Google Summer of Code 2022

Equivariant Neural Networks for Dark Matter Morphology with Strong Gravitational Lensing

ML4SC-Deeplense

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About The Project

The study of dark matter was always a mystery.The past studies of dark matter using strong gravitaional lensing showed us some interesting results.I also think that we can explore much more in this field using Deep Learning.

However,identifying images containing substructure is still not possible by pure CNN's.Current CNN's are only capable of translational equivariance.

However, in our application , a larger groups of symmetries, including rotations and reflections are present in the data as well that needs to be exploited. This gives rise to the topic of Equivariant Convolutional Networks.

We need to design a network that use ECN or RESNET instead of vanilla CNN to caputre the symmetries in our data.

1. **Data filtering:** We will filter the data provided and split it into train and test sets.This is one of most important and time consuming step.We can just remove some of noise and split data into 9:10 ratio for train and test.

2. **Model Creation:** We will now create the EQN models using Groupy and pytorch.We will create some models of RESNET and EQN and try training for some epochs to check results by this we can check which type of model we need to create for this particular dataset.If its need to deep or branchfull.

3. **Model Training:** Its time to train our model.We will use gradient clipping and learning rate decay to get a good hold.We will also know if our networks are good or we need to change.

4. **Analyze:** Now, we will analyze our results like loss,accuracies.etc.We can then know on which learning rate we should go and if we need to change our model or if we are overfitting.

5. **Model Improvement:** Improve Model according to evaluation.This is the best part we will be doing all along our timeline.

6. **Validation test:**This is the time we were waiting for we will finally know performance of our model on real world datasets.

7. **Application:** This is best part where we will apply our all of previous months hardwork in actual application by implementing our model in Deeplense's pipeline.

Timeline

- **Week1(may20-jun13):Community Bonding Period-** Discuss the exact procedure and workflow with mentors.The timeline mentioned in application in flexible and can change as per common view with mentor.Along with this I will help necessary skills which will help me to make the solution easier and accurate and I will set up my development enviroment.
- **Week2-3(June14-june20):Data Sorting-** We will discuss about the data sorting and come up with ideas of data filtering to reduce noise and unwanted data and divide the given data into train and test sets.We will also discuss different strategies with mentor on the type of model we will create.
- **Week3-4(June21-july11):Coding-Models-** This is the week we will code different types of models using different tools to analyze which type of model suits best to filtered data.This is the week of showing your skills to you teammates and help each other to come up with best model.
- **Week4-5(july12-July25):Training and analyzing-** This week we will train the all different models we came up in the previous week and evaluate with parameters like accuracy and loss with different learning rates and training times.
- **Midpoint Evaluation(July12-July15)**
- **Week6-7(July25-August1):Improving Model-**This is the week we will improve our model based on our previous evaluation and training.Our target is to come up with a best Model with least loss and highest accuracy.We will set the deepness and branching factor of our model in this week.
- **Week7-8(August1-August5):Application-** This week we will apply this model into DeepLense's Pipeline and see it working happily.
- **Week8-9(August5-august15):Wrap up-**If a problem comes up or a bug this is the extra week.
- **Final Evaluation(august15-Enddate)**

Note: We can also finish this project in 2-3 weeks depending on the knowledge of teammates .

Previous test experience

While working on the test that deeplense gave me I learned a lot about the things like gravitational lensing,structures and substructures.I also learned about EQN's

Availablity Schedule

During the GSOC period,I am available to work 40+ hours a week.I don't have any preplanned vactations or any other work so I will be available full time during the intership.For me time commitment will not be an issue.

About Me

I am a undergraduate student in LPU,India currently studying CSE with AI and ML(spec.).I am a Machine learning lover.I am certified by NPTEL in courses "Python for Data science" and "Reinforcement Learning(course by deepmind)".I have 1.5 years of experience with Deep learning as you can see that on my website.

I am a avid open source contributer .I have contributed in hacktoberfest . Becoming a part of programme like this will give me some confidence and excitement for keep working in this amazing field.

Why Me

I think this project is apt for me.I have 2 years of experience with python and Deeplearning.I am certified in “Python for data science” course by NPTEL .I never leave a work in between no matter how hard its is even if I do not have the skills to do it I will learn them that keep me working toward new ideas.I have experience with working with teams on platform like github.This project will help me euip real wold skills which will help me in long run.

Why ML4SC

First reason is that I love astronomy and I want to learn more about it.I also love deep learning,When I saw ML4SC in GSOC22 oragnization it was like a godly combination of astronomy and deep learning.Then I decided to work with ML4SC.Second reson is that I respect opensource and now I also have chance to contribute.I will give me immense satisfaction to see people using code I wrote.

What after GSOC

For me GSOC is not he stopping point,I will continue contributing to opensource project like this.I would love to keep working on development of the code I wrote.