Neural Networks to Score Galaxy Models

S20-Group 2 (*Pandemonium*)

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Galaxy Mergers

Introduction and Background

MO1

Galaxy Mergers

Big Picture

The merging of galaxies plays a critical part in galaxy evolution.

Scientists CANNOT obtain vital knowledge such as velocities, orientations, and mass-ratios from observation alone.

To obtain these unknowns, scientists guess at those values and simulate the merging.

By finding galactic models that best fit, we can find true measurable parameters.

Slide 4

MO1 Matthew O, 5/6/2020

Galaxy Mergers

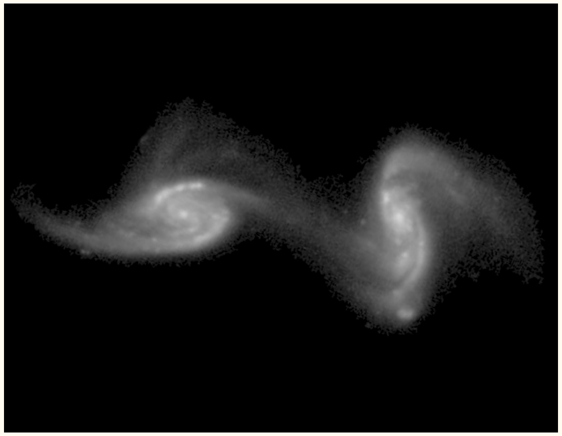
Background Code and Data

We used data from SPAM, a restricted three-body model simulation software which simulates collisions and adds particles for realistic bridge and tail formations.

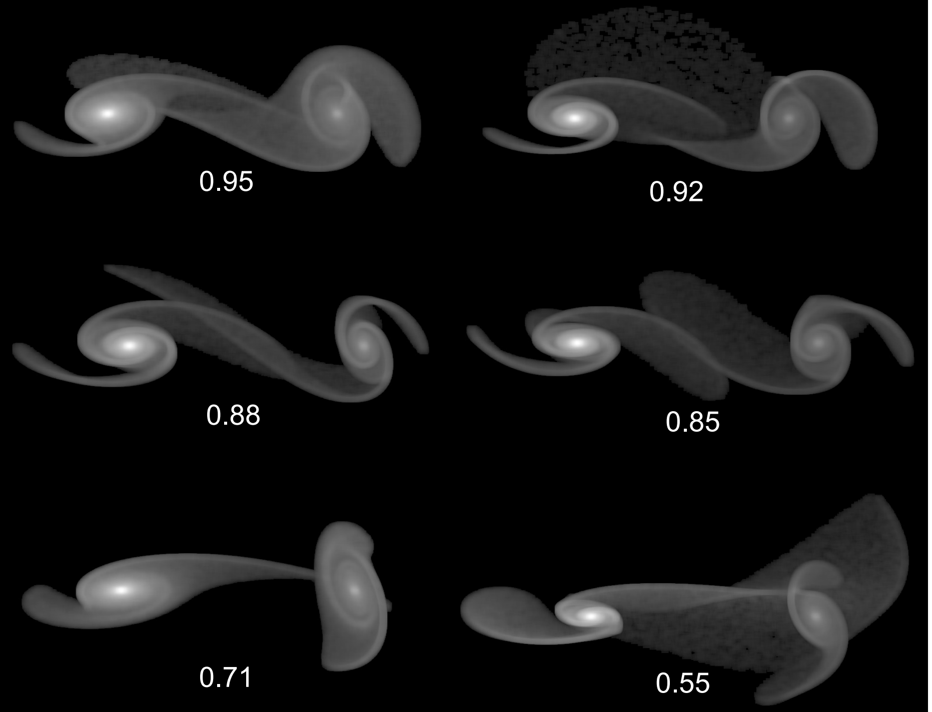
We also used Galaxy Zoo: Mergers data sets. Mergers is a citizen scientist effort to explore unknown parameter space for galactic models. This is done by tournaments to place human fitness scores with images of galaxy mergers.

Galaxy Mergers

Galaxy Zoo: Mergers
Target Image



Galactic Model Images



Galaxy Mergers

Goals and Results

Galaxy Mergers

What are the goals and aims of this project?

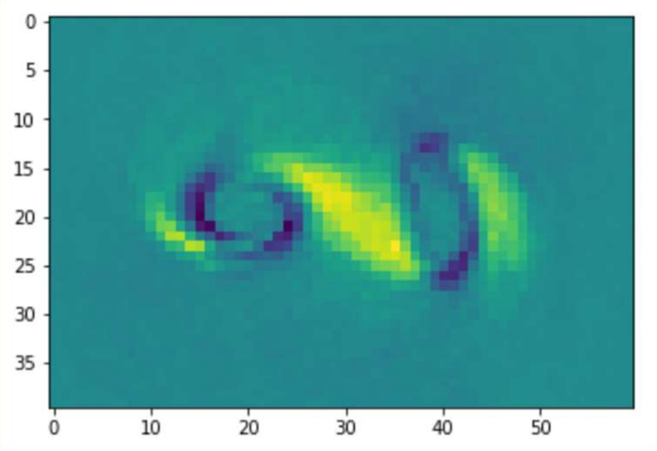
Goals:

- Create Neural Networks to read a galactic model image and create a "fitness score"
- Train on known models and Human Scores from Galaxy Zoo: Mergers
- Understand how the Neural Networks are scoring the images

Aim: Quicken the search for well-fitting models, explore galactic model parameter space, and hopefully find true dynamic parameters for observable galaxy collisions

Galaxy Mergers

Single-Layer Results



MSE = .012 (training) and .019 (validation)

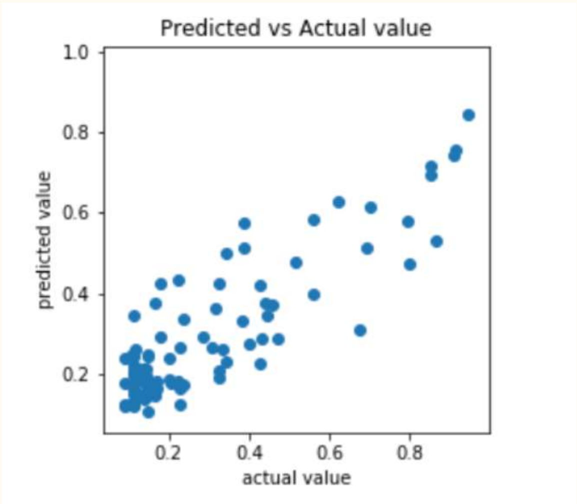
There was overfitting no matter the shifts in hyperparameters.

We found linear correlations between the predicted score versus the actual score.

Visualizing weights successfully illustrated bridges and tails.

Galaxy Mergers

Convolution Results



We found MSE = .013 (training) and .021 (validation)

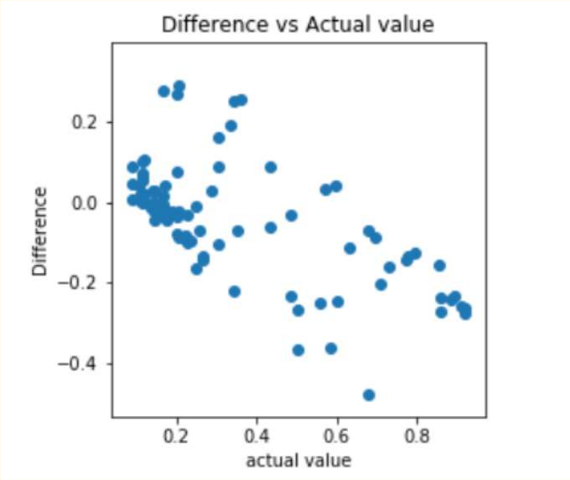
There was continued overfitting.

There arose a linear correlation with tendencies to underscore higher human-scored models and overscore lower human-scored models.

While the weights were hard to quantify, the activations of layers showed galactic cores, bridges, and tails.

Galaxy Mergers

Examining Results



Both do fairly well for creating a rough prediction for the fitness score.

Both single-layer and CNN performed similar, suggesting the data set is small and likely has noise in the human scores. Leads to overfitting in both networks.

Both networks over-predicted bad models and under-predicted good models. Likely due to uneven distribution of model quality. Most models had a lower human score.

Let’s hear from the team…