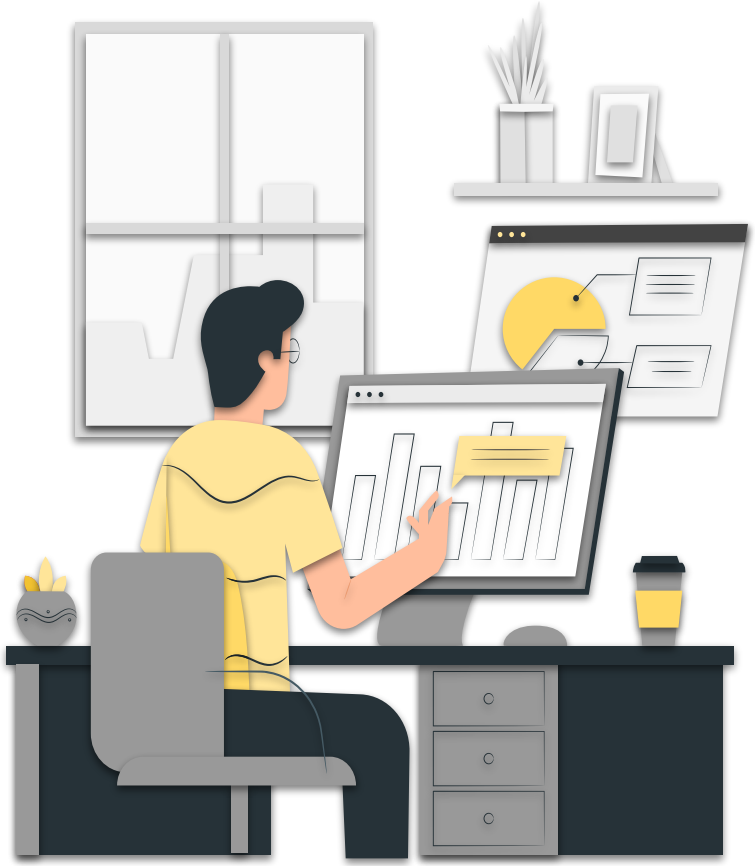

Data Mining from Two Line Element(TLE) sets

CS685A COURSE PROJECT

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- Group No - 45
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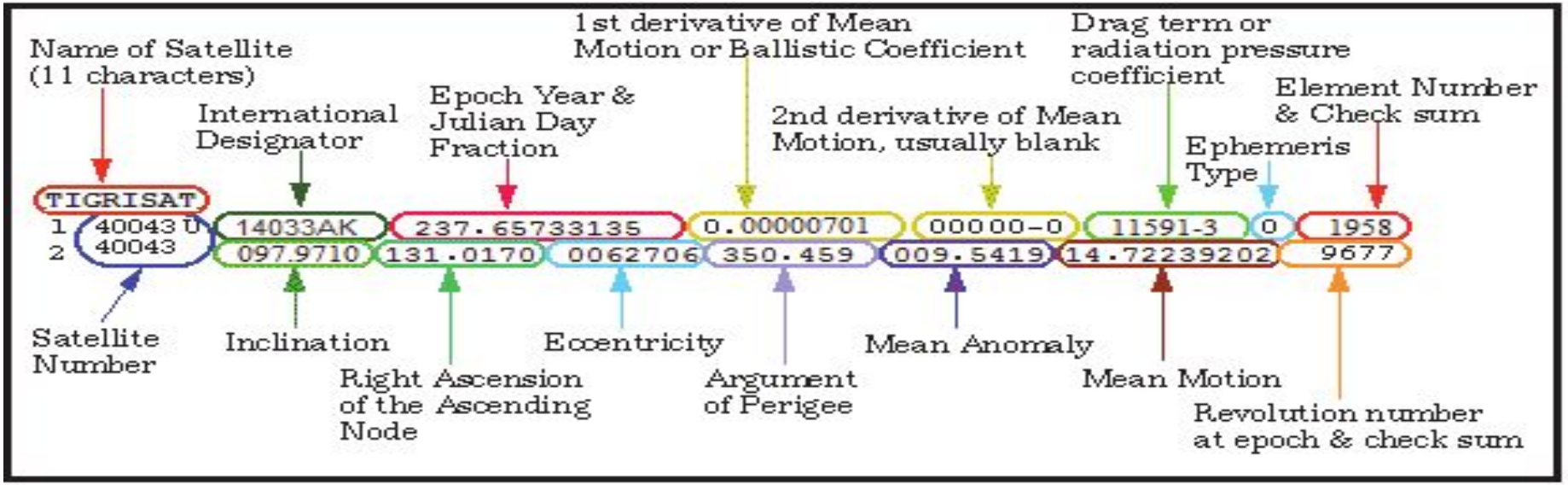
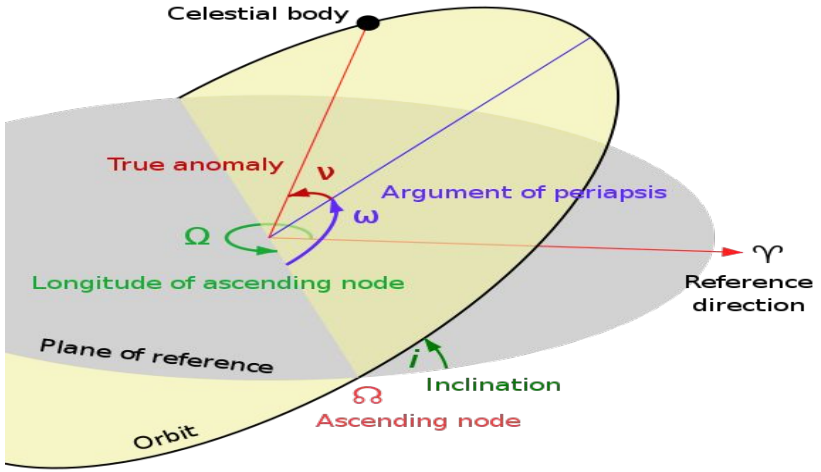


TLE Data and its Interpretation



Project Work

1

Error Analysis

The Error in propagation of position and velocities through TLEs is analysed.

2

Catalogue Formation

A Catalogue is created from recent TLE data, which contains several important fields in tabular format.

3

Clustering and Patterns

Satellites within same orbital planes are grouped by clustering & patterns of orbital arrangements.

4

Debris Prediction

Classifier for predicting an celestial object as Space Debris or satellite.

5

Maneuver Detection

Algorithms to detect possible maneuvers done for an active satellite.

Data Mining Methodology

7 State-of-Art ML models

6 Basic prediction models

5 Add more Features

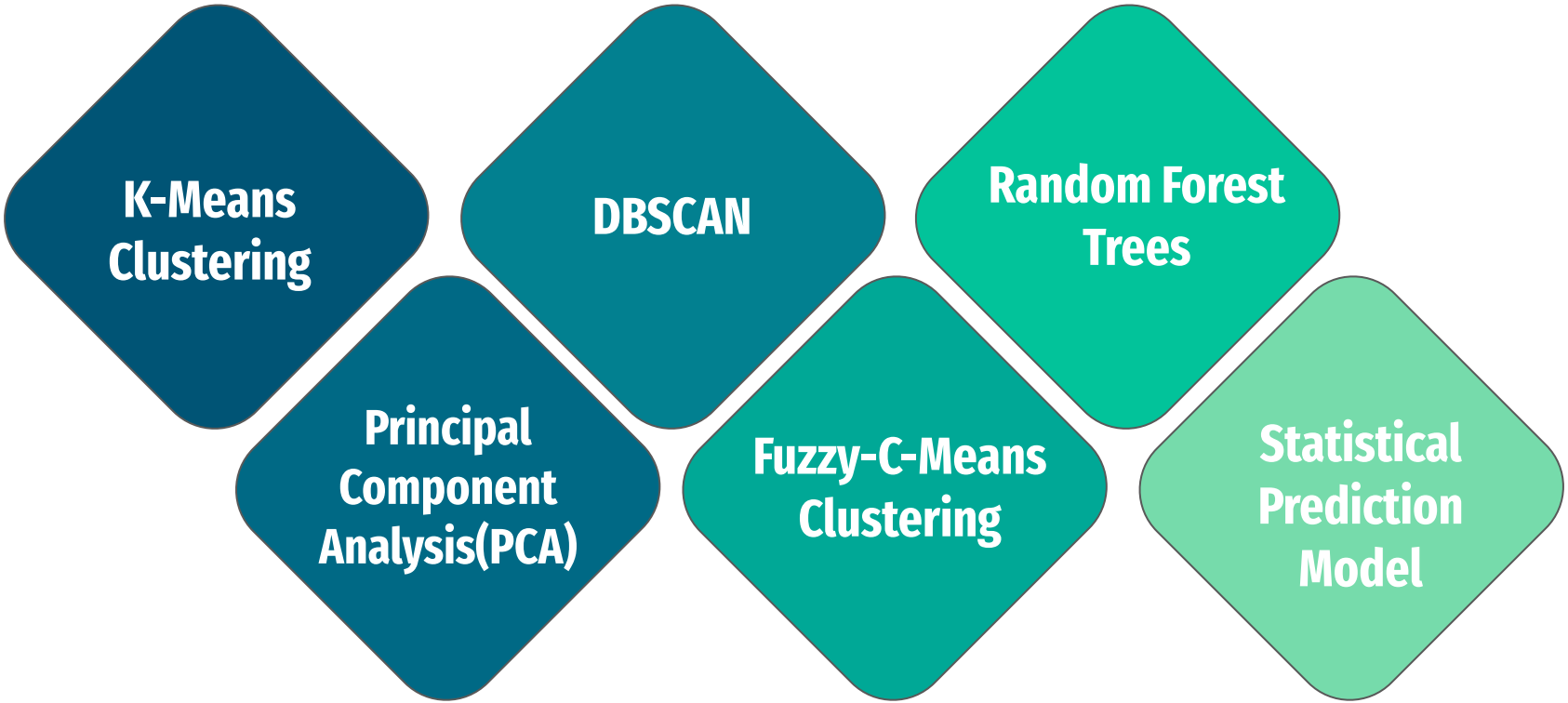
4 Filtering Data

3 Interpretable form

2 Integration of Data

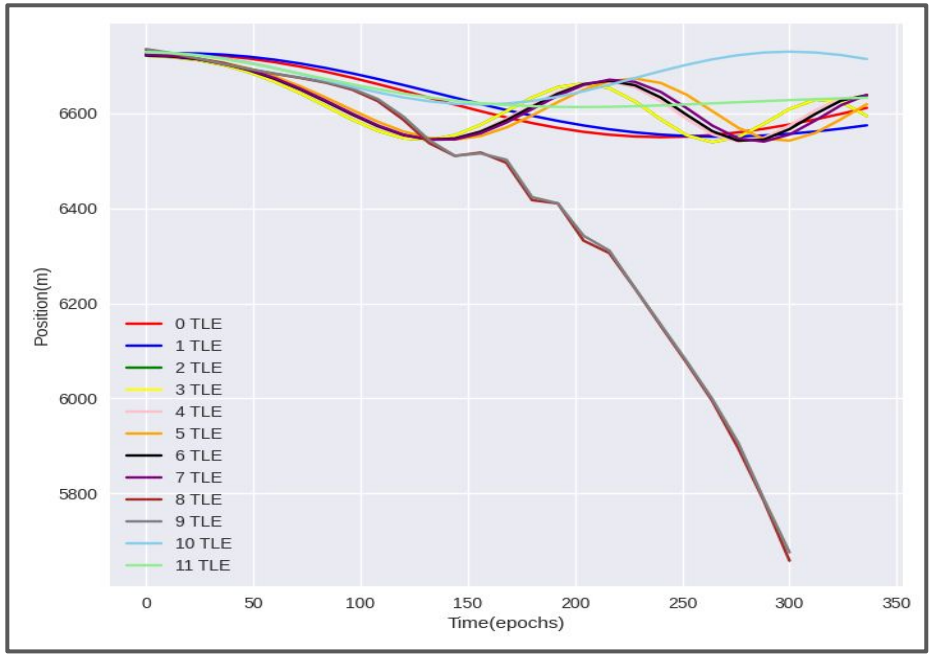
1 Accuracy of Data

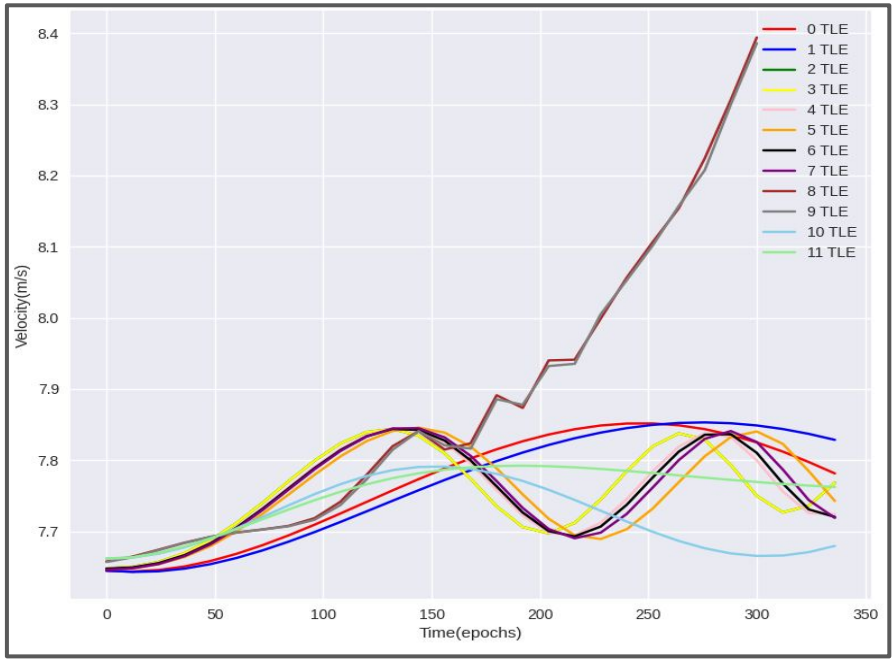
Data Mining Algorithms Used



Some Results

- ERROR ANALYSIS OF TLE DATA

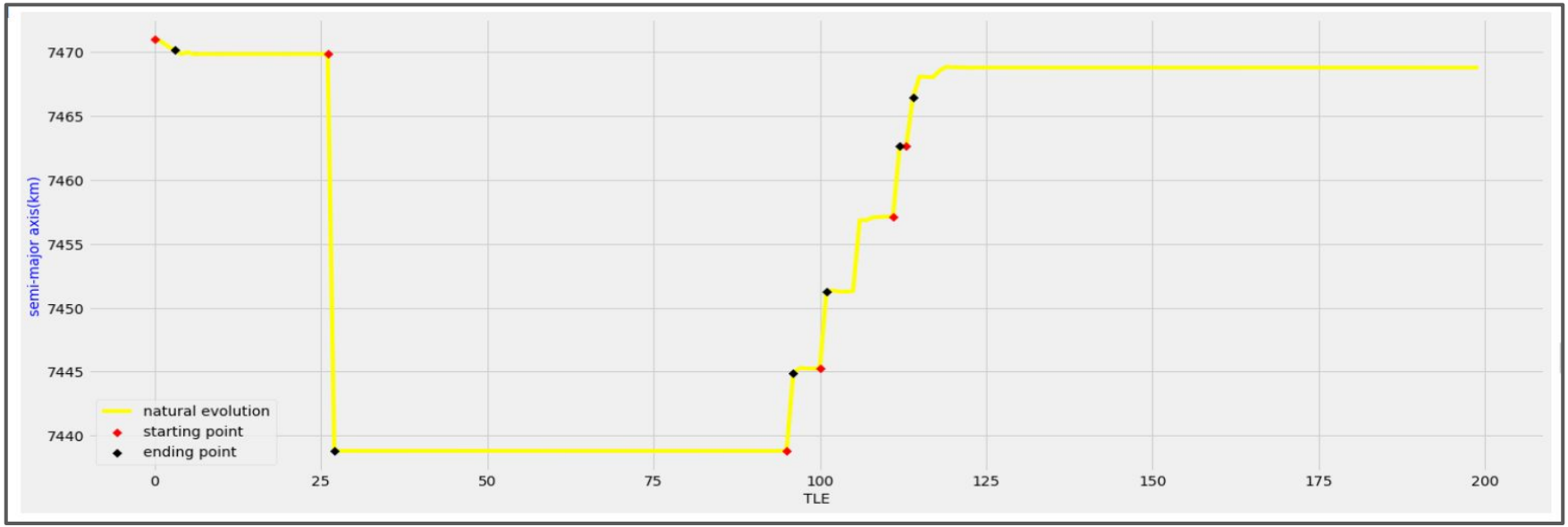




The graphs are plots of future estimates of position and velocity respectively. The variation is observed across 11 TLEs of the same object(ISS-ZARYA) on a timespan of 350 epochs

Some Results

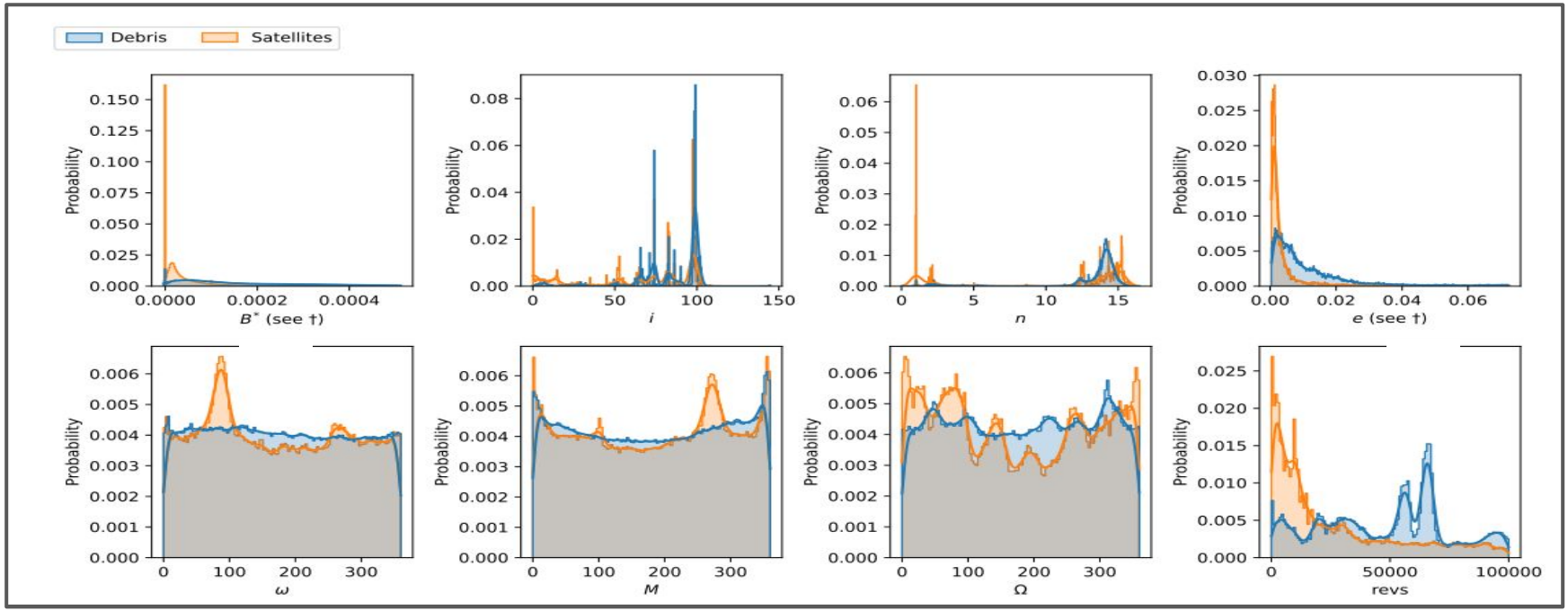
- MANEUVER DETECTION BY USING K-MEANS FOR YAOGAN 9A SATELLITE



Semi-major axis curve marked with orbit control points by the K-means clustering method: the yellow line indicates the natural evolution process; the red asterisk indicates the starting point of the orbital maneuver; and the black asterisk indicates the end point of the orbital maneuver.

Some Results

- DEBRIS AND SATELLITE CLASSIFICATION



Distribution of orbital elements by object type

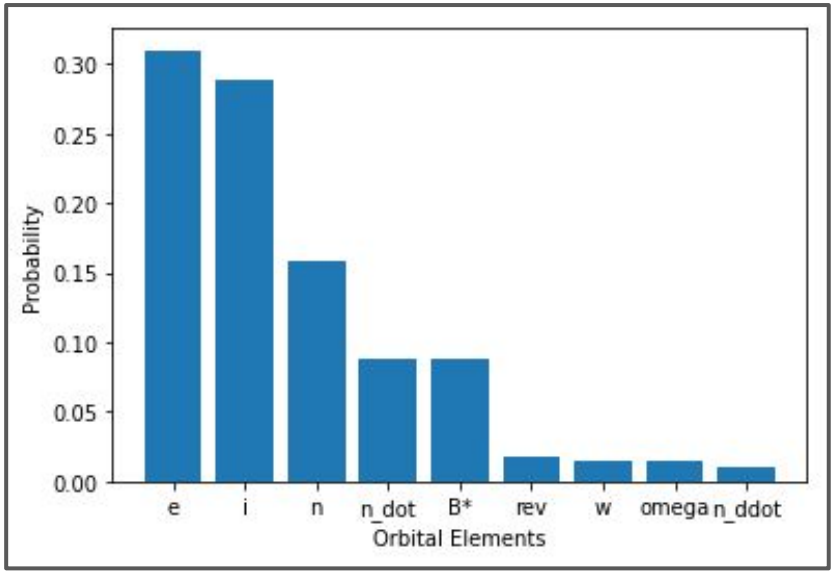
Some Results

- DEBRIS AND SATELLITE CLASSIFICATION

	precision	recall	f1-score	support
Sat	0.96	0.88	0.92	45337
Deb	0.84	0.95	0.89	30116
accuracy			0.91	75453
macro avg	0.90	0.91	0.90	75453
weighted avg	0.91	0.91	0.91	75453

Accuracy = 0.9062197659470134

Results of Random Forest Classifier



Random Forest Feature Importances

Important Links for Project Work:

LINK TO PROJECT REPOSITORY: https://github.com/Aaryansh7/CS685_G45_project

LINK TO DETAILED DOCUMENTATION:
https://drive.google.com/file/d/1aS3vejtcCvXKGEEbKBBCp3sjcmPoqeuR/view?usp=sharing

References:

- https://www.researchgate.net/publication/242742404_Satellite_Maneuver_Detection_Using_Two-line_Elements_Data
- https://ieeexplore.ieee.org/document/8830454
- https://www.researchgate.net/publication/222413947_Improved_orbit_predictions_using_two-line_elements

THANK YOU