Satellite Collision Reduction and Avoidance Model (SCRAM)

SCRAM is an artificial intelligence model that predicts satellite orbits, which is crucial as anything in orbit is at risk of collision. A single collision has the potential to send thousands of debris shards in multiple directions and, even without a large amount of debris, even a slight crash can damage the sensitive equipment onboard, rendering the satellite useless. We also have to consider the Kessler Syndrome (Adilov), a theoretical scenario that predicts that a single satellite collision can cause a chain reaction that would lead to the downfall of all things in orbit.

Physics-based models exist that predict a satellite's orbit, but the commonly accepted models have several issues that make them problematic to use. The main issue is that none of these models use more than one past data point in its prediction. To improve the prediction technique and provide a more accurate orbital path, we will create a machine-learning model that considers multiple past data points and uses them in the prediction generation. We will use the Two-Line Element data provided by spacetrack.org as our training data and then use SGP4's (Hoots) predicted pathing to compare our machine learning. SPG4 is the most commonly accepted physics model for predicting satellite orbits. SPG4 is built off the previous SPG (Simplified Perturbation Model) developed by Hilton & Kuhlman in 1966. It uses Two-Line Element data and physics methods to predict orbits and calculate drag and natural decay.

At this time, we have gathered data from low earth orbit payloads using the spacetrack.org Historical Elset Search program. Our data points include the date the data was gathered, the inclination, the argument of the pericenter, and the mean motion dot, among other things. From there, we started to build a model using K-Nearest Neighbors (Peterson) and are continuing to work on the programming of our AI.

Currently, we have data from about 50 satellites. All of these satellites are in low earth orbit (LEOs), meaning their apogee and perigee are between 200 and 600 miles. Apogee is the highest part of the orbit from the entire data set, and perigee is the lowest part of the orbit. These satellites come from all over the world and encompass a wide range of different orbits. These files have been split into a 20:20:60 ratio for, working on the program, testing the AI after training, and training the AI. Now that we have this data properly split we can continue work on the AI and comparisons to the traditional SGP4 methods.

We expect to be able to predict the orbit of satellites using our model with 90% accuracy compared to the SPG4 physics-based model. From there we will improve the accuracy of the prediction and extend the distance of the predicted orbit. We hope this will ultimately, replace the current standard of SPG4 predictions, and reduce the total number of satellites collisions.

Resources

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