

Machine Learning



People tend to associate the term “artificial intelligence” with science fiction; with robots that move, talk, think, and even look like humans. Today, however, artificial intelligence already has several real-world applications. In this module we will explore machine learning and how this approach to artificial intelligence is being used in many of today’s technologies.

Objectives:

10_Obj01: Define important terms related to Machine Learning such as Artificial Intelligence, Machine Learning, Learning, Programming, etc.

10_Obj02: Identify the Different Methods of Machine Learning

10_Obj03: Identify the Different Layers of Artificial Neuron

10_Obj04: Identify the Current Applications of Machine Learning

Artificial intelligence

What is Artificial Intelligence?

The dictionary definition of artificial intelligence or AI is “a branch of computer science dealing with the simulation of intelligent behaviour in computers” or “the capability of a machine to imitate intelligent human behaviour”

The term *artificial intelligence* was coined in 1955 by John McCarthy, an American computer scientist and cognitive scientist. McCarthy believed that "every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it." He later came to be known as the father of artificial intelligence because of his pioneering work in this field.

Machine Learning

What is machine learning?

In 1959, Arthur Samuel, a pioneer in the field of artificial intelligence defined machine learning as a "*field of study that gives computers the ability to learn without being explicitly programmed*".

Another widely quoted definition of machine learning came from Tom Mitchell, an American computer scientist. He said "*A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P if its performance at tasks in T , as measured by P , improves with experience E .*"

In simpler terms, a machine is said to learn if there is measurable improvement in its performance of a task as it gains more experience.

Learning Vs. Programming

When we are born, we humans can't do anything useful but as we mature, we acquire knowledge and skills through experience or study. This is called *learning*.

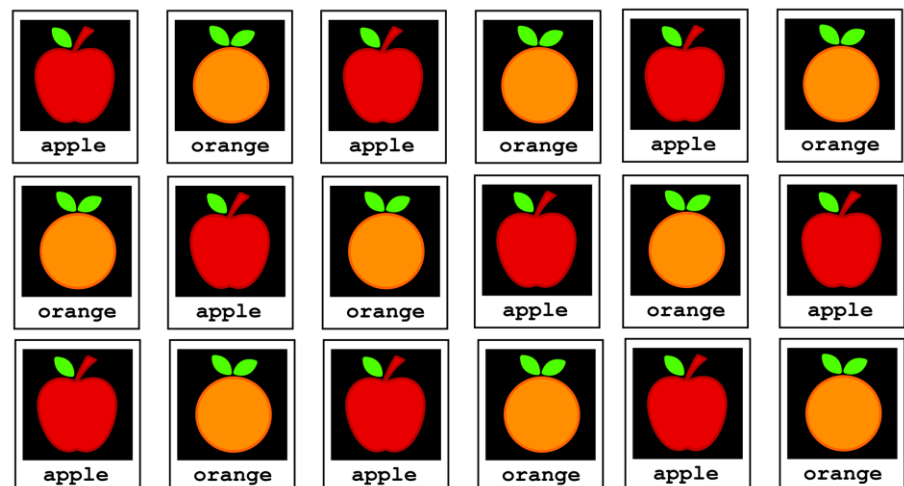
Computers, on the other hand, can only perform tasks that they are programmed to do. *Programming* is the process of writing instructions in a computer's memory. Computers cannot acquire knowledge and skills on their own.

At least that is how we used to see it. Today, there are computer systems that are capable of performing tasks that they were not programmed to do. Furthermore, they can use the data that they encounter to improve their performance. In other words, these machines can learn.

Machine learning methods

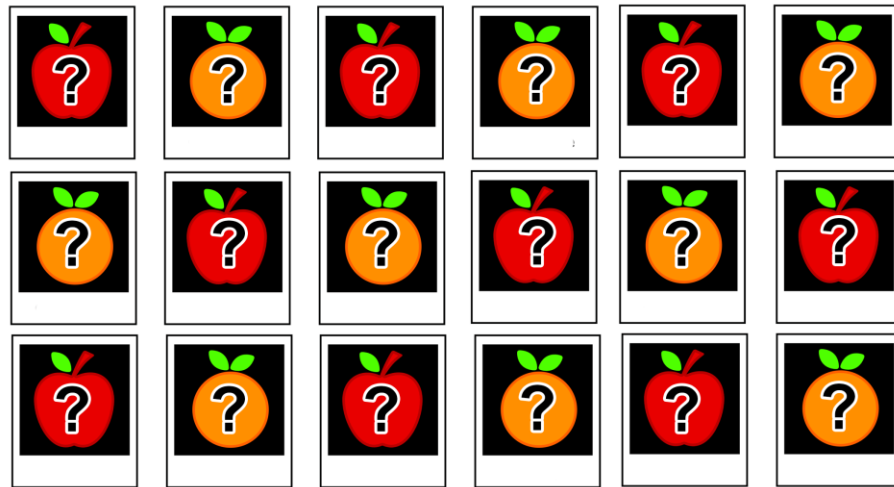
The most popular method is ***supervised learning*** where inputs and outputs are clearly defined. About 70% of machine learning done today falls under supervised learning. This works by exposing the machine to *training examples* which is data that contains an input-output pair.

Here is an example; we want our machine to scan pictures of fruits and tell which ones are apples and which ones are oranges. To teach our machine the difference between the two, we give it several training examples in the form of pictures with the correct labels.



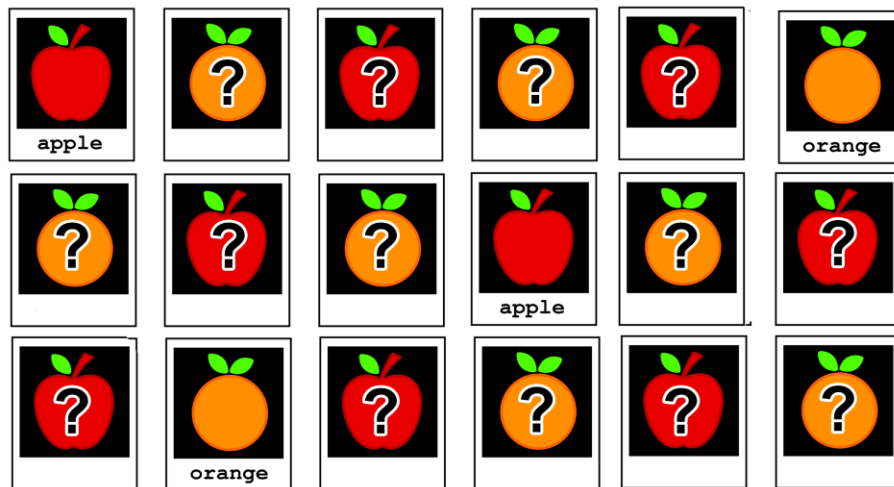
Through these examples, our machine will “learn” the two types of input and the corresponding category or output for each type.

Another method is ***unsupervised learning*** where the machine receives an input but there is no clearly defined output. Going back to our example, we let our machine scan pictures of fruits. With unsupervised learning, we do not give our machine an expected output.



Instead, we let our machine discover the underlying structure within the inputs. In other words, we let the machine make sense of the data.

Semi-supervised learning is a method that is used the same way as supervised learning. The main difference is that semi-supervised learning uses both labelled and unlabeled training examples.



Normally, there is only a small amount of labelled data. Semi-supervised learning is useful when labelled examples are hard to acquire or are costly to prepare.

Reinforcement learning is a method that allows the machine to determine the ideal behaviour within a specific context, in order to maximize its performance. Reinforcement learning has three main components:

- Agent – the machine or program
- Environment - everything the machine interacts with
- Action – what the machine can do

Reinforcement learning uses a feedback similar to a reward. If the machine performs an ideal action, it receives a positive feedback or a reward. Through experience, the machine will learn which actions are most likely lead to a reward.

Deep Learning

Deep learning is a branch of Machine Learning that uses algorithms based on artificial neural networks. Artificial neural networks are based on the biological neural network which is the network of cells called neurons found in human and animal brains.

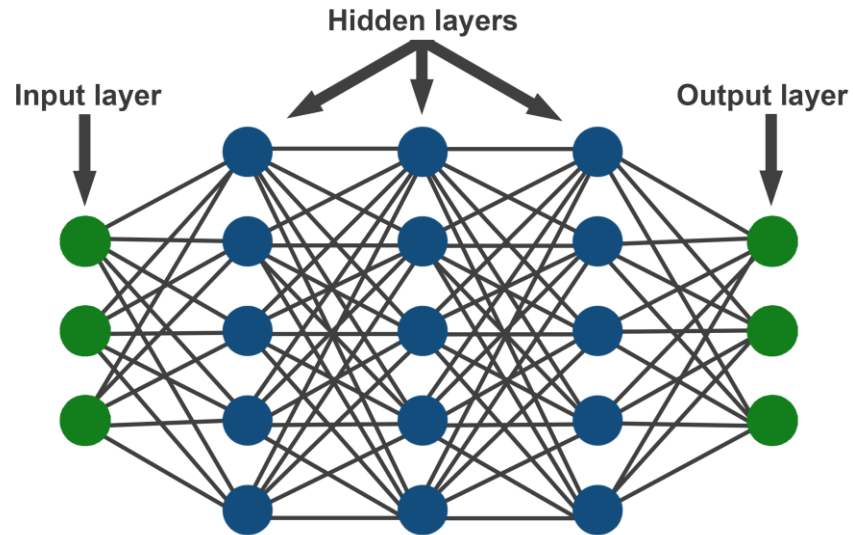
Andrew Ng, an American computer scientist and founder of the Google Brain Deep Learning Project stated the following goals of Deep Learning:

“Using brain simulations, hope to:

- Make learning algorithms much better and easier to use.
- Make revolutionary advances in machine learning and AI.”

How Deep Learning works

The neurons in an artificial neural network are grouped into *layers*. Information enters the network through the *input layer* which sends it to several *hidden layers*. by which time the information is passed on to the output layer.



Each unit in an artificial neural network is called a neuron, named after the brain cell. These artificial neurons are grouped into layers with different functions. Here are the main types of layers:

- **Input layer** – receives data or input that enters the artificial neural network
- **Hidden layer** – the information from the input layer is sent to several hidden layers. Each hidden layer performs a specific task. The output of a hidden layer may serve as the input for another hidden layer. This goes on until the desired outcome has been achieved,
- **Output layer** – processed information exits the neural network through the output layer.

Applications of Machine Learning

In a previous module, we learned about Big Data and the opportunities and challenges that come with it. As you may recall, the sheer volume, variety, and velocity of Big Data makes it impossible to manually process. Machine learning offers a solution to this challenge. It enables the creation of programs or algorithms that can deal with the *volume*, keep up with the *velocity*, and adjust to the *variety* of data. Here are some of the current applications of machine learning:

Cybersecurity

Machine learning is currently being used to improve security measures such as malware detection, spam filtering, and risk assessment.

Financial Trading

Because machine learning can process vast quantities for data, it can be used to predict the behaviour of the stock market and foreign exchange market.

Healthcare

As previously discussed in this module, machine learning can detect patterns in large data sets. This can be extremely useful in the field of medicine. For example, it can be used to analyze symptoms and detect disease at an early stage. It can also be used to analyze potential health threats to a population.

Marketing

Machine learning is already being used to analyze the habits and preferences of consumers. This gives businesses valuable insight. For example, by analyzing your previous purchases, they can suggest products that you will probably like or they can show advertisements that you are most likely to respond to.

Online Search

Search engines use machine learning to improve search results. The insight gained from analyzing user behaviour enables search engines to provide more accurate search results.

Transportation

In a previous module, we talked about smart cars. Machine learning plays a big role in the smart technologies that are used in transportation today. Furthermore, machine learning is a vital element of driverless cars which are currently being developed and are foreseen to revolutionize transportation.

Glossary of Terms

ARTIFICIAL INTELLIGENCE - a branch of computer science dealing with the simulation of intelligent behaviour in computers

MACHINE LEARNING - field of study that gives computers the ability to learn without being explicitly programmed

LEARNING - Acquiring knowledge and skills through experience or study

PROGRAMMING - process of writing instructions in a computer's memory

INPUT LAYER - receives data or input that enters the artificial neural network

OUTPUT LAYER - Processed information exits the neural network through this layer

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