

DIGANTARA

Assignment - Data Analyst

Background: The task involves analyzing data related to RSOs in Earth's orbit and their close approaches or conjunctions. With an increase in space traffic, the number of predicted conjunctions has risen, posing a challenge for data analytics with around 250,000 conjunctions per day.

Data Source: Data can be downloaded from Celestrak, specifically from the SOCRATES (Satellite Orbital Conjunction Reports Assessing Threatening Encounters in Space) project.

Task 1:

Part A: Derive high-level analytics from the whole data set for a single day, which could include general metrics like the number of conjunctions among active satellites. The analysis should be intuitive and easily understandable.

Part B: Represent the conjunctions data for a single satellite or constellation in a way that enables decision-making from a satellite operator's point of view.

Task 2:

Analyze and visualize data over five days, focusing on the evolution of conjunctions for a specific RSO with the NORAD ID 12345 over 7 days of analysis.

About the Dataset:

NORAD_CAT_ID_1: The catalog number assigned by NORAD to the first object.

OBJECT_NAME_1: The name of the first object.

DSE_1: Days since epoch for the first object. This is the time in days from the epoch of the GP data used in the calculation to the calculated time of closest approach (TCA) and is an indication of how accurate the data might be at TCA.

NORAD_CAT_ID_2: The catalog number assigned by NORAD to the second object.

OBJECT_NAME_2: The name of the second object.

DSE_2: Days since epoch for the first object. This is the time in days from the epoch of the GP data used in the calculation to the calculated time of closest approach (TCA) and is an indication of how accurate the data might be at TCA.

TCA: Time of Closest Approach.

TCA_RANGE: The range at the time of closest approach, in kilometres.

TCA_RELATIVE_SPEED: The relative speed of the two objects at the time of closest approach, in kilometres per second.

MAX_PROB: The maximum probability of collision.

DILUTION: A measure of uncertainty or variability in the conjunction data.

Assumptions Made:**1. Relative Speed Category:** Categorized Relative speed into three Categories.

Slow: Speed less than 5 KM/SEC

Moderate: Speed between 5-10 KM/SEC

Fast: Speed Greater than 5 KM/SEC

2. Collision Risk Category:

Low: Probability less than 0.00001

Medium: Probability between 0.00001 and 0.0001

High: Probability Greater than 0.0001

3. TCA Range Category:

0-1 KM: Distance less than equal to 1

1-2 KM: Distance greater than 1 and less than equal to 2

2-3 KM: Distance greater than 2 and less than equal to 3

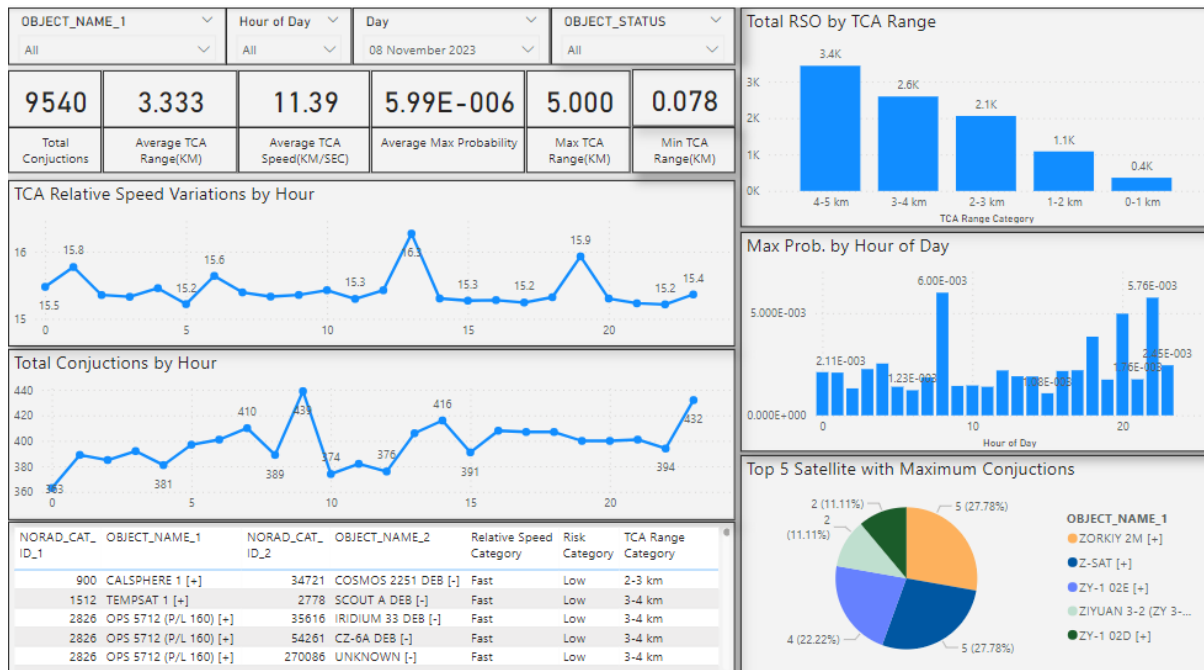
3-4 KM: Distance greater than 3 and less than equal to 4

4-5 KM: Distance greater than 4 and less than equal to 5

Task 1:

Part A: Derive high-level analytics from the whole data set for a single day, which could include general metrics like the number of conjunctions among active satellites. The analysis should be intuitive and easily understandable.

Summary Statistics for the 8th of November 2023:



Total Conjunctions: The count of all potential conjunction events for the day is 9,540.

Average TCA Range: The average closest approach distance is 3.333 kilometres.

Average TCA Speed: The average relative speed at the time of the closest approach is 11.39 kilometres per second.

Average Max Probability: The average maximum probability of a conjunction leading to a collision is approximately 0.00000599.

Max TCA Range (KM): The maximum TCA range observed is 5 kilometres.

Min TCA Range (KM): The minimum TCA range in kilometres is 0.078.

TCA Relative Speed Variations by Hour: The line chart shows the variation in relative speed throughout the day. The speeds fluctuate, peaking at different times, with the highest around 15.8 kilometres per second.

Total Conjunctions by Hour: The line chart displays the number of conjunctions for each hour of the day, revealing that conjunctions can occur at any time, with notable peaks at certain hours such as around the 11th and 21st hours.

Total RSO by TCA Range: A histogram visualizes the distribution of TCA ranges, with most conjunctions occurring with a TCA range of 3-4 kilometres.

Maximum Probability of Conjunctions: A Histogram Chart shows the Max Probability of Conjunctions by Hour. At the Hour 8 we see the maximum probability of 6.00-E003.

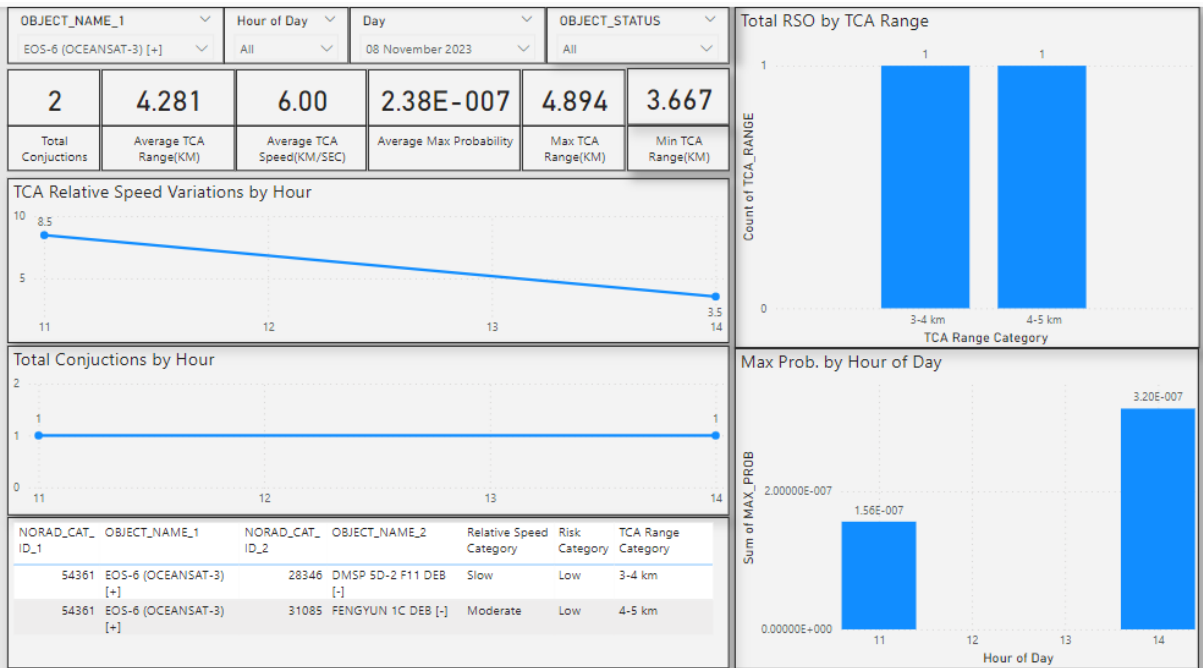
Top 5 Objects with Maximum Conjunctions: A pie chart highlights the five objects with the most conjunctions. The chart provides both the count and the percentage, indicating a significant proportion of conjunctions are associated with these objects.

Detailed Conjunction Data Table: The table at the bottom list’s individual conjunction events, showing the NORAD catalog IDs, object names, relative speeds, risk categories, and TCA range categories.

Part B: Represent the conjunctions data for a single satellite or constellation in a way that enables decision-making from a satellite operator's point of view.

Data Analysis Report for RSO EOS-6 (OCEANSAT-3)

Date of Analysis: **08 November 2023**



1. Overview of Conjunctions:

Total Conjunctions: There were 2 total recorded conjunctions involving EOS-6 on the specified date.

Average TCA Range: The average closest approach distance for these conjunctions was 4.281 kilometres.

Average TCA Speed: The average relative speed at the time of the closest approach was 6.00 kilometres per second.

Average Maximum Probability: The average maximum probability of collision across these conjunctions was 2.38e-007 (or 0.0000238%).

Maximum TCA Range: The maximum distance at the time of the closest approach was 4.894 kilometres.

Minimum TCA Range: The minimum distance at the time of the closest approach was 3.667 kilometres.

2. TCA Relative Speed Variations by Hour:

A line chart indicates a downward trend in relative speed from around 8.5 kilometres per second at 11:00 to approximately 3.5 kilometres per second at 14:00. This suggests that the conjunctions involving EOS-6 occurred at varying relative velocities throughout the day.

3. Total Conjunctions by Hour:

The bar chart displays that one conjunction occurred at 11:00 and another at 13:00, indicating that the conjunction events were spread across different times of the day.

4. Total RSO by TCA Range:

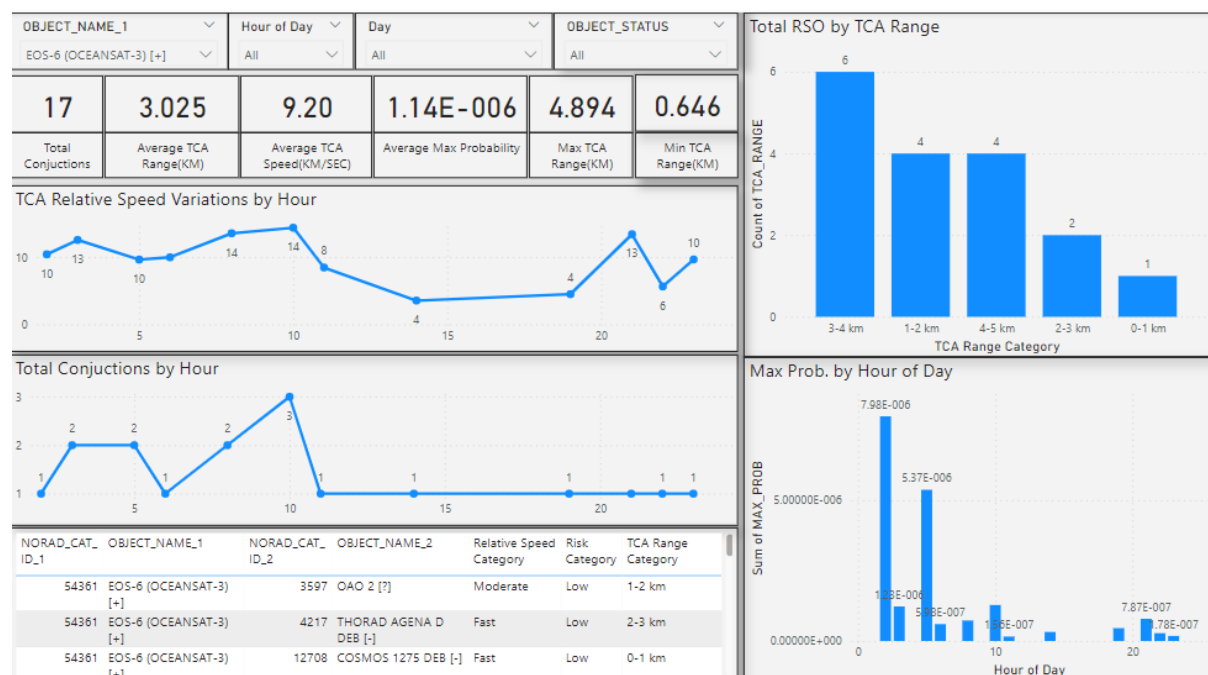
A bar chart categorized by TCA range shows that there was one conjunction each in the 3–4-kilometres range and the 4–5-kilometres range.

5. Maximum Probability of Conjunctions: A Histogram Chart shows the Max Probability of Conjunctions by Hour. At the Hour 11 we see the maximum probability of 3.20-E007.

Task for Question 2:

Use a dataset that spans about five days to derive analytics and visualize the evolution from the first day (for example, tracking the number of conjunctions of the RSO having NORAD ID 12345 over 7 days of analysis).

Data Analysis Report for RSO EOS-6 (OCEANSAT-3)



1. General Summary:

Total Conjunctions: There were 17 total recorded conjunctions involving EOS-6 on the observed day.

Average TCA Range: The average closest approach distance for these conjunctions was approximately 3.025 kilometres.

Average TCA Speed: The average relative speed at the time of closest approach was 9.20 kilometres per second.

Average Max Probability: The average maximum probability of collision across these conjunctions was 1.14×10^{-6} (or 0.000114%).

Max TCA Range: The maximum distance at the time of closest approach was recorded as 4.894 kilometres.

Min TCA Range: The minimum distance at the time of closest approach was 0.646 kilometres.

2. TCA Relative Speed Variations by Hour: The line chart indicates fluctuations in relative speed throughout the day, with peaks at 10 kilometres per second around 10:00 and 20:00, and a notable dip to approximately 4 kilometres per second at 15:00.

3. Total Conjunctions by Hour: A line chart shows the distribution of conjunctions throughout the day, with two conjunctions occurring at several hours (5:00, 10:00, and 13:00), and singular events at other times.

4. Total RSO by TCA Range: The bar chart categorizes the conjunctions by TCA range, with the majority occurring at distances between 3-4 kilometres (6 conjunctions) and 1-2 kilometres (4 conjunctions). Fewer conjunctions occurred at closer ranges, with 2 in the 4-5 kilometres range, 2 in the 2-3 kilometres range, and 1 in the 0-1 kilometres range.

5. Maximum Probability of Conjunctions: A Histogram Chart shows the Max Probability of Conjunctions by Hour. At the Hour 2 we see the maximum probability of 7.98×10^{-6} . The second Highest probability occurs at the Hour 5.