DEEPLENSE - Search for Strong Gravitational Lenses.

Personal Info.

Name :- Devin Yasith De Silva.

Email:- devin.18@cse.mrt.ac.lk

Github:- https://github.com/DevinDeSilva/GSOC-DeepLenseTest

Address:- 145/5 Salgas Mawatha, Mattegoda, Western Province, Sri Lanka.

Problem Statement (Proposal)

Strong gravitational lensing is a powerful tool for exploring various astrophysical questions, including probing the substructure in dark matter haloes of the lensing galaxies. However, one of the main limitations of such analysis is the relatively small number of known lens candidates and confirmed lens systems. Recent works have shown the potential of CNNs in the task of lens finding — the classification of images obtained from the telescopes into lensed and non-lensed systems. Since the number of real lenses is insufficient for training a machine learning algorithm, training datasets heavily rely on simulations. Even though simulated systems are designed to resemble observational data as closely as possible, there is still a need to bridge the gap between simulated data used for training and real images showing a wider variety of object morphologies.

The goal of this project is to develop and test methods to identify lensed systems in the data from wide-area surveys (such as Hyper Suprime-Cam or Dark Energy Survey) with a focus on applying domain adaptation techniques with simulated data as a source and real observational images as a target.

Key Points.

- During the submission phase, the impact of data augmentation was explored and found that augmentation has an improvement in model stability and accuracy: - Using Mean and standard deviations of the image to normalize (Please Refer to GitHub for results:- https://github.com/DevinDeSilva/GSOC-DeepLenseTest)
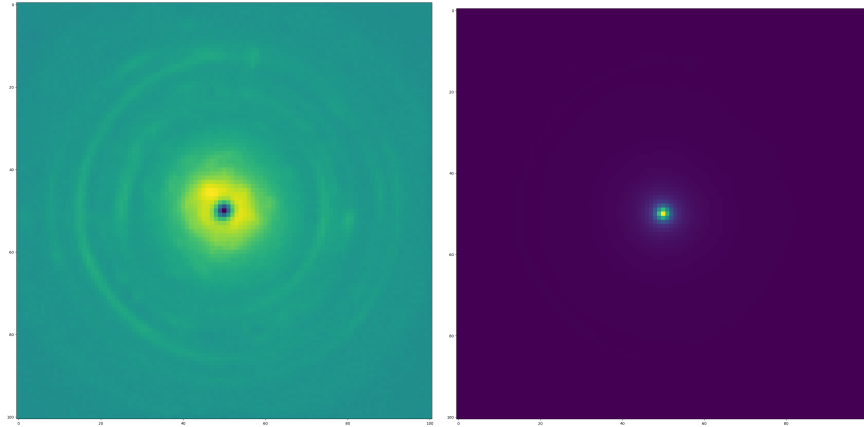
Fig.1 Mean image with lensing (left) and without lensing (right)

- ViT (Visual attention Transformers) has provided the best results from the experiments conducted and further exploration in this sector will be conducted.

Deliverables.

- Deep Learning model:- Given an image classify whether that image contains a lens or not.
- Analysis of said model.
- Documentation.

Project Schedule

I intend to work for 30 hours a week for approximately the rest of the period.

May 8th 2023 – May 28th 2023 (Community bonding period):

- To further explore the dataset.
- If possible check on the real-world dataset.
- To further check out Domain adaptation methods [1].
  - This is to bridge the gap between real-world data and simulations.

Below is the timeline after May 28th 2023 to July 09th 2023

Week	Task
1	- Explore Real data. - Testing the current models created with real-world data.
2	- Using Domain adaptation techniques to bridge the gap of real data and simulations - Improvements in a real-world dataset
3	- Using Domain adaptation techniques to bridge the gap of real data and simulations - Improvements in a real-world dataset
4	- Hyperparameter tuning. - Testing Approach and analysing
5	Checking out Unsupervised training techniques for improving the project further [1].
6	Clean up code and write documentation for all the added functionality

Bio

I am Devin De Silva, a 4th-year Computer Science and Engineering undergraduate at the University of Moratuwa, Sri Lanka. My favourite field of science is Astronomy/Cosmology, I have volunteered as an educator to uplight the STEM education of students in rural areas through night camps conducted by our school astronomical society. I presented our projects at the CAP Conferences (Communicating Astronomy to the public) in 2020 and 2022.

My passion for Machine Learning and Computer Vision was back when I was in 2020. I worked on several personal projects initially like [Pneumonia detection using images](#), [Text Recognition using images](#) and [Gastro - Intestinal tract anomaly detection](#).

 Further, I have done several Certifications and Competitions which are listed below.

Certifications.

- Introduction to Deep Learning (With Honors) - HSE University(Coursera-Advanced Level)
- Deep Learning with PyTorch: Zero to GANs - Jovian. Ml

Competitions.

- Runners up, Datathon 2022- Inter-University Data Science Competition,

    For this competition, we use images to do skin disease detection using Images. The main highlight was to do monkeypox detection. For the final, it was on anomaly Detection in Server side Events.

I believe that I would be the best person for this project because I already have some experience in image processing and computer vision while also being quite comfortable with the math behind the implementations. Further Astronomy is a passion of mine which I have worked on as a public communicator. Additionally, I intend to contribute to Astronomy related projects after the GSoC period as often as I can. Programming and Astronomy are somethings I genuinely do enjoy and something I could work hard at.

Citations

[1] S. Alexander, S. Gleyzer, P. Reddy, M. Tidball, and M. W. Toomey, 'Domain Adaptation for Simulation-Based Dark Matter Searches Using Strong Gravitational Lensing', arXiv [astro-ph.CO]. 2021.