University of Waterloo

PHYS 449/ PHYS 773 – Fall 2022

Project Proposal

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Selected Research Paper:

M. K. Cavanagh *et al.*, "Morphological classification of galaxies with deep learning: comparing 3-way and 4-way CNNs", MNRAS, **506-1**, 659–676 (2021). DOI: https://doi.org/10.1093/mnras/stab1552

Project Overview:

The objective of the research presented in Cavanagh *et al.* 2021 is to automatically classify galaxies based on their morphology. Classifying galaxies has historically been done by visual inspection, however with the increasing size of current and future datasets, it becomes necessary to have an automated classification technique. For this project, we will attempt to replicate the results of Cavanagh *et al.* 2021 by classifying galaxies into three categories (elliptical, lenticular, spiral) using a 3-way Convolutional Neural Network (CNN) and into four categories (elliptical, lenticular, spiral, irregular/miscellaneous) with a 4-way CNN.

Dataset:

The dataset used by Cavanagh *et al.* 2021 contains 14,034 galaxies which have been visually classified based on their morphology by Nair *et al.* 2010 and made into a publicly available catalogue. The classification uses the g-band filter images from the SDSS Data Release 4 (Adelman-McCarthy *et al.* 2006) which have a special resolution of 50 kpc (Cavanagh *et al.* 2021). Using the J2000 ID of these object available in the catalogue, we will be able to recover the publicly available SDSS images and use them to train our machine learning algorithm.

References:

P. B. Nair *et al.*, "A Catalog of detailed visual morphological classifications for 14,034 galaxies in the Sloan Digital Sky Survey", ApJS, **186**, 427 (2010). DOI: https://iopscience.iop.org/article/10.1088/0067-0049/186/2/427

J. K. Adelman-McCarthy *et al.*, "The fourth data release of the Sloan Digital Sky Survey", ApJSS, **162**, 38 (2006). DOI: https://iopscience.iop.org/article/10.1086/497917