IBM Developer
SKILLS NETWORK

Winning Space Race with Data Science

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Outline

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

This presentation summarized methodology and results of a case study into SpaceX.

After collecting data from the SpaceX API and enriching it by Wikipedia data, exploratory analysis is conducted into mission parameters and success factors, and finally a model to predict mission success is created.

Introduction

This project is created as a capstone exercise for the IBM data science course.

It is meant to apply a variety of data science methodology in order to deepen the project owners understanding of them.

Content of this presentation is therefore limited to display this progress.

Section 1

Methodology

Methodology

Executive Summary

- Data collection methodology:
  - Describe how data was collected
- Perform data wrangling
  - Describe how data was processed
- 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

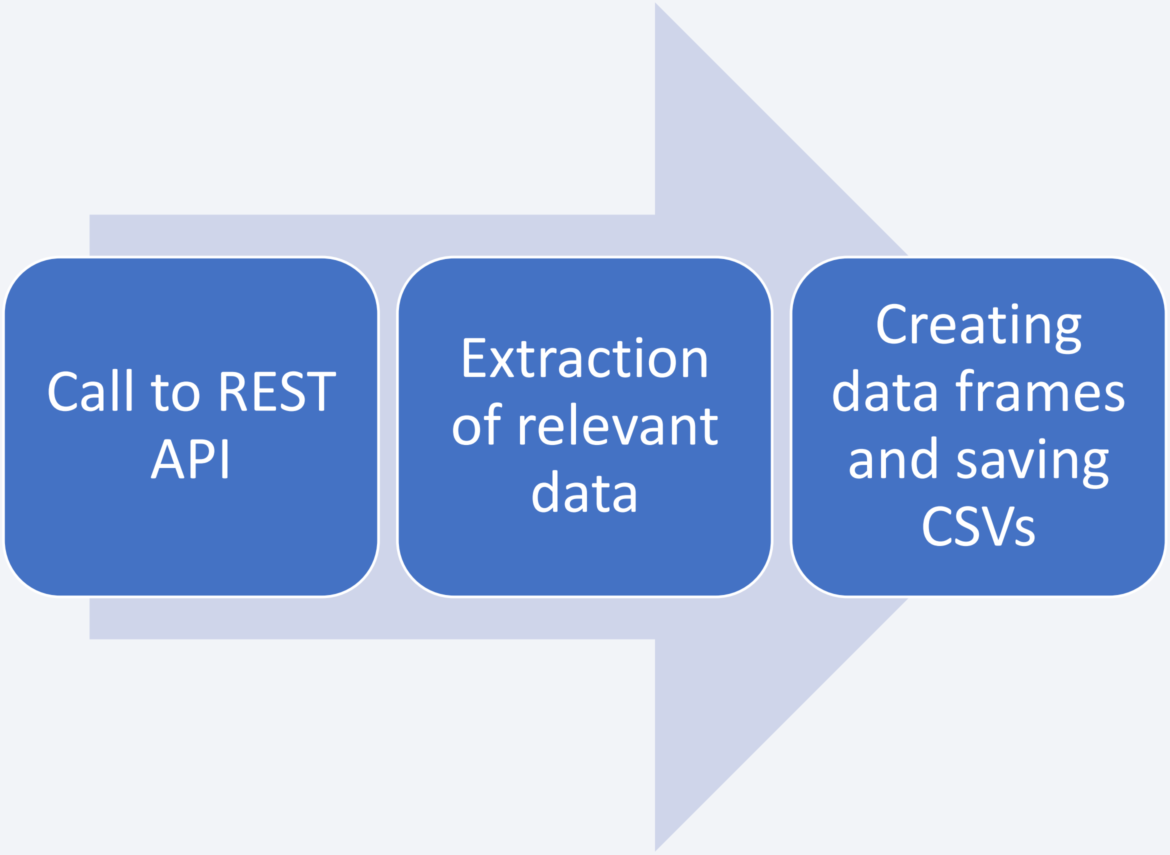
Data Collection

- Base Data was collected from SpaceX accessible online sources
- This was further enriched by web-scraping relevant Wikipedia sources

Data Collection – SpaceX API

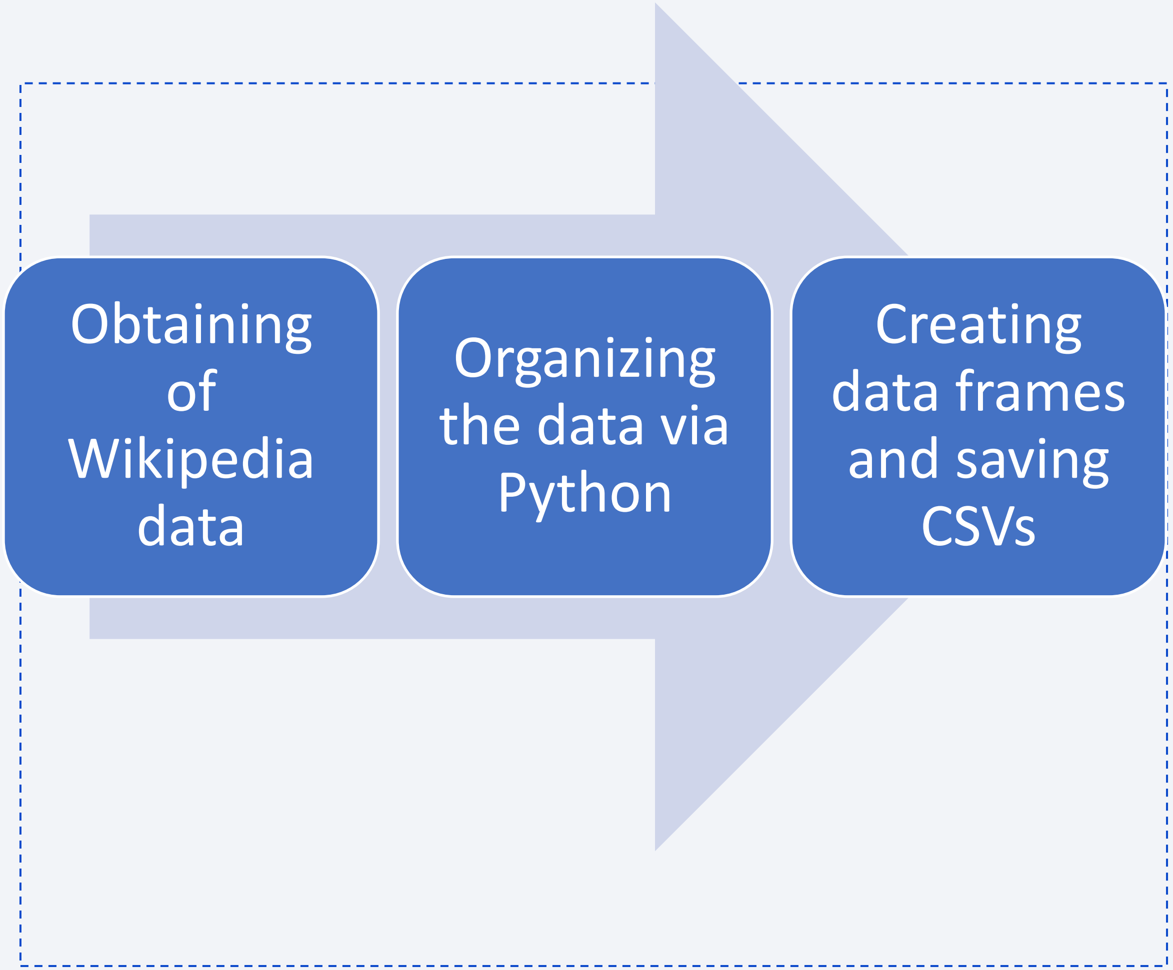
- The REST API was contacted via http calls, specifically its “core” component. Data was then loaded into data frames using the Python library “Pandas”

- The Notebook can be found here



Data Collection - Scraping

- Data was scraped from Wikipedia via the Python library “beautifulsoup”, relevant data was loaded into data frames and stored as CSV
- The notebook can be found here



Data Wrangling

- Data was cleaned and data types were assigned
- Mission and landing outcomes were calculated based on relevant parameters such as orbit type and launch site
- Notebook can be found here

EDA with Data Visualization

- Outcomes were plotted against potential predictive variables such as flight number and date (to track progression), payload, and orbit type
- Notebook with full set of visuals can be found here

EDA with SQL

- SQL was used to create summarized overviews such as success counts, payload averages, and others. More detailed information on certain booster types was also obtained that way.
- Notebook can be found here

Build an Interactive Map with Folium

- The Python library "Folium" was used to create an interactive map showing lauch sites, missions and their outcomes, as well as distances to certain points of interest
- This enabled a better understanding how launch site locations are chosen and how well they perform as starting points for missions.
- Notebook can be found here

Build a Dashboard with Plotly Dash

- A dashboard with insights into success rates based on launch site and payload was created
- This allows a quick interactive overview
- Code file can be found here

Predictive Analysis (Classification)

- Mission outcome prediction models were created and tested via grid search
- Predictive variables were chosen and prepared
  - Normalizing numerical variables
  - One-hot encoding categorical variables
- Notebook can be found here

Results

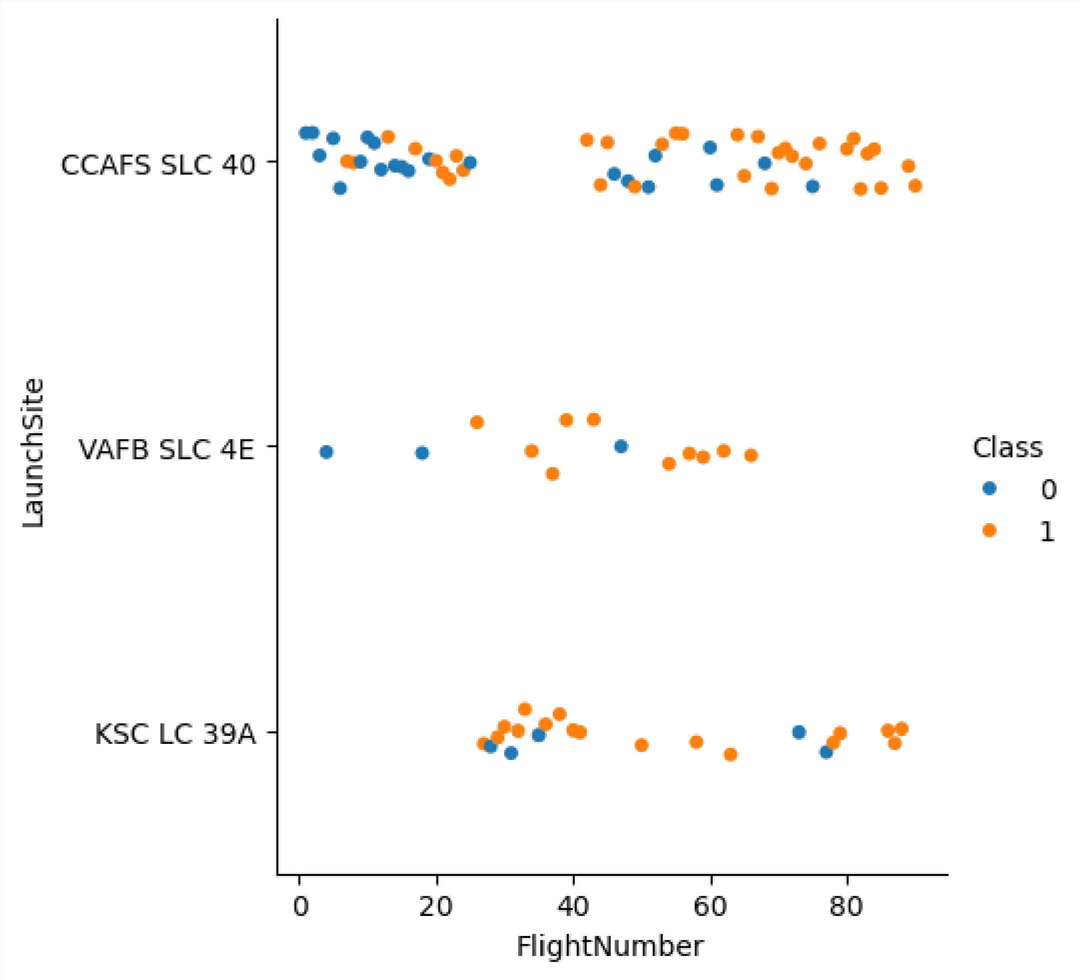
- Exploratory data analysis results
- Interactive analytics demo in screenshots
- Predictive analysis results

Section 2

Insights drawn from EDA

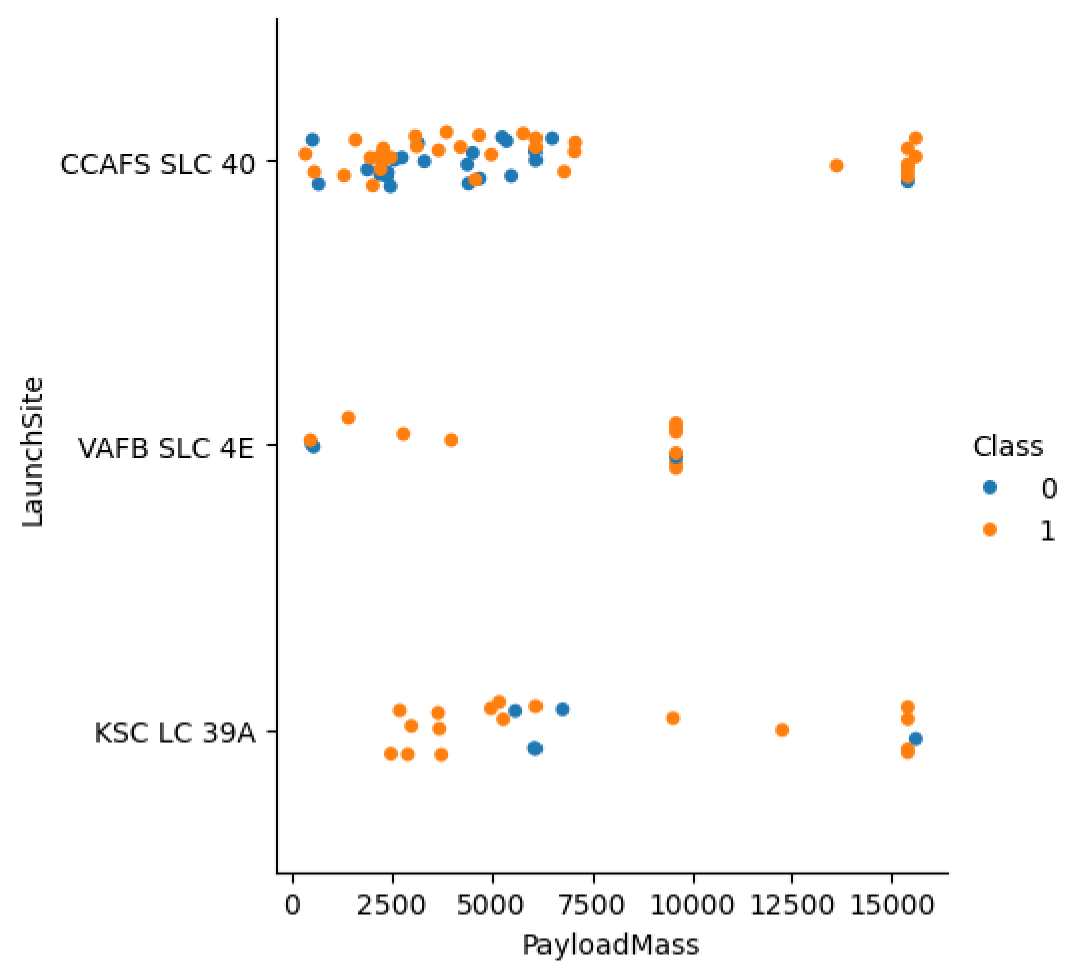
Flight Number vs. Launch Site

- Flights over time can be seen broken down by the three launch sites
- Red dots indicate successful missions, blue dots failures



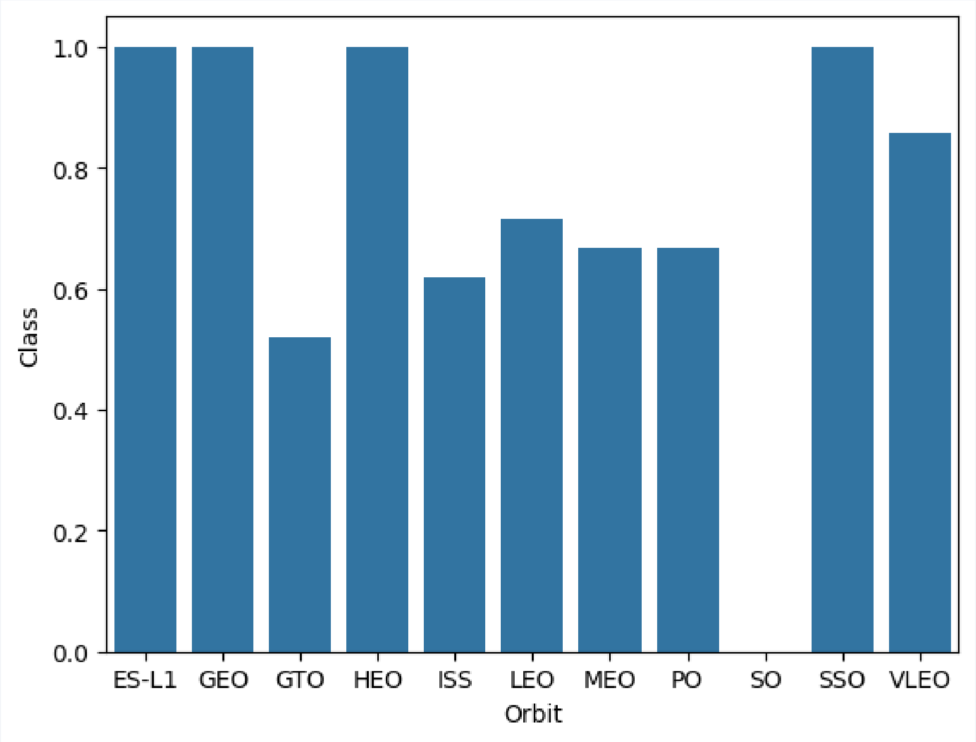
Payload vs. Launch Site

- Payload massed can be seen broken down by the three launch sites
- Red dots indicate successful missions, blue dots failures



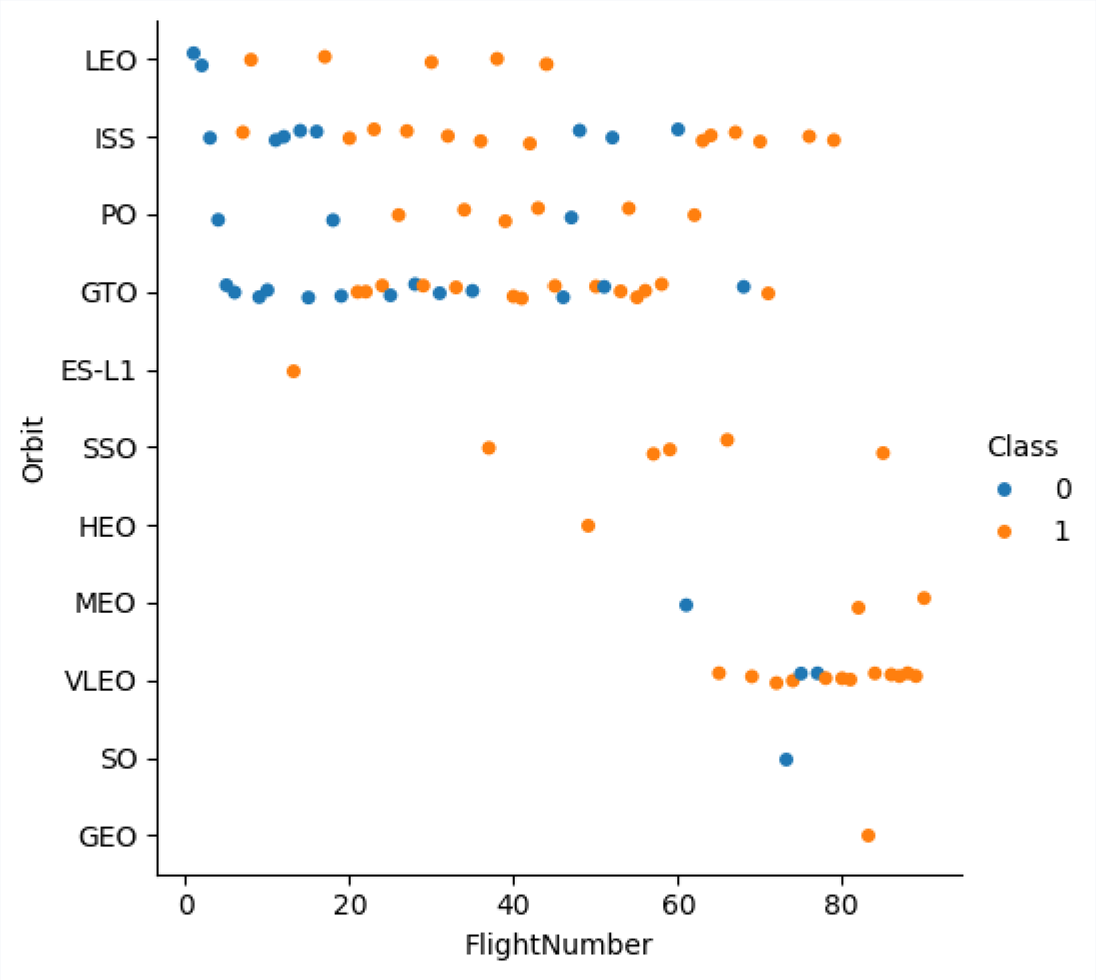
Success Rate vs. Orbit Type

- This bar chart shows the mission success rates for different orbit types



Flight Number vs. Orbit Type

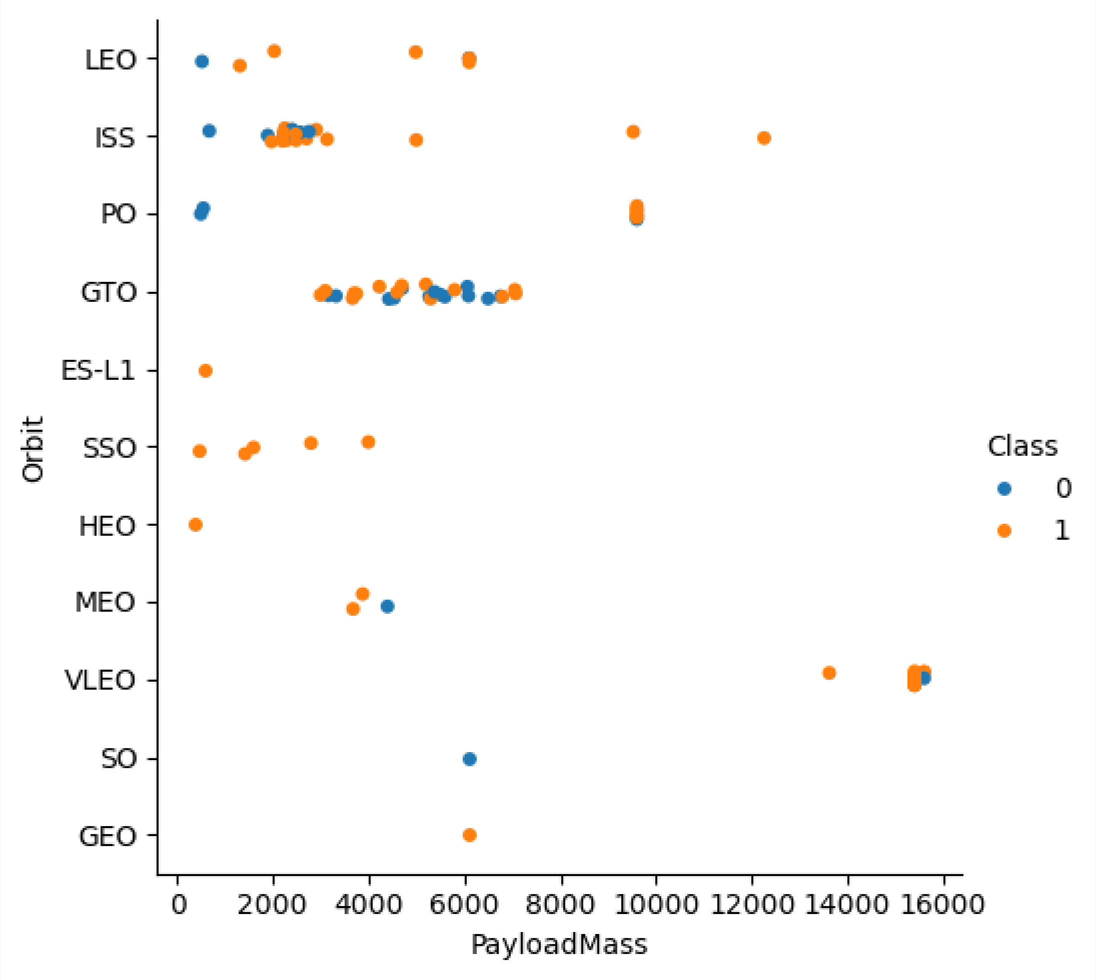
- This plot shows the orbit types by flight number, giving an overview over when missions started going to those orbits
- Red dots indicate successful missions, blue dots failures



Payload vs. Orbit Type

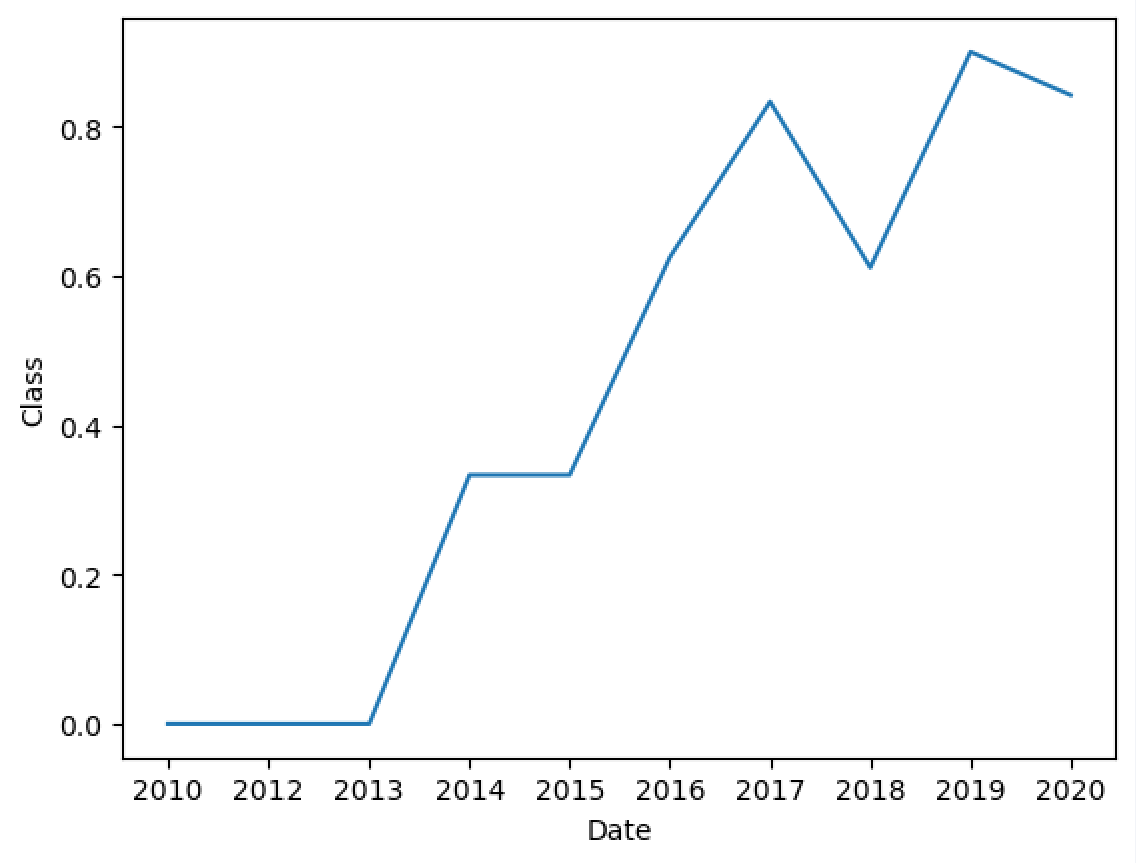
- The plot shows payload masses broken down by orbit types

- Red dots indicate successful missions, blue dots failures



Launch Success Yearly Trend

- The graph shows mission success rate over time



All Launch Site Names

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

Launch Site Names Begin with 'CCA'

In [14]:
```
%sql select * from SPACEXTABLE where Launch_Site like "CCA%" limit 5
```

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

Out[14]:

Date	Time (UTC)	Booster_Version	Launch_Site	Payload	PAYLOAD_MASS__KG_	Orbit	Customer	Mission_Outcome	Landing_Outcome
2010-04-06	18:45:00	F9 v1.0 B0003	CCAFS LC-40	Dragon Spacecraft Qualification Unit	0	LEO	SpaceX	Success	Failure (parachute)
2010-08-12	15:43:00	F9 v1.0 B0004	CCAFS LC-40	Dragon demo flight C1, two CubeSats, barrel of Brouere cheese	0	LEO (ISS)	NASA (COTS) NRO	Success	Failure (parachute)
2012-05-22	07:44:00	F9 v1.0 B0005	CCAFS LC-40	Dragon demo flight C2	525	LEO (ISS)	NASA (COTS)	Success	No attempt
2012-08-10	00:35:00	F9 v1.0 B0006	CCAFS LC-40	SpaceX CRS-1	500	LEO (ISS)	NASA (CRS)	Success	No attempt
2013-01-03	15:10:00	F9 v1.0 B0007	CCAFS LC-40	SpaceX CRS-2	677	LEO (ISS)	NASA (CRS)	Success	No attempt

Total Payload Mass

In [22]:
```
%sql select SUM(PAYLOAD_MASS__KG_) from SPACEXTABLE where Customer = "NASA (CRS)"
```

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

Out[22]:

SUM(PAYLOAD_MASS__KG_)
45596

Average Payload Mass by F9 v1.1

Task 4

Display average payload mass carried by booster version F9 v1.1

In [23]:
```
%sql select AVG(PAYLOAD_MASS__KG_) from SPACEXTABLE where Booster_Version like "F9 v1.1 %"
```

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

Out[23]:

AVG(PAYLOAD_MASS__KG_)
2337.8

First Successful Ground Landing Date

```
In [28]: %sql select MIN(Date) from SPACEXTABLE where Landing_Outcome = "Success (ground pad)"

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

Out[28]:

MIN(Date)
2015-12-22

Successful Drone Ship Landing with Payload between 4000 and 6000

```
In [30]: %sql select distinct(Booster_Version) from SPACEXTABLE where PAYLOAD_MASS__KG_ > 4000 and PAYLOAD_MASS__KG_ < 6000 and Land:

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

Out[30]:

Booster_Version
F9 FT B1022
F9 FT B1026
F9 FT B1021.2
F9 FT B1031.2

Total Number of Successful and Failure Mission Outcomes

In [41]:
```
%sql select count(Mission_Outcome) as Successes from SPACEXTABLE where Mission_Outcome = "Success" union select count(Missi
```

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

Out[41]:

Successes
1
98

Boosters Carried Maximum Payload

```
In [42]: %sql select Booster_Version from SPACEXTABLE where PAYLOAD_MASS__KG_ = (SELECT MAX(PAYLOAD_MASS__KG_) from SPACEXTABLE)

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

Out[42]:

Booster_Version
F9 B5 B1048.4
F9 B5 B1049.4
F9 B5 B1051.3
F9 B5 B1056.4
F9 B5 B1048.5
F9 B5 B1051.4
F9 B5 B1049.5
F9 B5 B1060.2
F9 B5 B1058.3
F9 B5 B1051.6
F9 B5 B1060.3
F9 B5 B1049.7

2015 Launch Records

```
In [74]: %%sql
select
    substr(Date,0,5) as year_,
    substr(Date, 6,2) as month,
    Booster_Version,
    Launch_Site,
    count(Mission_Outcome) as launches,
    sum(case when Landing_Outcome = "Failure (drone ship)" then 1 else 0 end) as landing_fails_droneship

from SPACEXTABLE
where substr(Date,0,5)='2015'
group by year_, month, Launch_Site, Booster_Version
```

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

Out[74]:

year_	month	Booster_Version	Launch_Site	launches	landing_fails_droneship
2015	02	F9 v1.1 B1014	CCAFS LC-40	1	0
2015	04	F9 v1.1 B1015	CCAFS LC-40	1	1
2015	04	F9 v1.1 B1016	CCAFS LC-40	1	0
2015	06	F9 v1.1 B1018	CCAFS LC-40	1	0
2015	10	F9 v1.1 B1012	CCAFS LC-40	1	1
2015	11	F9 v1.1 B1013	CCAFS LC-40	1	0
2015	12	F9 FT B1019	CCAFS LC-40	1	0

Rank Landing Outcomes Between 2010-06-04 and 2017-03-20

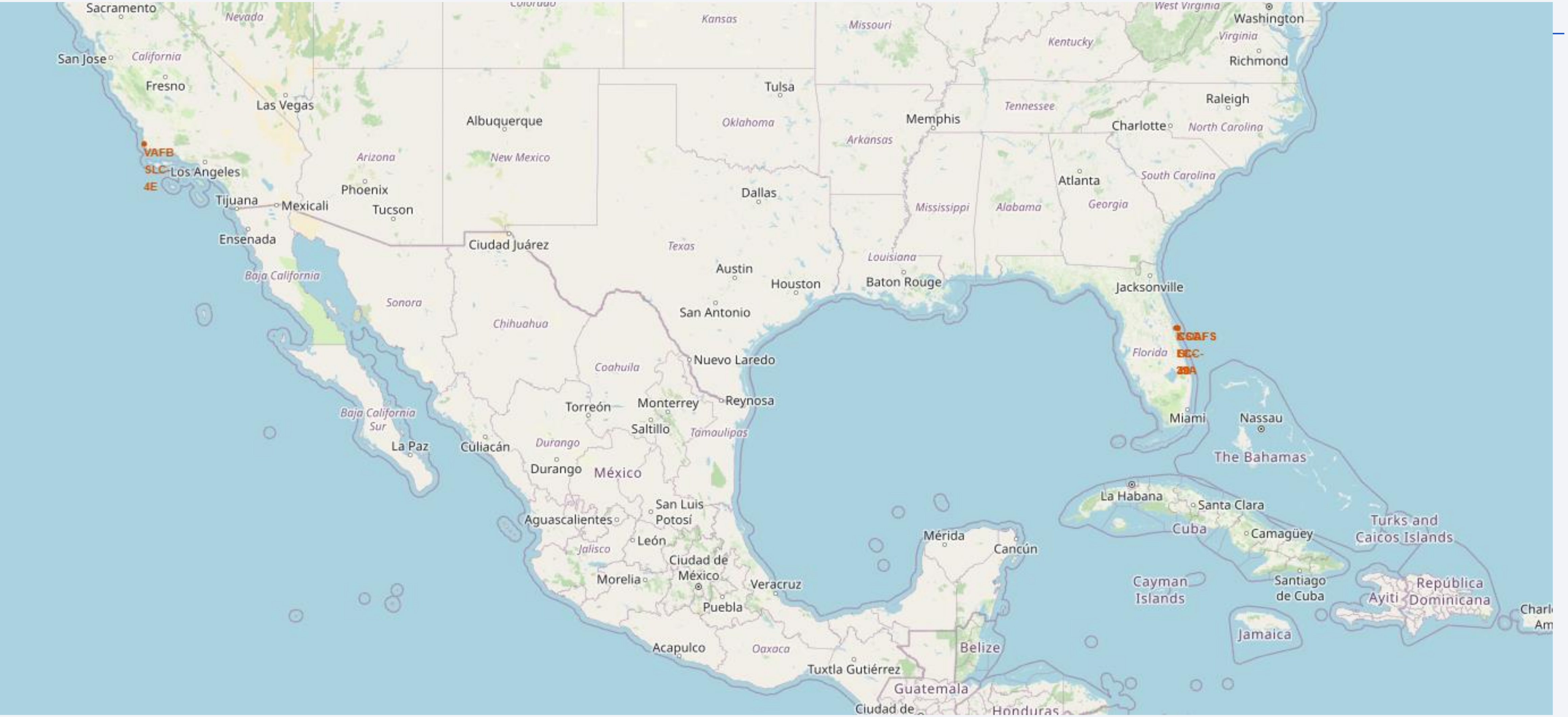
- Rank the count of landing outcomes (such as Failure (drone ship) or Success (ground pad)) between the date 2010-06-04 and 2017-03-20, in descending order

- Present your query result with a short explanation here

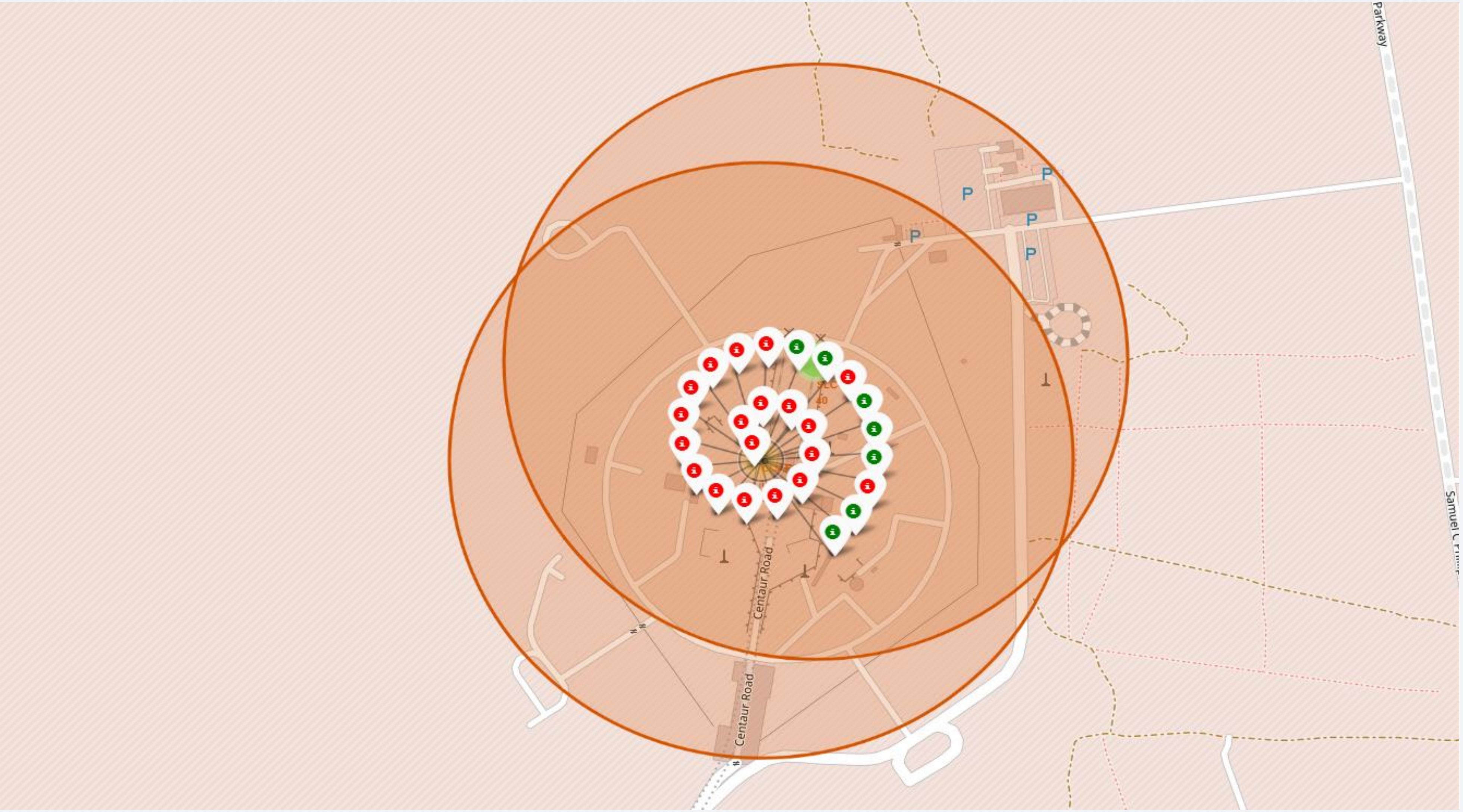
Section 3

Launch Sites Proximities Analysis

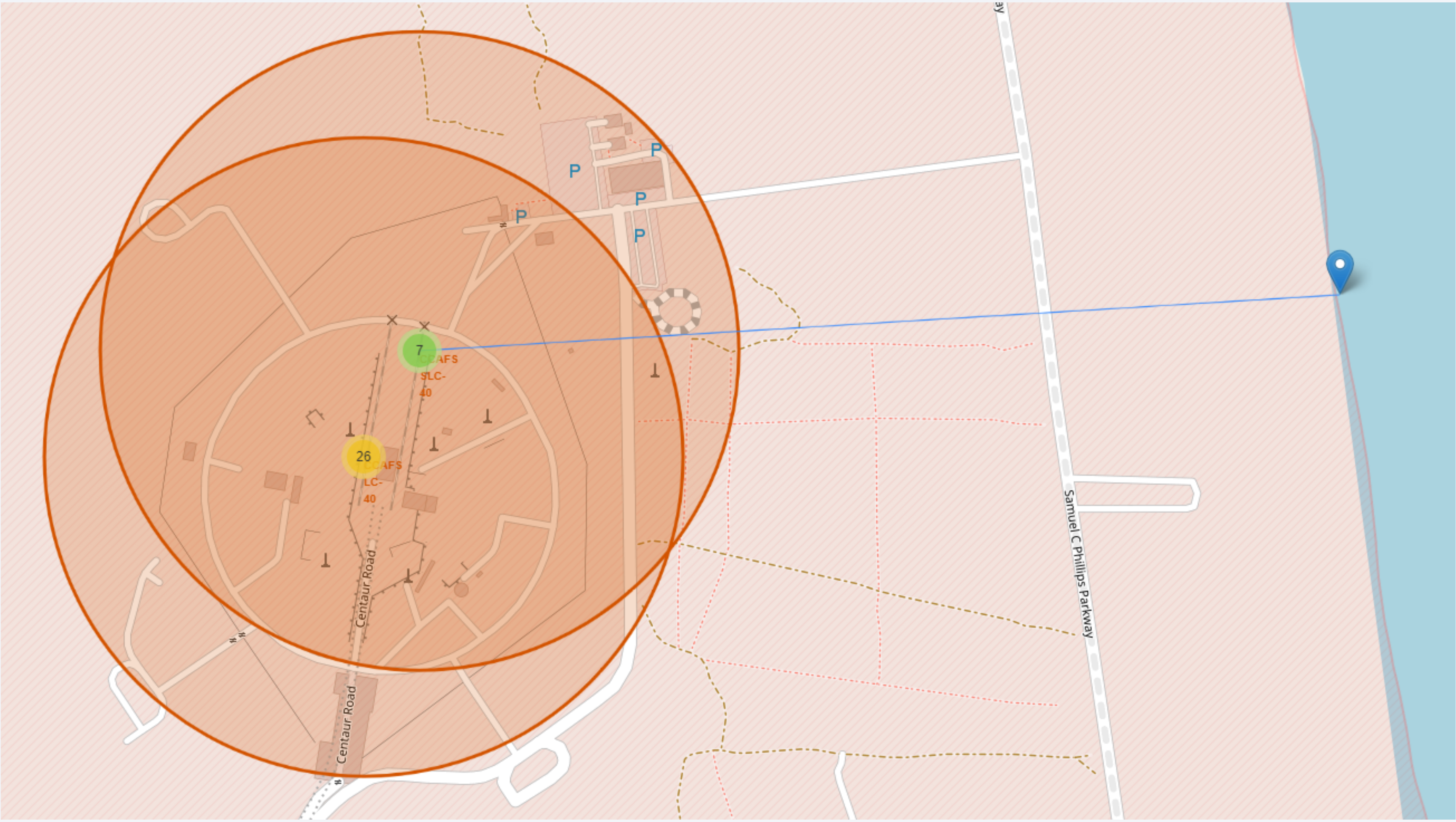
<Folium Map Screenshot 1>



<Folium Map Screenshot 2>



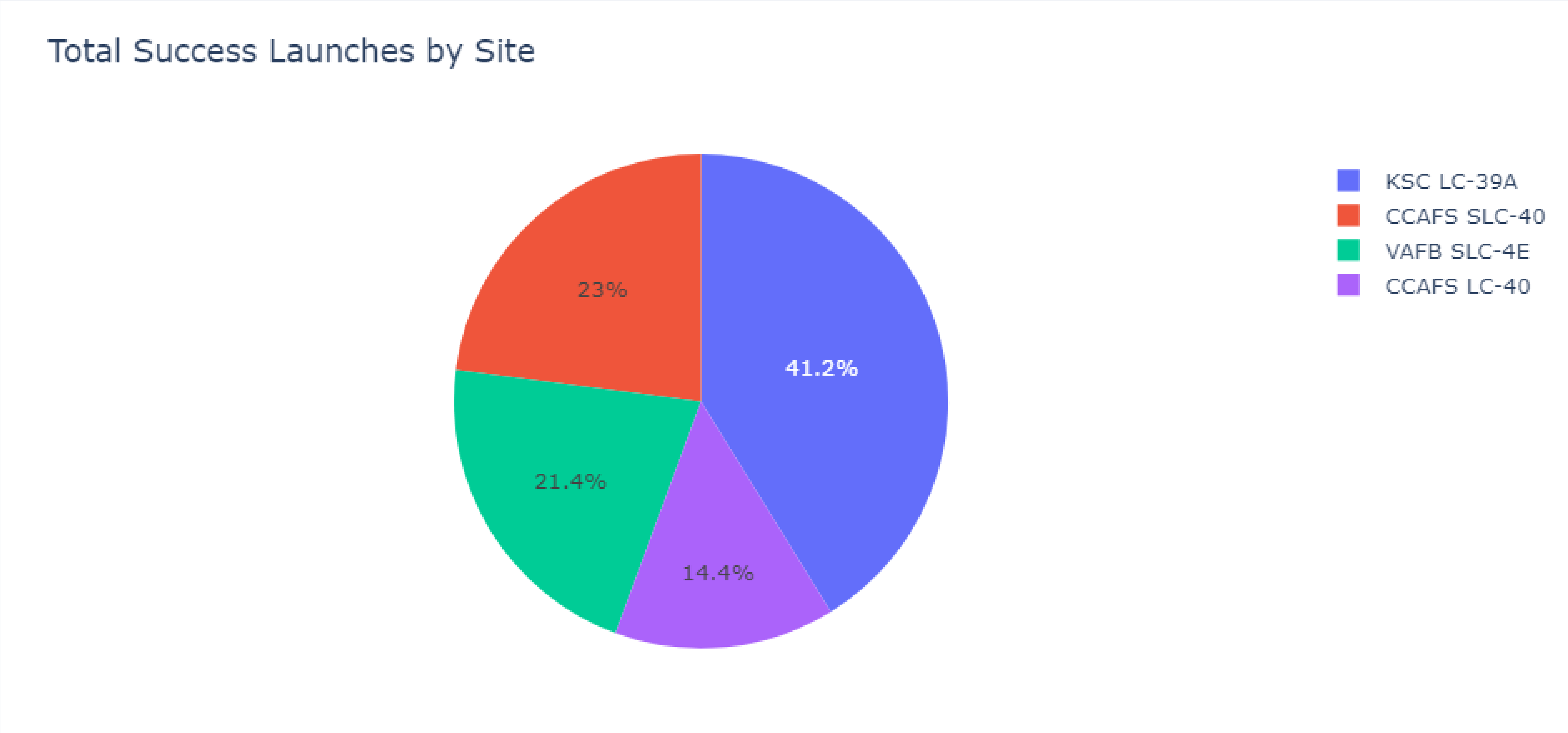
<Folium Map Screenshot 3>



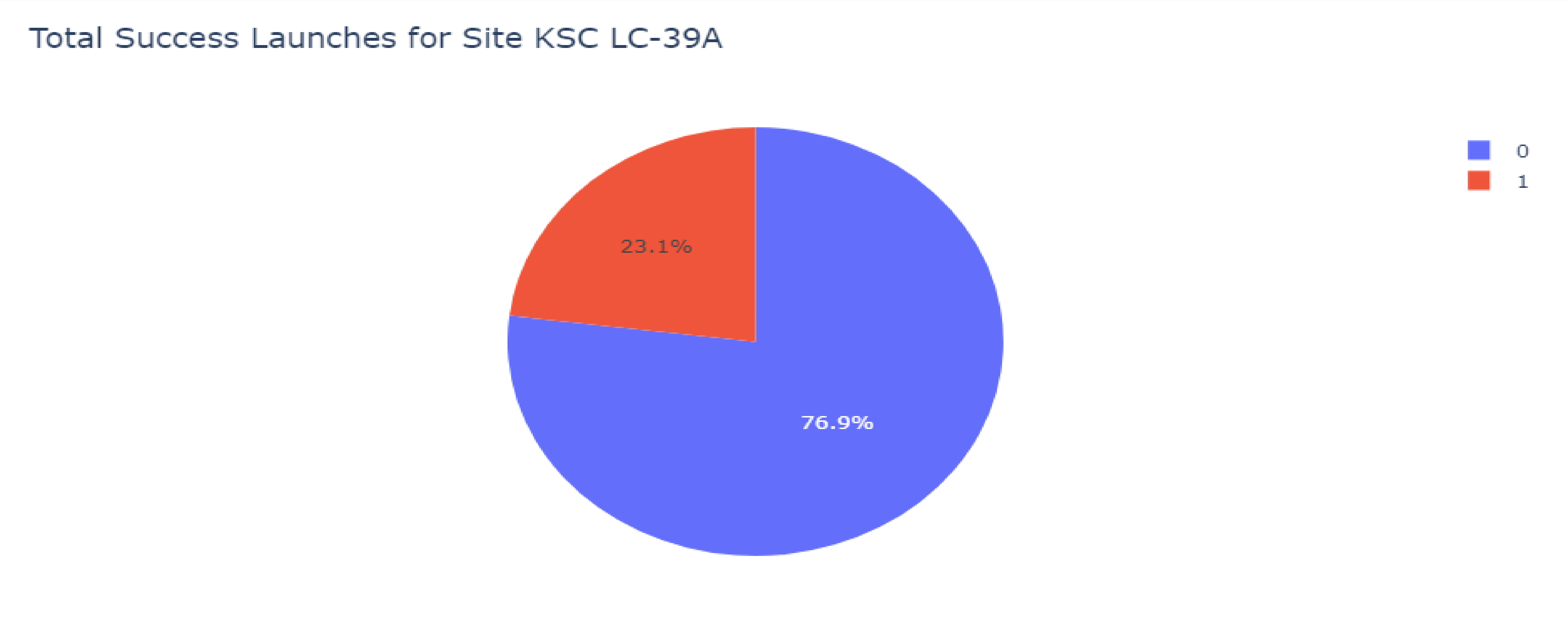
Section 4

Build a Dashboard with Plotly Dash

<Dashboard Screenshot 1>



<Dashboard Screenshot 2>

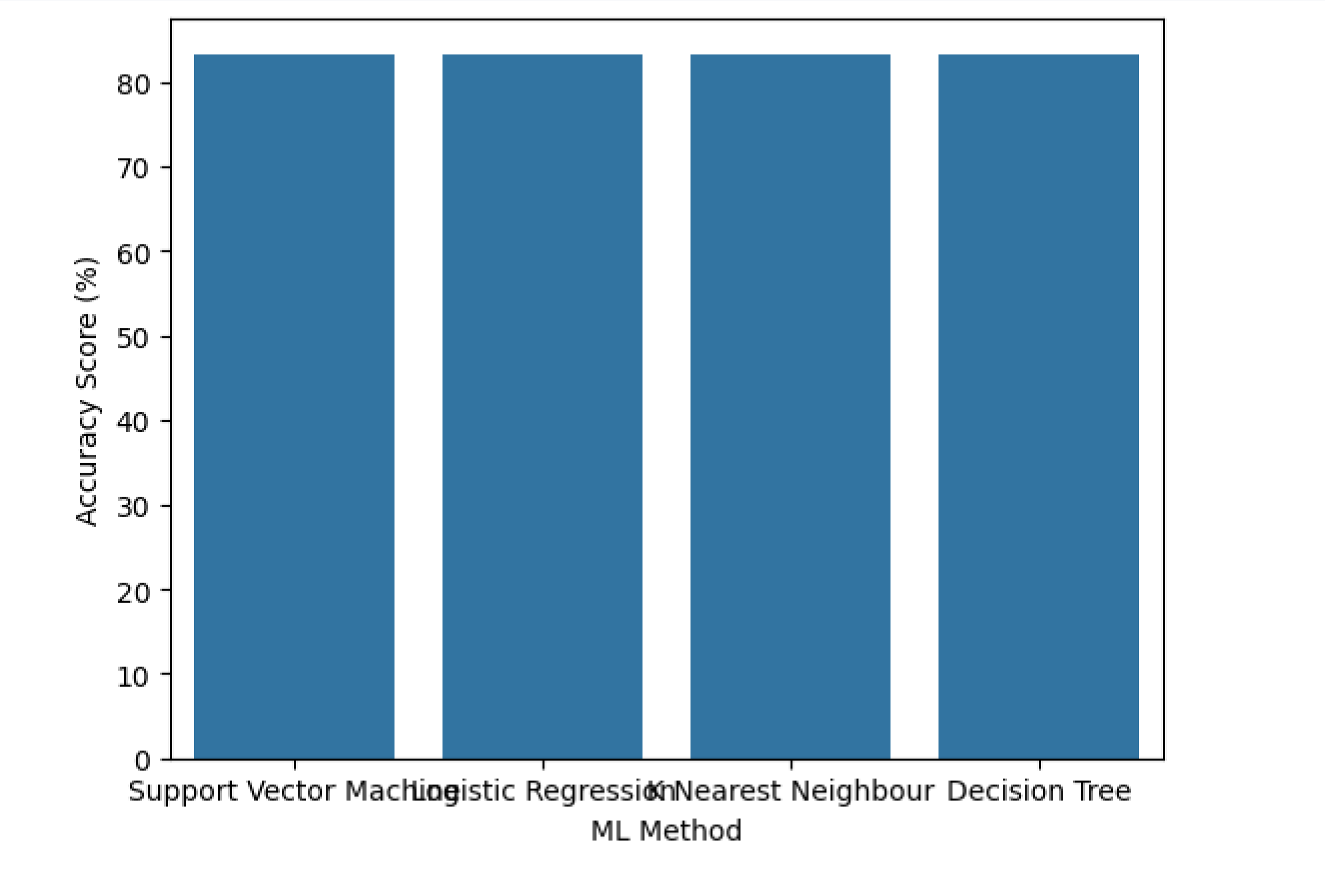


<Dashboard Screenshot 3>

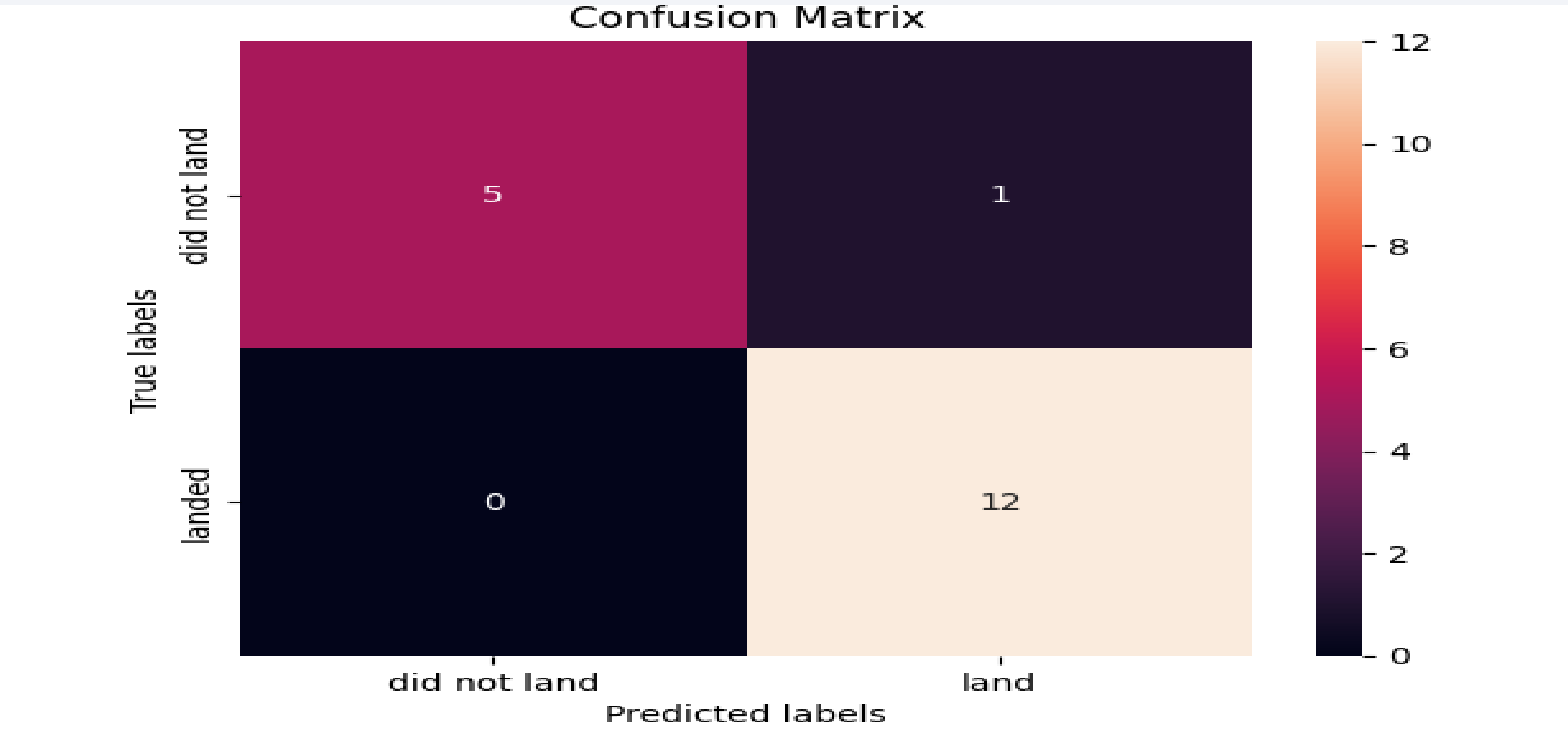
Section 5

Predictive Analysis (Classification)

Classification Accuracy



Confusion Matrix



Conclusions

- Data showed interesting insights into SpaceX progress over time and success factors
- A model was built with decent success to create launch outcomes

Appendix

- [Link to full repository]

Thank you!