

COMP2211 Exploring Artificial Intelligence

Introduction to Artificial Intelligence

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About Artificial Intelligence

What is Artificial Intelligence?

- There is not a widely accepted definition of artificial intelligence.
- **John McCarthy** (one of the founders of AI) coined the term in 1955:

AI is the **science and engineering** of **making intelligent machines**, especially intelligent computer programs.

- From our observations, **AI borrows characteristics from human intelligence** and applies them as algorithms in a computer-friendly way.



John McCarthy, artificial intelligence and timesharing pioneer, playing chess at Stanford's IBM 7090, in 1967. [Image source.](#)

Why Study Artificial Intelligence (AI)?

- Brighter career

- You can work as a Machine Learning Engineer, Data Scientist, Business Intelligence Developer, Research Engineer, etc., once you have studied AI.

- AI is versatile (skillful)

- AI is not just limited to the computer and space-related industries. Still, it also plays a significant role in industries directly related to a common person, like healthcare, automobile, and even the banking and finance sector.

- Skill of the century

- It is undeniably true that someday, AI will replace many jobs that humans do and create many different job opportunities in related fields.

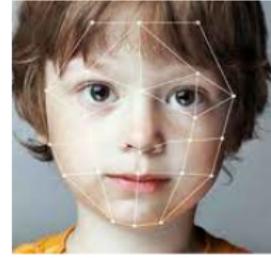
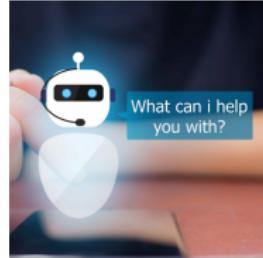
Academic Disciplines to AI

AI is interdisciplinary, and its foundations are in various fields.

- **Philosophy and cognition science:** Logic, methods of reasoning, foundation of learning, language, rationality.
- **Mathematics:** Important to write the logic and algorithm for machine learning. Good knowledge of mathematics is a must skill to develop a model of AI.
- **Neuroscience:** Provide information about how the human brain works and how neurons respond to a particular event. This enables AI scientists to develop programming models to work like the human brain.
- **Psychology:** Study and find the process of thinking of humans and animals.
- **Computer Science:** Write the codes for making the neural network for artificial intelligence. Computer programmers should have very high programming skills and knowledge of Mathematics and other disciplines used with AI.
- **Linguistics:** Knowledge representation, grammar.

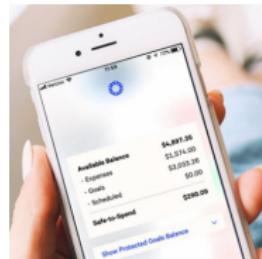
Importance of AI

- **Gaming and entertainment:** AI guides the actions of non-human player characters.
- **Speech recognition:** AI converts speech to text.
- **Understanding natural language:** AI carries out a dialogue with a computer using natural language.
- **Computer vision:** AI identifies and locates objects in digital images and videos.
- **Expert systems:** AI emulates the decision-making ability of a human expert.



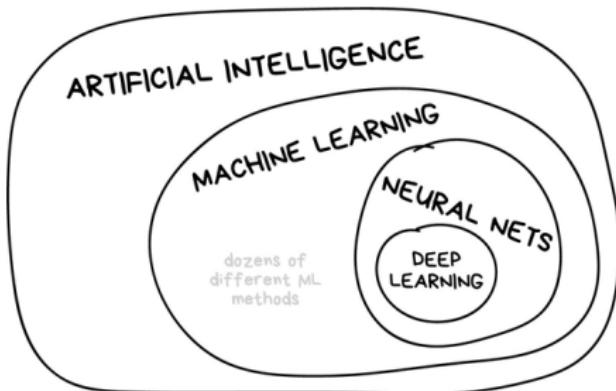
Importance of AI

- **Healthcare:** AI assists diagnosis, provides telemedicine, assists surgery using robots, monitors vital stats.
- **Air transport:** AI delivers safer air transport while reducing its environmental impact.
- **Banking and Financial Institutions:** AI automates services, manage risk.
- **Logistics:** AI delivers goods using autonomous vehicles.
- **E-commerce:** AI personalizes content for customers to boost sales. AI filters spam and fake reviews.
- **Hiring:** AI goes through thousands of CVs and ascertains if there's a good fit.



Confusing Terms

- The terms **Artificial Intelligence**, **Machine Learning**, **Neural Networks**, **Deep Learning** tend to be used interchangeably in conversation, leading to some confusion around the nuances between them. But how are they related?



- Machine learning (ML) is a **sub-field of artificial intelligence** that provides systems with the ability to automatically learn and improve from experience without being explicitly programmed.
- In ML, there are different algorithms (e.g., **neural networks**) that help to solve problems.
- Deep learning (DL) is a **sub-field of machine learning**, which uses neural networks to analyze different factors with a structure similar to the human neural system.

Advantages of AI

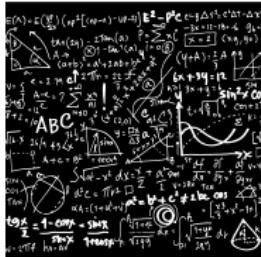
- **Reduction in human error:** Computers do not make mistakes if they are programmed properly.
- **Takes risks instead of humans:** Overcome many risky limitations of humans by developing an AI Robot which can do the risky things for us.
- **Available 7x24:** Using AI, we can make machines work 7x24 without any breaks, and they don't even get bored, unlike humans.
- **Helps in repetitive work:** Using AI, we can productively automate mundane tasks and can remove “boring” tasks for humans.
- **Digital assistance:** Use digital assistants to interact with users which save the need for human resources.
- **Faster decisions:** Using AI alongside other technologies, we can make machines make decisions faster than a human and carry out actions quicker.
- **New inventions:** AI is powering many inventions in almost every domain which will help humans solve the majority of complex problems.

Disadvantages of AI

- **High costs of creation:** As AI updates every day, the hardware and software need to get updated with time to meet the latest requirements. Machines need repairing and maintenance, which need plenty of costs.
- **Making humans lazy:** AI is making humans lazy with its applications automating most of the work.
- **Unemployment:** AI is replacing most repetitive tasks and other works with robots. Human interference is becoming less, which will cause a major problem in the employment standards. Every organization is looking to replace the minimum qualified individuals with AI robots that can do similar work with more efficiency.
- **No emotions:** Machines can not develop a bond with humans, which is an essential attribute for Team Management.
- **Lacking out of box thinking:** Machines can perform only those tasks which they are designed or programmed to do. Anything out of that tends to crash or give irrelevant outputs, which could be a major backdrop.

Prerequisites for AI

- A stronghold on **Mathematics**, namely discrete math, calculus, statistics and probability.
- A good amount of experience in **programming languages** like Python, or Java.
- A stronghold in understanding and writing **algorithms**.
- A strong background in **data analytical skills**.
- The will to learn **machine learning languages**.



Algorithm 1: Pseudo code for the random forest algorithm

```

To generate c bootstrap samples:
For i = 1 to c do
    Randomly sample N_i from training data D with replacement to produce D_i
    Create a root node, N_i containing D_i
    Call BuildTree(N_i)
end for

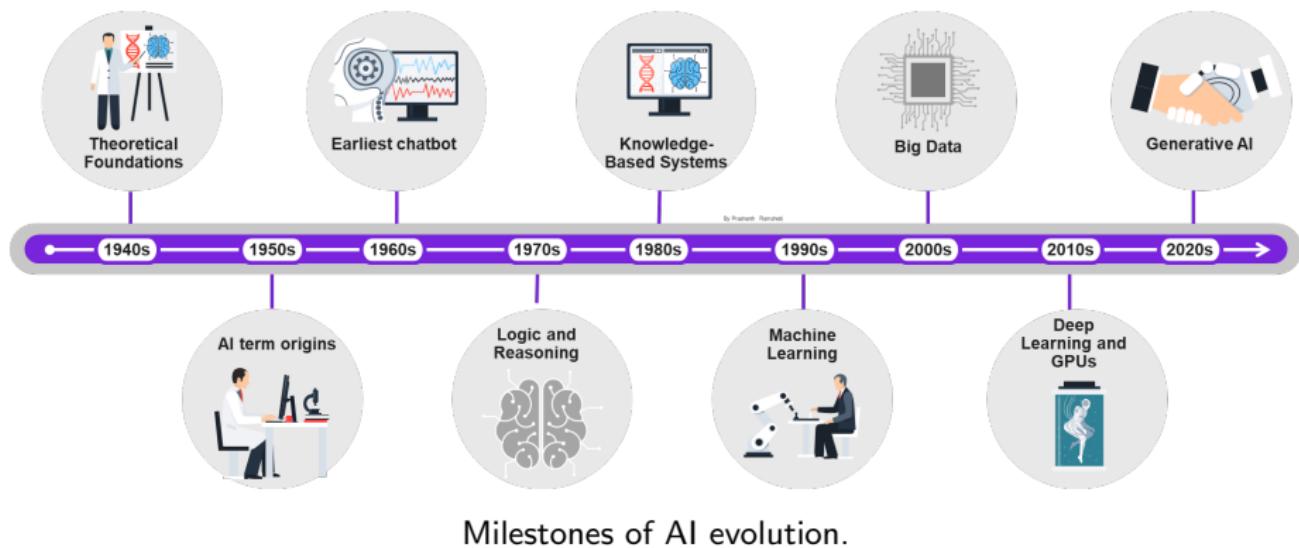
BuildTree(N)
N contain instances of only one class then
return this
else
    Randomly select p% of the possible splitting features in N
    Select the feature F_i with the highest information gain to split on
    Create f child nodes of N, N_1, ..., N_f , where F_i has f possible values (F_1, ...
    For j = 1 to f do
        Sort the contents of N_j to D_j, where D_j is all instances in N that match
        F_i
        Call BuildTree(N_j)
    end for
end if

```



History of Artificial Intelligence

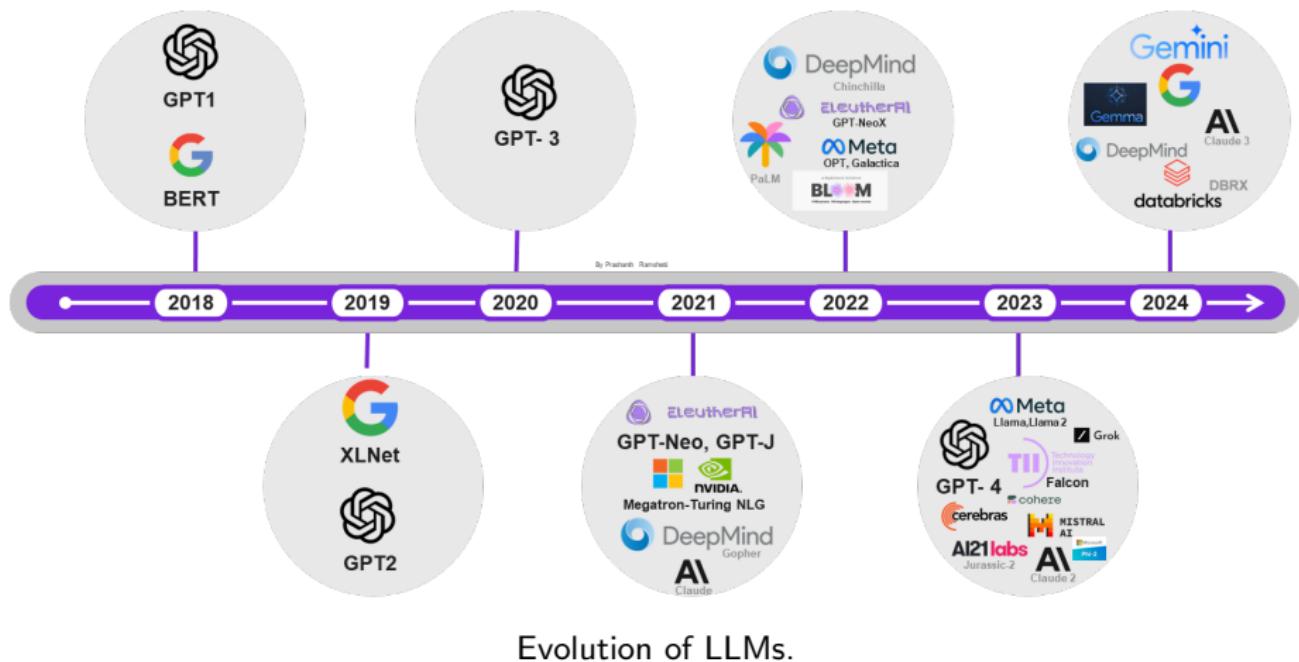
Brief History of AI



Brief History of AI

1642	First mechanical calculating machine built by French mathematician and inventor Blaise Pascal.	
1837	First design for a programmable machine, by Charles Babbage and Ada Lovelace.	
1943	Foundations of neural networks established by Warren McCulloch and Walter Pitts, drawing parallels between the brain and computing machines.	
1950	Alan Turing introduces a test—the Turing test—as a way of testing a machine's intelligence.	
1955	'Artificial intelligence' is coined during a conference devoted to the topic.	
1965	ELIZA, a natural language program, is created. ELIZA handles dialogue on any topic; similar in concept to today's chatbots.	
1980s		
2002		
2009		
2011-2014	Google builds the first self-driving car to handle urban conditions. iRobot launches Roomba, an autonomous vacuum cleaner that avoids obstacles.	  
2014		
2016		 
2018		
2021	IBM's Watson defeats champions of US game show Jeopardy!	
2021-2025	Personal assistants like Siri, Google Now, Cortana use speech recognition to answer questions and perform simple tasks.	
2024	Ian Goodfellow comes up with Generative Adversarial Networks (GAN).	
2025	AlphaGo beats professional Go player Lee Sedol 4-1.	
2026	Most universities have courses in Artificial Intelligence.	

Brief History of AI



Different Periods

- 1950 - 1956: The birth of Artificial intelligence
- 1956 - 1974: Symbolic AI
- 1974 - 1980: The first AI winter
- 1980 - 1987: Boom
- 1987 - 1993: The second AI winter
- 1993 - 2011: AI (Finally achieved some of its oldest goals, e.g., it began to be used successfully throughout the technology industry. The success was due to increasing computer power)
- 2011 - Present: Deep learning, big data and artificial general intelligence

1950 [The birth of AI]

- English mathematician, computer scientist Alan Turing wrote a landmark paper titled “Computing Machinery and Intelligence” that asked: “**Can machines think?**”.
- He felt that such machines would eventually be constructed.
- But he also realized a **bigger problem**: “**How would we know if we have succeeded?**”.

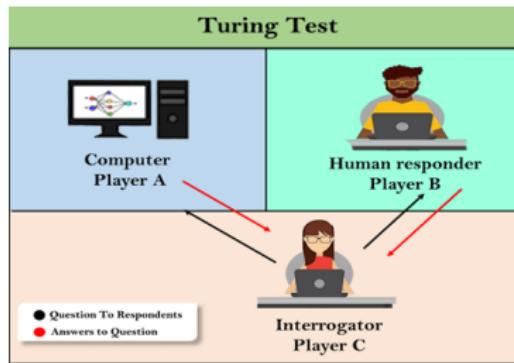


Prediction

Predicated that by 2000, a machine might have a 30% chance of fooling a layman for 5 minutes.

The Turing Test

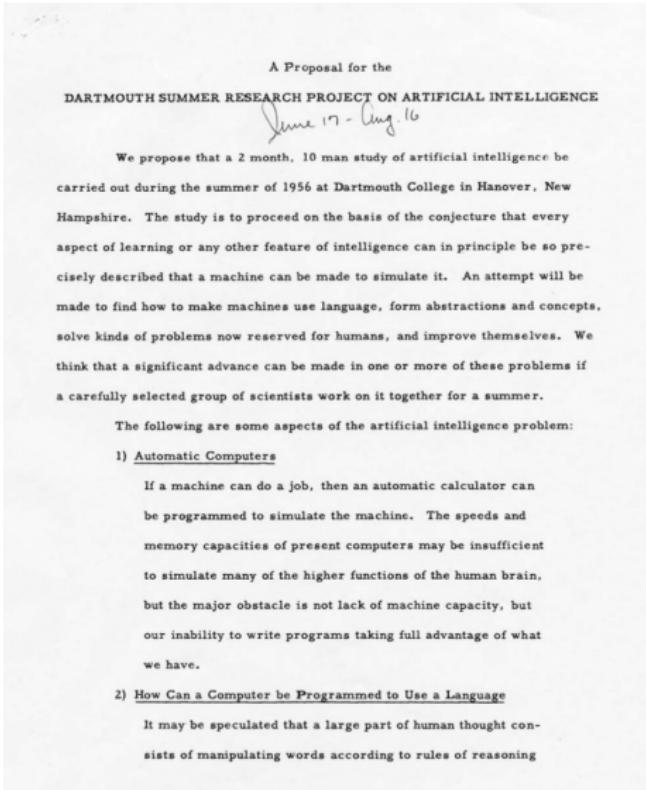
- A test to empirically determine whether a computer has achieved intelligence.



- In these tests, one of the humans functions as the questioner, while the second human and the computer function as respondents.
- Using a specified format and context, the questioner interrogates the respondents within a specific subject area. 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.

1956 [The birth of AI]

- John McCarthy coined the term “artificial intelligence” as the topic of the Dartmouth Conference, the first conference devoted to the subject.
- In 1955, J. McCarthy, M.L. Minsky, N. Rochester, and C.E. Shannon published a proposal for the Dartmouth summer research project on artificial intelligence.



1959 [Symbolic AI]

- Arthur Samuel coined the term “machine learning”, reporting on programming a computer “so that it will learn to play a better game of checkers than can be played by the person who wrote the program”.



Arthur Samuel: Pioneer in the field of computer gaming and AI

1965 [Symbolic AI]

- The first natural language processing computer program, ELIZA, was created.

```
Welcome to
      EEEEEE  LL      IIII    ZZZZZZ  AAAAAA
      EE     LL      II      ZZ      AA    AA
      EEEEEE  LL      II      ZZZ     AAAAAAAA
      EE     LL      II      ZZ      AA    AA
      EEEEEE  LLLLLL  IIII    ZZZZZZ  AA    AA

Eliza is a mock Rogerian psychotherapist.
The original program was described by Joseph Weizenbaum in 1966.
This implementation by Norbert Landsteiner 2005.

ELIZA: Is something troubling you ?
YOU: Men are all alike.
ELIZA: What is the connection, do you suppose ?
YOU: They're always bugging us about something or other.
ELIZA: Can you think of a specific example ?
YOU: Well, my boyfriend made me come here.
ELIZA: Is it important to you that your boyfriend made you come here ?
YOU: He says I'm depressed much of the time.
ELIZA: I am sorry to hear that you are depressed.
YOU: It's true. I am unhappy.
ELIZA: Can you explain what made you unhappy ?
YOU:
```

ELIZA, a computer program that emulates a Rogerian psychotherapist.

1980s [Boom]

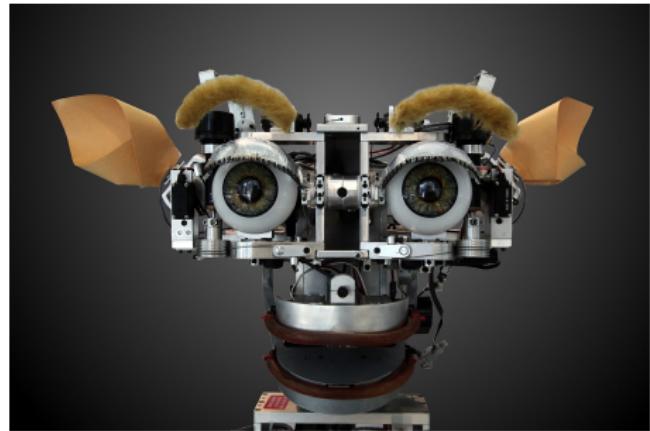
- Edward Albert Feigenbaum developed the first expert system in artificial intelligence.



Edward Albert Feigenbaum: The father of expert systems

1990s [AI: Human-Robot Interaction]

- Cynthia Breazeal, a pioneer of social robotics and human–robot interaction, created the robot **Kismet** at MIT in 1990s.
- **Kismet** was designed to engage in social interaction with humans, marking a significant step forward in the field of human-robot interaction.
- Breazeal's work has opened up new possibilities for how humans and robots can interact and coexist.



1997 [AI: Deep Blue]

- An IBM computer called **IBM Deep Blue Beat the world chess champion**, Garry Kasparov, after a six-game match: two wins for IBM, one for the champion and three draws.



2002 [AI: Roomba]

- iRobot launched **Roomba**, an autonomous vacuum cleaner that avoids obstacles.



2009 [AI: Self-Driving Car]

- Google built **the first self-driving car** to handle urban conditions.



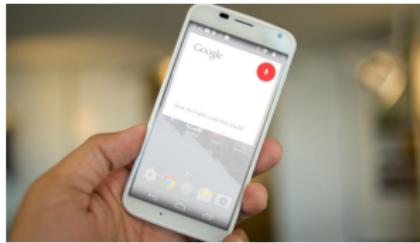
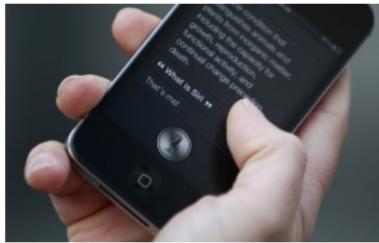
2011 [AI: Watson Supercomputer]

- IBM's Watson supercomputer defeated humans in the final Jeopardy match.



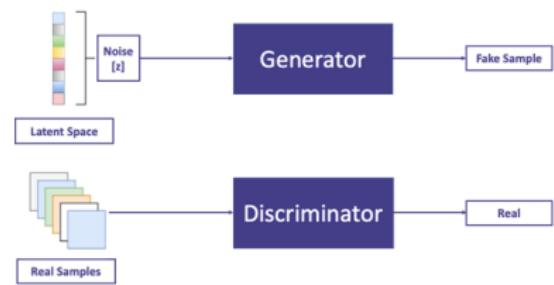
2011-2014 [DL, BD, Artificial General Intelligence]

- Personal assistants like Siri, Google Now, Cortana use speech recognition to answer questions and perform simple tasks.



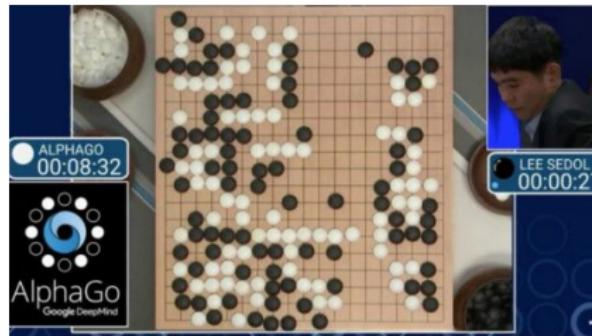
2014 [DL, BD, Artificial General Intelligence]

- Ian Goodfellow comes up with **Generative Adversarial Network (GAN)**.



2016 [DL, BD, Artificial General Intelligence]

- AlphaGo beats professional Go player Lee Sedol 4-1.



2018 [DL, BD, Artificial General Intelligence]

- Most universities have [courses in Artificial Intelligence](#), including the HKUST.
 - COMP 2211 Exploring Artificial Intelligence
(1st Offering: Spring 2022, 2nd Offering: Fall 2022,
3rd Offering: Spring 2023, 4th Offering: Fall 2023)
 - COMP 3211 Introduction to Artificial Intelligence
 - COMP 4211 Machine Learning
 - COMP 4221 Introduction to Natural Language Processing
 - COMP 4222 Machine Learning with Structured Data
 - COMP 4421 Image Processing
 - COMP 4471 Deep Learning in Computer Vision
 - COMP 4901V Large-Scale Deep Perception, Localization, and Planning for Autonomous Vehicles

2022 [DL, BD, Artificial General Intelligence]

- The release of ChatGPT (Chat Generative Pre-trained Transformer), a large language model trained by OpenAI, demonstrated the enormous potential of AI for transforming the way we communicate and interact with machines.

ChatGPT is an AI-powered language model developed by OpenAI, capable of generating human-like text based on context and past conversations.



2023 [DL, BD, Artificial General Intelligence]

- The release of Bard.
- Bard is an experimental conversational AI chat service developed by Google.
- It operates in a similar manner to ChatGPT, but with a notable distinction: Bard retrieves information directly from the web as a source of knowledge.



Implementations of Artificial Intelligence

Some Useful AI & Machine Learning Libraries

- **TensorFlow**: It is a **machine learning framework from Google**. It is a fast, flexible, and scalable open-source machine learning library for research and production. With TensorFlow 2.0 and newer versions, more efficiency and convenience was brought to the game.
- **Keras**: It is the high-level application programming interface (**API built on top of TensorFlow**). It is incredibly user-friendly and easy to pick up. It is good for fast experimentation.
- **PyTorch**: It is TensorFlow's direct competitor **developed by Facebook**, and is widely used in research projects. It allows almost unlimited customization and is well adapted to running tensor operations on GPUs.
- **Scikit-learn**: It is another **user-friendly framework** that contains a great variety of useful tools: classification, regressions and clustering models, as well as pre-processing, dimensionality reduction and evaluation tools.

Comparisons



- **TensorFlow vs Pytorch:** TensorFlow has a very difficult learning curve but has good documentation and lots of examples available. PyTorch is slightly easier to use than TensorFlow but its documentation is weak and skimpy.
- **Good choice for beginners:** Scikit-learn and Keras.

Pros and Cons of using Python for AI

- Pros:

- Easy to learn and read
- A vast number of machine learning libraries and useful tools
- Popularity and large community
- Many useful machine-learning repositories
- Easy to integrate with other programming languages

- Cons:

- Speed limitations
- Not suitable for mobile and game development
- Design limitations



That's all!

Any question?



Welcome
Back!

Acknowledgments

- The lecture notes are developed based on Dr. Desmond Tsoi's lecture slides.