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# Machine Learning for Internet of Things

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**Abstract:**
By 2020 around 25-50 billion devices are likely to be connected to the internet. Due to this new development, it gives rise to something called Internet of Things (IoT). The interconnected devices can generate and share data over a network. Machine Learning plays a key role in IoT to handle the vast amount of data. It gives IoT and devices a brain to think, which is often called as intelligence. The data can be feed to machines for learning patterns, based on training the machines can identify to predict for the future. This paper gives a brief explanation of IoT. This paper gives a crisp explanation of machine learning algorithm and its types. However, Support Vector Machine (SVM) is explained in details along with its merits and demerits. An algorithm is also proposed for weather prediction using SVM for IoT.

**Keywords:** SVM, Internet of Things, features selection, smart data.

## 1. Introduction

Internet of Things is a combination of embedded technologies regarding wired and wireless communications, sensor and actuator devices, and the physical objects connected to the Internet [1] [2]. The volume of data on the Internet and the Web has already been overwhelming and is still growing at stunning pace: everyday around 2.5 quintillion bytes of data is created and it is estimated that 90% of the data today was generated in the past several years [3].

Machine Learning is the process of elimination of human intervention whenever possible. The data can learn pattern by itself and take independent decisions without a coder. One of the applications is Siri/Google Assistant, the more the user uses these voice assistant, the more polished and appropriate will be the results.

Sensory data generated by IoT devices can be analyzed using machine learning algorithms. This technology can change our life automatically and drastically. For e.g., readings from meters can be used to better predict and balance power consumption in smart grids; analyzing combination of traffic, pollution and congestion sensory data records can provide better traffic and city management; monitoring and processing sensory devices attached to patients or elderly can provide better remote healthcare [4].

The Support Vector Machine (SVM) was first proposed by Vapnik and has since attracted a high degree of interest in the machine learning research community [5]. They are capable of delivering higher performance as compared to other classification algorithm. Its aim is to find a hyperplane in an N-dimensional space that distinctly classifies the data points, where N is the number of features. Data points falling on either side of the hyperplane can be qualified to become member of different classes. In 2-dimenisonal space hyperplane is simply a line dividing the plane in two parts.

The purpose of this paper is to propose an algorithm to implement weather prediction using SVM for IoT. The weather data is smart data basically include temperature, humidity, rainfall, sunshine and wind. This data can be feed to machine for training. Based on past experience the SVM will decide for the future.

## 2. Internet of Things (IoT)

It is a system of connected devices that are capable to transfer data over a network. Devices are interrelated computing devices that can be

mechanical and digital machines. Each device in the network has a unique identifier. The devices on the network can communicate without human-to-human or human-to-computer interaction. IoT is a sensor network to collect and share data among billions of smart devices that connect people, system and other applications. The information collected using these powerful IoT platforms are either sent to the cloud to be analyzed or analyzed locally. Further it can identify what information is valuable and what can be disregarded. There are several real-world applications of the internet of things, ranging from consumer IoT and enterprise IoT to manufacturing and industrial IoT.

**Some of the IoT applications are listed below:-**

- Smart City
- Smart Car
- Wearable
- Smart Appliances
- Smart Health
- Smart Farming
- Smart TV
- Smart Home
- Smart buildings

IoT connects devices on a network and combines those devices that generate some kind of intelligence.

## 3. Machine Learning (ML) Algorithm

Machine Learning is a subset of Artificial Intelligence (AI). Machines learn through examples and past experience without being explicitly programmed. The algorithms for machines are designed in such a way that they trained and improve over time when exposed to new data. Machine is able to carry out tasks of classification, clustering, pattern recognition, regression, predictions etc. The sample data are usually characterized by measurable characteristics called features and an ML algorithm attempts to find a correlation between the features and some output values called labels [6].Then, training results are used to recognize patterns or make decisions based on new data.

## 4. Types of Machine Learning Algorithm

There are four categories and the categories are divided according to their purpose .i.e. the type of input output data and type of problems that they intended to solve.

### i. Supervised Learning

In this type of ML, the learning is guided by the instructor, known as labeled dataset. As the name suggest the labeled dataset is one which have both input and output parameters. The dataset role is to train the model. After training the model can then make prediction whenever the new data arrived.

Two types of Supervised Learning are there:-

- *Classification:* In this we predict one of the values in a set of values, like is this mail is spam or not? Or will it rain today or not? Classification is further divided into binary classification and multi-class classification.
- *Regression:* In this we predict number which can vary from –infinity to +infinity, like what is price of patrol/diesel in particular city? Or what is the value of property in a particular area? The basic difference between the two is that the classification divides the data while regression fits the data.

Some of the common algorithms of supervised learning are Nearest Neighbor, Support Vector Machines (SVM), Decision Trees, Neural Networks and Naive Bayes.

### ii. Unsupervised Learning

In this type of ML, the learning is not guided by the instructor. The model is trained with unlabeled data. It has only input parameter. Once the model is given a dataset, it creates clusters of data by finding patterns and relationships among them. However, it cannot add labels to the clusters.

Two types of Unsupervised Learning are there:-

- *Clustering:* It is a type of investigation of data used to segment it into meaningful groups based on their patterns without any prior knowledge.
- *Association:* It is a rule based technique. It used to finds out useful relations between parameters of large datasets.

Some of the common algorithms of unsupervised learning are K-means clustering, Principal Component Analysis (PCA) and Density based clustering (DBSCAN).

### iii. Semi-Supervised Learning

It is in-between of supervised and unsupervised learning. In the real world scenario presented data are a combination of labeled and labeled data. Unsupervised methods are used to predict the labels and these labels become input for supervised methods.

**iv. Reinforced Learning**

It is based on the concept of hit and trail method. To minimize the risk and to maximize the reward, this ML method aims at interpretations that are gathered from the interaction with environment to take actions. These algorithms are also known as agents. Each time a correct decision is based the agent is rewarded and penalized for each wrong answer. On the basis of reward the agent train itself.

Some of the common algorithms of reinforcement learning are Monte-Carlo Tree Search (MCTS), Temporal Differences (TD) and Q-Learning.

For our proposed algorithm for weather prediction we are using Support Vector Machine (SVM) that falls under the supervised learning category of machine learning.

## 5. Support Vector Machine (SVM)

SVM is a supervised machine learning algorithm. It is also known as Support Vector Network. It is used for classification and as well as for regression analysis. The prerequisite is that the data must be of numeric values. SVM as a classifier separates data into training sets and testing set. Each instance in the training set contains one "target value" (i.e. the class labels) and several "attributes" (i.e. the features or observed variables) [7]. The main objective of SVM is based on training data; it predicts the target values of the test data. The main characteristic of SVM is that it concurrently minimizes the observed classification error and maximizes the geometric margin. As a result it is also known as Maximum Margin Classifier.

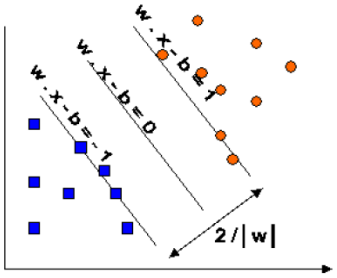


**Figure 1:** Maximum margin hyperplanes for a SVM trained with samples of two-classes [8]

The choice of kernel functions is also essential. There are four basic kernel functions [5]:-

- Linear:

$$K(x_i, x_j) = x_i^T x_j.$$

- Polynomial:

$$K(x_i, x_j) = (\gamma\, x_i^T x_j + r)^d \quad , \quad \gamma > 0$$

- Radial basis function (RBF):

$$K(x_i, x_j) = \exp(-\gamma \left\| x_i - x_j \right\|^2) \quad , \quad \gamma > 0$$

- Sigmoid:

$$K(x_i, x_j) = \tanh(\gamma\, x_i^T x_j + r)$$

Here,

$\gamma$, $r$, and $d$ are kernel parameters.

The main kernel function is RBF because it has less numerical difficulties, less hyper parameters and it maps samples into a higher dimensional space.

### 5.1 Support Vector Machine: Merits

Below are some significant advantages of Support Vector Machine:-

- SVM prediction precision is normally high.
- It works well with structured as well as unstructured datasets, even problems in high dimension that are not linearly separable.
- Small change in dataset doesn't affect the results therefore the model is pretty stable.
- SVM gives enhanced results as compared to Artificial Neural Networks (ANN) models.
- By a careful selection of kernel function, any complex non linear problems can be solved.
- The real power of SVM lies in the kernel trick.
- Dimension of input data is not proportional to computational complexity of SVM.
- It does not produce local minima.
- The risk of over-fitting is less.

### 5.2 Support Vector Machine: Demerits

It has drawbacks from practical point of view. Some are listed below:-

- It has high algorithmic complexity and wide memory requirements in large scale tasks.
- Choice of kernel functions and attributes selection are difficult, as they are crucial to the classification results.
- It needs to set several key parameters to accomplish best classification result.
- Originally it is a two-class binary classifier therefore appropriate alteration is required for addressing multi-class classification problems.
- Training time will be long for large datasets.
- The model is difficult to interpret by human beings in contrast with decision trees.

## 6. Proposed Algorithm for Weather Prediction

IoT combined with Machine Learning can be used to predict weather data. Following are the steps of the proposed algorithm:-

1. Weather Data of smart cities is required. The data should typically include values for Temperature in °C, Humidity in percentage, Rainfall in mm, Sunshine in hour and Wind in km/hr.

2. A threshold can be set for each of the smart weather data, namely Temperature t, Humidity named as h, Rainfall as r, Sunshine as s and Wind as w.
3. One of Machine learning classification algorithm named Support Vector Machine (SVM) can then be used for training purpose. Each of the weather data can be classified by SVM into one of the two categories, high or low depending upon their respective threshold values.
4. Whenever a new data arrives the SVM will be able to classify the data under test into one of the predetermined classes (high or low).
5. The SVM will repeat step no. 4 for each of the five weather data.
6. A confusion matrix will be prepared for each of the weather data to test the performance of SVM

**Table 1:** Confusion Matrix (CM)

| *CM* | *Predicted High* | *Predicted Low* |
|---|---|---|
| Actual High | TP | FN |
| Actual Low | FP | TN |

Where, TP: True Positive, TN: True Negative, FP: False Positive and FN: False Negative.

All the weather data then together can be used to predict Temperature, Humidity, Rainfall, Sunshine and Wind for a particular period.

## 7. Conclusions

Every Time the IoT sensor gather data, someone at the backend must classify the data, process it and ensure that information is sent out back to the device for decision making. That's where Machine Learning comes into picture. In order to generate smart data the devices should be smart devices means they must be connected to the internet. Smart home, smart city, driverless car are some example of smart devices. In this paper we demonstrate a technique through which weather can be predicted using smart weather data.

## References


[1] L. Atzori, A. Iera, G. Morabito, "The internet of things: A survey, Computer networks" 54 (15) 2787-2805, 2010.

[2] C. Cecchinel, M. Jimenez, S. Mosser, M. Riveill, "An architecture to support the collection of big data in the internet of things", World Congress on Services, IEEE, 2014 pp. 442-449.

[3] IBM, "Bringing Big Data to the Enterprise", http://www-01.ibm.com/software/data/bigdata/, accessed on 10/07/2012.

[4] Dr.N. Preethi, "Performance Evaluation of IoT Result for Machine Learning", Transactions on Engineering and Sciences, Vol.2, Issue 11, 2014, http://techscripts.org/nov_2014/nov201401.pdf

[5] V. Vapnik, The Nature of Statistical Learning Theory, NY: Springer-Verlag. 1995.

[6] Mohssen Mohammed, Muhammad Badruddin Khan, Eihab Bashier Mohammed Bashier, Machine Learning: Algorithms and Applications, USA: Crc Press: Boca Raton, FL, USA,2016.

[7] Chih-Wei Hsu, Chih-Chung Chang, and Chih-Jen Lin, "A Practical Guide to Support Vector Classification", 2003.

[8] Durgesh K. Srivastava and Lekha Bhambhu, "Data Classification using Support Vector Machine", Journal of Theoritical and Applied Information Technology, 2005-2009.