IDENTIFYING CANDIDATES FOR FREE-FLOATING ARTIFACTS IN THE SOLAR SYSTEM

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Abstract

One approach to a search for the artifacts within the Solar system is to look for the objects (e.g., probes, defunct or active) with anomalous orbits that are significantly different from those of the asteroids. To this effect, we used the data on the orbital parameters of 524,214 asteroids from AstDys-2. Approximately 24% of the asteroids belong to the known families in the orbital parameter space. The unclassified ones are labeled as the 'background', produced mainly by the dynamical scattering in the course of the evolution of the solar system. We apply Machine Learning tools to identify objectively defined outliers in the feature space of orbital parameters. Various techniques can be used for this task, including DBSCAN, which use distance measures, and Isolation Forest, which use decision trees, and many others.

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OBJECTIVE

One approach to a search for the artifacts within the Solar system is to look for the objects (e.g., probes, defunct or active) with anomalous orbits that are significantly different from those of the asteroids.

To this effect, we used the data on the orbital parameters of 524,214 asteroids from AstDys-2. Approximately 24% of the asteroids belong to the known families in the orbital parameter space. The unclassified ones are labeled as the 'background', produced mainly by the dynamical scattering in the course of the evolution of the solar system.

We apply Machine Learning tools to identify objectively defined outliers in the feature space of orbital parameters. Various techniques can be used for this task, including DBSCAN, which use distance measures, and Isolation Forest, which use decision trees, and many others.

METHODS

UNSUPERVISED ANOMALY DETECTION

- Identifying rare or significantly different (from a majority of unlabeled data) objects.

ALGORITHMS

Mahalanobis Distance (M.D)

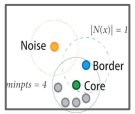
Distance between a point and a distribution

Parameters: Deciding a cut-off value.

DBSCAN

Density-Based Spatial Clustering of Applications with Noise.

Parameters: Epsilon (eps) & minimum samples (minpts)



Isolation Forest

Isolates anomalies using a collection of decision trees.

Parameters: no. of trees, no. of samples, no. of features,contamination

DATA AND EXPERIMENT

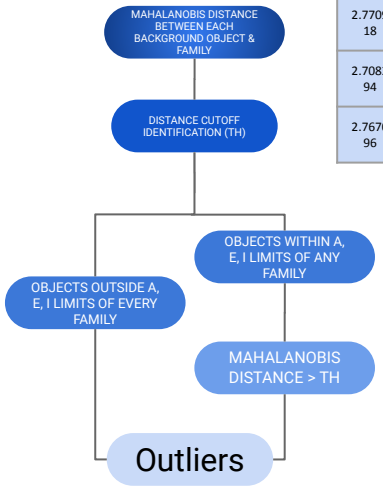
DATASET

Based on the asteroid family classification literature, the features selected are; Eccentricity (e), Inclination (i), Semi-Major Axis (a).

Narrowed down the search to only the main-belt asteroids by applying thresholds on the values of 'a'.

There are two classes of objects; background objects (397834) and asteroid families (106).

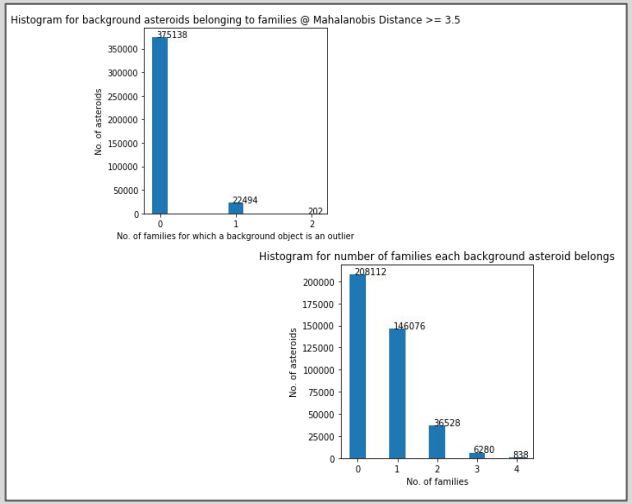
EXPERIMENT



Dataset Snapshot

a	e	i	Family
2.770918	0.281258	0.547547	0
2.708394	0.132625	0.084467	43
2.767096	0.116198	0.167585	-1

PRELIMINARY RESULTS



FUTURE WORK

Apply DBSCAN and Isolation Forest to narrow down the search by eliminating natural groupings within the outliers detected by Mahalanobis Distances.

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