Takneek PS - Quest

70 Points

AstroExplorer

Introduction:

In the modern era of astronomy, the advancements in telescope technology and space missions have drastically increased the amount of data being generated. The sheer volume of information is so vast that manual processing by astronomers is no longer feasible. One of the primary challenges in astronomy today is not just capturing this data but also efficiently classifying and processing it. Astronomers must identify the type of astronomical object in each image and then apply specific techniques to enhance these images for further study and visualisation. Traditionally, this task required significant manual effort, but with the exponential growth of data, the need for automation has become critical.

Machine learning has emerged as a powerful tool in addressing this challenge. By training algorithms to recognize and classify different types of astronomical objects, researchers can automate the classification process. Moreover, these algorithms can be used to process and enhance the images, combining different spectral bands to produce the colourful, detailed images.

The objective of this project is to develop an automated tool that can classify various astronomical objects from FITS images and light curves and apply appropriate image enhancement techniques based on the detected object type.

Problem Statement:

You must create an all-in-tool that can classify astronomical objects based upon the image or the light curve received. If the input is an image, it should automatically process the image based on the properties of the object it has detected. A more detailed explanation of what is expected is given below:

1. Data Collection and Dataset generation

You have to make the following datasets which will be used for training and testing of your model. You have to find and create datasets on your own.

- **Images dataset**: Collect a diverse set of astronomical objects in FITS format (e.g., stars, galaxies, planets, quasars, and nebulas) with labels. The objects given above are suggestive, you are free to explore more or less objects.

- **Light Curve dataset**: Create a dataset of light curves of as many types of astronomical objects as you can. These objects can be different from the ones used of image classification

  The datasets should contain an equal number of training and testing data points for each object type. Each object type should have at least 200 training data points. Process the datasets accordingly. These need to be submitted.

2. Image Classification Model

- **Build and train the machine learning mode**l: Develop a model capable of classifying various astronomical objects by image format using an optimal neural network.
- **Optimise accuracy**: Experiment with different architectures, hyperparameters, and techniques like transfer learning to achieve high classification accuracy.
- The evaluation of the model will be as follows:
  - The model will only be accepted if its accuracy is greater than 55%
  - Score = (Accuracy (in %age) + 5* (Number of objects model is capable of classifying))/2
  - The pool with the maximum score will be given full points, other pools will be given points according to:
    - (Pool score/maximum score) * full points

3. Image Enhancement Algorithm

- **Develop the enhancement algorithm**: Create an algorithm that processes the classified objects by combining multiple bands from FITS images into a single colour-enhanced image. Tailor the enhancements according to the object type. The enhanced image should improve the visibility of various features and also improve the signal-to-noise. It will be judged on several objective parameters.

4. Light Curve Classification

- **Light Curve Classification**: Build an additional model capable of classifying astronomical objects based on light curves instead of images.
- The evaluation criteria will be the same as for the Image classification model

Takneek PS - Quest

70 Points

Deliverables:

1. Code

- Machine Learning Model: Submit the trained model code that can classify various astronomical objects (e.g., stars, galaxies, planets, quasars) from FITS images. Include the Jupyter notebook in which you have trained and tested the model. Ensure the code is well-documented and includes instructions for running the model.
- Enhancement Algorithm: Provide the algorithm code that enhances the images based on the classified object type.
- Light Curve Model: submit the code for classifying objects based on light curves. Include the Jupyter notebook in which you have trained and tested the model.
- All the code should be written in Python and instructions on how to run each part individually as well as running it end-to-end with only one input stage

2. Documentation

- **Astronomical Object Details**: A LaTeX document explaining the objects being classified, including their characteristic properties that differentiate them. This should reflect a deep understanding of the subject matter.
- **Model Design and Approach**: Describe your approach to building the machine learning model, including preprocessing steps, architecture, and any challenges faced.
- **Enhancement Techniques**: Explain the specific image enhancement techniques used for different objects and why those techniques were chosen.
- The documentation should not be more than 10 pages.

3. Presentation Slides

The presentation should not be more than 10 slides.

A 10-minute presentation will be demanded from 1 representative of each pool.

4. Dataset

- You need to submit all your compiled data used for training and testing with valid references in an organised manner.

Takneek PS - Quest

70 Points

Submission to be made as a GitHub repository.

- Code and Documentation: Upload all relevant code (model, enhancement algorithm, etc.) and documentation to a GitHub repository. Ensure that it is well-structured and accessible.
- README: Include a README file with instructions on how to run the models and a brief overview of the repository contents.

Evaluation Criterion:

Parameter	Weightage
Image classification Model	30%
Image Enhancing Algorithm	20%
Light curve classification model	15%
Dataset	10%
Technical report (Documentation)	15%
Presentation	10%
Total	100%

Team Structure:

Total team members should be **6** ensuring the following conditions

Batch	Team members
Y22s	Max 2
Y23s	Min 2
Y24s	Min 2

Submission deadline: 23:59, date: 06/09/2024