Creating Patterns for Machine Learning Using Multiple Alignment

Saritha Kinkiri, Wim J.C. Melis & Simeon Keates

s.kinkiri@greenwich.ac.uk, Wim.J.C.Melis@greenwich.ac.uk, s.keates@greenwich.ac.uk

Faculty of Engineering and Science, University of Greenwich,

Chatham Maritime ME4 4TB, UK

Introduction

Learning is a basic skill that helps every human on a day to day basis to improve their life. It is one of the key features to achieve knowledge and deliver intelligence. Learning involves a combination of human thoughts, thinking-process and their behaviour and that on a regular basis. This change in behaviour is achieved through the feedback of information given by and/or received from the surroundings, and that with the aim to improve the accuracy of processes. For example, sensory organs get information from the environment, but the human brain cannot take in and process all the data in one go, so it converts data into patterns, and then arranges and stores it for later retrieval. This process is continuous as these patterns are continuously adjusted to fit recent events. In order to be able to mimic this learning to artificial systems it is key to find answers to questions like: “how do humans learn with patterns?” and “how can humans improve their learning experiences?”.

Method

While it is generally believed that the human brain takes most of its input from our sensory organs, it does not necessarily rely on all of them to develop and learn. For example, Helen Killer has no sight and no hearing, yet she managed to learn a language and became one of the best writers in the world [1]. This shows that humans do not need all senses to become intelligent, and so while the brain is currently considered as a dark box with no knowledge, there are still time flowing patterns on its inputs from the environment. While many researchers are aiming to better understand how the brain works at the lowest level and how it provides for its learning functionalities, it may be that more suitable answers need to be searched in how the brain converts information into patterns, as it seems to be those patterns that lie at the basis of most, if not all, of our learned information. For example, if someone asks you to explain the structure of your home, you will first think about where to start from, kitchen or cellar, and from there you will work your way methodologically through the remainder. So even though all information is there, you will prioritise and then explain to your friend following a particular most often logical, pattern. Similarly,, the human face is learned as a collection of patterns of nose, mouth and eyes. Here, the question becomes, how can machine learning algorithms learn to learn like the human brain, with regards to these patterns?

One method that aims at learning patters like the human brain is the SP theory [3], which is a method of learning, where information is compressed by identifying common patterns. It operates according to the multiple alignment principle, and consequently aims to find similarities along multiple dimensions. To achieve these alignments, similarities are identified within each provided pattern during the learning phase and used to reduce storage requirements, which leads to an overall data compression. Each unique pattern is saved, and so when a new pattern is presented, the SP theory will check whether there is any similarity by identifying patterns to ensure maximum compression.

The SP theory represents information through symbols, which are effectively multi-dimensional patterns. Since this theory operates similarly to how a human brain learns, it is a useful starting point to improve how machines become more able to learn like a human. The question then becomes how this machine saves and retrieves information?

Generally, the human brain retrieves information from "memory", which for the brain are a set of interconnected neurons. While neurons are quite slow in comparison to transistors in current computers also their functionality is quite different. For example, if you want to catch a ball, you need to estimate the trajectory of the ball to be able to catch it, which happens automatically in the brain through a derivative pattern that aligns with previously learned patterns influenced by certain parameters, such as estimated weight of the ball, force of throwing and environmental conditions such as wind etc. On the other hand, computers, would need to calculate each step of the trajectory to ensure that a robot catches the same ball [2]. An additional difference between computers and the brain lies in the fact that a computer uses separate memory in the form of memory cards and hard drives, and does not store data automatically, while the brain seems to be one large pattern focused memory that stores/adjusts continuously.

Expected Outcome

Currently, very few machine learning algorithms care about the information coming from the environment. It would therefore be interesting to identify suitable ways to use multilevel alignment for information to create patterns like those in the brain. These machines should then also be able to retrieve data automatically, and even predict the output results based on incomplete patterns being presented. While overall, the data would be stored efficiently due to the inherent compression, the system would easily be able to learn and continuously improve its patterns. Our research will propose such a multi-level model, build a prototype simulation and evaluate its performance against baseline methods.

Discussion

Input to the human brain travels through the cerebellum and striatum, before reaching the cortex. Within the cortex, it is generally believed that there would be one unique algorithm that processes the information which is received from sensory organs. The cortex also stores information as patterns in a hierarchical structure. However, it appears that the brain does not know the difference between information received from sensory organs and virtual creations of the brain itself. Consequently, being able to create a multilevel hierarchy to store different patterns will help a machine to learn in a way like us humans, and should then also allow the machine to deliver similar functionality to that of the human brain.

References

[1]. Hawkins, J. (2005). *On Intelligence.* New York: New York : Holt Paperback .

[2]. Tsang, W. (11 August 2016). *The Fractal Brain Theory* (First ed.). Wai H. Tsang.

[3]. Wolff, J. G. (May 12, 2016). The SP Theory of Intelligence and the Representation and Processing of Knowledge in the Brain, Frontiers in Psychology, 7, 1584, 2016