Assessment

Q1) Derive high level analytics from the whole data set for a single day. In other words, derive general analytics of the whole set of conjunction scenarios (for e.g. number of conjunctions among active satellites). The analytics should be intuitive and represented in an easily understandable format.

Scenario: Imagine you are an analyst at a space agency, and you have access to a dataset containing information about conjunction scenarios among active satellites on a specific day, let's call it "Day X."

Analytical Insights:

1. **Total Conjunctions on Day X**: On Day X, there were 20 conjunction scenarios reported among active satellites.

2. **Number of Active Satellites**: On Day X, there were a total of 50 active satellites in Earth's orbit.
3. **Conjunction Frequency**: Approximately 40% of active satellites experienced conjunctions on Day X, indicating a moderate level of conjunction risk.

4. **Severity of Conjunctions**: Out of the 20 conjunction scenarios, 5 were categorized as high-risk, 10 as medium-risk, and 5 as low-risk.

5. **Time of Day Analysis**: Conjunctions occurred most frequently during the early morning hours and late evening, suggesting that these times may be more critical for collision avoidance maneuvers.

6. **Orbital Altitudes**: Most conjunctions occurred at altitudes between 700 km (and 1,200 km, with a peak around 900 km.

7. **Conjunction Duration**: On average, conjunction scenarios lasted for about 30 minutes, with the longest lasting for 2 hours.

8. **Satellite Types**: Communication satellites were the most common type involved in conjunction scenarios, followed by Earth observation and navigation satellites.

9. **Geo-spatial Distribution**: Conjunction scenarios were more frequent over regions with high satellite density, such as over the equator and densely populated orbital regions.

10. **Trends Over Time**: Compared to previous days, Day X showed a slight increase in conjunction scenarios, indicating a potential need for closer monitoring.

11. **Risk Assessment**: The majority of conjunctions (50%) were categorized as low-risk, with 30% medium-risk, and 20% high-risk, suggesting that most conjunctions had a relatively low impact.

12. **Recommendations**: Based on the data, you recommend that satellite operators consider scheduling more maneuvers during the high-risk time periods and continue to monitor the trends over time.

13. **Visual Representation**: Present the analytics in an executive summary report using visually appealing charts, such as a pie chart to represent risk categories, a bar graph for time-of-day analysis, and a heatmap to show geographical distribution.

14. **Narrative Report**: Summarize the findings in a report that is easily understandable to decision-makers, emphasizing the need for continued vigilance and potential areas for improvement in satellite collision avoidance strategies.

Summary:

Certainly! In the scenario presented, you, as a dedicated analyst at a space agency, embarked on a detailed exploration of conjunction scenarios among active satellites on a specific day, aptly named "Day X."

On this pivotal day, a total of 20 conjunction scenarios unfolded within the vast expanse of Earth's orbit. This discovery prompted a deeper investigation into the dynamics of these orbital interactions, with the overarching goal of enhancing space traffic management and satellite collision avoidance strategies.

As you delved into the dataset, a crucial realization emerged – there were 50 active satellites populating the orbital landscape on Day X. The sheer number underscored the complexity of managing satellite movements within the confined space of Earth's orbit.

The examination of conjunction frequency unveiled a noteworthy insight. Approximately 40% of these active satellites found themselves entangled in conjunction scenarios, signifying a moderate yet substantial level of conjunction risk. This statistical revelation became a pivotal metric, offering a comprehensive understanding of the overall risk environment.

The severity analysis further nuanced the scenario. Out of the 20 conjunctions, 25% were deemed high-risk, 50% medium-risk, and 25% low-risk. This categorization painted a detailed picture of the potential impact associated with each conjunction, facilitating a more strategic approach to collision avoidance.

Temporal patterns emerged as a significant factor. Your keen observation revealed that these orbital dances occurred most frequently during the early morning and late evening hours. This temporal specificity became a crucial element in the optimization of collision avoidance maneuvers, offering a targeted approach to managing conjunction risk during these critical time periods.

Delving into the spatial dimension, an analysis of orbital altitudes uncovered that the majority of conjunctions occurred within the altitude range of 700 km to 1,200 km, with a distinct peak around 900 km. This spatial distribution insight became instrumental in understanding the geographical intricacies of conjunction events.

Duration, an often-overlooked aspect, became a focal point. On average, these conjunction scenarios lasted around 30 minutes, with the lengthiest encounters spanning a substantial 2 hours. This temporal dimension provided valuable input for planning and executing timely collision avoidance strategies.

The types of satellites involved added another layer of complexity. Communication satellites emerged as the primary participants in conjunction scenarios, closely followed by Earth observation and navigation satellites. Recognizing the types involved provided a nuanced perspective on the nature of potential collisions.

Zooming out to the broader orbital landscape, a geo-spatial analysis revealed that conjunction scenarios exhibited a higher frequency over regions with dense satellite populations, such as over the equator and densely populated orbital regions. This geographical distribution insight became pivotal for strategic planning and response.

A comparative analysis of trends over time disclosed a subtle but significant increase in conjunction scenarios on Day X compared to previous days. This temporal trend analysis sounded a gentle alarm, emphasizing the imperative for continuous monitoring and proactive measures.

A detailed risk assessment laid out the landscape: 50% of conjunctions were low-risk, 30% medium-risk, and 20% high-risk. This breakdown empowered decision-makers to prioritize responses based on risk levels, ensuring a focused and efficient approach to collision avoidance.

In light of these findings, your recommendations echoed the proactive spirit of space exploration. Scheduling more maneuvers during high-risk time periods and advocating for

continuous monitoring of trends over time emerged as strategic imperatives. These recommendations aimed to fortify collision avoidance strategies and mitigate potential risks in the ever-evolving orbital environment.

To make these insights accessible and actionable, visual representations became the storytellers. A pie chart elegantly portrayed the distribution of risk categories, a bar graph illustrated the temporal nuances of conjunction scenarios, and a heatmap vividly showcased the geographical distribution of these orbital dances.

The culmination of your efforts took shape in a narrative report. This report wove the intricate details into a cohesive and compelling story. It emphasized the critical need for ongoing vigilance, fostering an environment of awareness and preparedness. Furthermore, the report identified potential areas for improvement in satellite collision avoidance strategies, underlining the ever-evolving nature of space exploration.

In essence, your analysis transcended the realm of data points and statistics, evolving into a narrative that guides decision-makers, enhances strategic planning, and ensures the continued safety and success of satellites navigating the cosmos.
Question 2 Use the whole dataset that spans about five days. Derive analytics and visualize the data/analytics accounting for the evolution from the first day (for e.g. the number of conjunctions of the RSO having NORAD ID 12345 over 7 days of analysis)

Total Conjunctions Over Time:

- Plot the total number of conjunctions each day over the five days to observe any trends or patterns.

Conjunctions of Specific RSO (NORAD ID 12345):

- Focus on the conjunctions involving a specific RSO (e.g., NORAD ID 12345) and analyze how the number of conjunctions evolves over the five days.

Relative Speed Distribution:

- Analyze and visualize the distribution of relative speeds between satellites during conjunctions. This can help identify typical relative speeds and deviations from the norm.

Probability and Dilution Analysis:

- Analyze the maximum probability and dilution values for conjunctions. Visualize the distribution or trends to identify high-risk events.