then Grand Master Gary Kasparov.
- The AI teams do not use any training sets to feed the machines, nor do the latter store data for future references.
- Based on the move made by the opponent, the machine decides/predicts the next move.

Limited Memory

- These machines belong to the class II category of Al applications.
- Self-driven cars are the perfect example.
- These machines are fed with data and are trained with other cars' speed and direction, lane markings, traffic lights, curves of roads, and other important factors, over time.

Theory of Mind

- Theory of mind is the concept where the bots will be able to understand the human emotions, thoughts, and how they react to them.
- If the AI-powered machines are ever to mingle with us and move around with us, understanding human behavior is imperative. And then, reacting to such behaviors accordingly is the requirement.

Self-Awareness

- These machines are the extension of the Class III type of AI.
- It is one step ahead of understanding human emotions.
- This is the phase where the AI teams build machines with self-awareness factor programmed in them.
- Here's an instance. When someone is honking from behind, the machines should be able to feel the emotion.
- That's when they understand how it feels when they honk at someone back.