What is machine learning?

The science of programming computers so they can learn from data.

In other words, ML gives computers the ability to learn without being explicitly programmed.

Where we use ML?

- Problems for which existing solutions require a lot of fine tuning or long lists of rules.
- Complex problems for which using a traditional approach yields no good solution (or in some cases there is no solution at all).
- Fluctuating environments (its so difficult to keep the traditional solutions up to date in fluctuating environments).
- Getting insights about complex problems and large amounts of data (data mining).

Types of ML systems based on how they are supervised during training:

1. ***Supervised learning:***

   in this type, the training set includes the desired solution (label).

   The typical supervised learning tasks:
   - Classification:

     It is used when the target values consist of small set of discrete values named classes (e.g. spam filter).
   - Regression:

     It used when the desired values are continuous numerical values (e.g. price of house).

2. ***Unsupervised learning:***

   The training data in this type is unlabeled. So that the system tries to detect hidden connections, groupings, and anomalies in the data.

   The most important unsupervised tasks:
   - Dimensionality reduction:

     It aims to simplify the data without losing too much information
   - Anomaly detection:

     The process of identifying unusual patterns or data points (e.g. removing outliers from a dataset).

3. *Self-supervised learning:*

in this type the algorithms generating fully labeled dataset from fully unlabeled dataset, then apply supervised learning algorithms on the generated dataset (e.g. algorithms for recover images).

4. *Semi supervised learning:*

This type dealing with partially labeled data.
Most of this type's algorithms are combinations of supervised and unsupervised learning.

5. *Reinforcement learning:*

This approach is different from other ML approaches, It depends on trial and receiving rewards for good actions and penalties for bad or negative action, then learn the best strategy based on the rewards.

Batch learning versus online learning:

➢ *Batch learning:*

In batch learning the system must be trained using all the available data. Its typically done offline.

In this type the system goes through two separate stages:

- First the system is trained and this stage it can't be launched into production.
- As soon as the training stage end, then the system is launched into production and runs without learning anymore.

Batch learning has too many negatives:

- It takes a lot of time and computing resources.
- A models performance tends to decay slowly over time.
- If you want a system to know about new data, you need to train anew version of it from scratch on the full dataset.

➢ *Online learning:*

In online learning, the system trained incrementally by feeding it data instances sequentially, either individually or in small groups (mini-batches).
In this type the system can learn about new data on the fly.

Online learning is useful for:
- Systems that need to adapt to change extremely rapidly.
- For limited computing resources.
- Train models on huge datasets that cannot fit in one machine's main memory.

The main challenge with online learning is that if bad data is fed to the system, the system's performance will decline.

Instance based versus model based learning:

❖ *Instance based learning:*

In this type the system learns the examples by heart, then generalizes to new cases by using similarity measure.

❖ *Model based learning:*

In this way you need to build a model of the dataset and then use the model to make prediction.

Main challenges of ML:

- Insufficient quantity of training data.
- Nonrepresentative training data.
- Poor quality data.
- Irrelevant features.
- Overfitting the training data.
- Underfitting the training data.

Machine learning (according to my understanding):

Simulating the human learning process by building basically mathematical and statistical models to enable the computers to build knowledge based on experiences and datasets in order to solve more complex problems, or analyzing and understanding huge and complex data.

An idea can be applied using machine learning:

Searching in videos by content, extracting the description for each part of each video I have, using an image caption model and then searching on them using semantic search techniques.