IBM Developer
SKILLS NETWORK

Winning Space Race with Data Science

<Name>
<Date>

Outline

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

Executive Summary

- **Summary of methodologies:**
  - Data collection/ data wrangling
  - EDA with data visualization and SQL
  - Interactive Folium map and a plotly dashboard
  - Predicative analysis with classification ML algorithms
- **Summary of all results**

  EDA results and Interactive analytics demo:

  - Which features of the dataset are valid for the classification task?

  Preductive analysis results:

  - Can we predict the success of the landing of the first stage of the Falcon 9 rocket?

Introduction

- **Project background and context**
  - The commercial space age is here, companies are making space travel affordable for everyone. SpaceX, one popular player, advertises Falcon 9 rocket launches on its website with a cost of 62 million dollars; other providers cost upwards of 165 million dollars each, much of the savings is because SpaceX can reuse the first stage.
- **Problems you want to find answers:**
  - Determine the price of each launch by gathering information about Space X and creating dashboards.
  - Determine if SpaceX will reuse the first stage.
  - Train a machine learning models instead of using rocket science and use public information to predict if SpaceX will reuse the first stage.

Section 1

Methodology

Methodology

Executive Summary

- Data collection methodology:
  - SpaceX Rest API and web scraping from Wikipedia
- Perform data wrangling:
  - One-hot-encoding for categorical features + dropping of irrelevant featurrs
- Perform exploratory data analysis (EDA) using visualization and SQL
- Perform interactive visual analytics using Folium and Plotly Dash
- Perform predictive analysis using classification models
  - Build and finetune the hyperparameters of multiple ML classification models
  - Evaluate them on our data to determine the best model

Data Collection

1. The launch data was gathered from the SpaceX Rest API
   - The API returns information about the used rocket, its payload, launch and landing specifications and the overall landing outcome.

2. A second data source for Falcon 9 launch data was provided by webscraping Wikipedia using the Beautiful Soup Package

SpaceX API

Web scraping

Data Collection – SpaceX API

- Present your data collection with SpaceX REST calls using key phrases and flowcharts

- 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

- Present your web scraping process using key phrases and flowcharts

- Add the GitHub URL of the completed web scraping notebook, as an external reference and peer-review purpose

Data Wrangling

- Describe how data were processed
- You need to present your data wrangling process using key phrases and flowcharts
- Add the GitHub URL of your completed data wrangling related notebooks, as an external reference and peer-review purpose

EDA with Data Visualization

- Summarize what charts were plotted and why you used those charts
- Add the GitHub URL of your completed EDA with data visualization notebook, as an external reference and peer-review purpose

EDA with SQL

- Using bullet point format, summarize the SQL queries you performed
- Add the GitHub URL of your completed EDA with SQL notebook, as an external reference and peer-review purpose

Build an Interactive Map with Folium

- Summarize what map objects such as markers, circles, lines, etc. you created and added to a folium map
- Explain why you added those objects
- 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

- Summarize what plots/graphs and interactions you have added to a dashboard
- Explain why you added those plots and interactions
- Add the GitHub URL of your completed Plotly Dash lab, as an external reference and peer-review purpose

Predictive Analysis (Classification)

- Summarize how you built, evaluated, improved, and found the best performing classification model
- You need present your model development process using key phrases and flowchart
- Add the GitHub URL of your completed predictive analysis lab, as an external reference and peer-review purpose

Results

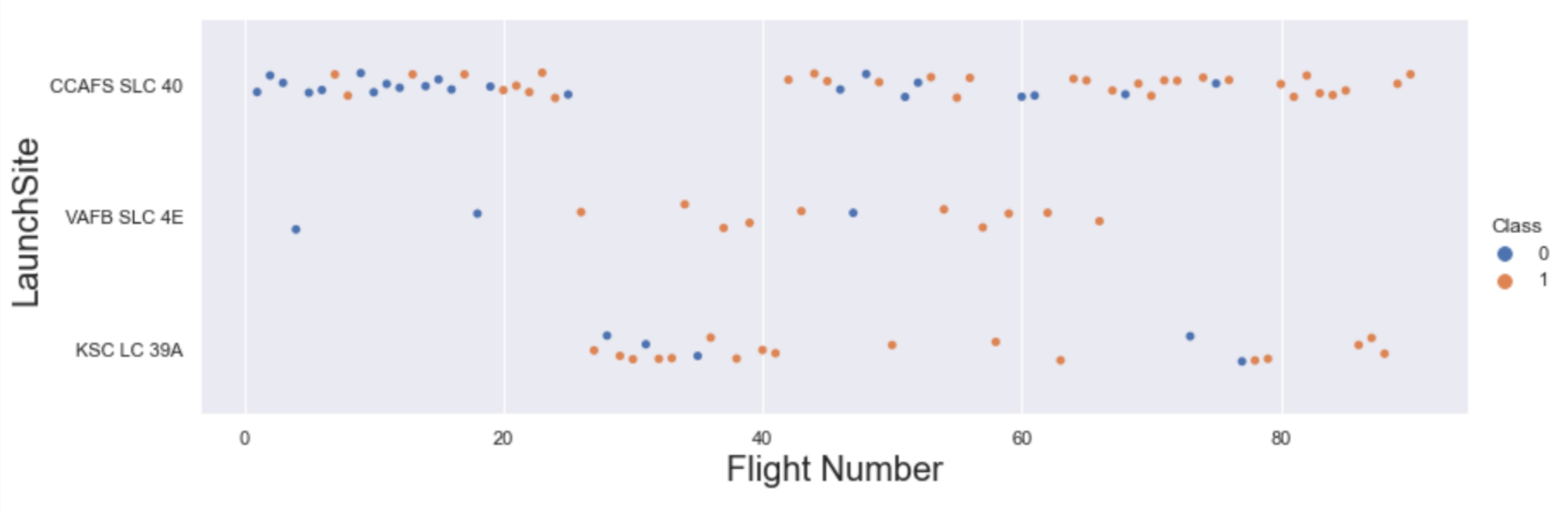
- Exploratory data analysis results
- Interactive analytics demo in screenshots
- Predictive analysis results

Section 2

Insights drawn from EDA

Flight Number vs. Launch Site

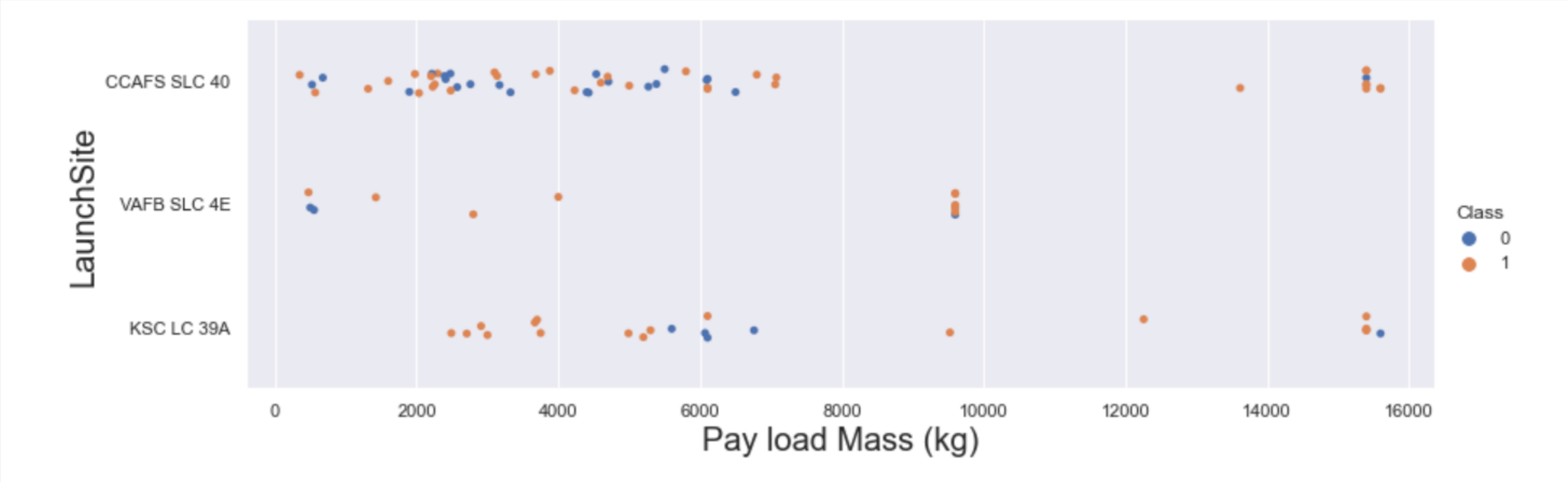
- Show a scatter plot of Flight Number vs. Launch Site
- Show the screenshot of the scatter plot with explanations



- The success rate increases with a higher flight number

Payload vs. Launch Site

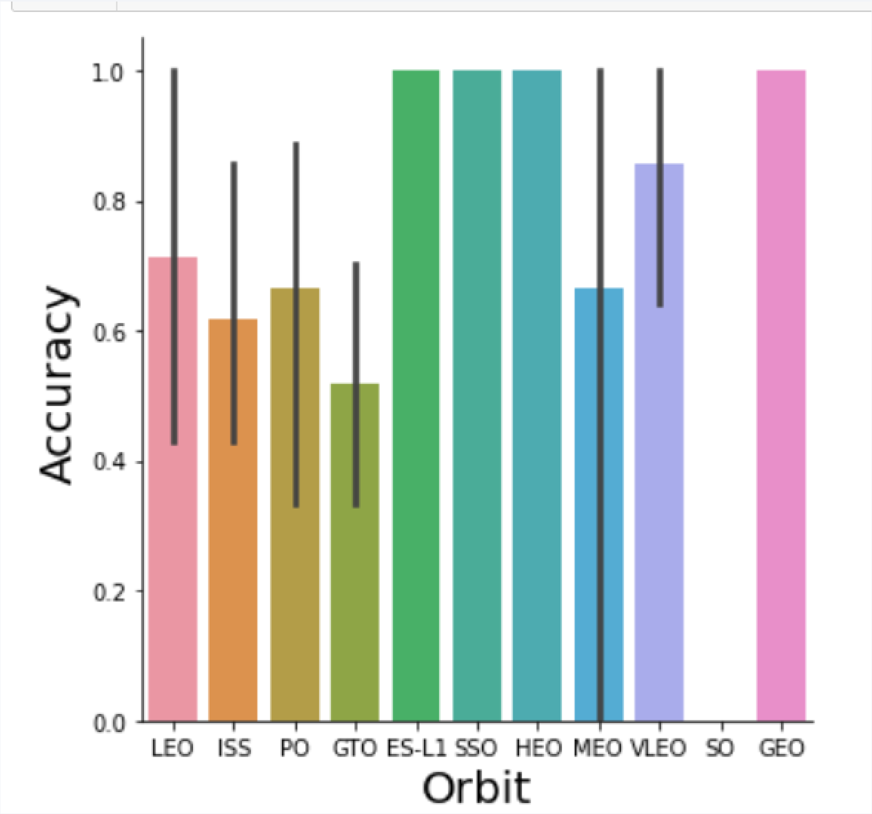
- Show a scatter plot of Payload vs. Launch Site
- Show the screenshot of the scatter plot with explanations



- Clusters of success/failure depending on the payload mass

Success Rate vs. Orbit Type

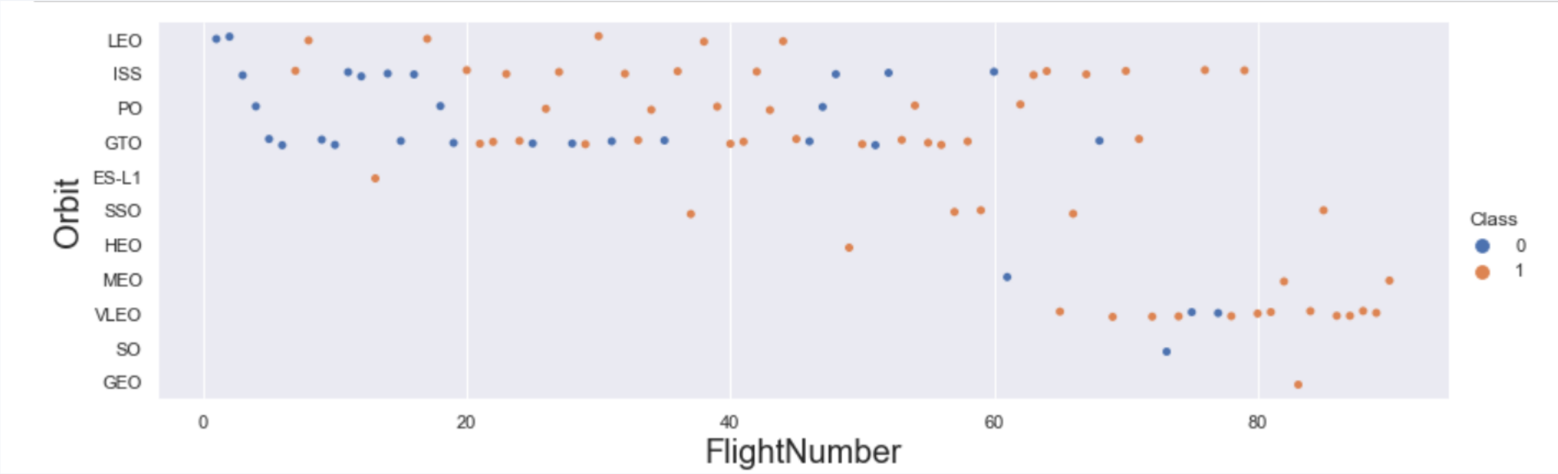
- Show a bar chart for the success rate of each orbit type
- Show the screenshot of the scatter plot with explanations



- The ES-L1, SSO,HEO and GEO are most successful.

Flight Number vs. Orbit Type

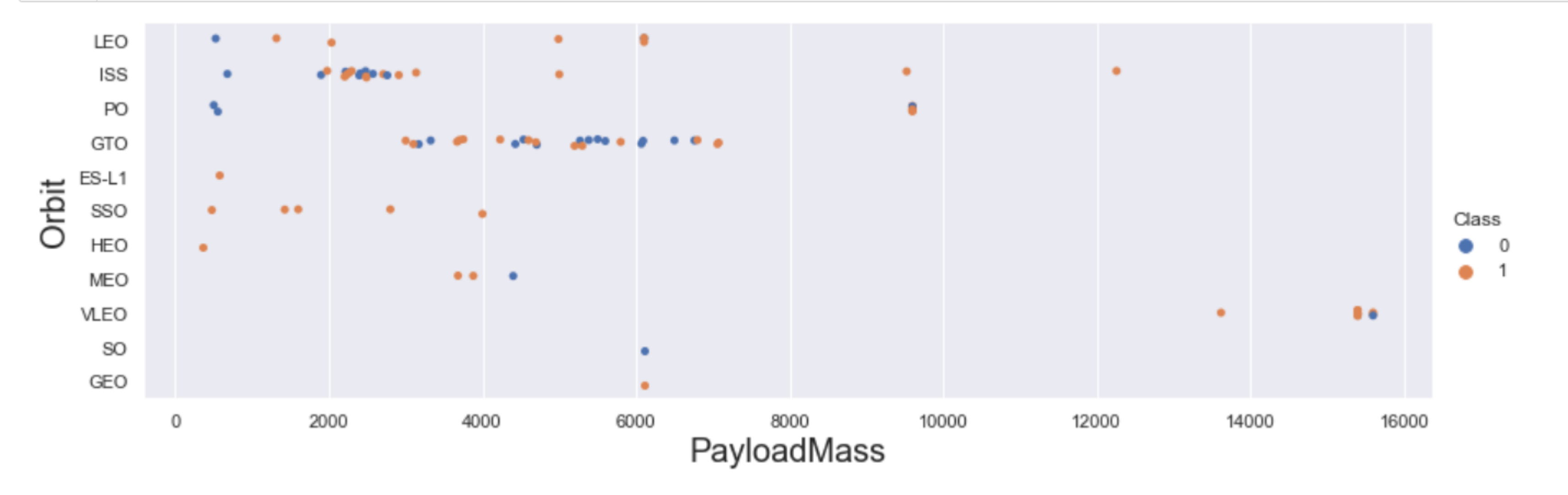
- Show a scatter point of Flight number vs. Orbit type
- Show the screenshot of the scatter plot with explanations



- In some orbits (e.g. LEO) the success rate increases with more flights

Payload vs. Orbit Type

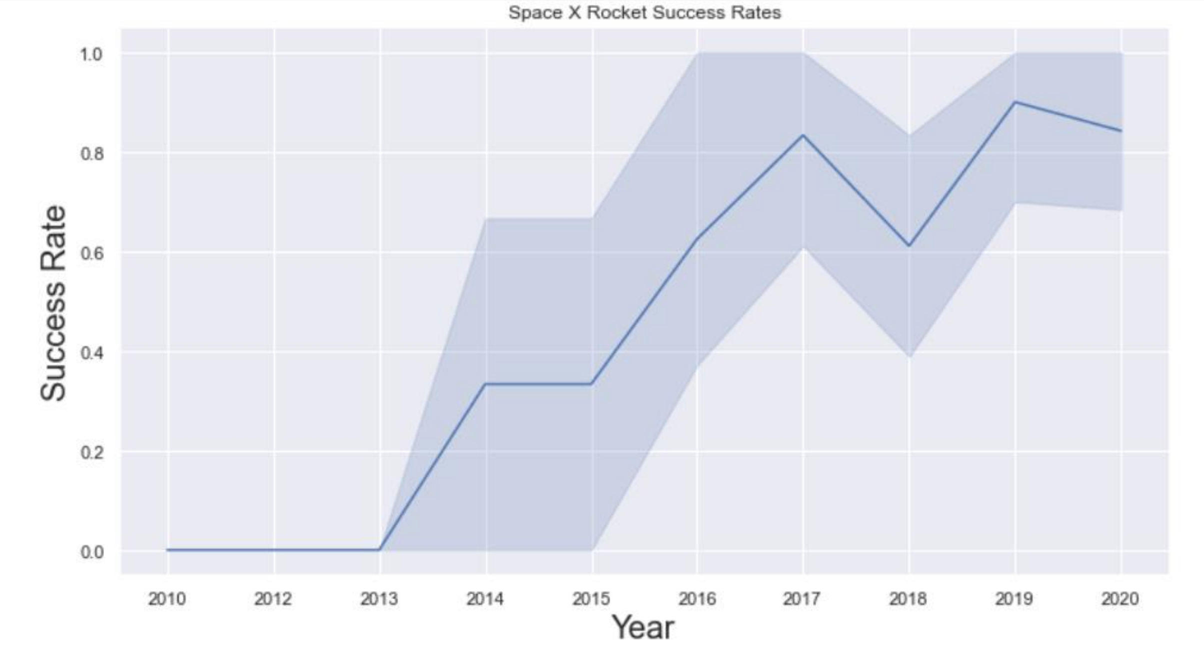
- Show a scatter point of payload vs. orbit type
- Show the screenshot of the scatter plot with explanations



- Heavy payloads increase the success rate on some orbits

Launch Success Yearly Trend

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



- The success rate is directly proportional to the year

All Launch Site Names

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

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

```
 * ibm_db_sa://ngz89646:***@54a2f15b-5c0f-46d
Done.
```

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`
- Present your query result with a short explanation here

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

```
 * ibm_db_sa://ngz89646:***@54a2f15b-5c0f-46df-8954-7e38e612c2bd.c1ogj3sd0tgtu0lqde00.databases.appdomain.cloud:32733/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

Total Payload Mass

- Calculate the total payload carried by boosters from NASA
- Present your query result with a short explanation here

```
%sql SELECT SUM(PAYLOAD_MASS__KG_) AS "Total payload by NASA(CRS)" FROM SPACEX WHERE (CUSTOMER = 'NASA (CRS)');
```

```
 * ibm_db_sa://ngz89646:***@54a2f15b-5c0f-46df-8954-7e38e612c2bd.c1ogj3sd0tgtu0lqde00.databases.appdomain.cloud:32733/bludb
Done.
```

Total payload by NASA(CRS)
45596

Average Payload Mass by F9 v1.1

- Calculate the average payload mass carried by booster version F9 v1.1
- Present your query result with a short explanation here

```
%sql SELECT AVG(PAYLOAD_MASS__KG_) AS "Avg payload by booster version F9 v1.1" FROM SPACEX WHERE (BOOSTER_VERSION = 'F9 v1.1');
```

```
 * ibm_db_sa://ngz89646:***@54a2f15b-5c0f-46df-8954-7e38e612c2bd.c1ogj3sd0tgtu0lqde00.databases.appdomain.cloud:32733/bludb
Done.
```

Avg payload by booster version F9 v1.1
2928

First Successful Ground Landing Date

- Find the dates of the first successful landing outcome on ground pad
- Present your query result with a short explanation here

```
%sql SELECT MIN(DATE) AS "First successfull landing date" FROM SPACEX WHERE (LANDING__OUTCOME = 'Success (ground pad)');
```

```
 * ibm_db_sa://ngz89646:***@54a2f15b-5c0f-46df-8954-7e38e612c2bd.c1ogj3sd0tgtu0lqde00.databases.appdomain.cloud:32733/bludb
Done.
```

First successfull landing date
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

```
%sql SELECT BOOSTER_VERSION FROM SPACEX WHERE (LANDING__OUTCOME = 'Success (drone ship)') AND (PAYLOAD_MASS__KG_ > 4000) AND (PAYLOAD_MAS
S__KG_ < 6000);
```

```
 * ibm_db_sa://ngz89646:***@54a2f15b-5c0f-46df-8954-7e38e612c2bd.c1ogj3sd0tgtu0lqde00.databases.appdomain.cloud:32733/bludb
Done.
```

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
- Present your query result with a short explanation here

```
%sql SELECT COUNT(*) AS "Number of successful missions" FROM SPACEX WHERE MISSION_OUTCOME LIKE 'Success%';
```

 * ibm_db_sa://ngz89646:***@54a2f15b-5c0f-46df-8954-7e38e612c2bd.c1ogj3sd0tgtu0lqde00.databases.appdomain.c
Done.

Number of successful missions
100

```
%sql SELECT COUNT(*) AS "Number of failed missions" FROM SPACEX WHERE MISSION_OUTCOME LIKE 'Failure%';
```

 * ibm_db_sa://ngz89646:***@54a2f15b-5c0f-46df-8954-7e38e612c2bd.c1ogj3sd0tgtu0lqde00.databases.appdomain.c
Done.

Number of failed missions
1

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

2015 Launch Records

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

- Present your query result with a short explanation here

```
%sql SELECT LANDING__OUTCOME, BOOSTER_VERSION, LAUNCH_SITE FROM SPACEX WHERE DATE LIKE '2015%' AND LANDING__OUTCOME = 'Failure (drone shi
p)';
```

```
 * ibm_db_sa://ngz89646:***@54a2f15b-5c0f-46df-8954-7e38e612c2bd.c1ogj3sd0tgtu0lqde00.databases.appdomain.cloud:32733/bludb
Done.
```

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

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

```
%sql SELECT COUNT(LANDING__OUTCOME),LANDING__OUTCOME FROM SPACEX WHERE (DATE > '2010-06-04') AND (DATE < '2017-03-20') GROUP BY LANDING__OUTCOME ORDER BY COUNT(LANDING__OUTCOME) desc;
```

```
 * ibm_db_sa://ngz89646:***@54a2f15b-5c0f-46df-8954-7e38e612c2bd.c1ogj3sd0tgtu0lqde00.databases.appdomain.cloud:32733/bludb
Done.
```

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

Section 4

Launch Sites Proximities Analysis

<Folium Map Screenshot 1>

- Replace <Folium map screenshot 1> title with an appropriate title
- Explore the generated folium map and make a proper screenshot to include all launch sites' location markers on a global map
- Explain the important elements and findings on the screenshot

<Folium Map Screenshot 2>

- Replace <Folium map screenshot 2> title with an appropriate title

- Explore the folium map and make a proper screenshot to show the color-labeled launch outcomes on the map

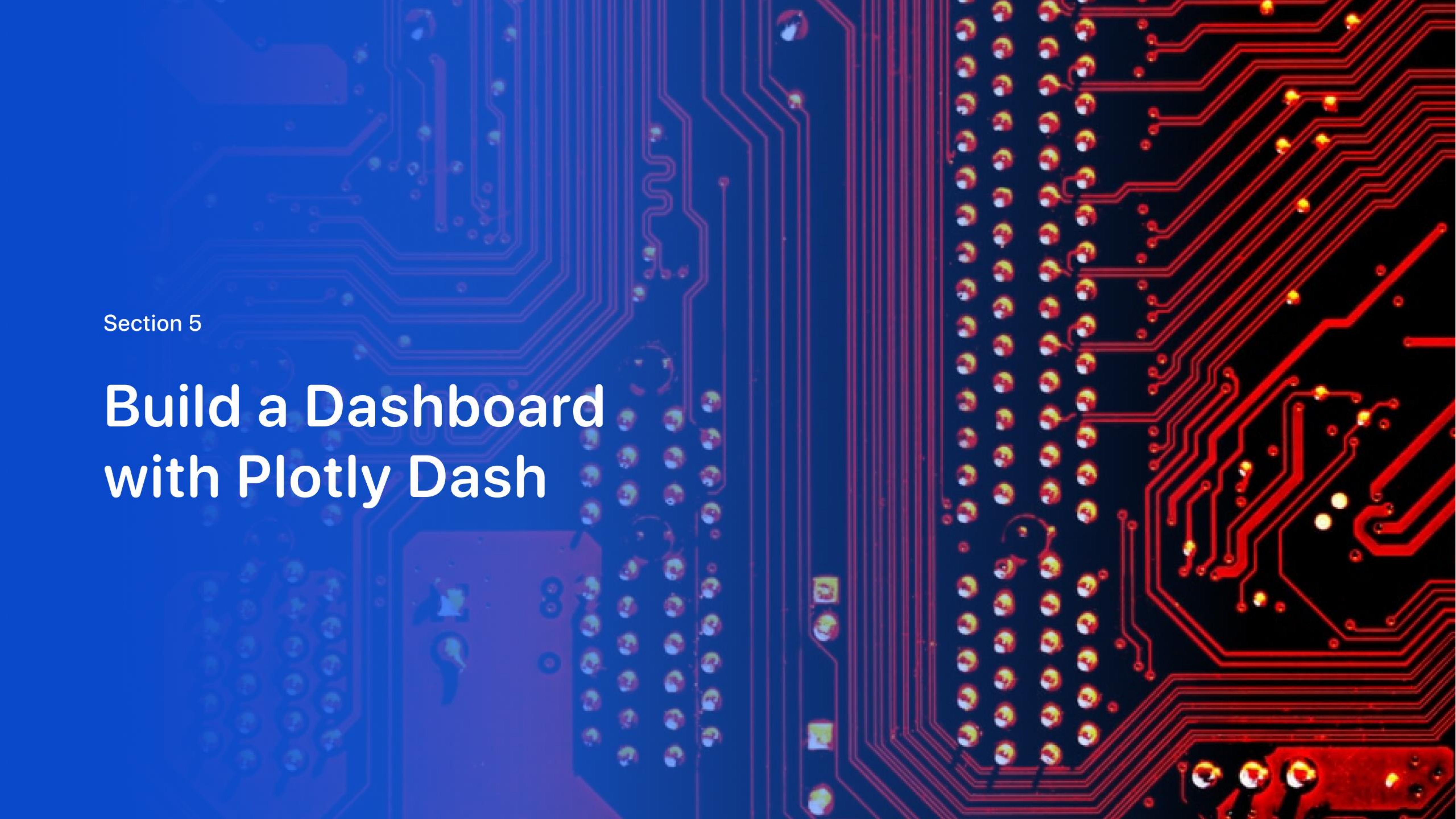
- Explain the important elements and findings on the screenshot

<Folium Map Screenshot 3>

- Replace <Folium map screenshot 3> title with an appropriate title

- Explore the generated folium map and show the screenshot of a selected launch site to its proximities such as railway, highway, coastline, with distance calculated and displayed

- Explain the important elements and findings on the screenshot



Section 5

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, such as which payload range or booster version have the largest success rate, etc.

Section 6

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:

Results:

```
logreg_cv.score(X_test,Y_test)
0.8333333333333334
```

```
svm_cv.score(X_test,Y_test)
0.8333333333333334
```

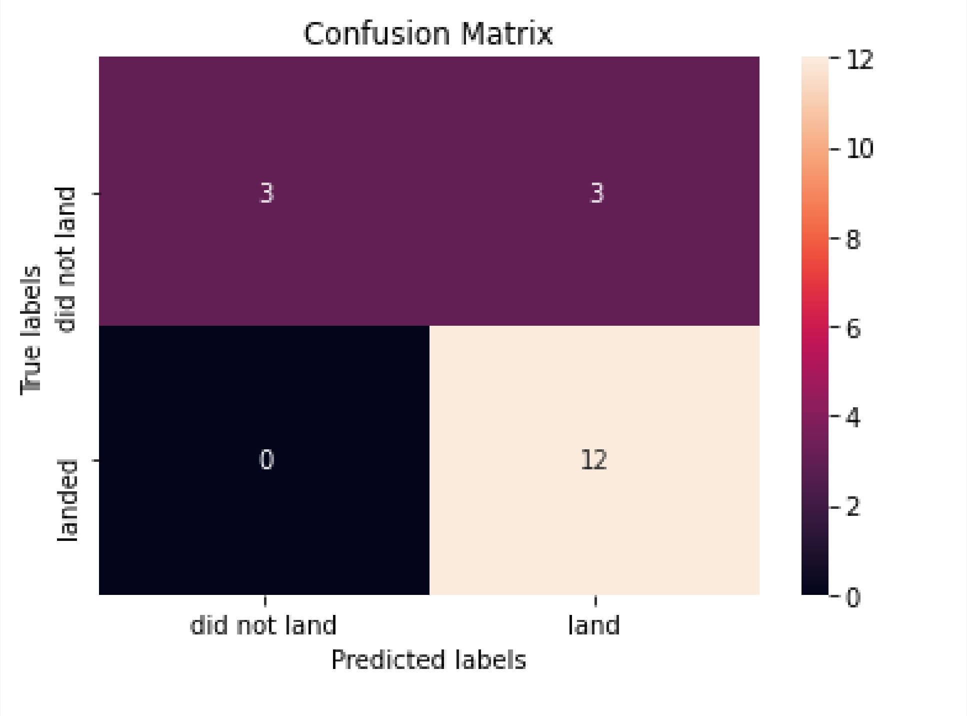
```
tree_cv.score(X_test,Y_test)
0.8333333333333334
```

```
knn_cv.score(X_test,Y_test)
0.8333333333333334
```

- All four algorithms perform equally well with a performance of 83.3% accuracy on the test data

Confusion Matrix

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



We see that logistic regression can distinguish between the different classes.

We see that the major problem is the high number of false positives.

Conclusions

- All ML methods perform equally well on the data
- An accuracy of up to 83% is possible for the first stage landing outcome prediction
- Low weighted payloads perform better than the heavy ones
- The mission Success rate is proportional to and increases with the number of years spent on the project
- The ES-L1, SSO,HEO and GEO are most successful

Appendix

- Include any relevant assets like Python code snippets, SQL queries, charts, Notebook outputs, or data sets that you may have created during this project

Thank you!