Agenda

- Course Objectives
- Course Outcomes
- Prerequisites
- Text / Reference Books
- Assessment Methods
- Introduction to Artificial Intelligence
- AI Approaches

Course Objectives

1. To conceptualize the basic ideas and techniques underlying the design of intelligent systems.
2. To make students understand and Explore the mechanism of mind that enables intelligent thought and action.
3. To make students understand advanced representation formalism and search techniques.
4. To make students understand how to deal with uncertain and incomplete information.

Course Outcomes

1. Ability to develop a basic understanding of AI building blocks presented in intelligent agents.
2. Ability to choose an appropriate problem solving method and knowledge representation technique.
3. Ability to analyze the strength and weaknesses of AI approaches to knowledge– intensive problem solving.
4. Ability to design models for reasoning with uncertainty as well as the use of unreliable information.
5. Ability to design and develop AI applications in real world scenarios.

Prerequisites

- CSC 303 : Discrete Mathematics
- CSC 305 : Data Structures
- CSC 402 : Analysis of Algorithm

Text / Reference Books

Text Books :

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Fourth Edition" Pearson Education, 2020.
2. Saroj Kaushik, "Artificial Intelligence", Cengage Learning, First edition, 2011
3. George F Luger, "Artificial Intelligence" Low Price Edition, Fourth edition, Pearson Education.,2005

Text / Reference Books

Reference Books :

1. Nils J. Nilsson, Principles of Artificial Intelligence, Narosa Publication.
2. Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication
3. Patrick H. Winston, Artificial Intelligence, 3rd edition, Pearson Education.
4. Elaine Rich and Kevin Knight, "Artificial Intelligence", Third Edition, McGraw Hill Education,2017.

Assessment Methods

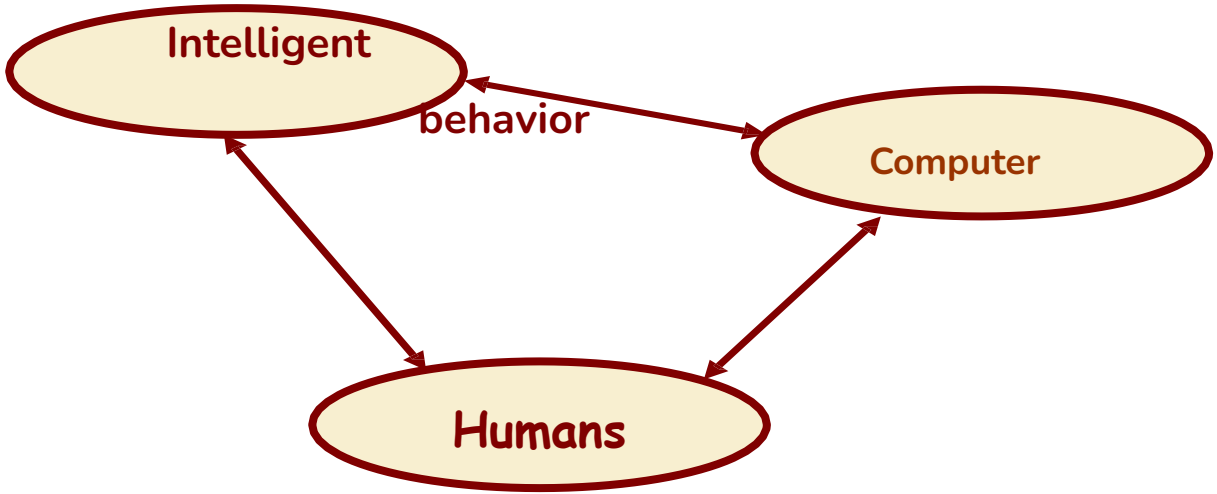
- Internal Assessments : 20 %
  - Tests - 2
  - Quizzes
  - Assignments
- End Semester Examination : 80%

Background

- Our intelligence is so important .
- From many years , we have tried to understand *how we think*, perceive, understand, predict, and manipulate
- The field of artificial intelligence, or AI, goes further still: it attempts not just to understand but also to *build* intelligent entities

What is AI?

- AI is the reproduction of human reasoning and intelligent behavior by computational methods



What is Artificial Intelligence?

- John McCarthy, who coined the term AI in 1956,
- defines it as "the science and engineering of making intelligent machines", especially intelligent computer programs
- Artificial intelligence is intelligence of machines and the branch of Computer science that aims to create it
- Ai is the study of : How to make computers do things which, at the moment, people do better
- AI is the study and design of intelligent agents, where an intelligent agent is a system that perceives its environment and takes actions that maximize its chances of success.
- **AI = Automation of Intelligence (Behavior + Acting)**

General AI Goal

- Replicate human intelligence : still a distant goal.
- Solve knowledge intensive tasks
- Make a intelligent connection between perception and action
- Enhance human-human, human-computer and computer to computer interaction/ communication

What is AI?

Discipline that systematizes and automates reasoning processes to create machines that:

Act like humans	Act rationally
Think like humans	Think rationally

AI Approaches

- Acting Humanity – Turing Test Approach
- Thinking Humanly – Cognitive Modeling approach
- Thinking Rationally - Laws of Thought / Logic Approach
- Acting Rationally – Rational Agent Approach

TURING TEST

The **Turing test**, developed by Alan Turing in 1950, is a test of a machine's ability to exhibit intelligent behaviour equivalent to, or indistinguishable from, that of a human.

- **Why he Invented ?**
  - Can A Computer talk like a Human?
  - He invented Turing Test as a method of inquiry in artificial intelligence (AI) for determining whether or not a computer is capable of thinking like a human being

The Turing Test

A test to empirically determine whether a computer has achieved intelligence

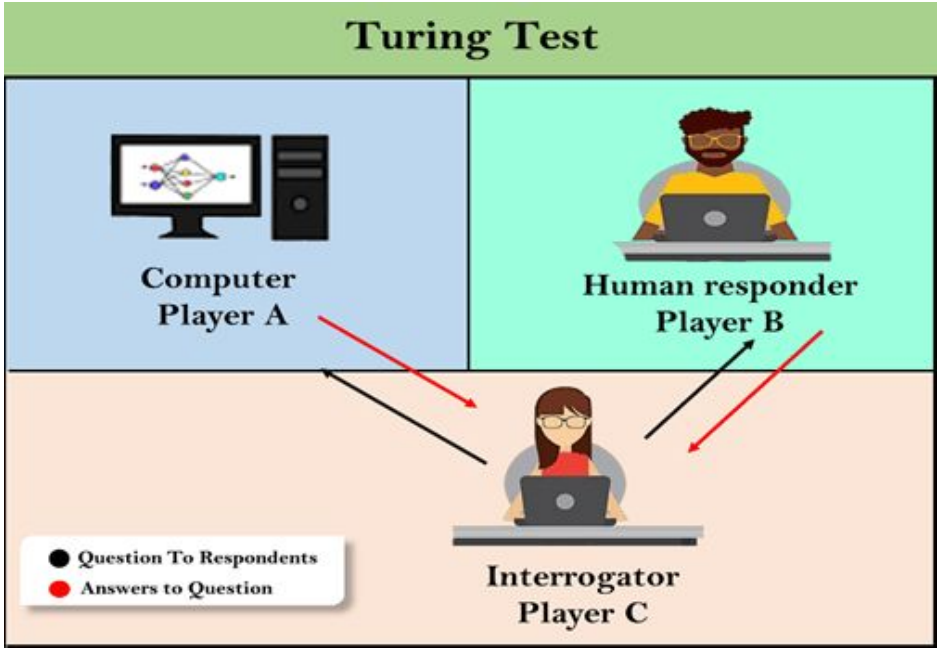


Figure 13.2
In a Turing test, the interrogator must determine which respondent is the computer and which is the human

What is Turing Test?

- Turing Test requires three terminals, each of which is physically separated from the other two. One terminal is operated by a computer, while the other two are operated by humans.
- During the test, one of the humans functions as the questioner, while the second human and the computer function as respondents The questioner interrogates the respondents within a specific subject area, using a specified format and context.
- After a preset length of time or number of questions, the questioner is then asked to decide which respondent was human and which was a computer.

What would a computer need to pass the Turing test?

- Natural language processing : to communicate with examiner.
- Knowledge representation: to store and retrieve information provided before or during interrogation.
- Automated reasoning: to use the stored information to answer questions and to draw new conclusions.
- Machine learning: to adapt to new circumstances and to detect and extrapolate patterns.
- Vision (for Total Turing test): to recognize the examiner's actions and various objects presented by the examiner.
- Motor control (total test): to act upon objects as requested.
- Other senses (total test): such as audition, smell, touch, etc.

What is AI?

- AI Methodology: Take a task at which people are better, e.g.:
  - Prove a theorem
  - Play chess
  - Plan a surgical operation
  - Diagnose a disease
  - Navigate in a building

  and build a computer system that does it automatically
- But do we want to duplicate human imperfections?

What is AI?

- Here, how the computer performs tasks does matter
- The reasoning steps are important
- Ability to create and manipulate symbolic knowledge (definitions, concepts, theorems, ...)
- What is the impact of hardware on low-level reasoning, e.g., to go from signals to symbols?

What is AI?

- Now, the goal is to build **agents** that always make the "best" decision given what is available (knowledge, time, resources)
- "Best" means maximizing the expected value of a utility function
- Connections to economics and control theory
- What is the impact of self-consciousness, emotions, desires, love for music, fear of dying, etc

  ... on human intelligence?

Yes, but what is intelligence?

- Intelligence is the computational part of the ability to achieve goals in the world.
- Varying kinds and degrees of intelligence occur in people, many animals and some machines.

Intelligent Behaviors in humans:

- Perception – ability to see, hear sensory information.
- Reasoning – reasoning with the information we have
- Learning – Learning for new situations,
- understanding natural language, communicating in natural language
- solving problems.
- Etc..

Intelligence

- Relate to tasks involving higher mental processes:-
- e.g. How to solve traffic problems in Mumbai ?
- Solution- Intelligent traffic control system
  - Intelligent Transport System.

Intelligence

- Relate to tasks involving higher mental processes:- How to solve traffic problems in Mumbai –
- Soln- Intelligent traffic control system.
  - Creativity,
  - solving problems,
  - pattern recognition , classification,
  - learning , induction, deduction ,
  - building analogies, optimization,
  - language processing, knowledge and many more
  - Intelligence is the computational part of the ability to achieve goals.

Intelligence

- **Intelligence:**
  - "the capacity to learn and solve problems"
  - in particular,
    - *the ability to solve novel problems*
    - *the ability to act rationally*
    - *the ability to act like humans*

- **Artificial Intelligence**
  - build and understand intelligent entities or agents
  - 2 main approaches: "engineering" versus "cognitive modeling"

Typical AI Problems

- **Routine Tasks (Mundane Tasks)**
  - Planning route/activity
  - Recognizing people/objects –(through vision)
  - Communicating (through natural language)
  - Navigating round obstacles on street etc
- **Expert task**
  - Medical diagnosis
  - Math problem solving
  - Playing chess etc

What is easy & What is Hard?

Easier to solve problems which are expert task

AI Approaches – Strong AI

- Strong AI -The principle behind Strong AI is that the machines could be made to think or in other words could represent human minds in the future
- It is also known as general AI or artificial general intelligence (AGI). Strong AI refers to AI that exhibits human-level intelligence.
- So, it can understand, think, and act the same way a human might in any given situation

Weak AI

- The principle behind Weak AI is simply the fact that machines can be made to act as if they are intelligent.
- For example, when a **human player plays chess** against a computer, the human player may feel as if the computer is actually making impressive moves.

Differences between strong and weak AI

With strong AI, machines can actually think and carry out tasks on their own, just like humans do. With weak AI, the machines cannot do this on their own and rely heavily on human interference.

Strong AI has a complex algorithm that helps it act in different situations, while all the actions in weak AIs are pre-programmed by a human.

Strong AI-powered machines have a mind of their own. They can process and make independent decisions, while weak AI-based machines can only simulate human behavior.

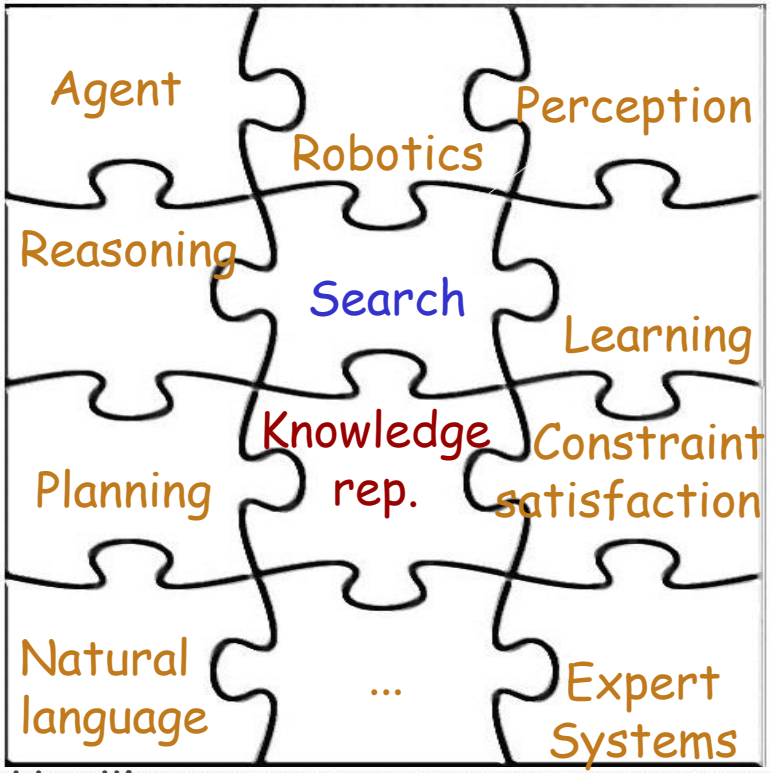
Academic Disciplines relevant to AI

Philosophy	Logic, methods of reasoning, mind as physical system, foundations of learning, language, rationality.
Mathematics	Formal representation and proof, algorithms, computation, (un)decidability, (in)tractability
Probability/Statistics	modeling uncertainty, learning from data
Economics	utility, decision theory, rational economic agents
Neuroscience	neurons as information processing units.
Psychology/ Cognitive Science	how do people behave, perceive, process cognitive information, represent knowledge.
Computer Engineering	building fast computers
Control theory	design systems that maximize an objective function over time
Linguistics	knowledge representation, grammars

Main Areas of AI

- Knowledge representation

  (including formal logic)
- Search, especially heuristic search (puzzles, games)
- Planning
- Reasoning under uncertainty, including probabilistic reasoning
- Learning
- Agent architectures
- Robotics and perception
- Natural language processing



History of AI

- 1943 McCulloch & Pitts: Boolean circuit model of brain
- 1950 Turing's "Computing Machinery and Intelligence"
- 1956 Dartmouth meeting: "Artificial Intelligence" adopted
- 1950s Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
- 1965 Robinson's complete algorithm for logical reasoning
- 1966—73 AI discovers computational complexity
  Neural network research almost disappears
- 1969—79 Early development of knowledge-based systems
- 1980-- AI becomes an industry
- 1986-- Neural networks return to popularity
- 1987-- AI becomes a science
- 1995-- The emergence of intelligent agents

State of the art

- Deep Blue defeated the reigning world chess champion Garry Kasparov in 1997
- Proved a mathematical conjecture (Robbins conjecture) unsolved for decades
- No hands across America (driving autonomously 98% of the time from Pittsburgh to San Diego)
- 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 on-board autonomous planning program controlled the scheduling of operations for a spacecraft
- Proverb solves crossword puzzles better than most humans
- Stanford vehicle in Darpa challenge completed autonomously a 132 mile desert track in 6 hours 32 minutes.

Consider what might be involved in building a “intelligent” computer....

- **What are the “components” that might be useful?**

  - Fast hardware?
  - Foolproof software?
  - Chess-playing at grandmaster level?
  - Speech interaction?
    - speech synthesis
    - speech recognition
    - speech understanding
  - Image recognition and understanding ?
  - Learning?
  - Planning and decision-making?

An intelligent system can make errors and still be intelligent

- humans are not right all of the time
- we learn and adapt from making mistakes
  - e.g., consider learning to surf or ski
    - we improve by taking risks and falling
    - an intelligent system can learn in the same way

Conclusion:

- **NO**: intelligent systems will not (and need not) be foolproof

Can Computers Recognize Speech?

Speech Recognition:

- mapping sounds from a microphone into a list of words.
- Hard problem: noise, more than one person talking, occlusion, speech variability,..
- Even if we recognize each word, we may not understand its meaning.

Recognizing single words from a small vocabulary

- systems can do this with high accuracy (order of 99%)
- e.g., directory inquiries
- Limited vocabulary (area codes, city names
- computer tries to recognize you first, if unsuccessful hands you over to a human operator
- saves millions of dollars a year for the phone companies

Recognizing human speech (ctd.)

- **Recognizing normal speech is much more difficult**
  - speech is continuous: where are the boundaries between words?
    - e.g., “John’s car has a flat tire”
  - large vocabularies
    - can be many tens of thousands of possible words
    - we can use **context** to help figure out what someone said
      - try telling a waiter in a restaurant:

        “I would like some dream and sugar in my coffee”
  - background noise, other speakers, accents, colds, etc
  - on normal speech, modern systems are only about 60% accurate

Can Computers Understand speech?

- **Understanding is different to recognition:**
  - "Time flies like an arrow"
    - assume the computer can recognize all the words
    - but how could it understand it?
      - 1. time passes quickly like an arrow?
      - 2. command: time the flies the way an arrow times the flies
      - 3. command: only time those flies which are like an arrow
      - 4. "time-flies" are fond of arrows
    - only 1. makes any sense, but how could a computer figure this out?
      - clearly humans use a lot of implicit commonsense knowledge in communication
- **Conclusion: NO, much of what we say is beyond the capabilities of a computer to understand at present**

Can Computers plan and make decisions?

- **Intelligence**
  - involves solving problems and making decisions and plans
  - e.g., you want to visit your cousin in Boston
    - you need to decide on dates, flights
    - you need to get to the airport, etc
    - involves a sequence of decisions, plans, and actions
- **What makes planning hard?**
  - the world is not predictable:
    - your flight is canceled or there's a backup on the 405
  - there is a potentially huge number of details
    - do you consider all flights? all dates?
      - no: common sense constraints your solutions
  - AI systems are only successful in constrained planning problems
- **Conclusion: NO, real-world planning and decision-making is still beyond the capabilities of modern computers**
  - exception: very well-defined, constrained problems: mission planning for satellites.

Intelligent Systems in Your Everyday Life

- **Post Office**
  - automatic address recognition and sorting of mail
- **Banks**
  - automatic check readers, signature verification systems
  - automated loan application classification
- **Telephone Companies**
  - automatic voice recognition for directory inquiries
- **Credit Card Companies**
  - automated fraud detection
- **Computer Companies**
  - automated diagnosis for help-desk applications
- **Netflix:**
  - movie recommendation
- **Google:**
  - Search Technology

AI Applications: Consumer Marketing

- **Have you ever used any kind of credit/ATM/store card while shopping?**
  - if so, you have very likely been "input" to an AI algorithm
- **All of this information is recorded digitally**
- **Companies like Nielsen gather this information weekly and search for patterns**
  - general changes in consumer behavior
  - tracking responses to new products
  - identifying customer segments: targeted marketing, e.g., they find out that consumers with sports cars who buy textbooks respond well to offers of new credit cards.
  - Currently a very hot area in marketing
- **How do they do this?**
  - Algorithms ("data mining") search data for patterns
  - based on mathematical theories of learning
  - completely impractical to do manually

AI Applications: Identification Technologies

- **ID cards**
  - e.g., ATM cards
  - can be a nuisance and security risk:
    - cards can be lost, stolen, passwords forgotten, etc
- **Biometric Identification**
  - walk up to a locked door
    - camera
    - fingerprint device
    - microphone
    - iris scan
  - computer uses your biometric signature for identification
    - face, eyes, fingerprints, voice pattern, iris pattern

AI Applications: Predicting the Stock Market

- **The Prediction Problem**
  - given the past, predict the future
  - very difficult problem!
  - we can use learning algorithms to learn a predictive model from historical data
    - prob(increase at day t+1 | values at day t, t-1,t-2....,t-k)
  - such models are routinely used by banks and financial traders to manage portfolios worth millions of dollars

AI-Applications: Machine Translation

- **Language problems in international business**
  - e.g., at a meeting of Japanese, Korean, Vietnamese and Swedish investors, no common language
  - or: you are shipping your software manuals to 127 countries
  - solution; hire translators to translate
  - would be much cheaper if a machine could do this!
- **How hard is automated translation**
  - very difficult!
  - e.g., English to Russian
    - "The spirit is willing but the flesh is weak" (English)
    - "the vodka is good but the meat is rotten" (Russian)
  - not only must the words be translated, but their meaning also!
- **Nonetheless....**
  - commercial systems can do alot of the work very well (e.g.,restricted vocabularies in software documentation)
  - algorithms which combine dictionaries, grammar models, etc.
  - see for example babelfish.altavista.com

Components of AI program

Artificial Intelligence has following components –

- Learning
- Reasoning
- Problem solving
- Perception
- Language understanding

Components of AI

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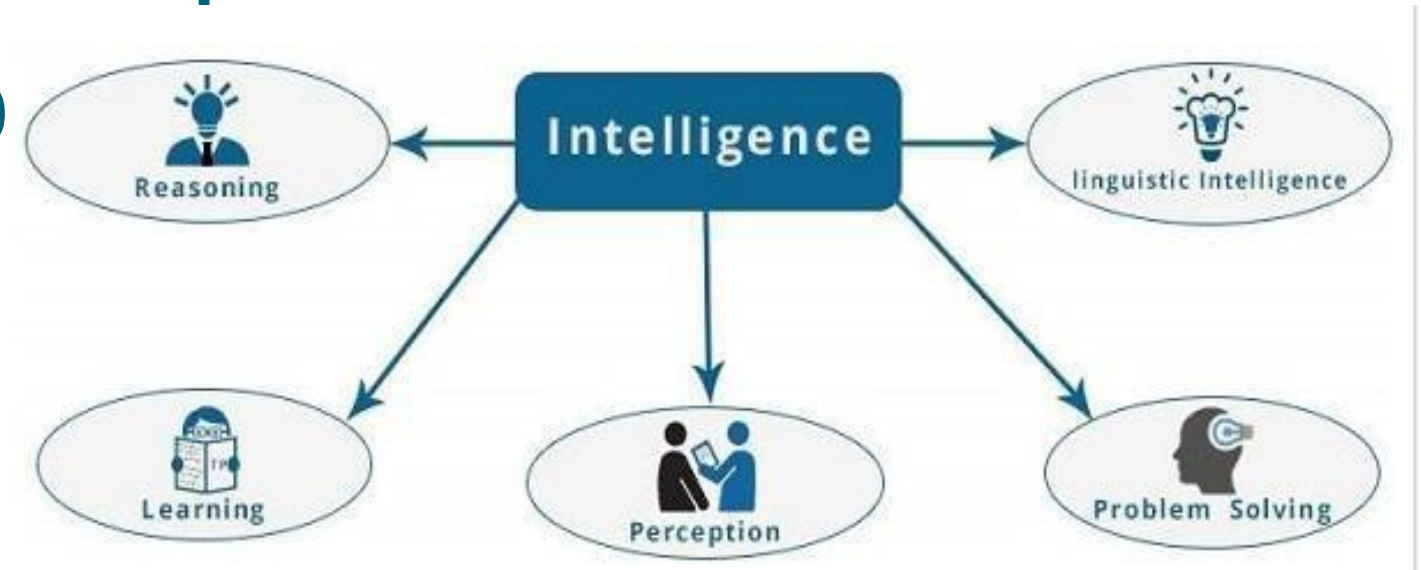


What Can AI systems do today?

- Computer vision: face Recognition
- Robotics: Autonomous automobile
- Natural Language Processing – simple machine translation
- Expert system -Medical Diagnosis in narrow domain

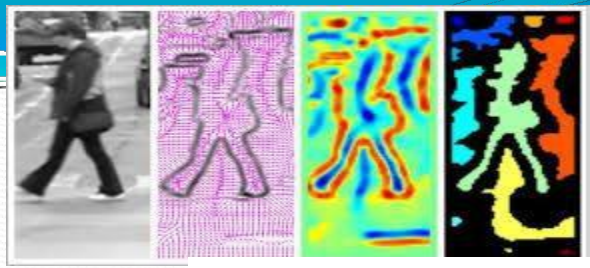
What Can AI systems do today?

- Spoken language – 1000 word continuous speech
- Planning and Scheduling system- Hubble telescope system – gather data
- Learning – text categorization into ~1000 topics
- Games- Grand master level in chess (world champion),checkers etc.

What AI cannot do yet?

- Understand Natural language robustly(e.g. read and understand articles in a newspaper)
- Interpret an arbitrary visual scene
- Learn a natural language
- Construct plans in dynamic real time domains
- Exhibit true autonomy and intelligence

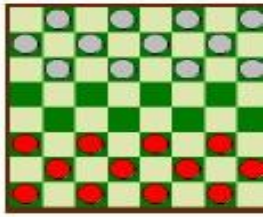
AI Applications



- Computer vision
- Image reorganization
- Robotics
- Speech processing
- Autonomous vehicle
- Expert system – medical diagnosis etc
- Machine Learning
- Automated Reasoning and Theorem proving

AI Playing Games

- CHESS:
  - *Deep Blue* BEAT Kasparov (May '97)
  - Matches expert level performance
    - "intelligent & creative" play
  - . . . thinks differently from human expert by examining 200million board-positions/move
- Checkers:
  - *Chinook* is 1994 World champion CHECKERS Player!
  - 2007: proven to be draw!
- Othello
  - Logistello beat Human Champion, 6-0 !
- Backgammon
  - TD-Gammon is competitive with World Champion
- Poker
  - Comparable with best humans! (2007)



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AI Applications

- RoboRocks Vaccum Cleaner Robots
- Automated Car - Google Self driving car, Volvo's Self- driving car in Sweden
- ALVINN – Automatic Land Driven Vehicle in NN(1986)
- Machine Translation – Carnegie Mellon university working with " Speechlator" for use in doctor-patient interviews.,
- US military forces uses "Phraselator"(one-side translator) – communicate with injured Iraqis, prisioners of war, travelers at checkpoints etc

Questions

- List various equipment in day-to-day life, where AI is used?
- List five things that AI can achieve in next five years.
- List five things that AI cannot achieve in next five years.

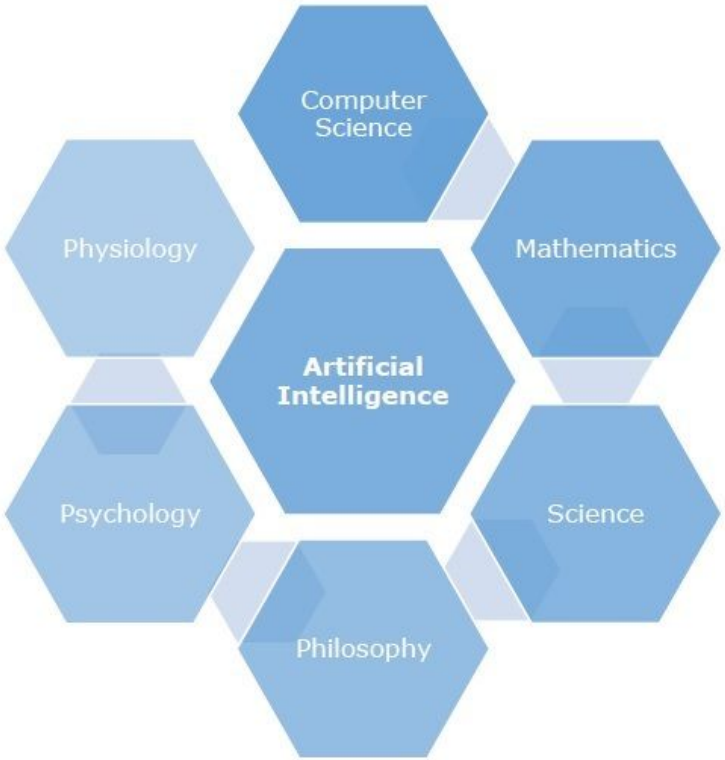
Have the following been achieved by AI?

- World-class chess playing
- Playing table tennis
- Cross-country driving
- Solving mathematical problems
- Discover and prove mathematical theories
- Engage in a meaningful conversation
- Understand spoken language
- Observe and understand human emotions
- Express emotions
- .....

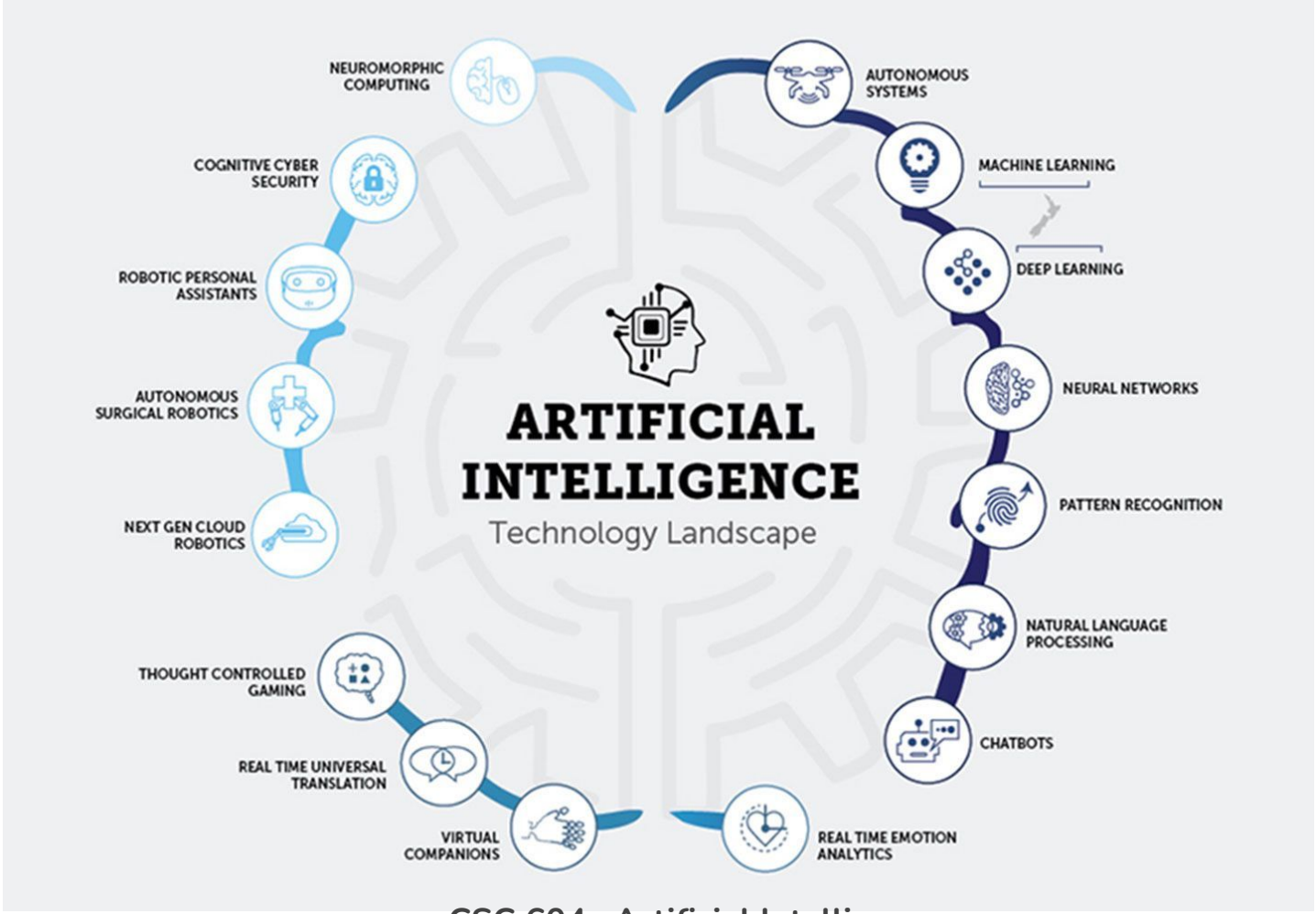
Questions

- What is intelligence? How do you measure it?
- What is AI? What are applications of AI?
- What is Turing Test?
- What are the five things AI could do in next five years?
- What are the five things AI cannot do in next five years?
- Identify AI Applications in following domain:
  - Image Processing
  - Sentimental analysis
  - Healthcare
  - Insurance
  - Environment

Foundations of AI



Tutorial Point

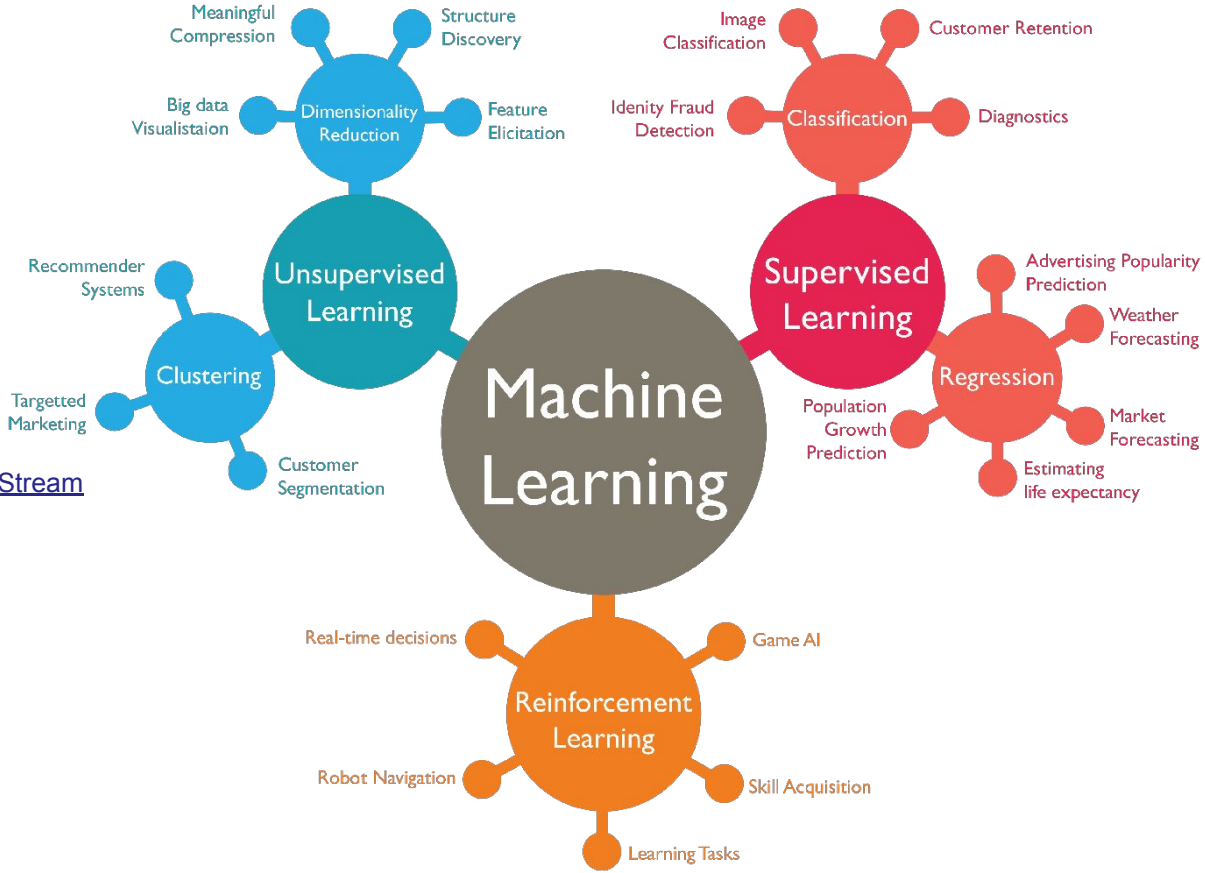

NEUROMORPHIC COMPUTING
COGNITIVE CYBER SECURITY
ROBOTIC PERSONAL ASSISTANTS
AUTONOMOUS SURGICAL ROBOTICS
NEXT GEN CLOUD ROBOTICS
THOUGHT CONTROLLED GAMING
REAL TIME UNIVERSAL TRANSLATION
VIRTUAL COMPANIONS
AUTONOMOUS SYSTEMS
MACHINE LEARNING
DEEP LEARNING
NEURAL NETWORKS
PATTERN RECOGNITION
NATURAL LANGUAGE PROCESSING
CHATBOTS
REAL TIME EMOTION ANALYTICS
ARTIFICIAL INTELLIGENCE
Technology Landscape

Pinterest

Approaches to AI

	Human	Rational
Thinking	Thinking like humans • Cognitive science • **Neuron level** • Neuroanatomical level • Mind level	Thinking rationally • Aristotle, syllogisms • Logic • "Laws of thought"
Acting	Acting like humans • Understand language • Play games • Control the body • The Turing Test	Acting rationally • Business approach • Results oriented

Courtesy :
Russell & Norvig



Courtesy : WordStream