Enhancing Gravitational Lensing with Deep Learning-based Super-Resolution.

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About Me :

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Pre-required task and specific task repository link:

https://github.com/anudeepadi/gsoc_task

Background:

Strong gravitational lensing is a promising probe of the substructure of dark matter to better understand its underlying nature. However, the data collected is often limited by the resolution of the instruments or observing conditions. This project aims to develop deep learning-based image super-resolution techniques to enhance the resolution of gravitational lensing data, allowing for more precise measurements of the lensing effects and a better understanding of the distribution of matter in the lensing system.

Project Goals:

- The primary goal of this project is to develop a superresolution model for DeepLense, a framework for strong gravitational lensing analysis. This will involve:

- Conducting a thorough review of the existing literature on superresolution algorithms and techniques, as well as relevant astrophysics and gravitational lensing concepts.
- Designing and implementing a deep learning-based superresolution model using PyTorch, which can enhance the resolution of low-resolution gravitational lensing images while preserving important features.
- Evaluating the effectiveness of the model using appropriate metrics, and optimizing its hyperparameters and regularization techniques to avoid overfitting.
- Integrating the superresolution model into the DeepLense framework, allowing it to be used for training and inference.
- Investigating the potential of leveraging the superresolution models for other strong lensing tasks such as regression and lens finding.

Deliverables:

- At the end of the project, the following deliverables are expected:
- A well-documented and well-tested superresolution model suitable for use with DeepLense.
- A set of metrics for evaluating the effectiveness of the model, and a report summarizing the results of the experiments.
- An optimized set of hyperparameters and regularization techniques for the model.
- An integrated version of the superresolution model in the DeepLense framework, including a user guide for its usage.
- A report investigating the potential of leveraging the superresolution models for other strong lensing tasks such as regression and lens finding.

Project Timeline:

The project will be completed over a period of 12 weeks, with a total of 350 hours of work. The following is a tentative timeline for the project:

Week 1-2: Conduct a thorough review of the literature and relevant concepts, and design the superresolution model.

Week 3-4: Implement and train the superresolution model, and evaluate its effectiveness using appropriate metrics.

Week 5-6: Optimize the hyperparameters and regularization techniques for the model.

Week 7-8: Integrate the superresolution model into the DeepLense framework, and test it thoroughly.

Week 9-10: Investigate the potential of leveraging the superresolution models for other strong lensing tasks such as regression and lens finding.

Week 11-12: Finalize the project, write a comprehensive report summarizing the results, and prepare the code and documentation for submission.

Skills:

To successfully complete this project, I have the following skills:

- Strong proficiency in Python, and experience with deep learning frameworks such as PyTorch.
- Experience with machine learning and computer vision algorithms, particularly in the context of image processing.
- Good understanding of astrophysics and gravitational lensing concepts.
- Ability to conduct a thorough review of the existing literature and synthesize information from multiple sources.
- Good communication skills and ability to work collaboratively with a team.

Conclusion:

I am excited about the opportunity to work on the "Enhancing Gravitational Lensing with Deep Learning-based Super-Resolution." project. I believe this project will not only give me the opportunity to further develop my machine learning and computer vision skills but also contribute to the important field of astrophysics. I am confident that I have the necessary skills and expertise to successfully complete the project, and I am committed to working hard and delivering high-quality results within the given timeline.

Thank you for considering my proposal, and I look forward to the opportunity to work with you on this project.