Optimizing Convolutional Neural Networks for Text Analysis

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Abstract

Deep Learning Neural Networks simulate neurobiological features that allow learning new concepts through comparison and differentiation to form weighted connections between them through processing information and building an understanding over time, much like a human would [1]. Programming machines to automate more tasks, which can be performed faster or cheaper than the same task performed by a human. With further development, this would allow for more accurate machine translations, object or handwriting recognition, as well as the sentiment analysis of text or similar text classification task.

At the time of this writing, machine learning is not able to perfectly replicate the level of sophistication the ability of the human brain to efficiently learn at a finer granularity and perceive subtle distinctions; development evolutionary algorithms that might allow machines to more closely mimic human learning are still in their infancy stage. This paper focuses on methods machine learning models use to sufficiently emulate neurons and the forming of pathways through optimization in performing better in classification or regression tasks upon image and text datasets, which will be further modified for research upon improving accuracy in a pre-trained model for specialized text analysis tasks.

I. Introduction

Background

One of the main tasks of machine learning is to generalize previously acquired information, apply that understanding to new information and accurately identify or categorize the concept in a more efficient manner than could be performed by humans [2] Depending on the intended use of the task, an improvement might not be limited only increased accuracy; it be a tradeoff between accuracy, time, or cost – which may include hardware limitations.

The deep learning concept of convolutional neural networks allows a network to require less space for parameters due to its properties of parameter sharing, sparse connections, and equivariance [1]. Unlike in the use of fully connected layers which do not have sparse connections, every input does not directly influence every output as represented by arrows in Figure 1, as illustrated in [1, Figure 9.14]. Parameter sharing allows the weight of one input to be shared among the other inputs in the network, which allows the property of equivariance, where the change in one input will have an effect on the output [1].

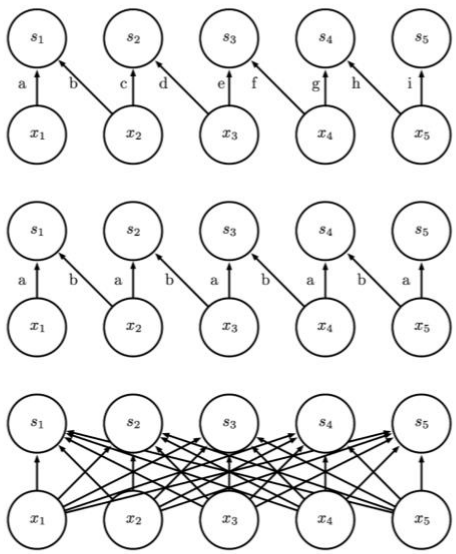

Figure 1. Comparison of local connected layers, convoluted layer, and fully connected layers, as illustrated in [1, Figure 9.14]

Object Recognition in Images

Convolutional Neural Networks allow the recognition of images or text even after small translations in the input, a property called invariance, using methods such as pooling, which might not otherwise be accurately identified when using other machine learning algorithms [1]. This makes it useful in practical applications with datasets in which images might be at varying angles depending on the angle the camera was pointed at the time the subject was captured.

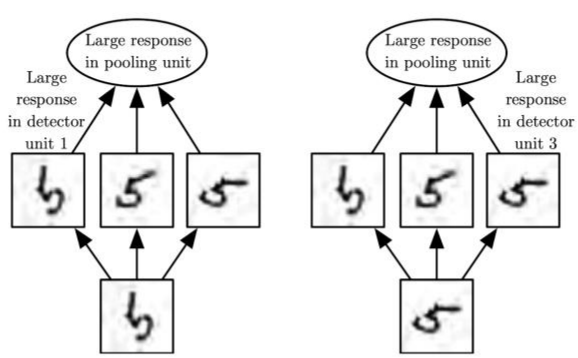

Figure 2. Example of learned invariances in handwriting analysis, as illustrated in [1, Figure 9.9]

Sentiment Analysis in Text

As mentioned in [3], the use of convolution with pooling works better with image recognition than it does with analyzing the meaning of sequences of words, where the location of the word in the sentence would have impact on the meaning, whereas in a picture a single pixel, being in a slightly different location might only mean it's at an angle rather than change the understanding of the image itself. In [4], the use Convolutional Neural Networks and Long Short-Term Memory (LSTM) is shown to improve the accuracy of text analysis when determining the overall sentiment of reviews on IMDB, which uses LSTM to train the model to understand the differences in meaning as a result of the sequences of the words in the reviews.

II. Approach

Due to the relatively new research on machine learning algorithms the constant development of variations to mitigate potential computational cost, such as the ones detailed in [1], current models applied to image or text analysis might be missing optimizations detailed in recent deep learning publications. These techniques may be required to develop pre-trained models that can perform better than publicly available generalized models on more specialized tasks, as shown in optimizations of text sentiment analysis [4].

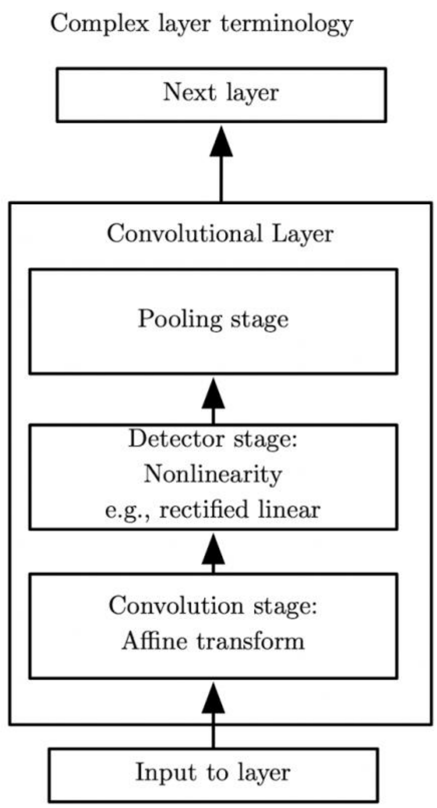

Figure 3. example implementation of Convolutional Neural Network layers, as illustrated in [1, Figure 9.7]

III. Conclusion

I have yet to apply my current understanding of this material and develop and test my own model on a real task.

The next steps in this research are to apply a model using Convolutional Neural Networks in conjunction with Long Short-Term Memory to analyze text from a pre-labeled sarcasm dataset and train a model to identify sarcasm with greater accuracy than any models which are currently published.

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