Types of Machine Learning Systems

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Abstract: Usually when anybody listens to the term Machine learning, they visualize a robot. Machine meaning is not a future fantasy it was with us for many years till now. Technologies like OCR(Optical Character Recognition) are examples of such applications where Machine Learning is applied. The first Machine learning application which made the whole world look at it in the 1990’s is spam filter. From then on there were many machine learning applications that power hundreds of applications and products starting from recommendations in an app to voice recognition search. If any computer is downloaded with encyclopaedia information, then does that mean the computer is equipped with that knowledge? Not exactly. In this paper we discuss types of Machine Learning Systems.

Key words: Machine learning, supervision, patterns, clusters.

I. INTRODUCTION

Definition of Machine learning: Machine Learning is the field of study that gives computers the ability to learn without being explicitly programmed. – Arthur Samuel [2]

For instance our spam filter in our mail boxes is a Machine learning program because it learns to flag spam by examples given by users and also it takes examples of e-mails which are not spam(regular). These are also called as ham e-mails. The examples that the system is using to learn about data are called training set. Each record of the training set is called as training instance.

As the problem is not simple or trivial our program will have a big list of diverse errors.

In contrast with our program a Machine learning techniques automatically learns the words and phrases that are to be termed as spam by detecting the frequency in patterns in spam examples and also compares with regular mails examples. [2]

Fig 1:1 The Traditional approach

Fig 1:2 Machine Learning Approach
Let us see each algorithm in the chart mentioned above. If, spammers notice the keywords using which their mails are blocked they tend to change their keywords. For example: If we have blocked all the mails with keywords in the subject as “4U” then they might change the wording to “For U”. A spam filter using traditional programming approach cannot be blocking such mails. So we need to update the rules of the spam filter continuously. Whereas, if it is a spam filter using Machine Learning techniques encounters such problem, then it automatically notices the increase in the spam mails with keyword “For U” which are flagged by the user and starts flagging them as spam mails without user’s intervention.

II. TYPES OF MACHINE LEARNING SYSTEMS
There are several categories of Machine learning systems, but if we categorise them broadly as follows:
A. Trained with Human supervision
   - Supervised, Unsupervised, Semi supervised, and Reinforcement learning.
B. Learning on fly
   - Online versus batch learning

3. Comparing new data points to old data points
Detecting Patterns in the training data and build a predictive model (instance based vs model based). Let us look at each category.

III. SUPERVISED/UNSUPERVISED LEARNING:
There are four major categories under this classification based on the amount and type of supervision they get during training the data.[4]

a. Supervised learning
b. Unsupervised learning
c. Semi supervised learning
d. Reinforcement learning

A. Supervised Learning
In this type of learning we feed the training data which has the desired solutions in the form of labels. An example of typical supervised learning is Classification – spam filter, as it trained with so many example emails with their class (spam or ham) and thus it classifies which is spam and ham accordingly. [5]

![Figure 1:3 e.g., spam classification](image)

In a nutshell, supervised machine learning algorithms are competent by example. We feed the algorithms datasets containing examples which are already labelled or categorized, and this enables the algorithm to build a general model of each type. Then, the algorithm processes the real (un-categorized) data and attempts to put each item into one of the pre-learned categories. Since a supervised algorithm only knows the categories on which it has been trained, and its training was conducted on pre-labelled examples. [2][3]

Regression is also one of the examples that can be cited for supervised learning. In the data flow if there are any new data points that are joined then we can see a regression in the graph where data points are mapped.

Some of the most important supervised algorithms are:
- k – Nearest Neighbours
- Linear Regression
- Logistic Regression
- Support Vector Machines
- Decision Trees and Random Forests

B. Unsupervised Learning
In unsupervised learning, the system has to learn on its own as there will be no labels or supervision.[5]

For example, if we take an online shopping website where we want to classify the users based on their selection or content browsed. Using a hierarchical clustering algorithm we can group the users into clusters. Using these clusters the system can further group. This may help us give personalised choice for users when they sign in every time.

![Figure 1:4 e.g.: Clustering](image)

Visualization algorithms are good illustrations of unsupervised learning. An algorithm is fed with complex and unlabelled data. The algorithm gives output in the form of a plotted representation. These algorithms try to preserve separate clusters so that we can understand how data is organised.

![Figure 1:5 e.g. Visualization](image)

Next approach in unsupervised learning is dimensionality reduction. In this approach the data is simplified without losing much information. One method to do it is to merge several correlated features into one. A machine’s performance depends on the age of the machine. So,
performance can be correlated with its age, therefore the dimensionality reduction will name the two attributes as wear and tear by merging them both into a single feature. The above procedure is called as feature extraction. Another important unsupervised task is anomaly detection. Definition: An anomaly is something that sways away from common rules and requisites. Data \( x_1, x_2, \ldots, x_n \) each \( x_i \in \mathbb{R}^d \), a mixture of nominal points and anomaly points. Anomaly detection with respect to Condition monitoring is more challenging these days. Any machine like pump, compressor, and distillation will eventually reach a point of poor health. This point may not be actual failure or shutdown. This situation signals that there might be need of some maintenance. How? We can do condition monitoring by observing each sensor in the machine and setting a maximum value and minimum value limits to it which we can call as normal bracket value. If the current value is within the bound then the machine is healthy, unlike that if the machine is out of bound it is not healthy. Then an alarm is sent. The main challenge in using unsupervised machine learning methods for detecting anomalies is deciding what is normal for the time series being monitored.[1]

Another technique using unsupervised learning is Association rule learning. In this type of learning we need to dive deep into the data and understand that discover relationships between the attributes. For example, in a supermarket if we observe the data almost every customer who buys bread is buying milk and jam. So, to better our service we need to place these items close to each other. [2]

Some of the important unsupervised Machine learning algorithms are:

- Clustering
  - k – Means
  - Hierarchical Cluster Analysis
  - Expectation Maximization
- Visualisation and Dimensionality Reduction
  - PCA(Principal Component Analysis)
  - Kernel PCA
  - Locally – Linear Embedding (LLE)
  - t – distributed stochastic Neighbour Embedding(t – SNE)
- Association rule learning
  - Apriori
  - Eclat

C. Semi supervised Learning

If some algorithms are not fed with complete labelled training data but are given partially labelled data, they can deal with it. This is called Semisupervised learning. [6]

Best example for Semisupervised learning is Google photos. In this type of photo hosting services, once you upload your family pictures and not all the members are labelled, a person X is recognised by the service in some pictures and person Y shows up in some other photos. If you can just label one or two people it will be able to form clusters with faces which makes our job easier while searching. [2]

D. REINFORCEMENT LEARNING

This method is a different way all together when compared to other techniques. A learning system called agent has to observe in an environment. It has to act according to the policy given. A policy defines what should be done the system according to the situation. According to its actions rewards and penalties are awarded. The system must update its policy according to the penalties and rewards. Generally robots are trained in such techniques. They are exposed to millions of situations or games to observe and learn.

E. Batch And Online Learning

A system when learns incrementally from a stream of incremental data.

**Batch Learning:** In this method the system in not capable of learning on the fly, so it must be trained by feeding all the available data. It is very time consuming and resource consuming. That is why this process is done offline. Once the system is trained with all the data available offline, then it is launched for production. If there is any new data that arrives, a new system has to be trained from scratch and then released for production. But thankfully the whole process of training, evaluating and launching is automated easily.

**Online Learning**

In online learning, we need to train the system on the go. This can be done by feeding data incrementally, or in small batches called mini – batches. Each learning is fast and economic, so the system learns about the new data on the fly.

Online works great for applications like condition monitoring of satellites, stock exchanges, twitter data etc.
As these systems receive data continuously and the system need to change rapidly and autonomously. An advantage about such systems is once the online learning systems learn about the new instances from the new data, they do not need the data, and it can be discarded, which saves a lot of space. Also, online learning algorithms can be used for huge datasets which cannot be fit in one machine’s main memory. The algorithms loads a part of data, runs a training step on it. Thus, this process is repeated till the entire data is fed. A very important parameter of online learning is learning rate: it means how fast a system can adapt to the changing data. Let us take the example of our spam filter here. If we set the learning rate as high then the system will learn the new instances rapidly but at the same time forgets the old instances, which we do not want with our spam filter. On the contrary if we give low learning rate then system runs slowly and captures all the spam. This is because the system will have inertia, which is why it will learn more slowly.

III. INSTANCE BASED LEARNING VS MODEL – BASED LEARNING

Instance based learning needs measure of similarity. That means it learns by the similarities of the data points and flags the new data points according to the similarity. It then generalizes the learning for all the new arriving data points.

IV. CONCLUSION

The above mentioned classification of machine learning techniques is useful if we select suitable technique to handle data. The challenges of machine learning are insufficient quantity of training data, Non representative training data, poor quality of data etc.

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