**PROJECT PROPOSAL FOR SENIOR RESEARCH**

**BACKGROUND**

I have always had a fascination with neural networks; I have been to a few technical presentations discussing the advancements in machine learning and AI, and although these presentations have quite a bit of information about the various applications of artificial intelligence, the lack of precise information about *how* a neural network works disturbs me. To some degree, the extent of specific, technical information given in these presentations amounts to the statement, “we don’t really know how these things work…they just do.” As a mathematician and computer scientist, this is simply not enough to satisfy my desire to understand the inner workings of these seemingly complex structures. As a venture into the depth of the math and computer science that drives them, I have elected to study neural networks in higher detail for this project.

There is an abundance of applications for neural networks, including but certainly not limited to financial, medical, and industrial applications. Neural networks can be used to classify information, extrapolate based on trends in high-dimensional data, and make decisions based on input state information. These applications are all useful in the sense that they show their users valuable information about the data they have collected; for example, an industrial use of neural networks is the determination of appropriate process control for a manufacturing plant. To quote Alyuda systems, “complex physical and chemical processes that may involve the interaction of numerous (possibly unknown) mathematical formulas can be modeled heuristically using a neural network” [1].

In particular, there is a partition of these applications – in which I am particularly interested – called computer vision. In short, “computer vision is the science that aims to give [a machine the capability to visually sense the world around them]” [2]. There has been an investigation into computer vision for some time now, and as such, there is quite a bit of information about heuristics used to design these networks and criteria (such as “ground truth-ing” [3]) for judgement on efficiency and performance of them. These issues are of interest from the computer science perspective. Competition computer vision architectures for networks have been wrestling each other for the best performance, and as a result, there are several standardized datasets available for use by those looking to compare results. Because this data is so accessible, it is reasonable to pursue undergraduate research in the realm of computer vision. The accessibility of this data nixes the requirement for manual data set creation, which would be tedious and unfeasible in the scope of this project.

There is also interest in the general neural network. The use of a network to classify has its merits, but as a mathematician, I need to see more information about what these complex constructs can be used to solve. The abstract (and yet somehow simultaneously definite) mathematics used to structure the neural network is the real core of the issue. Questions about *why* a particular architecture works better than another delve into the multidimensional calculus that defines the networks; these clearly define the differences between one architecture and another. One-dimensional problems (such as approximating/producing a sine function) are likely to give a first step into the precise details in the construction of a multidimensional architecture (as opposed to the practical aspect of function overcoming justification of function in applications).

**PROJECT DESCRIPTION**

**FOUNDATIONS**

**IMPLEMENTATION PLAN AND TIMELINE**

**CONCLUSION**

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