Machine learning (ML) usually consists in the training of a single or multiple models to perform a specific task, this performance is then evaluated for the model to be fine-tuned until the performance no longer improves. [A] However there are multiple approaches which complement ML and can increase efficiency and the overall execution depending on the desired task.

Multi-Task Learning

One of these approaches is Multi-Task Learning (MTL), which consist of utilizing the information obtained from the training signals of the related or auxiliary tasks and using this information to allow the model to make a better generalization of the original task. [A] This approach is actually fairly common, since every time more than one loss function is being optimized in the model, MTL is being executed. [A]

Multi-task learning is based on trying to exploit the results of certain features in the model by allowing them to be used in other auxiliary tasks. Firstly common features are found in the foremost layers of the network, while individual tasks are solved in later branches of the network. This can be done through what can be known as an encoder-decoder structure. [B] Auxiliary tasks are less important or might even be irrelevant to the overall main application of the model, yet despite being unrelated they are used to find a tougher and more robust representation of the input data which is then used for the main task and as a consequence improve the performance of the network. One of the main characteristics of these related tasks is that they should be easy enough to be learned and that they must require little to no effort to obtain the labels or annotations. The use of these tasks is to force the network to generalize a bigger amount of tasks and by having the auxiliary tasks the network restricts the parameter space during optimization and are therefore used as a regularization measure. [B]

In the encoder-decoder structure the auxiliary tasks explained previously, enact as a specialized decoder to the representation supplied by the encoder. The encoder favours the learning of the features in common, which are in turn exploited by the rest of the tasks, which enhance the performance of both the auxiliary tasks and the overall network. [B]

Deep Learning

Multi-task learning can also be used in deep learning methods, one of this methods is the Deep Neural Network, which consists of a neural network with a hierarchy of layers, which is used to extract representations form raw input data. Each hidden layer has an output that can be considered as a feature extraction, each output is used to construct advanced representation of the original data, and this is known as feature learning. Once a respectable representation of the features is obtained the classification can be done satisfactorily. [C] Deep Neural Networks are only one of the methods of deep learning, this approaches are important since according to [C] studies have shown, that for many applications, using a deep learning approach can outperform a standard machine learning method. One of the main issues of the deep learning approaches is overfitting, which will be discussed to a bigger extent later in the section.

Autoencoders

Another approach of Deep learning includes autoenconders, which play an important part in the extraction of the representation of input training patterns. [F]The representation that the autoenconder creates is an abstract representation which includes informative features to demonstrate a large set of data. [F]An autoenconder compresses and decompresses data, however they are data specific, which means that the data that they will be able to compress must be similar to the one they were trained on, and the decompressed data will always loose resolution, when compared to the original input data. [D] Autoencoders encompass the previously discussed terms, they follow a deep learning architecture and follow multi-task learning in the distance or loss function. They can also be used for classification and feature selection, especially after sparse regularization of the hidden outputs which allows for a high learning performance. [F]

Previous approaches

Introduction

The proposed project will consist of the creation of an autoenconder and a neural network in order to ff