

Introduction to Artificial Intelligence and Machine Learning

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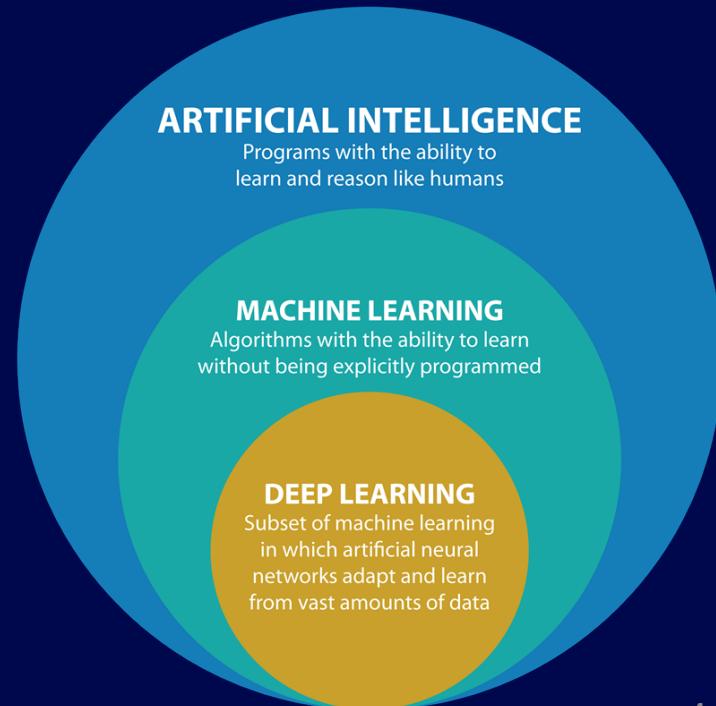
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Introduction to Artificial Intelligence and Machine Learning

Outline

- 1 What is Artificial Intelligence (AI)
- 2 What is Machine Learning (ML)
- 3 What is Deep Learning (DL)
- 4 Applications of AI and ML



1 What is AI



Definition of AI

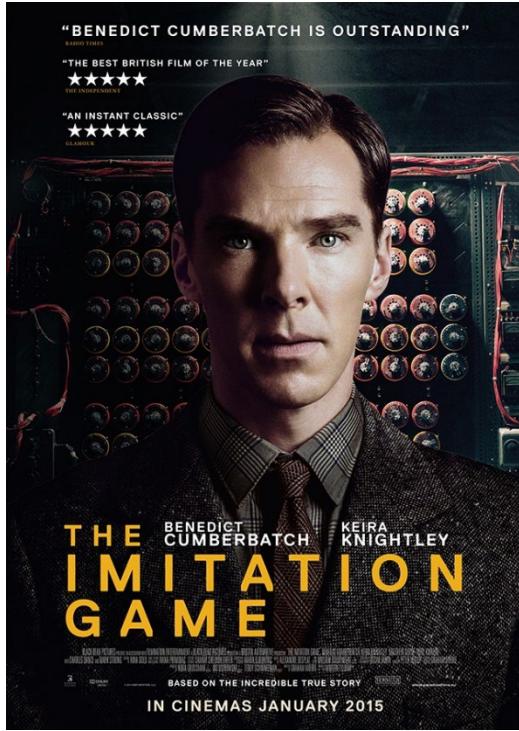
Artificial Intelligence is the ability of a program or machine to think and behave like a human.

Turing Test

A machine is said to pass the Turing Test when it exhibits behaviour that is indistinguishable from that of a human.

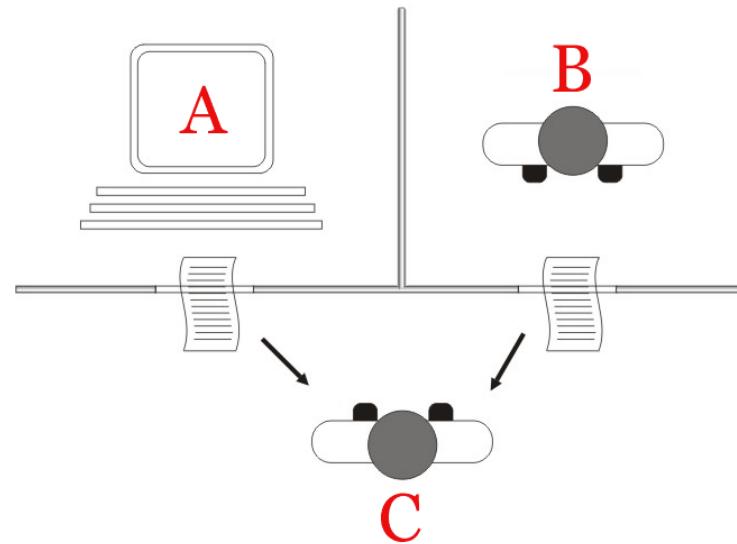


Alan Turing (1912–1954)



The Turing Test

A computer passes the test if a human interrogator, after posing some written questions, cannot tell whether the written responses come from a person or from a computer



Artificial Intelligence - The **Turing test**, developed by [Alan Turing](#) in 1950

History of AI



Workshop on AI at Dartmouth College

"... every aspect of learning or any other feature of intelligence can be so precisely described that machine can be made to simulate it."
- John McCarthy



Knowledge engineering
Expert systems
Computer vision
Natural language understanding
Lisp machines
Japan's fifth generation computer project



Microsoft released the first individual intelligent assistant Microsoft Cortana in the world.

Watson won Jeopardy game



Deep Blue beat world chess champion



AlphaGo won Go champion



ChatGPT



Claude



Generative AI

The golden years

First AI winter

AI boom

Second AI winter

AI renaissance

AI revolution

1943

1956

1974

1980

1987

1993

1997

2011

2016

2020

2023 ...

Artificial neurons (McCullouch and Pitts)

Symbolic processing
Formal representation (logic, ...)
Reasoning, inference
Search and problem solving
Connectionism (neural networks)

... within a generation the problem of creating artificial intelligence will be substantially solved.

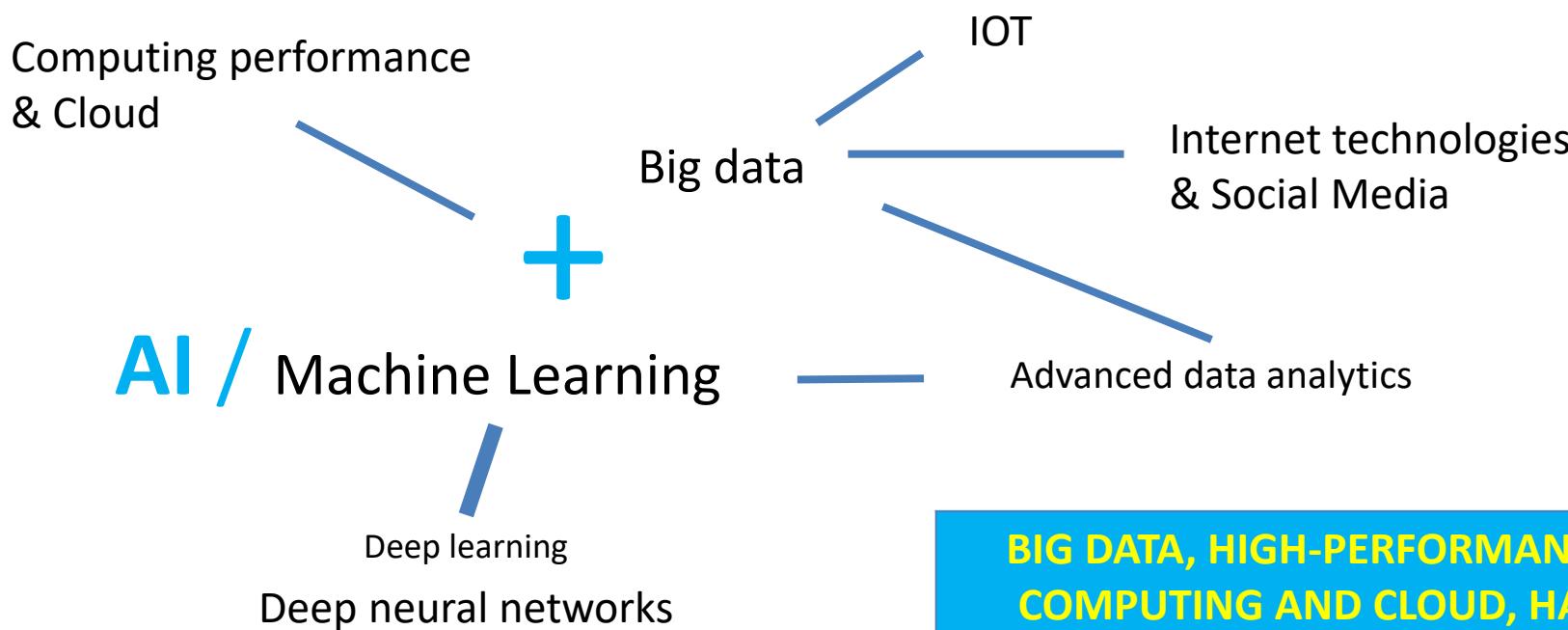
- Marvin Minsky



Data mining
knowledge discovery
Machine learning
Cognitive computing
Mathematical/statistical methods
Supercomputers

Big data
Data analytics
Massively distributed computing
Big data distributed databases
Cloud IOT

AI Resurgence



**BIG DATA, HIGH-PERFORMANCE
COMPUTING AND CLOUD, HAS
TRANSFORMED AI**

AI is All Around Us



Image search



Smart IoT devices



Facial recognition



First chess, then Jeopardy, then Go. Now poker too has fallen to AI



Gemini

ChatGPT



Generative AI



Recommendation engines



Self-driving vehicles



Spam filters



Virtual smart assistants



Chatbots

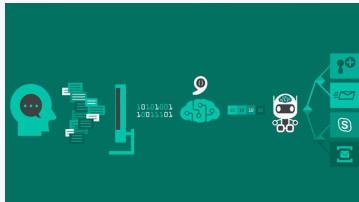


Language translation



Robo-advisors

AI Technologies



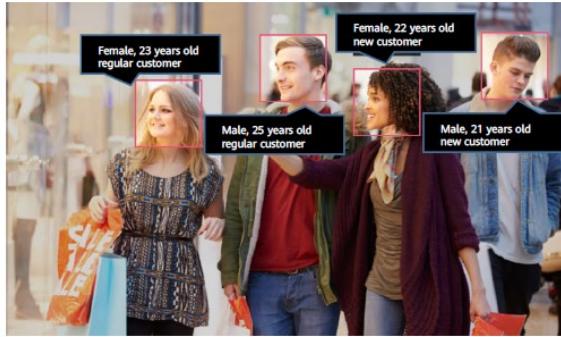
Computer vision: a field of AI that focuses on enabling machines to interpret, analyze and understand visual information such as images and videos.

Speech processing: analyzing, interpreting, and generating human speech using AI techniques including voicing process, statistical features of speech signals, speech recognition, machine-based speech synthesis, and speech perception

Natural language processing (NLP) and Large Language Model (LLM): the use AI to understand and process text and human language for a range of applications, including language translation, sentiment analysis, chatbots, and content creation.

Generative AI (or Gen AI) generate new, unique data samples that are similar to the examples it was trained on such as image, art, text, music and video generation

Computer Vision



Traffic Analysis

Facial recognition

Comparison Gallery

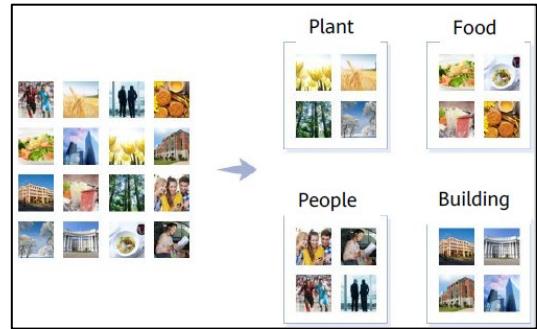
Authentication result



Electronic Attendance



Common applications include image classification, target detection, image segmentation, target tracking, optical character recognition (OCR), and facial recognition.



Smart Album

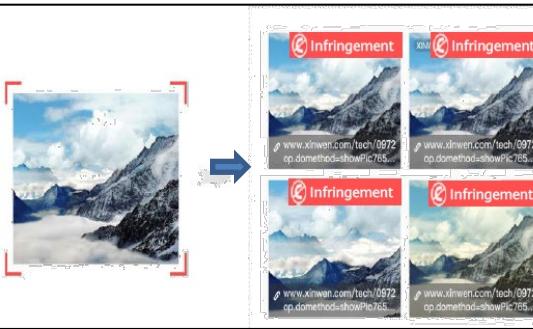


Image Search



Authentication



Action Analysis

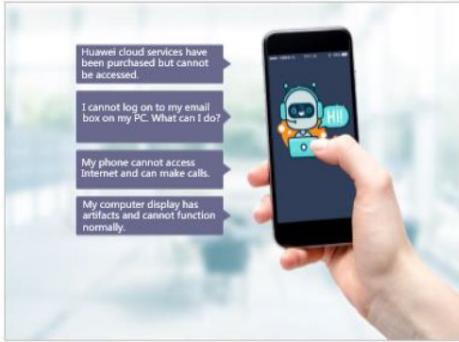


Computer Vision Demo (20 mins)

- Activity 1 – Hands-on Workshop



Speech/Audio Processing



Question Answering Bot (QABot)



Voice Navigation



Intelligent Education

Other applications:

- Spoken language evaluation
- Diagnostic robot
- Voiceprint recognition
- Smart sound box
- ...



Real-time Conference Records



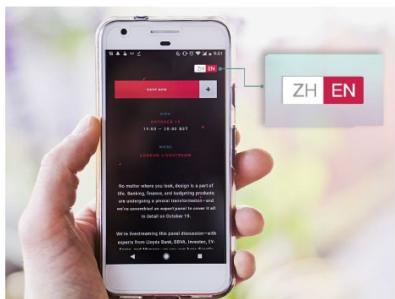
Natural Language Processing & Large Language Models



Public Opinion Analysis



Evaluation Analysis



Machine Translation

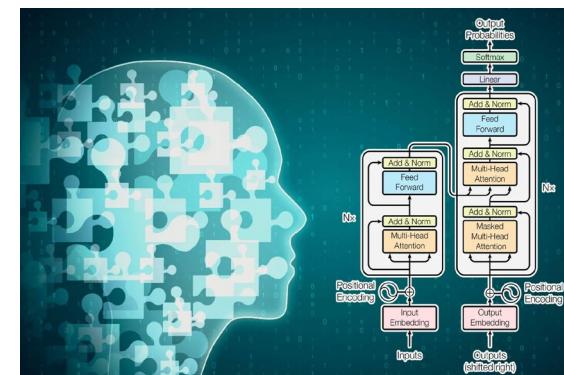
Common applications include machine translation, text mining, content creation, chatbot, text summarization, and sentiment analysis.



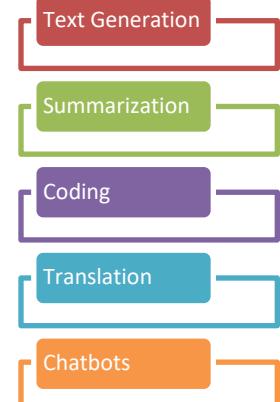
Text Classification



Chatbots



Large Language Model, e.g. ChatGPT

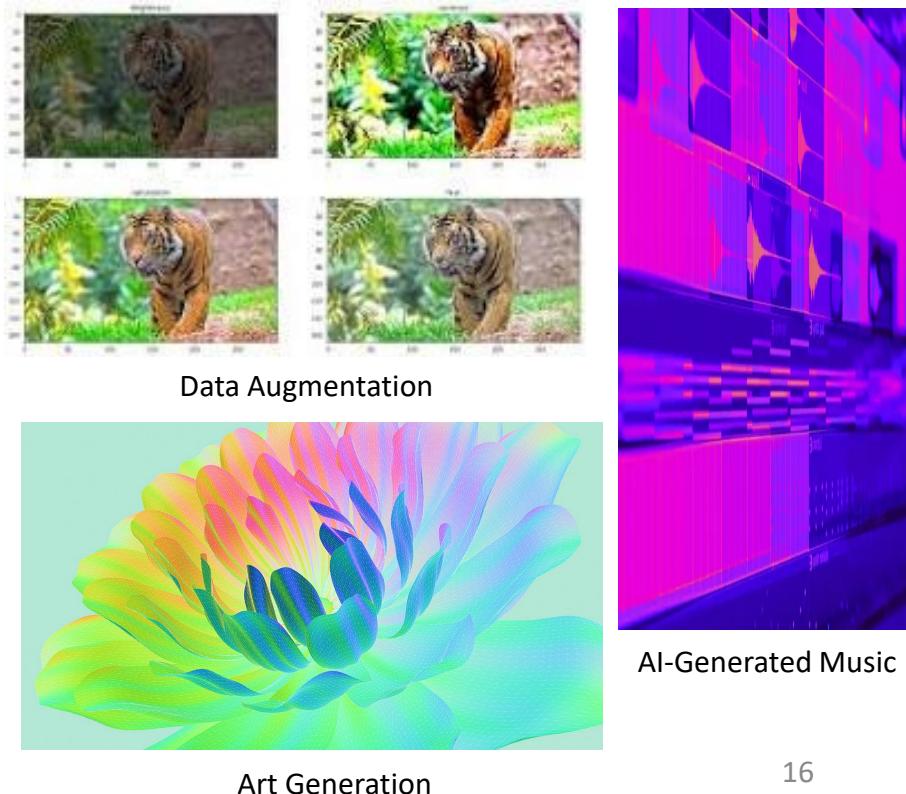




Video Generation

Google's Imagen video (<https://Imagen.research.google/video/>) can produce short high-definition video clips using a similar technique to the one it uses to make images. (Photo by Google AI)

Generative AI



Art Generation



Application scenarios:

- **Police use:** suspect identification, vehicle analysis, suspect tracking, suspect search and comparison, and access control at key places
- **Civil use:** facial recognition, warning against potential danger, and home protective measure deployment

AI Application Fields- Security



Intelligent Security / Security Protection



Face recognition identifying criminals



Unmanned supermarkets of Amazon and Alibaba, use sensors, cameras, computer vision, and deep learning algorithms to completely cancel the checkout process, allowing customers to pick up goods and "just walk out".



AI Application Fields - Retail



Unmanned Store: Amazon Go



Unmanned store : Alibaba



AI Application Fields – Hospitality and Smart Hotel/Home



Control smart home products with voice processing such as air conditioning temperature adjustment, curtain switch control, and voice control on the lighting system.

Implement **home security protection** with computer vision technologies, for example, facial or fingerprint recognition for unlocking, real-time intelligent camera monitoring, and illegal intrusion detection.

Develop user profiles and recommend content to users with the help of machine learning and deep learning technologies and based on historical records of smart speakers and smart TVs.



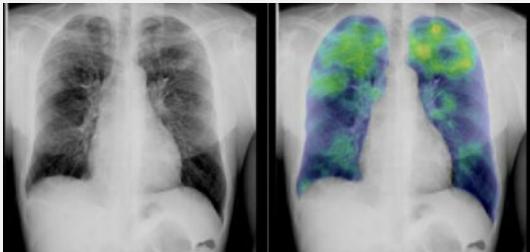
Frontdesk Robots



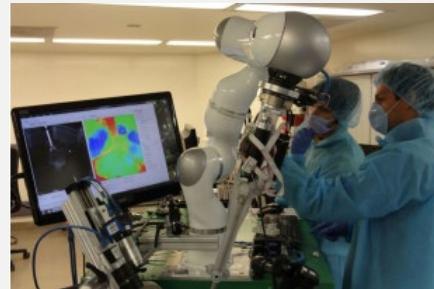
Chatbot for hotel/services



AI Application Fields – Healthcare



Identifying tuberculosis



Robotics-assisted surgery



Detecting brain bleeds



Detecting Alzheimer's disease

Other applications:

Medicine mining: quick development of personalized medicines by AI assistants

Health management: nutrition, and physical/mental health management

Hospital management: structured services concerning medical records (focus)

Assistance for medical research: assistance for biomedical researchers in research

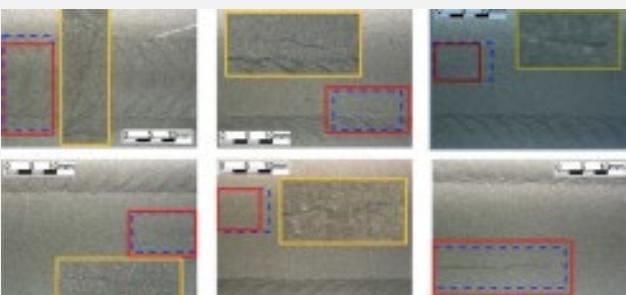
Virtual assistant: electronic voice medical records, intelligent guidance, intelligent diagnosis, and medicine recommendation

Medical image: medical image recognition, image marking, and 3D image reconstruction

Assistance for diagnosis and treatment: diagnostic robot

Disease risk forecast: disease risk forecast based on gene sequencing

AI Application Fields – Smart Manufacturing



Defect Detection



AI in Pharmaceutical Manufacturing Process



Robots in Mfg



AI Robots in Amazon's Warehouse



AI Application Fields – Auto Industry

```

{
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    {
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      "ymin": 139,
      "xmax": 474,
      "ymax": 351
    },
    {
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      "score": "high",
      "xmin": 408,
      "ymin": 312,
      "xmax": 535,
      "ymax": 399
    },
    {
      "label": "Scratch",
      "score": "medium",
      "xmin": 639,
      "ymin": 332,
      "xmax": 867,
      "ymax": 585
    }
  ]
}
  
```

Automatic Vehicle Insurance and Loss Assessment

AI technologies help insurance companies optimize vehicle insurance claims and complete vehicle insurance loss assessment using deep learning algorithms such as image recognition.



Autonomous Driving

Currently, only some commercial passenger vehicle models, such as Audi A8, Tesla, and Cadillac, support L2 and L3 Advanced driver-assistance systems (ADAS). L4 and L5 autonomous driving is expected to be first implemented on commercial vehicles in closed campuses. A wider range of passenger vehicles require advanced autonomous driving, which requires further improvement of technologies, policies, and infrastructure. It is estimated that L4 and L5 autonomous driving will be supported by common roads in 2025–2030.

The Society of Automotive Engineers (SAE) in the U.S. defines 6 levels of driving automation ranging from 0 (fully manual) to 5 (fully autonomous). L0 indicates that the driving of a vehicle completely depends on the driver's operation. The system above L3 can implement the driver's hand-off operation in specific cases, L5 depends on the system when vehicles are driving in all scenarios.



Ethical AI to Mitigate its Potential Risks

- Developing robust AI governance frameworks and regulations
- Promoting transparency and explainability in AI systems
- Conducting thorough ethical reviews of AI applications
- Investing in AI safety research
- Educating the public about AI capabilities, limitations, and its potential abuse (e.g. scam, manipulation)



Quiz

What is the Turing test?

- A. A test to determine whether a machine can exhibit human-like intelligence
- B. A test to determine whether a machine can understand natural language
- C. A test to determine whether a machine can learn from data
- D. A test to determine whether a machine can generate data



Quiz

Which of the following is NOT an example of AI?

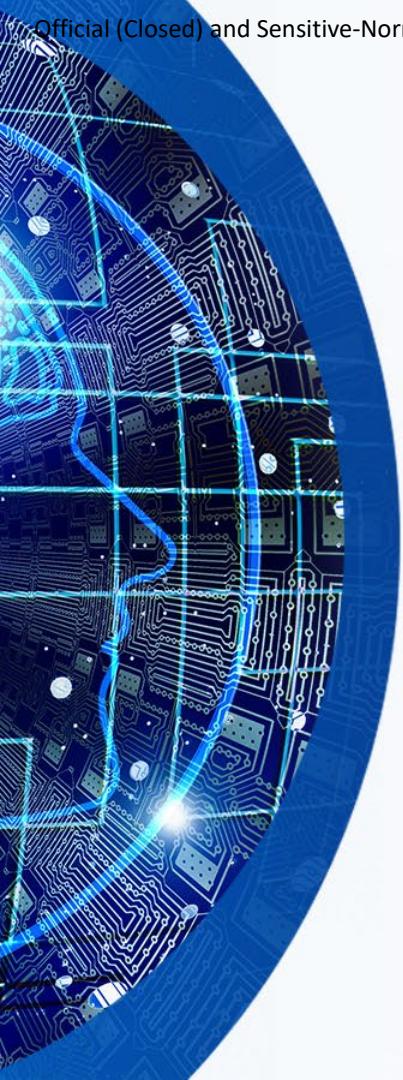
- A. Use of computer vision to do away with the grocery checkout process
- B. Sorting department store items by bar code
- C. Identifying tuberculosis in an x-ray image based
- D. Recommend movies based on users' watching history



Quiz

Which of the following is NOT an application example of Large Language Models (LLMs)?

- A. Chatbots
- B. Code generation
- C. Generate music
- D. Text summarization



Discussion Question

- How could artificial intelligence transform your industry, and what are some concrete examples of its potential applications and impacts?

What is LLM

- An AI model that is trained on large amounts of text to identify patterns between words, concepts, and phrases so that it can generate responses to prompts.

Training



Chunk of the internet ~ 10TB of text



6,000 GPUs for 12 days, $\sim 1e24$ FLOPS



140 GB

*numbers for Llama 2 70B



140 GB



run .c
~ 500 lines

Llama-2 (70B)

What is LLM (Cont'd)



Inference

A vicuña is a species of South American camelid, related to camels and llamas. They are known for their luxurious coat, which is highly prized in the fashion industry. Vicuñas are considered an endangered species due to overgrazing and hunting.

how much do their fleece cost

The price of vicuña fleece can vary depending on factors such as quality, size, and the market demand at a given time. However, it is generally considered one of the most expensive natural fibers in the world due to its exceptional warmth and softness. A high-quality vicuña fleece can cost thousands of dollars per pound.

how do they compare with alpacas

...

Type a message or type "/" to select a prompt...
CharBot UI: Chatbot UI is an advanced chatbot kit for OpenAI's chat models aiming to mimic ChatGPT's interface and functionality.

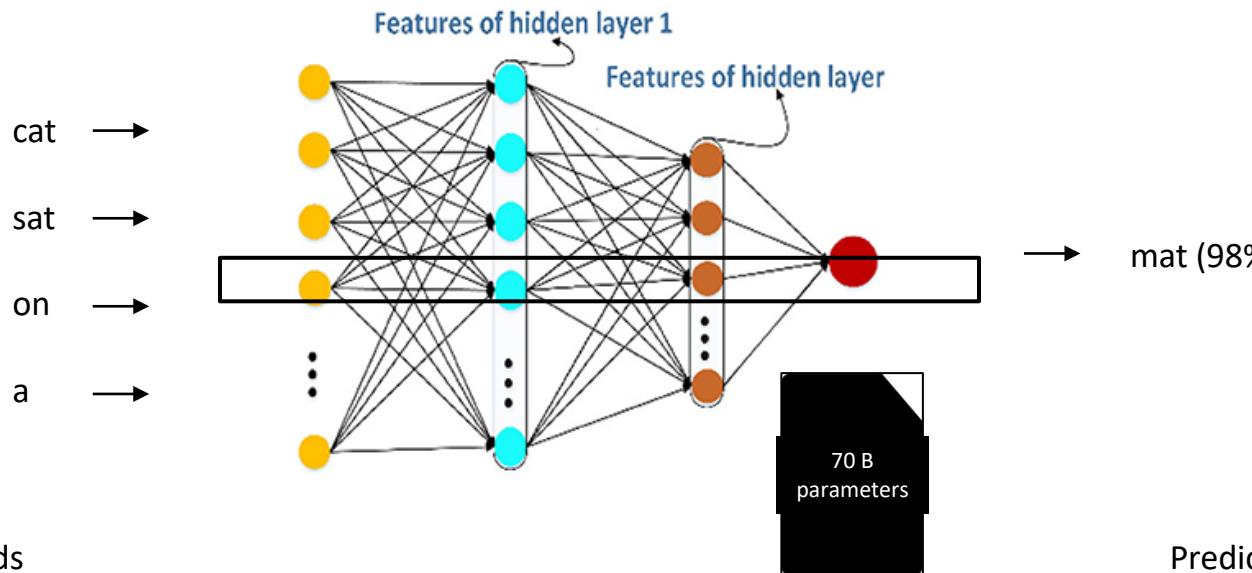


Examples of LLMs

- Popular examples are ChatGPT, Google Gemini, Microsoft CoPilot, Meta LLAMA, Anthropic Claude, and more. For example:
 - ChatGPT at <https://chatgpt.com/>
 - Claude at <https://claude.ai/>
 - Copilot at <https://copilot.microsoft.com/>
 - Gemini at <https://gemini.google.com/>
 - Llama at <https://llama.meta.com/>

How does LLM work

Neural Network Transformer (simplified for illustration)



The network adjust the billions of parameters iteratively adjusting them to make better prediction (measure)



Is a Pretrain LLM Useful?

- Pretrain - Base model
- Finetuning - tune your LLM base model into an assistant model



Write high quality labelling
instructions`



How does LLM work

- Identifies patterns in human languages
- Predict the word most likely to come next in a sequence of words (complete the sentence)
- Uses statistics to analyse the relationships between all the words in a given sequence
- Computes the probability for thousands of possible words to come next in that sequence
- The predictive power enables LLMs to response to question/requests whether to complete a simple sentence or to develop a compelling business strategy, or a persuasive new product launch or a creative ad campaign



What is Prompt Engineering

- Is the practice of developing effective prompts that elicit useful output from generative AI
- **Key rule:** The clearer and more specific the prompts, the more likely you are to get useful output
- **Helpful tip:** Use iteration to evaluate the output and revising your prompts
- **Techniques:** Use techniques such as few-shot prompting
- **Required:** Critical thinking and creativity (a skill that can be practiced)



LLM Limitations

- Although LLMs are powerful, you may not always get the output you want
- It may generate information that is skewed. For instance, the LLM is trained on bias data (e.g. websites, articles reflects unfair biases)
- Or it might not generate sufficient content about a specific domain or topic because the data it was trained on does not contain enough information about that topic
- Or it has the tendency to hallucinate – AI outputs that are not true. This means LLM can generate texts that are factually inaccurate
- The same prompt may not generate the same output in another instance
- Therefore, LLM, while a power AI tool, requires human guidance for effective use



Factors contributing to AI hallucination

- Quality of the LLM's training data
- Phrasing of the prompt
- Method an LLM uses
- One must verify the AI generate text to determine the quality of the output if it
 - Is factually accurate
 - Provides sufficient information
 - Relevant to the specific request
 - Is unbias



How to write prompts

- **Key rule:** Quality of the prompt affects the quality of the output
- **Prompt design:** The design the prompt to get the best output you want
- Prompt examples:

“Generate a list of 5 potential themes for an event” vs

“Generate a list of 5 potential themes for a professional conference on customer experience in the hospitality industry.”

- The latter prompt has specific, relevant context and instructions
- *Note: There will be instances where you will not get a quality output regardless of the quality of your prompt due to the limitations of LLMs*



Iterative process in prompt engineering

- Sometimes when you provide a quality prompt, it may not generate the you want on your first try
- In this instance, you can revise the prompt.
- On the second or subsequent iterations, try to be more specific or provide clearer instruction to produce a more useful output.



Prompt Examples: Information Retrieval

- Question Answering: "What is the capital of France?"
- Summarization: "Summarize the key findings of this research paper."
- Topic Exploration: "Provide five interesting facts about space exploration."



Prompt Examples: Creative Writing/Content Creation

- Story Starter: "Once upon a time, in a world where..."
- Poem Generator: "Compose a poem in the style of [famous poet] about [theme or topic]."
- Script Writing: "Create a movie scene showcasing a tense conversation between two characters."

Prompt Examples: Code Generation

- Function Creation: "Write a Python function that takes two numbers as input and returns their sum."
- Code Translation: "Translate this Java code into Python."
- Bug Fixing: "Fix the syntax error in this code snippet."

Prompt Examples: Translation

- Language Translation: "Translate this sentence from English to Spanish."
- Dialect Conversion: "Rewrite this text in British English."
- Formal/Informal Conversion: "Write a more formal version of this email."



Group Exercise 1 (20 mins): Content Creation with Prompt Engineering

- Appoint a prompt engineer in the group. The rest of the group members give ideas and suggestions to the prompt design and assist to verify the output quality
- Ask an LLM to create an outline for an article on the importance of energy conservation. The article should include the use of data visualization to help guide energy usage and consumption.
- Use one of the LLM tools below. You may create an account on the website or use it without one:
 - ChatGPT at <https://chatgpt.com/>
 - Claude at <https://claude.ai/>
 - Copilot at <https://copilot.microsoft.com/>
 - Gemini at <https://gemini.google.com/>
 - Llama at <https://llama.meta.com/>
- Share your solution using a slide deck



Tips on creating MS Powerpoint via Outline

- Cut and paste the outline output by the LLM into MS Word
- Save the file in rich text format
- Create level 1 and 2 bullets based on the outline
- Open MS PowerPoint, in the ‘New Slide’ click the down arrow and select ‘Slides from Outline.’
- Upload the .rtf file you just created
- Use the Designer function in MS PowerPoint to develop an attractive slide deck



Group Exercise 2 (20 mins): Summarization

- Appoint a prompt engineer in the group. The rest of the group members give ideas and suggestions to the prompt design and assist to verify the output quality
- Ask an LLM to summary a lengthy document one paragraph not more than 100 words.
- Use one of the LLM tools below. You may create an account on the website or use it without one:
 - ChatGPT at <https://chatgpt.com/>
 - Claude at <https://claude.ai/>
 - Copilot at <https://copilot.microsoft.com/>
 - Gemini at <https://gemini.google.com/>
 - Llama at <https://llama.meta.com/>
- Share your findings



End of Chapter 1