IBM Developer
SKILLS NETWORK

Winning Space Race with Data Science

Adedayo Abiodun Adeboye

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Outline

- Executive Summary
- Introduction
- Methodology
- Results
- Conclusion
- Appendix

Executive Summary

- **Summary of methodologies**

  API Data Collection

  Web Scraping Data Collection

  Data Wrangling

  Exploratory Data Analysis with SQL

  Exploratory Data Analysis with Data Visualization

  Interactive Visual Analytics with Folium

  Machine Learning Prediction

- **Summary of all results**

  Exploratory/Descriptive Data Analysis

  Interactive visualization analytics

  Creating dashboard for the team

  Predictive Analytics

Introduction

- **Project background and context**

  There is an advertisement on Space X's website that Falcon 9 rocket launches cost 62 million dollars, while other providers charge upwards of 165 million dollars per launch. Savings were largely achieved through the reuse of the first stage. It is therefore possible to determine the cost of a launch if we can predict the landing of the first stage. SpaceX may be able to use this information if an alternative company wishes to bid on a rocket launch against it. Our project is designed to construct a machine-learning pipeline that will be able to predict whether the first stage will be successful in a successful landing.

- **Problems you want to find answers**

  To determine the price of each launch.

  Create dashboard to determine if SpaceX will reuse the first stage.

  The factor that determine successful landing

Section 1

Methodology

Methodology

Executive Summary

- Data collection methodology:

  Data collection using API and Web Scraping

- Perform data wrangling

  Exploratory data analysis was performed to categorize outcomes into the training category

- Perform exploratory data analysis (EDA) using visualization and SQL
- Perform interactive visual analytics using Folium and Plotly Dash
- Perform predictive analysis using classification models
  - How to build, tune, evaluate classification models

Data Collection

- **Data Collection Methods**

  The data was obtained from the SpaceX REST API. A get request was performed using the request library to obtain the launch data

  The result was viewed by calling the .json() method

  The result was in the form of JSON, specifically a list of JSON objects.

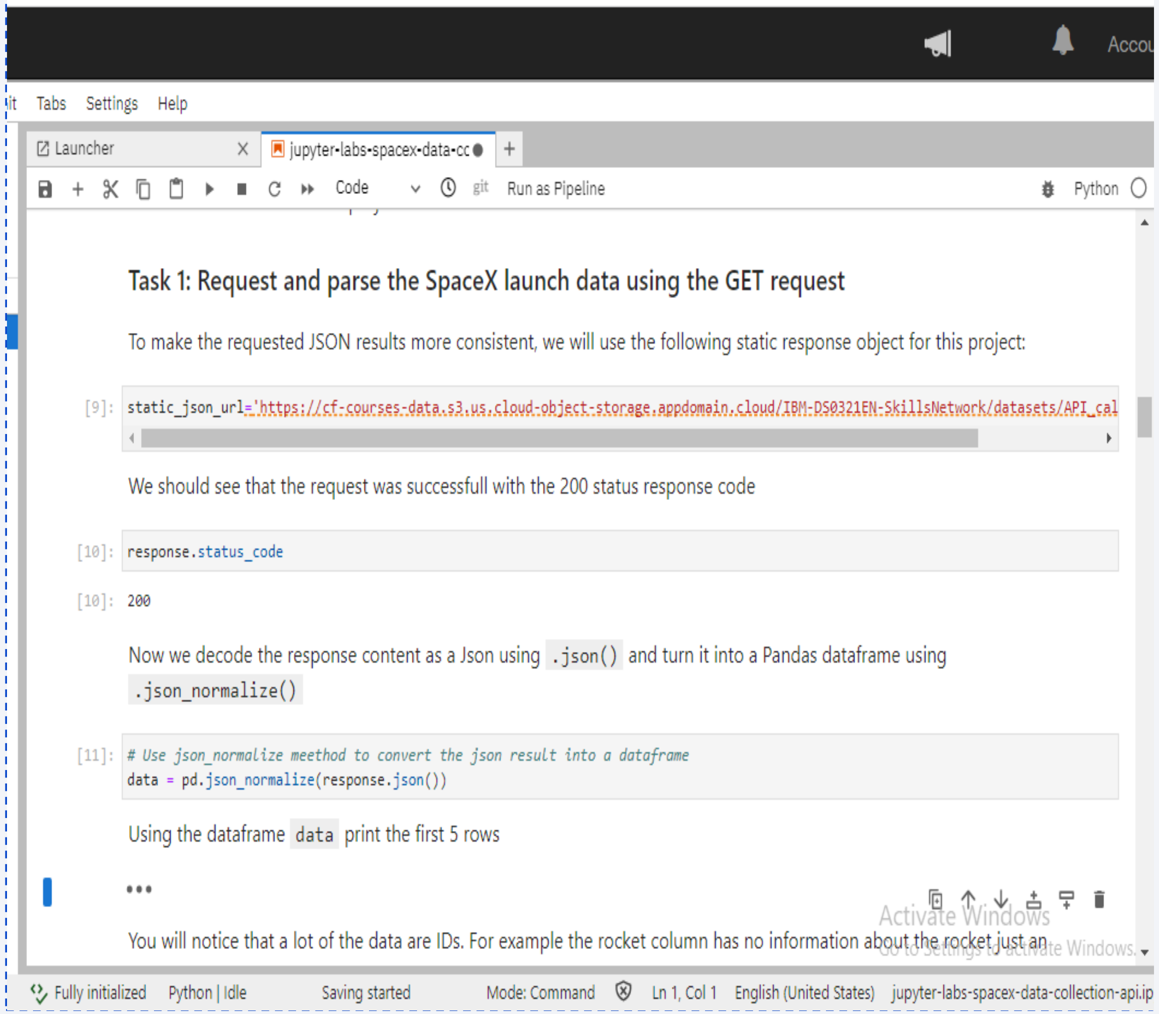
  JSON list of Objects then converted to DataFrame by using the jsom_normalize function

  Web Scraping using Beautiful soap was another method used to scrape some HTML tables that contain valuable Falcon9 Launch records

Data Collection – SpaceX API

- To gather data from SpaceX's API, we used the get request and did some basic data wrangling.
- Here is a link to the first API data collection process:

  https://github.com/Dayorboye/Spaces_X-s_Falcon_9_launch_Project/blob/main/jupyter-labs-spacex-data-collection-api%20(1).ipynb

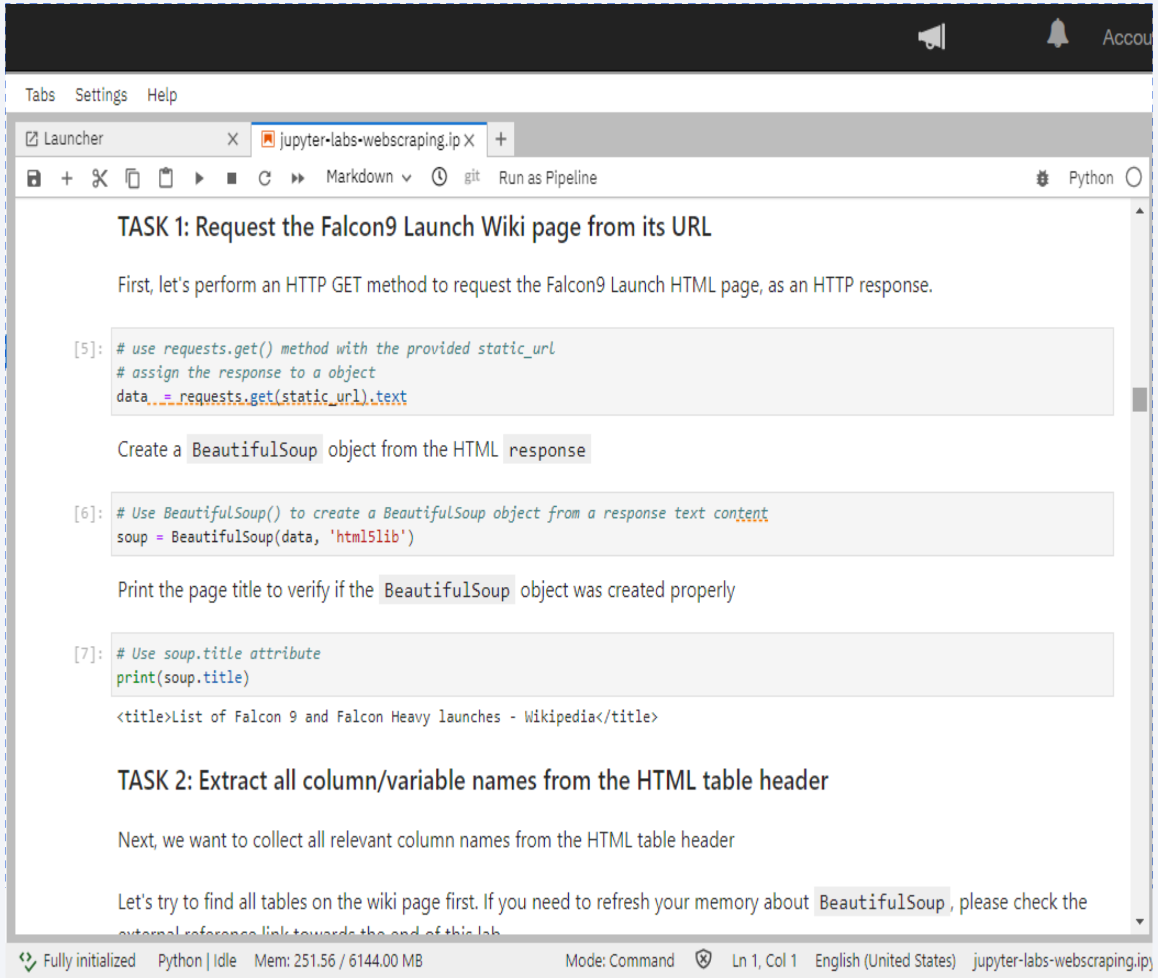


Data Collection - Scraping

- A web scraper was used to collect Falcon 9 launch records, and using BeautifulSoup, the table was converted into a pandas dataframe.

- Here is a link to the Web Scraping data collection process:

  https://github.com/Dayorboye/Spaces_X-s_Falcon_9_launch_Project/blob/main/jupyter-labs-webscraping.ipynb



Data Wrangling

- Exploratory Data Analysis (EDA) to find some patterns in the data and determine what would be the label for training supervised models which leads to the following finding

    Number of launches on each site

    Number and occurrence of each orbit

    Number and occurrence of mission outcomes per orbit type

    Create a landing outcome label from the Outcome column

- Here is a link to the Web Scraping data collection process:

    https://github.com/Dayorboye/Spaces_X-s_Falcon_9_launch_Project/blob/main/labs-jupyter-spacex-data_wrangling_jupyterlite.jupyterlite.ipynb

EDA with Data Visualization

- We perform exploratory Data Analysis and Feature Engineering using Pandas and Matplotlib to visualize the data:

  The FlightNumber (indicating the number of launches attempted) and Payload variables are plotted to observe how they affect the launch outcome.

  Observed the relationship between the FlightNumber and LaunchSite, plot the FlightNumber against the LaunchSite using the function catplot.

  The relationship between the success rate of each orbit type can be visualized

  Developed a visual representation of the relationship between FlightNumber and Orbit type

- Here is a link to data visualization process:

  https://github.com/Dayorboye/Spaces_X-s_Falcon_9_launch_Project/blob/main/jupyter-labs-eda-dataviz.ipynb.jupyterlite.ipynb

EDA with SQL

We applied EDA with SQL to get insight into the following queries.

- We queried the names of the unique launch sites in the space mission
- We queried 5 records where launch sites begin with the string 'CCA'
- We queried the total payload mass carried by boosters launched by NASA (CRS)
- We queried average payload mass carried by booster version F9
- List the date when the first successful landing outcome in ground pad was achieved.
- List the names of the boosters which have success in drone ship and have payload mass greater than 4000 but less than 6000
- List the total number of successful and failure mission outcomes
- List the names of the booster_versions which have carried the maximum payload mass. Use a subquery
- Rank the count of successful landing_outcomes between the date 04-06-2010 and 20-03-2017 in descending order
- Here is a link to data Qeuries process:

  https://github.com/Dayorboye/Spaces_X-s_Falcon_9_launch_Project/blob/main/jupyter-labs-eda-sql-coursera_sqllite.ipynb

Build a Dashboard with Plotly Dash

- Pie charts were plotted to illustrate the number of launches made by certain sites
- Relationship between Outcome and Payload Mass (Kg) for the different booster versions visualized by plotting Scatter graph

- Here is a link to data dashboard server:

  https://github.com/Dayorboye/Spaces_X-s_Falcon_9_launch_Project/commit/b124c1237afa00abcc2eb98f79aae7c5c1bd00b9

Predictive Analysis (Classification)

- Prediction Steps

  Necessary Libraries: numpy, pandas as well as seaborn imported to get started

  Data collection using dataset url and converted to dataframe

  Data collected processed into features (X_train) and target label (Y_train)

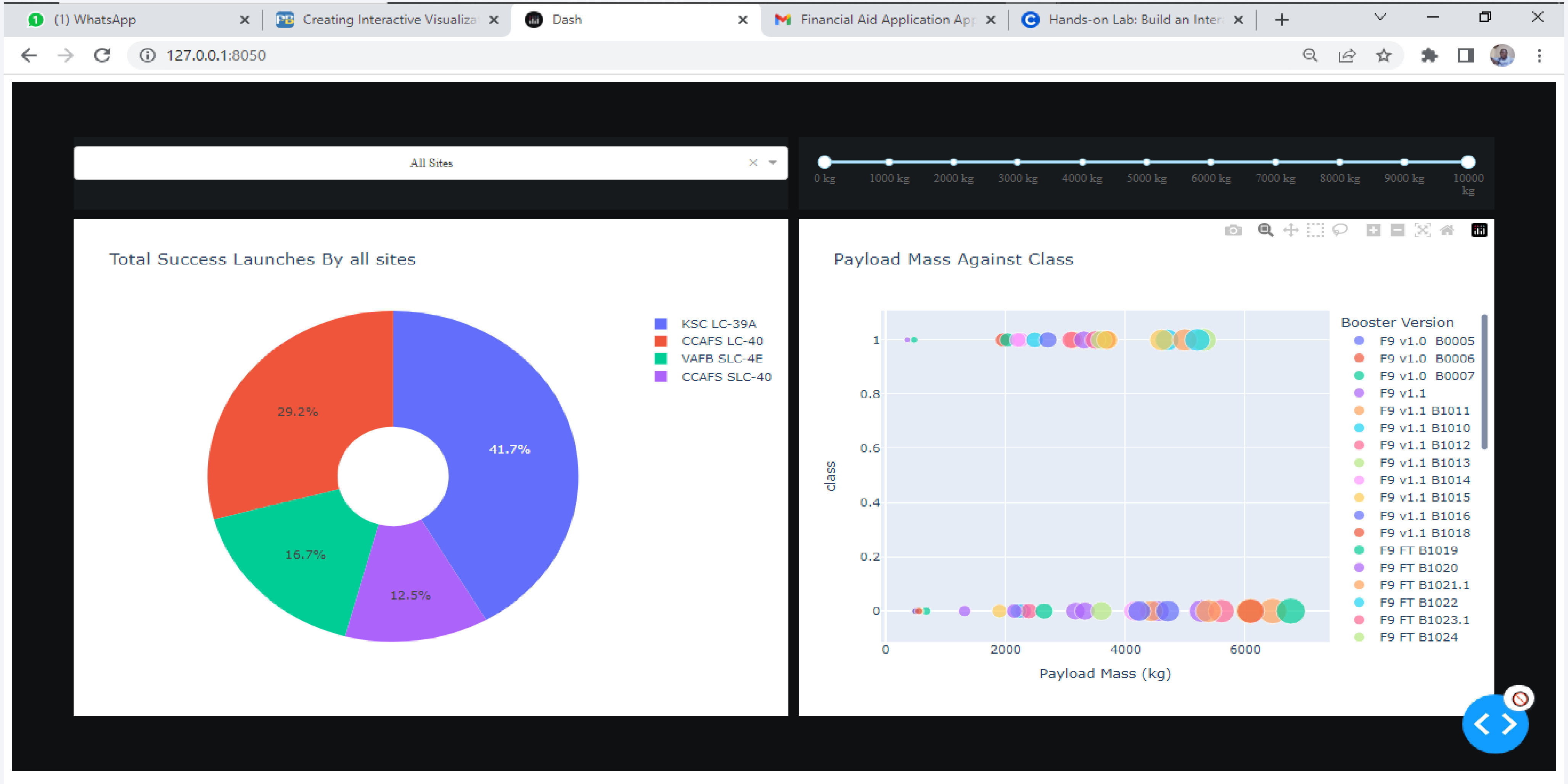
  Accuracy model conducted to validate performance of our model

- Here is a link to data dashboard server

  https://github.com/Dayorboye/Spaces_X-s_Falcon_9_launch_Project/blob/main/SpaceX_Machine_Learning_Prediction_Part_5.jupyterlite.ipynb

Results

Interactive analytics demo in screenshots



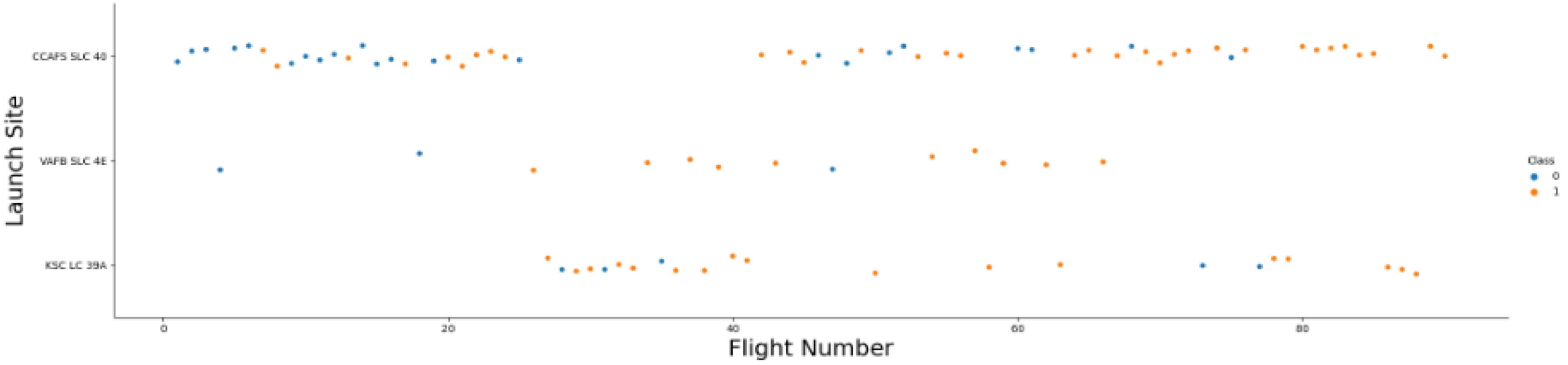
Section 2

Insights drawn from EDA

Flight Number vs. Launch Site

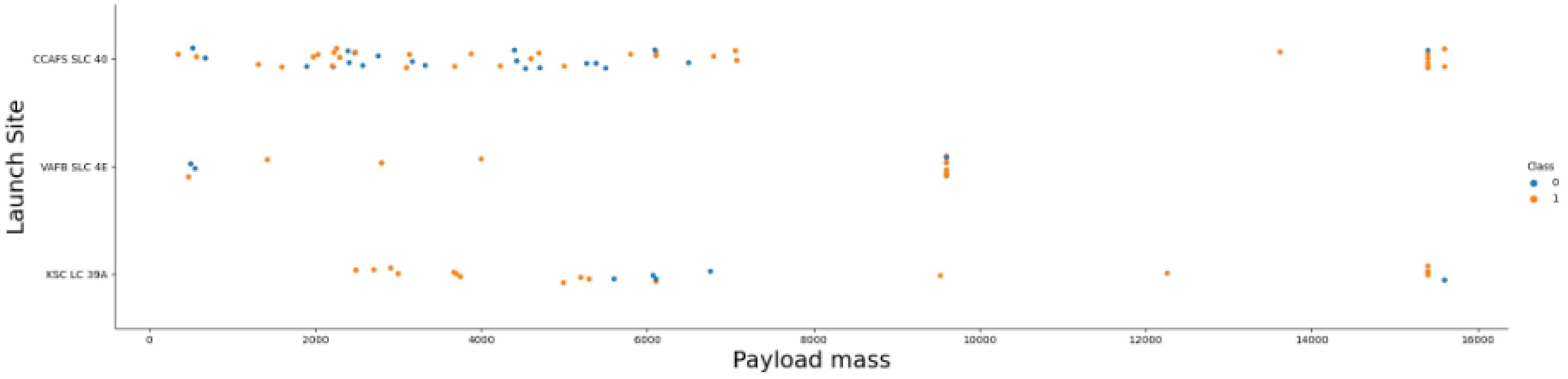
- Launch site have significant impact on the success of the launch site rate

[7]:
```
# Plot a scatter point chart with x axis to be Flight Number and y axis to be the launch site, and hue to be the class value
sns.catplot(y="LaunchSite",x="FlightNumber",hue='Class',data=df, aspect=4)
plt.xlabel("Flight Number",fontsize=22)
plt.ylabel("Launch Site",fontsize=22)
plt.show()
```



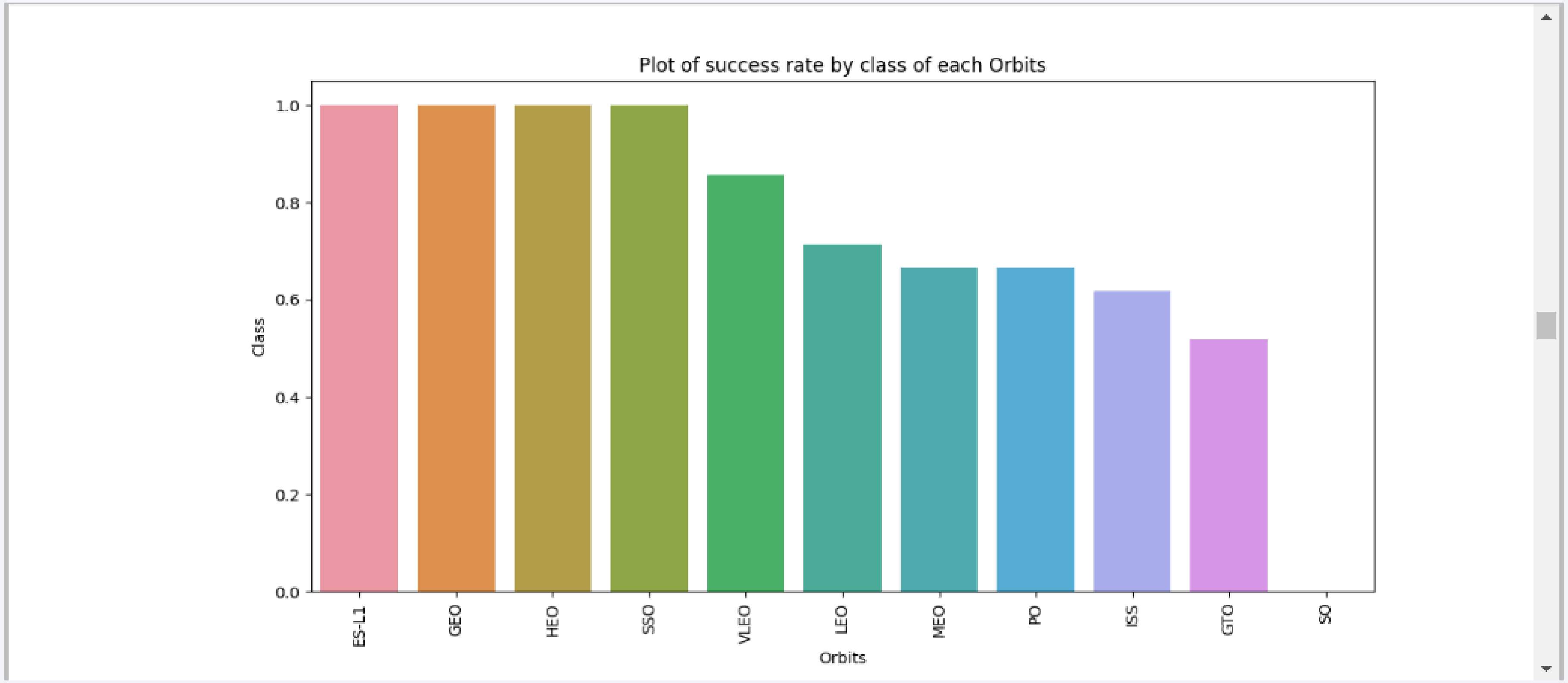
Payload vs. Launch Site

```
[19]: # Plot a scatter point chart with x axis to be PayloadMass and y axis to be the launch site, and hue to be the class value
sns.catplot(y="LaunchSite",x="PayloadMass",hue='Class',data=df, aspect=4)
plt.xlabel("Payload mass",fontsize=22)
plt.ylabel("Launch Site",fontsize=22)
plt.show()
```

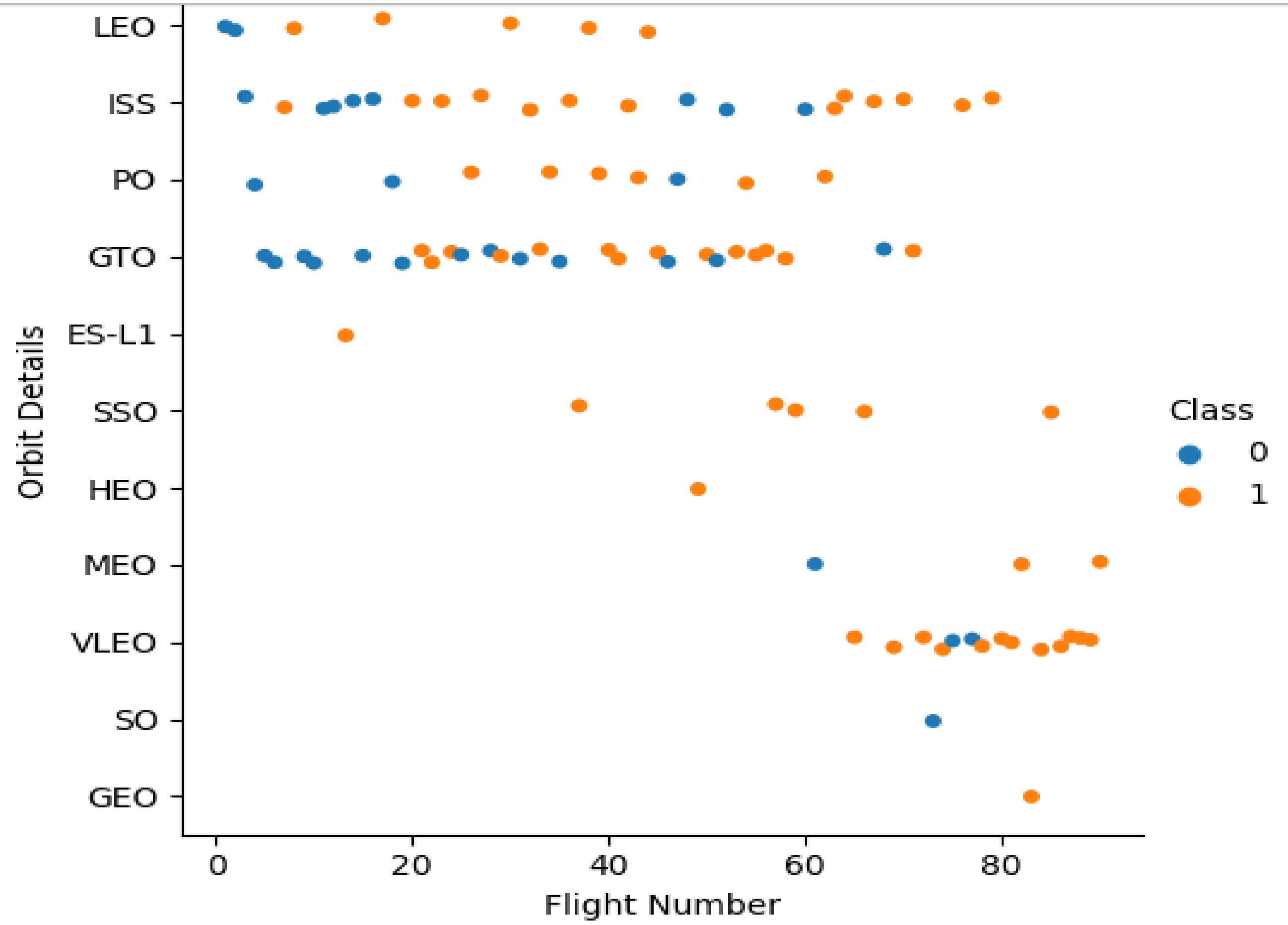


Success Rate vs. Orbit Type

- Respective success rate is observed from below plotted graph

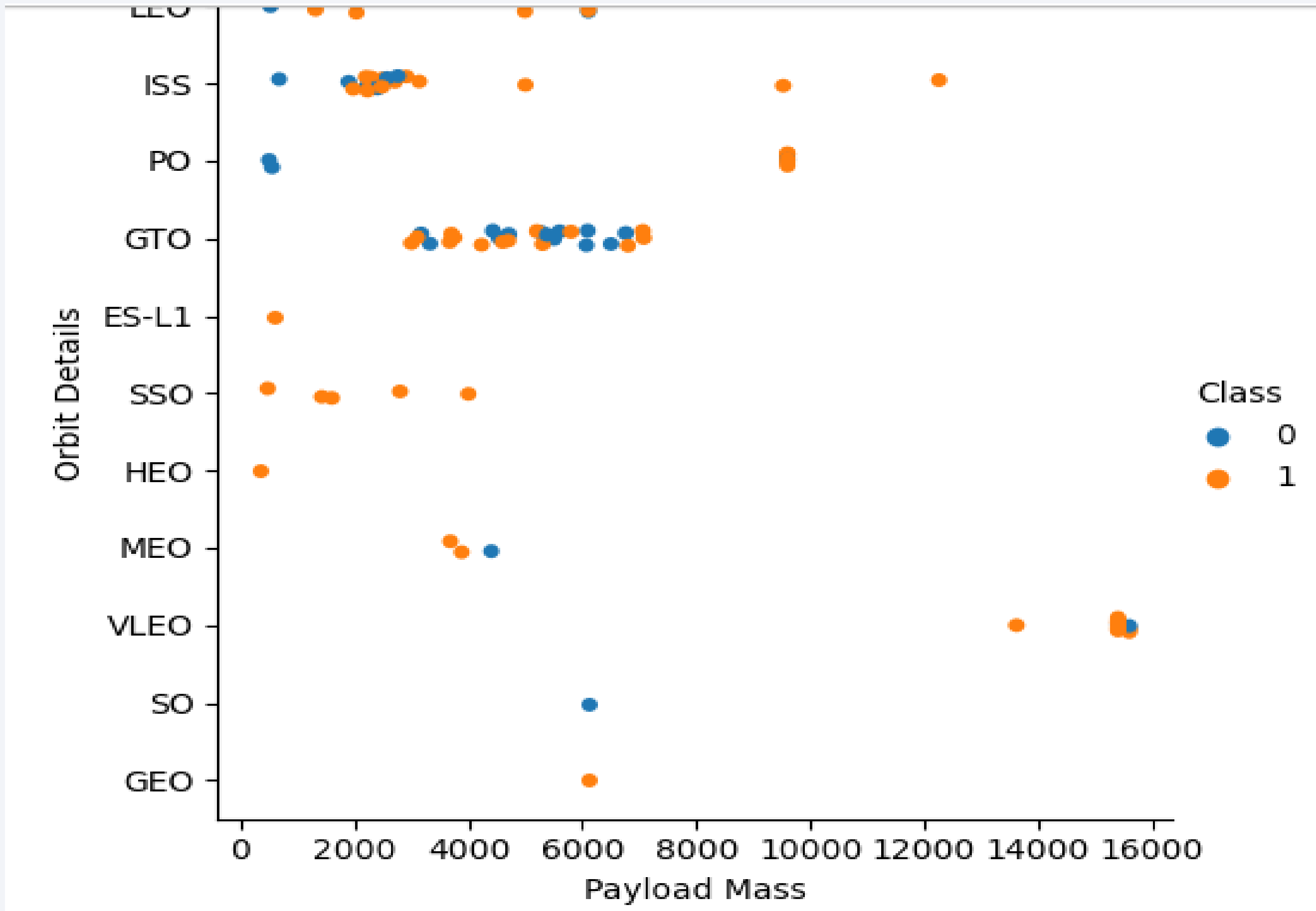


Flight Number vs. Orbit Type



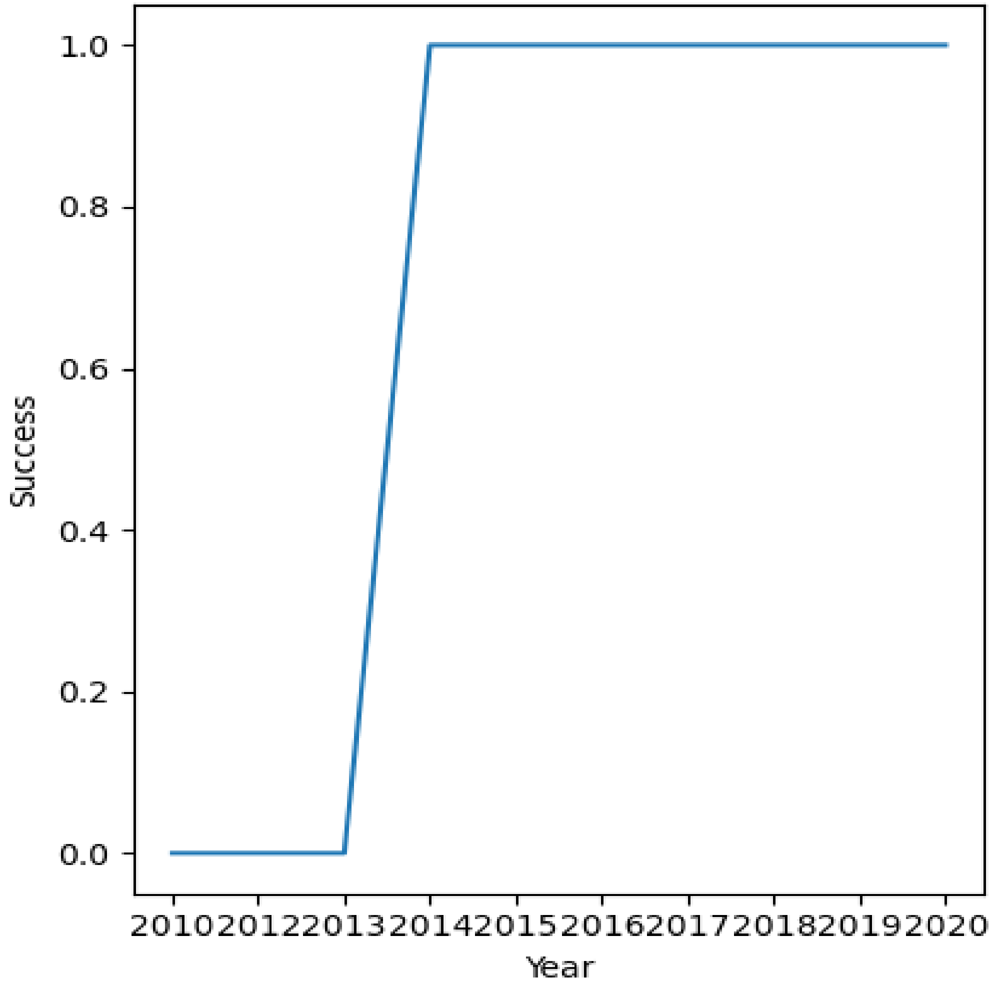
Success have significant relationship with number of flights

Payload vs. Orbit Type



We can see here strong relationship between PO, LEO and ISS orbits with payloads mass

Launch Success Yearly Trend



All Launch Site Names

The key word DISTINCT get the request

For the unique sites from the data

```
(Background on this error at: http://sqlalche.me/e/e3q8)

[17]: %sql select DISTINCT LAUNCH_SITE FROM SPACEXTBL

 * sqlite:///my_data1.db
Done.
```

[17]:

Launch_Site
CCAFS LC-40
VAFB SLC-4E
KSC LC-39A
CCAFS SLC-40

Launch Site Names Begin with 'CCA'

- Use of %sql SELECT LAUNCH_SITE from SPACEXTBL where LAUNCH_SITE LIKE 'CCA%' LIMIT 5 printed 5 record where launch sites begin with ‘CCA’

Display 5 records where launch sites begin with the string 'CCA'

```
[8]: %sql SELECT LAUNCH_SITE from SPACEXTBL where LAUNCH_SITE LIKE 'CCA%' LIMIT 5;
```

```
 * sqlite:///my_data1.db
Done.
```

[8]:

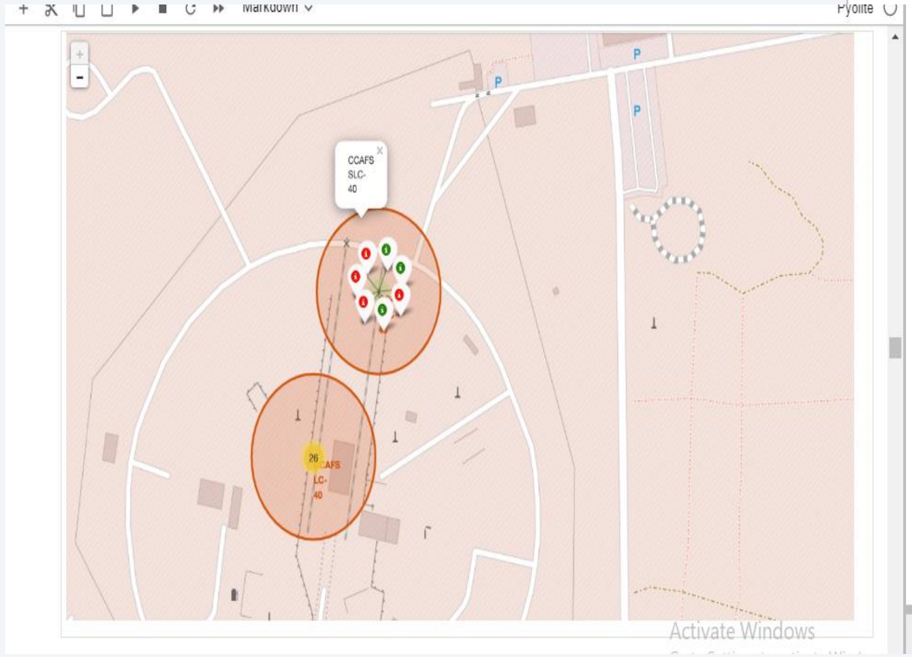
Launch_Site
CCAFS LC-40
CCAFS LC-40
CCAFS LC-40
CCAFS LC-40
CCAFS LC-40

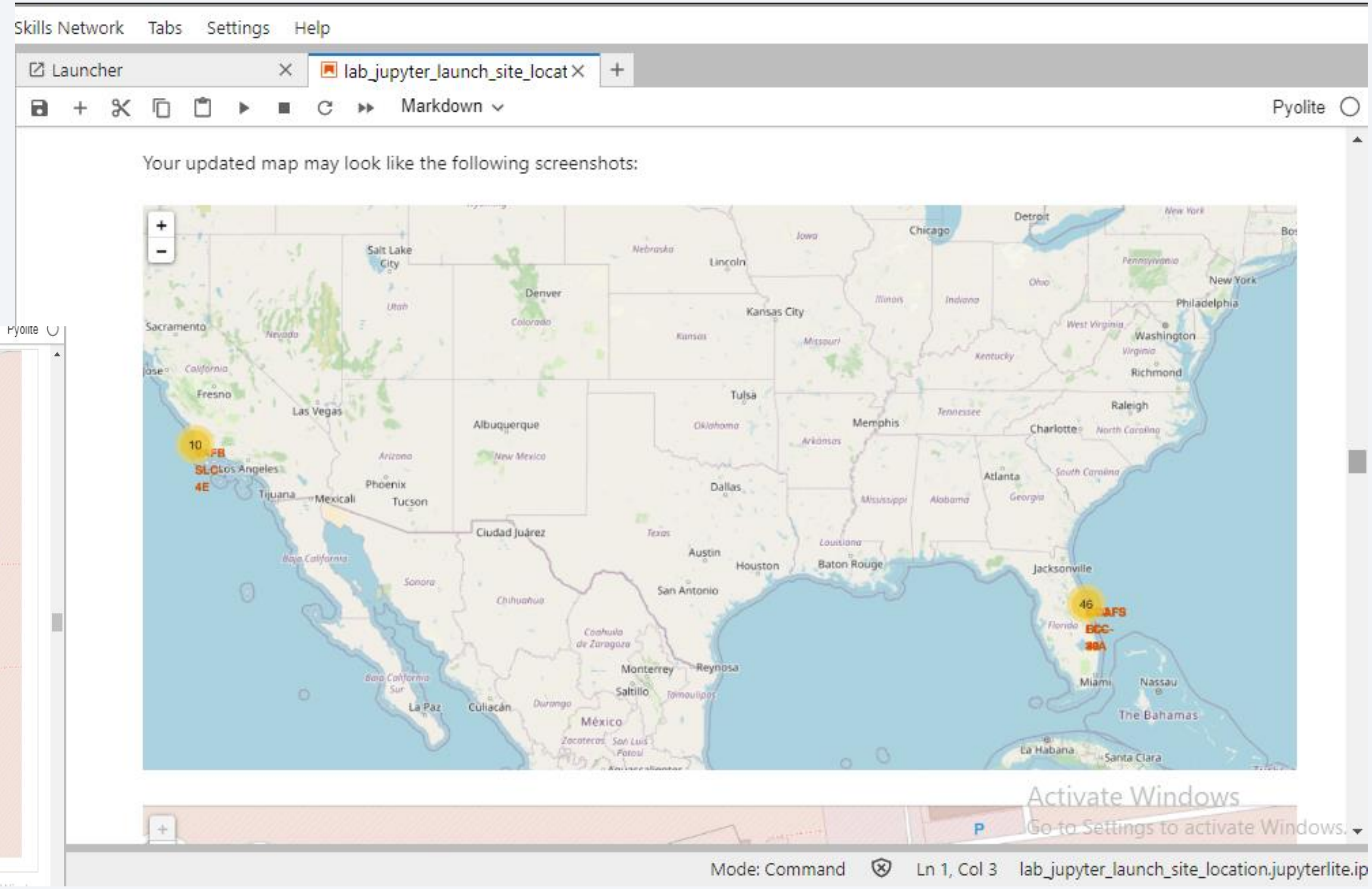
Section 3

Launch Sites Proximities Analysis

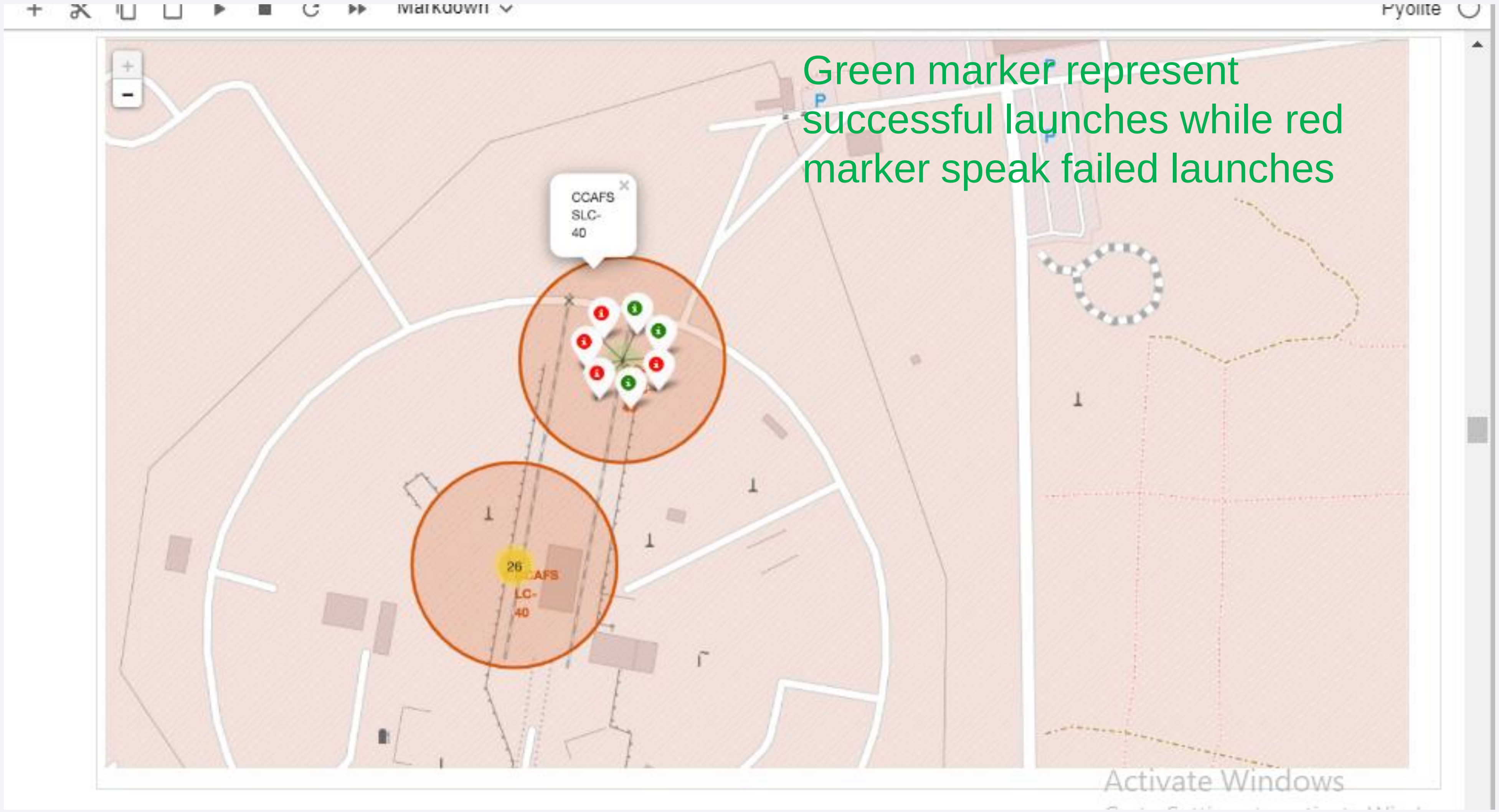
<Folium Map Screenshot 1>

The global map show both successful and failed launch site represented with green marker for success while red marker for failure





Folium Map Identified Success and Failed Sites



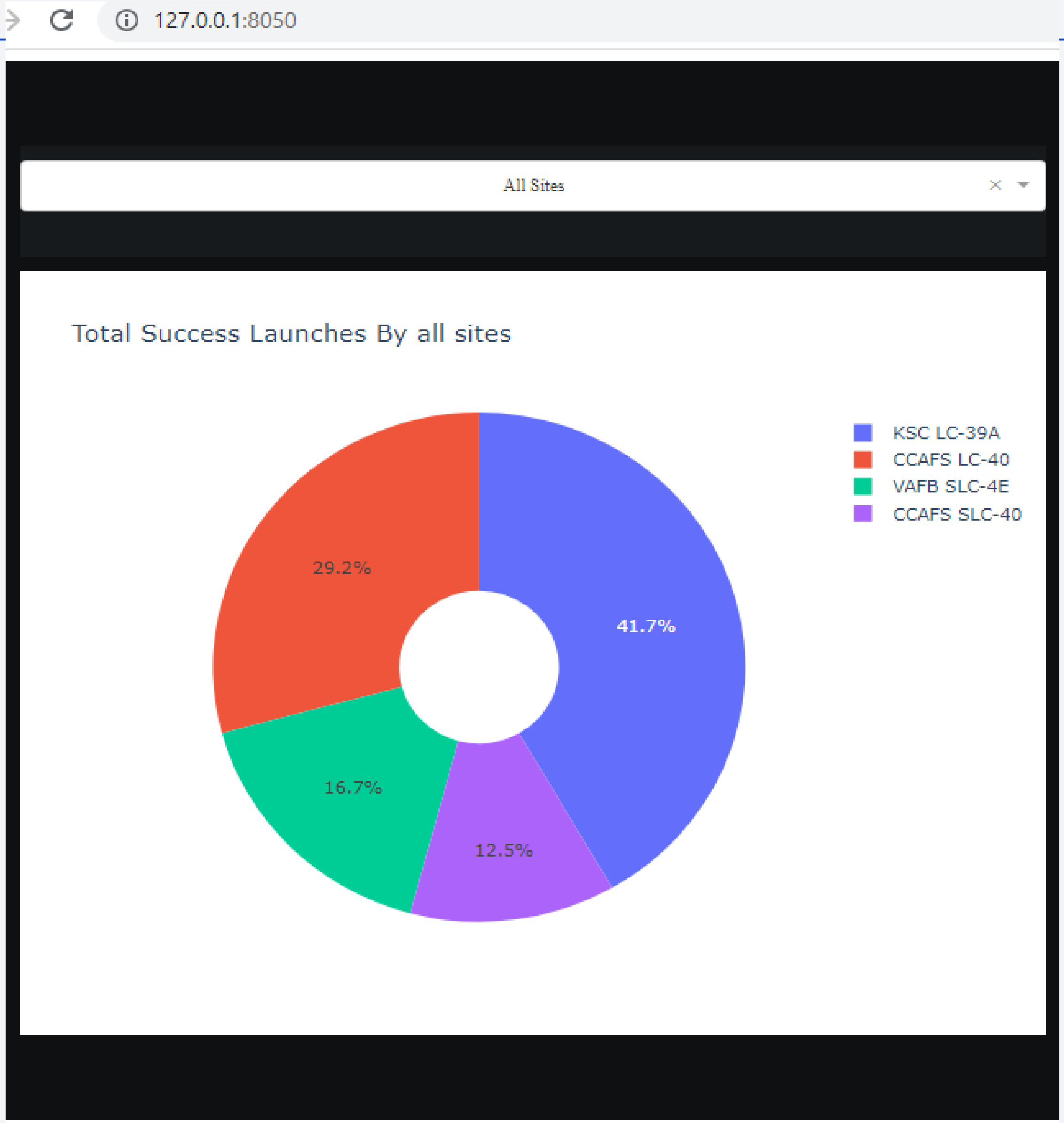
Green marker represent successful launches while red marker speak failed launches

Section 4

Build a Dashboard with Plotly Dash

Pie Chart Visualization Showing % Success

KSC LC-39A record the most successful launches of all the sites



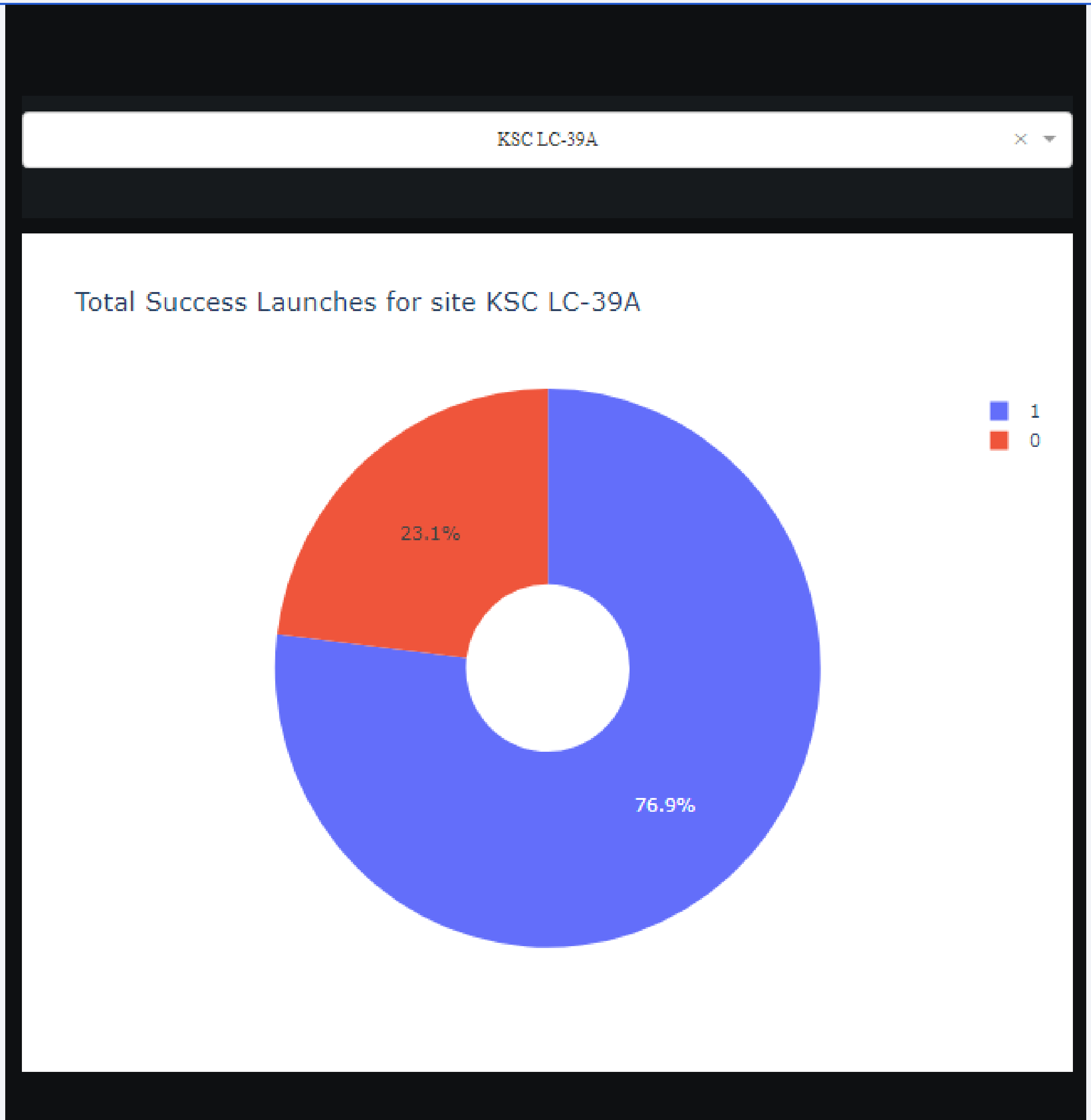
Launch site with highest success rate

KSC LC -39A

achieved a 76.9%

success with 23.1%

failed record



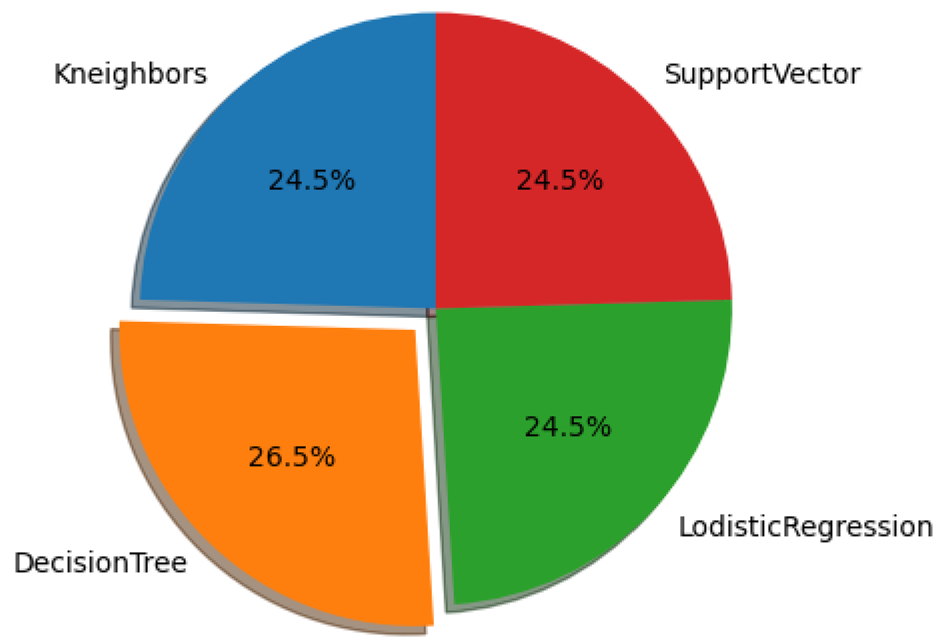
Scatter Plot Shows Relationship Between Payload Mass and Success Rate

More success recorded when payload mass is lighter

Section 5

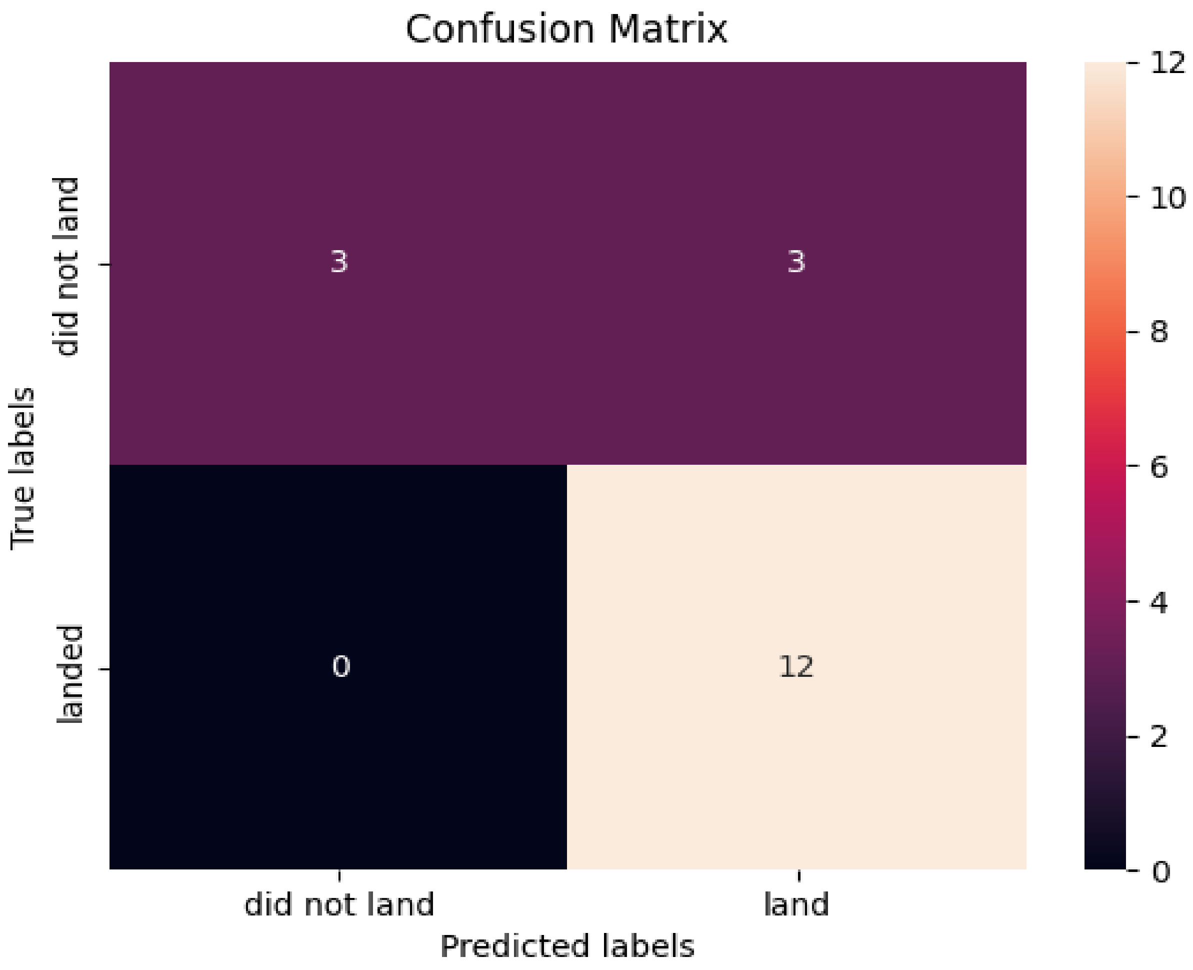
Predictive Analysis (Classification)

Classification Accuracy



The pie chart proved DecisionTree most effective model with accuracy of 26.5%

Confusion Matrix



The

Conclusions

IN CONCLUSION, WE CAN SAY:

The more launches at a launch site, the higher the success rate will be

When the payload mass is lighter, more success is recorded

KSC LC-39A recorded the most successful launches of all sites

Launch success rate started to increase in 2013 till 2020.

Orbits ES-L1, GEO, HEO, SSO, VLEO had the highest success rate.

In this scenario, the decision tree classifier is the most effective machine-learning algorithm.

Thank you!