# Space missions data understanding, visualization and analysis

*Hello everyone!*
*In this kernel I am going to present basic EDA with interactive charts. Also we will see some interesting insights and prepare basic model for time series forecating.*
*Let's do it!*

01

IBM DATA SCIENCE PROJECT

# SpaceX Reusable Rocket

Van Chau

01/09/2021

# Outline

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

# Executive Summary

| Collect data with SpaceX REST API and Web Scraping using BeautifulSoup.<br>Data cleansing using python libraries. | Using SQL commands and visualization like bar chart, scatter plot.<br>Using interactive map and dashboard to visualize more clearly. | Machine Learning Models used:<br>• Logistic Regression<br>• Support Vector Machine<br>• K-Nearest Neighbors<br>• Decision Trees<br>All have 83.33% accuracy. |
|---|---|---|
| Data Collection & Data Wrangling | Exploratory Analysis | Predictive Models |

# Introduction

- SpaceX

  an American aerospace manufacturer, space transportation services and communications company

- Cost per launch

  -Normal: $165 million
  -Falcon9: $62 million

Goal

To maximize success rate
and the best model to predict

# SpaceX Falcon 9

Reusable Rocket Model

## $62 million

per launch

# Methodology

## Data Collection

-Web Scraping
-SpaceX REST API

## Data Wranging

-Removing irrelavant data
-Handling missing values
-Turning categorical variables into numerical variables

## Exploratory Data Analysis using visualization

-Using visualization (scatter plot, bar chart) to present data

# Methodology (continue)

| | | |
|---|---|---|
| Exploratory Data Analysis using SQL<br><br>-Using SQL commands to obtain the data insights | Interactive visual analytics<br><br>-Using Ploty Dash to create interactive dashboard and visualize to data<br>-Using Folium to create interactive maps | Prediction using classification models<br><br>-Using machine learning models such as KNN and SVM to predict the outcome<br>-Model evaluation |

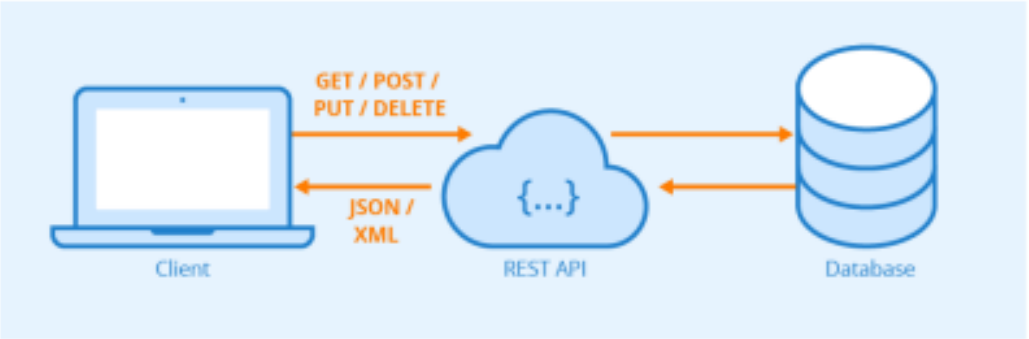


## Data Collection

# Data Collection

## Using SpaceX REST API

:use get request to obtain the response and then convert it to data frame




## Using Beautiful Soup

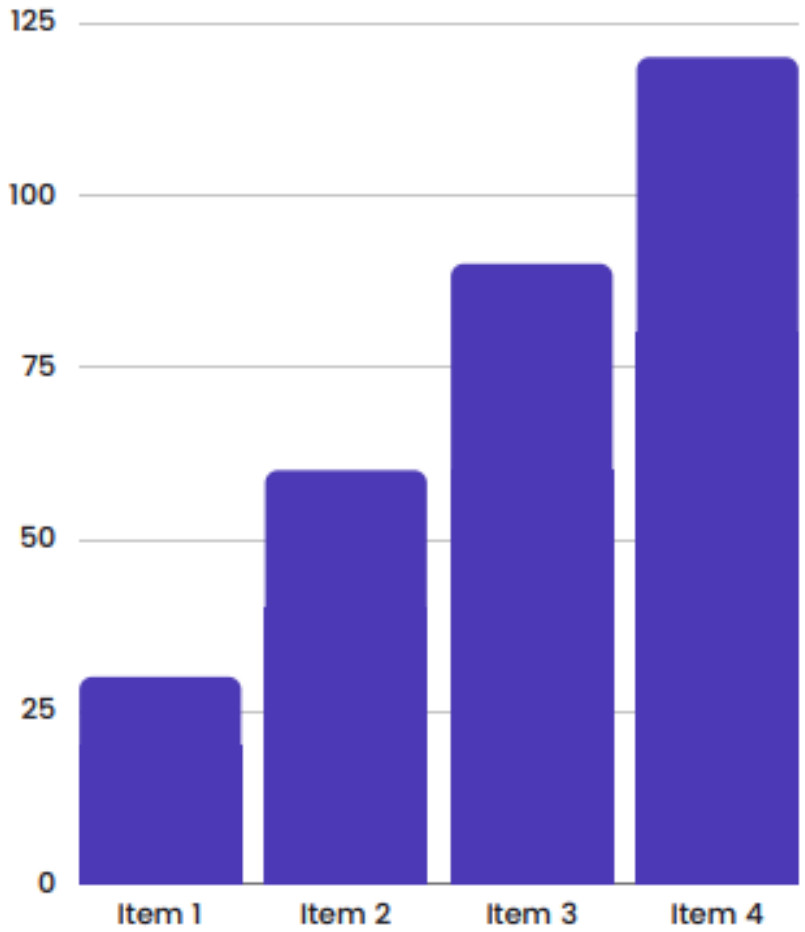
: use beautiful soup for web scraping from webpages to obtain the data

# Data Wrangling

Filter the data frame
:only include Falcon 9 launches

Dealing with Missing Values
: replace them by the mean

Converting caterical variable into numerical
successful: 1
unsuccessful: 0



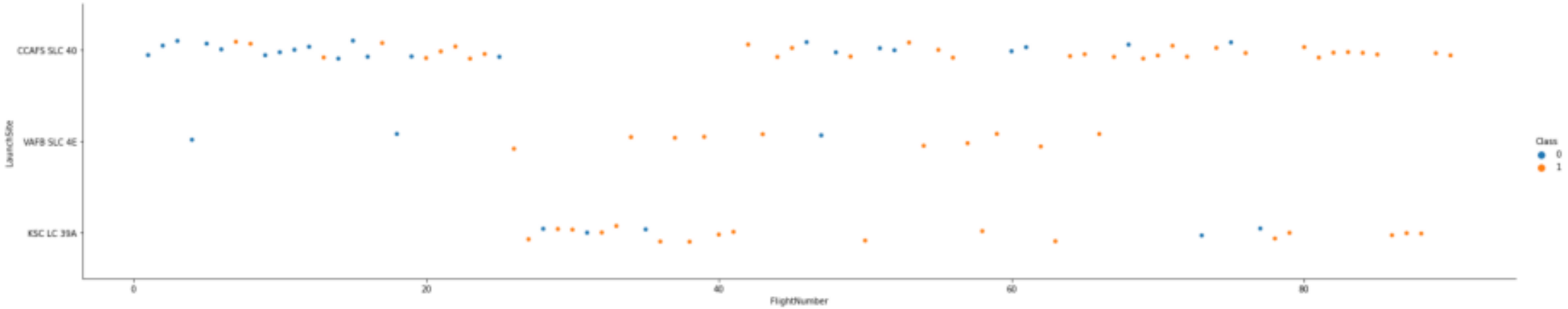

# Results

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

# EDA with visualization

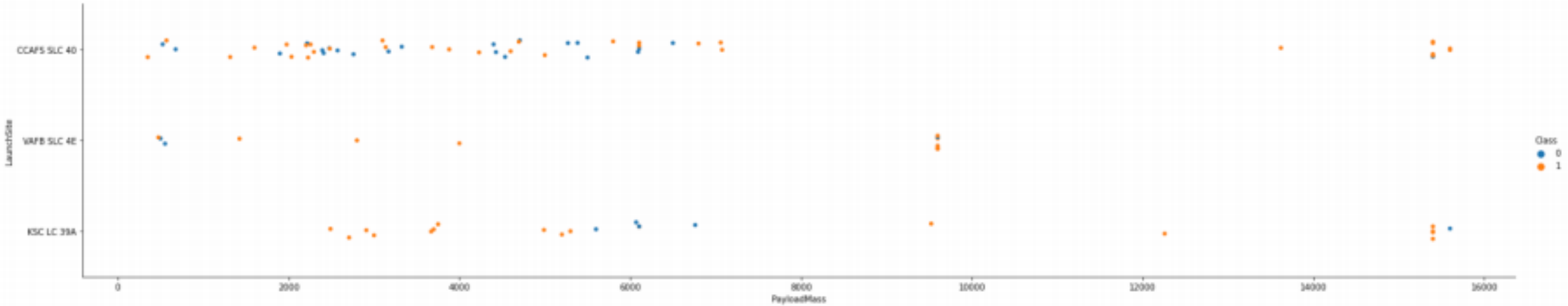
- Scatter plot between Flight Number and Launch Site
- Scatter plot between Payload and Launch Site
- Bar chart between success rate of each orbit type
- Scatter plot between FlightNumber and Orbit type
- Scatter plot between Payload and Orbit type
- Line chart of the launch success yearly trend

# Flight Number vs. Launch Site



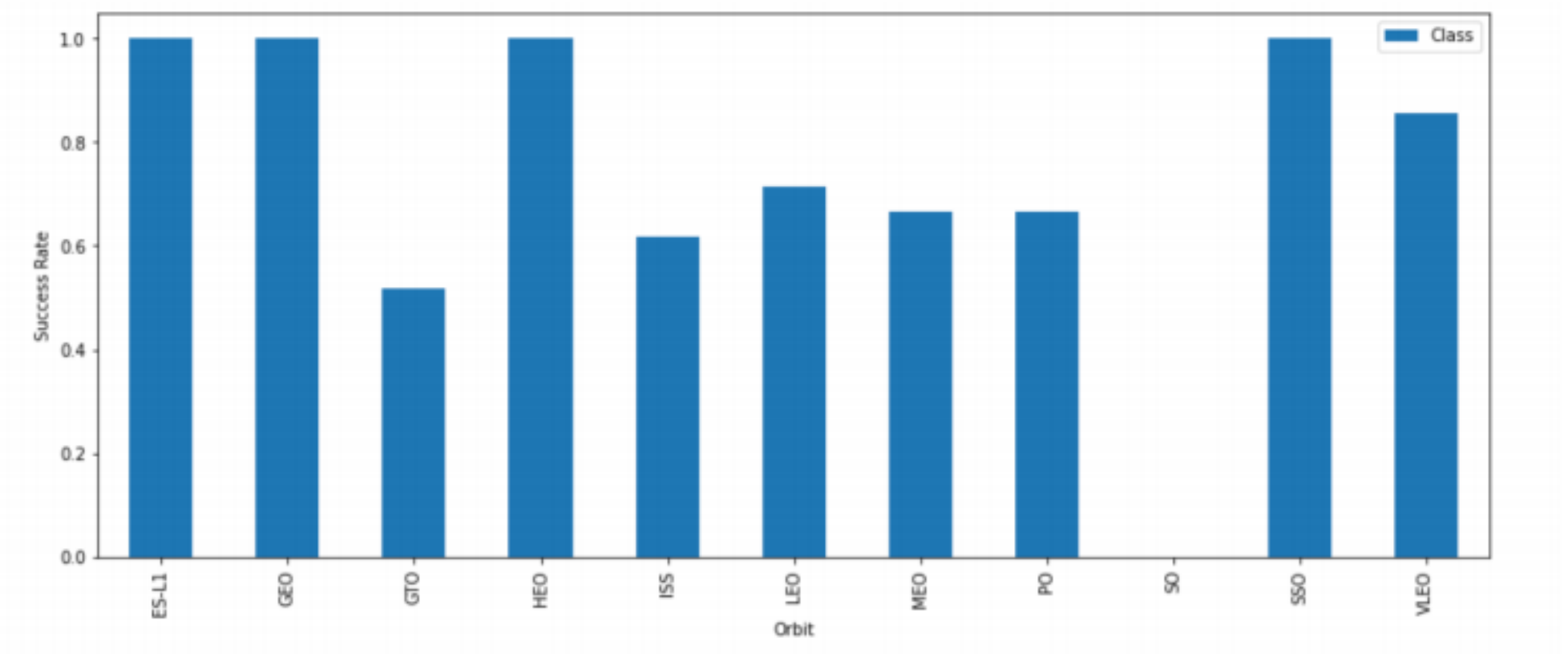

Higher flight number seems to have more success rate on the same launch site.

# Payload vs. Launch Site



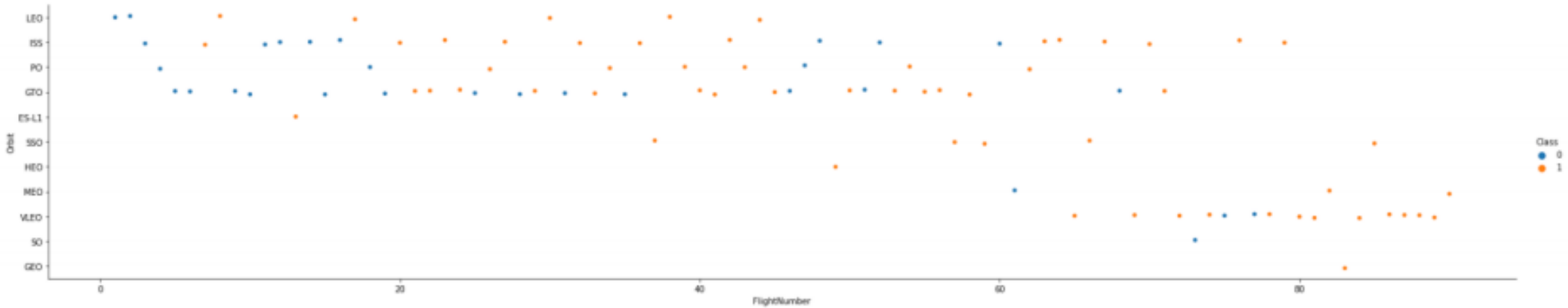

For CCAFS SLC 40 and VAFB SLC 4E, higher payload mass seems to be more successful. For KSC LC 39A, payload mass between 6,000-7,000 seems to be unsuccessful.

# Success rate vs. Orbit type



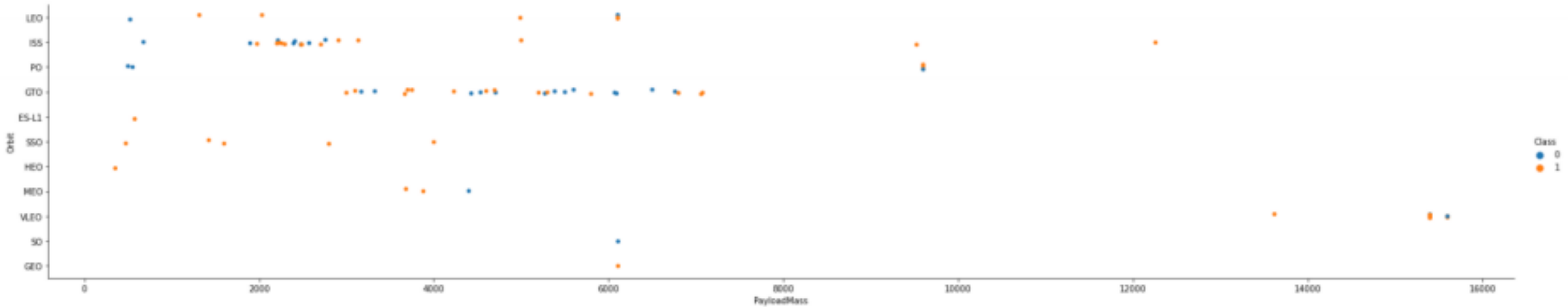

There are 4 orbit types that have the highest success rate, which are ES-L1, GEO, HEO, SSO.

# Flight Number vs. Orbit type



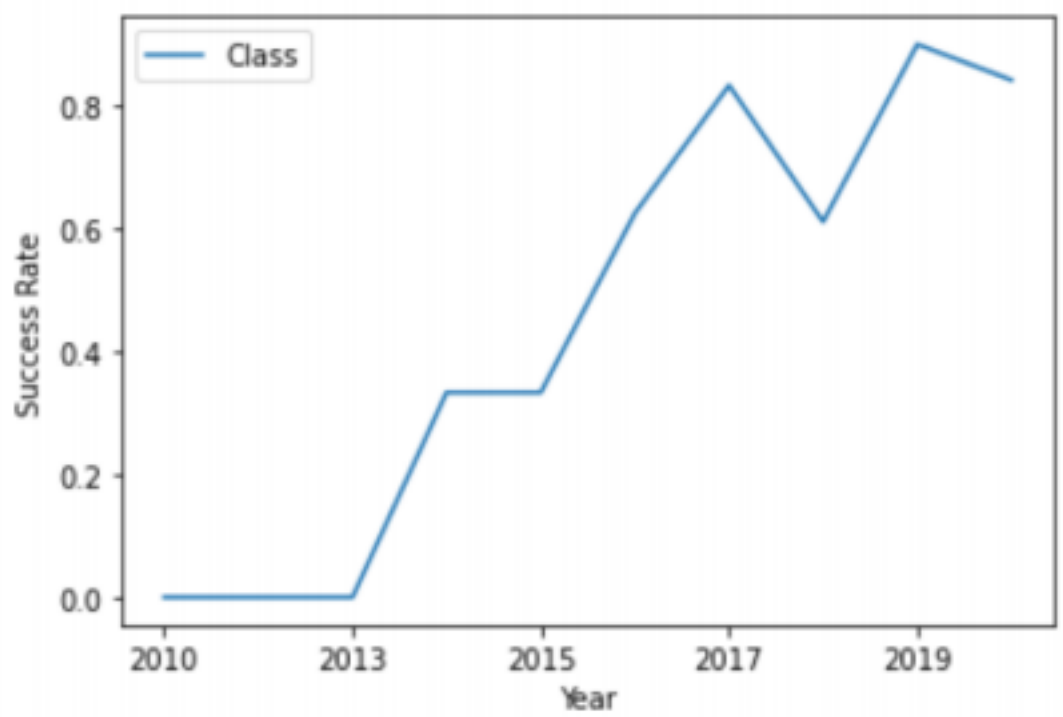

For GTO, less flight number seems to be unsuccessful on the same orbit type.

# Payload vs. Orbit type




Higher payload mass seems to have negative influence with GTO orbit type.

# Launch success yearly trend




Success rate's trend keeps increasing until 2020, which corresponds with the scatter plot that indicates that the higher flight number is, the higher success rate is.

# EDA with SQL

## Using SQL commands to gain more data insights

**Task 1**

***Display the names of the unique launch sites in the space mission***

```
%sql select DISTINCT launch_site from spacextbl
```

```
 * ibm_db_sa://xwx66212:***@0c77d6f2-5da9-48a9-81f8-86b520b87518.bs2io90108kqblod8lcg.databases.appdomain.cloud:3119
8/bludb
Done.
```

| launch_site |
| --- |
| CCAFS LC-40 |
| CCAFS SLC-40 |
| KSC LC-39A |
| VAFB SLC-4E |



# EDA with SQL

### Task 2

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

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

```
 * ibm_db_sa://xwx66212:***@0c77d6f2-5da9-48a9-81f8-86b520b87518.bs2io90l08kqb1od8lcg.databases.appdomain.cloud:3119
8/bludb
Done.
```

| DATE | Time (UTC) | booster_version | launch_site | payload | payload_mass__kg_ | orbit | customer | mission_outcome | landing_outcome |
|---|---|---|---|---|---|---|---|---|---|
| 2010-06-04 | 18:45:00 | F9 v1.0 B0003 | CCAFS LC-40 | Dragon Spacecraft Qualification Unit | 0 | LEO | SpaceX | Success | Failure (parachute) |
| 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 (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 |
| 2012-10-08 | 00:35:00 | F9 v1.0 B0006 | CCAFS LC-40 | SpaceX CRS-1 | 500 | LEO (ISS) | NASA (CRS) | Success | No attempt |
| 2013-03-01 | 15:10:00 | F9 v1.0 B0007 | CCAFS LC-40 | SpaceX CRS-2 | 677 | LEO (ISS) | NASA (CRS) | Success | No attempt |



# EDA with SQL

### Task 3

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

```
%%sql select sum(payload_mass__kg_) as sum from spacextbl
where customer = 'NASA (CRS)'
```

```
 * ibm_db_sa://xwx66212:***@0c77d6f2-5da9-48a9-81f8-86b520b87518.bs2io90108kqblod8lcg.databases.appdomain.cloud:3119
8/bludb
Done.
```

| SUM |
| --- |
| 45596 |

### Task 4

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

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

```
 * ibm_db_sa://xwx66212:***@0c77d6f2-5da9-48a9-81f8-86b520b87518.bs2io90108kqblod8lcg.databases.appdomain.cloud:3119
8/bludb
Done.
```

| average |
| --- |
| 2534 |



# EDA with SQL

### Task 5

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

*Hint:Use min function*

```
%%sql select min(date) from (select date from spacextbl
                             where landing_outcome = 'Success (ground pad)')
```

| 1 |
| --- |
| 2015-12-22 |



# EDA with SQL

**Task 6**

***List the names of the boosters which have success in drone ship and have payload mass greater than 4000 but less than 6000***

```
%%sql select booster_version from spacextbl
where payload_mass__kg_ between 4000 and 6000
```

```
 * ibm_db_sa://xwx66212:***@0c77d6f2-5da9-48a9-81f8-86b520b87518.ba2io90l08kqblod8lcg.databases.appdomain.cloud:3119
8/bludb
Done.
```

| booster_version |
|---|
| F9 v1.1 |
| F9 v1.1 B1011 |
| F9 v1.1 B1014 |
| F9 v1.1 B1016 |
| F9 FT B1020 |
| F9 FT B1022 |
| F9 FT B1026 |
| F9 FT B1030 |
| F9 FT B1021.2 |
| F9 FT B1032.1 |
| F9 B4 B1040.1 |
| F9 FT B1031.2 |
| F9 B4 B1043.1 |
| F9 FT B1032.2 |
| F9 B4 B1040.2 |
| F9 B5 B1046.2 |
| F9 B5 B1047.2 |
| F9 B5 B1046.3 |
| F9 B5B1054 |
| F9 B5 B1048.3 |
| F9 B5 B1051.2 |
| F9 B5B1060.1 |
| F9 B5 B1058.2 |
| F9 B5B1062.1 |

# EDA with SQL

**Task 7**

***List the total number of successful and failure mission outcomes***

```
%%sql select count(mission_outcome) as SUCESS_MISSION from spacextbl
where mission_outcome like 'Success%'
```

```
 * ibm_db_sa://xwx66212:***@0c77d6f2-5da9-48a9-81f8-86b520b87518.bs2io90l08kqb1od8lcg.databases.appdomain.cloud:3119
8/bludb
Done.
```

| sucess_mission |
|---|
| 100 |

```
%%sql select count(mission_outcome) as FAILED_MISSION from spacextbl
where mission_outcome like 'Failure%'
```

```
 * ibm_db_sa://xwx66212:***@0c77d6f2-5da9-48a9-81f8-86b520b87518.bs2io90l08kqb1od8lcg.databases.appdomain.cloud:3119
8/bludb
Done.
```

| failed_mission |
|---|
| 1 |



# EDA with SQL

**Task 8**

***List the names of the booster_versions which have carried the maximum payload mass. Use a subquery***

```
%%sql select booster_version from spacextbl
where payload_mass__kg_ = (select max(payload_mass__kg_) from spacextbl)
```

```
 * ibm_db_sa://xwx66212:***@0c77d6f2-5da9-48a9-81f8-86b520b87518.bs2io90108kqblod8lcg.databases.appdomain.cloud:3119
8/bludb
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 |



# EDA with SQL

**Task 9**

***List the failed landing_outcomes in drone ship, their booster versions, and launch site names for the in year 2015***

```
%%sql
Select SPACEXTBL.landing__outcome, SPACEXTBL.booster_version, SPACEXTBL.launch_site from SPACEXTBL
where SPACEXTBL.landing__outcome in ('Failure (drone ship)') and year(SPACEXTBL.Date) = 2015;
```

| landing__outcome | booster_version | launch_site |
|---|---|---|
| Failure (drone ship) | F9 v1.1 B1012 | CCAFS LC-40 |
| Failure (drone ship) | F9 v1.1 B1015 | CCAFS LC-40 |



# EDA with SQL

### Task 10

***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***

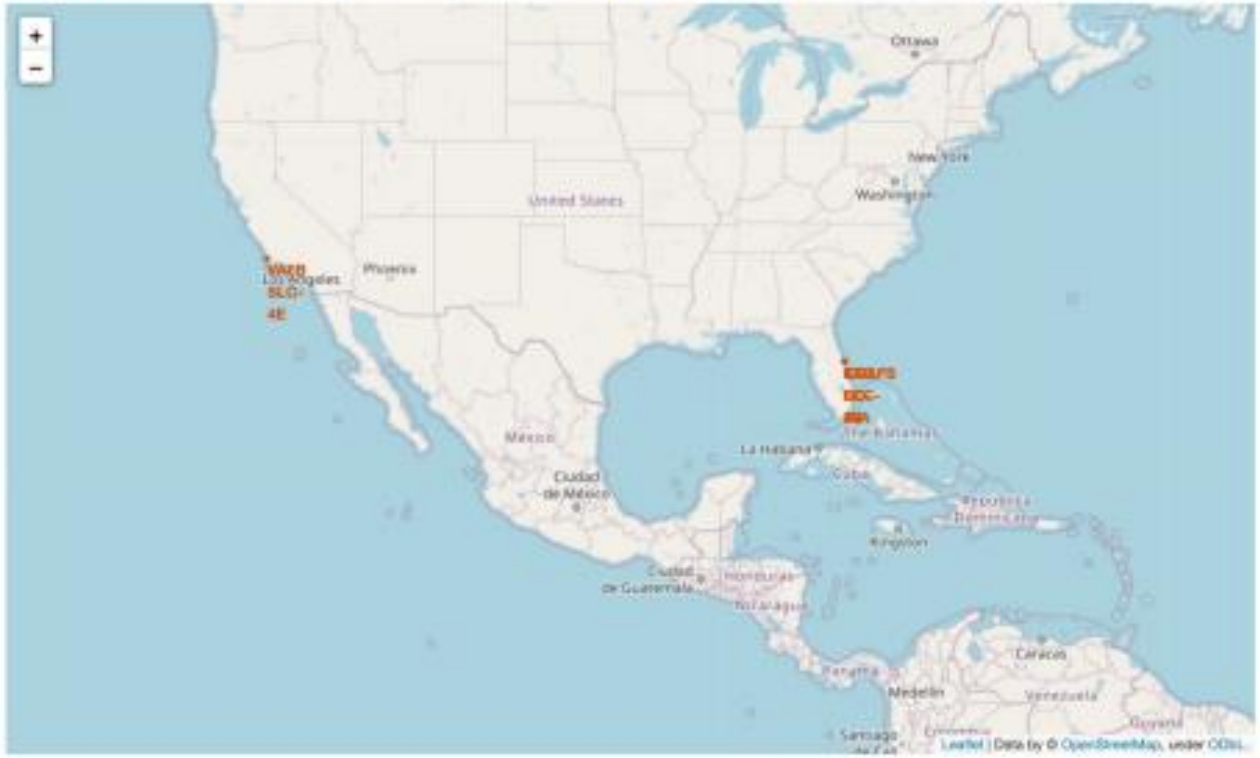
```
%%sql
SELECT landing__outcome,COUNT(landing__outcome) as OccurenceValue FROM SPACEXTBL
where SPACEXTBL.Date between '2010-06-04' and '2017-03-20'
GROUP BY landing__outcome ORDER BY OccurenceValue desc;
```

| landing__outcome | occurencevalue |
|---|---|
| No attempt | 10 |
| Failure (drone ship) | 5 |
| Success (drone ship) | 5 |
| Controlled (ocean) | 3 |
| Success (ground pad) | 3 |
| Failure (parachute) | 2 |
| Uncontrolled (ocean) | 2 |
| Precluded (drone ship) | 1 |



# Build an interactive map with Folium

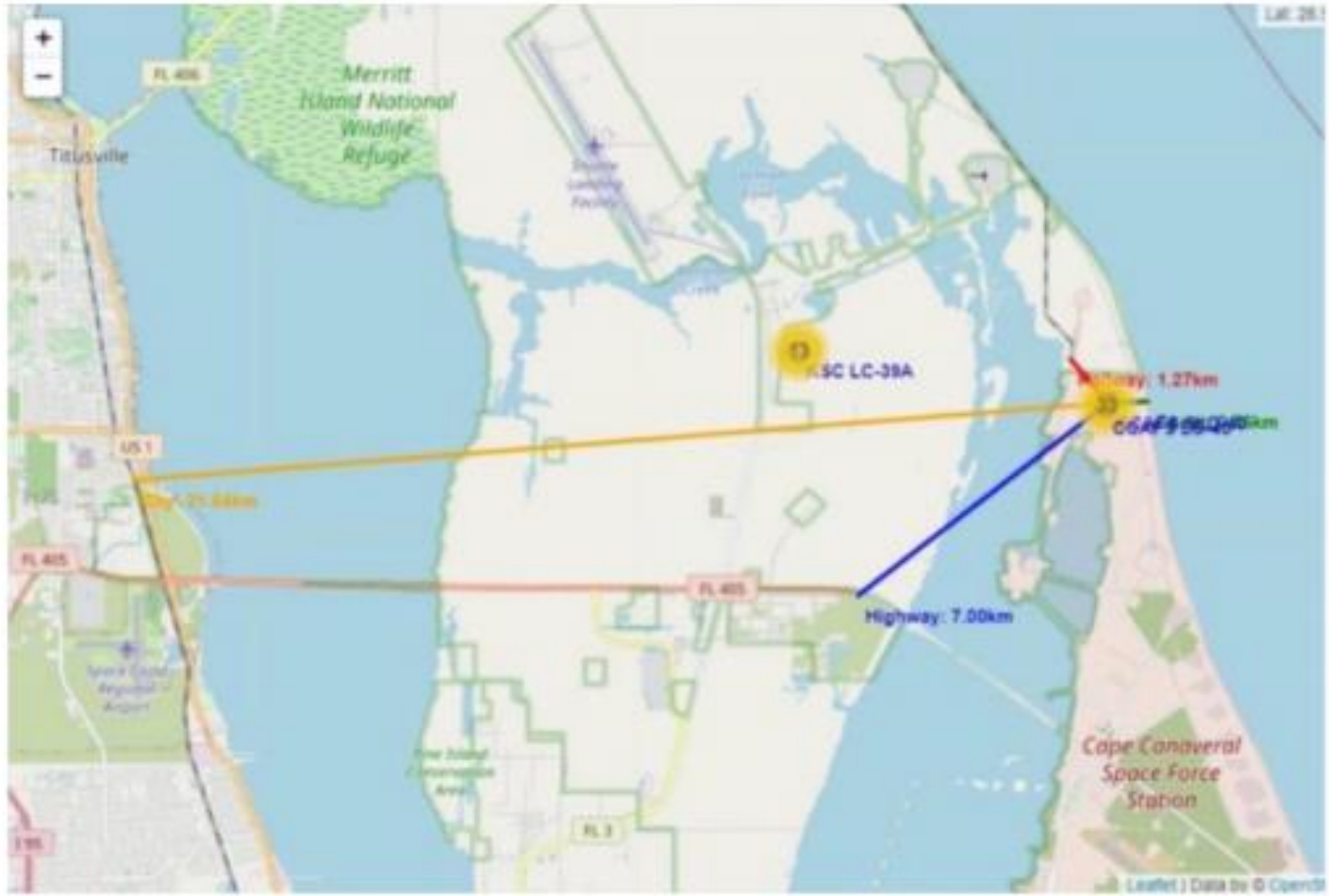
## Locations of all launch sites




All locations of launch sites are near the ocean.

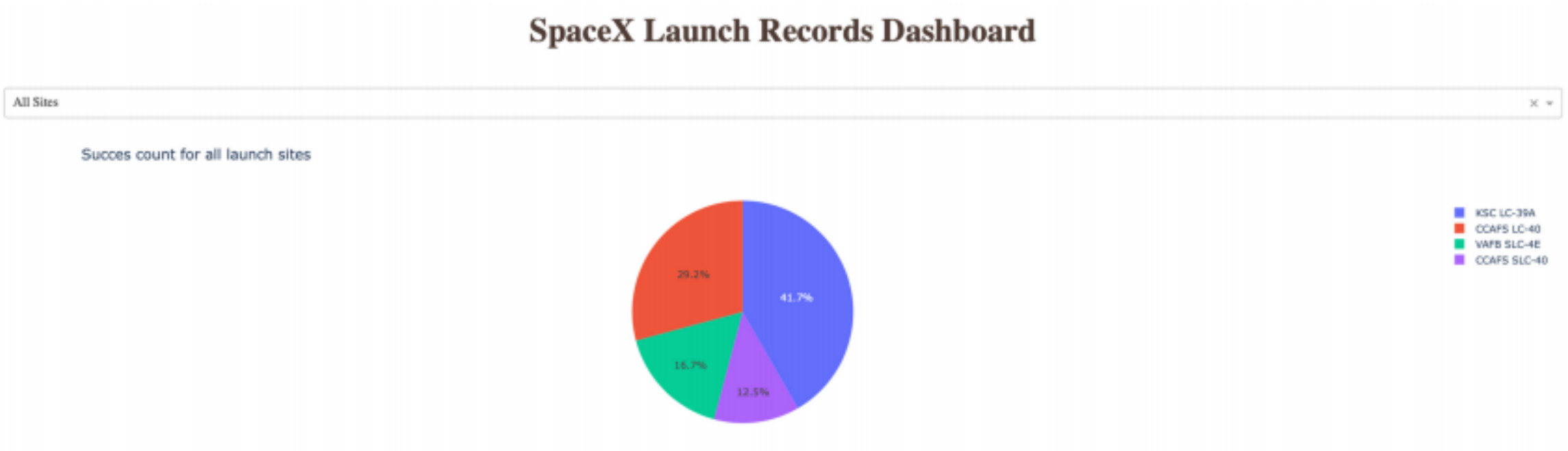
# Folium Map

# Folium Map


Merritt Island National Wildlife Refuge
Titusville
KSC LC-39A
1.27km
US 1
FL 405
Highway: 7.00km
Cape Canaveral Space Force Station

# Build a dashboard

## Using Plotly Dash



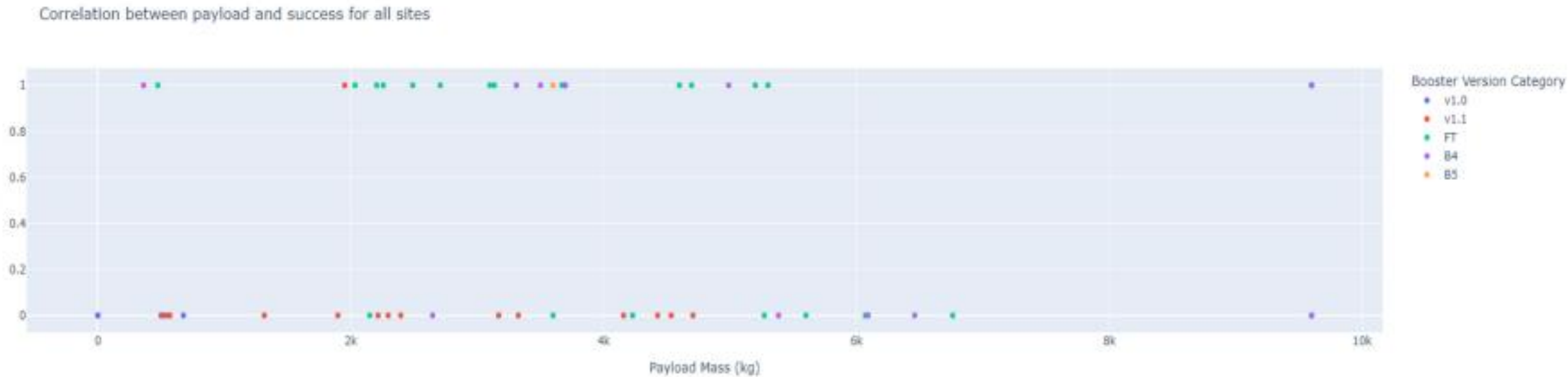

KSC LC-39A has the most successes with 41.7% of all combined.

# Dashboard

Total Success Launches for site KSC LC-39A

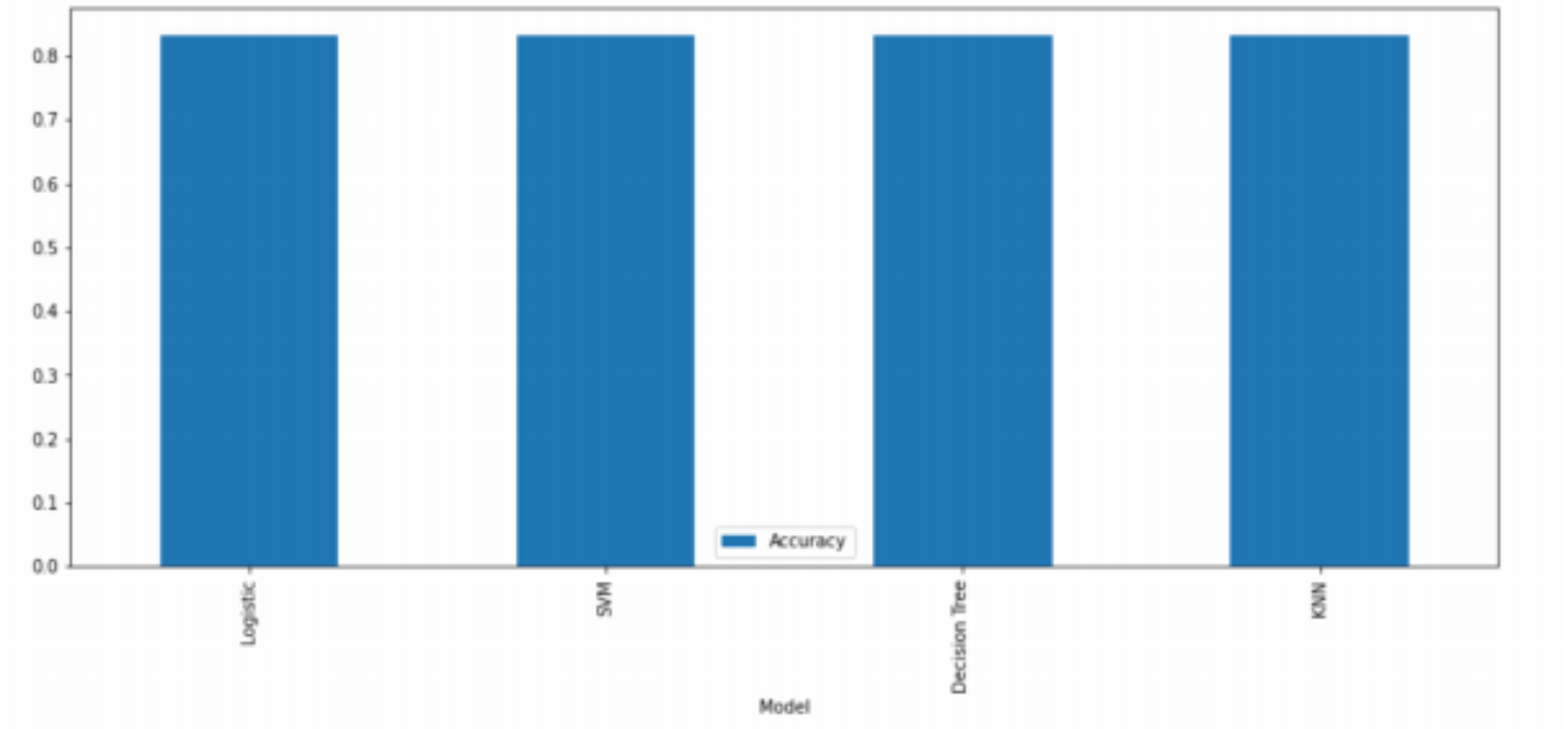

KSC LC-39A also has the most success rate of 76.9% of all operations launched at site KSC LC-39A.

# Dashboard



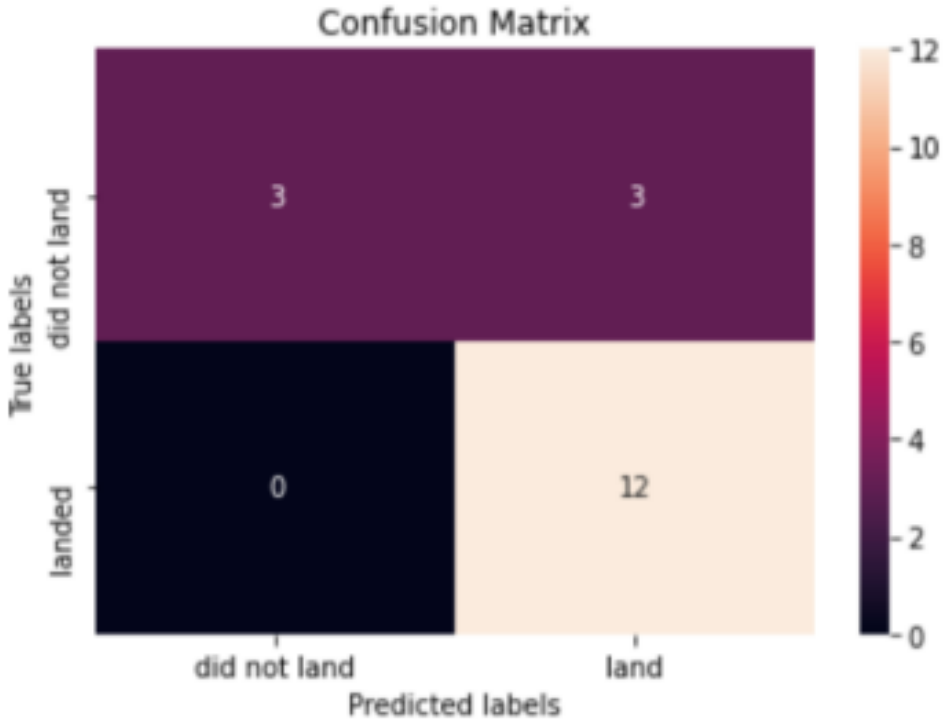

v1.1 booster version has a low success rate.

# Predictive Analysis (Classification)




All models have the same accuracy of 0.83 .

# Predictive Analysis (Classification)




This is the confusion matrix of all 4 models.

They have same confusion matrix with 18 sample tests.

# Conclusions

### Orbit type and payload mass

have influences on the success rate.

### The success rate

keeps increasing yearly.

### Launch Site locations

should be near the ocean.

### Most success rate site

is KSC LC-39A

### Machine Learning Models

All 4 models' ,namely LogReg, SVM, KNN, Tree, performances are similar for the data.

# Appendix

All Notebooks are in

Van Chau Github Profile

https://github.com/vvchauit/Data_Science_Projects