THE CURIOSITY CUP 2024

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What is the trended future space mission

And the expected space problems?

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ABSTRACT

This report presents the results that the scientists of the Union of Concerned Scientists (UCS) found in our satellite database, which consists of more than 7,560 operational satellites currently in orbit around Earth. Getting more information about the earth and discovering its natural resources and how to get benefits from them starts with space. Our goal is to produce an analysis of that type of data to know and forecast the future of space and if it faces any problems that affect the space industry.

Data analysis will provide us with answers to many other questions, such as: what is the future of the current satellite fleet, which missions are launched and used most frequently, which satellite orbits are densely populated, which countries are interested in satellites and how many satellites they own in orbit, and many other questions. The information we receive aids us in making judgments on the new space mission we want to launch as well as the difficulties plaguing the space industry going forward, including the rise in space debris and overcrowded orbits and how to solve those issues.

Introduction

The space industry and its numerous missions that launch into space to create countless achievements for various users, such as: military, civic, commercial, and more, have been crucial to the recent discovery of Earth's natural resources as a result of technological advancements.

As a result, we must analyze this data to learn new insights from the number of satellites that are currently in operation about the future of space missions and what new fields space science can advance and develop in the future. We also need to find solutions to the issues that will prevent the advancement of future missions and extend the life of current missions so that we can forecast their future.

The primary issue facing all upcoming missions that are launched into particular orbits is space debris since we are unable to launch new missions into an environment full of debris, which raises the likelihood of a mission's failure.

DATA

The data was obtained from Kaggle, and the author indicated that it was sourced from experts at the Union of Concerned Scientists (UCS),Our dataset is updated three times per year and obtain more than 7,560 operational satellites that now in their orbit around Earth and consist of 7,560 raw and 33 columns and its very large data for the specific target of analyzing so we reduce by deleting the comments, Longitude of GEO (degrees) which is not have all required information and all is missing value and some additional sources which reduce size of data from 1582 KB to 474.2 KB by using SAS studio.

The original satellite.csv data file was transformed into a SAS data file using SAS Studio® from SAS OnDemand for Academics® for preparation and validation This newly formatted data file was then uploaded into SAS Viya for Learners to be used for the study and analysis.

METHODOLOGY

The methodology of this study involves a four-step process for analyzing a dataset of satellites data using SAS software. SAS Studio is used for data validation and preparation in the first two methods, whereas SAS Viya is used for data analysis and visualization. We will obtain each of them as the following:

IMPORTING AND ACCESSING DATASET

The given text describes a code that uses the SAS programming language to import a data file in xlsx format located at a specific file path. stored in an Excel file. Think of it like getting a map to guide us through the data's location. This is done through the libname statement, where we establish a connection to the Excel spreadsheet and create a library called "sate" and using options statement with 'validvarname=v7' system option forces table and column names read from Excel to adhere to recommended SAS naming conventions:

```
 options validvarname=v7;
 libname Sate xlsx
    "/home/u58936705/SAS COMPETITION/UCS-Satellite-Database 5-1-
2023.xlsx";
```

DATA CLEANING AND VALIDATION

Starting data cleaning and validation moreover creating new columns with data set statement we create an output file name "Satellite" and drop all columns from AC to BP, VARS 17 VARS 18 and comments from the sheet1 of library sate to be sure that it won't appear again at the final table

Then we using keyword 'rename' to change the name of column "VAR21" to a new name "expected_lifetime_years" that obtain number of years that each satellite will be at its operation. Then we create "date_of_launch" and "expected_lifetime_years_rounded" and making dropping for them as I need it for only some calculations and don't need it to appear in the output.

Then time of formatting and validation so we format columns "launch_date" "expected_expire_date" and modifying the length of columns "satellite_status" "expected_expire_date" and filtering our data and get rid of the missiong values according to specific columns "Inclination_degrees_" , "Perigee_Km_" "abogee_Km_" , "eccentricity" to be ready for preparation moreover we handle the "Launch_date" column that was created because of an error from exported of excel file as code obtained at the following:

```
Data Satellite (drop=AC--BP VAR17 VAR18 Comments);
        set sate.sheet1 (rename=(var21=expected lifetime years));
        drop date of launch expected lifetime years rounded;
        format launch date date9.;
        length expected expire date 8;
        length Satellite Status $30;
        format expected expire date date9.;
/* Filter out records with missing values in specific variables. */
        Where Inclination  degrees  is not missing and Perigee  km  is not
missing and apogee  km  is not missing and eccentricity is not missing;
        launch date=(date of launch - 21916);
```

Data Preparation and Exportation

We use the round function to round the "expected_lifetime_years" column and put the new values at new column that we created name "expected_lifetime_years_rounded" that will be used its values to calculate new column "expected_expire_date" for satellites after that step we select satellite status if it was on operation from the day of launch until day of today then the value will be (Active Satellite)value for column "Satellite_status" that was created above if not the value will be (Debris Satellite) and if the "expected_expire_date" is missing the value will be (unkown):

```
  if missing(expected expire date) then
          Satellite status = 'Unknown Status';
        else if expected expire date <=today() then
                Satellite Status="Debris Satellite";
        else if expected expire date > today() then
                Satellite Status="Active Satellite";
```

Then we obtain the value of the orbit inclination to be one of that values (equatorial, polar, direct orbit, indirect orbit) according degree of inclination,so we can detect direction of motion of satellites that is so important to know type of missions depended on the direction of the orbit moreover which was crowded orbits. After that we detect the shape of the orbits according to value of eccentricity if it greater than or smaller than or equal to detect the shape as the code obtain:

```
        if inclination  degrees =0 or inclination  degrees =180 then
                Orbit inclination="Equatorial orbit";
        else if inclination  degrees =90 then
                orbit inclination="polar orbit";
        else if inclination  degrees  > 90 or inclination  degrees  LE 180
then
                orbit inclination="Indirect orbit";
        else if inclination  degrees  < 90 then
                orbit inclination="Direct orbit";
        else
                orbit inclination="Unknown orbit";

        /* Categorize orbital shapes based on eccentricity. */
        if eccentricity=1 then
                Orbital shape="Parabola";
        else if eccentricity > 1 then
```

```
                Orbital shape="Hyparabola";
        else if eccentricity=0 then
                Orbital shape="Circle";
        else if eccentricity <1 or eccentricity >0 then
                Orbital shape="Elipse";
        else
                Orbital shape="Unknown shape";
run;
```

Then after finishing all preparation the data is ready for analysis so we will export it using proc import statement and specify where is the location to export the data and use replace statement to replace the file if it exists, so it will be ready for analysis and visualized at SAS Viya.

```
proc export
    data = satellite /* Specify the name of the SAS dataset you want to export
*/
    outfile = "/home/u58936705/SAS COMPETITION/UCS-Satellite-Database 5-1-
2023.xlsx" /* Specify the path and name of the output Excel file */
    dbms = xlsx  /* Specify the database management system */ replace;
    sheet = "Sheet1"; /* Specify the name of the sheet */
    /* Replace the existing Excel file if it exists */
run;
```

Data Analysis and Visualization

The data is prepared for analysis and provides valuable insights that will enable us to predict and understand the future development of the space sector. Using SAS Viya to analyze our satellite data, we have determined that just 4.7K of the 7,560 satellites are operational and live, with the remainder being nearly inoperable debris that poses a threat to the space environment**.**

According to A1 in the appendix, the most popular and crowded orbit is LEO (Low Earth Orbit), with an ellipse orbit shape that is "the most used shape for missions" and 4,321 active satellites, 475 debris, and a large number of satellites with unknown status (i.e., debris or in operation). This means that fewer missions, such as Earth observation and remote sensing, will be launched on this orbit in the future because there is a high likelihood that they will crash if they are unable to find a solution. In the second tier, there are 306 operational satellites in geostationary orbit (GEO) and 172 trash satellites, which is a big number but not as crowded as low-Earth orbit (LEO).

Specifically for LEO orbit, which will be crowded for a while and that is what we expected as much of the missions launched to it, A2 at the appendix obtains that 42.33% of satellites will be on operation for 5 years; however, 16.95% of GEO orbit will last for more than 12 years due to the type of missions launched into GEO that take more years. After more analysis we find that there are top 5 countries control the space industry as the following order (USA, Russia, china, Japan and united kingdom) and that for LEO orbit which is most usable however for GEO there are a lot of countries such as (i.e., Japan, USA) as A3 and A4 illustrate and Most of this countries use LEO for specific fields such as (Commercial, Military, Government purposes and others) as shown at A5.

This number of missions are a great evidence that the space sector are at continuous developing however the number of debris is so impressive that will treat the industry as at the future as A6 show that at 2025 there will be increase in number of debris which mean that there are some mission won't be launched or will be launched for higher orbits than its usual one and that will cost a lot of money moreover maybe not the required results, so we should find solution to get rid of that all debris or reducing its number at the future missions by making the satellites or cubesate travelling into atmosphere after ending its mission and burned out there using Drag deorbit devices or any other additional subsystem added to satellites to decrease number of debris.

SUGGESTIONS FOR FUTURE STUDIES

Because this data is updated three times a year, it will be easier for us to track and predict the future of the space industry. We can also use new techniques, like machine learning models, to learn more about this sector, which is where all technologies and fields will develop in the future.

CONCLUSION

That research obtain all types of orbits that used for most, missions that launched at continuous for specific purpose and which fields that affected, number of satellites work or not and which countries interested in space exploration. Moreover forecasting number of space debris at the future and how to solve this problem to save the future of space industry and all other technologies.

REFERENCES

- Satellite Database | Union of Concerned Scientists(ucsusa.org)
- SAS Institute Inc. 2018. SAS® Studio 3.8: User's Guide. Cary, NC: SAS Institute Inc Accessed February 8, 2023. https://documentation.sas.com/doc/en/sasstudiocdc/3.8/webeditorcdc/webeditorug/titlepage.htm

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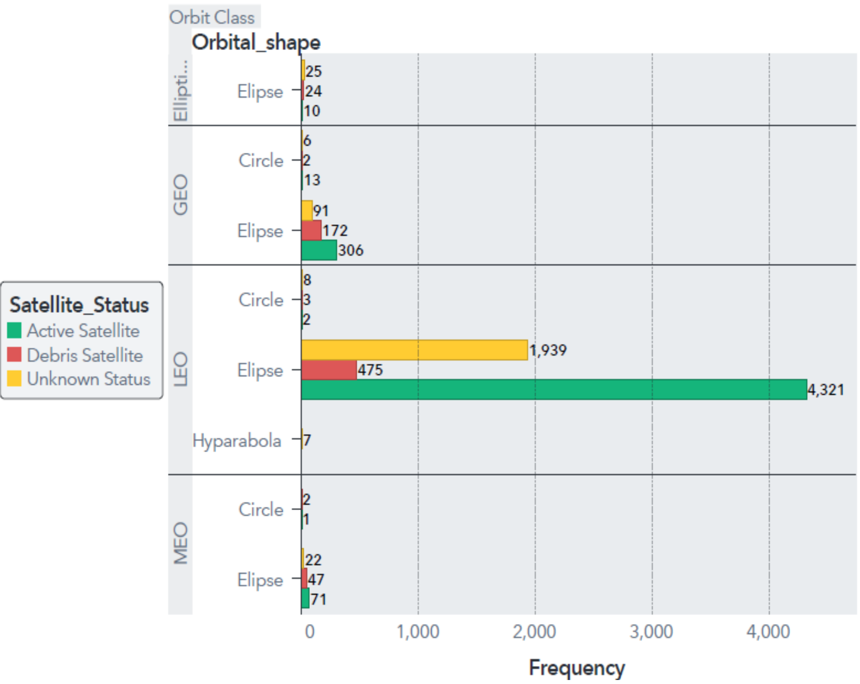
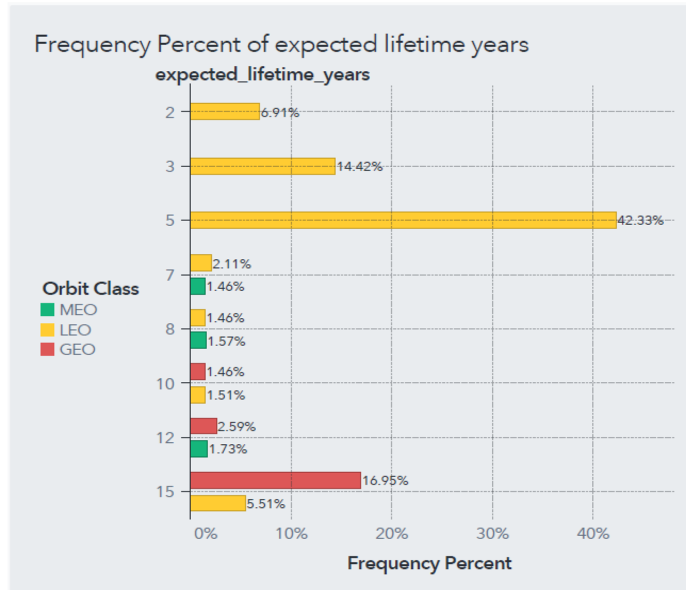
APPENDIX



A1



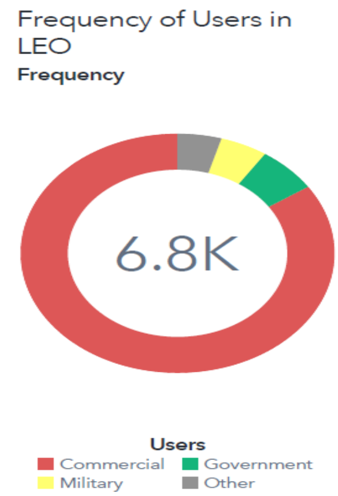
A2

Orbit Class	Satellite_Status / OPERATOR OWNER COUNRTY	Active Satellite Frequency	Debris Satellite Frequency	Unknown Status Frequency
GEO	USA	66	78	40
	United Kingdom	11	9	1
	Russia	22	8	5
	Multinational	34	17	1
	Luxembourg	27	8	—
	Japan	17	6	2
	India	25	3	1
	China	34	13	36

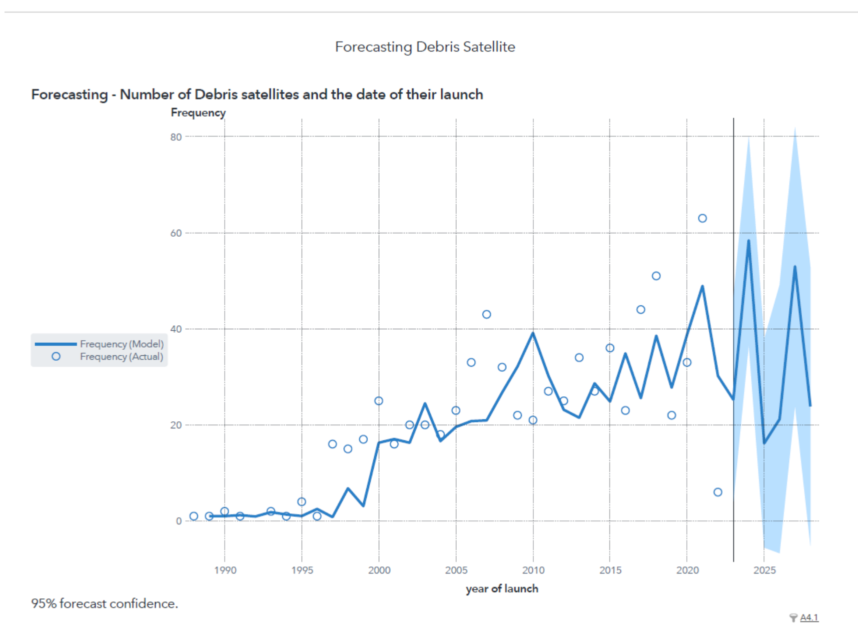
A3

Orbit Class	OPERATOR OWNER COUNRTY	Active Satellite Frequency	Debris Satellite Frequency	Unknown Status Frequency
LEO	USA	3,624	235	1,058
	Russia	14	51	37
	China	40	31	431
	Japan	6	24	30
	United Kingdom	593	1	16

A4



A5



A6