IBM Developer
SKILLS NETWORK

Winning Space Race with Data Science

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Outline

Executive Summary

- Summary of methodologies
  - Data Collection with API
  - Data Collection with Web Scraping
  - Data Wrangling
  - Exploratory Data Analysis with SQL, Data Visualization
  - Interactive Visual Analytics with Folium
  - Prediction with Machine Learning
- Summary of all results
  - Exploratory Data Analysis result
  - Interactive analytics in screenshots
  - Predictive analytics result from Machine Learning Lab

Introduction

- To improve the success rate of the rival company of SpaceX by identifying SpaceX previous mistakes from their public data.
- Problems included
  - Best location to make launches.
  - The most efficient way to estimate the total cost for launches, by predicting successful landings of the first stage of rockets.

Section 1

Methodology

Methodology

Executive Summary

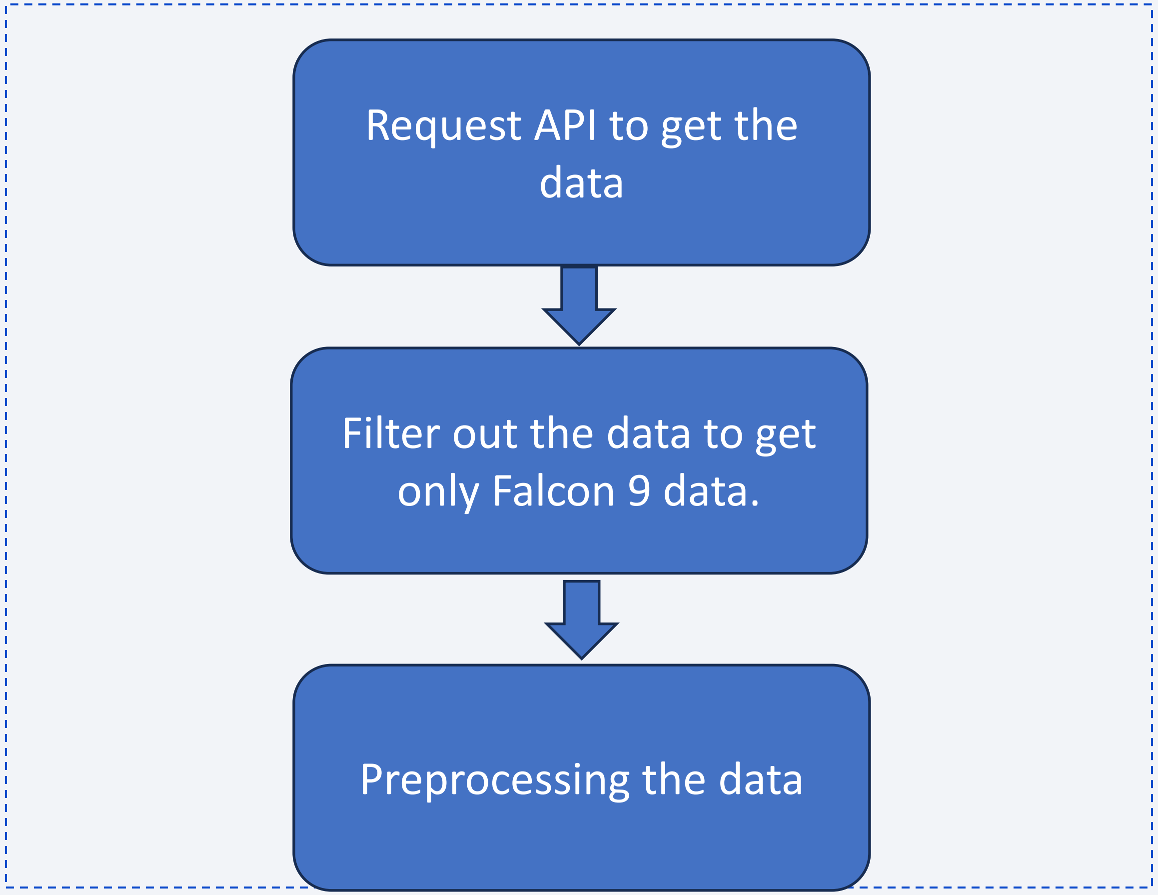
- Data collection methodology:
  - Data was collected from 2 sources by the SpaceX API and WebScraping from the wiki.
- Perform data wrangling
  - We made the collected data more useful by adding a label to show what happened, after we looked at and analyzed the important features.
- Perform exploratory data analysis (EDA) using visualization and SQL
- Perform interactive visual analytics using Folium and Plotly Dash
- Perform predictive analysis using classification models
  - We took the data gathered up to this point, normalized it, split it into training and test sets, and assessed it using four classification models. We measured the accuracy of each model by trying out various parameter combinations.

Data Collection

- Dara sets were collected from Space X API and from Wikipedia by WebScraping

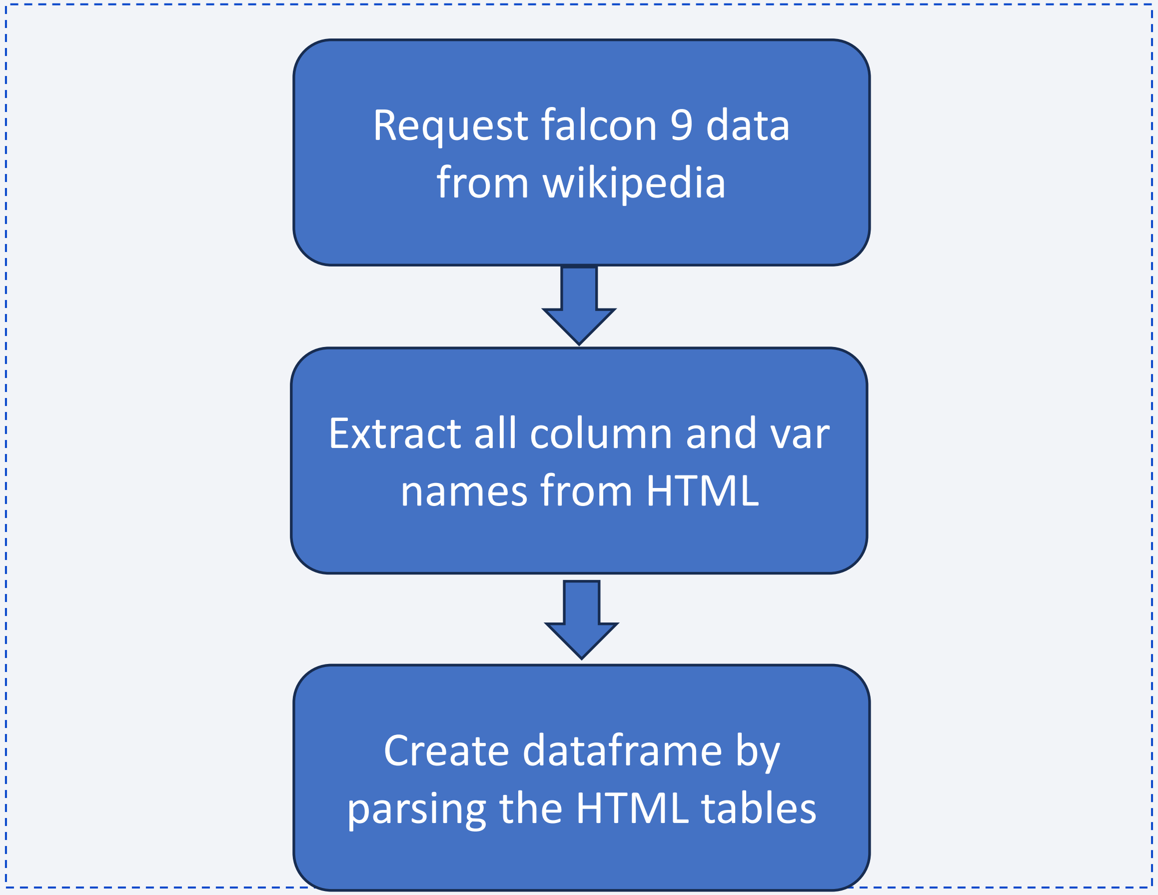
Data Collection – SpaceX API

- We requested with API to get the data and used that data
- Add the GitHub URL of the completed SpaceX API calls notebook (must include completed code cell and outcome cell), as an external reference and peer-review purpose



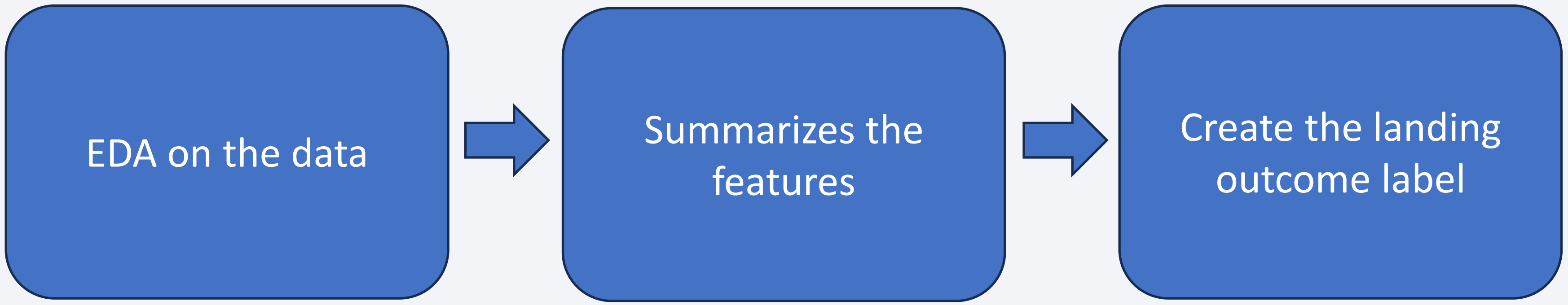
Data Collection - Scraping

- We WebScraped data from Wikipedia source.
- Add the GitHub URL of the completed web scraping notebook, as an external reference and peer-review purpose



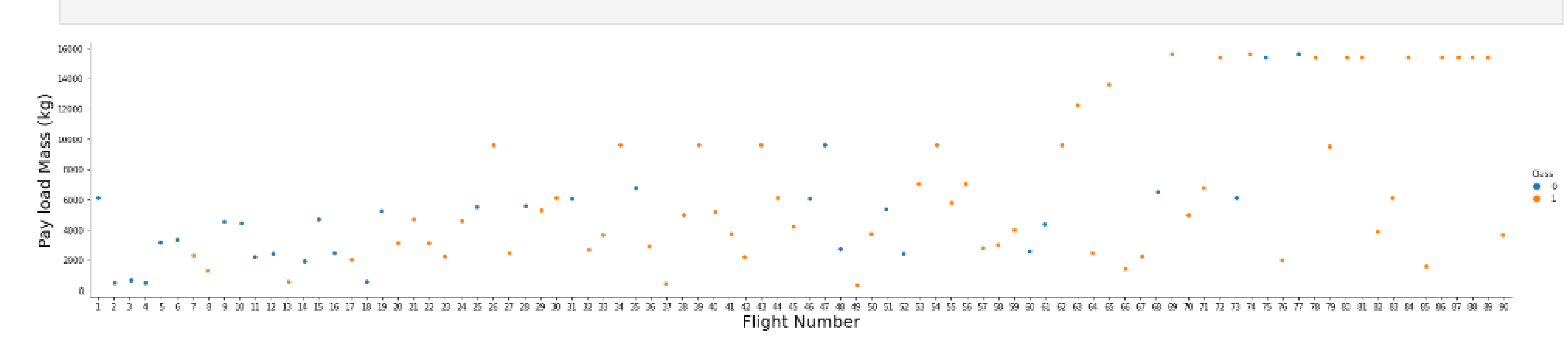
Data Wrangling

- We did EDA on our data to gain more insights.
- Then summarize the feature that might be involve with the success rate(launches per site, occurrences of each orbit , etc.)
- Add the GitHub URL of your completed data wrangling related notebooks, as an external reference and peer-review purpose



EDA with Data Visualization

- Exploring data with scatter and bar plots to visualize the relationship of pair features.



EDA with SQL

- SQL performs

Names of the unique launch sites in the space mission;

- Top 5 launch sites whose name begin with the string 'CCA’;
- Total payload mass carried by boosters launched by NASA (CRS);
- Average payload mass carried by booster version F9 v1.1;
- Date when the first successful landing outcome in ground pad was achieved;
- Names of the boosters which have success in drone ship and have payload mass between 4000 and 6000 kg;
- Total number of successful and failure mission outcomes;
- Names of the booster versions which have carried the maximum payload mass;
- Failed landing outcomes in drone ship, their booster versions, and launch site names for in year 2015; and
- Rank of the count of landing outcomes (such as Failure (drone ship) or Success (ground pad)) between the date 2010-06-04 and 2017-03-20.

- Add the GitHub URL of your completed EDA with SQL notebook, as an

Build an Interactive Map with Folium

- Markers, circles, lines and marker clusters were used with Folium Maps
  - Markers indicate points like launch sites
  - Circle indicate highlighted areas around coordinates
  - Markers clusters highlighted areas around coordinates

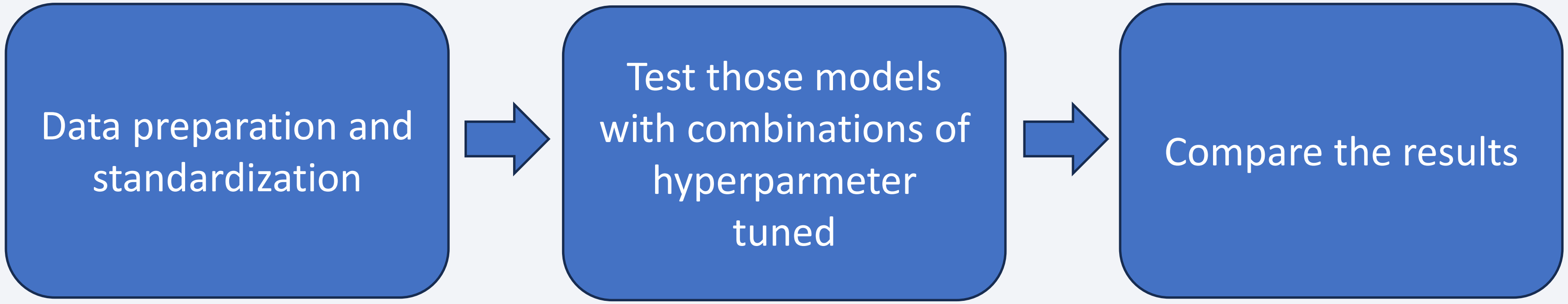
- Add the GitHub URL of your completed interactive map with Folium map, as an external reference and peer-review purpose

Build a Dashboard with Plotly Dash

- The following graphs and plots were used to visualize data
  - Percentage of launches by site
  - Payload range
- The combinations allows us to analyze the data more quickly.
- Add the GitHub URL of your completed Plotly Dash lab, as an external reference and peer-review purpose

Predictive Analysis (Classification)

- 4 Classifications model were compared (logistic regression, support vector machine, decision tree and k nearest neighbors)



- Add the GitHub URL of your completed predictive analysis lab, as an external reference and peer-review purpose

Results

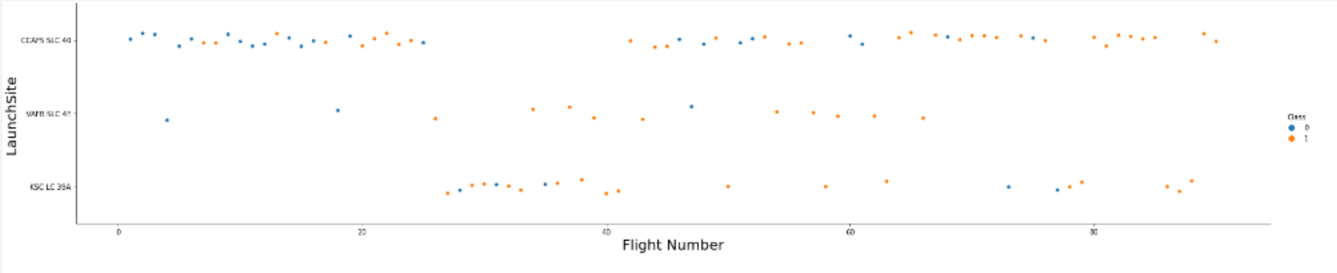
- Exploratory data analysis results
    - SpaceX uses 4 different launch sites.
    - The first launches were done to SpaceX itself and NASA.
    - The average payload is 2,928 kg.
    - The first success landing happened in 2015.
    - Falcon9 success rate is more than the average in drone ships.
    - The number of landing outcomes improve through the year.
- Using interactive analytics was possible to identify that launch sites use to be in safety places, near sea, for example and have a good logistic infrastructure around.
- Most launches happens at east cost launch sites.
- Predictive Analysis showed that Decision Tree Classifier is the best model to predict successful landings, having accuracy over 87% and accuracy for test data over 94%.

Section 2

Insights drawn from EDA

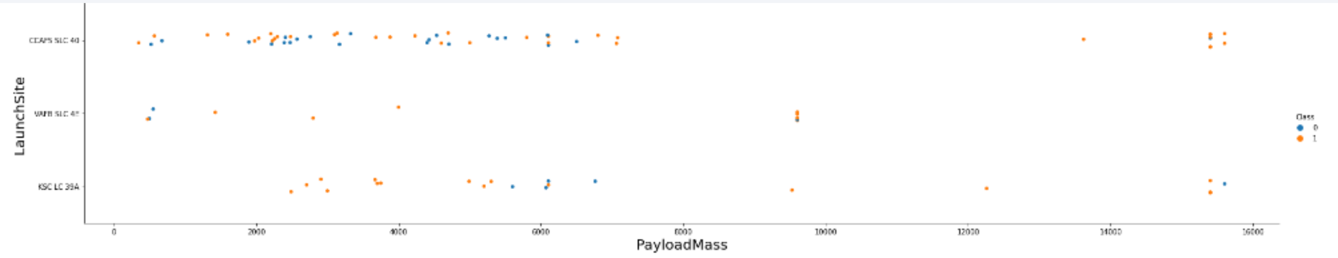
Flight Number vs. Launch Site

- Show a scatter plot of Flight Number vs. Launch Site



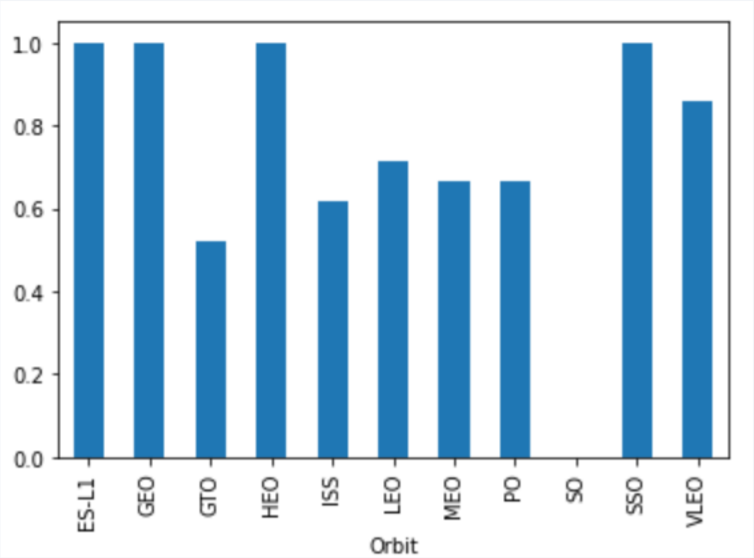
Payload vs. Launch Site

- Show a scatter plot of Payload vs. Launch Site



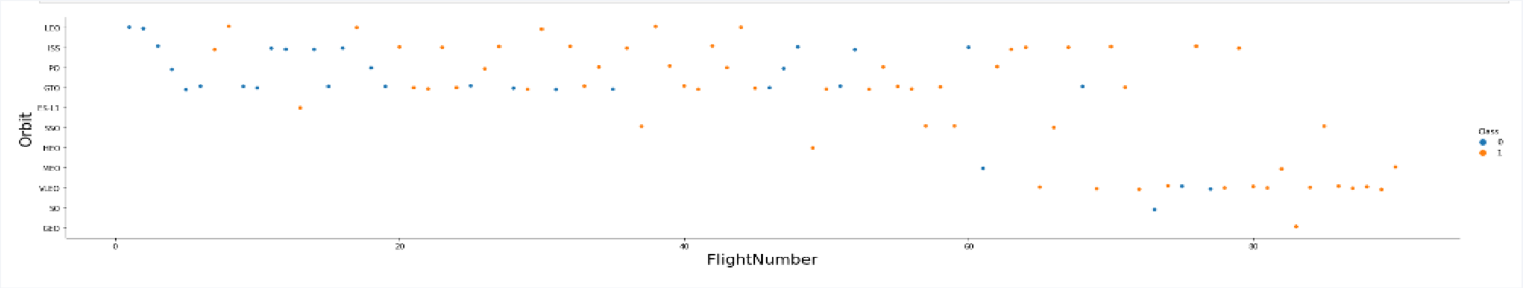
Success Rate vs. Orbit Type

- The biggest success rates happens to orbits:
  - ES-L1
  - GEO
  - HEO
  - SSO
- Followed by
  - VLEO
  - LFO



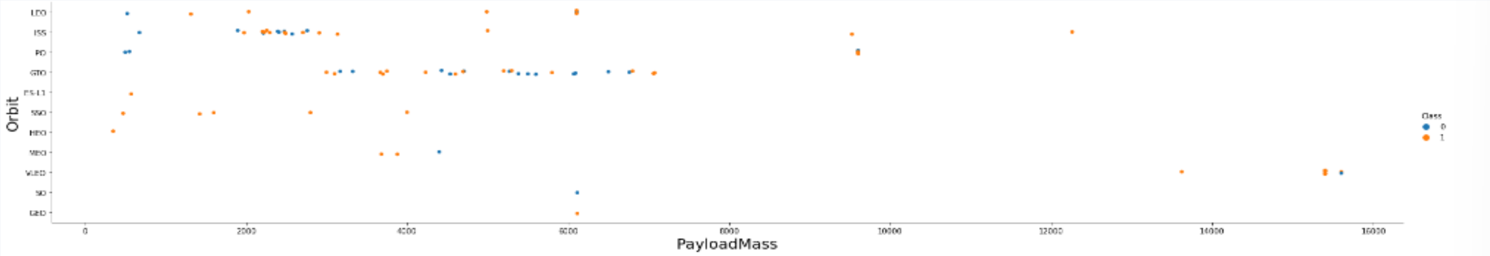
Flight Number vs. Orbit Type

- Show a scatter point of Flight number vs. Orbit type



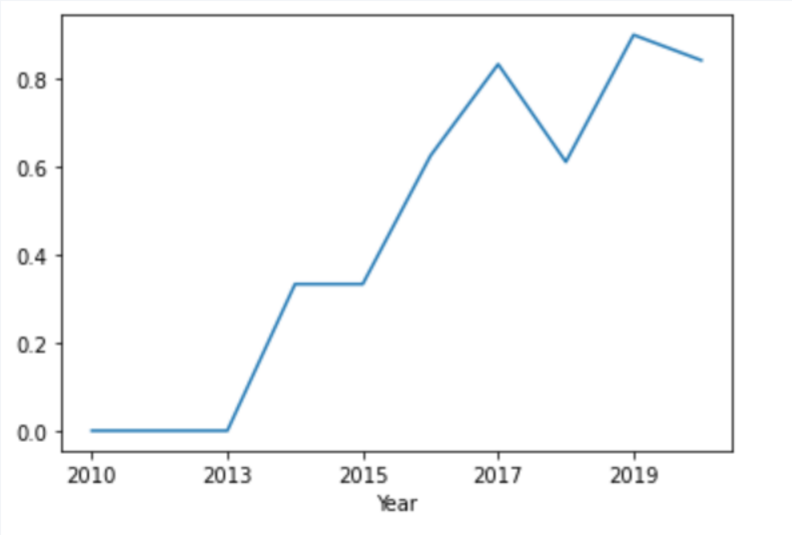
Payload vs. Orbit Type

- Show a scatter point of payload vs. orbit type



Launch Success Yearly Trend

- Show a line chart of yearly average success rate
- Show the screenshot of the scatter plot with explanations



All Launch Site Names

- Find the names of the unique launch sites
- Present your query result with a short explanation here

```
sql SELECT DISTINCT LAUNCH_SITE FROM SPACEXTBL ORDER BY 1;
```

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

Launch Site Names Begin with 'CCA'

- Find 5 records where launch sites begin with `CCA`

DATE	time__utc_	booster_version	launch_site	payload	payload_mass__kg_	orbit
2010-06-04	18:45:00	F9 v1.0 B0003	CCAFS LC-40	Dragon Spacecraft Qualification Unit	0	LEO
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)
2012-05-22	07:44:00	F9 v1.0 B0005	CCAFS LC-40	Dragon demo flight C2	525	LEO (ISS)
2012-10-08	00:35:00	F9 v1.0 B0006	CCAFS LC-40	SpaceX CRS-1	500	LEO (ISS)
2013-03-01	15:10:00	F9 v1.0 B0007	CCAFS LC-40	SpaceX CRS-2	677	LEO (ISS)

- Present your query result with a short explanation here

```
sql SELECT * FROM SPACEXTBL WHERE LAUNCH_SITE LIKE 'CCA%' LIMIT 5;
```

Total Payload Mass

- Calculate the total payload carried by boosters from NASA

total_payload
111268

- Present your query result with a short explanation here

```
sql SELECT SUM(PAYLOAD_MASS__KG_) AS TOTAL_PAYLOAD FROM SPACEXTBL WHERE PAYLOAD  LIKE '%CRS%';
```

Average Payload Mass by F9 v1.1

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

avg_payload
2928

- Present your query result with a short explanation here

```
sql SELECT AVG(PAYLOAD_MASS__KG_) AS AVG_PAYLOAD FROM SPACEXTBL WHERE BOOSTER_VERSION = 'F9 v1.1';
```

First Successful Ground Landing Date

- Find the dates of the first successful landing outcome on ground pad\

first_success_gp
2015-12-22

- Present your query result with a short explanation here

```
sql SELECT MIN(DATE) AS FIRST_SUCCESS_GP FROM SPACEXTBL WHERE LANDING__OUTCOME = 'Success (ground pad)';
```

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

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

- Present your query result with a short explanation here

```
sql SELECT DISTINCT BOOSTER_VERSION FROM SPACEXTBL WHERE PAYLOAD_MASS__KG_ BETWEEN 4000 AND 6000 AND LANDING__OUTCOME = ':
```

Total Number of Successful and Failure Mission Outcomes

- Calculate the total number of successful and failure mission outcomes

mission_outcome	qty
Failure (in flight)	1
Success	99
Success (payload status unclear)	1

- Present your query result with a short explanation here

```
sql SELECT MISSION_OUTCOME, COUNT(*) AS QTY FROM SPACEXTBL GROUP BY MISSION_OUTCOME ORDER BY MISSION_OUTCOME;
```

Boosters Carried Maximum Payload

- List the names of the booster which have carried the maximum payload mass
- Present your query result with a short explanation here

```
sql SELECT DISTINCT BOOSTER_VERSION FROM SPACEXTBL WHERE PAYLOAD_MASS__KG_ = (SELECT MAX(PAYLOAD_MASS__KG_) FROM SPACEXTB
```

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

2015 Launch Records

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

booster_version	launch_site
F9 v1.1 B1012	CCAFS LC-40
F9 v1.1 B1015	CCAFS LC-40

- Present your query result with a short explanation here

```
sql SELECT BOOSTER_VERSION, LAUNCH_SITE FROM SPACEXTBL WHERE LANDING__OUTCOME = 'Failure (drone ship)' AND DATE_PART('YEA
```

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

```
sql SELECT LANDING__OUTCOME, COUNT(*) AS QTY FROM SPACEXTBL WHERE DATE BETWEEN '2010-06-04' AND '2017-03-20' GROUP BY LANI
```

landing_outcome	qty
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

Section 3

Launch Sites Proximities Analysis

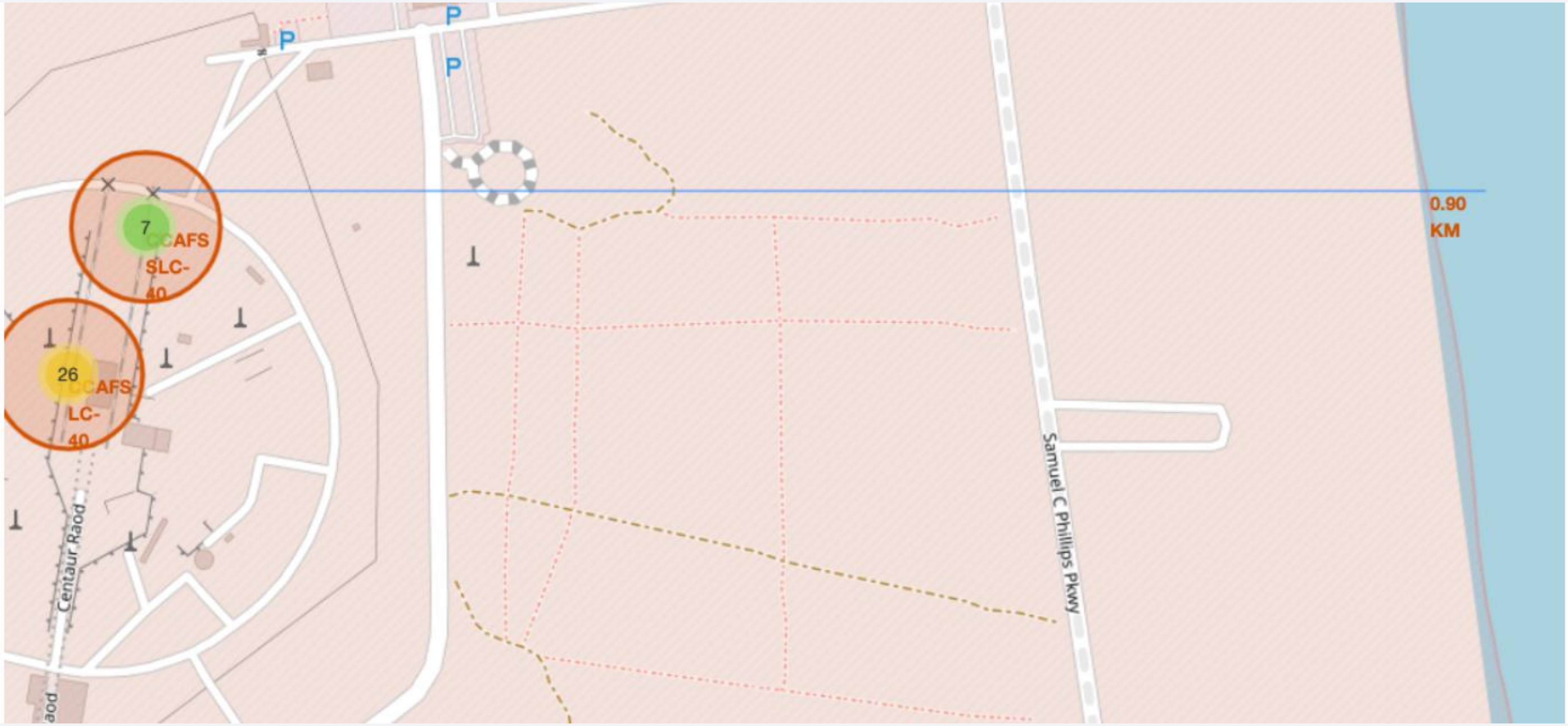
All Launch Sites

- Launch sites are near sea but not too far from roads and railroads.

Launch Outcomes by Site

- Green = successful, Red = failure

Coastline distance

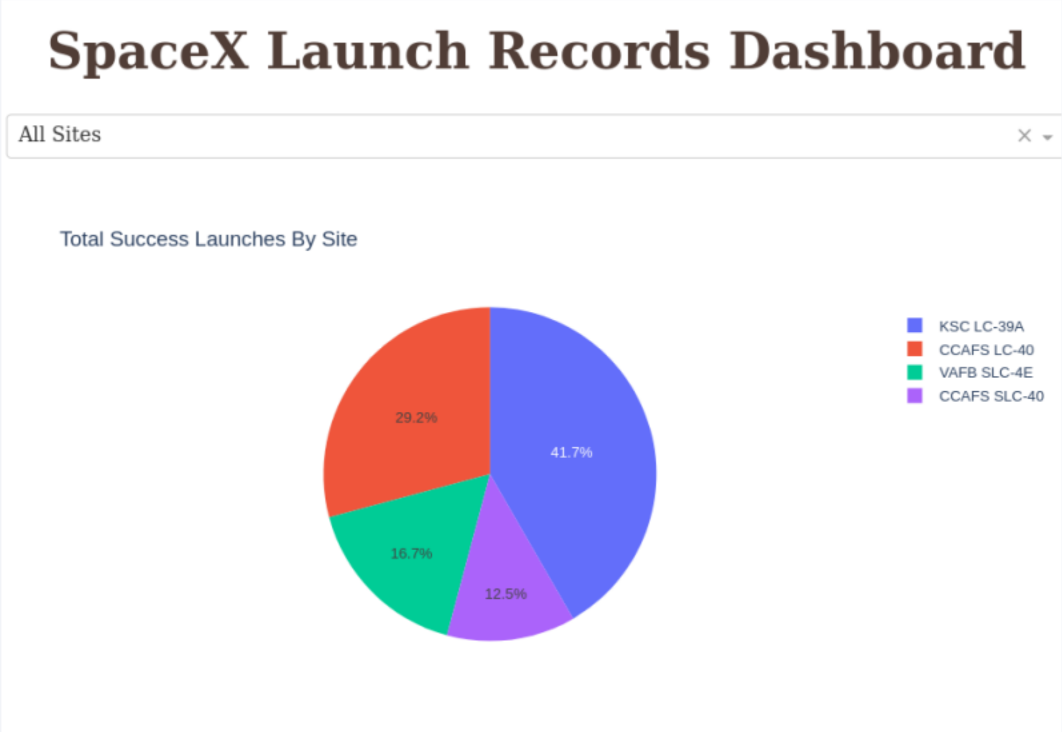


- Launch site KSC LC-39A near coastline.

Section 4

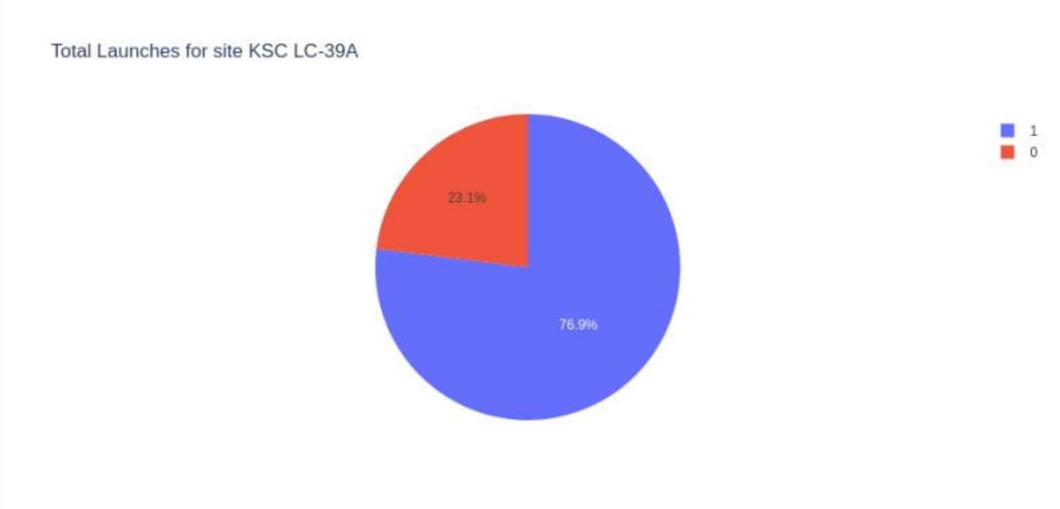
Build a Dashboard with Plotly Dash

Successful Launches by Site



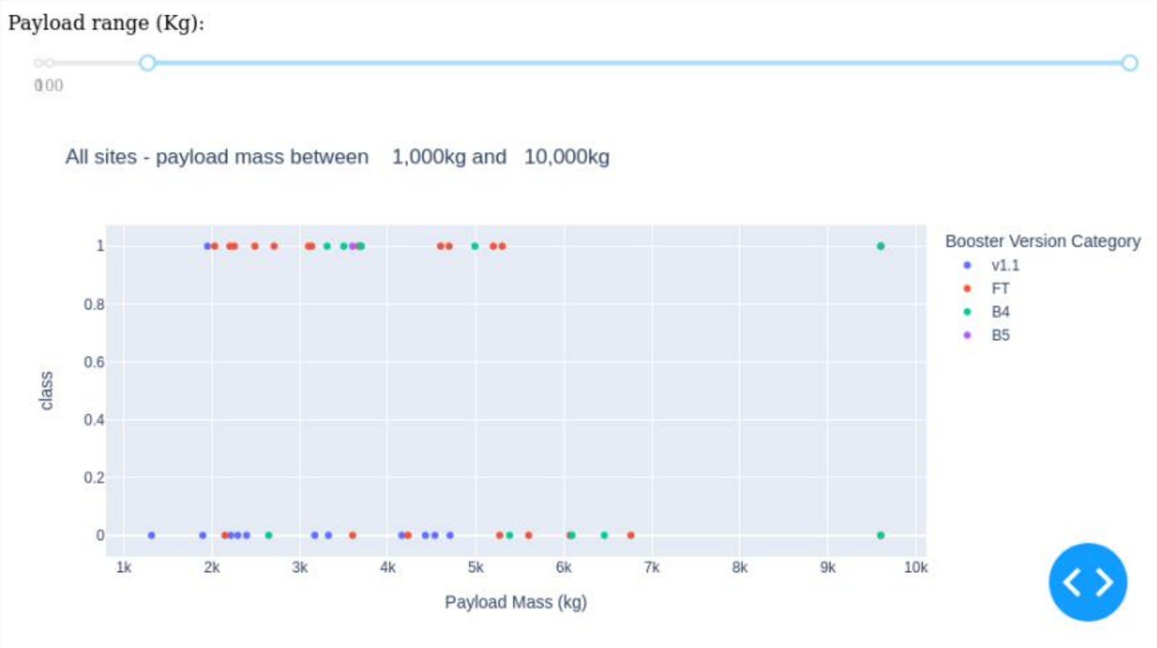
- The place from where launches are done seems to be a very important factor of success of missions.

Launch Success Ratio of KSC LC-39A



- 76.9% successful launches.

Payload vs. Outcome



- Payloads under 6,000 kg and FT boosters are the most successful combination.

Payload vs. Outcome

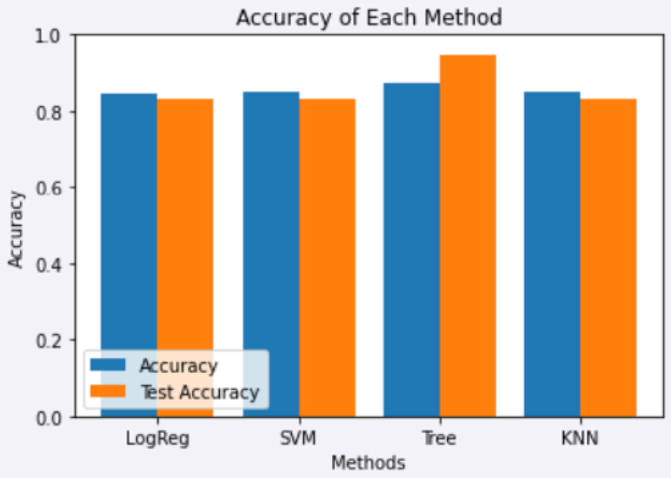
- It's not enough data for launches risks over 7,000 kg

Section 5

Predictive Analysis (Classification)

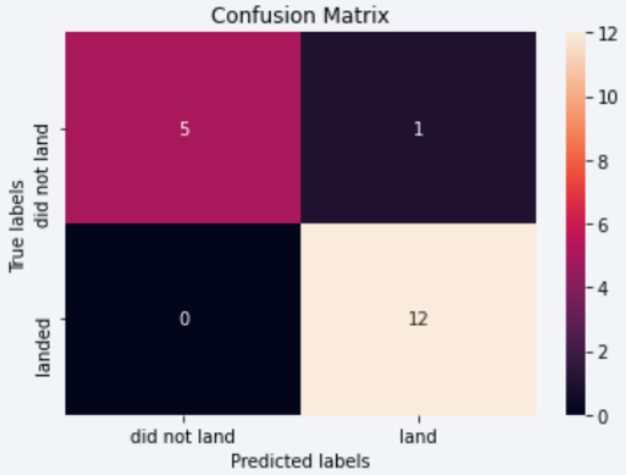
Classification Accuracy

- 4 Predictions accuracy points.
- The highest model is Decision Tree Classifier, which has accuracies over than 87%



Confusion Matrix

- Confusion matrix of Decision Tree Classifier proves its accuracy by showing the big numbers of true positive and true negative compared to the false cases.



Conclusions

- The best launch site is KSC LC-39A
- Launches > 7,000 kg is KSC LC-39A
- Mission outcomes improve over time, according the evolution of processes and technologies.
- Decision Tree Classifier is the best predictions that predict successful landings and increase profits.

Appendix

- Folium didn't show maps on Github

Thank you!