ASTEROID CLASSIFICATION

A UG PROJECT PHASE-1 REPORT

Submitted to

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY, HYDERABAD

In partial fulfillment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

COMPUTER SCIENCE AND ENGINEERING

Submitted by

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CERTIFICATE OF COMPLETION UG PROJECT PHASE-1

This is to certify that the UG Project Phase-1 Report entitled**"ASTEROID CLASSIFICATION"** is being submitted by **KURRE SINDHUJA(20UK1A0565), ANIGALA BHARATH (20UK1A0585), ETYALA TEJA (20UK1A0564),EKKALADEVI VAMSHI(20UK1A05A3)**in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Computer Science and Engineering to Jawaharlal Nehru Technological University Hyderabad during the academic year 2022-23, is a record of work carried out by them under the guidance and supervision.

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ABSTRACT

Asteroids, celestial bodies orbiting the Sun, play a crucial role in understanding the formation and evolution of our solar system. With an increasing interest in space exploration and potential asteroid mining, accurate classification of asteroids is essential for assessing their composition, trajectory, and potential impact on Earth. This project focuses on developing a robust classification system for asteroids using advanced machine learning techniques.

The primary objectives of the project include the collection and preprocessing of asteroid data from astronomical databases, feature engineering to extract relevant characteristics, and the implementation of machine learning algorithms for accurate classification. The dataset comprises various attributes such as size, shape, rotation, and spectral characteristics obtained through ground-based and space-based observations.

The proposed machine learning models will be trained on a labeled dataset, leveraging algorithms such as Support Vector Machines, Random Forests, and Neural Networks. The classification system aims to categorize asteroids into different classes based on their composition, structure, and potential risk to Earth. The project also explores the use of deep learning techniques to extract hierarchical features from asteroid data, enhancing the accuracy and robustness of the classification model.

Validation and performance assessment of the developed models will be conducted using metrics such as precision, recall, and F1 score. Additionally, the project aims to investigate the interpretability of the models to provide insights into the key features influencing asteroid classification

The outcomes of this project are expected to contribute to the field of astronomy, providing a more efficient and automated method for classifying asteroids. The developed classification system can be integrated into existing astronomical tools and observatories, facilitating real-time decision-making for space agencies and researchers

1. INTRODUCTION

1.1 OVERVIEW

Brief explanation of the significance of asteroid classification in astronomy and space exploration.

Mention the potential applications, including impact assessment, space missions, and asteroid mining.

Clearly define the primary objectives of the project.

Highlight the importance of accurate asteroid classification for understanding their properties and behaviors.

The classification system aims to categorize asteroids into different classes based on their composition, structure, and potential risk to Earth. The project also explores the use of deep learning techniques to extract hierarchical features from asteroid data, enhancing the accuracy and robustness of the classification model.

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1.2 PURPOSE

Understanding Asteroid Properties**:**Classifying asteroids helps in characterizing their physical properties, such as size, shape, composition, and rotational dynamics. This information is crucial for gaining insights into the formation and evolution of our solar system.

Trajectory Prediction and Impact Assessment: Accurate classification aids in predicting the trajectories of asteroids, especially those that come close to Earth. Understanding their potential impact risks is essential for developing strategies to mitigate potential threats.

Space Mission Planning**:** For future space exploration missions, knowing the characteristics of asteroids is vital. Classification enables mission planners to select appropriate targets based on scientific objectives, resource availability, and the feasibility of spacecraft rendezvous**.**

Asteroid Mining and Resource Utilization:Some asteroids are rich in valuable resources such as metals and water. Classification helps identify suitable candidates for future asteroid mining operations, contributing to the development of space resource utilization technologies.

2. LITERATURE SURVEY

The first asteroids to be discovered were assigned iconic symbols like the ones traditionally used to designate the planets. By 1855 there were two dozen asteroid symbols, which often occurred in multiple variants.

In 1851, after the fifteenth asteroid, Eunomia, had been discovered, Johann Franz Encke made a major change in the upcoming 1854 edition of the Berliner Astronomisches Jahrbuch (BAJ, Berlin Astronomical Yearbook). He introduced a disk (circle), a traditional symbol for a star, as the generic symbol for an asteroid. The circle was then numbered in order of discovery to indicate a specific asteroid. The numbered-circle convention was quickly adopted by astronomers, and the next asteroid to be discovered (16 Psyche, in 1852) was the first to be designated in that way at the time of its discovery. However, Psyche was given an iconic symbol as well, as were a few other asteroids discovered over the next few years. 20 Massalia was the first asteroid that was not assigned an iconic symbol, and no iconic symbols were created after the 1855 discovery

2.1 EXISTING PROBLEM

There were various efforts and initiatives focused on asteroid classification, combining astronomical observations with machine learning techniques. However, the specific state of existing solutions can evolve over time. Here are some general approaches and projects that were notable in the field:

Pan-STARRS (Panoramic Survey Telescope and Rapid Response System):

Pan-STARRS is a wide-field astronomical survey program designed to monitor the sky for various celestial objects, including asteroids. It employs image processing and data analysis techniques to classify and track asteroids based on their characteristics.

NEOWISE (Near-Earth Object Wide-field Infrared Survey Explorer):

NEOWISE is a NASA space telescope that has been used to discover and characterize asteroids. It observes in the infrared spectrum, providing valuable information about an asteroid's size, composition, and thermal properties.

Asteroid Zoo:

Citizen science projects, such as Asteroid Zoo, engage the public in asteroid classification. Participants review telescope images and contribute to the identification and classification of asteroids through online platforms.

2.2 PROPOSED SOLUTION

The proposed solution for the project on asteroid classification involves a combination of data acquisition, preprocessing, feature engineering, and the application of machine learning techniques. Below is an outline of the key steps and components of the proposed solution:

1. Data Acquisition:
   - Collect observational data on asteroids from astronomical databases, telescopes, and space missions.
   - Include attributes such as size, shape, rotation, spectral characteristics, and any other relevant features.
2. Data Preprocessing:
   - Clean the dataset to handle missing or erroneous data.
   - Normalize or scale numerical features to bring them to a consistent range.
3. Feature Engineering:
   - Extract relevant features from the dataset that are indicative of asteroid characteristics.

3. THEORETICAL ANALYSIS

3.1 TECHNICAL ARCHITECTURE

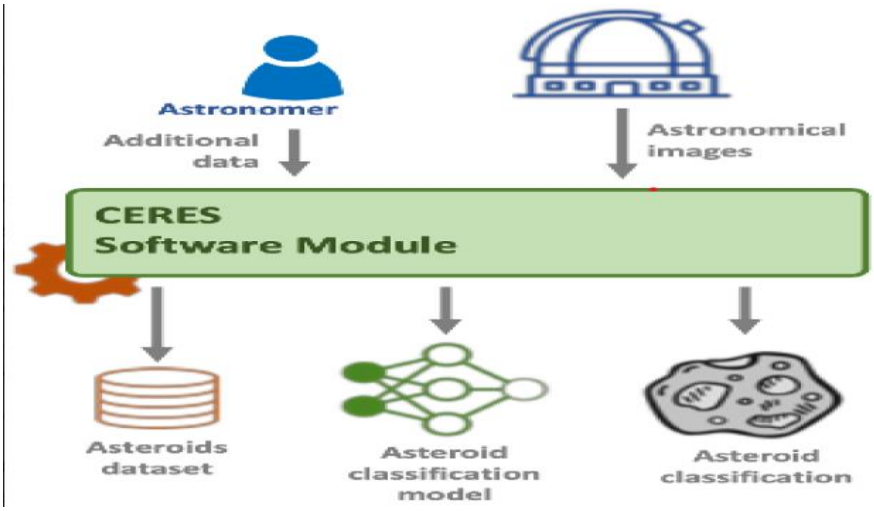

Figure 1: Architecture

3.2 PROJECT WORKFLOW

- User interacts with the UI to enter the input.
- Entered input is analysed by the model which is integrated.
- Once model analyses the input the prediction is showcased on the UI To accomplish this, we have to complete all the activities listed below,
- Define Problem / Problem Understanding
    - Specify the Missing-Migrants-2019 problem
    - Literature Survey
- Data Collection & Preparation
    - Collect the dataset
    - Data Preparation
- Exploratory Data Analysis
    - Visual Analysis
- Model Building
    - Performing Clustering operation
    - Clusters will imported to dataset ,and label the dataset as clustering
    - Apply the Machine learning algorithms
- Performance Testing & Hyperparameter Tuning
    - Testing model with multiple evaluation metrics
    - Comparing model accuracy
- Model Deployment
    - Save the best model
    - Integrate with Web Framework
- Project Demonstration & Documentation

3.2.2 Software requirement

- Spyder IDE
- Python (pandas, NumPy,)
- HTML
- Flask
- OpenCV
- Imutils
- Geopy
- Requests
- Anaconda Distribution
- Windows OS

3.2.3 HARDWARE REQUIREMENTS

REQUIREMENT	SPECIFICATION
Operating system	Microsoft Windows UNIX Linux®
Processing	Minimum: 4 CPU cores for one user. For each deployment, a sizing exercise is highly recommended.
RAM	Minimum 8 GB.
Operating system specifications	File descriptor limit set to 8192 on UNIX and Linux
Disk space	A minimum of 7 GB of free space is required to install the software.

Table 1: Hardware Requirements

4. DESIGN

Most asteroids are irregularly shaped, though a few are nearly spherical, and they are often pitted or cratered. As they revolve around the Sun in elliptical orbits, the asteroids also rotate, sometimes quite erratically, tumbling as they go. More than 150 asteroids are known to have a small companion moon (some have two moons). There are also binary (double) asteroids, in which two rocky bodies of roughly equal size orbit each other, as well as triple asteroid system

project for asteroid classification involves several key components, including data acquisition, preprocessing, model selection, training, and evaluation. Here's a high-level outline of how you might approach this project:

4.1 collecting the data

There are many popular open sources for collecting the data. Eg: kaggle.com, UCI repository, etc.

In this project we have used .csv data. This data is downloaded from kaggle.com.