CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

**Name(s)**

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**Project Number**

**S0831**

**Project Title**

# Galaxy Morphological Classification through Convolutional Neural Networks

## Abstract

**Objectives**

The creation of new telescopes in the future will lead to the generation of more images of new distant galaxies which will need efficient and accurate classification to better understand the processes that govern the evolution of universe. Thus, the objective of this project is to design, train, and test a neural network that can classify different types of galaxies based off of their morphological structures.

**Methods**

A dataset of over 100,000 images of hand-classified galaxies is obtained online and separated into sub-sets of elliptical and spiral galaxies for classification task one, specific spiral types (Sa and Sc) for task two, and specific elliptical types (E0-E3 and E4-E7) for task three. These datasets will be trained, processed, and tested on a convolutional neural network. A neural network is then created with multiple convolutional layer blocks for the processing of input images and for the generation of classification probabilities. This same neural network is used for all three classification tasks. For each task, the model weights are saved after training and used to predict on unseen datasets of galaxies to generate the official accuracy of the neural network.

**Results**

For the objective of classifying between elliptical and spiral galaxies, the training accuracy was 94% with a test accuracy of 100%. For the classification between spiral types, despite the training accuracy being 80%, there was 100% accuracy on the test dataset, and for the classification between elliptical types, there was a training accuracy of 95% with a test accuracy of 100%. For each classification task, the test accuracy was a result of the model predicting on 5 unclassified galaxy images and outputting a probability array of what the machine thinks is the classification.

**Conclusions**

The results demonstrate the capabilities of a convolutional neural network to classify different kinds of galaxies in place of simple and unreliable hand classification because it is not only fast, but accurate to a significant degree. As a result, this galaxy classifier can have large implications when new galaxies are imaged because the model can be used to rapidly and accurately classify those galaxies, giving a more accurate insight into the processes how the universe has evolved over time.

**Summary Statement**

I created a machine learning model that could accurately and efficiently classify images of different types of galaxies.

**Help Received**

Online resources helped me understand how to code the graphs to show the performance of my neural network, and everything else was done on my own.