

# Applied AI

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# Agenda

- Introduction to the Course
- Assessment
- Resources
- Lecture Schedule
- Seminar/tutorial schedule
- History, developments, issues
- Next steps

# Introduction

- **Aims: To give the student the background knowledge and practical skills to use and evaluate AI techniques over a range of problem domains.**
  - Understand the fundamental concepts, issues, and techniques of AI.
  - Implement and use AI techniques across a broad range of AI sub-fields.
  - Evaluate when and under what conditions it is appropriate to use each AI technique.
  - Understand the historical background and evolution of AI techniques.
- Each week an essential technique will be demonstrated via a working implementation followed by a presentation of the theory and conditions needed to enable the student to set up and use the techniques themselves
- Guest presentations by experts in a relevant topic will be arranged where possible.

# Assessment

| Session | Period | Assessment Type                          | Assessment Name | Weight | Qual Marks |
|---------|--------|--|-----------------|--------|------------|
| 2022/3  | SEM1   | Coursework                               | Coursework      | 50     | 30         |
| 2022/3  | SEM1   | In-Class Test/Assignment exam conditions | In-class Test   | 50     | 30         |

# Resources

- Your main resource will be the Book :
  - Artificial Intelligence, A Modern Approach, 4<sup>th</sup> Edition by Russel and Norvig
  - Access via the Reading List on Blackboard
- Sample code in many languages and available on the book website:  
**<https://github.com/aimacode>**
  - The web (obviously) and related online materials
  - Guest lecturers

# Lecture Schedule

- 1. Introduction and History of AI
- 2. Agents and Environments
- 3. Problem Solving
- 4. Planning
- 5. Knowledge representation and reasoning
- 6. Engagement week
- 7. Uncertain Knowledge and Reasoning
- 8. Neural Networks
- 9. Speech and Language Processing (Dr Maria Chondrogianni)
- 10. Computer Vision/Deep Learning (Dr Aleka Psarrou)
- 11. Reinforcement Learning/Deep Learning (Dr Dimitris Dracopoulous)
- 12. Revision session

# Seminar/tutorial schedule

- 1. No Seminar – Seminar Exercises will be released every Friday**
2. Python, Jupyter and development environment
3. Search Algorithms in Agent Environment
4. Planning – Adversarial search
5. Knowledge representation and reasoning
- 6. Engagement week – No seminar/tutorial**
7. Probabilistic Reasoning

# Seminar/tutorial schedule (Contd..)

8. Neural Networks

9. Speech and Language Processing (Dr Maria Chondrogianni)

10. Computer Vision/Deep Learning (Dr Aleka Psarrou)

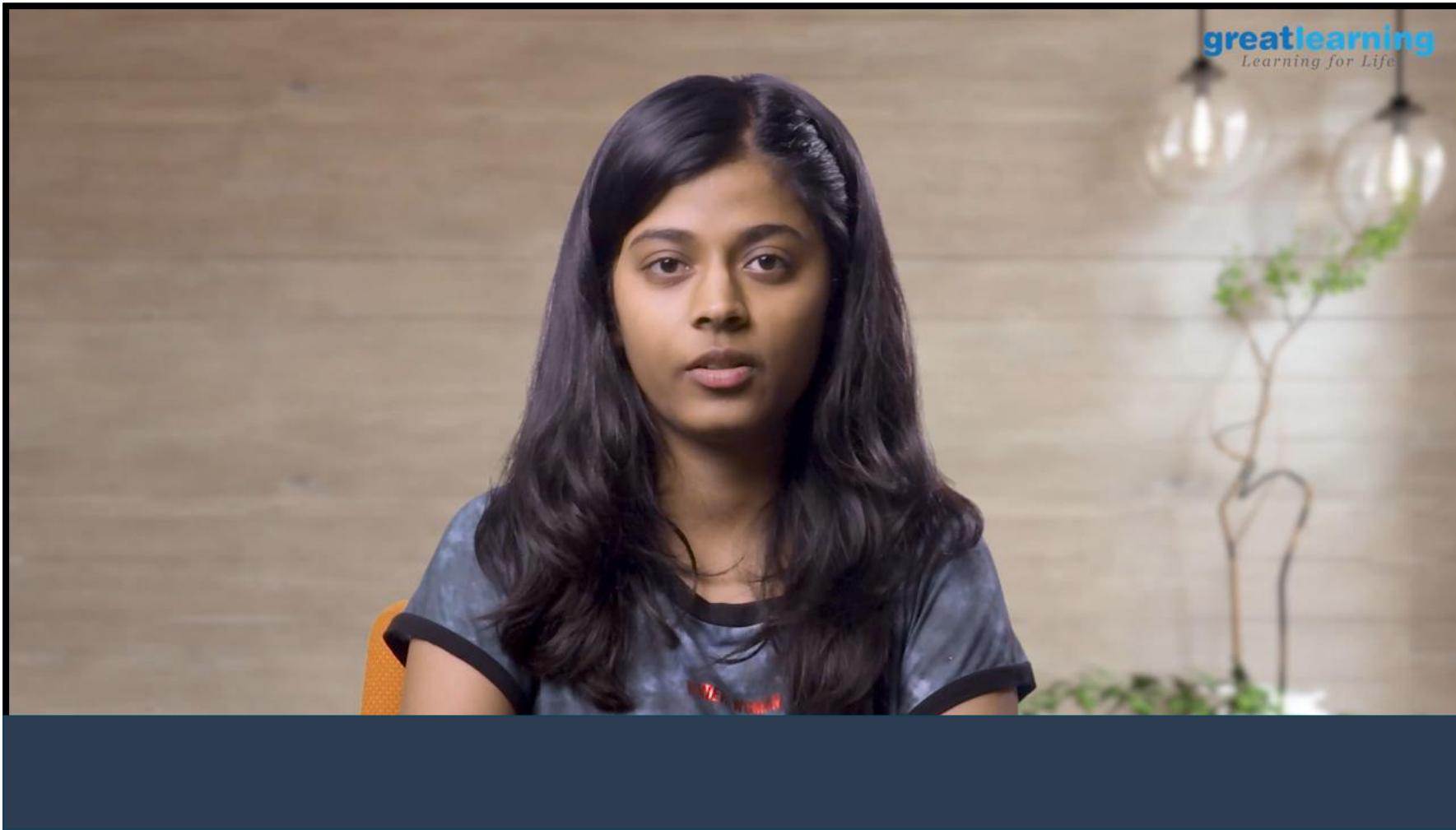
11. Reinforcement Learning/Deep Learning (Dr Dimitris Dracopoulous)

**12. In-class test in your allocated seminar**

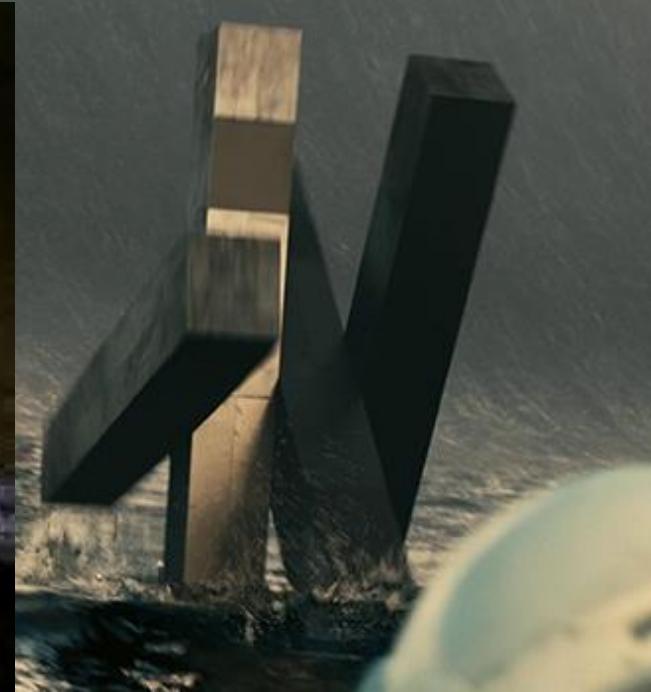
# Foundations in AI

- What is artificial intelligence?
- Where are we and how did we get here?
- How do we think about the design of AI systems?

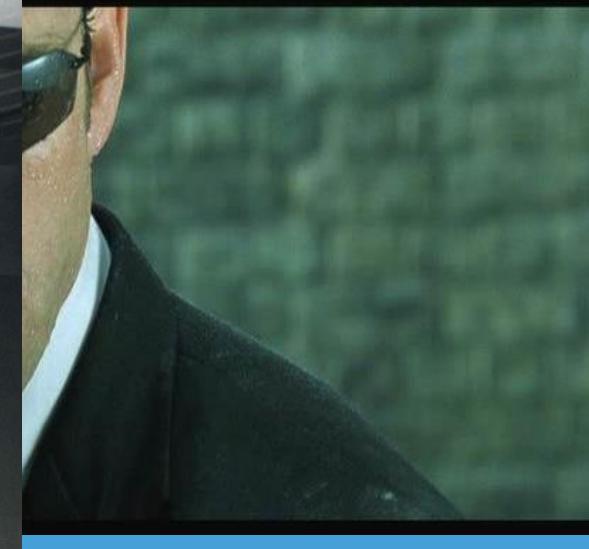
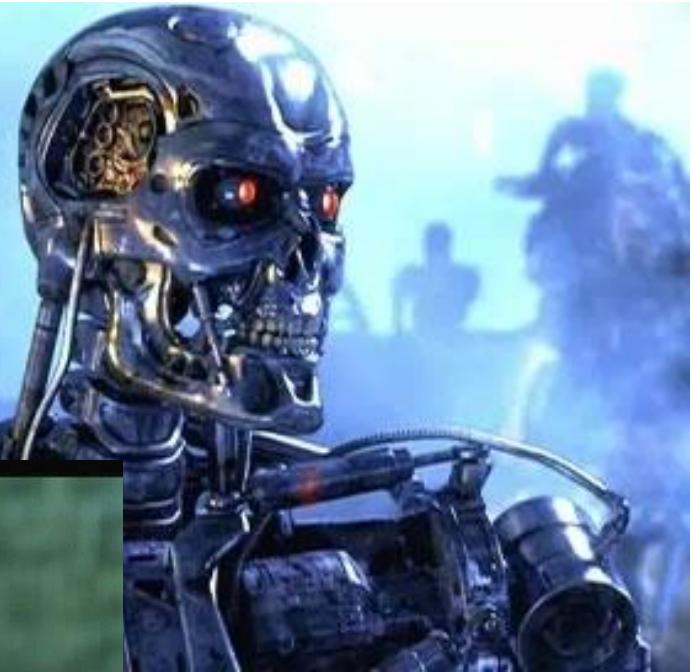
# AI as 4<sup>th</sup> Industrial Revolution



# Movie AI



# Movie AI



YESTERDAY DR. WILL CASTER WAS ONLY HUMAN



[entertainmentfilms.co.uk](http://entertainmentfilms.co.uk)

AI is the biggest risk we face as a civilisation, Elon Musk says



4

## Billionaire burn: Musk says Zuckerberg's understanding of AI threat 'is limited'

HOME » FINANCE » FINANCE TOPICS » DAVOS

BY PE  
Published  
Updated

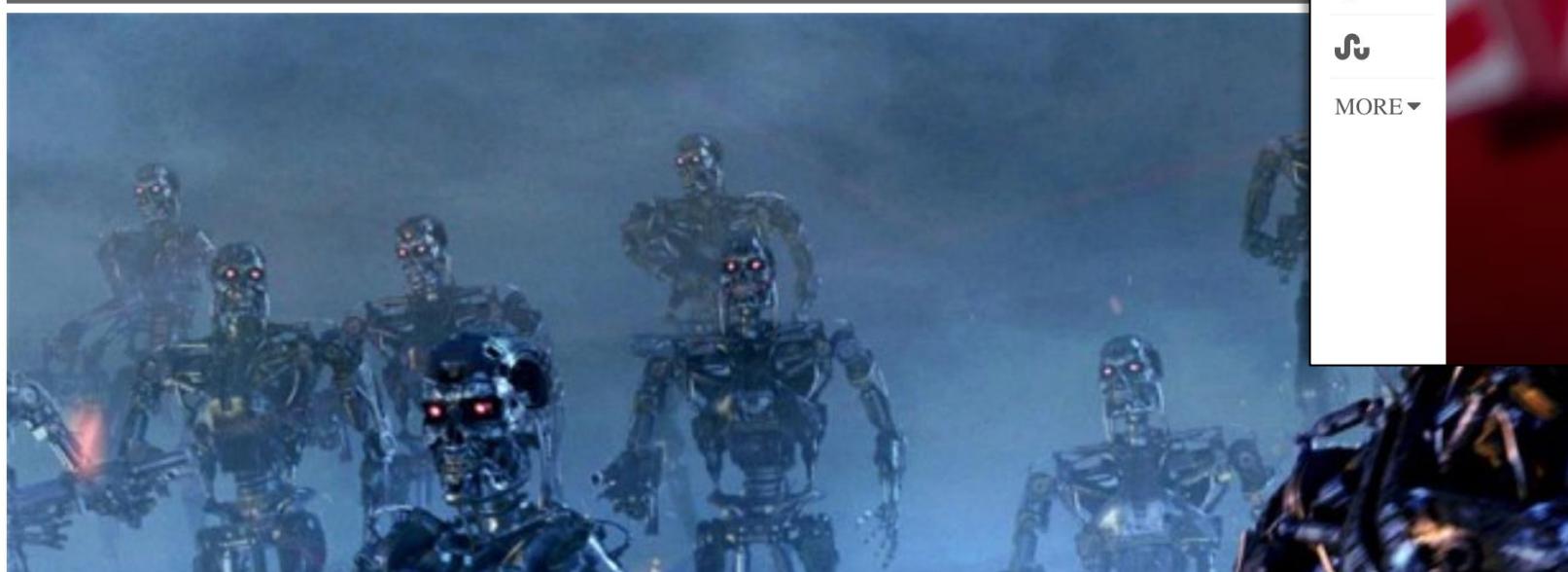
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## 'Sociopathic' robots could overrun the human race, says a generation

Computers should be trained to serve humans to reduce their threat to the human race, says a leading expert on artificial intelligence



# LIVE SCIENCE

NEWS TECH HEALTH PLANET EARTH

Live Science > Tech

## Lifelike 'Sophia' Robot Granted Citizenship to Saudi Arabia

By Mindy Weisberger, Senior Writer | October 30, 2017 03:39pm ET

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## United Kingdom Plans \$1.3 Billion Intelligence Push

France to spend \$1.8 billion on compete with U.S., China

EU wants to invest £18b development

## China's Got a Huge Artificial Intelligence Plan

'Whoever leads in AI will rule the world': Putin to Russian children on Knowledge Day

Published time: 1 Sep, 2017 14:08

Edited time: 1 Sep, 2017 14:40



NATURAL 'PROZAC': DOES IT REALLY WORK?

N

# IBM's Watson Jeopardy Computer Shuts Down Humans in Final Game

DAILY NEWS 9 March 2016

Sili

## 'I'm in shock!' How world's best human



## Blizzard will show off Google's Deepmind AI in StarCraft 2 later this week

By Andy Chalk 4 hours ago

Google and Blizzard launched the artificial intelligence project in 2016.

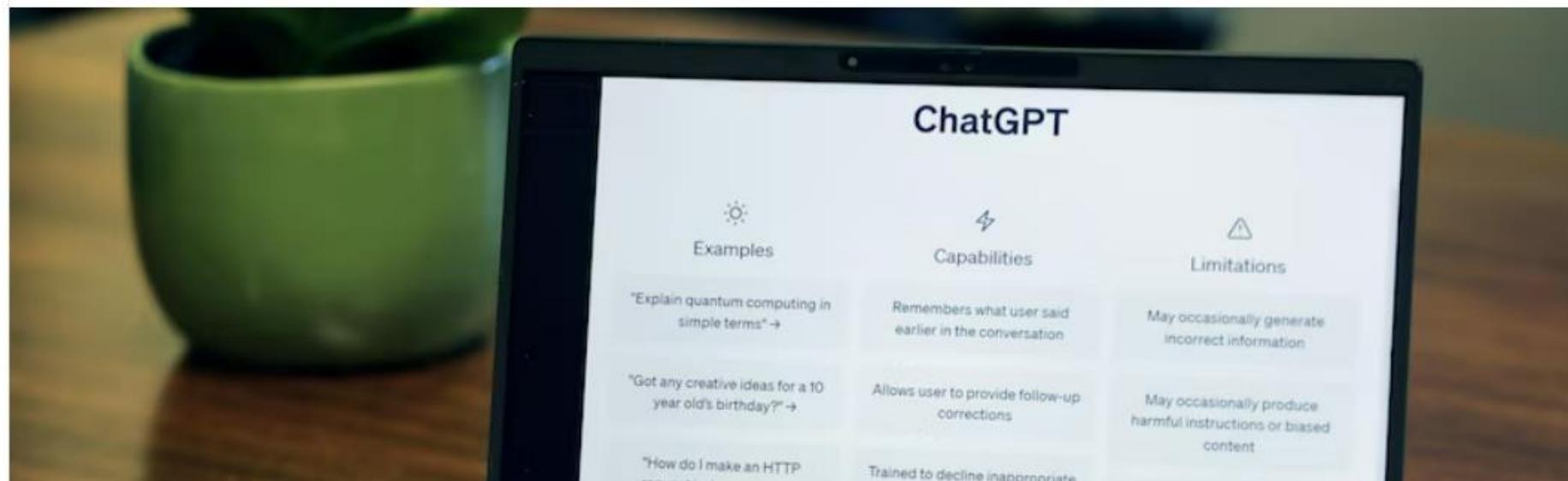
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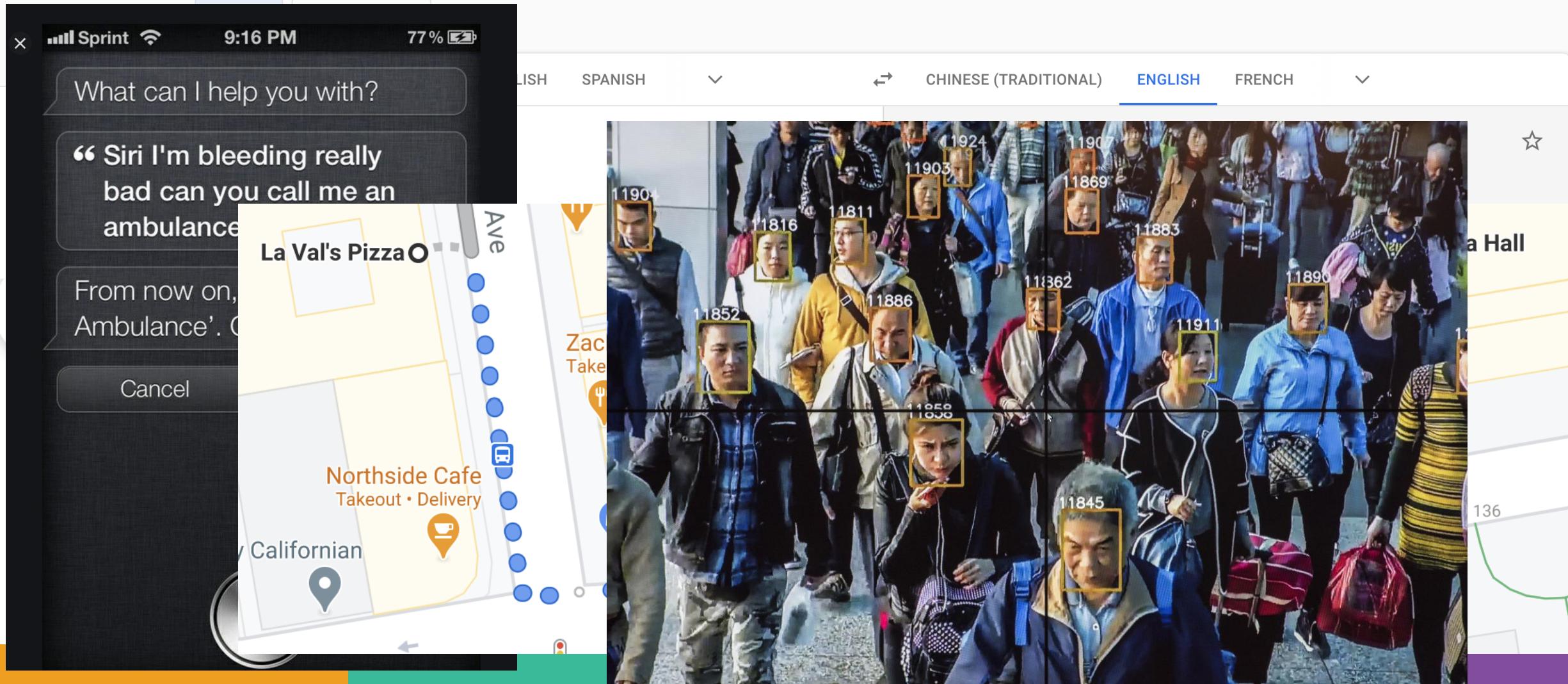


# Recruiters warn against overuse of AI tools such as ChatGPT to write resumes, cover letters

ABC Gold Coast / By Danielle Mahe

Posted Yesterday at 2:03am







EXIT



A black BigDog robot is walking through a forest. It is a quadruped robot with a dark, textured body and a segmented tail. It is moving across a ground covered in fallen brown leaves. The background consists of tall, thin trees with green and yellow foliage.

Boston Dynamics



# Inspiration for the development of Artifacts



Nature



Artifact

# Inspiration for the development of Artifacts







## Left brain

Logic

Reason

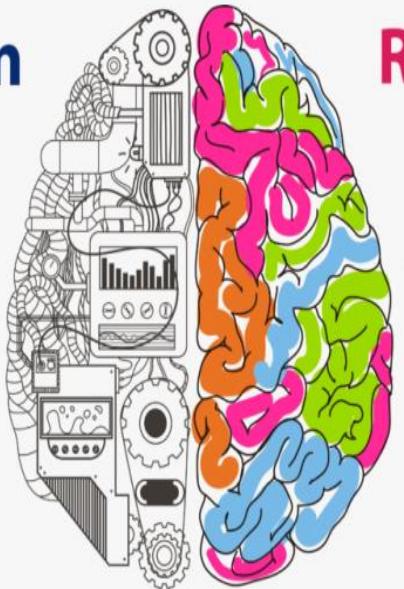
Informational Learning

Detail Oriented

Serial Processing

Knowledge

Structured



## Right brain

Creativity

Imagination

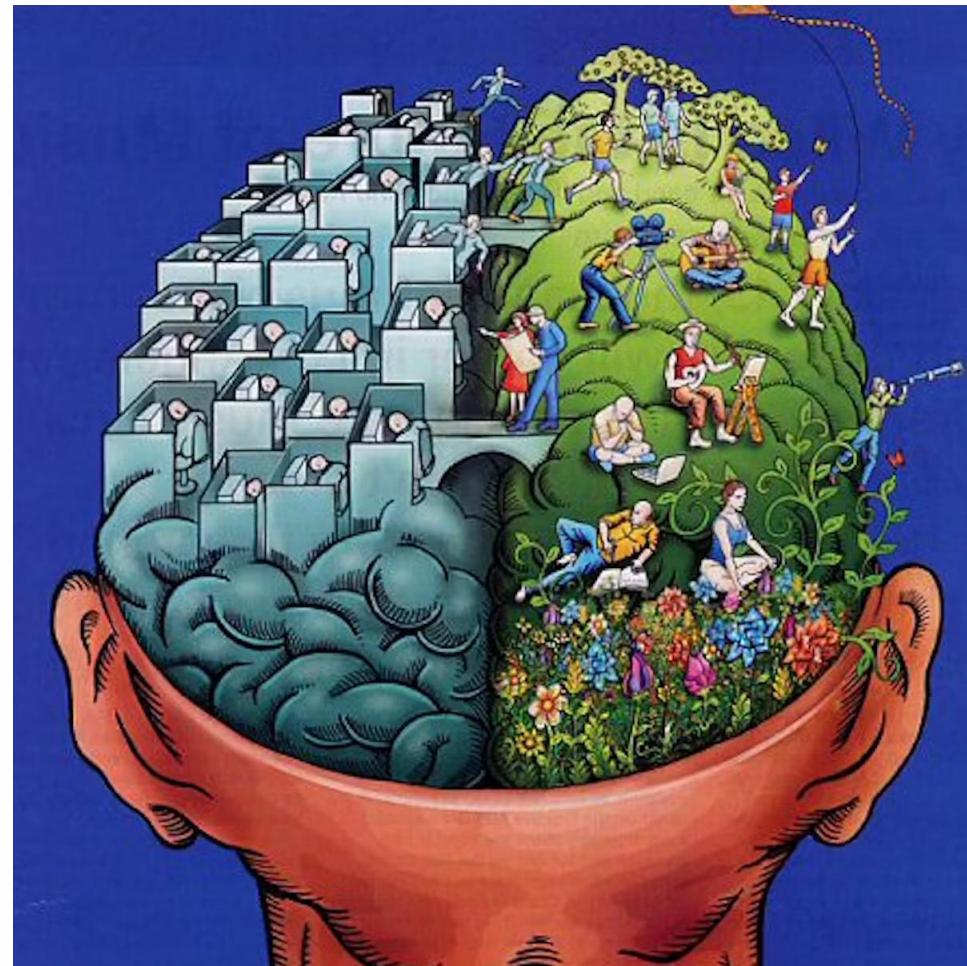
Transformative Learning

Whole Oriented

Parallel Processing

Understanding

Free-Flow



# Introduction - General

- We are in an era of Intelligent Machines (1950s)  
Here we model Natural Intelligence into machines
  - understand intelligence and build intelligent machines
- This area is named as Artificial Intelligence (AI)  
AI is Science and Engineering to build intelligent machines
- AI has gone into all sectors of the society  
Nowadays people cannot live without AI
- AI has changed the way people work and live
- AI is the fuel for the 4<sup>th</sup> industrial revolution
  - 1<sup>st</sup> steam, 2<sup>nd</sup> Electricity, 3<sup>rd</sup> Electronics, 4<sup>th</sup> AI
- AI has revolutionized academia and industry

# Introduction - Academic

- AI solves problems that could not be solved otherwise
  - Any problem can be solved by AI
- Problem solving needs *Knowledge/theory* and/or *Data*
- AI can model both knowledge and data
- Neuroscience provides a strong basis for AI
  - Logical/analytical based intelligence (symbolic AI)- Artificial Cognitive Systems
  - Training-based intelligence (non-symbolic AI) – Machine Learning

In 1950s, AI began as modules in Computer Science and has evolved as Bachelor's degrees in computing

Degree in AI encompasses

- Artificial Intelligence, Computer Science, Mathematics, Statistics

# Introduction - Industry

- AI implements how humans/animals solve problems
- Given any problem has one or more solutions
- A problem can be solved by more than one way
- AI can generate evolvable solutions
- AI solutions are extensible
- AI solutions can be built on existing systems
- Some AI solutions work, but cannot be justified
- Some AI solutions can be justified

# Introduction - Enthusiasm for AI

Many programs gave popularity for AI

- XCON (1984) – used to configure mini-computers (ACS)
- DART (1991) – Expert system executes entire Gulf-war (ACS)
- Pathfinder (1997) – Rover explores unknown environment (ACS)
- IBM Deep Blue (1996) – Defeated grandmaster of chess (ACS)
- Watson (2011) – Answering any question (ACS + ML)
- AlphaGo (2015) – demonstrated power of training over rules (ML)
- Self-driving cars (2009) – autonomy in technology (ML)
- Tesla (2015) – self-driving cars/trucks (ML)
- Sophia (2016) – Citizenship in Saudi Arabia (ACS+ML)
- Amazon Alexa – work as a hub for controlling device at home
- Google Assistant – Answer any question
- Neurlink – Chip implanted in the brain
- ChatGPT

Future of AI – the gap between man and machine will be reduced

# A short prehistory of AI

- Philosophy (428BC) – can a machine be intelligent?
- Mathematics and Statistics (800)
  - Algebra/Geometry-Formal representation of knowledge
- Economics (1776)- Effective use of resources/profit
- Neuroscience (1861-) – Structure and function of the brain
- Psychology (1887-) – Mental health
- Computer Science – Algorithms, Data structures, etc.
- Computer engineering (1940-) – Machine to do coding
- Control theory and Cybernetics (1984-) – controlling/networking
- Linguistics (1957-) – Theory of languages
- Education, Physics, Biology (to model animal intelligence)

Aristotle: For if every instrument could accomplish its own work, obeying or anticipating the will of others . . . if, in like manner, the shuttle would weave and the plectrum touch the lyre without a hand to guide them, chief workmen would not want servants, nor masters slaves

# AI's official birth: Dartmouth, 1956



"An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. ***We think that a significant advance can be made if we work on it together for a summer.***"



**John McCarthy and Claude Shannon  
Dartmouth Workshop Proposal**

# A (Short) History of AI

## 1940-1950: Early days

- 1943: McCulloch & Pitts: Boolean circuit model of brain
- 1950: Turing's "Computing Machinery and Intelligence"

## 1950—70: Excitement: Look, Ma, no hands!

- 1950s: Early AI programs: chess, checkers (RL), theorem proving
- 1956: Dartmouth meeting: "Artificial Intelligence" adopted
- 1965: Robinson's complete algorithm for logical reasoning

## 1970—90: Knowledge-based approaches

- 1969—79: Early development of knowledge-based systems
- 1980—88: Expert systems industry booms
- 1988—93: Expert systems industry busts: "AI Winter"

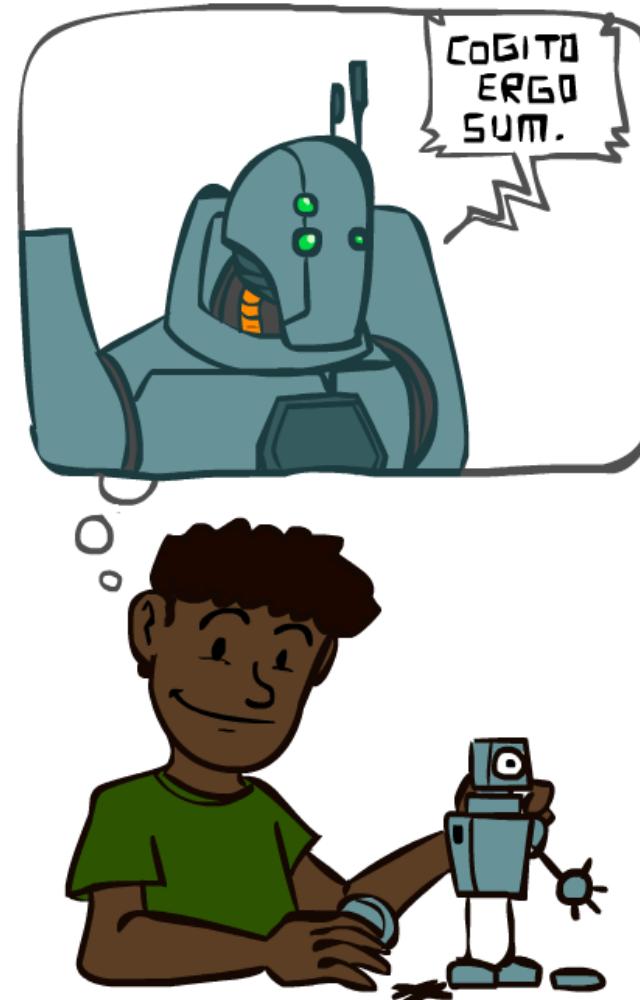
## 1990— 2012: Statistical approaches + subfield expertise

- Resurgence of probability, focus on uncertainty
- General increase in technical depth
- Agents and learning systems... "AI Spring"?

## 2012— \_\_: Excitement: Look, Ma, no hands again?

- Big data, big compute, deep learning
- AI used in many industries

2022 : Chat GPT



# POWER & Control

- Any technology has

|             | Power      | Control    |
|-------------|------------|------------|
| Electricity | Technology | Human      |
| Automobile  | Technology | Human      |
| .....       | Technology | Human      |
| AI          | Technology | Technology |

In AI both power and control are built into technology itself.  
That is why autonomy.

# Nature of Knowledge

Science – Experiment-based decisions, know why

Mathematics – measurements, calculations, patterns

Engineering – building artifacts (profit, durability, appearance, weight, shape)

Technology – know how (even without a science)

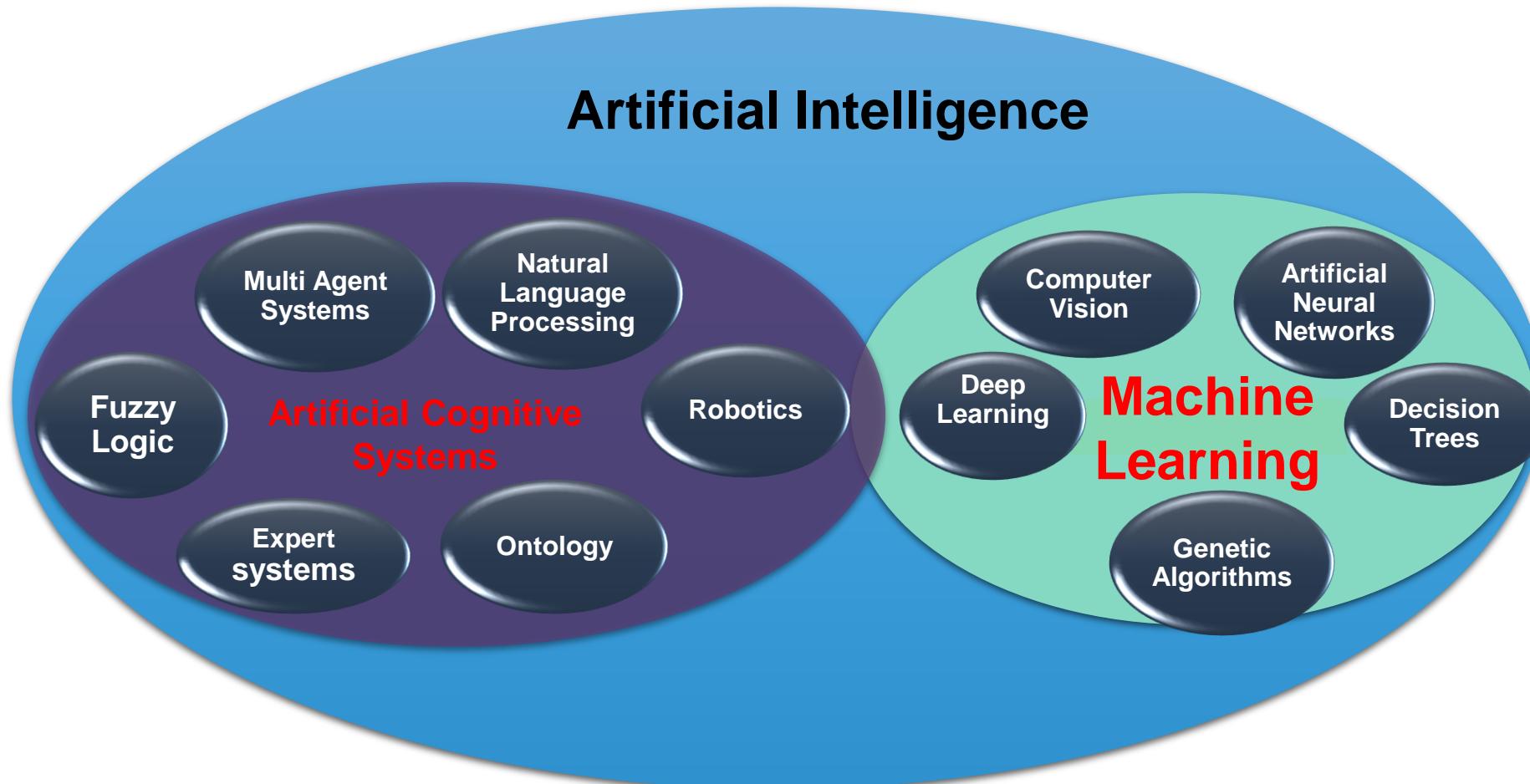
Informal knowledge – beliefs, experiences,

Formal knowledge – theories/models (S, M, E, T)

Where is AI? – informal + formal

If people (nature) can do, so does AI

# Major Areas of AI



Problem solving knowledge

Domain specific knowledge

Get the insight from how a medical expert  
Examine a patient

- ES is the champion of ACS
- Provide solutions
- Give Explanations
- Give alternative solution
- Handle incomplete information
- Handle uncertainty

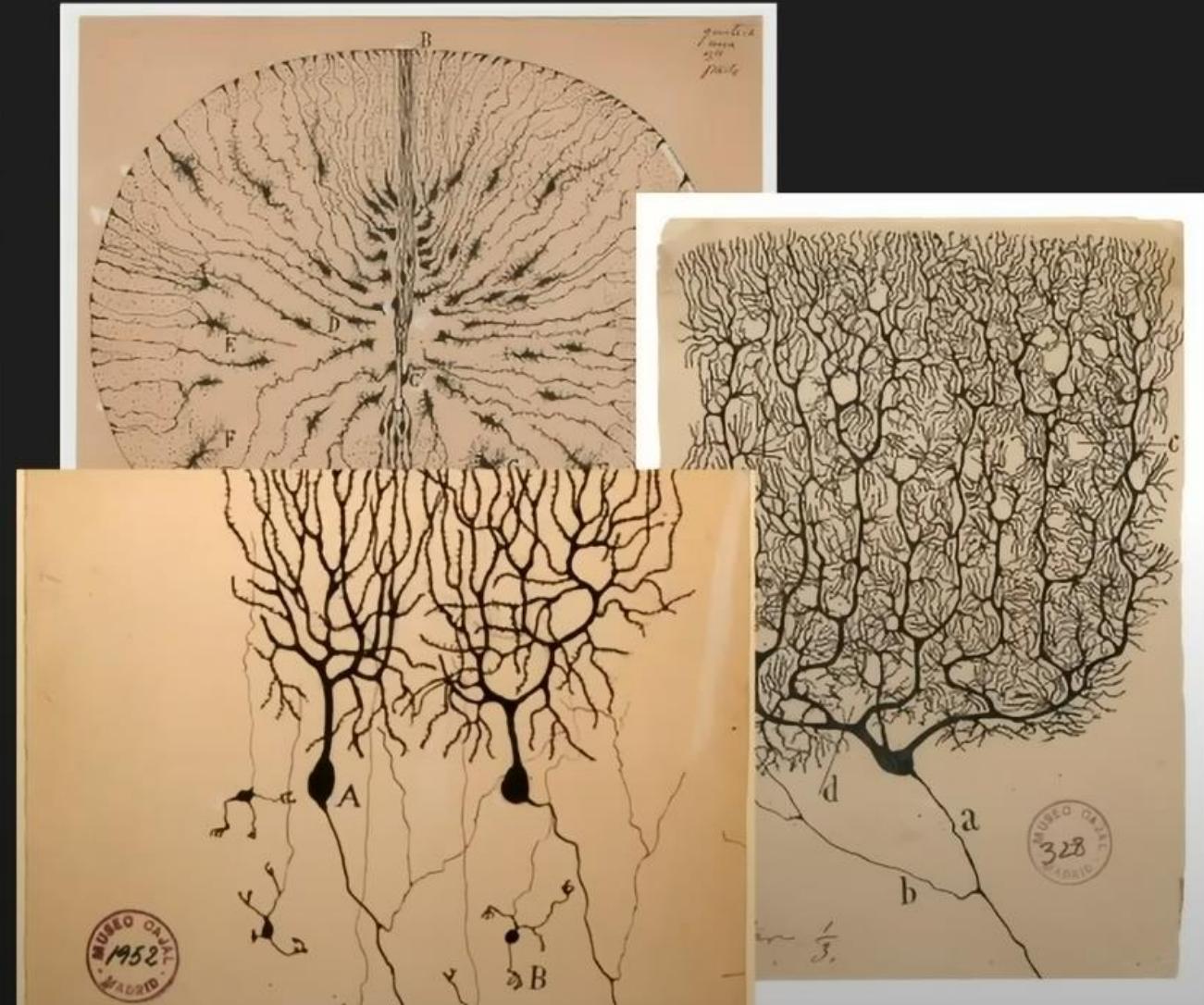
## Expert Systems



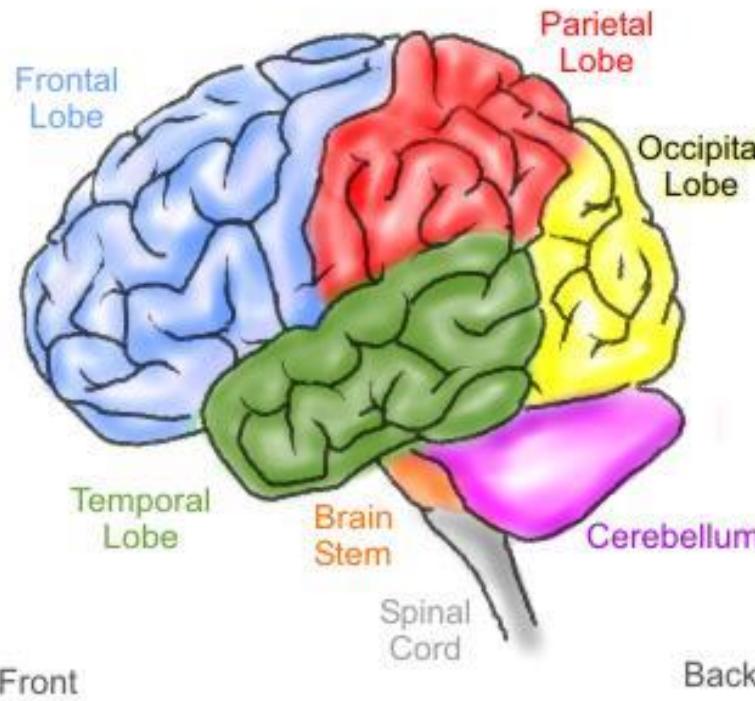
# Discovery of our brain structure



Santiago Ramón y Cajal  
(1852 - 1934)

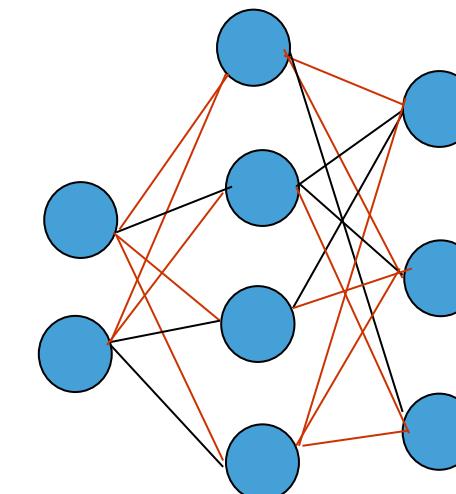


Regions of the Human Brain



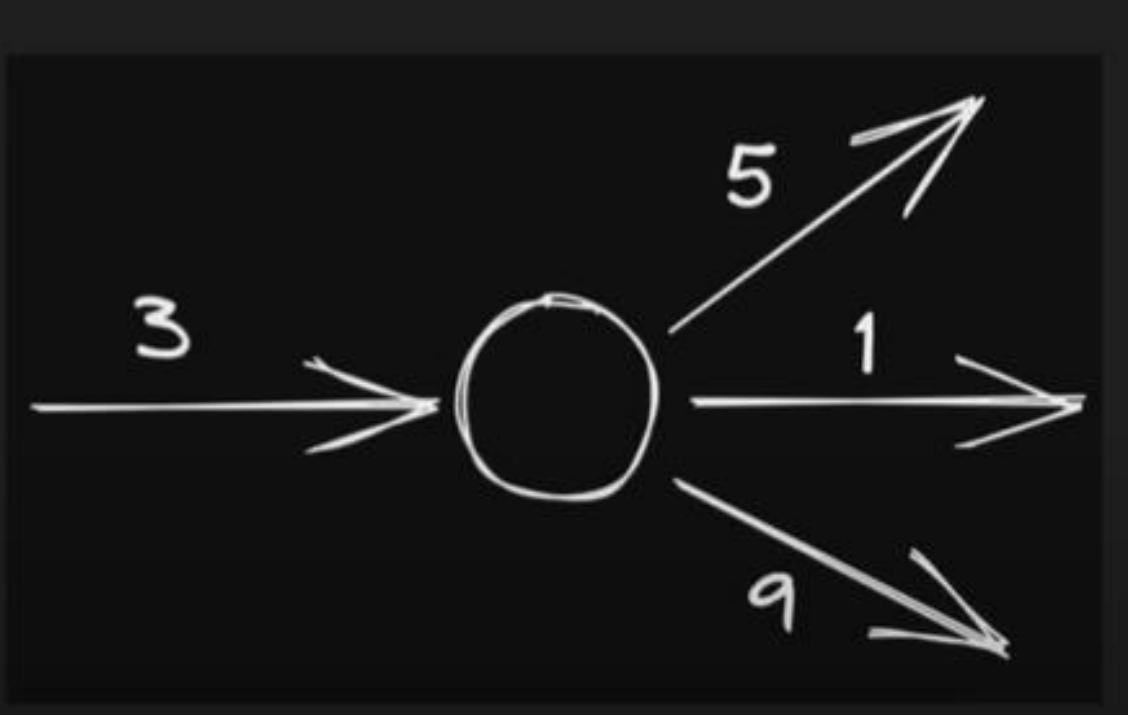
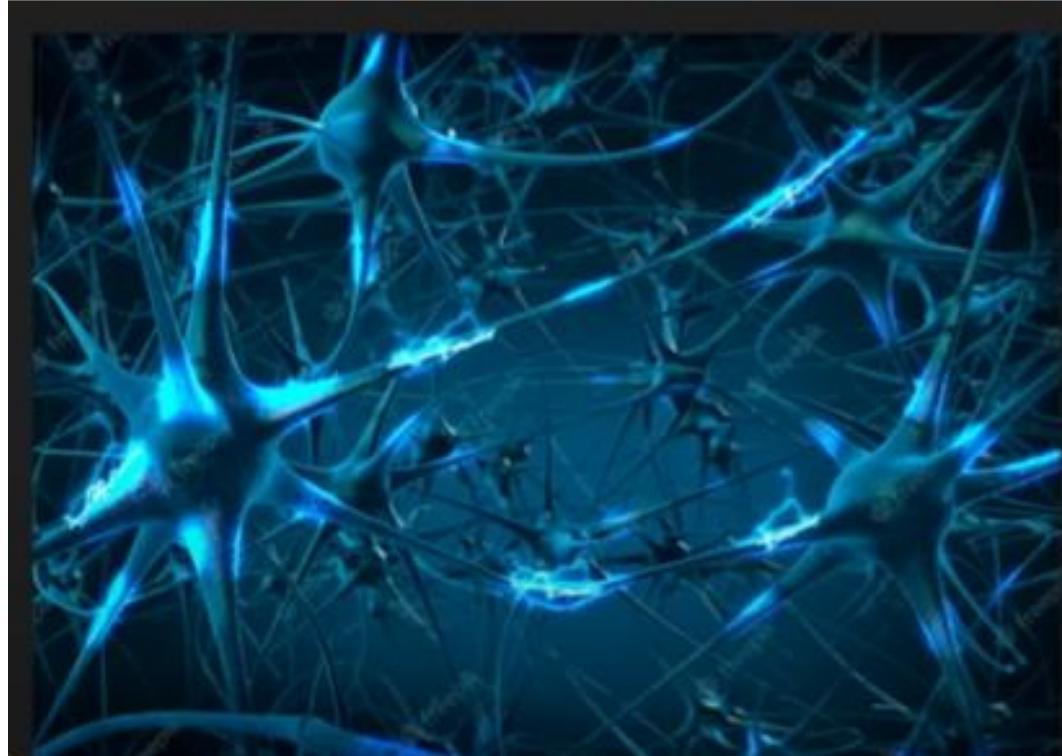
Model of human brain with neurons  
(100 billion neurons) and connections

- ANN is the champion of Machine Learning
- Learn from non-algorithmic situation with
- noisy, incomplete, partial data
- (handwriting, distorted images, unclear images)
- When ANN is trained for certain purpose, it cannot be used for another purpose
- Signature recognition, Weather forecasting, self-driving vehicles, face recognition, gaming,
- **Limitations – ANN cannot explain reasons for solutions, requiring large amount of data**

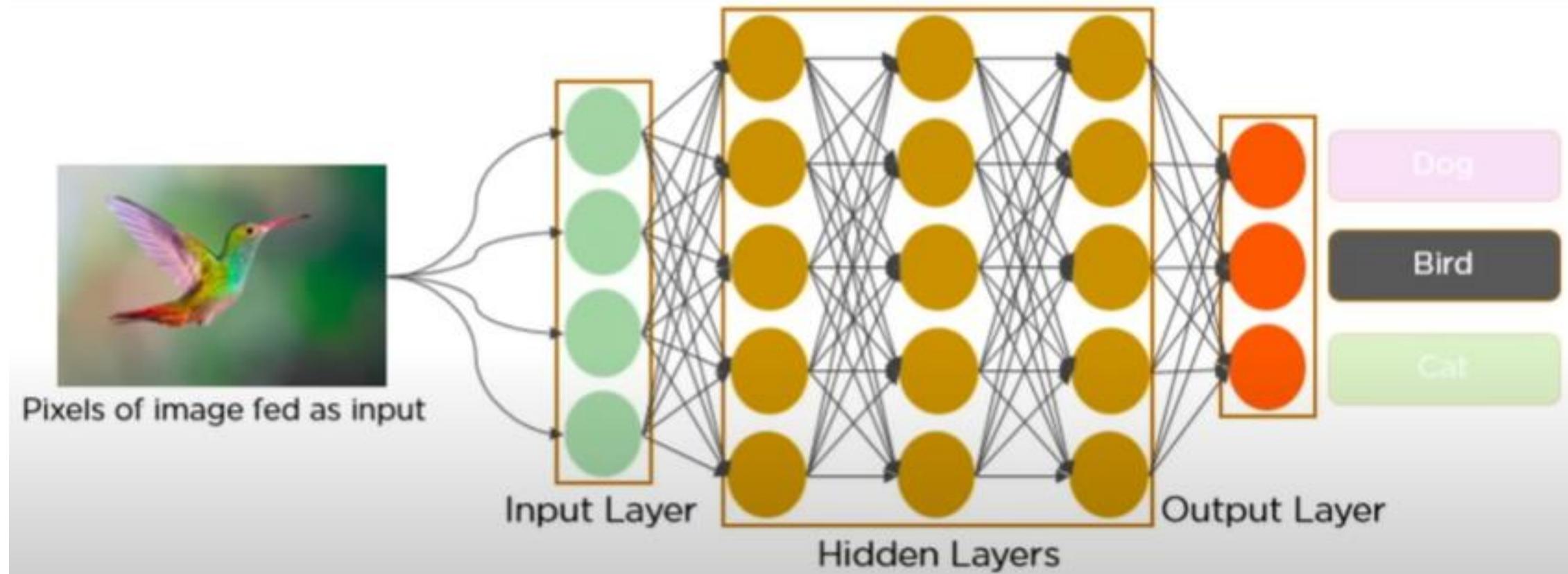


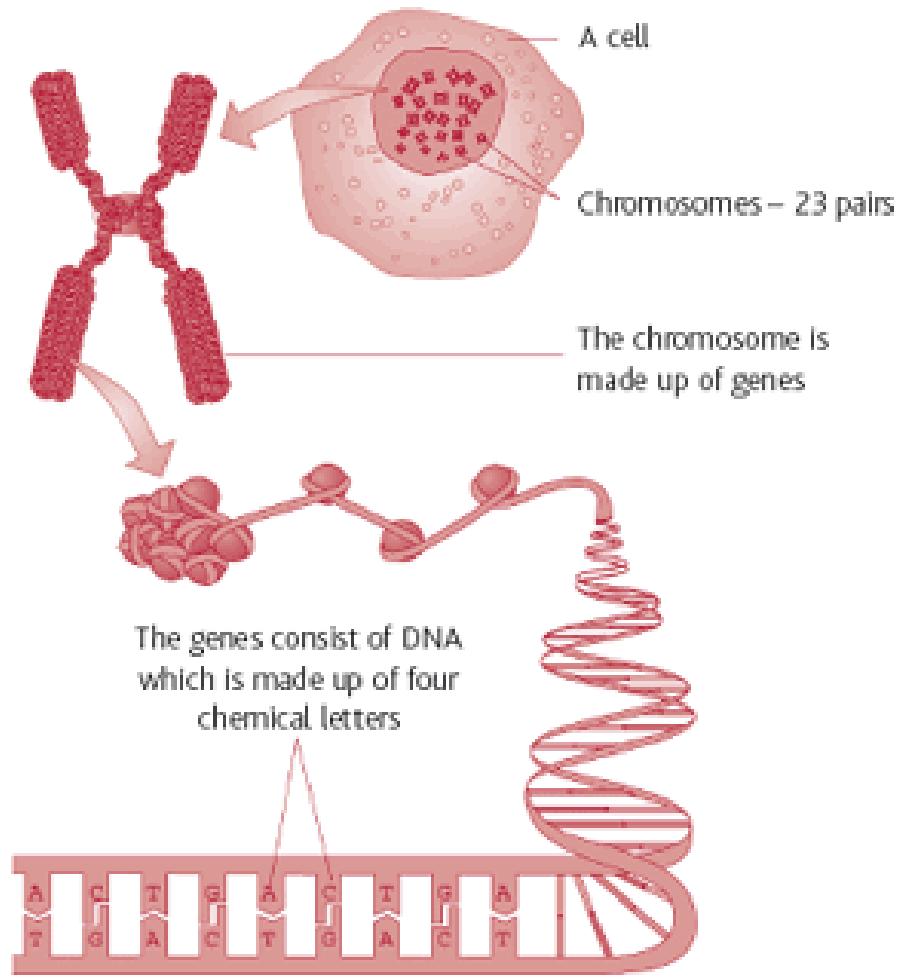
## Artificial Neural Networks

# Simplified Neurons



# Application of Neural Network





# Genetic Algorithm

# GA Model of Chromosome and genes in biological systems

F1 F2 F3 F4

M1 M2 M3 M4

Biological operation cross-over F1 M1 swap  
mutation M1 becomes M1'  
cloning M1 copied as M1

B D T Y

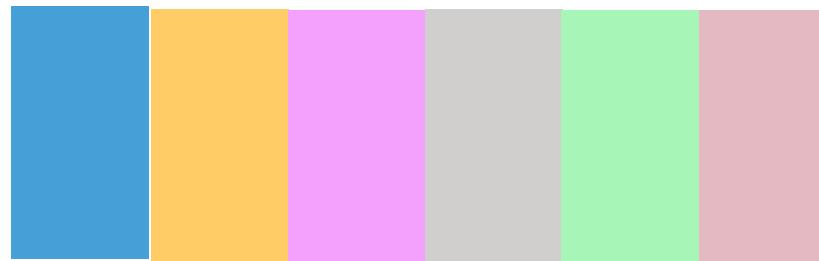
R P M O

R P' M Q

## B P T Y (cross-over)

# P' Chicken

- Mutation followed by cross-over generate solutions that accommodate a change
  - GA can model dynamically changing situations





Machine with human like appearance



**Robotics**

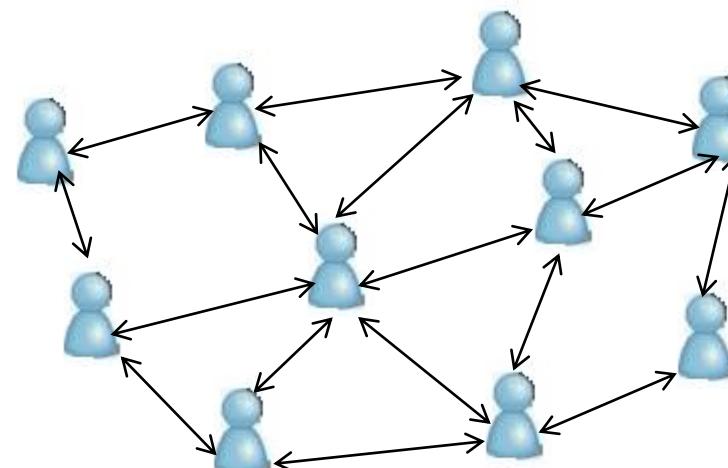


## A model of problem solving by teamwork

- This is shown in ant, fish, bats colonies
- Problem solving by message passing rather than algorithms
- Better quality solutions acceptable to many in the team
- Any problem can be solved by MAS technology
- Because whenever we cannot solve a problem we form group, and they can come up with a solution

The best model about MAS is our BRAIN which has 100 billion agent working as a team

## Multi Agent Systems



# Fuzzy Logic

World is full of situations where a conclusion does not fall into one end but set of acceptable values in between.

- Adding salt into a curry (10ml – 9.5ml-10.4ml)
- Function of a thermostat of an AC (18C – 17.6-19)
- Automatic focusing of a camera (4m – 3.8-4.3m)
- Weight-based spins of a washing machine (5kg, 7kg)

FL can be primarily implemented as ACS solutions

# Natural Language Processing

Communication ability is an essential intelligent activity involving natural languages

It includes

- Understanding
- Dealing with incomplete sentences
- Translation among languages
- Generating/synthesizing answer
- There are 10 balls in box A and 12 balls in box B. Saman has taken 3 balls from A and he kept two with him and remainder is added to A. Find how many balls now in A. (understanding, generating answer)

Such NLP systems can be implemented as ChatGPT, ACS and ML solutions. (Chatbot/Google assistant/Watson)

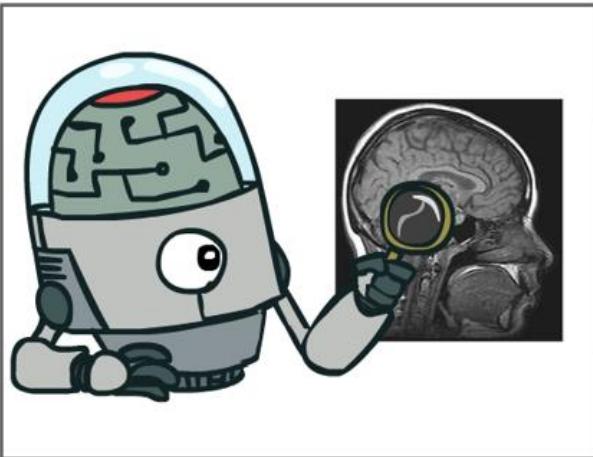
# What Can AI Do?

Quiz: Which of the following can be done at present?

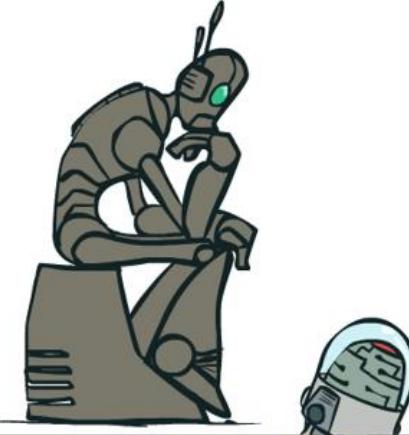
- ✓ Play a decent game of table tennis?
- ✓ Play a decent game of Jeopardy?
- ✓ Drive safely along a curving mountain road?
- ✗ Drive safely along Telegraph Avenue?
- ✓ Buy a week's worth of groceries on the web?
- ✗ Buy a week's worth of groceries at a grocery store?
- ✗ Discover and prove a new mathematical theorem?
- ✗ Converse successfully with another person for an hour?
- ✗ Perform a surgical operation?
- ✓ Put away the dishes and fold the laundry?
- ✗ Translate spoken Chinese into spoken English in real time?
- ✗ Write an intentionally funny story?

# The science of making machines that:

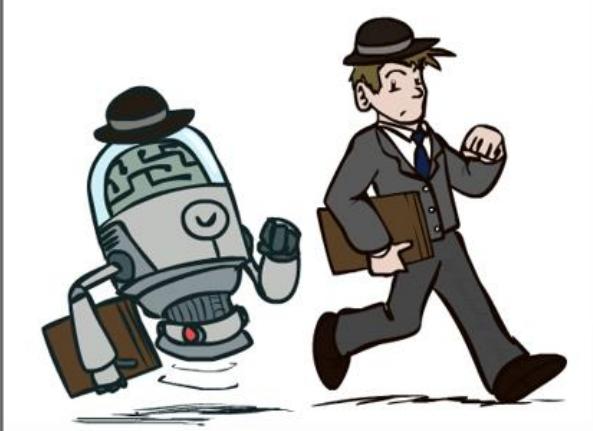
Think like people



Think rationally



Act like people



Act rationally



Doing the right thing. The new approach to AI

# Rational Decisions

We'll use the term **rational** in a very specific, technical way:

- Rational: maximally achieving pre-defined goals
- Rationality only concerns what decisions are made  
(not the thought process behind them)
- Goals are expressed in terms of the **utility** of outcomes
- Being rational means **maximizing your expected utility**

# Definition for AI

- 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 & Knight, 1991)
- The exciting new effort to make computers think .....machines with minds, in the full and literal sense (Haugeland, 1985)
- Automation of activities that we associate with human thinking, activities such as decision making , problem solving, learning (Bellman, 1978)

# Definition for AI....

The study of mental faculties through the use of computational models  
(Charniak and McDermott, 1985)

The study of computations that make it possible to perceive, reason and act (Winston, 1992)

Computational Intelligence is the study of the design of intelligent agents  
(Poole et al, 1998)

AI is concerned with the intelligent behaviour in artifacts (Nilsson, 1998)

# Turing Test

- An approach to test machine intelligence
- A man and a woman communicate with an interrogator without seeing each other
- Man is replaced with a machine without knowing the interrogator and he continues questioning
- If interrogator cannot notice a difference between answers provided by the woman and the machine then woman and Machine are equally intelligent (Machine fools the interrogator)

# Implications –Turing Test

- Intelligence is measured comparatively
- Can be used to prove that a machine is intelligent or machine is not intelligent
- Depends on the nature (easiness) of the questions asked
- Depends on the level of intelligence of the interrogator
- Depends on the level of intelligence with whom the machine is compared

# Technological limitations for TT

- Natural language processing to improve inputs mechanisms
- Knowledge representation to store knowledge
- Automated reasoning to store knowledge and answer questions and to draw conclusion
- Machine learning to adapt to new scenario and to detect and extrapolate patterns

# Total Turing Test

## New technology required

- Natural language processing
- Image processing
- Computer vision

## 'Loebner Prize

- The Loebner Prize is an annual competition that awards prizes to the Chatterbot considered the most humanlike for that year.
- ALICE won it twice

# John Searle's argument

- A person who knows neither English nor Chinese is kept in room with a hug book containing the Chinese translation for any given an English phrase, in adjacent pages
- Yet person can find the correct translation just by manipulating symbols, without being aware what the symbols mean
- Due to the lack of consciousness about what it does, Searle says that machine is not intelligent

# Implications – Chinese room argument

- Machine can never be intelligent
  - Should we really bother about whether a submarine can swim when it behaves as if it can swim
- Yet consciousness is an important theme to investigate in the context of intelligent machines

# Advantages and benefits of AI

- Higher intelligence brings greater insight and understanding. Did AlphaGo destroy the game of Go?
- AI/Robots can do jobs that humans cannot. Greater efficiency 24x7, productivity and hence quality of life.
- Copy/paste knowledge. Transfer of skills – humans need years.
- Aid human engineering and creativity. Bicycles for the mind.
- Autonomous wars – no/less humans involved?

# Questions Discussion?

