Assignment #1

Vijay Chennupati, standonopenstds@gmail.com

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Summary

Machine learning techniques can automatically detect patterns in the underlying data and use them to make predictions on unseen data. In traditional machine learning, we handpick the features based on domain knowledge to train the models. Deep learning is one of the more popular ways to solve machine learning problems. Deep learning models are deep in that they have a large number of layers; these models are capable of addressing low-level perceptual data[2].

Every machine learning problem has the following key components[2]:

- Data - A collection of examples we can learn from
- Model - The function that transforms the input to output
- Loss function - A loss function that determines how good our model is
- Optimization Algorithms - A algorithm to fine-tune the model parameters to minimize the loss

Types of machine learning [2],[4]: Machine learning is usually divided into three main types.

- Supervised learning: the goal is to learn the best mapping out of several available mappings from input to output given a set of input-output pairs. Regression is learning the mapping from input to output; in this case, the output is a nominal value. Classification is also learning from input to output; in this case, the output is a categorical value or the number of classes. If the number of classes is two, then it is called binary classification. If the number of classes is more than two and the classes are mutually exclusive, it is called multiclass classification. When the classes are not mutually exclusive, then we call it a multi-label classification.
- Unsupervised Learning: In Unsupervised learning, we are just given the data. We can form clusters on the data to form groups. We can discover latent features by doing principal component analysis. GANs can help augment data from existing data by adding new data when the data is sparse.

- Reinforcement Learning: Supervised and Unsupervised learning is done in an offline fashion, where we don't interact with any environment. We get lots of input data, train on the data, and make predictions on new data. But when we need to take some action instead of just predicting, then we need reinforcement learning. In reinforcement learning, the agent interacts with an environment in timesteps. At each timestep, we are given observations from the environment, and we need to choose the best action. This action is sent back to the environment through actuators in the case of robots. The environment provides feedback in the form of rewards. This reward is either positive or negative. The goal of reinforcement learning is to come up with an optimal policy based on the rewards.

Road to Deep Learning [2]:

The main highlights of deep learning like multiperceptron, convolutional neural networks, long short term memory, and reinforcement learning are rediscovered in the last decade due to the availability of large amounts of data and cheap computing based on GPUs. There are many novel approaches in deep learning like dropout, which address the vanishing gradient problem. The attention mechanism helped increase the memory and complexity of a system while keeping the learnable parameters constant. GANs helped in creating arbitrary data. The advances in parallel computing algorithms also helped in advancing reinforcement learning by simulating or creating synthetic data. Deep learning frameworks also played a very crucial role in getting ideas from research to mainstream industries.

Exercise Answers

1. We have a recommender system that recommends the best available meeting slots. The system uses a rule-based algorithm to select the best possible slots for meetings. The main problem with this approach is it doesn't take into account the current action taken after suggesting slot whether the meeting slot is accepted or canceled. A reinforcement learning approach considers past actions like whether a recommended slot is selected or canceled into its algorithm and suggest better meeting slots.

2. The problem is a lot with IoT devices; for example, I have a humidity and water detection system that records the activity every 30 min. They collect a lot of data and precisely don't recommend doing anything with the humidity or water detection system. It just merely alerts there is high humidity, or it detected water. We can develop a proper end to end deep learning models with the collected data and add additional external disturbances like outside weather to suggest some recommendations.

3. In traditional learning algorithms, we create models by training handcrafted features from data to make a prediction. With the advance in

computing power and the availability of more data, the deep learning algorithm can master some complex tasks by learning the low-level perceptual data. The data acts as a fuel to the algorithms to improve their performance on a particular task. In particular, the algorithms are like steam engines that used coal as fuel to allow for deeper mines and higher coal production and run machinery anywhere [3]

4. One example where we can apply or agument by using end to end deep learning is econometrics. In econometrics, we try to find the causal relationships between variables. For example, we can use deep learning to convert images from unstructured data to structured data and used as input to econometric models to study the economic meaning of those features combined with other data [1].

References

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