IBM Developer
SKILLS NETWORK

Winning Space Race with Data Science

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Outline

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

Executive Summary

- Methodologies:
    - Problem Definition
    - Data Collection:
    - Data Cleaning and Preprocessing
    - Exploratory Data Analysis (EDA)
    - Model Selection, Training, Evaluation and Deployment
- Summary of all results
    - Building a model for Space X Falcon 9 First Stage Landing Prediction

Introduction

- Project background and context
  - The aim of the project is Space X Falcon 9 First Stage Landing Prediction
- Problems you want to find answers
  - We need to build a model in order to predict the Landing Success Rate of Space X Falcon 9

Section 1

Methodology

Methodology

Executive Summary

- Data collection methodology:
- Perform data wrangling
- Perform exploratory data analysis (EDA) using visualization and SQL
- Perform interactive visual analytics using Folium and Plotly Dash
- Perform predictive analysis using classification model

Data Collection

Data is collected from :

- SpaceX Rest API
- Web scraping the SpaceX website

Data Collection – SpaceX API

- SpaceX provide the API to utilize its’s data
- Data collection notebook in github is **here**

Start → Make API Request →

← Parse Data ← Receive Response

Process Data → Display Results →

End

Data Collection - Scraping

- Web scraping is other method that I used to collect the data
- Github link is **here**

Start → Choose Website → Identify Data to Scrape → Inspect HTML Structure → Scrap the Data You want → Store the Data → End

Data Wrangling

- In Data Wrangling we go through the data once, how the data arranged, what are the data types present, basic statistics about the data and any addition of columns
- Github link is **here**

EDA with Data Visualization

- **EDA**
  - It is further exploration of the data by plotting different visualizations inorder to find outerliers, patterns, uneven occurances etc.
  - We plotted scatter plot between many variables inorder to find the relationship between variables
  - And Bar graph inorder to find the count of each value in column

Github link is **here**

EDA with SQL

- We also performed the EDA using SQL on my_data1.db
- Github link is **here**

Build an Interactive Map with Folium

- I used Folium to visualize the launch sites and the objects I used
  - Circle to mark the points on map
  - Markercluster, as there are many marker to make it look beautifull
  - MousePosition, to get the position of mouse on the map
  - PolyLine, to visualize the distance between two locations
- Github link is **here**

Build a Dashboard with Plotly Dash

- I built a dashboard inorder to present the insights from data using python library dash and plotly. The graph I used are:
  - Pie chart to show the success rate of each Launch Site
  - Scatter plot to show the relation between PayloadMass and success rate
- Github link is **here**

Predictive Analysis (Classification)

- Final I build many Classification models using the python library sklearn and found the best model using the error evaluation
- I found the best parameters for each model using GridSearchCv method.
- Github link is **here**

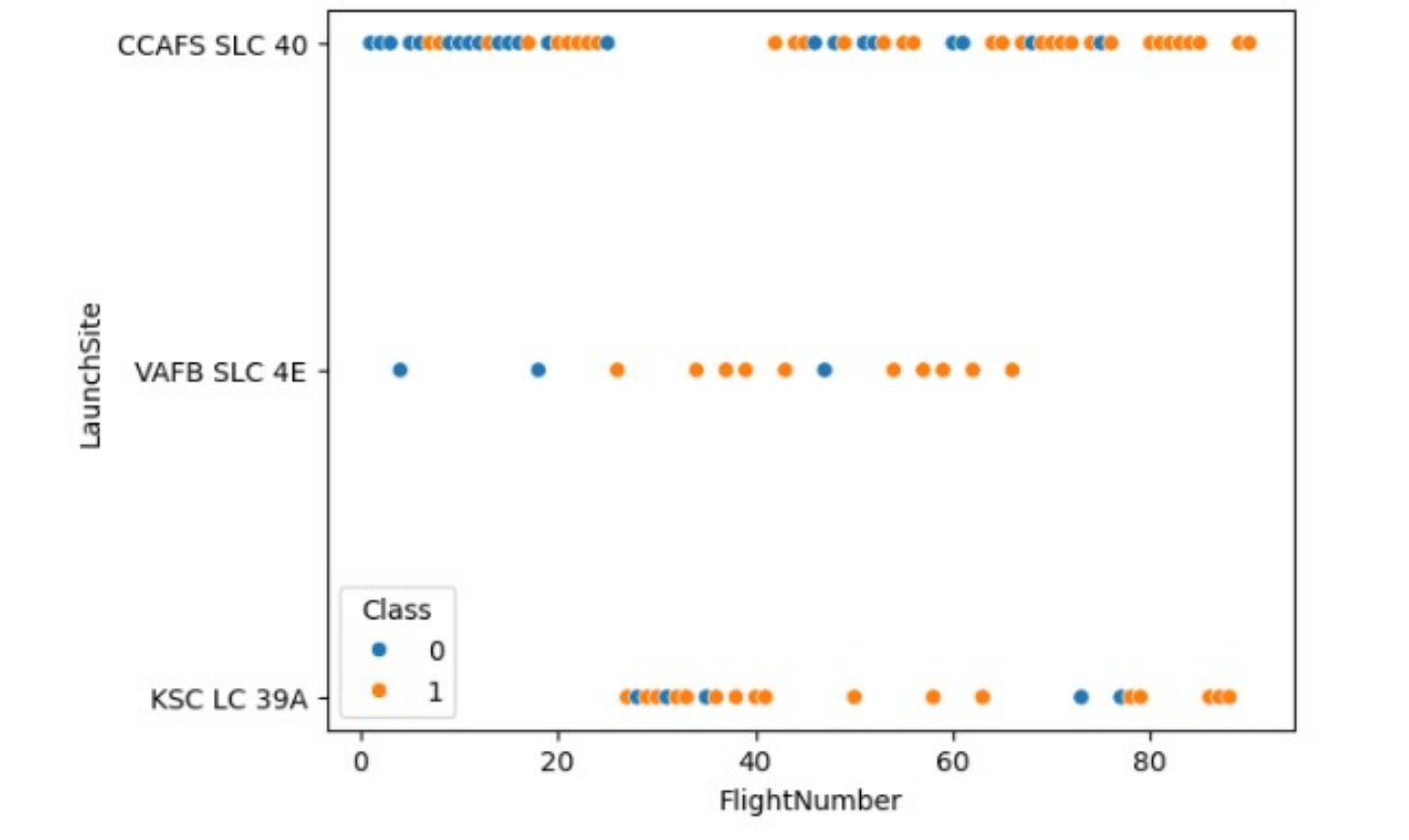
Results

- In EDA we came to know that there is a correlationship between payload and success rate
- Final we build a model inorder to predict the success rate of Falcon 9

Section 2

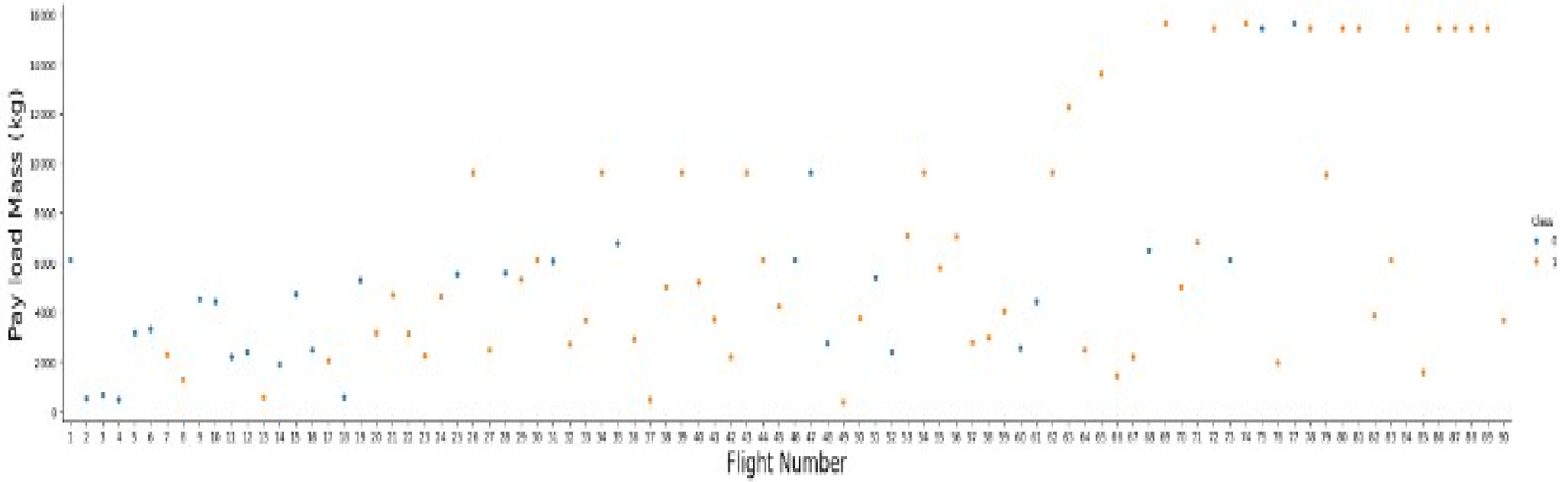
Insights drawn from EDA

Flight Number vs. Launch Site



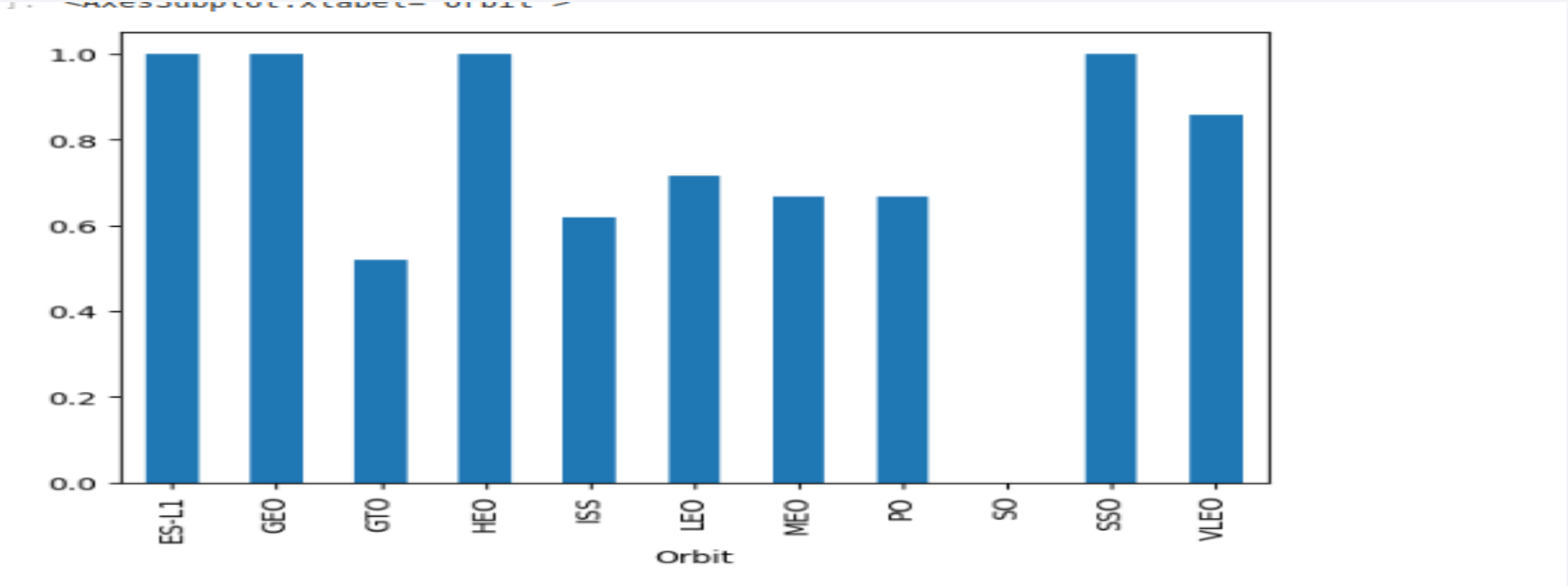
We can few flight were launched from VAFB SLC site, most of the flight launches from KSC LC are successful and most of the failured launches occurred at CCAFS SLC

Payload vs. Launch Site



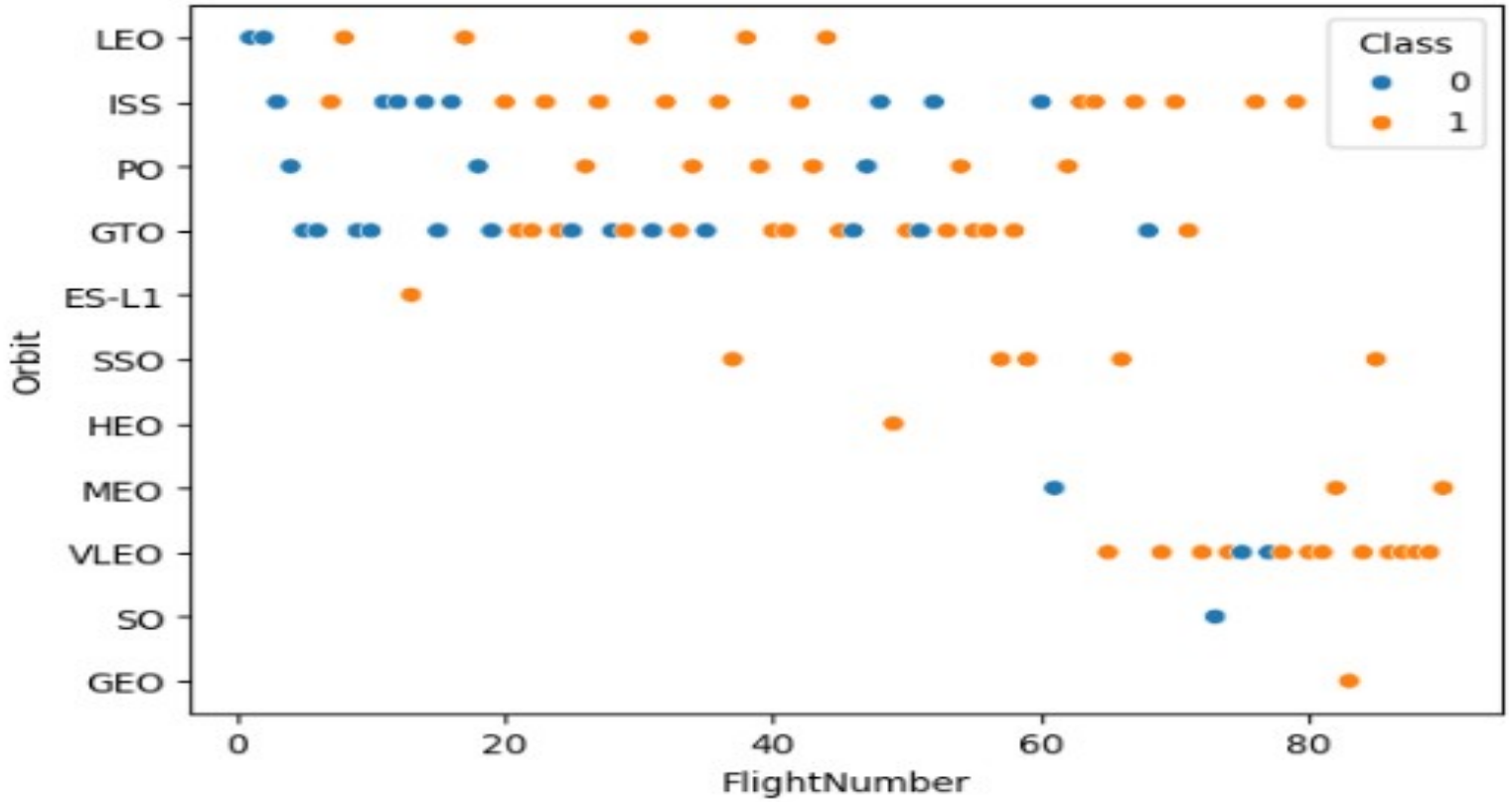
We see that different launch sites have different success rates. `CCAFS LC-40`, has a success rate of 60 %, while `KSC LC-39A` and `VAFB SLC 4E` has a success rate of 77%.

Success Rate vs. Orbit Type



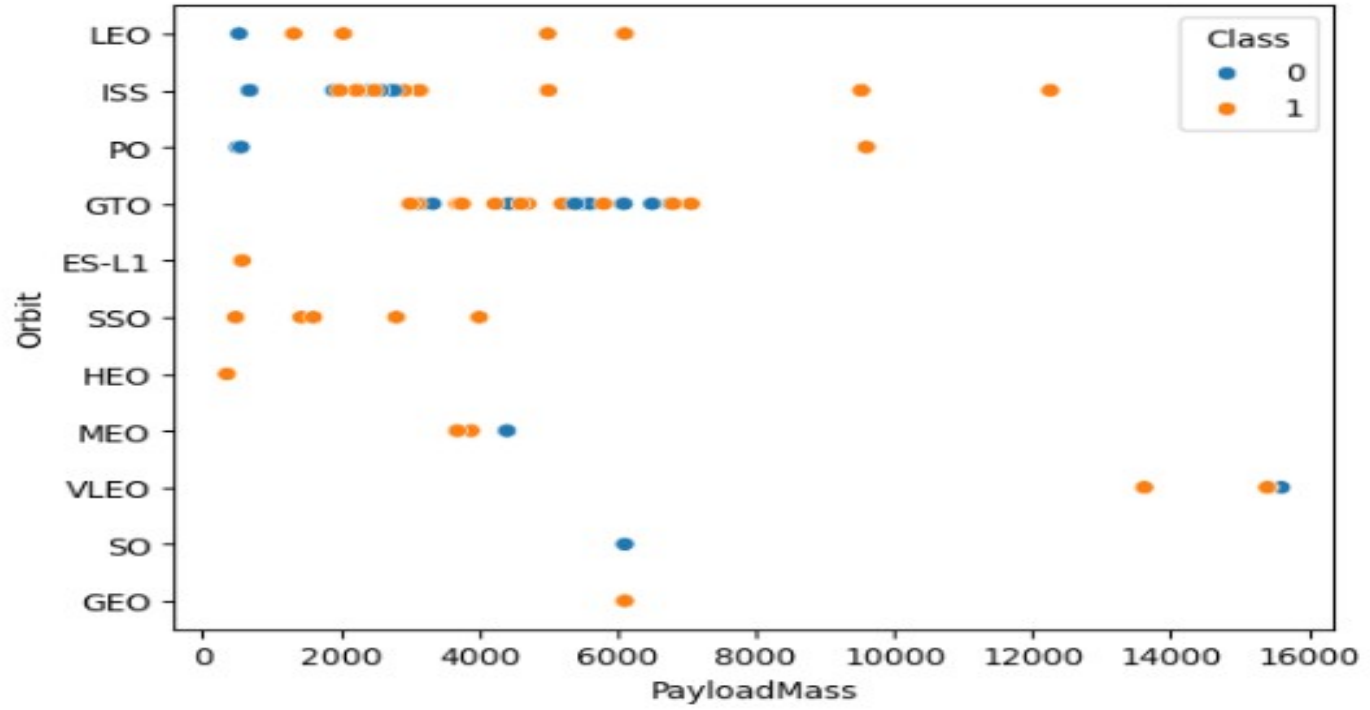
We can see that ES-L1,GEO, HEO, SSO type of orbits have good success rate than other orbits

Flight Number vs. Orbit Type



You should see that in the LEO orbit the Success appears related to the number of flights; on the other hand, there seems to be no relationship between flight number when in GTO orbit.

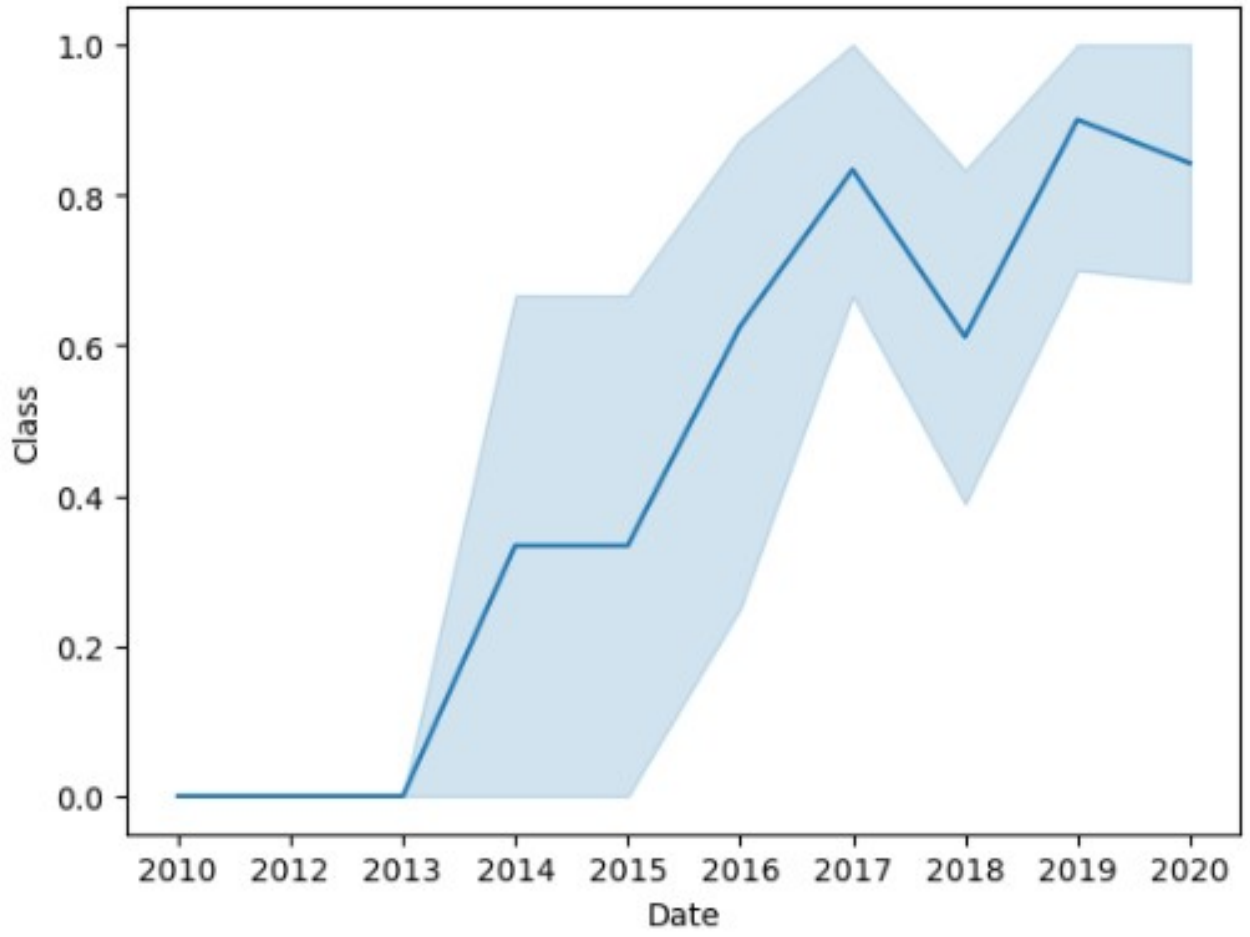
Payload vs. Orbit Type



With heavy payloads the successful landing or positive landing rate are more for Polar,LEO and ISS.

However for GTO we cannot distinguish this well as both positive landing rate and negative landing(unsuccessful mission) are both there here.

Launch Success Yearly Trend



you can observe that the sucess rate since 2013 kept increasing till 2020

All Launch Site Names

[49]:
```
%sql select DISTINCT("Launch_Site") from SPACEXTBL
```

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

[49]:

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

Launch Site Names Begin with 'CCA'

```
%sql select * from SPACEXTBL where "Launch_Site" like "CCA%" limit 5
```

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

Time (UTC)	Booster_Version	Launch_Site	Payload	PAYLOAD_MASS__KG_	Orbit	Customer	Mission_Outcome	Landing_Outcome
18:45:00	F9 v1.0 B0003	CCAFS LC-40	Dragon Spacecraft Qualification Unit	0	LEO	SpaceX	Success	Failure (parachute)
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)
7:44:00	F9 v1.0 B0005	CCAFS LC-40	Dragon demo flight C2	525	LEO (ISS)	NASA (COTS)	Success	No attempt
0:35:00	F9 v1.0 B0006	CCAFS LC-40	SpaceX CRS-1	500	LEO (ISS)	NASA (CRS)	Success	No attempt
15:10:00	F9 v1.0 B0007	CCAFS LC-40	SpaceX CRS-2	677	LEO (ISS)	NASA (CRS)	Success	No attempt

Total Payload Mass

```
53]: %sql select sum(PAYLOAD_MASS__KG_)  as "Load","Customer" from SPACEXTBL group by "Customer" having Customer = "NA
```

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

53]:

Load	Customer
45596	NASA (CRS)

Average Payload Mass by F9 v1.1

```
6]: %sql select avg(PAYLOAD_MASS__KG_) as "Avg_pay_load" , "Booster_Version" from SPACEXTBL group by "Booster_Version
 * sqlite:///my_data1.db
Done.
```

6]:

Avg_pay_load	Booster_Version
2928.4	F9 v1.1

First Successful Ground Landing Date

```
%sql select min(Date) as "first successful landing" from SPACEXTBL where Landing_Outcome = "Success (ground pad)"
```

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

first successful landing
2015-12-22

Successful Drone Ship Landing with Payload between 4000 and 6000

List the names of boosters which have successfully landed on drone ship and had payload mass greater than 4000 but less than 6000

Present your query result with a short explanation here

Total Number of Successful and Failure Mission Outcomes

```
%%sql select count(*) as "Total count",CASE
        WHEN Mission_Outcome like "%Failure%" then "Failure"
        else "Success"
    end as simplified_outcome
from SPACEXTBL group by simplified_outcome
```

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

Total count	simplified_outcome
1	Failure
100	Success

Boosters Carried Maximum Payload

```
%sql select DISTINCT(Booster_Version) from SPACEXTBL where PAYLOAD_MASS__KG_ = (select max(PAYLOAD_MASS__KG_) frc
```

```
 * 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

```
%sql select substr(Date,6,2) as "month",Landing_Outcome,Booster_Version,Launch_Site from SPACEXTBL where substr(D
```

```
 * 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

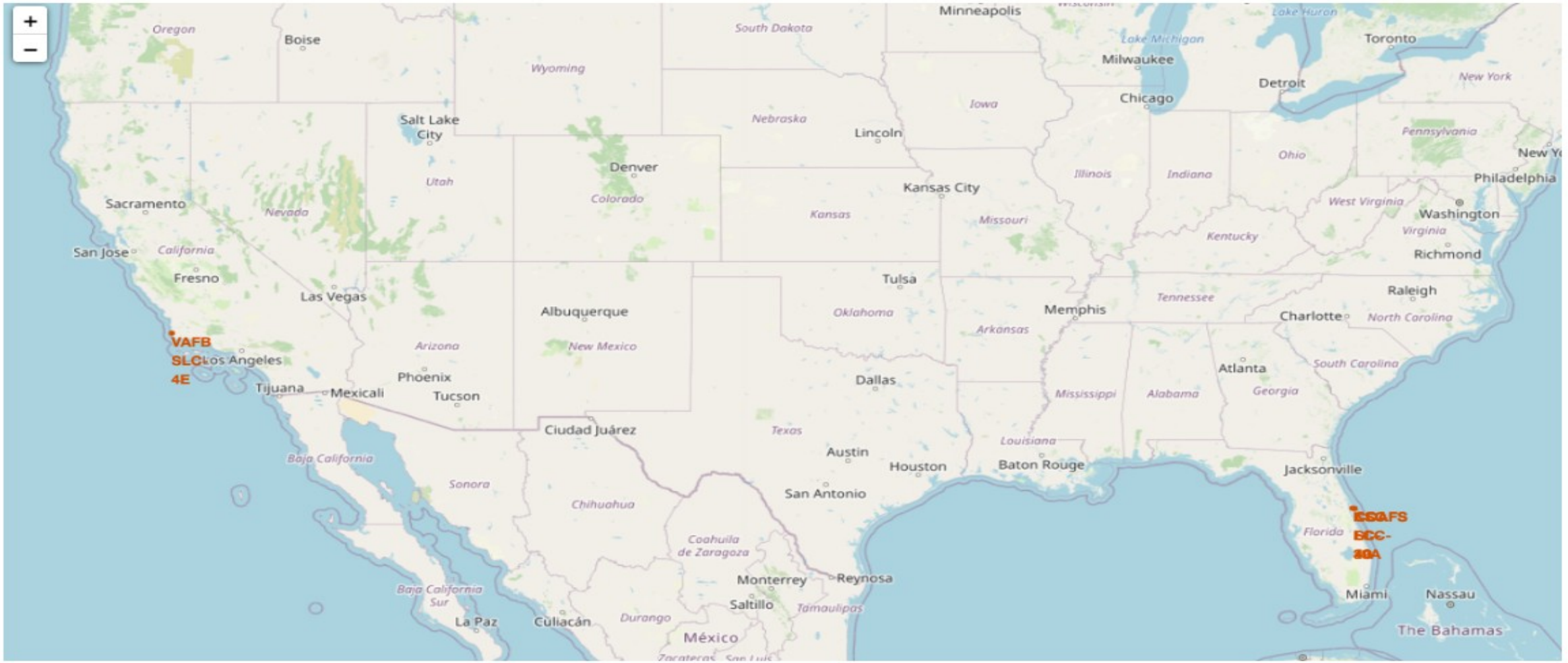
```
%sql select count(*) as "Count",Landing_Outcome from SPACEXTBL group by Landing_Outcome having Date Between "2010
```

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

Count	Landing_Outcome
21	No attempt
14	Success (drone ship)
9	Success (ground pad)
5	Failure (drone ship)
5	Controlled (ocean)
2	Uncontrolled (ocean)
2	Failure (parachute)
1	Precluded (drone ship)


Section 3
Launch Sites
Proximities Analysis

Mark all launch sites on a map

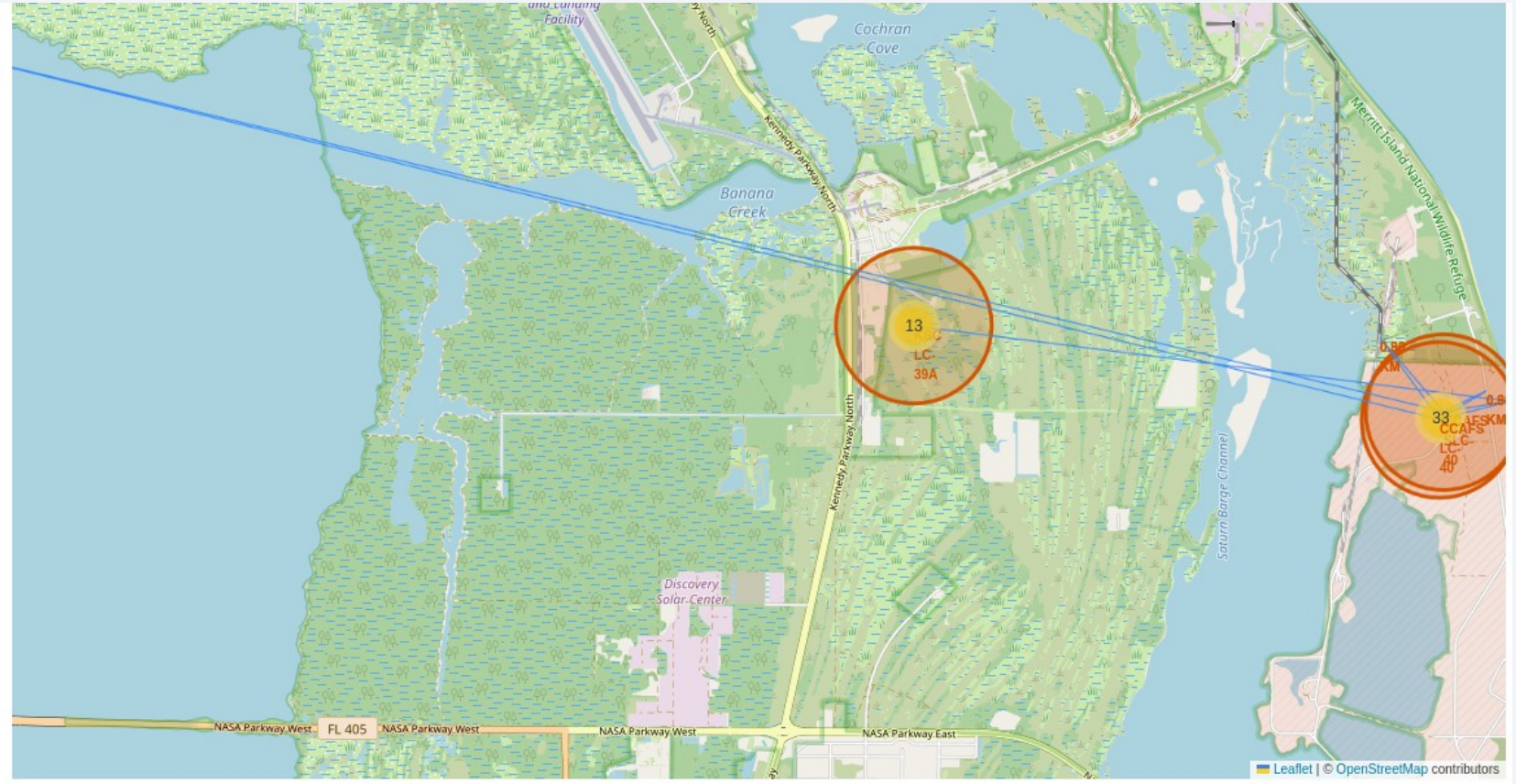


We can observe that all the four Launch sites are near to the coast, road , railways and cities

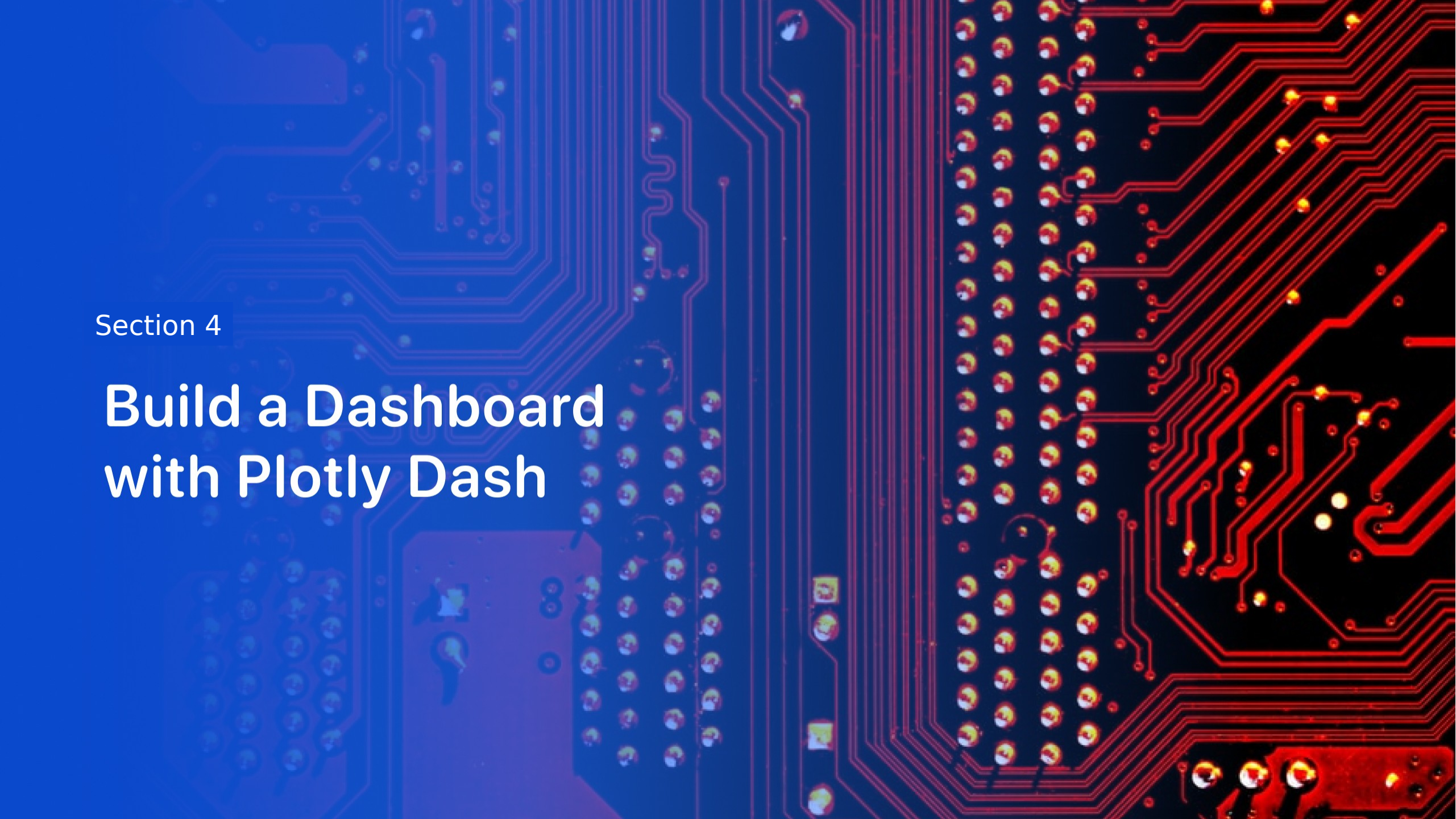
Success/Failed launches for each site

From the color-labeled markers in marker clusters, you should be able to easily identify which launch sites have relatively high success rates.

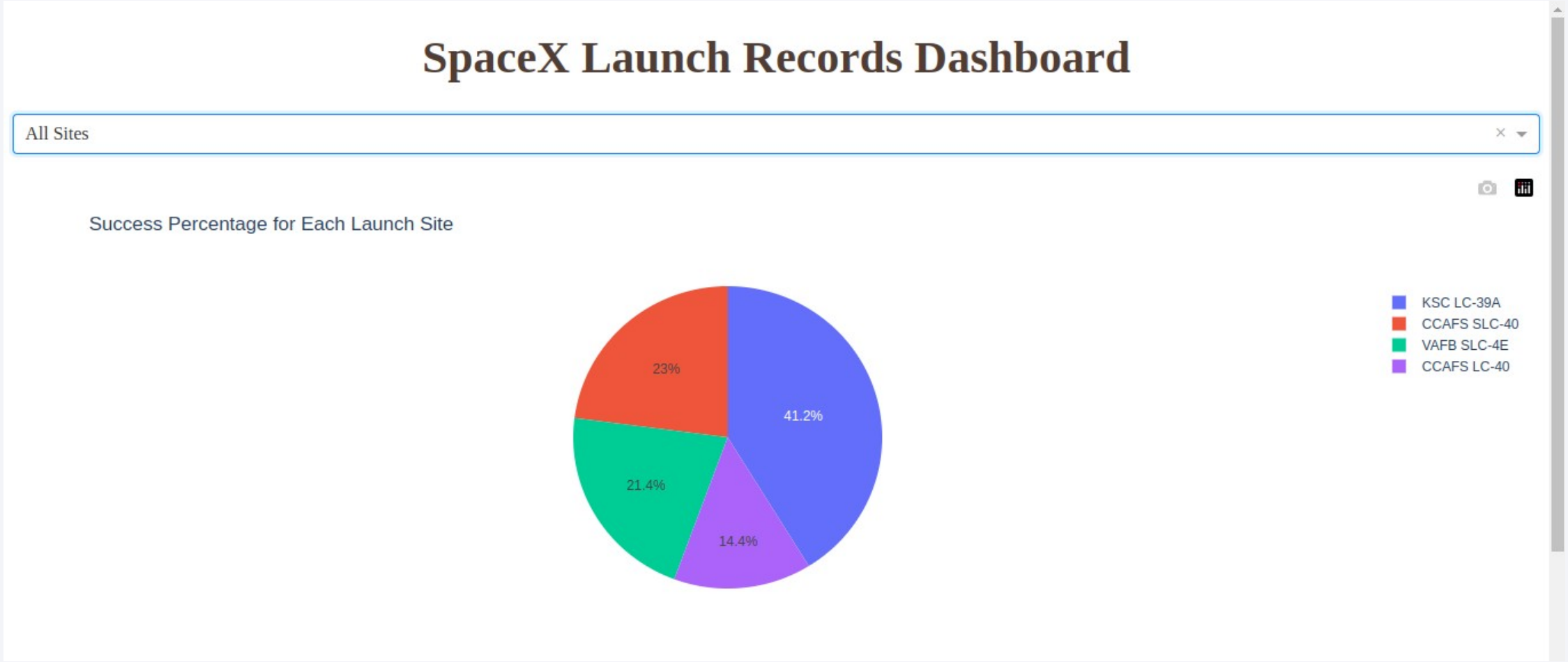
Distances btw a launch site to its proximities



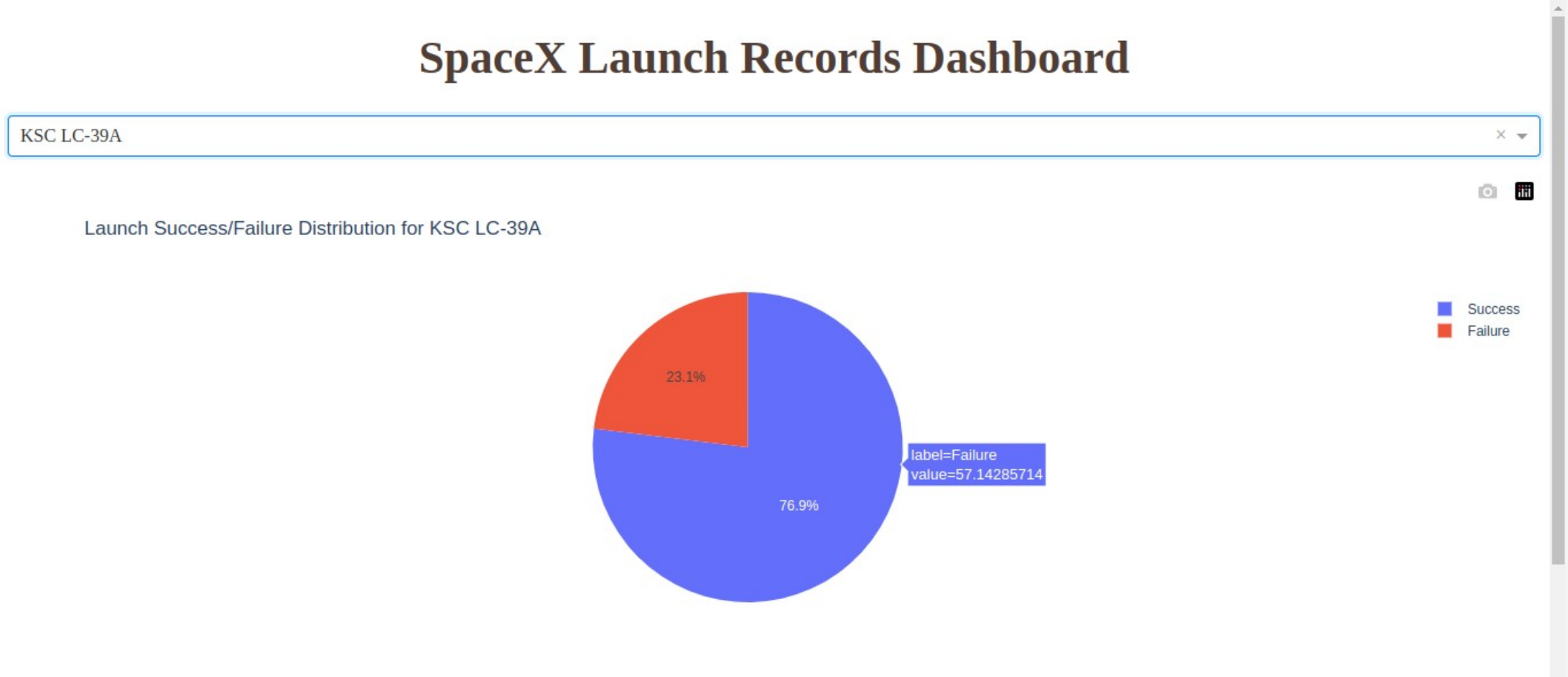
All the four are near to the railways,highways,coastline and from cities But the VAFB SLC-4E Station is far from highway and city


Section 4
Build a Dashboard with Plotly Dash

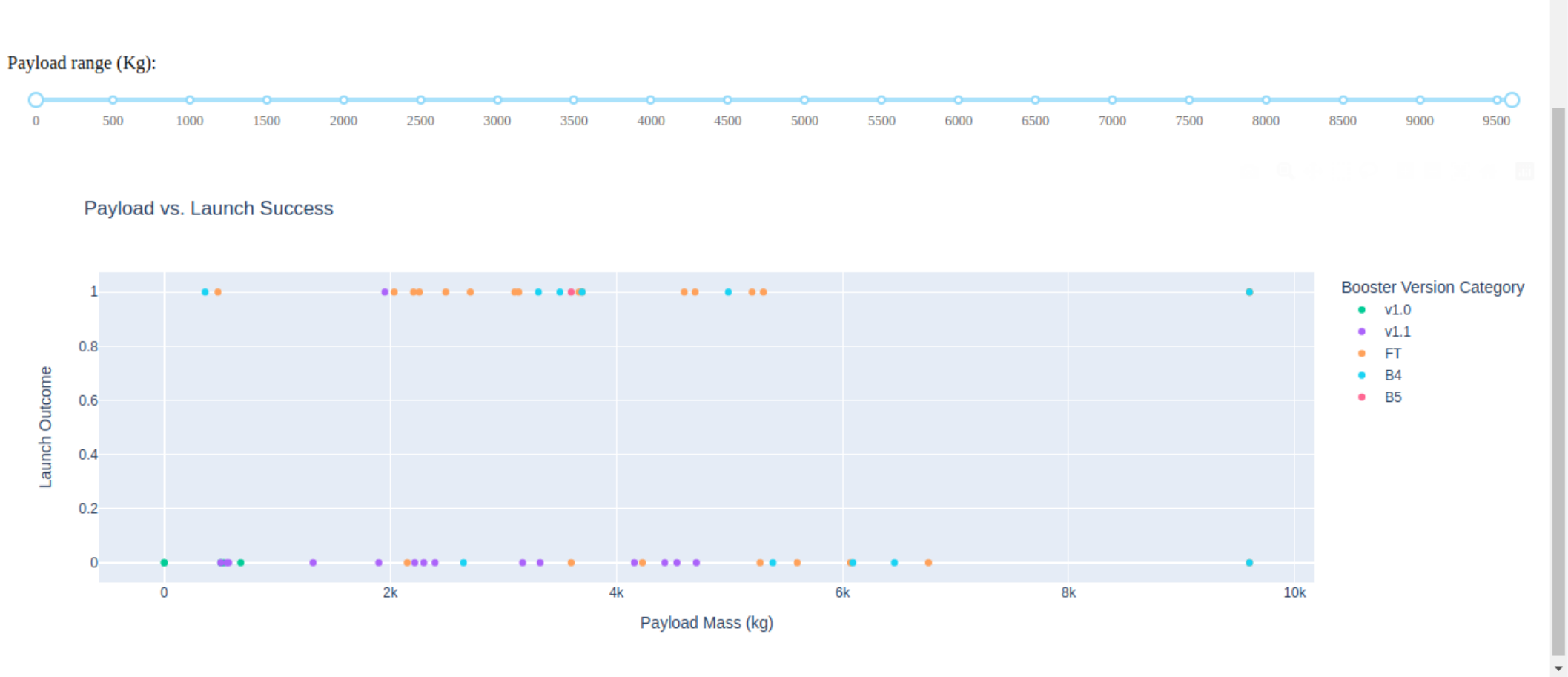
Pie chart for ALL sites



Pie chart for Launch site with max success



Scatter plot btw payloadmass and success rate

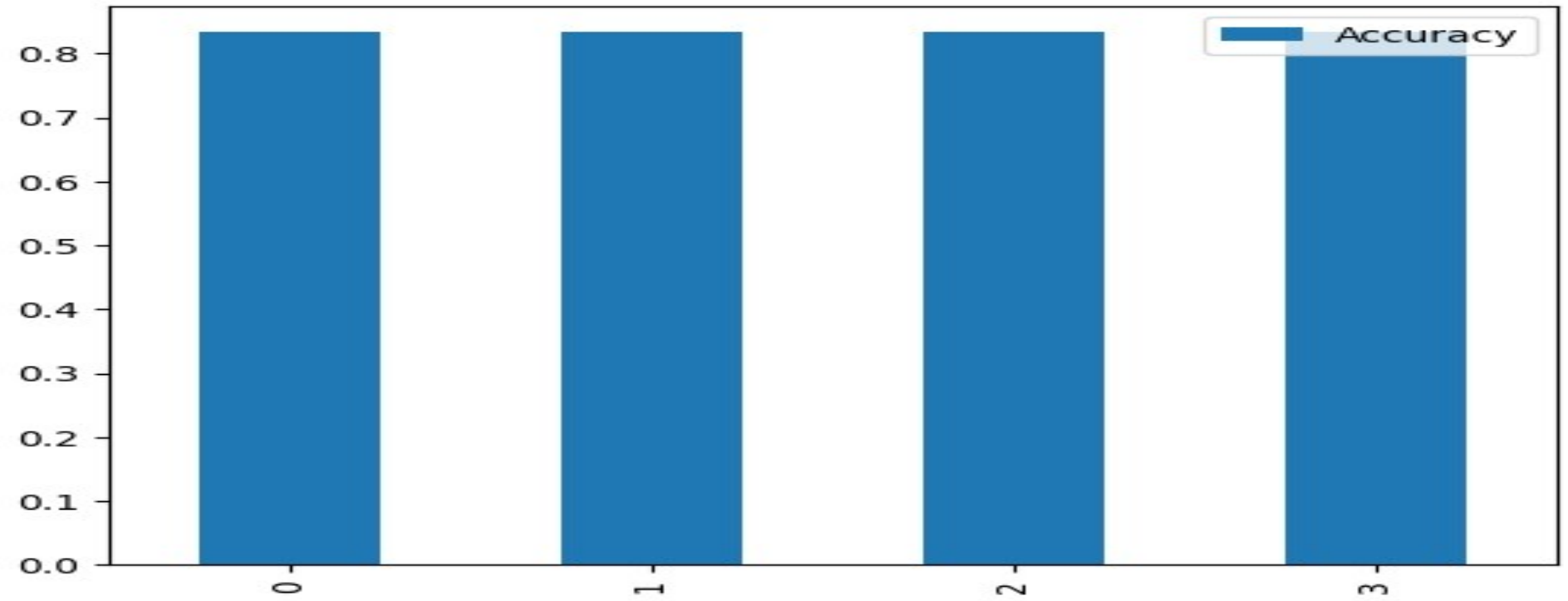


Section 5

Predictive Analysis (Classification)

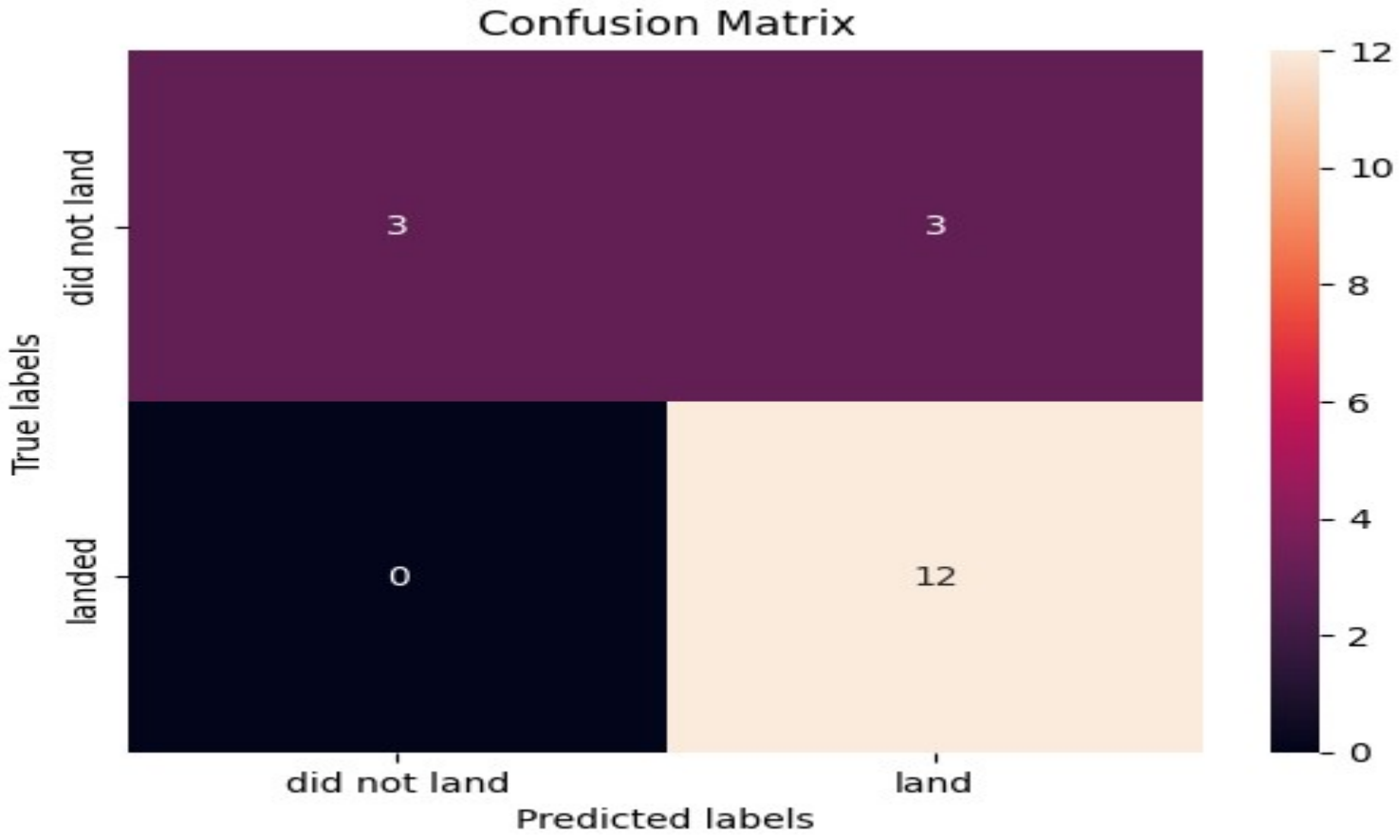
Classification Accuracy

```
]:  df.plot(kind="bar")
    plt.show()
```



We can observe that all model have same accuracy score

Confusion Matrix



All the models have same accuracy score i.e all models are best. But now I am showing confusion matrix for KNN model

Conclusions

- Except DecisionTree method all other perform the same and best than Decision Tree
- Finally we built a model inorder to predict the success rate of First Stage Landing of Spacex Falcon 9
- The model is able to predict with 83.333 accuracy which sounds good to hear.

Appendix

For full access to all the python notebooks and files you can visit the github. Link is **here**.

Thank you!