

Introduction

Given the rapid colonization of area of Low Earth Orbit (LEO), namely with SpaceX's plans of adding 30,000 additional satellites to their existing ~7,000 Starlink satellites, our team's goals are to create tools that allow both other researchers and legislators to easily research and convey the detrimental effects of overcrowding LEO.

Methodology

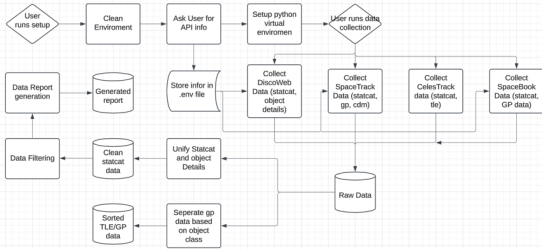
Our data is sourced from publicly available satellite tracking datasets, which are acquired, cleaned, and unified by the data acquisition team to ensure consistency and reliability.

The insights team employs Python-based algorithms (i.e., NASA standard breakup model) to extract meaningful patterns and trends from the processed data.

The visualization team presents these insights in a clear and interpretable manner, facilitating informed decision making and further insights.

DATA ACQUISITION

- Data Collection and Aggregation**
 - Sources:
 - SpaceTrack
 - SpaceBook
 - DiscoWeb
 - SATCAT data
 - Combines sources on the fields containing the International Designator. Conflicts are resolved with the order of priority the same as the order the data sets are listed above
 - TLE data
 - Grabs all TLE data from all sources, combines them, saves combined TLE/GP data in a file
- Data Filtering**
 - Functions that allow us to generate subsets of the data based on certain input parameters from the user. Example parameters:
 - Type
 - Altitude
 - Launch Date
 - Data Reports
 - Takes in filtering functions and finds the number of rows that are returned from each filtering function. This allows us to see things like how many rocket bodies there are, how many objects are within a certain area, and much more



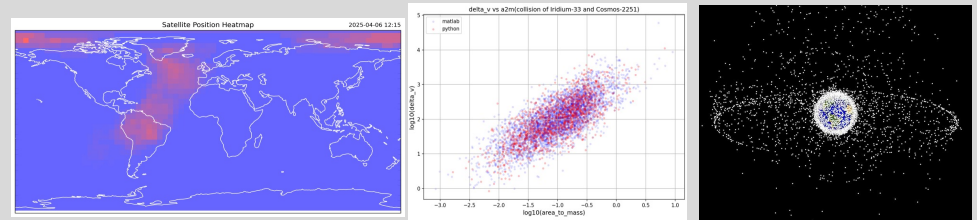
Conclusions, Future Work, Acknowledgements

Conclusion: The issue of space debris offers extensive opportunities for data acquisition, analysis, and visualization. We have developed tools that highlight the current state of space traffic in Low Earth Orbit. With these insights and visualizations, we hope to bring increased attention to the current and future state of space debris and ensure that we can continue to deploy and operate satellites.

Future Goals: The next phase of development would focus on creating further functionalities for insight generation, increased data sources, and more avenues for visualization. This platform will streamline workflows and improve accessibility for users of the tools developed, including researchers and policymakers. Through the implementation of these, we hope to better be able to generate insights on the future of space traffic and debris.

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DATA INSIGHTS



- Service Disruptions**
 - Model a threat actor that disables all satellites in a specific region. Generate an animation that shows how the service disruptions evolve over time using a heatmap.
 - Identify satellites visible at each grid point using TLE Data.
 - Show the propagation of disruptions zone over the globe after a service disruption event.
 - Demonstrates the resilience of a satellite constellation
- Fragmentation**
 - Modelling the fragments generated by the collision of two objects.
 - Implementation of the NASA breakup model in Python.
 - Use the model to power insights on space traffic and potential collisions.
 - Model provides characteristics and orbital parameters of each fragment.
- Decommissioning**
 - Identifying satellites nearing 'end of life'
 - Using the data, finding satellites that should be decommissioned.
 - Using multiple factors including, altitude, mission lifetime, operational status, orbit distance, and mass
 - Deorbit rules varies based on country of origin, we're focusing on the US

DATA VISUALIZATION

- Create dynamic Gabbard, Scatter, and Stacked-Bar plots
- Create visualizations in collaboration with projects done by insights
- Worked with Insights to create heatmap visualizations
- All 3 types of graphs include multiple functions for filtering data, such as by object type, size, group, country, and altitude
- Colors and other visual aspects are dynamic and customizable

