Symbolic Manipulation and Computation in the Same Graph

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Abstract

General artificial intelligence refers to machine intelligence than performs a task as successfully as a human does. A fundamental difference between human neural network and current machine neural networks is that only human networks combine symbolic reasoning with computation. Here we show how a graph can ...

1 Background

1. What is symbolic computation?

   A symbolic computation is a calculation performed with symbolic representations of values and operations. A simple example would be the expression $(x+1)(x-1)$ which would evaluate to x^2-1, rather than to some numerical result.

2. What is calculation?

   A calculation is a process by which one or more inputs is transformed into one or more results. One may calculate that the product of 5 and 4 is 20.

3. What is meant by a computational class? - do you mean complexity class?

Code for each subsection of this document can be found at NeuralNetworkResearch.

2 Methods

2.1 Network Construction

Figure 2 illustrates a neuron that receives three ordered inputs.

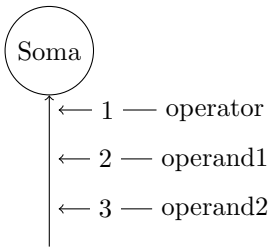

Figure 1: Single neuron receiving ordered intputs.

While this model is suitable for biological networks of neurons, a neural network in the computational sense would look more like an abstract syntax tree. In the following diagram, a network of operators and operands form a tree-like structure in which elements at lower levels represent values to manipulate which at higher levels interact with each other through arithmetic operations to produce a result. Any computation which involves a combination of operations on one or more values can be represented in this structure, such as logical operations or large-scale machine learning models.

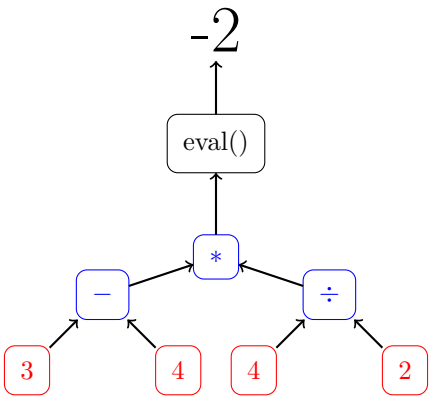

Figure 2: An Abstract Syntax Tree of arithmetic operations.

Research Idea: In a typical network, values which pass through weights are multiplied by them. Instead of just the values of the weights themselves being updated during training, the operation by which they modify their input are trained as well. Regular feedforward neural networks often have trouble modelling certain simply relationships, since the operations behind weights and activation functions are not suitable. For example, $\frac{x}{y}$ would be impossible for a typical feed forward network (given x and y as inputs) to model since there exists no operation in the network by which the inverse of y, $\frac{1}{y}$, can be taken and multiplied by x to yield a result. Biologically speaking, neurons in different parts of the brain operate very differently to one another, there's no reason the same shouldn't go for Artificial neurons.

3 Results

4 Conclusions