

Title - Adding Functionalities to DeepLense for Decoding Dark Matter

Synopsis - Pyautolens is an excellent tool for the simulation of gravitational lensing. My aim here is to use the functionality of the pyautolens library to make further development in the DeepLense pipeline. One of the things that I aspire to do is to make some progress in understanding whether Weakly Interacting Massive Particles (WIMP) is dark matter or not. I am looking to add some function to the DeepLense pipeline to estimate the distribution of dark matter in galaxies, Mass of dark matter halo and its gravitational effect. I am looking to use transfer learning for this process and would try with models like Resnet50, VGG16 and EfficientNet.

Timeline -

Before 26th april (First two weeks) -

- I will read more about dark matters, Gravitational effect on visible matters
- I will be setting up the workspace in Google Collab or Kaggle notebook which I messed up in my evaluation task by trying to load all kinds of data and making sure that GPU works fine.
- I will discuss and understand from the mentors what I can improve on and what more functionalities are there that are to be added.

26th april to 23rd may (Before the official coding period)

- I will start collecting all the data. For this I will take help of the mentors. I will get some images and data from them. I will try to make some simulations in pyautolens and might add them as data, Also I will check if there is any useful data on the data which I can scrape and use.
- As I will be collecting the data I will also train them on a pretrained model to see how much time it is taking. And how can I optimize the process so that the time taken can be reduced.
- I will also train the data on some custom model and then do hyper parameter optimisation on it (I will use optuna for that mainly, but will check whether GridSearchCV or Hyperopt perform better or not). The main reason for doing so is to check whether transfer learning gives better results or a custom model. I believe transfer learning will perform better

23rd may to 23rd june (First month of the coding period)

- Based on the result from the previous period, I will start adding the functionalities to the DeepLense pipeline. First functionality will be to add a module which would give a good estimation of the mass of the Dark Matter halo.
- Second module that I have in mind is to estimate the mass of dark matter subhalos. This will kind of be an addition to the previous module only.

- Third Module that I would like to add is to estimate whether the dark matter halo is that of a Cold Dark Matter(CDM) or Warm Dark Matter (WDM) or Massive compact halo object. For this I would need help from the mentors. This would be possible only if we have significant picture examples of the three types of Dark Matter.
- I might like to add some more modules as I gain more knowledge about the topic and discuss with the mentors.

23rd June to End of Coding period

- I will use this time mostly for testing the done work. To check whether the modules have been integrated properly or not.
- I will also look for ways to improve the estimation by improving the model.
- I will also use this time to take feedback from the DeepLense team and the mentors and find out ways to improve and make changes in the existing work.
- I will use the leftover time to implement these changes that were being suggested.
- Include these modules in the documentation with an example so that a beginner can easily start working on it.

This is the bare minimum that I wish to contribute.

Benefits to the Community - This will help researchers know about Dark matter to a great extent. But these simulations and predictions will go a long way in gaining knowledge about the properties and the location of dark matter, How they interact with matter, if at all they do and finally trying to answer what are the building blocks of dark matter. Dark matter plays a very important role in also answering the process of the universe creation, it might help in that.

Biographical Information -

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Resume -

<https://drive.google.com/file/d/1xjw2nZnD1ghU2gv65snCagRPFAxuwNF/view?usp=sharing>

Github Profile - <https://github.com/sayantan1410>

Kaggle Profile - <https://www.kaggle.com/sayantansadhu>