Machine Learning for Science (ML4SCI)

Proposal - Google Summer of Code 2023

Profile Information

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Project Proposal

Project Title

Exploring Self-Supervised Learning with Transformers for Strong Gravitational Lensing Analysis

Possible Mentor(s)

- Michael Toomey (Brown University)
- Pranath Reddy (BITS Pilani Hyderabad)
- Sergei Gleyzer (University of Alabama)
- Emanuele Usai (University of Alabama)
- Saranga Mahanta (Institut Polytechnique de Paris)
- Karthik Sachdev (RWTH Aachen)

Overview:

This proposal aims to investigate the potential of self-supervised learning (SSL) algorithms with Transformers for analyzing strong gravitational lensing data. The project will focus on exploring the use of Transformers/Hybrid architectures and Equivariant Transformers with SSL for representation learning and fine-tuning them for specific tasks such as regression or classification in the context of strong gravitational lensing.

The project will involve the development and implementation of self-supervised learning algorithms suitable for computer vision tasks in strong gravitational lensing data. The trained models will be evaluated on a range of tasks including substructure identification, and differentiation of different dark matter models. The project will also involve the expansion of the DeepLense functionality with SSL algorithms suitable for strong gravitational lensing data.

The primary objectives of this project include:

Implementation and testing of self-supervised learning algorithms with Transformers for strong gravitational lensing data
Evaluation of the trained models for specific tasks such as substructure identification and differentiation of different dark matter models
Expansion of the DeepLense functionality with SSL algorithms suitable for strong gravitational lensing data
The successful completion of this project will result in the development of robust SSL algorithms with Transformers and Equivariant

Transformers for strong gravitational lensing data analysis. This will provide a new toolset for researchers and enable more accurate and efficient analysis of strong gravitational lensing data, with potential implications for the understanding of dark matter and its substructure.

Timeline:

Community Bonding Period (May 4 – 28)

Introduce myself to the DeepLense community and mentors

Set up communication channels and have regular meetings with mentors to discuss project details

Familiarize myself with the existing codebase, documentation and tutorials

Setup development environment and understand the data pipeline

Participate in community discussions and ask questions to get better acquainted with the project.

Week 1-2 :

Start implementation of self-supervised learning techniques with Transformers

Investigate existing literature and start building models for self-supervised learning with Transformers.

Document the progress and discuss findings with mentors

Week 3-4 :

Test and validate self-supervised learning models and fine-tune for downstream tasks

Evaluate the performance of self-supervised learning with Transformers in comparison to CNNs.

Discuss findings with mentors and document progress.

Week 5-6 :

Investigate equivariant techniques for self-supervised learning in the context of strong gravitational lensing data.

Build models with equivariant Transformers and compare them with existing self-supervised learning models. And further, discuss findings with mentors and document progress.

Week 7-8 :

Expand DeepLense functionality with self-supervised learning algorithms suitable for computer vision tasks applicable to strong gravitational lensing data.

Integrate the developed models into the existing DeepLense framework.

Document progress and discuss findings with mentors.

Week 9-10 :

Fine-tune the developed models on specific regression and classification tasks.

Evaluate the performance of fine-tuned models on benchmark datasets and compare them to existing approaches.

Document progress and discuss findings with mentors.

Week 11-12 :

Test and evaluate the final models.

Write final report and submit it to the DeepLense community.

Document all code and experiments conducted during the project.

Final Week :

Submit final evaluation for GSoC.

Continue contributing to the project after the end of GSoC.

Academic Experience :

- I am sub-coordinator of Dataworks- DataScience Club at the Indian Institute Of Information Technology Kurnool.
- I am Coordinator of Astronomy Club IIIT Kurnool which organizes sky-gazing, trips to Astrophysics Institutes, workshops regarding Astronomy.
- I have learned Python and Data Visualization from Samsung Innovation Campus.
- I have made various projects using Python i.e., Student Face Recognition Attendance System, Hostel Management System , ML Algorithms to detect object with 70% accuracy.