IBM Developer
SKILLS NETWORK

Winning Space Race with Data Science

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Outline

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

Executive Summary

- **Summary of methodologies**
  - Data collection
  - Data wrangling
  - EDA with data visualization
  - EDA with SQL
  - Building an interactive map with folium
  - Building a dashboard with Plotty Dash
  - Predictive analysis (Classification)
- **Summary of methodologies**
  - Exploratory data analysis results
  - Interactive analytics demo in screenshots
  - Predictive analysis results

Introduction

- Project background and context

We predicted if the Falcon 9 first stage will land successfully.SpaceX advertises Falcon 9 rocket launches on its website,with a cost of 62 million dollars; other providers cost upward of 165 million dollars each, much of the savings is because SpaceX can reuse the first stage.Therefore,if we candetermine if the first stage will land,we can determine the cost of a launch.This information can be used if an alternate company wants to bid against SpaceX for a rocket launch.

- Problems you want to find answers

- What influences if the rocket will land successfully?

- The effect each relationship with certain rocket variables willimpact in determining the success rate of a successful landing

- What conditions does Spacex have to achieve to get the best results and ensure the best rocket success landing rate.

Section 1

Methodology

Methodology

Executive Summary

- Data collection methodology:
  - SpaceX Rest API
  - (web Scrapping) from wikipedia
- Perform data wrangling
  - Transforming data for Machine Learning
- 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

Data Collection

- data sets were collected using he API call from several websites
  https://api.spacexdata.com/v4

1. Collecting data with API call
2. Converting to data frame using JSON
3. Updating columns and rows
4. Filtering the data to keep Falcon 9 launches only
5. Convert data to csv file.

Data Collection - SpaceX API

1. Collecting data with API call

```
spacex_url="https://api.spacexdata.com/v4/launches/past"
```

```
response = requests.get(spacex_url)
```

2. Converting to data frame using JSON

```
# Use json_normalize meethod to convert the json result into a dataframe
data = pd.json_normalize(response.json())
```

3. Cleaning Data

```
# Call getLaunchSite
getLaunchSite(data)
```

```
# Call getPayloadData
getPayloadData(data)
```

```
# Call getCoreData
getCoreData(data)
```

4. Assign list to dictionary

```
launch_dict = {'FlightNumber': list(data['flight_number']),
'Date': list(data['date']),
'BoosterVersion':BoosterVersion,
'PayloadMass':PayloadMass,
'Orbit':Orbit,
'LaunchSite':LaunchSite,
'Outcome':Outcome,
'Flights':Flights,
'GridFins':GridFins,
'Reused':Reused,
'Legs':Legs,
'LandingPad':LandingPad,
'Block':Block,
'ReusedCount':ReusedCount,
'Serial':Serial,
'Longitude': Longitude,
'Latitude': Latitude}
```

5. Filter dataframe and Convert data to csv file.

```
data_falcon9.loc[:,'FlightNumber'] = list(range(1, data_falcon9.shape[0]+1))
data_falcon9
```

```
data_falcon9.to_csv('dataset_part\_1.csv', index=False
```

https://github.com/tatianagebrayel/Data-science-capstone/blob/master/collecting%20data.ipynb

Data Collection - Scraping

- web scraping from Wipedia
- https://github.com/tatianagebrayel/Data-science-capstone/blob/master/web%20scraping.ipynb

1. Getting Response from HTML

```
# assign the response to a object
data = requests.get(static_url).text
```

2. Creating BeautifulSoup Object

```
# Use BeautifulSoup() to create a BeautifulSoup
soup = BeautifulSoup(data, 'html5lib')
```

3. Finding Tables

```
html_tables = soup.find_all('table')
```

4. Getting Column names

```
column_names = []
```

5. Creating dictionary

```
launch_dict= dict.fromkeys(column_names

# Remove an irrelvant column
del launch_dict['Date and time ( )']

# Let's initial the launch_dict with ea
launch_dict['Flight No.'] = []
launch_dict['Launch site'] = []
launch_dict['Payload'] = []
launch_dict['Payload mass'] = []
launch_dict['Orbit'] = []
launch_dict['Customer'] = []
launch_dict['Launch outcome'] = []
# Added some new columns
launch_dict['Version Booster']=[]
launch_dict['Booster landing']=[]
launch_dict['Date']=[]
launch_dict['Time']=[]
```

6. Appending Data to Keys

```
extracted_row = 0
#Extract each table
for table_number,table in enumerate(soup.find_all('table',"wikitable plainrowheaders collapsible")):
   # get table row
    for rows in table.find_all("tr"):
```

7. Converting dictionary to dataframe

```
df=pd.DataFrame(launch_dict)
```

8. Converting Dataframe to csv

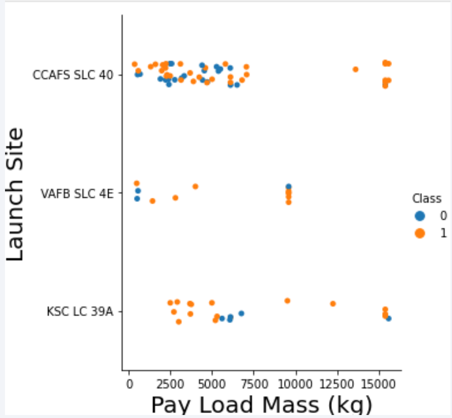
```
df.to_csv('spacex_web_scraped.csv', index=False)
```

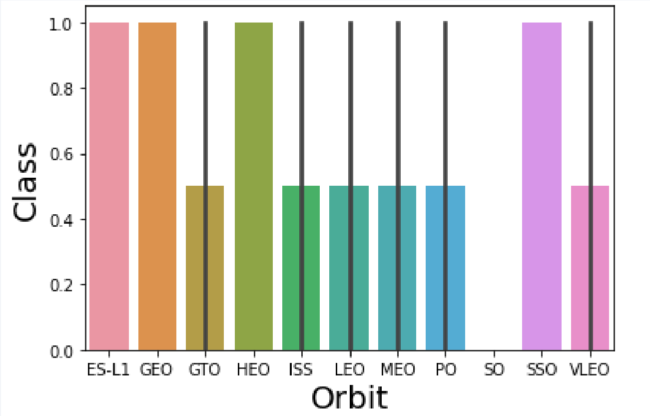
Data Wrangling

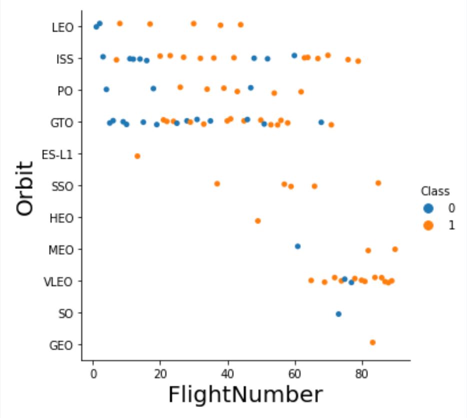
- Check null values
- Calculate the number of launches on each site
- Calculate the number and occurrence of each orbit
- Calculate the number and occurrence of mission outcome per orbit type
- Create a landing outcome label from Outcome column
- Handle null values

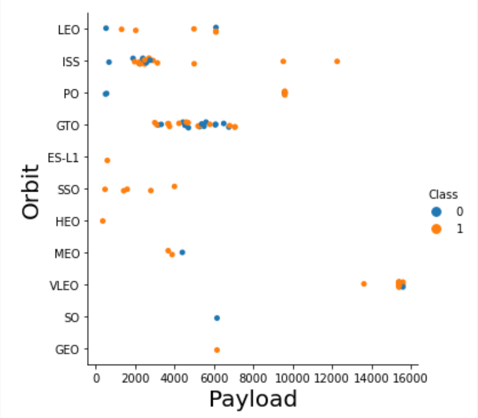
https://github.com/tatianagebrayel/Data-science-capstone/blob/master/data%20wrangling.ipynb

EDA with Data Visualization









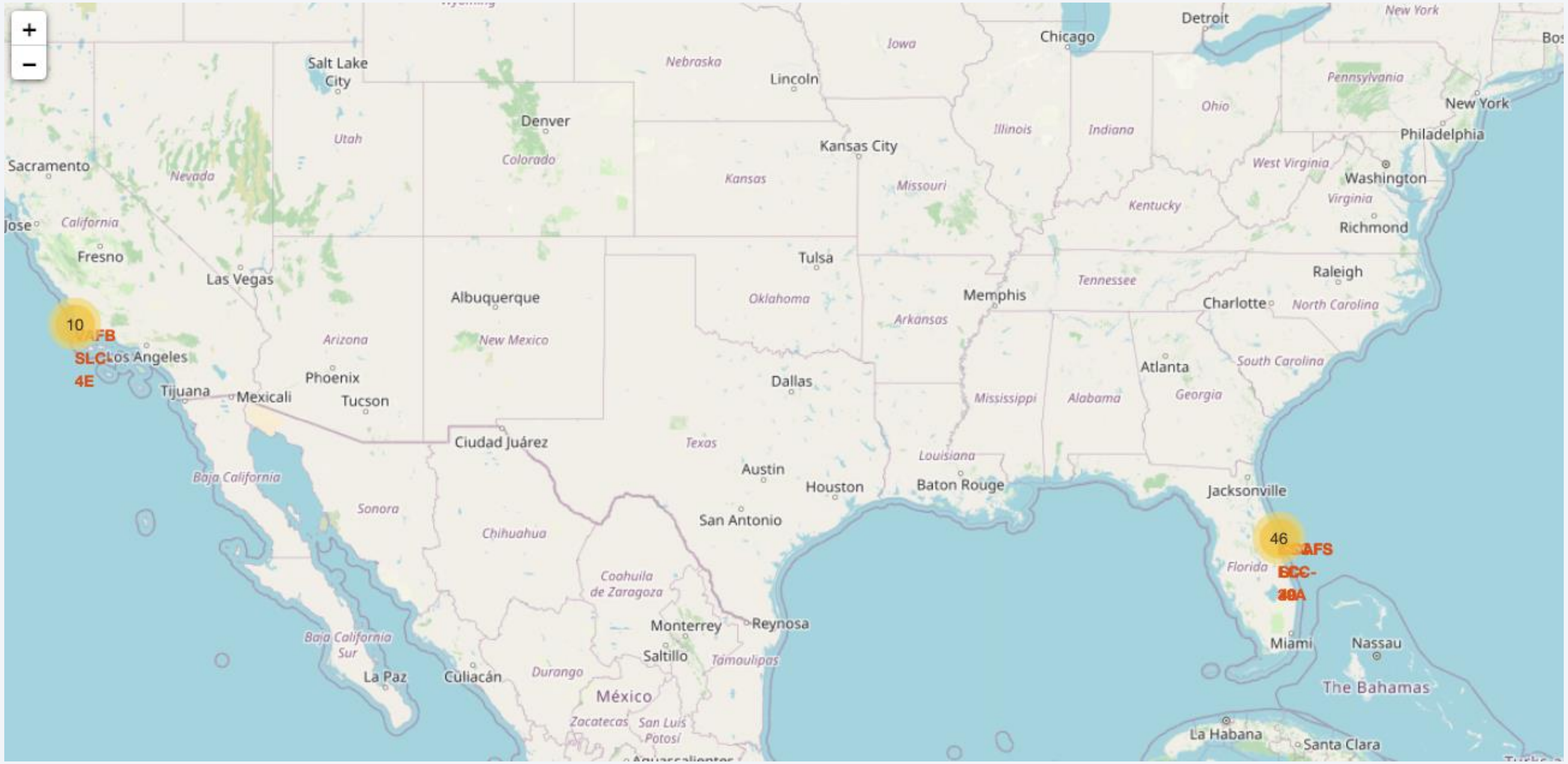
- https://github.com/tatianagebrayel/Data-science-capstone/blob/master/EDA%20with%20data%20visualization.ipynb

EDA with SQL

- Displaying names of the unique launch sites in the space mission
- Displaying 5 records where launch sites begin with ‘KSC’
- Displaying the total and average payload mass carried by boosters
- Listing the date where the successful landing outcome in drone ship was achieved
- Listing names of the boosters which payload mass is between 4000 and 6000
- Listing the total number of successful and failure mission outcomes…

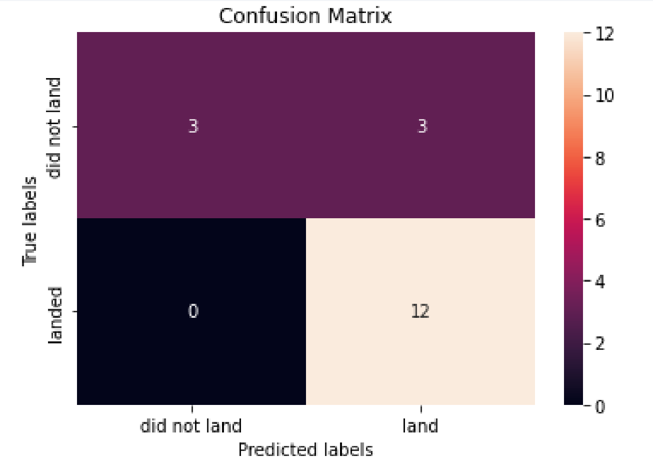
- https://github.com/tatianagebrayel/Data-science-capstone/blob/master/EDA%20with%20SQL.ipynb

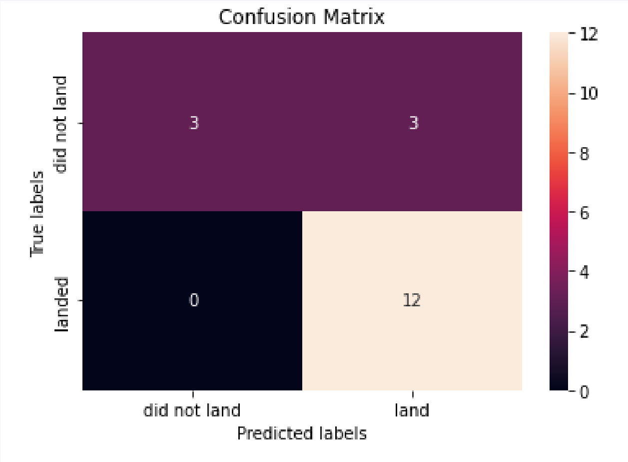
Build an Interactive Map with Folium

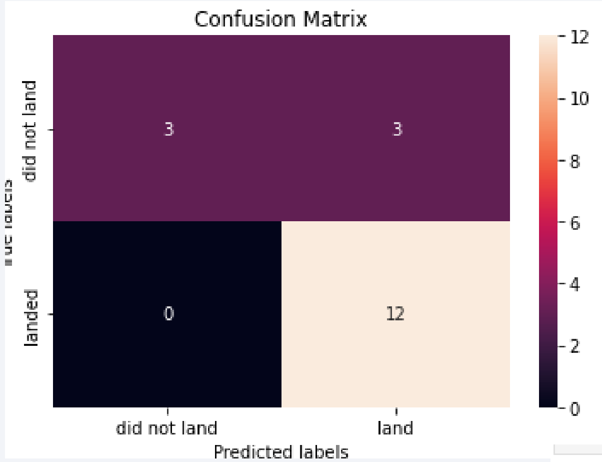


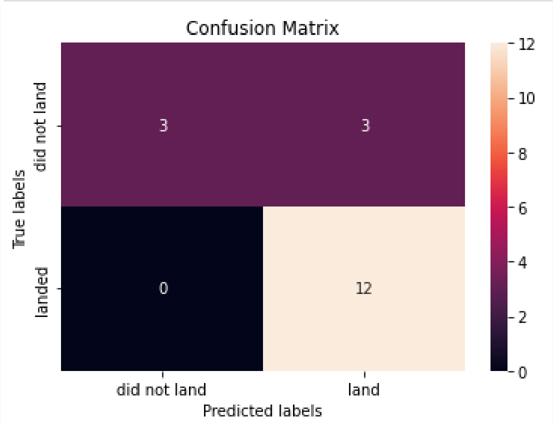
- https://github.com/tatianagebrayel/Data-science-capstone/blob/master/folium%20lab.ipynb

Predictive Analysis (Classification)









- Highest accuracy : 83.3%
- SVM performs the best in terms of Area Under the Curve at 0.958

- https://github.com/tatianagebrayel/Data-science-capstone/blob/master/machine%20learning%20prediction.ipynb

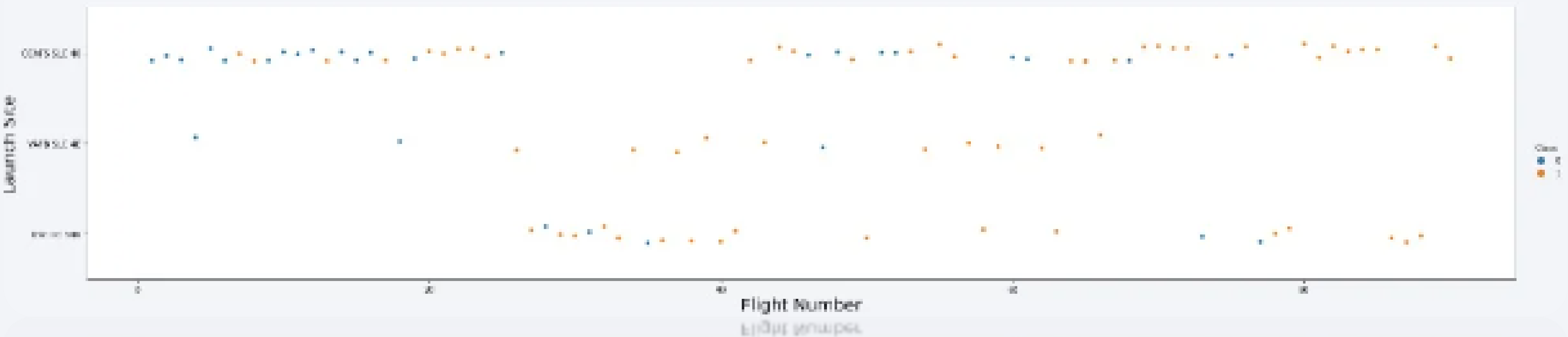
Results

- The SVM ,KNN and Logistic Regression models are the best in terms of prediction accuracy for this dataset
- Low weighted payloads perform better than the heavier payloads
- The success rates for SpaceX launches is directly proportional time in years
- KSC LC 39A had the most successful launches from all sites
- Orbit GEO,HEO,SSO, ES L1 have the best success rate

Section 2

Insights drawn from EDA

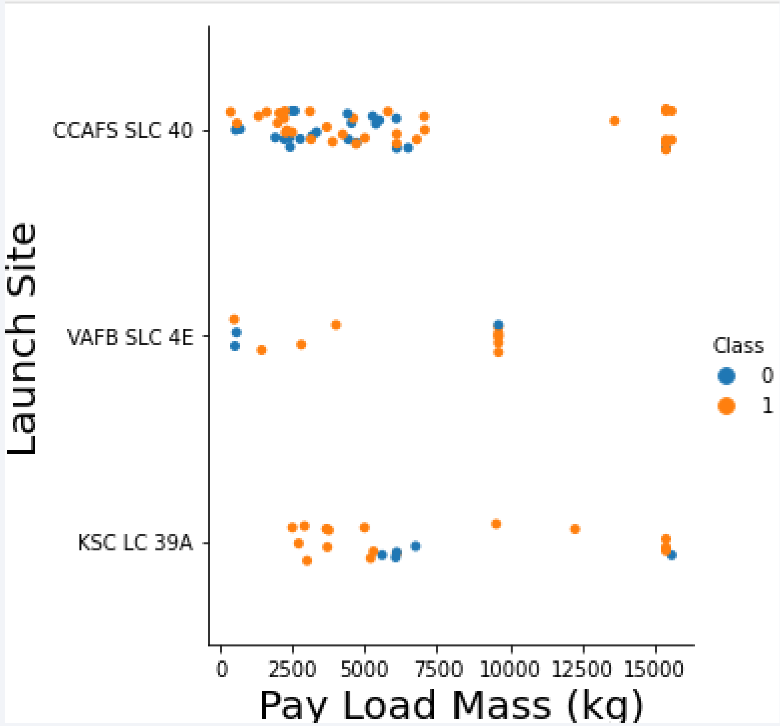
Flight Number vs. Launch Site



The highest launches are from CCAFS SLC 40

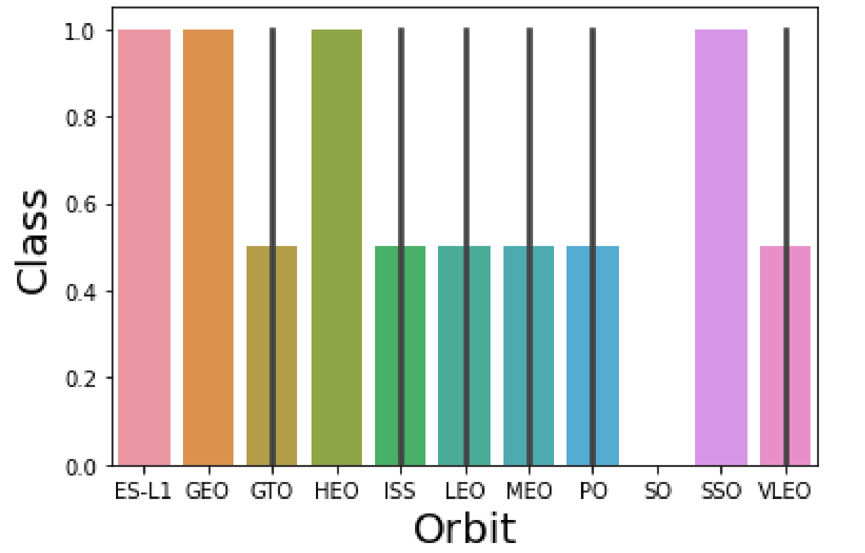
Payload vs. Launch Site

The majority of IPAY loads with lowe Mass have been launched from CCAFS SLC 40



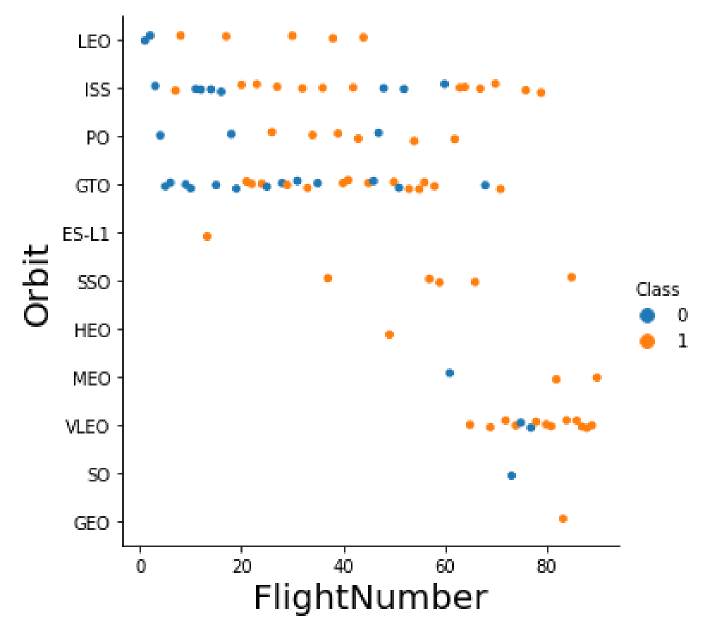
Success Rate vs. Orbit Type

- ES-L1 ,GEO , HEO and SSO have the highest success rate



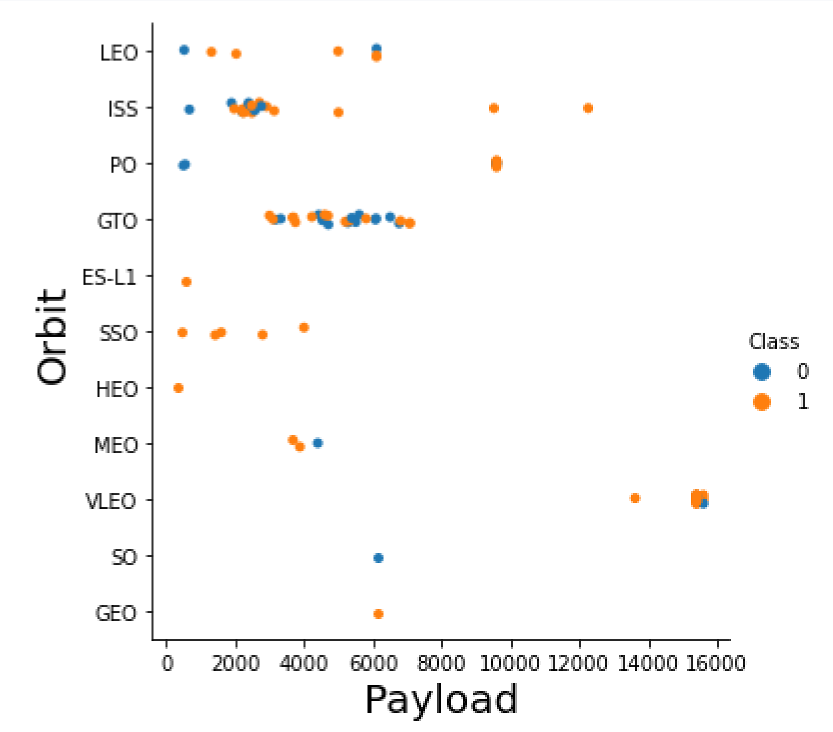
Flight Number vs. Orbit Type

- Changing to VLEO in recent years



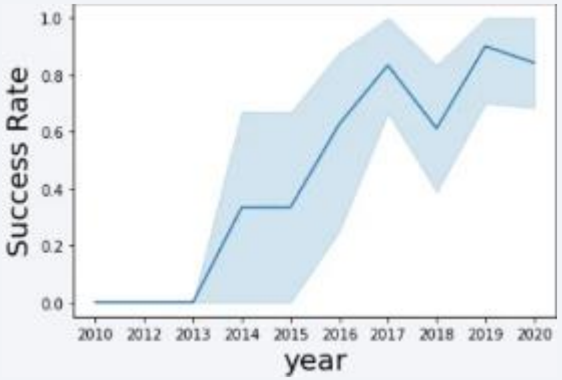
Payload vs. Orbit Type

- Strong correlation between ISS and Payload at the range 2000



Launch Success Yearly Trend

- Due to advance in technology success rate has increased since 2013



All Launch Site Names

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

Total Payload Mass

Total Payload Mass by NASA (CRS)
45596

Average Payload Mass by F9 v1.1

Average Payload Mass by Booster Version F9 v1.1
2928

First Successful Ground Landing Date

- date of the first successful landing outcome on ground pad :

  2015-12-22

- We can get it by using “MIN”, because first date is same wih the minimum date

Successful Drone Ship Landing with Payload between 4000 and 6000

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

  F9 FT B1022

  F9 FT B1026

  F9 FT B1021.2

  F9 FT B1031.2

- The payload mass data was taken between 4000 and 6000 only
- The landing outcome was determined to be “success drone ship”

Total Number of Successful and Failure Mission Outcomes

- Calculate the total number of successful mission outcomes : 100
- Calculate the total number of failure mission outcomes :1

Boosters Carried Maximum Payload

- 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

We can get the maximum payload masses by usin “MAX”

2015 Launch Records

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

  Month :1 Booster_version : F9v1.1B1012 Launch Site : CCAFSLC-40

  Month :4 Booster_version : F9v1.1B1012 Launch Site : CCAFSLC-40

- We can get the monyhs by using month (DATE) and in the WHERE function we assigned the year value to “2015”

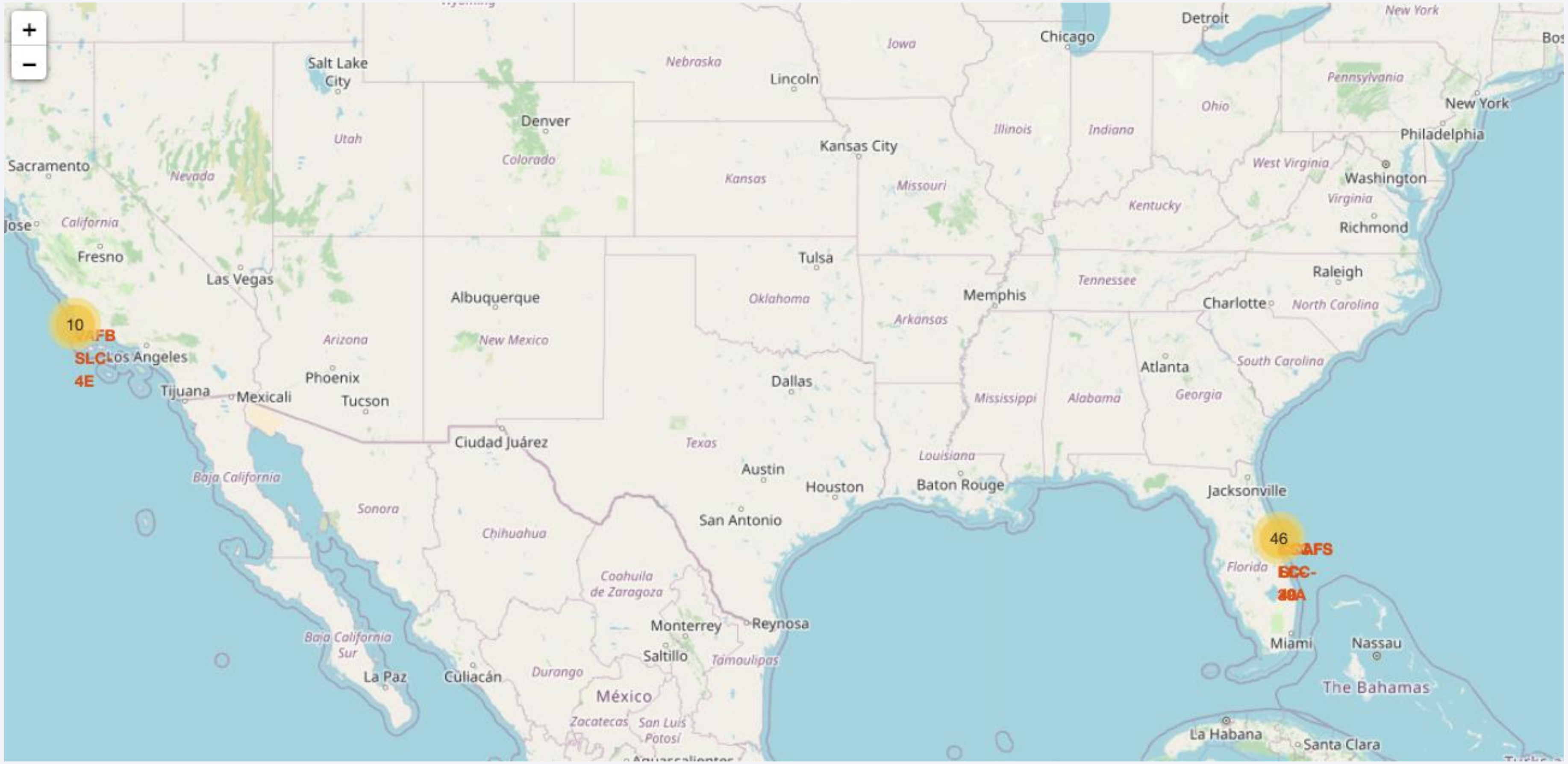
Rank Landing Outcomes Between 2010-06-04 and 2017-03-20

Landing Outcome	Total Count
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

Launch Sites



All the launches are near USA, Florida and California

Color_labeled Launch Outcomes

Launch sites to its Proximities

- All distances from launch sites to its proximities, they weren’t far fom railway tracks

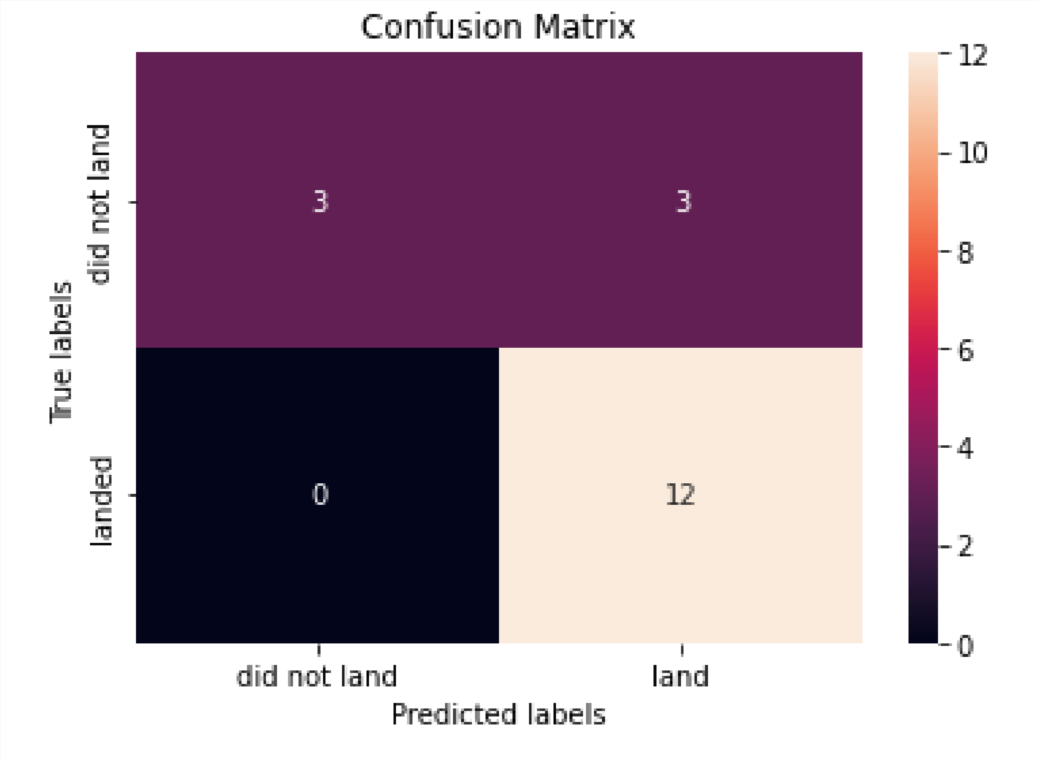
Section 4

Predictive Analysis (Classification)

Classification Accuracy

- Decision tree has the highest classification accuracy with almost 0.89

Confusion Matrix



Conclusions

- KSC LC -39A is the site with highest score
- Decision tree has the highest classification accuracy with almost 0.89
- Calculate the launch sites distance to its proximities
- The payload of 0 Kg to 5000 Kg is more diverse than 6000 Kg to 10 000 Kg

Thank you!