Data Science Capstone project

Zubair Kaif

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Outline

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

Executive Summary

- Summary of methodologies:
- **Data Collection/Data Wrangling**
- **Exploratory Data Analysis (EDA)**
- **Data visualization**
- **Predictive Analysis (Classification)**

- Summary of all results:
- **In this project we use data to find out whether the first stage of falcon 9 rocket land successfully or not using machine learning algorithm like SVM, Classification Trees, and Logistic Regression.**

Introduction

- Project background and context:
- **Falcon 9 rocket of SpaceX is most cost effective rocket (cost around 65 million) SpaceX reuse its first stage. So if we can predict the success rate of landing of first stage then we can use these results to rival SpaceX and can help companies build cheaper rockets.**
- Problems you want to find answers:
- **Success rate of Falcon 9 rocket first stage landing.**

Methodology

- Data collection methodology:
  - Data is collected using SPACEX API and web scrapping
- Perform data wrangling
  - Data is processed using python and pandas Library
- 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

Methodology

Data collection

- Data sets were collected from SpaceX api.

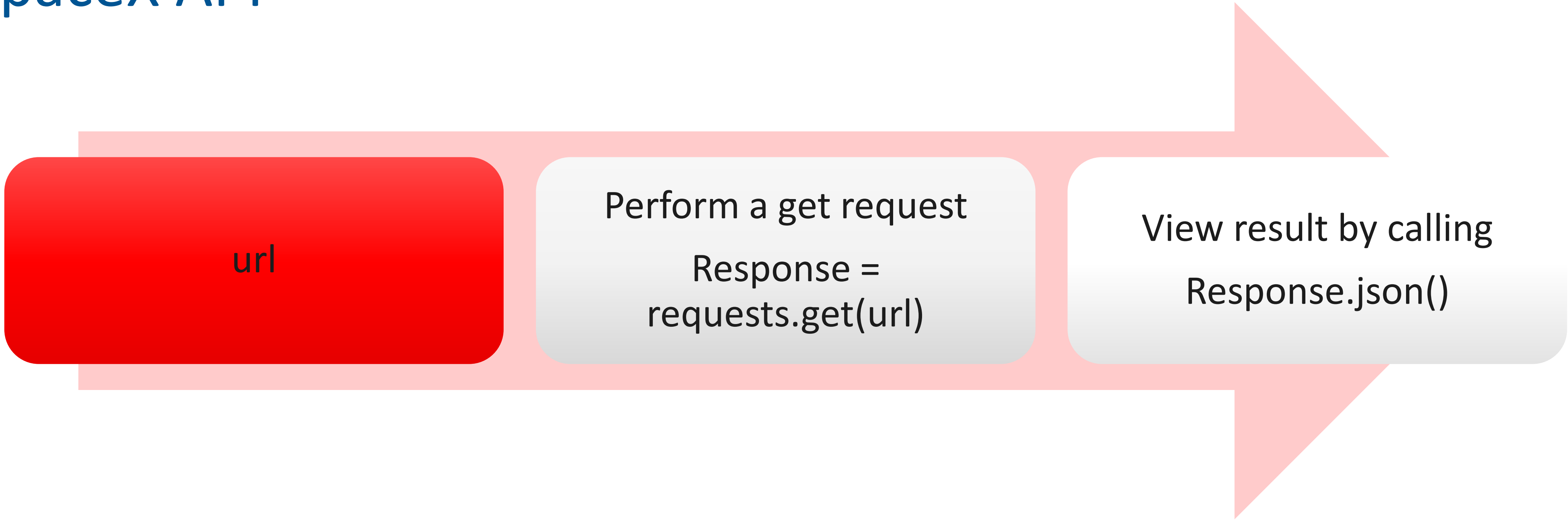
1. url = “https://api.spacexdata.com/v4/launches/past”

2. Perform a get request.

3. View result by calling Json() method on response.

Data collection – SpaceX API

Added a flowchart of SpaceX API calls here



url

Perform a get request

Response = requests.get(url)

View result by calling

Response.json()

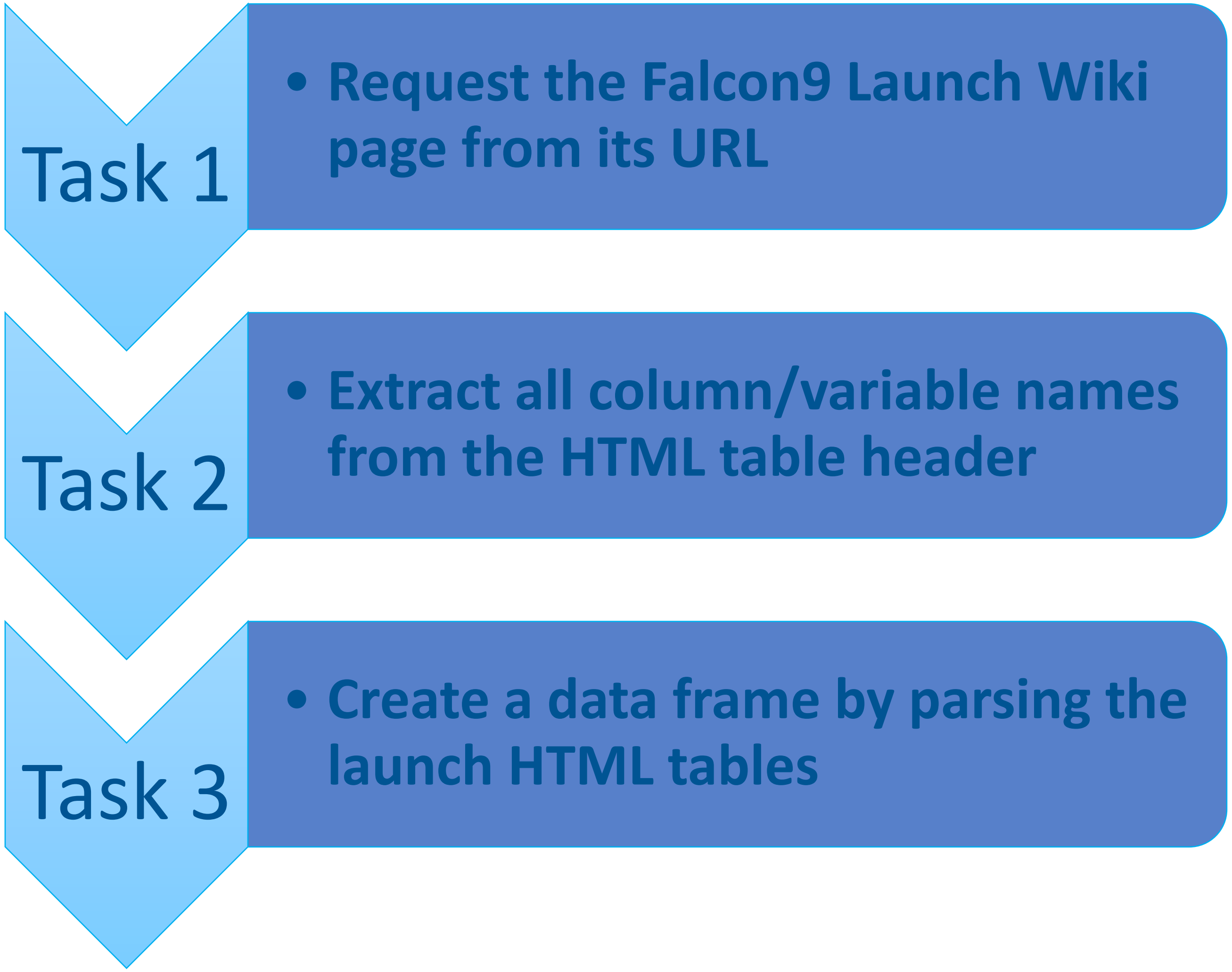
Github link:
https://github.com/zubairKaif/Coursera-assignment/blob/8bd87dad71ee4e1e21b863029bbf263e038976a1/Data%20Collection%20API%20Lab.ipynb

Data collection – Web scraping

Objectives

Web scrap Falcon 9 launch records with BeautifulSoup:

- Extract a Falcon 9 launch records HTML table from Wikipedia
- Parse the table and convert it into a Pandas data frame



Task 1

- **Request the Falcon9 Launch Wiki page from its URL**

Task 2

- **Extract all column/variable names from the HTML table header**

Task 3

- **Create a data frame by parsing the launch HTML tables**

GitHub URL:https://github.com/zubairKaif/Coursera-assignment/blob/0aad3fd81411d18f943765f606ff633e3b7fcab8/Data%20wrangling.ipynb

Data wrangling

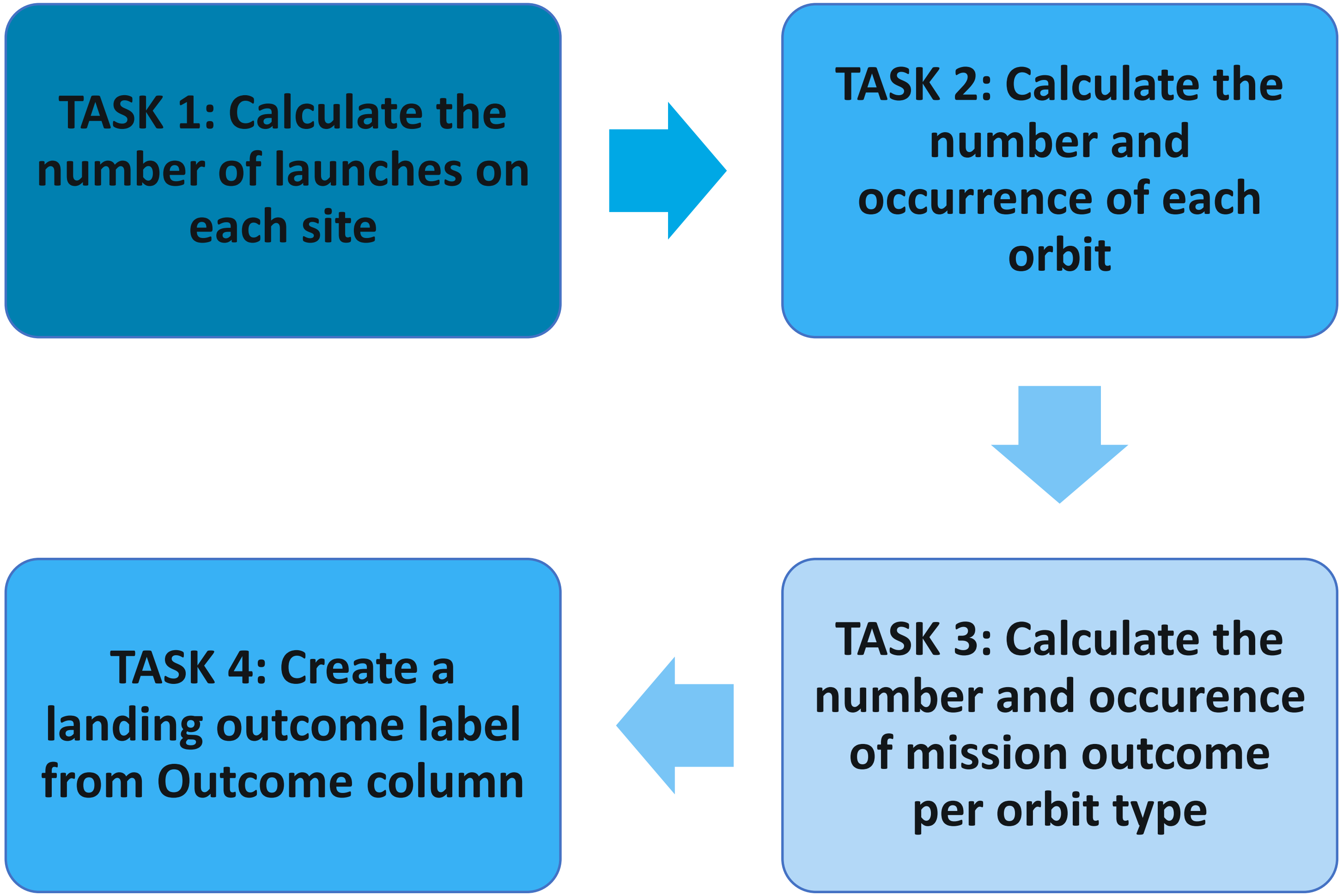
In this lab, we had perform some Exploratory Data Analysis (EDA) to find some patterns in the data and determine what would be the label for training supervised models

Objectives

Perform exploratory Data Analysis and determine Training Labels

- Exploratory Data Analysis
- Determine Training Labels
- Describe how data were processed

https://github.com/zubairKaif/Coursera-assignment/blob/0fcf48535175e6ad4f6fcc469885035d9c1faa5c/Data%20wrangling.ipynb



TASK 1: Calculate the number of launches on each site

TASK 2: Calculate the number and occurrence of each orbit

TASK 3: Calculate the number and occurence of mission outcome per orbit type

TASK 4: Create a landing outcome label from Outcome column

EDA with data visualization

- In this lab, I had performed Exploratory Data Analysis and Feature Engineering.

- Objectives

Perform exploratory Data Analysis and Feature Engineering using Pandas and Matplotlib

Exploratory Data Analysis

Preparing Data Feature Engineering

- Charts used:

we have used three kind of charts scatter plot, bar plot and line plot and by seeing them we find out that Heaviest payload has launched from only one orbit, one launch site has higher success rate and as the years are increasing success rate is also increasing.

GitHub Url:https://github.com/zubairKaif/Coursera-assignment/blob/dd81ff244b8a34047bb58401d5fd1af602e75157/EDA%20with%20Visualization%20lab.ipynb

EDA with SQL

- We use SQL for exploratory data analysis.
- We use IBM DB2 cloud database to store data.
- Load the dataset into the corresponding table in a Db2 database
- We also use SQL magic to use SQL in Jupyter notebook.
- Execute SQL queries in Notebook.

- GitHub URL:https://github.com/zubairKaif/Coursera-assignment/blob/4af26d5f9ab6bb025b1d2dfa7727caaab6d477b2/EDA%20with%20SQL%20lab.ipynb

Build an interactive map with Folium

- A interactive map is very useful to clearly understand how these launch sites are situated and what are there success rate.
- We have use some map object to clearly show where these sites are actually situated such markers, circles, lines, etc.
- Markers: are used to mark exact location of the launch site.
- Circles: used to show the area of that site.
- lines: Used to show distances between the sites.

- GitHub URL: https://github.com/zubairKaif/Coursera-assignment/blob/ecba4c0d5a122402867c3ae352bba7f7c5cb2ed1/Interactive%20Visual%20Analytics%20with%20Folium%20lab.ipynb

Build a Dashboard with Plotly Dash

- We build a dashboard using Plotly Dash to easily interact with charts of different type we build this application in theia.
- In this Dashboard we have added some features like:
  - Feature 1: Add a Launch Site Drop-down Input Component
  - Feature 2: Add a callback function to render success-pie-chart based on selected site dropdown
  - Feature 3: Add a Range Slider to Select Payload
  - Feature 4: Add a callback function to render the success-payload-scatter-chart scatter plot

- GitHub URL:

Predictive analysis (Classification)

- We use machine learning to predict the outcome we use algorithms like logistic regression, KNN, SVM and decision tree classifier.
- Objectives
  - Perform exploratory Data Analysis and determine Training Labels
  - create a column for the class
  - Standardize the data
  - Split into training data and test data -Find best Hyperparameter for SVM, Classification Trees and Logistic Regression
  - Find the method performs best using test data

- GitHub URL: https://github.com/zubairKaif/Coursera-assignment/blob/e13e3f200ef20b322654441c0e0fe1b3894b8daf/Machine%20Learning%20Prediction%20lab.ipynb

Results

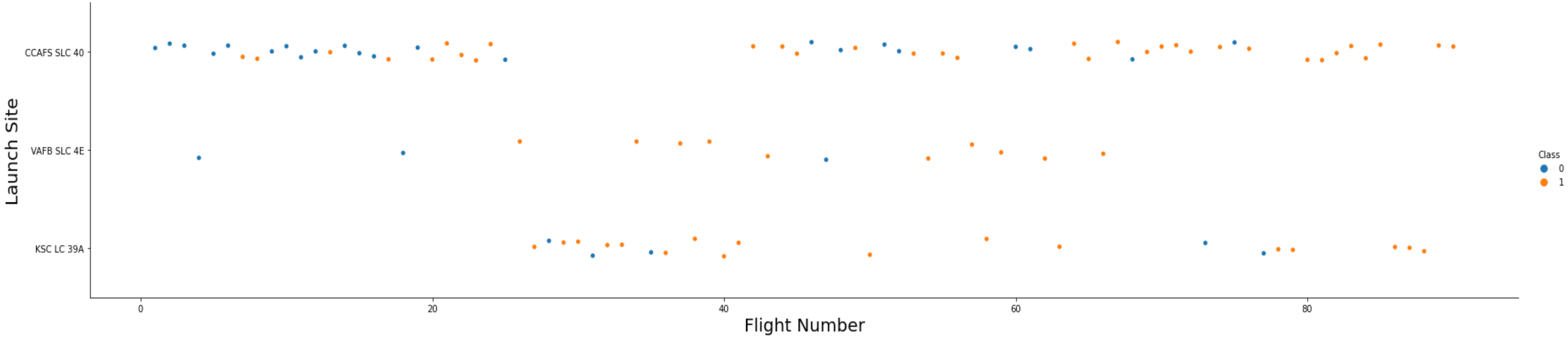
- Most Successful orbits are ES-01, GEO, HEO and SSO

- Interactive maps are very helpful

- We have calculated accuracy of every model.

EDA with Visualization

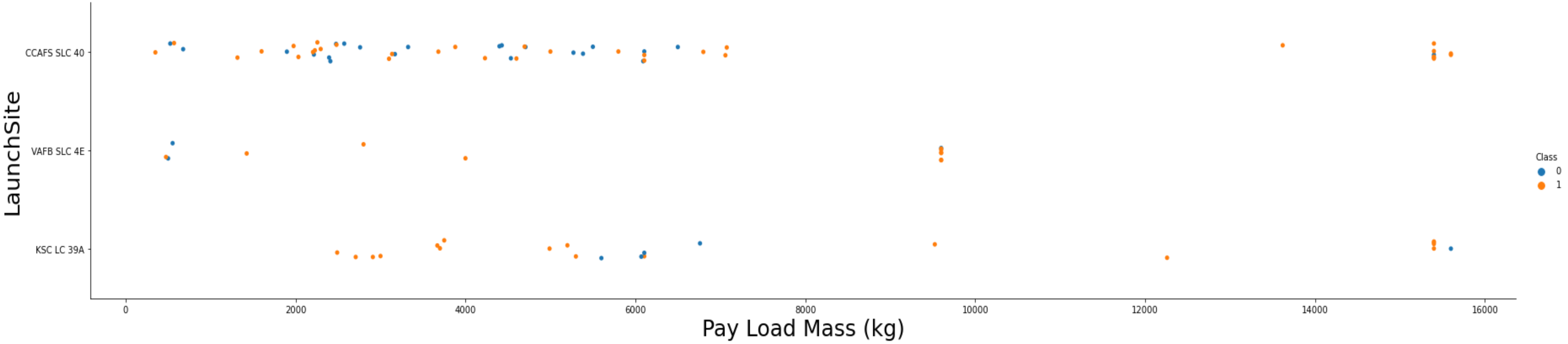
Flight Number vs. Launch Site



scatter plot of Flight Number vs. Launch Site

Explanation: Most of the flights and successful flights are launced from lauch site ‘CCAPS SLC 40’

Payload vs. Launch Site



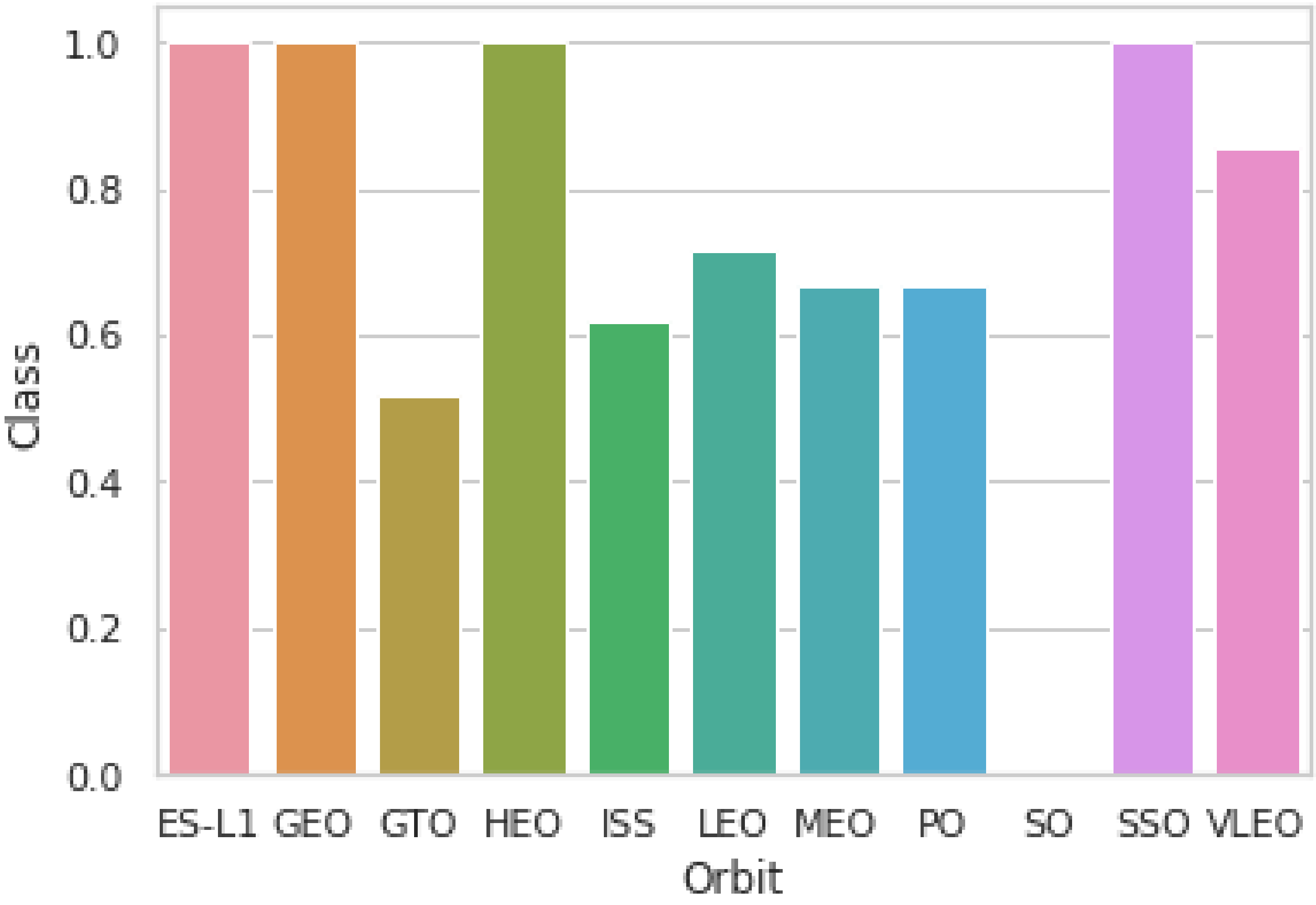
Scatter plot of Payload vs. Launch Site

Explanations: Highest payload mass launched from only two launch sites 'CCAPS SLC 40', 'KSC LC 39A'

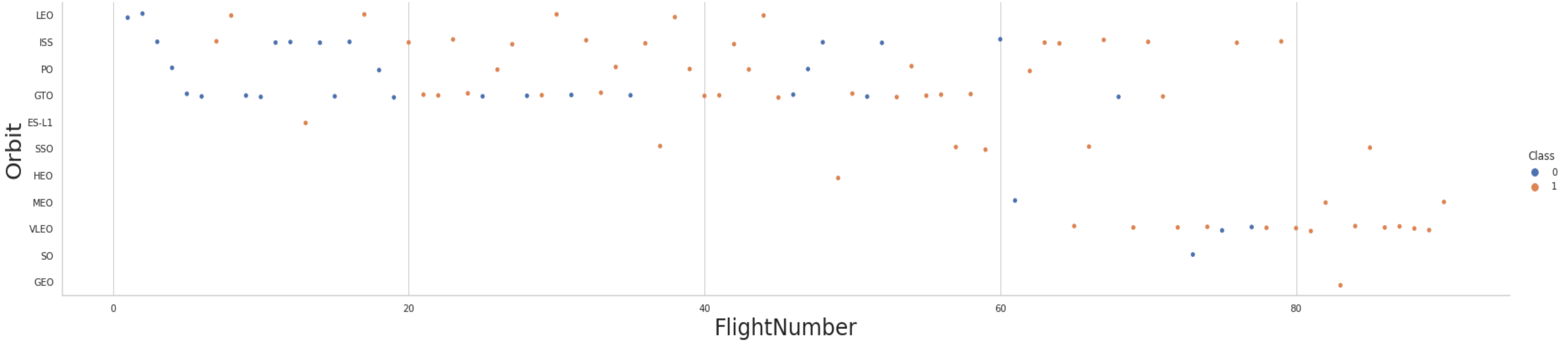
Success rate vs. Orbit type

A bar chart for the success rate of each orbit type

Explanations: minimum success rate is from orbit ‘GTO’ and maximum are ‘ES-L1’, ‘GEO’, ‘HEO’ and ‘SSO’



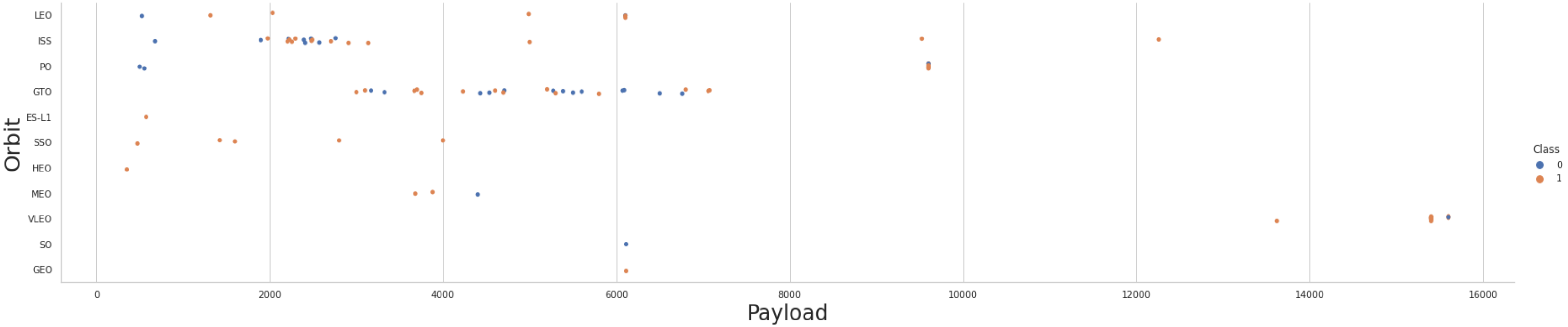
Flight Number vs. Orbit type



A scatter point of Flight number vs. Orbit type

Explanations: first almost 80 launches are to orbits LEO, ISS, PO, GTO and later most launches are to VLEO

Payload vs. Orbit type



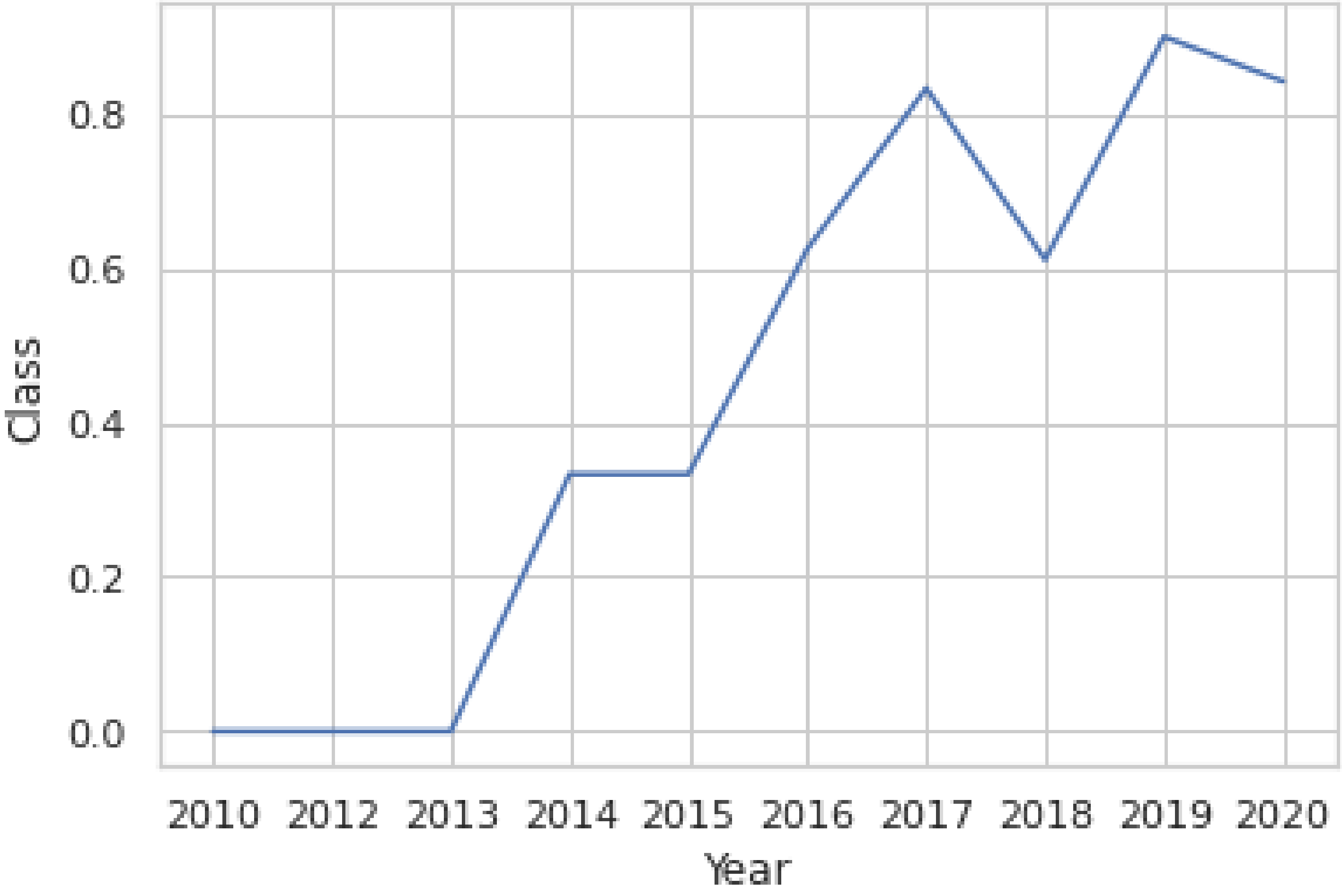
A scatter point of payload vs. orbit type

Explanations: Heaviest payload is launched only to orbit ‘VLEO’

Launch success yearly trend

A line chart of yearly average success rate

Explanations: as the year increases success rate also improved

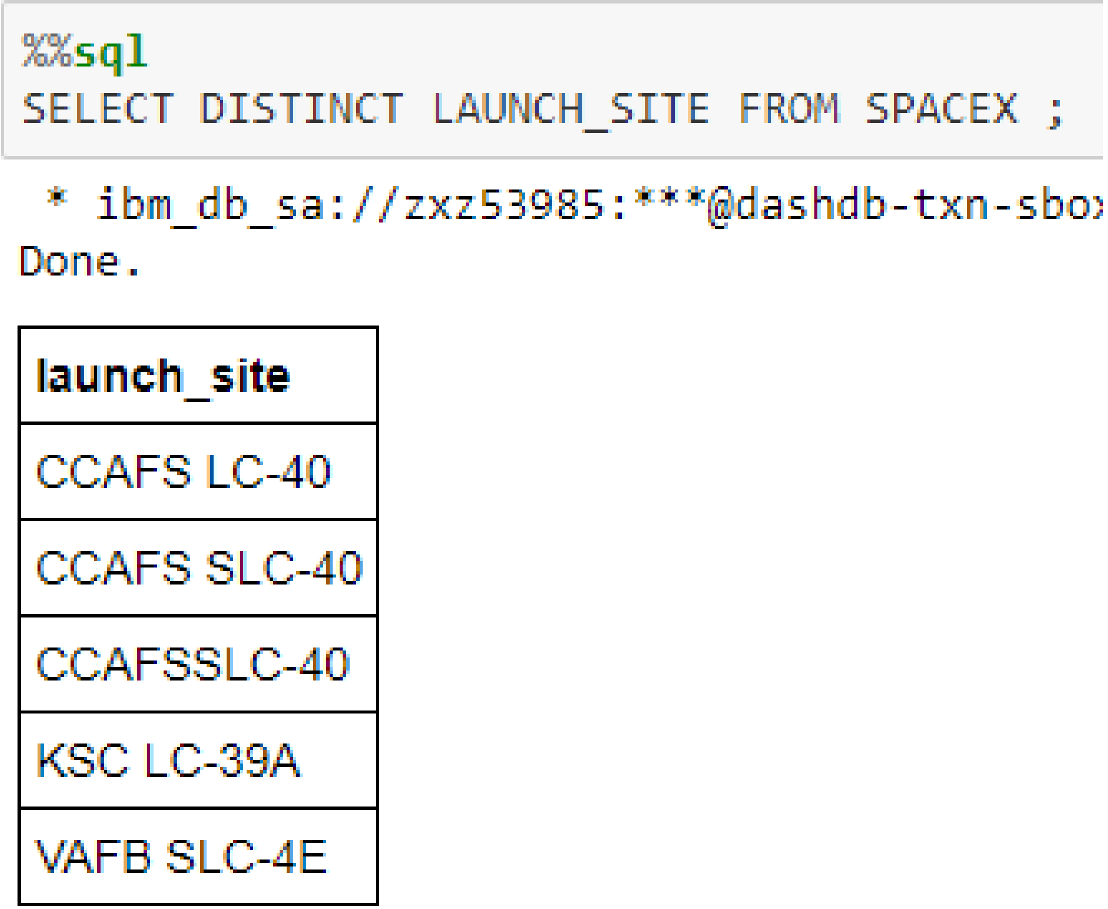


EDA with SQL

All launch site names

- There are 5 different launch sites

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

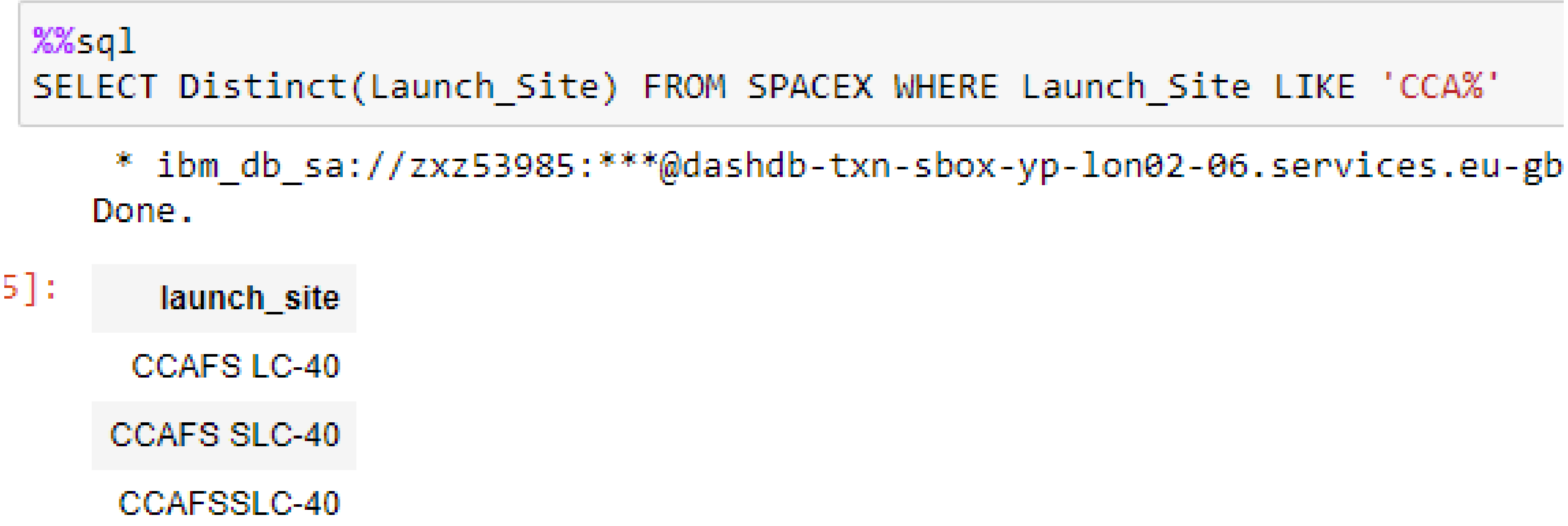


```
%%sql
SELECT DISTINCT LAUNCH_SITE FROM SPACEX ;
```

```
 * ibm_db_sa://zxz53985:***@dashdb-txn-sbo
Done.
```

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

Launch site names begin with `CCA`



```
%%sql
SELECT Distinct(Launch_Site) FROM SPACEX WHERE Launch_Site LIKE 'CCA%'
```

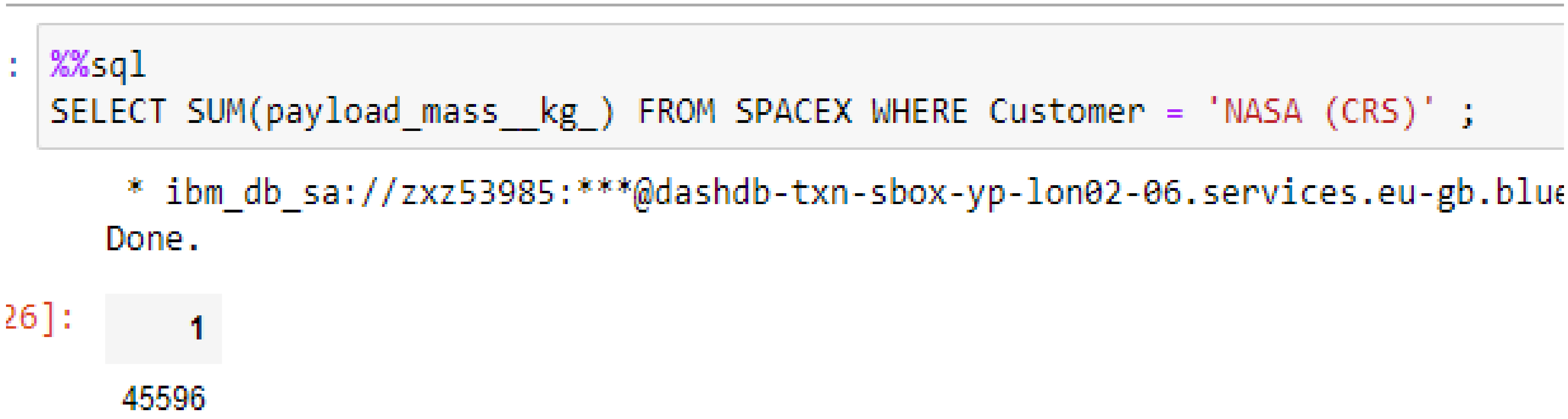
```
 * ibm_db_sa://zxz53985:***@dashdb-txn-sbox-yp-lon02-06.services.eu-gb
Done.
```

5]:

launch_site
CCAFS LC-40
CCAFS SLC-40
CCAFSSLC-40

- There are three launch sites starting with CCA

Total payload mass



```
:  %%sql
   SELECT SUM(payload_mass__kg_) FROM SPACEX WHERE Customer = 'NASA (CRS)' ;
```

```
 * ibm_db_sa://zxz53985:***@dashdb-txn-sbox-yp-lon02-06.services.eu-gb.blue
Done.
```

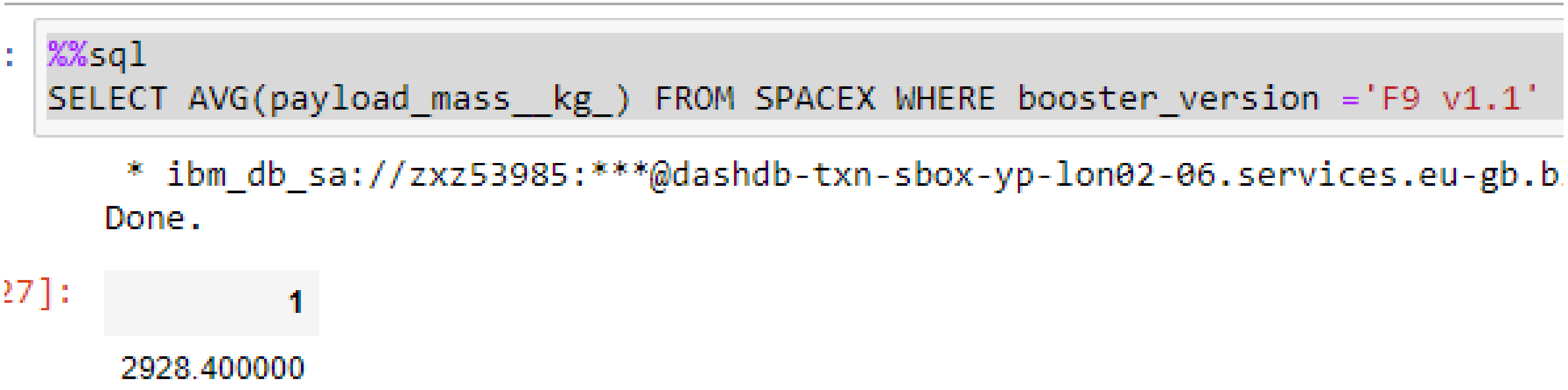
```
26]:      1
      45596
```

- The total payload mass is 45596 kg

Average payload mass by F9 v1.1

- Calculate the average payload mass carried by booster version F9 v1.1
- RESULT

- average payload mass = 2928.40 KG



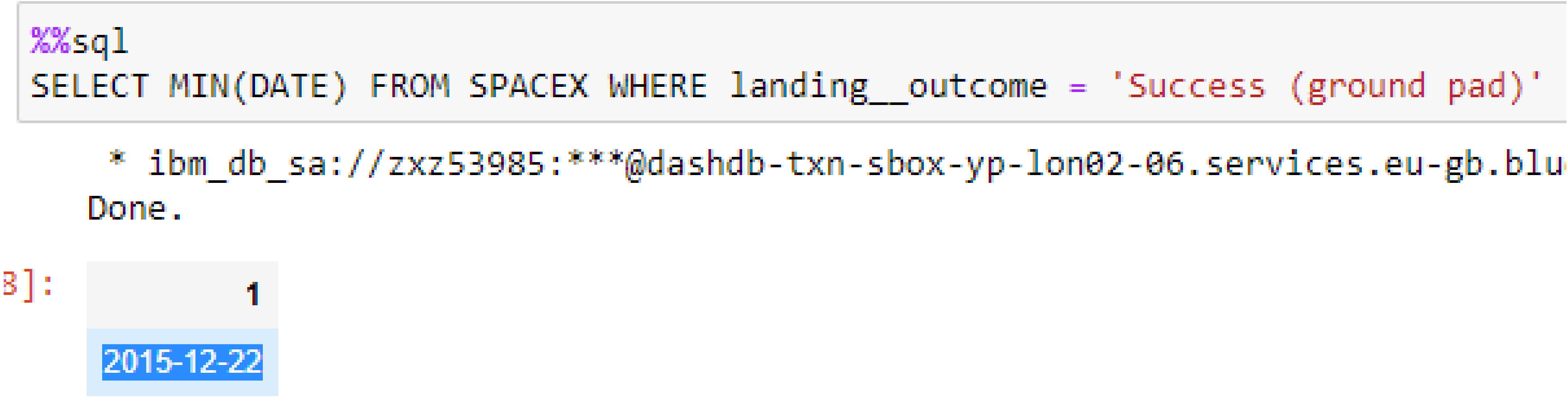
```
: %%sql
SELECT AVG(payload_mass__kg_) FROM SPACEX WHERE booster_version ='F9 v1.1'

  * ibm_db_sa://zxz53985:***@dashdb-txn-sbox-yp-lon02-06.services.eu-gb.b
 Done.
```

27]:

1
2928.400000

First successful ground landing date

- Find the date when the first successful landing outcome in ground pad
- RESULT
- Date = 2015-12-22



```
%%sql
SELECT MIN(DATE) FROM SPACEX WHERE landing__outcome = 'Success (ground pad)'
```

```
 * ibm_db_sa://zxz53985:***@dashdb-txn-sbox-yp-lon02-06.services.eu-gb.blu
Done.
```

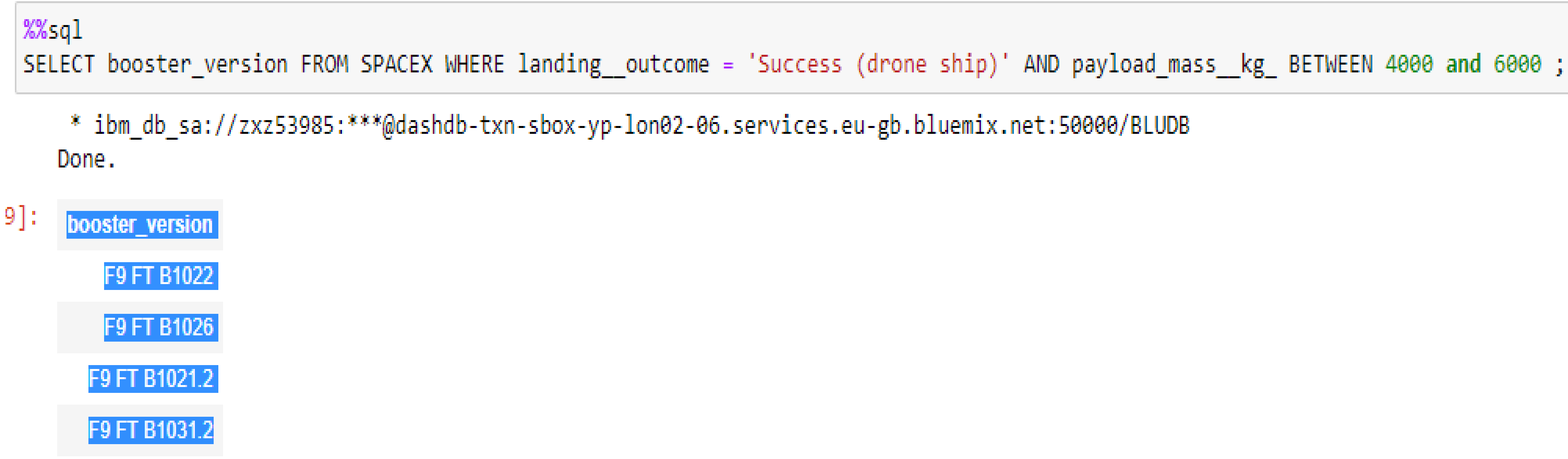
3]:

1
2015-12-22

Successful drone ship landing with payload between 4000 and 6000

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

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



```
%%sql
SELECT booster_version FROM SPACEX WHERE landing__outcome = 'Success (drone ship)' AND payload_mass__kg_ BETWEEN 4000 and 6000 ;
```

```
 * ibm_db_sa://zxz53985:***@dashdb-txn-sbox-yp-lon02-06.services.eu-gb.bluemix.net:50000/BLUDB
Done.
```

```
9]:  booster_version
       F9 FT B1022
       F9 FT B1026
     F9 FT B1021.2
     F9 FT B1031.2
```

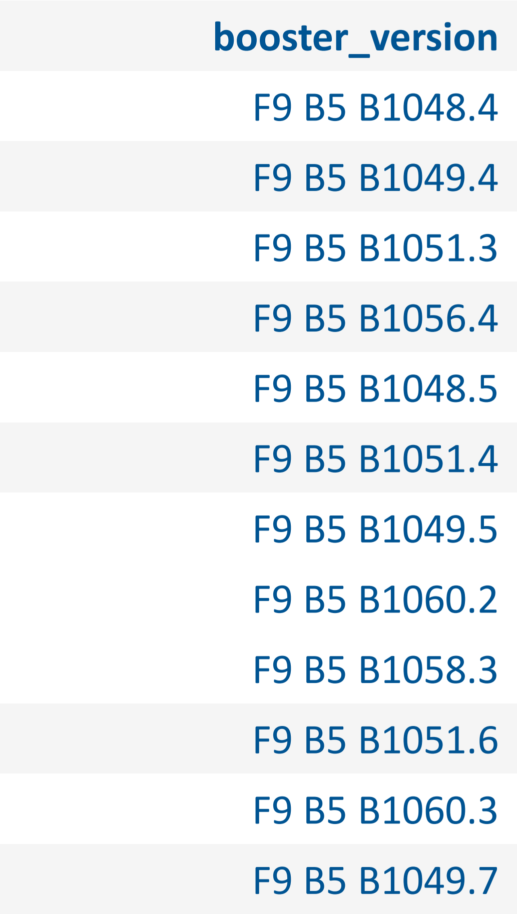
Total number of successful and failure mission outcomes

- Calculate the total number of successful and failure mission outcomes
- RESULT

- Successful outcomes = 100
- Failure outcome = 1

Boosters carried maximum **payload**

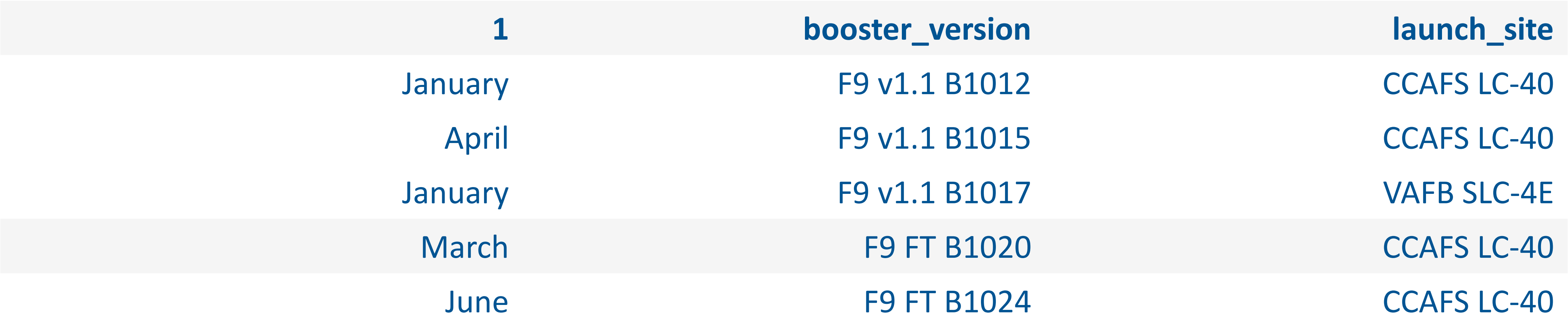
- List the names of the booster which have carried the maximum payload mass
- RESULT



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

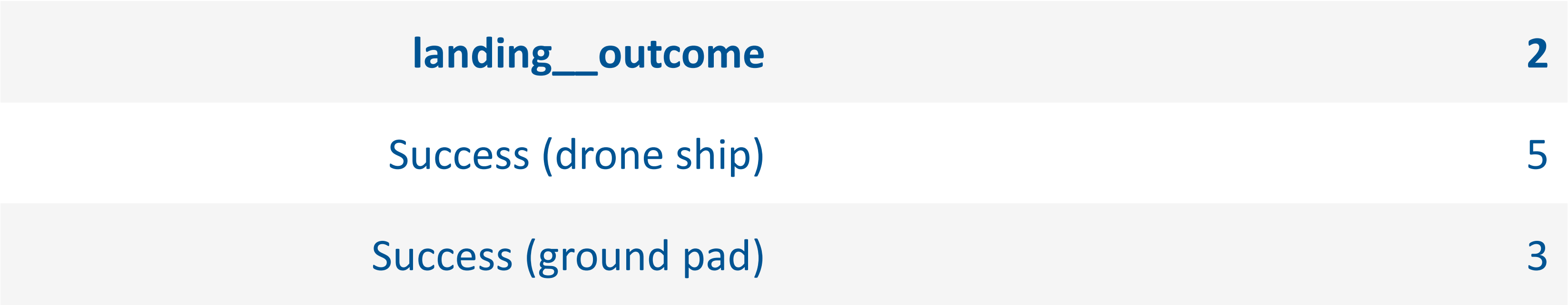
- List the records which will display the month names, failure landing_outcomes in drone ship ,booster versions, launch_site for the months in year 2015
- RESULT



1	booster_version	launch_site
January	F9 v1.1 B1012	CCAFS LC-40
April	F9 v1.1 B1015	CCAFS LC-40
January	F9 v1.1 B1017	VAFB SLC-4E
March	F9 FT B1020	CCAFS LC-40
June	F9 FT B1024	CCAFS LC-40

Rank success count between 2010-06-04 and 2017-03-20

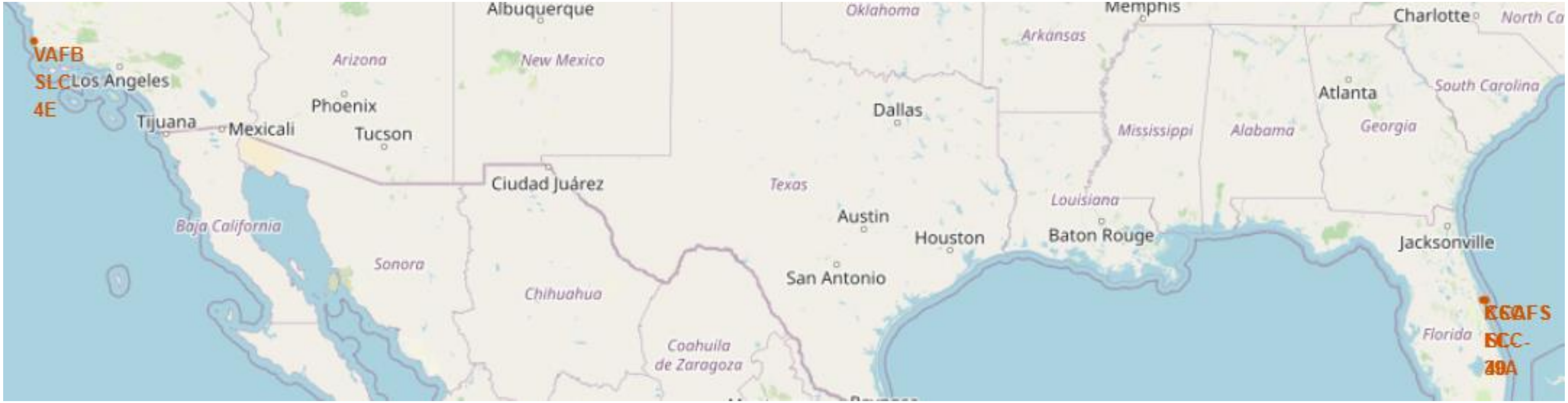
- Rank the count of successful landing_outcomes between the date 2010-06-04 and 2017-03-20 in descending order.
- RESULT



landing__outcome	2
Success (drone ship)	5
Success (ground pad)	3

Interactive map with Folium

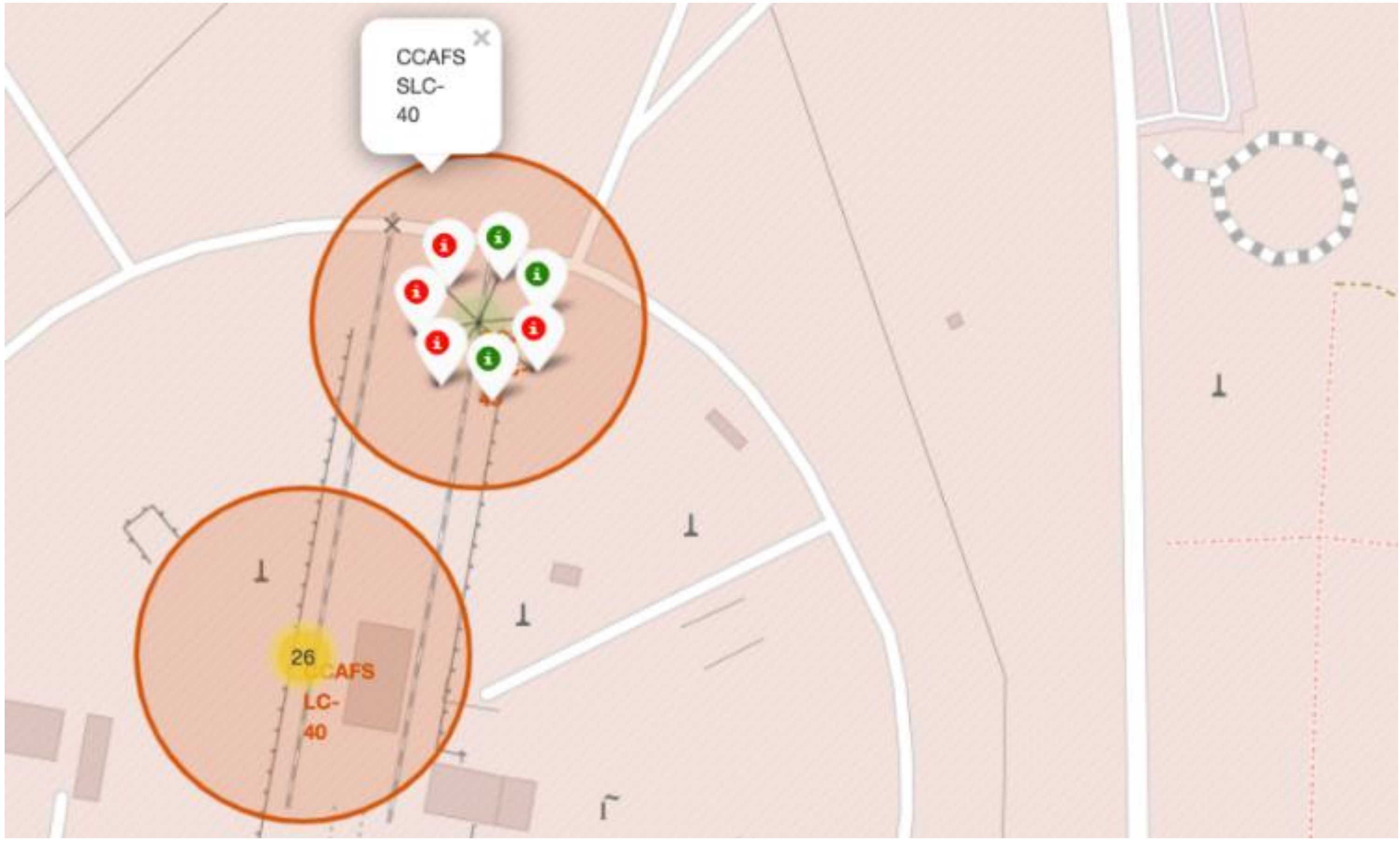
Map with marked launch sites



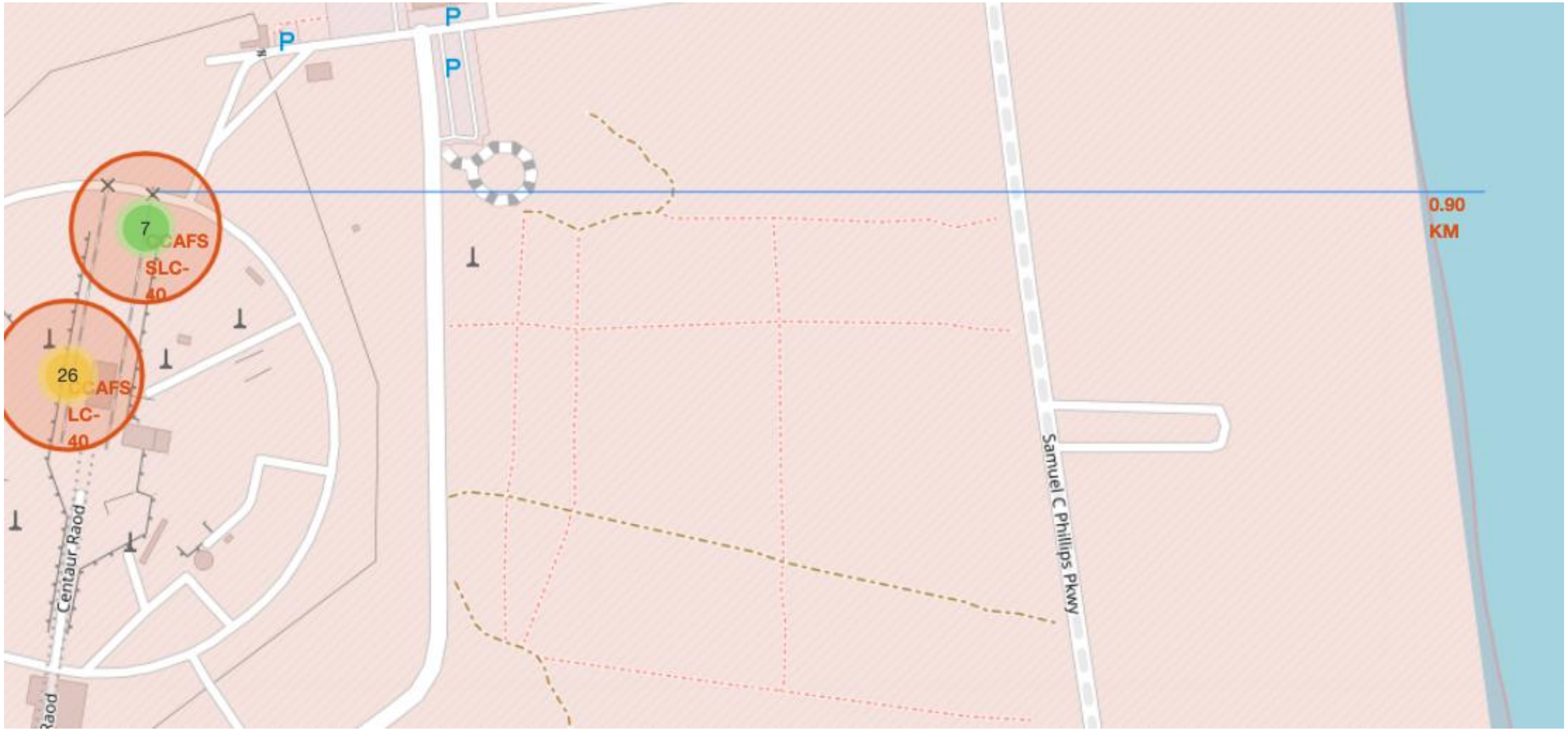
All the launch sites are near coast line

Marker Cluster on Maps

These Cluster show understandable view of success rate of launch sites Red color mark shows failure and green color mark shows success.



Distance between launch sites



This shows Distance between launch site

Build a Dashboard with Plotly Dash

<Dashboard screenshot 1>

- Replace <Dashboard screenshot 1> title with an appropriate title
- Show the screenshot of launch success count for all sites, in a piechart
- Explain the important elements and findings on the screenshot

<Dashboard screenshot 2>

- Replace <Dashboard screenshot 2> title with an appropriate title

- Show the screenshot of the piechart for the launch site with highest launch success ratio

- Explain the important elements and findings on the screenshot

<Dashboard screenshot 3>

- Replace <Dashboard screenshot 3> title with an appropriate title
- Show screenshots of Payload vs. Launch Outcome scatter plot for all sites, with different payload selected in the range slider
- Explain the important elements and findings on the screenshot

Predictive analysis (Classification)

Classification Accuracy

Visualize all the built model accuracy for all built models, in a barchart

Find which model has the highest classification accuracy

Confusion Matrix

Show the confusion matrix of the best performing model with explanation

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CONCLUSION

- We use api and web scrapping of for data collection
- SQL is very helpful in EDA
- We see from charts as the Time is increasing the success rate is also improving
- Launch sites are near coastal line area
- Dash Application is a very interactive and informative way to represent data

APPENDIX

- Pandas Library is very good for data frame building it makes calculation faster and code easier to implement