Assignement -08

Dhanush V Nayak
ee23btech11015@iith.ac.in

1 Forms of Learning

The best way to learn is to improvise by observation. But when such thing is done by a machine we call it machine learning. A computer analyses data , builds a model and then uses it to predict and solve problems. Various parts of an agent program can be made better by machine learning. For example, a self-driving car can learn different aspects by observing a human driver. It might learn when to apply brakes, recognize various objects on the road, and understand their consequences. Machine learning has become a very commonly used tool in software engineering, allowing various systems to improve automatically. Machine learning has also boosted the speed of work. For instance speed of analyzing complex astronomical data has been improved over the past few decades.
In the start, the agent starts with minimal or no knowledge and learns from data. The agents use techniques like transfer learning, where knowledge from one area is applied to another to accelerate the learning. But here we are primarily focusing on learning from factored representations of data. There are two types of learning problem: the problem of predicting one of the several categories called the classification and predicting a continuous value, like tomorrow's temperature called the regression.There are three types of feedback :

- **Supervised Learning:** It labels input-output pairs and identifies the next input using these labels.
- **Unsupervised Learning:** No labelling but instead uses clustering approach, to group similar items together.
- **Reinforcement Learning:** An approach with rewards and punishments for each correct and wrong action respectively. Agent maximizes rewards by adjusting actions based on past experiences.

2 Supervised Learning

In this type of learning the objective is to learn from a set of input-output pairs. Each example is considered as an input. We want estimate an unknown function $y = f(x)$. The function we estimate is called hypothesis h which is a part of hypothesis space H. Researchers use data tools like histograms and scatter plot to gain insights and identify the patterns. We not only see how well it fits the data but also its ability to generalize the unseen data. Bias refers to the error introduced by approximating a real-world problem with a simplified model. But high bias sometimes results in underfitting, which means the model fails to capture important patterns. And on the same line, a high variance leads to overfitting.
There is a tradeoff between bias and variance, known as the bias-variance tradeoff.Now we also have to worry about selecting best hypothesis. Supervised learning can be done by choosing the hypothesis h^* that is most probable in the data:

$$h^* = \underset{h \in H}{\operatorname{argmax}} P(h|data) = \underset{h \in H}{\operatorname{argmax}} P(data|h)P(h)$$

Simpler hypotheses tend to have higher prior probabilities, while complex models are penalized unless the data strongly supports their necessity. There is also a trade off between the expressiveness of a

hypothesis space and the computational complexity which was also discussed in the last assignment. Simpler models are easier to compute so favored in many research areas. However, in recent years deep learning has made it possible to use complex models and still compute efficiently.

2.1 An example Problem

There is an example in the textbook that illustrates a learning problem where we aim to predict whether a person will wait for a table at a restaurant or not. We consider ten factors that can influence his decisions like nearby restaurants, crowd level, wait time, and many others. Although we have only 12 past examples which is a small data set, still we make a educated guess about unknown scenarios. This helps us have a real-life feel about the concept of induction in supervised learning.