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Modelling learning systems
A DSL for cognitive neuroscientist

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1 Introduction

In the past years machine learning has surpassed humans in some recognition tasks, and the development shows no signs of slowing down. These developments are however based on relatively old research on neural networks (Nilsson 2009; Russell and Norvig 2002). Newer investigation into rehabilitation and learning indicates that such networks alone cannot account for the same amount of learning that happens in the brain (Mogensen 2011; Block 2007; Russell and Norvig 2002; Moravec 1998; Dennett 2017). For that reason the breakthroughs in machine learning is hard to transfer to the domain of cognitive neuroscience.

This paper takes two steps towards remedying this. First by describing a domain-specific language (DSL) that is capable of representing the concepts of learning systems in the domain of neuroscience. Second by validating the DSL through the modelling of a small learning task, which will be executed on standard machine architecture.

The hope is that the DSL will lay the foundation for a representation of learning and learning concepts, that will serve as better models of inference as well as accurate simulation tools for scientist.

1.1 Structure

This paper is structered ...

1.2 Problem statement

...

2 Theory

This section accounts for the theoretical foundation of paper and is divided into three parts. The first part concerns the broad topic of computation and learning in neural systems as seen from the perspective of computational neuroscience. By focusing on cognition, plasticity, learning and rehabilitation, it derives the necessary and sufficient language abstractions to capture the complexity of the domain. The second part introduces traditional machine learning from the perspective of computer science. These concepts will be applied when implementing learning models in section 3. And lastly the theoretical background for language abstractions and domain specific languages will be treated.

2.1 Computation and learning in neural systems

> Activity-dependent synaptic plasticity is widely believed to be the basic phenomenon underlying learning and memory (Dayan and Abbot 2001).

Commonly referred to as *what fires together, wires together*, Hebbian learning suggests that synaptic connections from neuron A to neuron B are strengthened or weakened when neuron A excites or inhibits the chance of firiing neuron B respectively (Dayan and Abbot 2001). Hebbian learning is believed to play a large part in the plastic nature of the brain, especially within learning and memory formation (Dayan and Abbot 2001; Johnston 2009; Robertson and Murre 1999).

(Robertson and Murre 1999) studied patients during rehabilitation of brain damage and conjectured that learning — whether when the brain acquires new information or recovers from lost information — occurs based on the structural changes induced by the Hebbian principle (Robertson and Murre 1999).

(Mogensen 2011)

Reorganisation of elementary functions

2.2 Machine learning

2.3 Language abstractions

3 Volr: A DSL for learning systems

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