Examining the Impact of Satellite Deployments on Space Debris Accumulation

Authors: Jonathan Masalu (202157590) & Akwaka Clinton (202152807)

Mar 07 2025

1 Broad Goal (Why?)

As satellite launches increase, concerns about space debris and orbital congestion grow. This project seeks to analyze **satellite deployment trends** and their **impact on space debris formation**. By identifying patterns in satellite lifespans, deorbiting practices, and debris generation, we aim to provide insights into sustainable space operations.

2 Initial Data Exploration & Key Findings

Early analysis of the dataset highlights:

- **Trend in Active Satellites**:

  - Early Years (1957–1980): Satellite launches were relatively low, starting from a few in the late 1950s.
  - Moderate Growth (1980–2000): The number of satellites launched increased at a steady pace. With a peak in 1999
  - Exponential Growth (2010–2025): The number of satellites launched surged dramatically, reaching and surpassing 3000 per year by 2020. Figure 1 shows a visual representation of this trend.

- **Growth in Space Debris**: A notable rise in defunct satellites and debris objects in various orbits.

- **Organizations/Country Contributions**: Certain nations and organizations are responsible for higher levels of orbital congestion.

Potential Visualizations

- A **trend graph** of satellite launches vs. debris formation.

- A **heatmap** of debris density in different orbital regions.

- A **bar chart** of satellite retirements and deorbiting actions by country/Organization.
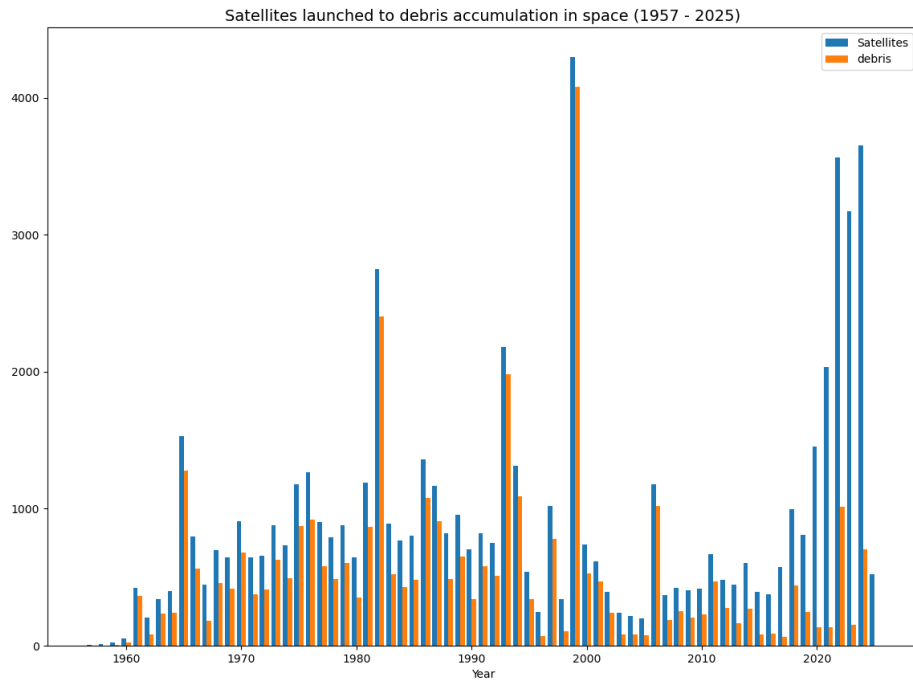

Figure 1: Satellite deployments vs debris accumulation

3 Intended Sub-goals

3.1 Infographic Goal

Design an **informative visualization of space debris accumulation**, including:

- Historical satellite launch trends.

- The proportion of active vs. defunct satellites.

- The role of deorbiting practices in space sustainability (How removing old satellites and debris from orbit helps keep space clean and safe for future missions.).

Tone & Experience: The infographic will be **explanatory**, presenting a compelling visual story about the **consequences of increasing satellite numbers**.

3.2 Interactive Dashboard Goal

Develop a **dashboard to explore space debris trends** through:

- Filtering by launch year, country/organization, and orbital zone.

- Visualizing satellite statuses (active, retired, debris).

- Assessing the effectiveness of deorbiting strategies.

Tone & Experience: The dashboard will be **exploratory**, allowing users to interact with **space debris data** dynamically.

4 Next Steps

1. **Further Data Analysis**:

   - Categorizing satellites based on their operational status and country/organization that owns them.
   - Identifying high-risk orbital regions for debris accumulation.

2. **Refinement & Additional Visualizations**:

   - Developing comparative charts of satellite deployments vs. removals.
   - Creating an interactive orbital map displaying debris hotspots.