# Weekly Report

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Summary of lectures given in Week-1 (Sept 2, Sept3 and Sept4)

**Topics Covered**

- **Basics of Learning**
  When can we really say that the given system is learning? Here is a formal definition: A system is said to be learning if its performance P of doing the task T increases with experience E. For example, we may be implementing a system that can distinguish whether a given mail is spam or not. Here, the task T is classification of mail as spam or not, the number of mails correctly classified may be considered as its performance P and the previous results obtained from the system can be considered as its experience E.

- **Underlying Assumptions**
  All the problems cannot be classified as a learnable problem. We generally have some constraints on a problem to be considered as a learnable problem. They are: 1. There must exist some process of generating data for that problem such that the underlying details is not known to us. 2. There must exist some pattern in the data which will be learned later by the system. The data must not be chaotic. 3. Construction of an ideal system that doesn't make any mistake is not practically feasible. Instead, we try to understand the dynamics of the data and choose a model that gives maximum accuracy.

- **Types of Learning Problems**
  Learning problems can be broadly classified into three classes:

  - **Supervised Learning** In this category, we basically deal with labelled data. We are given pairs of feature vector and corresponding labels $\{(x^{(1)}, y^{(1)}), (x^{(2)}, y^{(3)}), \dots, (x^{(m)}, y^{(m)})\}$ for training of the system and after training, system predicts the label of unseen feature vectors $\{x'^{(1)}, x'^{(2)}, \dots, x'^{(q)}\}$ and accordingly readjust its parameters so as to have a better accuracy.

  - **Unsupervised Learning** In this category, the data available to us is unlabelled and we try to build systems that could learn the underlying intricacies of the input data. Clustering is an example of this class.

  - **Reinforcement Learning** In this category, we build systems that could learn the sequence of actions to be undertaken to reach a particular goal from the input data. Building autonomous systems for navigation, sports fall in this class.

- **Mathematics for Machine Learning**

  - **Target function** Every learning problem has an implicit target function $c$. For supervised learning problems, for every $(x, y)$ pair in the available data, $c(x) = y$ is satisfied. Our goal is to make the system learn this target function.

  - **Hypothesis Space** Suppose we are solving a classification problem (that comes under supervised learning). Let each sample has $n$ features. Let $i^{th}$ feature for every sample can take $k_i$ distinct values. If we consider null and don't care values as well, it will be $k_i + 2$. Therefore, we have an $n$ −dimensional input space whether $i^{th}$ dimension can only take $k_i + 2$ values. Thus, maximum distinct input the system could expect is $\prod_{i=1}^{n}(k_i + 2)$. Now, for each such input a binary label could be assigned (as we are dealing with classification only). If we consider all possibilities, we can see that there exists a space containing all the possible variations. For this example, there would exist $2^{\prod_{i=1}^{n}(k_i+2)}$ possible variations of target function. This space is called hypothesis space. Our goal is to find the optimal function in this space that is very close to the target function.

**Interesting and Exciting concepts** I really liked the notion of hypothesis space.

**Ideas Out of Lessons** Currently, I am working on a project where deep learning is used for the identification of Autism Spectrum Disorder. I am developing a 1-D Convolutional ResNet architecture for extracting features from MRI data of the subjects.