IBM Developer
SKILLS NETWORK

Winning Space Race with Data Science

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Outline

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

Executive Summary

- Summary of methodologies

  - Data collection
  - Data wrangling
  - Exploratory Data Analysis with Data Visualization
  - Exploratory Data Analysis with SQL
  - Building an interactive map with Folium
  - Building a Dashboard with Plotly Dash
  - Predictive analysis (Classification)

- Summary of all results

  - Exploratory Data Analysis results
  - Interactive analytics demo in screenshots
  - Predictive analysis results

Introduction

- Project background and context

SpaceX is the most successful company of the commercial space age, making space travel affordable. We would like to determine if the first stage will land, we can determine the cost of a launch. Based on public information and machine learning models, we are going to predict if SpaceX will reuse the first stage.

- Problems you want to find answers

  - How do variables such as payload mass, launch site, number of flights, and orbits affect the success of the first stage landing?
  - What is the best algorithm that can be used for binary classification in this case?

Section 1

Methodology

Methodology

Executive Summary

- Data collection methodology

- Using SpaceX Rest API

- Using Web Scraping from Wikipedia

- Performed data wrangling

- Filtering the data

- Dealing with missing values

- Using One Hot Encoding to prepare the data to a binary classification

- Performed exploratory data analysis (EDA) using visualization and SQL

- Performed interactive visual analytics using Folium and Plotly Dash

- Performed predictive analysis using classification models

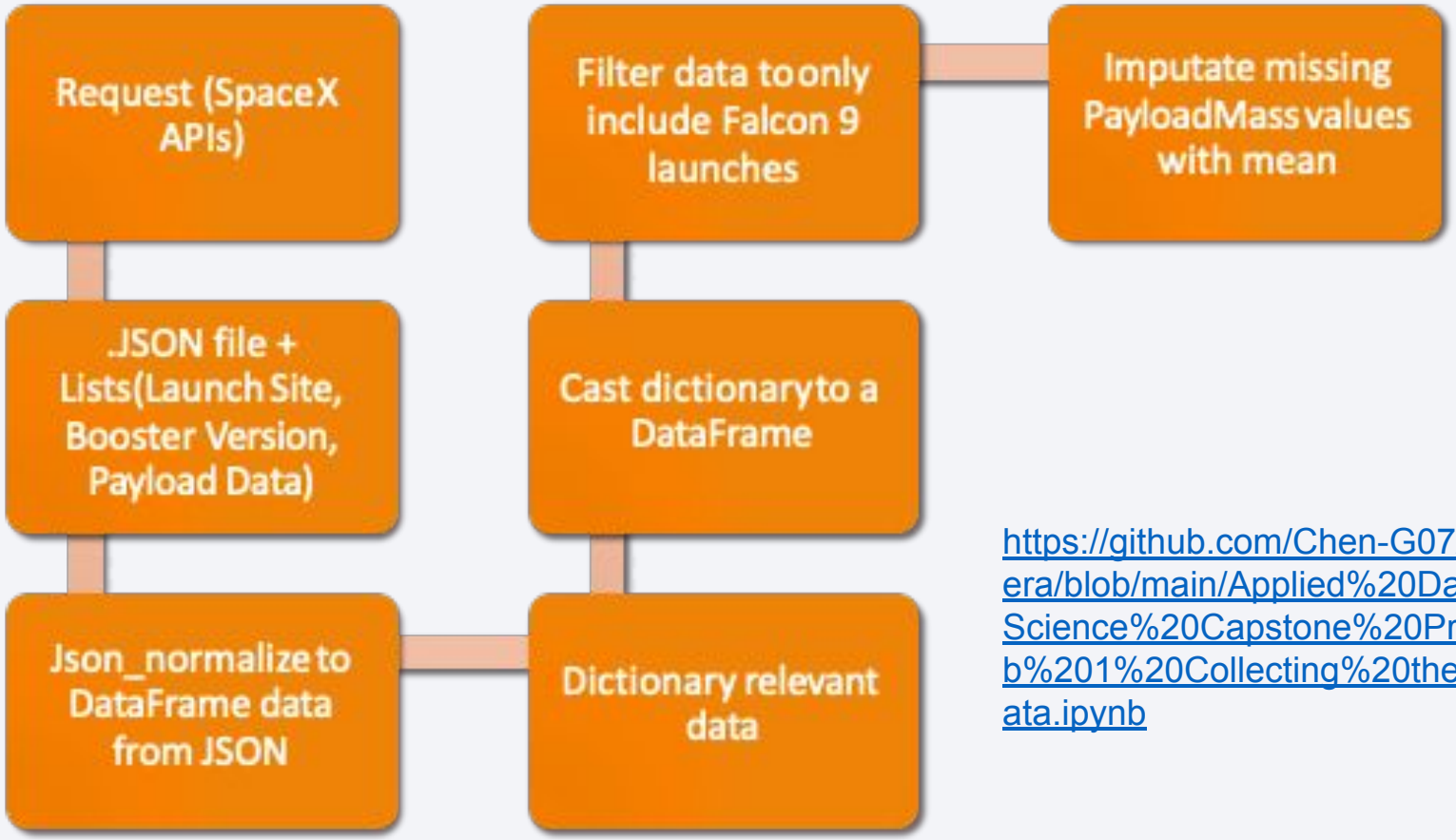
- Building, tuning and evaluation of classification models to ensure the best results

Data Collection

Data collection process involved a combination of API requests from Space X public API and web scraping data from a table in Space X's Wikipedia entry ：

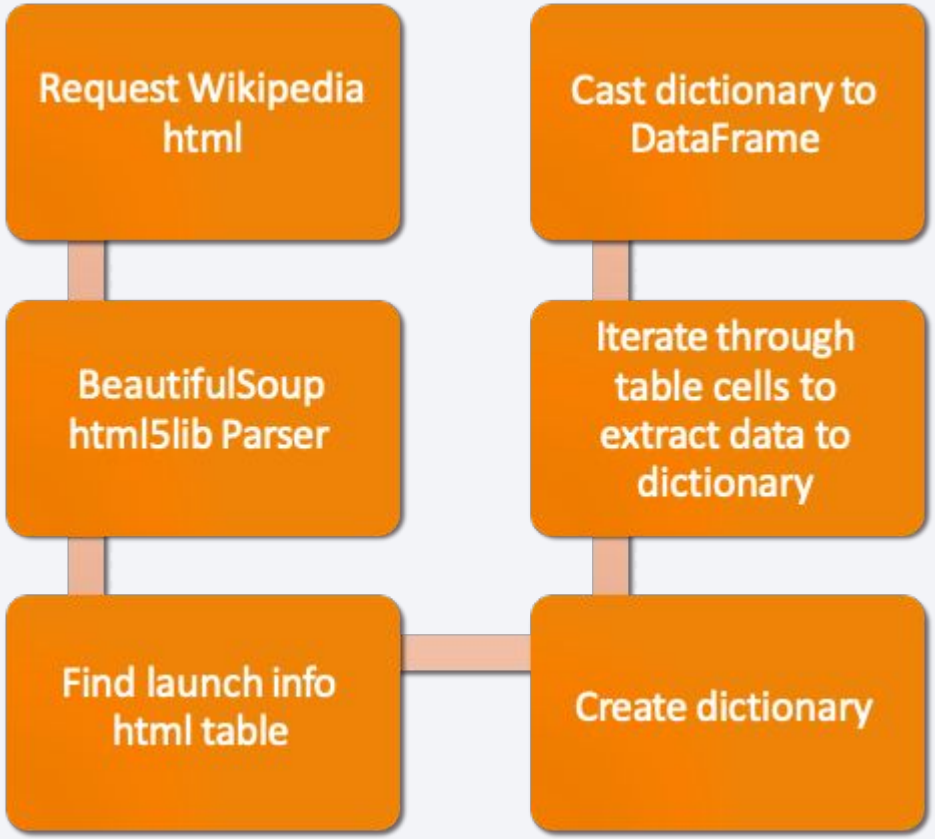
- Space X API Data
- Wikipedia Webscrape Data

Data Collection – SpaceX API



https://github.com/Chen-G07/Coursera/blob/main/Applied%20Data%20Science%20Capstone%20Projet/Lab%201%20Collecting%20the%20data.ipynb

Data Collection - Scraping



https://github.com/Chen-G07/Coursera/blob/main/Applied%20Data%20Science%20Capstone%20Projet/Data%20Collection%20with%20Web%20Scraping.ipynb

Data Wrangling

- Create a training label with landing outcomes where successful = 1 & failure = 0
- Outcome column has two components: ‘Mission Outcome’ ‘Landing Location’
- New training label column ‘class’ with a value of 1 if ‘Mission Outcome’ is True and 0 otherwise

https://github.com/Chen-G07/Coursera/blob/main/Applied%20Data%20Science%20Capstone%20Projet/Lab%202%20Data%20wrangling.ipynb

EDA with Data Visualization

- Plots Used:
  - Flight Number vs. Payload Mass, Flight Number vs. Launch Site, Payload Mass vs. Launch Site, Orbit vs. Success Rate, Flight Number vs. Orbit, Payload vs Orbit, and Success Yearly Trend
  - Scatter plots, line charts, and bar plots were used to compare relationships between variables to decide if a relationship exists so that they could be used in training the machine learning model

https://github.com/Chen-G07/Coursera/blob/main/Applied%20Data%20Science%20Capstone%20Projet/EDA%20with%20Visualization.ipynb

EDA with SQL

https://github.com/Chen-G07/Coursera/blob/main/Applied%20Data%20Science%20Capstone%20Projet/SQL%20Notebook%20for%20Peer%20Assignment.ipynb

- Display the names of the unique launch sites in the space mission
- Display 5 records where launch sites begin with the string 'CCA'
- Display the total payload mass carried by boosters launched by NASA (CRS)
- Display average payload mass carried by booster version F9 v1.1
- 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 all the booster_versions that have carried the maximum payload mass, using a subquery with a suitable aggregate function.
- List the records which will display the month names, failure landing_outcomes in drone ship ,booster versions, launch_site for the months in year 2015
- 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

Build an Interactive Map with Folium

Folium maps mark Launch Sites, successful and unsuccessful landings, and a proximity example to key locations: Railway, Highway, Coast, and City.

https://github.com/Chen-G07/Coursera/blob/main/Applied%20Data%20Science%20Capstone%20Projet/Interactive%20Visual%20Analytics%20with%20Folium.ipynb

Build a Dashboard with Plotly Dash

Dashboard includes a pie chart and a scatter plot：

- The pie chart is used to visualize launch site success rate
- The scatter plot can help us see how success varies across launch sites, payload mass, and booster version category

https://github.com/Chen-G07/Coursera/blob/main/Applied%20Data%20Science%20Capstone%20Projet/Build%20an%20Interactive%20Dashboard%20with%20Plotly%20Dash.py

Predictive Analysis (Classification)

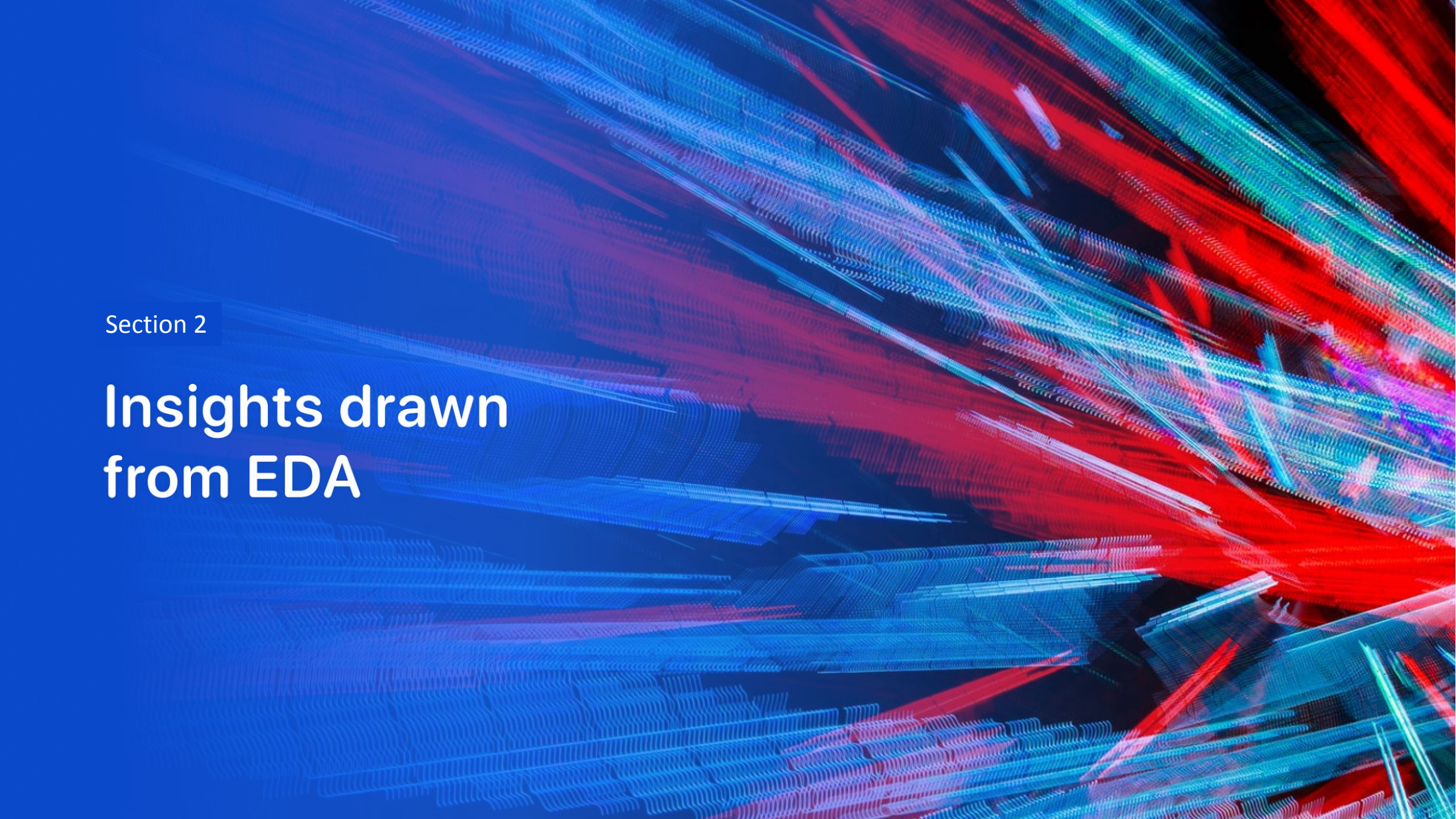
https://github.com/Chen-G07/Coursera/blob/main/Applied%20Data%20Science%20Capstone%20Projet/Machine%20Learning%20Prediction.ipynb

Results

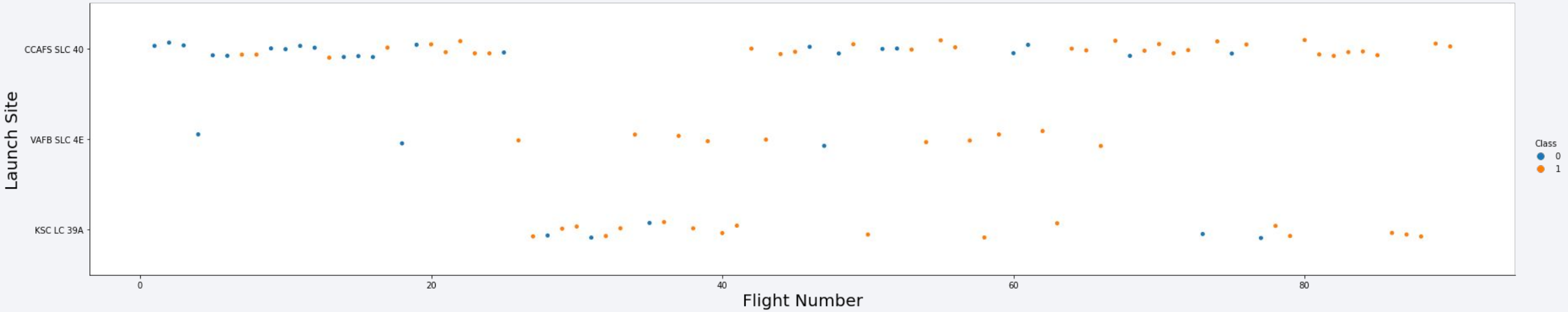
- Exploratory data analysis results
- Interactive analytics demo in screenshots
- Predictive analysis results

Section 2

Insights drawn from EDA



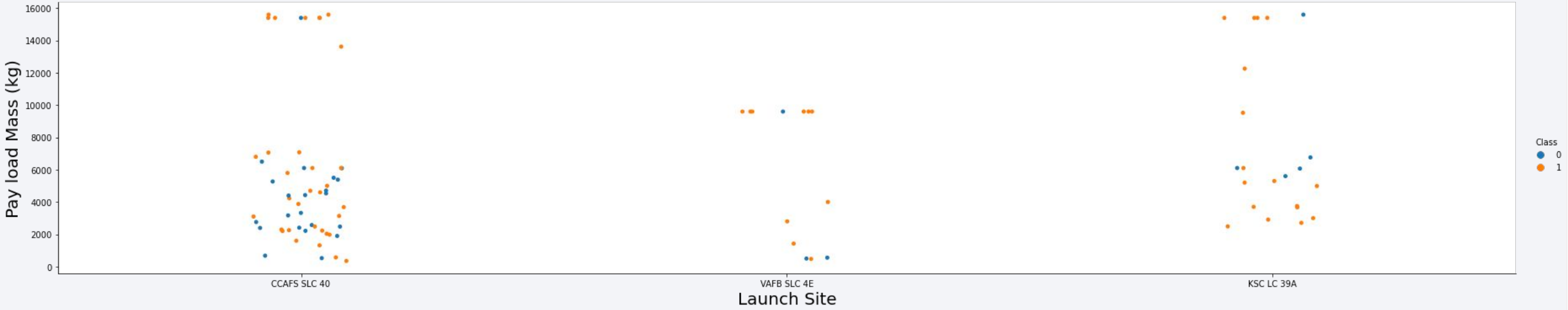
Flight Number vs. Launch Site



Explanation:

- The CCAFS SLC 40 launch site has about a half of all launches.
- VAFB SLC 4E and KSC LC 39A have higher success rates.

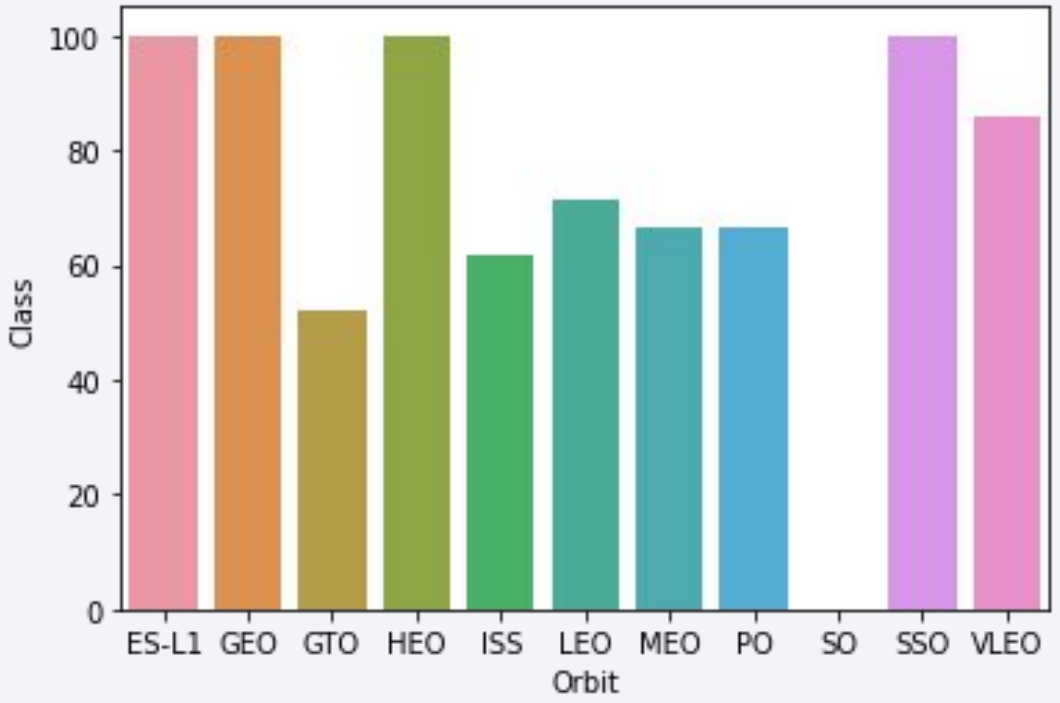
Payload vs. Launch Site



Explanation:

• Most of the launches with payload mass over 8000 kg were successful.

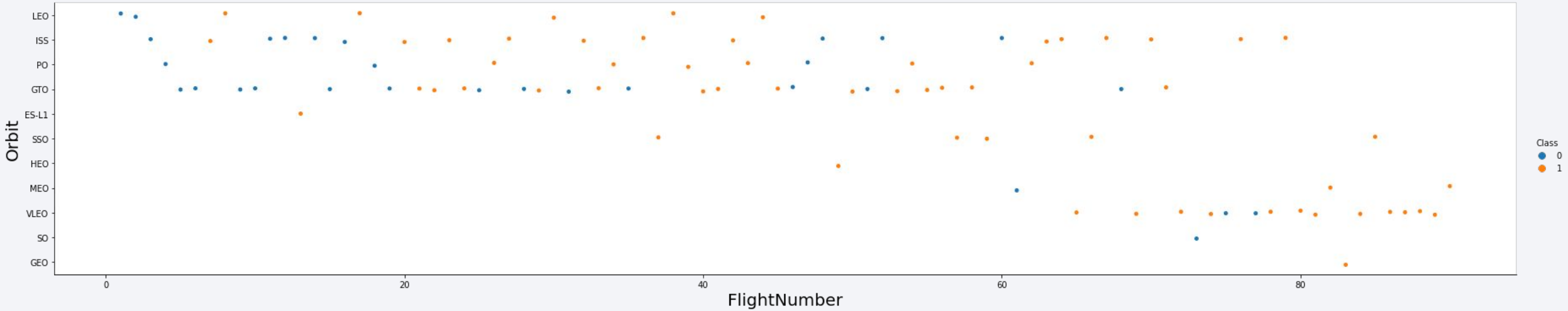
Success Rate vs. Orbit Type



Explanation:

- Orbits with 100% success rate: ES-L1, GEO, HEO, SSO
- Orbits with 0% success rate: SO
- Orbits with success rate between 50% and 85%: GTO, ISS, LEO, MEO, PO

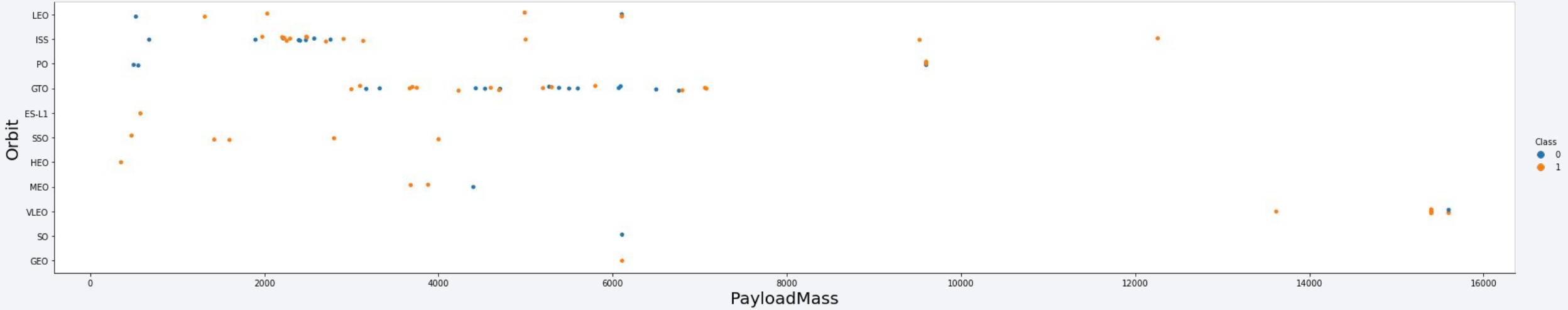
Flight Number vs. Orbit Type



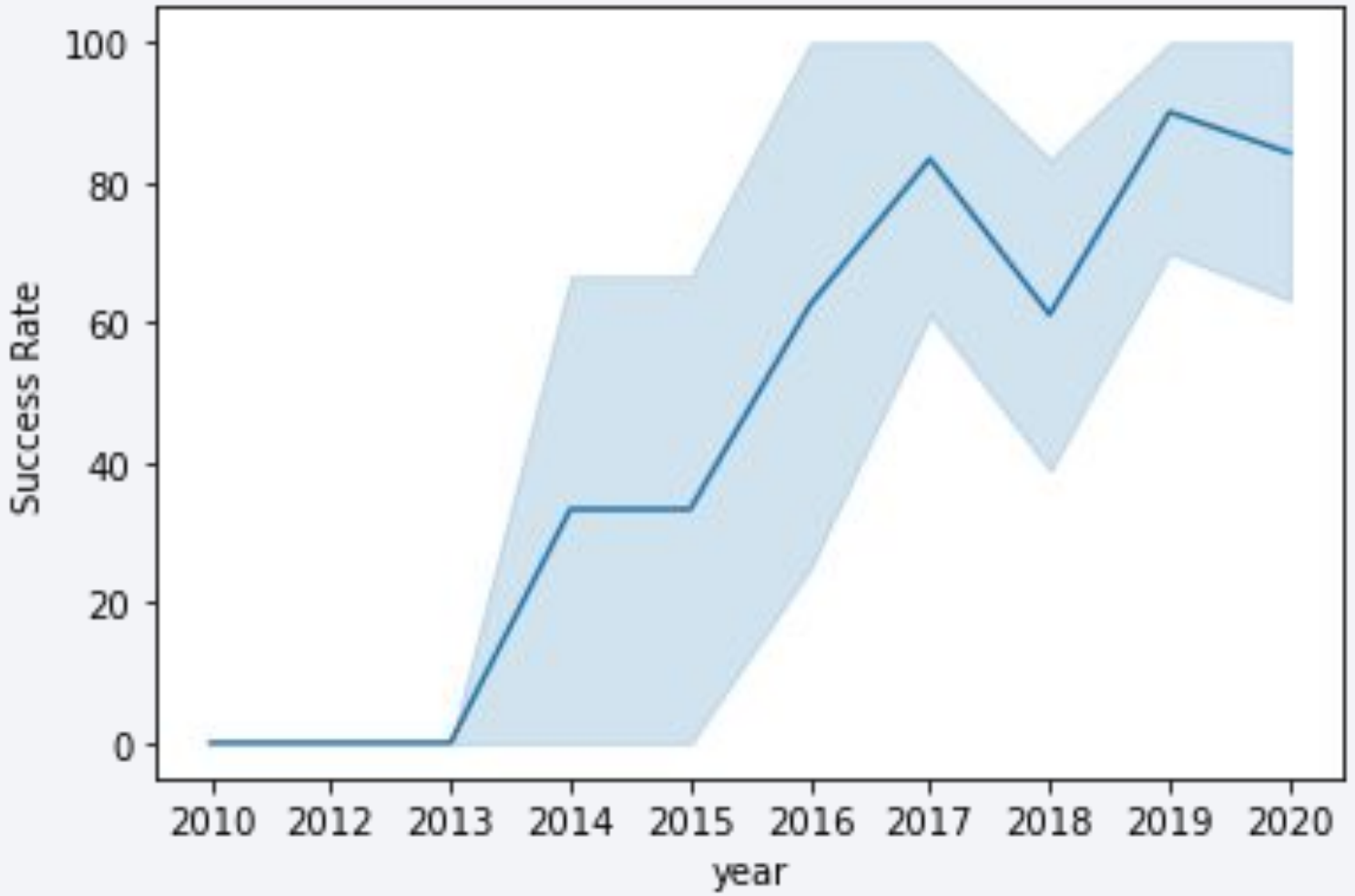
Explanation:

- There seems to be no relationship between flight number when in GTO orbit.

Payload vs. Orbit Type



Launch Success Yearly Trend



All Launch Site Names

```
%sql select DISTINCT LAUNCH_SITE from SPACEXTABLE
```

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

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

Launch Site Names Begin with 'CCA'

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

```
%sql select * from SPACEXTABLE where launch_site like 'CCA%' limit 5
```

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

Date	Time (UTC)	Booster_Version	Launch_Site	Payload	PAYLOAD_MASS__KG_	Orbit	Customer	Mission_Outcome	Landing_(
2010-06-04	18:45:00	F9 v1.0 B0003	CCAFS LC-40	Dragon Spacecraft Qualification Unit	0	LEO	SpaceX	Success	Failure (pa
2010-12-08	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 (pa
2012-05-22	7:44:00	F9 v1.0 B0005	CCAFS LC-40	Dragon demo flight C2	525	LEO (ISS)	NASA (COTS)	Success	No
2012-10-08	0:35:00	F9 v1.0 B0006	CCAFS LC-40	SpaceX CRS-1	500	LEO (ISS)	NASA (CRS)	Success	No
2013-03-01	15:10:00	F9 v1.0 B0007	CCAFS LC-40	SpaceX CRS-2	677	LEO (ISS)	NASA (CRS)	Success	No

Total Payload Mass

Display the total payload mass carried by boosters launched by NASA (CRS)

```
%sql select sum(payload_mass__kg_) as sum from SPACEXTABLE where customer like 'NASA (CRS)'
```

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

sum
45596

Average Payload Mass by F9 v1.1

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

```
%sql select avg(payload_mass__kg_) as Average from SPACEXTABLE where booster_version like 'F9 v1.1%'
```

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

Average
2534.6666666666665

First Successful Ground Landing Date

List the date when the first succesful landing outcome in ground pad was acheived.

Hint:Use min function

```
%sql select min(date) as Date from SPACEXTABLE where mission_outcome like 'Success'
```

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

Date
2010-06-04

Successful Drone Ship Landing with Payload between 4000 and 6000

List the date when the first succesful landing outcome in ground pad was acheived.

Hint:Use min function

```
%sql select min(date) as Date from SPACEXTABLE where mission_outcome like 'Success'
```

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

Date
2010-06-04

Total Number of Successful and Failure Mission Outcomes

List the total number of successful and failure mission outcomes

```
%sql SELECT mission_outcome, count(*) as Count FROM SPACEXTABLE GROUP by mission_outcome ORDER BY mission_outcome
```

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

Mission_Outcome	Count
Failure (in flight)	1
Success	98
Success	1
Success (payload status unclear)	1

Boosters Carried Maximum Payload

List all the booster_versions that have carried the maximum payload mass, using a subquery with a suitable aggregate function.

```
maxm = %sql select max(payload_mass__kg_) from SPACEXTABLE
maxv = maxm[0][0]
%sql select booster_version from SPACEXTABLE where payload_mass__kg_=(select max(payload_mass__kg_) from SPACEXTA
```

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

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

List the records which will display the month names, failure landing_outcomes in drone ship ,booster versions, launch_site for the months in year 2015.

Note: SQLLite does not support monthnames. So you need to use substr(Date, 6,2) as month to get the months and substr(Date,0,5)='2015' for year.

```
%sql select substr(Date, 6,2) as Month, landing_outcome, booster_version, launch_site from SPACEXTABLE where DATE
```

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

Month	Landing_Outcome	Booster_Version	Launch_Site
01	Failure (drone ship)	F9 v1.1 B1012	CCAFS LC-40
04	Failure (drone ship)	F9 v1.1 B1015	CCAFS LC-40

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

List the records which will display the month names, failure landing_outcomes in drone ship ,booster versions, launch_site for the months in year 2015.

Note: SQLLite does not support monthnames. So you need to use substr(Date, 6,2) as month to get the months and substr(Date,0,5)='2015' for year.

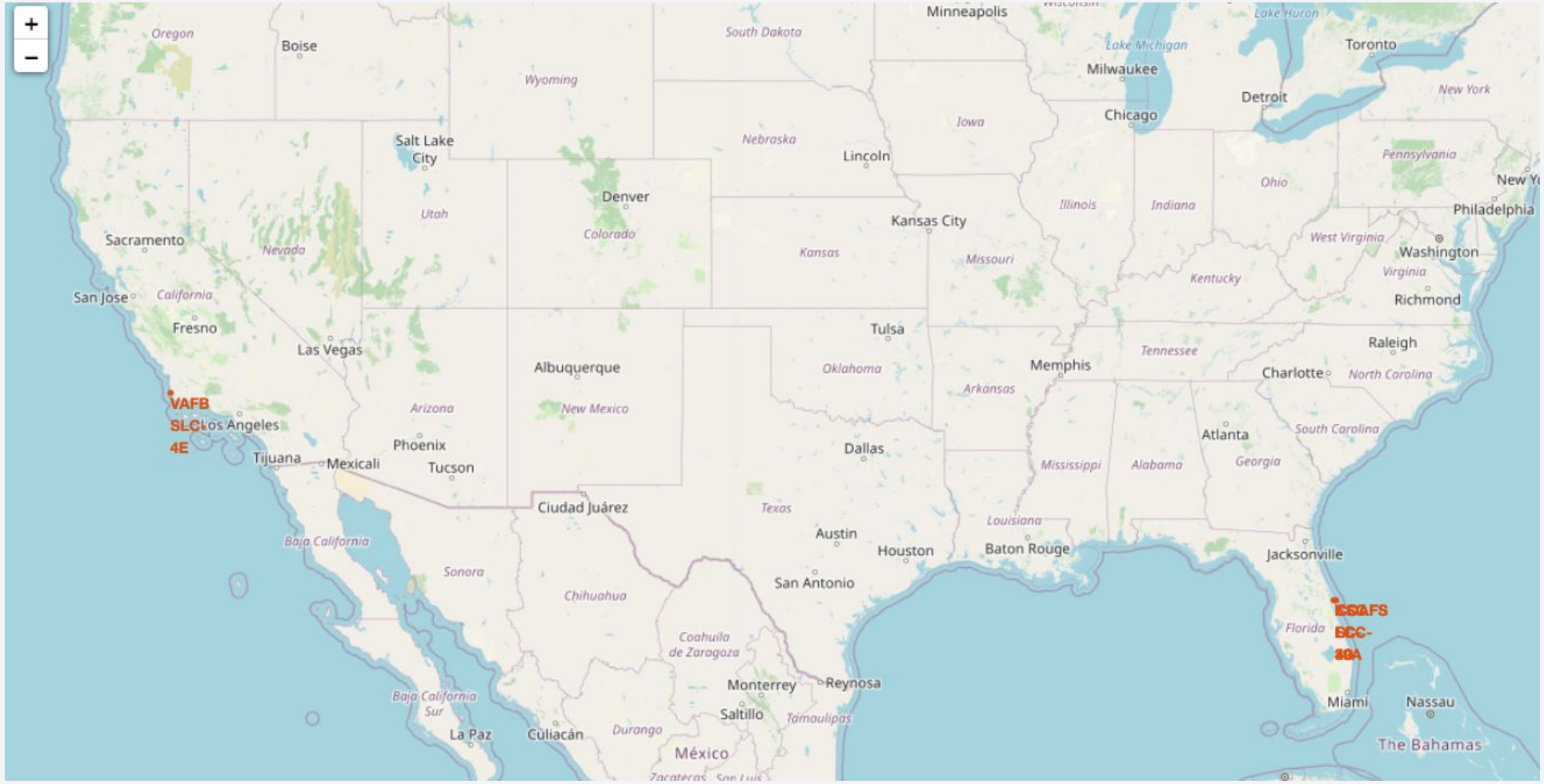
```
%sql select substr(Date, 6,2) as Month, landing_outcome, booster_version, launch_site from SPACEXTABLE where DATE
```

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

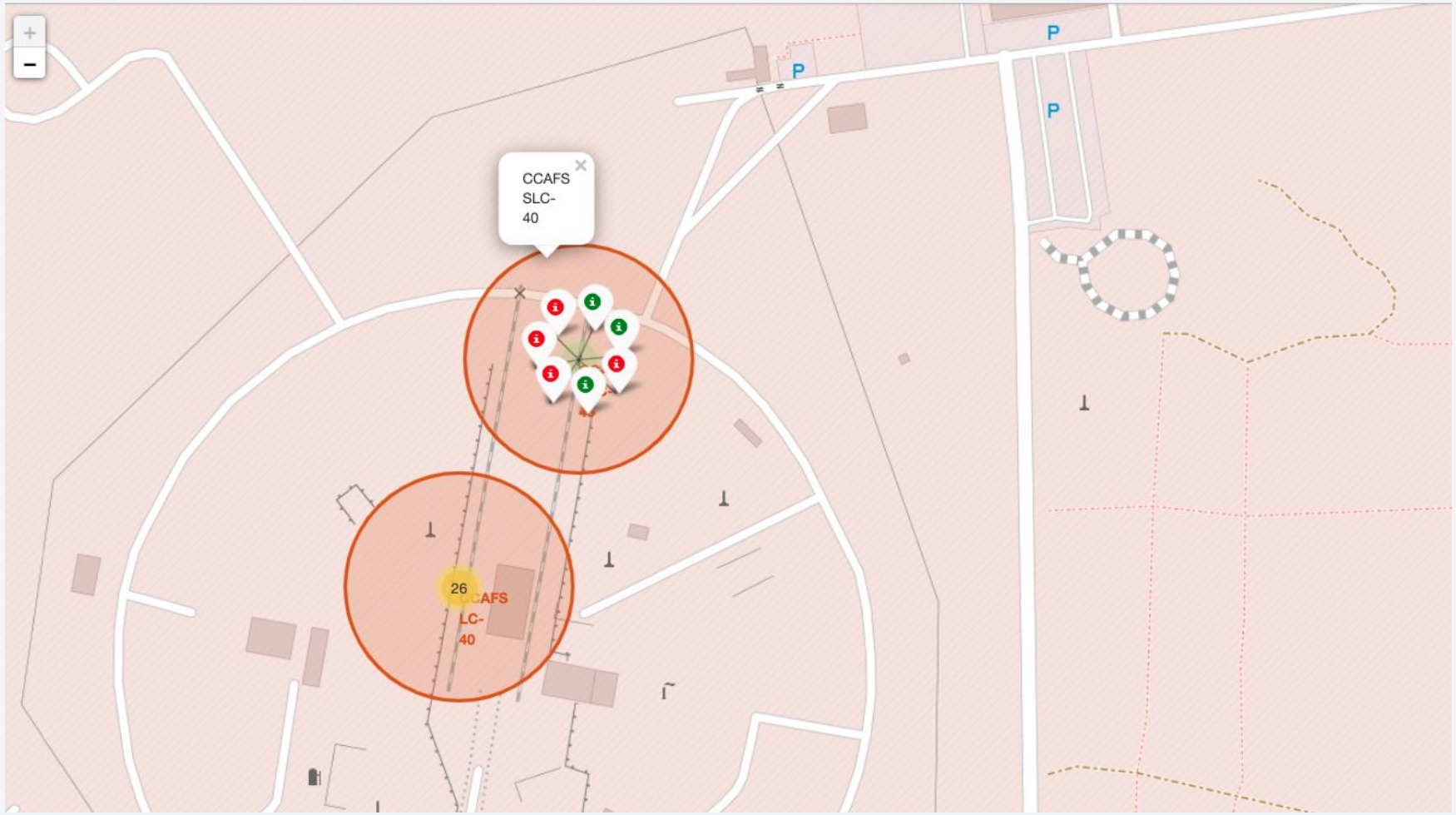
Month	Landing_Outcome	Booster_Version	Launch_Site
01	Failure (drone ship)	F9 v1.1 B1012	CCAFS LC-40
04	Failure (drone ship)	F9 v1.1 B1015	CCAFS LC-40


Section 3
Launch Sites
Proximities Analysis

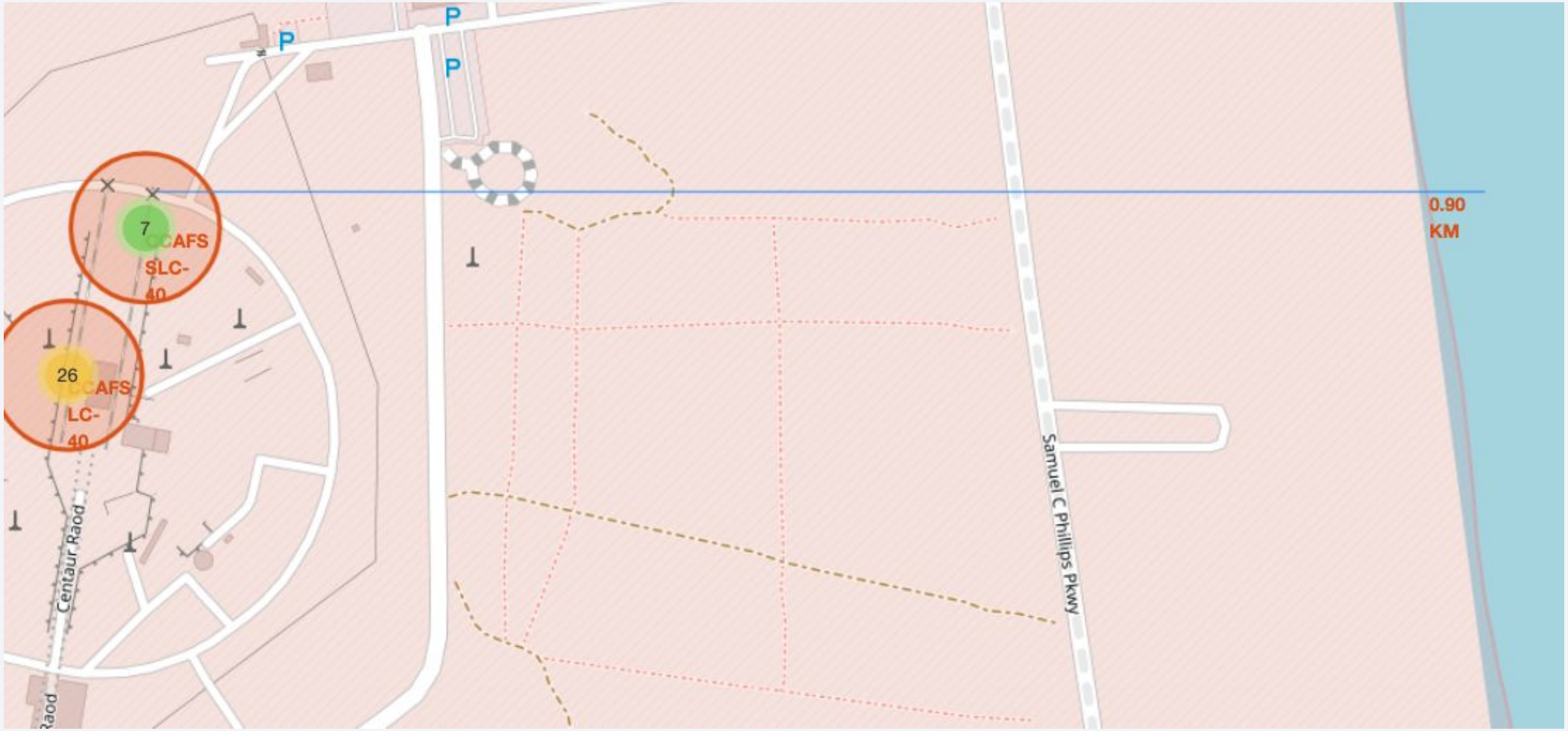
<Folium Map Screenshot 1>

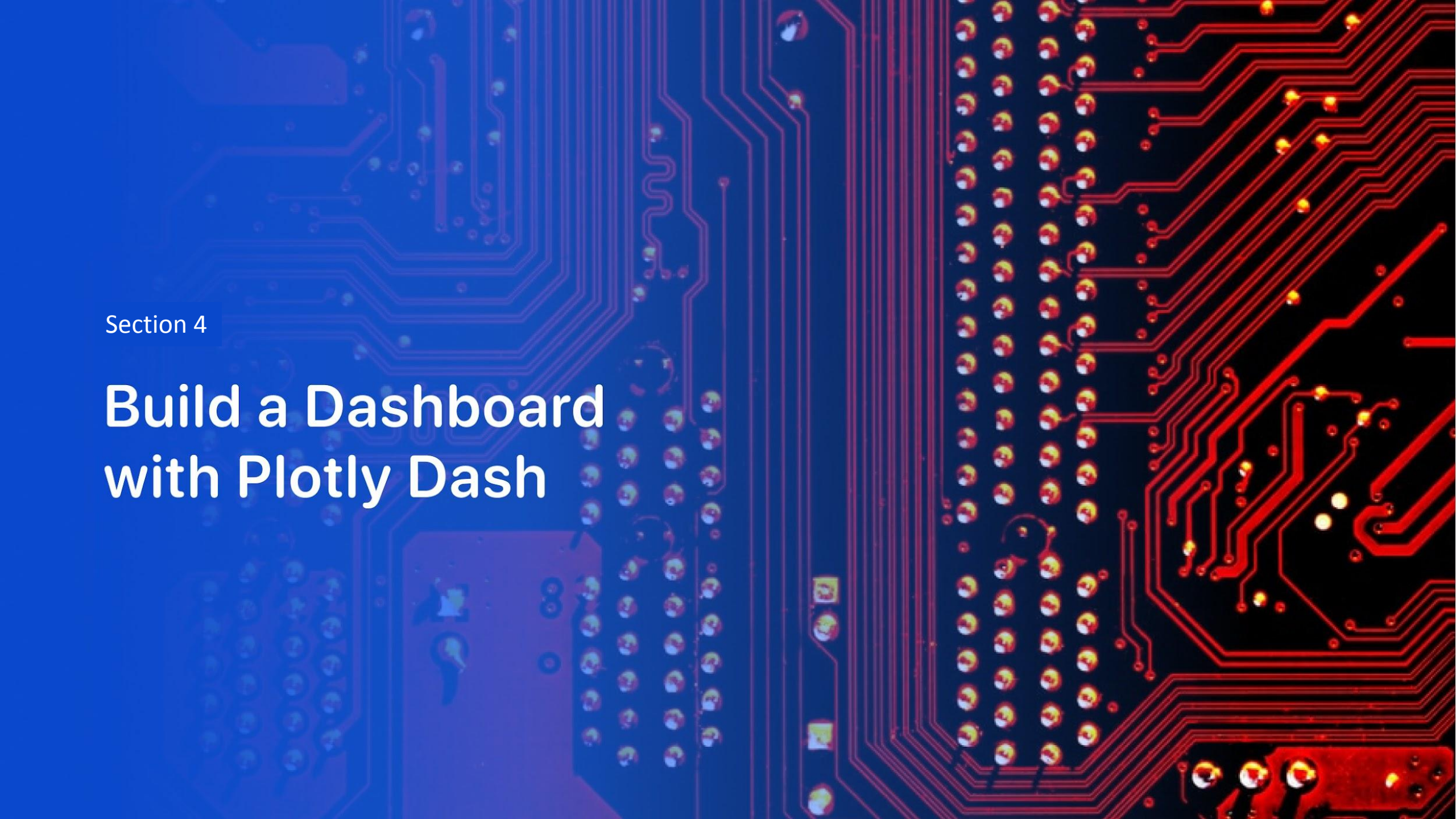


<Folium Map Screenshot 2>

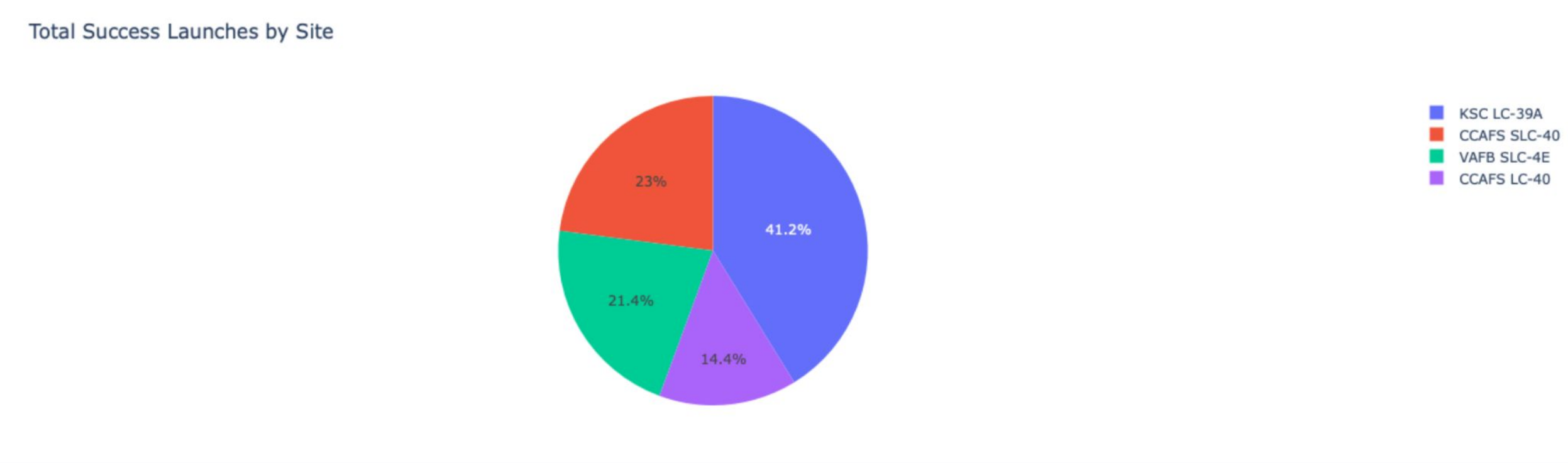


<Folium Map Screenshot 3>

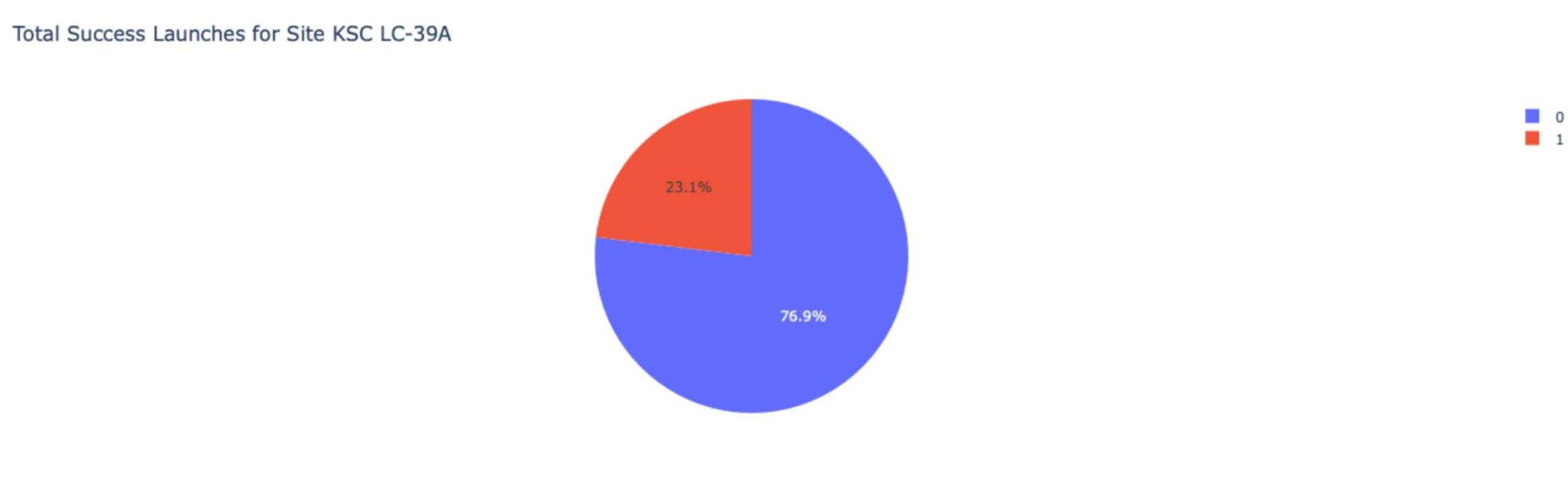



Section 4
Build a Dashboard with Plotly Dash

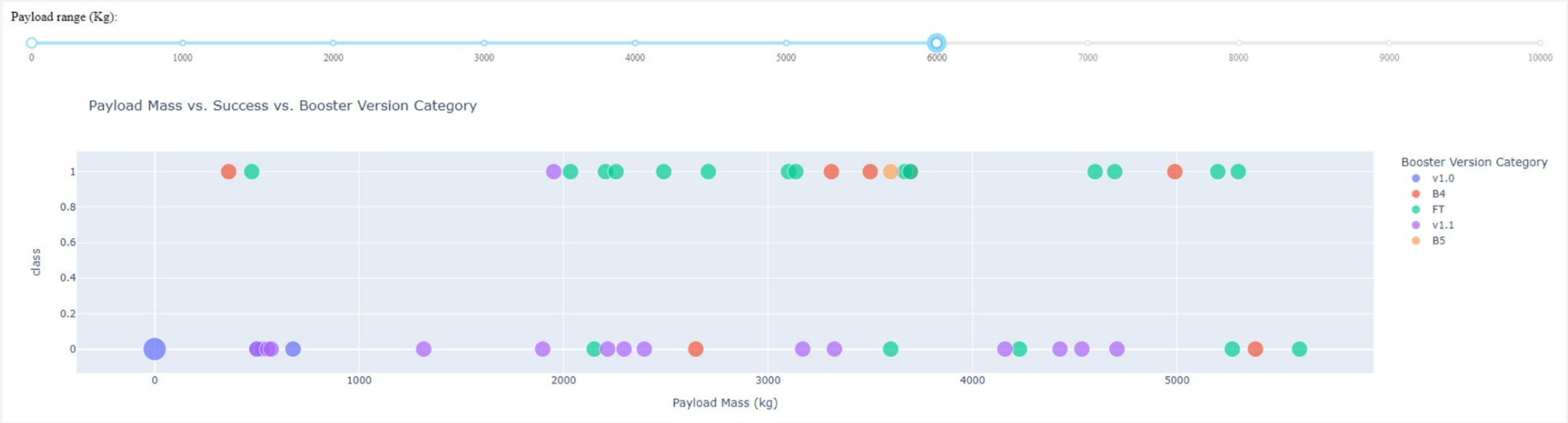
<Dashboard Screenshot 1>



<Dashboard Screenshot 2>



<Dashboard Screenshot 3>



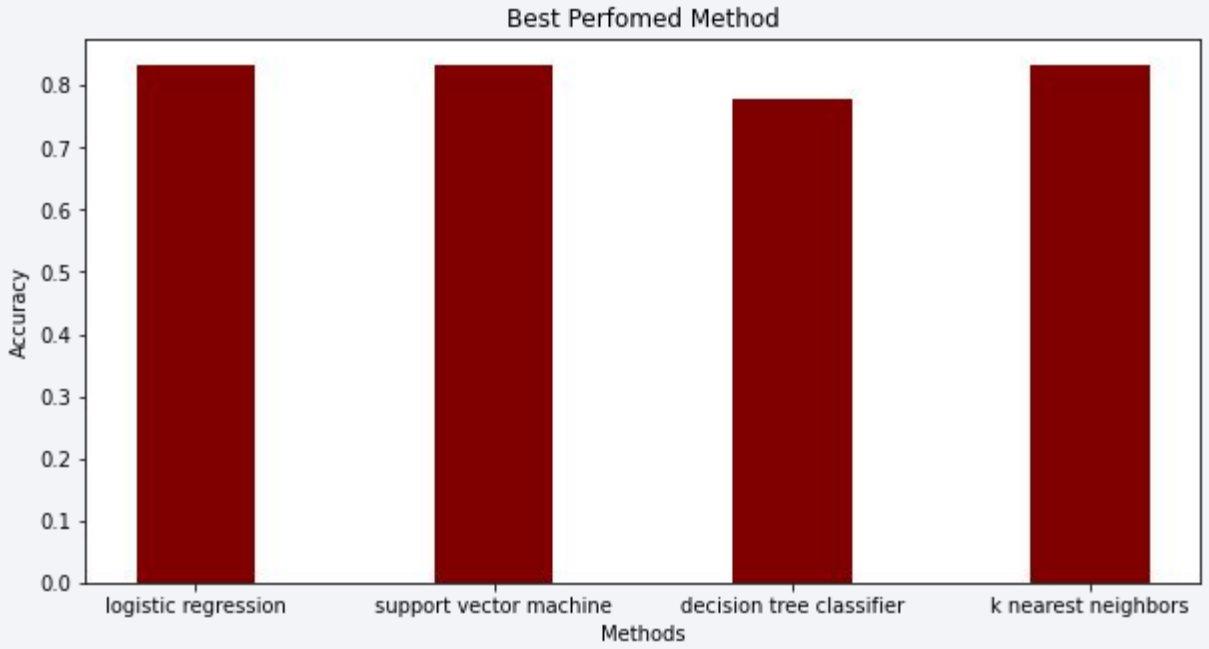
Section 5

Predictive Analysis (Classification)

Classification Accuracy

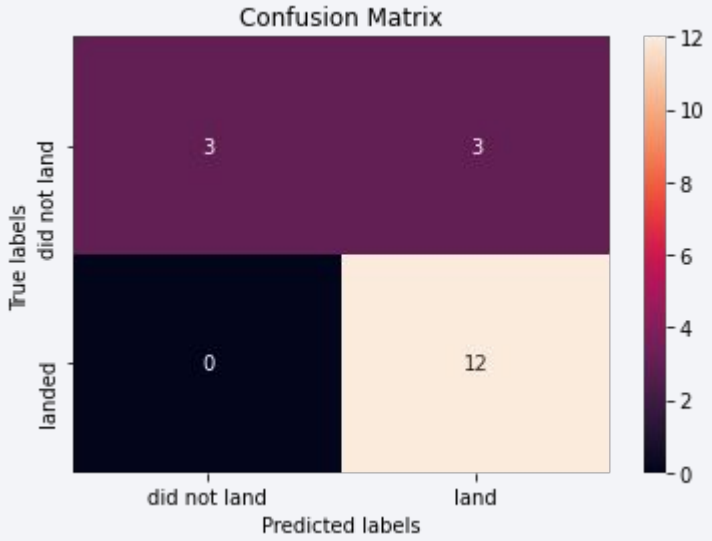
- Visualize the built model accuracy for all built classification models, in a bar chart

- Find which model has the highest classification accuracy



Confusion Matrix

- Show the confusion matrix of the best performing model with an explanation



Conclusions

- The CCAFS SLC 40 launch site has about a half of all launches.
- VAFB SLC 4E and KSC LC 39A have higher success rates.
- Most of the launches with payload mass over 8000 kg were successful.
- …

Appendix

THANK YOU !

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REVIEWER

Thank you!