Novel Architectures for the Artificial Neural Network: Implementation of Virtual Neurotransmitters

Iyer, Nikhil (School: Edgewood Junior Senior High School)

Artificial neural networks are biologically inspired computational structures that are capable of learning how to perform tasks heuristically. They derive this ability by imitating the structure and thereby the function of the human brain. Operating under the assumption that structures which more closely emulate the biological functions of the brain will more readily adapt to tasks and achieve human-level performance, the study seeks to analyze the significance of (novel) inclusion or (traditional) exclusion of virtual neurotransmitters in the performance of various neural network models. The details surrounding the role or underlying function of neurotransmitters in the brain is still a topic of ongoing research, however, it is definitively known that there are at least two types of neurotransmitters and that the neurons may control the output of each neurotransmitter independently. From these observations, I propose the activation of biological neurons may be represented as n-dimensional vectors where n is the total types of neurotransmitters. To-date neural networks implement only scalar activations and activation functions. This study was able to show that the implementation of these virtual neurotransmitters positively impacts the ability of the network to learn. In the worst case, the architecture performs identically to a scalar network, but on average it converges much more reliably. The architecture also effectively manages the vanishing/exploding gradient problem as the byproduct of normalization in the activation vector function.

Awards Won:

Fourth Award of $500

Association for the Advancement of Artificial Intelligence: Honorable Mention