

Team Name: ShallowMind

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**Title:** Neural Network Mathematics

**Proposal:**

We want to combine AI and mathematics by teaching one to perform mathematical computations. It is our hope to create an application that will help people learn how an AI is trained using mathematical equations. This will give a user the ability to train their own AI from scratch and learn what methods are most effective. To do this, the client needs a friendly user interface that will allow them to communicate mathematical equations as input to the AI and receive feedback. The client also needs a way for users to evaluate the intelligence and progress of the AI they have been training.

With this project we will create an AI that will be able to perform basic mathematical computations. Users will be able to give the AI equations and will be able to evaluate the output of the AI. This way the AI will learn from its mistakes and will become better with every equation that will be given. Users will also be able to generate a report detailing the intelligence and progress of the AI over each iteration.

Mathematical equations will be represented as tree structures. These will be produced via lexical and syntax analysis much in the same way a compiler parses a program. The tree will be used as training data (assuming the equation represented by the tree is correct) for a modular neural network. The network will split inputs to evaluate equations recursively. Each operator should have a node that activates via sigmoid function by recognizing operators using ASCII decimal representations for input.

The server will use Python Keras to train the network model and answer API requests using the trained model.

## Previous work

During our research we found that multiple attempts at teaching AI math has been done, for example by using the neural network api Keras. We also found research in the field of psychology where the neural network's learning of math is compared to that of a child's<sup>1</sup>.

The biggest project we found was DeepMind's attempt at teaching an AI to pass a high-school math exam, by teaching it mathematics. This includes simple arithmetic like our proposed project, but also higher-level math such as probability and algebraic generalisation. Their AI scored 14 out of 40 on the exam<sup>2</sup>.

### Sources:

Mickey, K. W., & McClelland, J. L. (2014). A neural network model of learning mathematical equivalence. In *Proceedings of the Annual Meeting of the Cognitive Science Society* (Vol. 36, No. 36).

Saxton, D., Grefenstette, E., Hill, F., & Kohli, P. (2019). Analysing mathematical reasoning abilities of neural models. *arXiv preprint arXiv:1904.01557*.

Task 4: Provide your rough plans in point form.

1. Set up development environment (8/11/2019)
2. Basic implementation of Keras (15/11/2019)
3. Basic prototype, the AI gives an answer (21/11/2019)
4. Testing and training the AI (28/11/2019)

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<sup>1</sup> <http://web.stanford.edu/~kmickey/pdf/MickeyMcClelland2014.pdf>

<sup>2</sup> <https://www.zdnet.com/article/ai-aint-no-a-student-deepmind-flunks-high-school-math/> & <https://arxiv.org/abs/1904.01557>