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Are the Long Short Term Memory and Convolution Neural Networks really based on biological systems ?

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Abstract

In general, it is not a simple task to predict sequences or classify images, and it is even more problematic when both are combined. Nevertheless, biological systems can easily predict sequences and are good at image recognition. For these reason Long-Short Term Memory and Convolutional Neural Networks where created and are based on the memory and visual systems. These algorithms have shown great properties and show certain resemblance, yet they are still not the same as their biological counterpart. This article review the biological bases and compares them.

Keywords: Classification Methods, Sequence Prediction, Image Classification, Vision, Memory

1. Introduction

Two automation problems are classification of complex inputs (i.e. images) and sequences prediction. The first problem requires interpreting the input by understanding what is in it. This can be solved by finding patterns, decomposing them and later appoint a class. On the other hand, sequence prediction requires to have recollection of past events that are similar to the one presented, establish a pattern and make a prediction. Consequently, it is even more problematic to predict sequences of complex inputs. Thus, to solve these problems, it is required an algorithm that can decompose the input and has some sort of memory.

The brain is capable of doing this things easily. Hopfield in 1988 defined the Human brain as computer made out of organic material and wet chemistry but, nonetheless, its one of the world's best computers [6]. This statement should not be taken lightly, while the brain requires more effort for mathematic operations than its silicon computer counterpart, its performance for object recognition and decoding natural language outperform most machines. The brain is so powerful that can quickly separate different inputs (visual, audio, sensory, motor, etc), process them, discard information and decide an action, while still having control of the organs.

At the moment the brain is far from being understood, nevertheless there are several areas and their basis on how they work that can serve as inspiration for new algorithms. Like, the auditory area that processes information of volume, pitch, sound localization, rhythmic patterns and understanding language; the sensory area involved in cutaneous and other senses; the Motor area, in charge of muscles voluntary control; the Visual Area, which decomposes images to understand information of spatial localization, object detection, recognition, movement, and color. Another area, is the memory area, in charge of collecting information, separating, reinforcing or decreasing connections and many more.

Two algorithms based on brain areas that have excel in classification, sequence prediction and decomposing complex data are Long-Short Term Memory and Convolutional Neural Networks. Even more important is that these two algorithms are currently being combined for classification of even more complex data. As said before, these areas are not completely understood, yet there are many theories on the basis of how they work. This paper intend to give a review of neural, visual and memory areas, to have a better understanding on how they work, and have a view on what they are currently missing.

2. Brain Activation

Humans are exposed to abundant information which has to reach many areas to be process, stored and discarded. The problem is most of this information is redundant, and unneeded, and requires to be discarded. Another problem is that most processes start at different times to accomplish a single task (grasping starts with arm movement before the fingers are completely configured). To accomplish these and understand what is happening inside the brain it is important to distinguish the path each signal follows, starting with nerve activation from external inputs, to the processing center or storage units.

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