Machine Learning for Near Earth Object Trajectories

Stage topic Description

To date, there are a few thousands of near Earth objects (NEOs) detected, and some of them can pose a potential threat for a future impact with the Earth. A database of trajectories to a selected number of asteroids can be useful for preliminary assessments of a future mission to these objects. As a proof of concept, the Advanced Concepts Team has developed a first version of such a database [1]. Over a thousand of globally optimal trajectories have been obtained using meta-heuristic global optimisers. Data are stored is a semantic fashion with assorted parameters (e.g., launch window, asteroid family, flyby strategies, Delta-V, etc.). A completed database will have over 50,000 trajectories.

Data analysis tools like Principal Component Analysis (PCA) and machine learning tools such as Support Vector Machines (SVMs) or Artificial Neural Networks (ANNs) can help to automatically extract interesting correlations among orbital characteristics (e.g., time of flight, semi-major axis, inclination, etc.) from such a large sample size of optimal trajectories. These tools offer automatic classification that may prove meaningful for human mission designers. For example, the final objective would be to learn the correlation between the optimal Delta-Vs (the amount of effort needed to carry out an orbital manoeuvre) and the asteroid's orbit.

Candidate's tasks

- Generate the complete trajectory set by solving the remaining global optimisation problems, using the tools and algorithms available and already implemented by the Advanced Concepts Team.
- Perform an analysis of the globally optimal trajectories found in relation to the NEOs characteristics.
- Apply machine learning techniques to estimate the relation between orbital parameters and optimal Delta-V.

The ideal candidate

Experience in Machine Learning, mathematical analysis methods and optimization

References

[1] Semantic Asteroids:
http://www.esa.int/gsp/ACT/inf/op/SemanticAsteroids/TheSemanticAsteroids.htm