Data Science and Machine Learning Capstone Project

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Outline

- Executive Summary
- Introduction
- Methodology
- Results
- Conclusions

Introduction

Just recent news reminds me I used to completed this SpaceX Projects few years ago, companies have been in fierce competition to make space travel more affordable. One of the leading successes in this field is SpaceX, which has significantly reduced the cost of rocket launches by reusing the first stage of its boosters which is already come true.

This study aims to explore the factors that influence the successful landing of the first stage, as well as determine how these factors affect the cost of each launch and SpaceX's decision on whether to reuse the booster

Data Collection

Data Collection via Web Scraping

Create a `BeautifulSoup` object from the HTML `response`

```
[11]: # Use BeautifulSoup() to create a BeautifulSoup object from a response text content
      soup = BeautifulSoup (html_data.text,'html.parser')
```

Print the page title to verify if the `BeautifulSoup` object was created properly

```
[12]: # Use soup.title attribute
      soup.title
```

```
[12]: <title>List of Falcon 9 and Falcon Heavy launches - Wikipedia</title>
```

Data Collection via API connection

```
In [6]: spacex_url="https://api.spacexdata.com/v4/launches/past"
```

```
In [7]: response = requests.get(spacex_url)
```

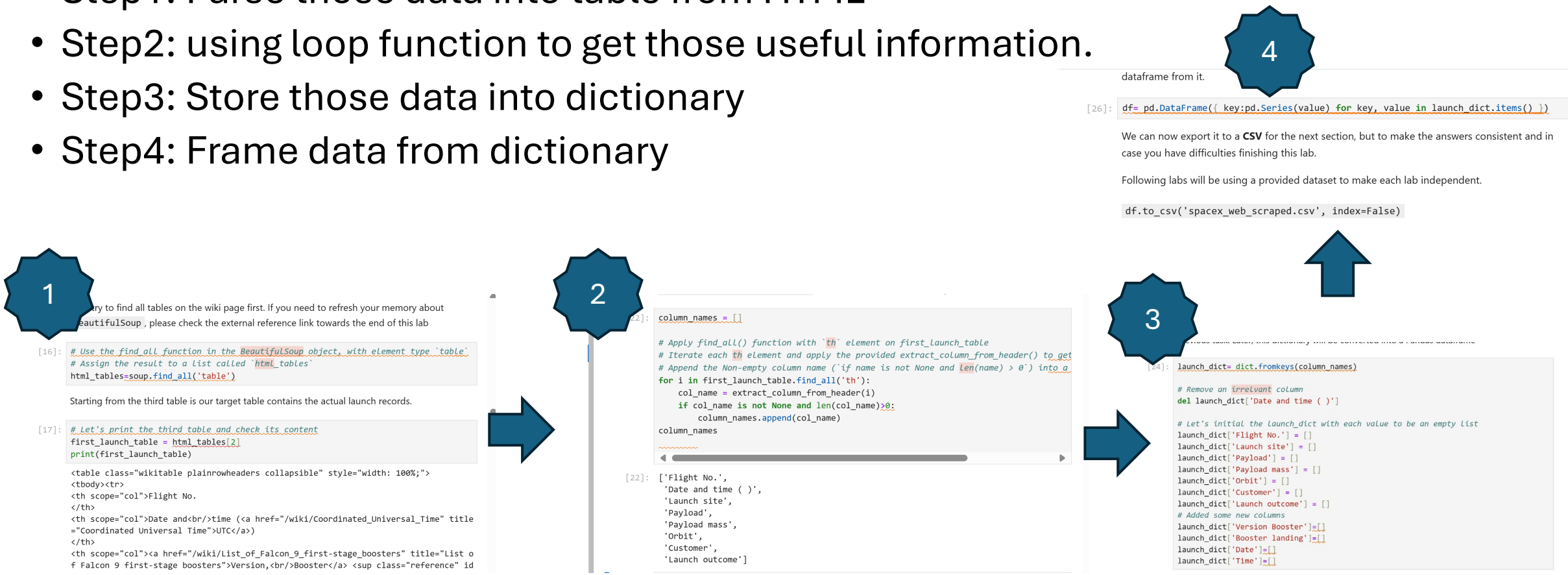
Check the content of the response

```
In [8]: print(response.content)
```


```
b'[{"fairings":{"reused":false,"recovery_attempt":false,"recovered":false,"ships":[]},"links":{"patch":{"smal
l":"https://images2.imgbox.com/94/f2/NN6Ph45r_o.png","large":"https://images2.imgbox.com/5b/02/QcxHUb5V_o.pn
g"},"reddit":{"campaign":null,"launch":null,"media":null,"recovery":null},"flickr":{"small":[],"original":[]},"pr
esskit":null,"webcast":"https://www.youtube.com/watch?v=0a_00nJ_Y88","youtube_id":"0a_00nJ_Y88","article":"http
s://www.space.com/2196-spacex-inaugural-falcon-1-rocket-lost-launch.html","wikipedia":"https://en.wikipedia.org/w
iki/DemoSat"},"static_fire_date_utc":"2006-03-17T00:00:00.000Z","static_fire_date_unix":1142553600,"net":false,"w
indow":0,"rocket":"5e9d0d95eda69955f709d1eb","success":false,"failures":[{"time":33,"altitude":null,"reason":"mer
lin engine failure"}],"details":"Engine failure at 33 seconds and loss of vehicle","crew":[],"ships":[],"capsule
s":[],"payloads":["5eb0e4b5b6c3bb0006eeb1e1"],"launchpad":"5e9e4502f5090995de566f86","flight_number":1,"name":"Fa
lconSat","date_utc":"2006-03-24T22:30:00.000Z","date_unix":1143239400,"date_local":"2006-03-25T10:30:00+12:00","d
ate_precision":"hour","upcoming":false,"cores":[{"core":"5e9e289df35918033d3b2623","flight":1,"gridfins":false,"l
egs":false,"reused":false,"landing_attempt":false,"landing_success":null,"landing_type":null,"landpad":null}],"au
to_update":true,"tbd":false,"launch_library_id":null,"id":"5eb87cd9ffd86e000604b32a"},{"fairings":{"reused":fals
```

Data Wrangling

- Data Cleansing
  - Step1: Parse those data into table from HTML
  - Step2: using loop function to get those useful information.
  - Step3: Store those data into dictionary
  - Step4: Frame data from dictionary



EDA - SQL

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

```
[9]: %sql Select distinct Launch_Site from SPACEXTABLE
```

```
 * sqlite:///my_data1.db
Done.
```

[9]:

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

Display 5 records where launch sites begin with the string 'KSC'

Display 5 records where launch sites begin with the string 'KSC'

```
[12]: %sql Select * from SPACEXTABLE where Launch_Site = 'KSC LC-39A' LIMIT
```

```
 * sqlite:///my_data1.db
Done.
```

[12]:

Date	Time (UTC)	Booster_Version	Launch_Site	Payload	PAYLOAD_MASS__KG
2017-02-19	14:39:00	F9 FT B1031.1	KSC LC-39A	SpaceX CRS-10	249
2017-03-16	6:00:00	F9 FT B1030	KSC LC-39A	EchoStar 23	560
2017-03-30	22:27:00	F9 FT B1021.2	KSC LC-39A	SES-10	530
2017-05-01	11:15:00	F9 FT B1032.1	KSC LC-39A	NROL-76	530
2017-05-15	23:21:00	F9 FT B1034	KSC LC-39A	Inmarsat-5 F4	607

EDA - SQL

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

```
[13]: %sql select distinct Customer from SPACEXTABLE
 * sqlite:///my_data1.db
Done.
```

[13]:

Customer
SpaceX
NASA (COTS) NRO
NASA (COTS)
NASA (CRS)
MDA
SES
Thaicom
Orbcomm
AsiaSat
U.S. Air Force NASA NOAA
ABS Eutelsat
Turkmenistan National Space Agency

Display average payload mass carried by booster version F9 V1.1

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

```
[15]: %sql select Avg(PAYLOAD_MASS__KG_) from SPACEXTABLE where Booster_Ver
 * sqlite:///my_data1.db
Done.
```

[15]:

Avg(PAYLOAD_MASS__KG_)
2928.4

EDA - SQL

List the date where the succesful landing outcome in drone ship was acheived

```
[17]: %sql select Date From SPACEXTABLE where landing_Outcome = 'Success (d
```

```
 * sqlite:///my_data1.db
Done.
```

[17]:

Date
2016-04-08
2016-05-06
2016-05-27
2016-08-14
2017-01-14
2017-03-30
2017-06-23
2017-06-25
2017-08-24

List the names of the boosters which have success in ground pad and have payload mass greater than 4000 but less than 6000¶

```
[18]: %sql select distinct landing_Outcome from SPACEXTABLE
```

```
 * sqlite:///my_data1.db
Done.
```

[18]:

Landing_Outcome
Failure (parachute)
No attempt
Uncontrolled (ocean)
Controlled (ocean)
Failure (drone ship)
Precluded (drone ship)
Success (ground pad)
Success (drone ship)
Success
Failure
No attempt

EDA - SQL

List the total number of successful and failure mission outcomes

```
[20]: %sql Select Mission_Outcome, Count(1) From SPACEXTABLE GROUP BY Missi
```

```
 * sqlite:///my_data1.db
Done.
```

[20]:

Mission_Outcome	Count(1)
Failure (in flight)	1
Success	98
Success	1
Success (payload status unclear)	1

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

```
[21]: %sql select Booster_version From SPACEXTABLE WHERE PAYLOAD_MASS__KG_=
```

```
 * sqlite:///my_data1.db
Done.
```

[21]:

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

EDA - SQL

List the records which will display the month names, succesful landing_outcomes in ground pad ,booster versions, launch_site for the months in year 2017

```
[23]: %sql select substr(date,6,2) as 'Month', Customer, Landing_Outcome, B
```

```
 * sqlite:///my_data1.db
Done.
```

[23]:

Month	Customer	Landing_Outcome	Booster_Version	Launch_Site
06	SpaceX	Failure (parachute)	F9 v1.0 B0003	CCAFS LC-40
12	NASA (COTS) NRO	Failure (parachute)	F9 v1.0 B0004	CCAFS LC-40

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

```
[28]: (select landing_Outcome, COUNT(1) AS 'counter' FROM SPACEXTABLE where
```

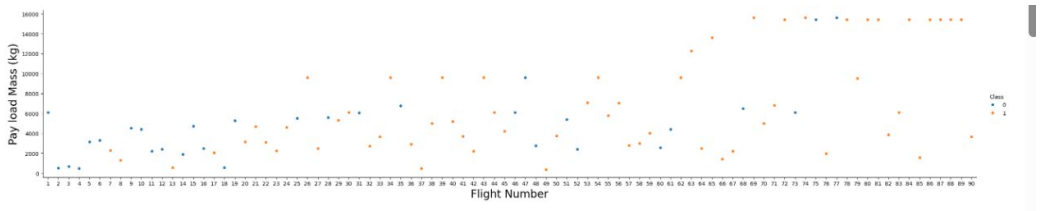
```
 * sqlite:///my_data1.db
Done.
```

[28]:

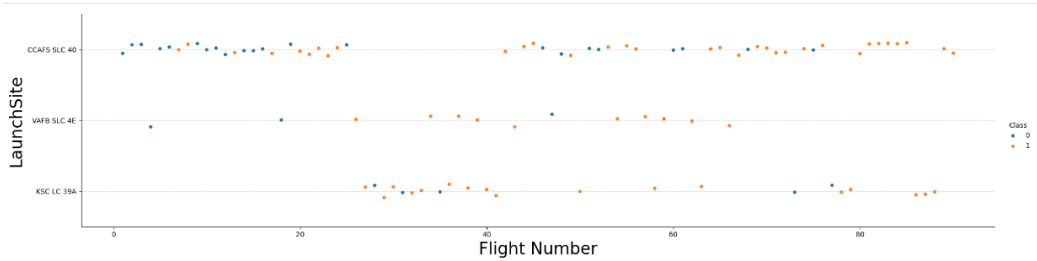
rank	landing_Outcome	counter
1	No attempt	10
2	Failure (drone ship)	5
2	Success (drone ship)	5
4	Controlled (ocean)	3
4	Success (ground pad)	3
6	Failure (parachute)	2
6	Uncontrolled (ocean)	2
8	Precluded (drone ship)	1

EDA – Data Visualization

Scatter Plot – Flight number Vs PayloadMass



Scatter Plot – FlightNumber Vs LaunchSite



EDA - Interactive Visual Analytics – Folium

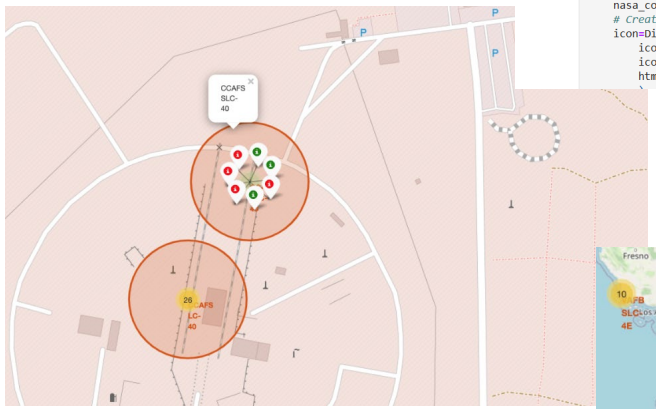
Interactive Map with Folium:

- **Label and text on the map**
- **Land marking with colour**
- **Show distance**

We could use `folium.Circle` to add a highlighted circle area with a text label on a specific coordinate. For example,

In [29]:

```
# Create a blue circle at NASA Johnson Space Center's coordinate with a popup label showing its name
circle = folium.Circle(nasa_coordinate, radius=1000, color='#d35400', fill=True).add_child(folium.Popup('NASA Johnson
# Create a blue circle at NASA Johnson Space Center's coordinate with a icon showing its name
marker = folium.map.Marker(
    nasa_coordinate,
    # Create an icon as a text label
    icon=DivIcon(
        icon_size=(20,20),
        icon_anchor=(0,0),
        html='<div style="font-size: 12; color:#d35400;"><b>%s</b></div>' % 'NASA JSC',
```



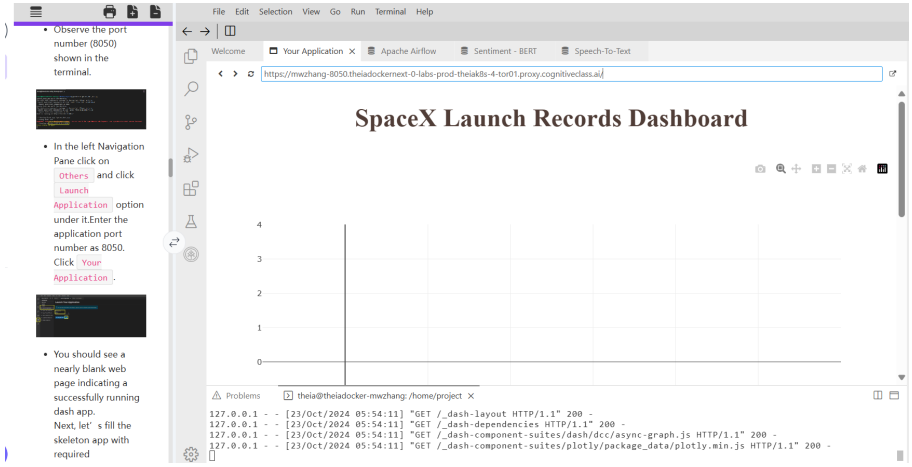
EDA - Interactive Visual Analytics -Plotly Dashboard 1/2

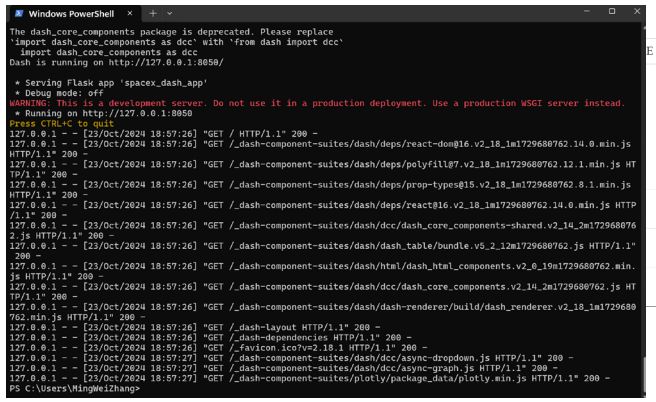
Can’t run properly in Skills Network, so have to run in local machine:

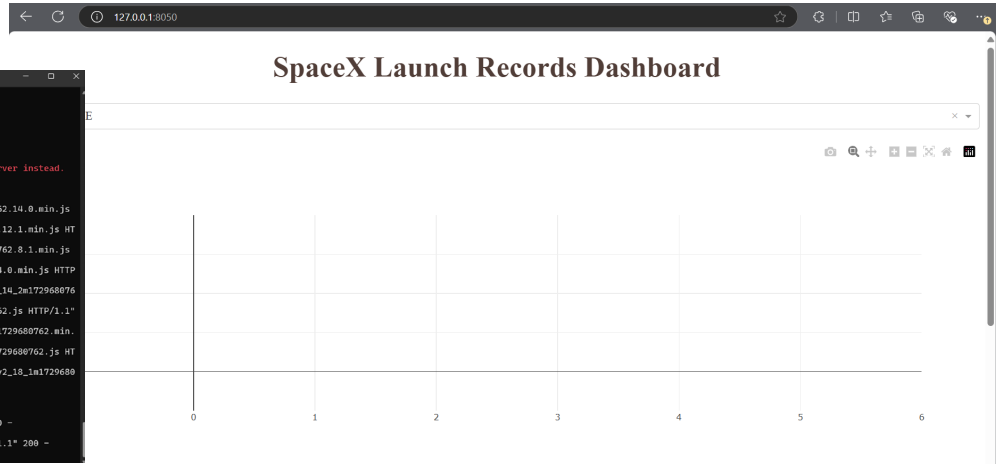
Install PowerShell and Python3.12 version

Dashboard with Select launch site

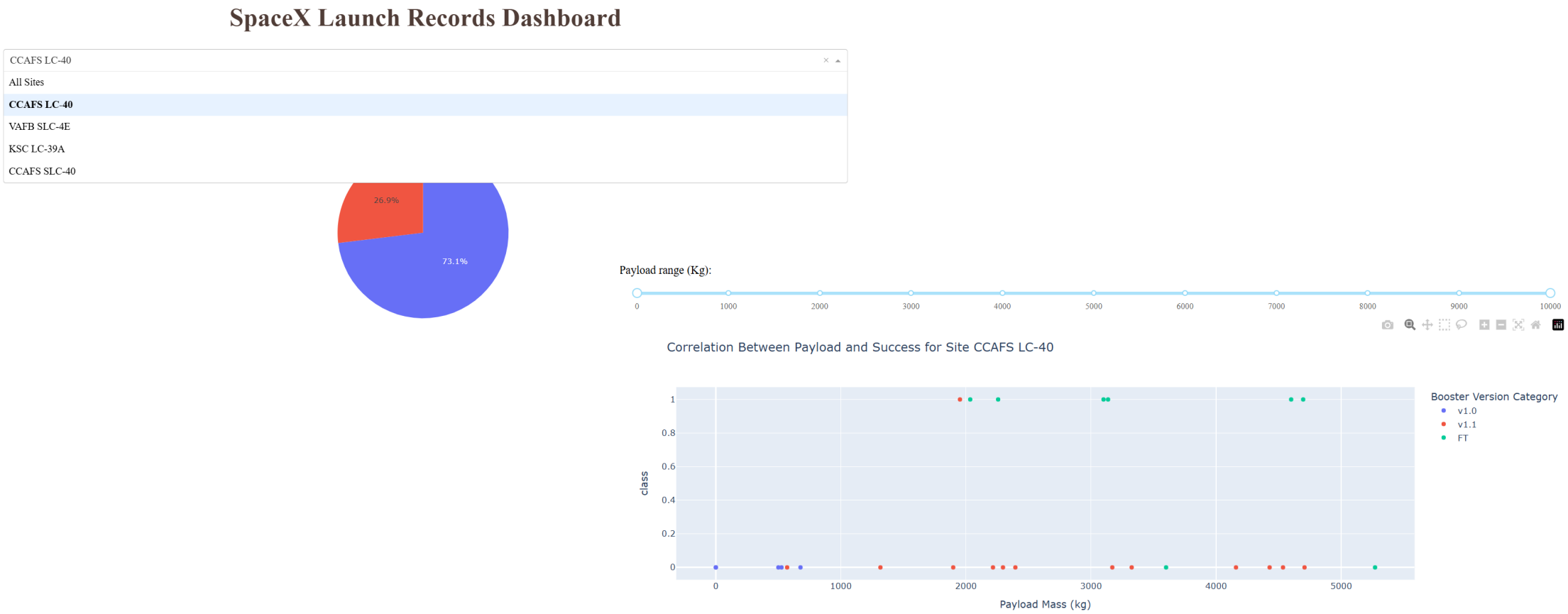
- ➢ Pie chat
- ➢ Range of payload mass]
- ➢ Scater plot class Vs. Payload mass by Booster version







EDA - Interactive Visual Analytics -Plotly Dashboard 2/2



Predictive Analysis 1/2

All test accuracy are same: 0.8334

Classifier Train Accuracy:

- KNN: 0.8482
- Decision Tree: 0.8750
- SVM： 0.8482
- Logreg： 0.8464

```
[36]: print(log_score, svm_score, tree_score, knn_score)

0.8333333333333334 0.8333333333333334 0.8333333333333334 0.8333333333333334
```

```
]: print("tuned hpyerparameters :(best parameters) ",logreg_cv.best_params_)
   print("accuracy :",logreg_cv.best_score_)

tuned hpyerparameters :(best parameters)  {'C': 0.01, 'penalty': 'l2', 'solver': 'lbfgs'}
accuracy : 0.8464285714285713
```

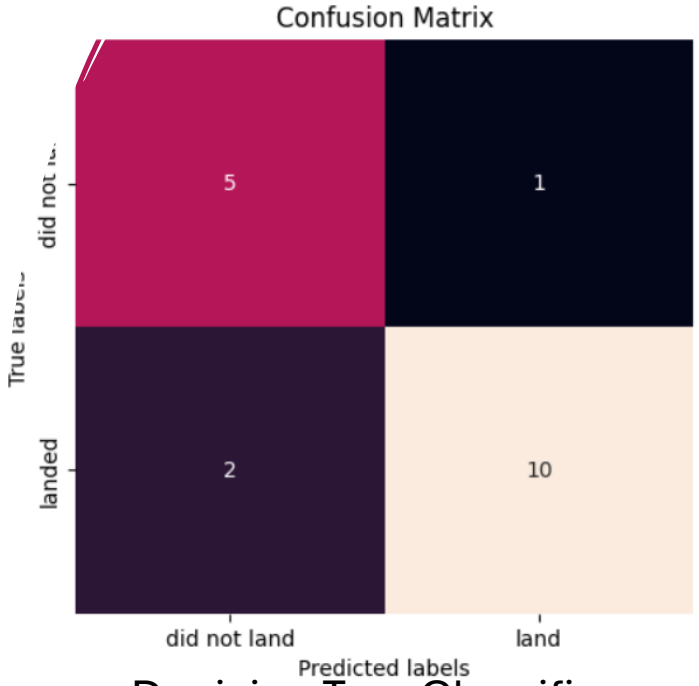
```
[23]: print("tuned hpyerparameters :(best parameters) ",svm_cv.best_params_)
      print("accuracy :",svm_cv.best_score_)

tuned hpyerparameters :(best parameters)  {'C': 1.0, 'gamma': 0.03162277660168379, 'kernel': 'sigmoid'}
accuracy : 0.8482142857142856
```

```
]: print("tuned hpyerparameters :(best parameters) ",tree_cv.best_params_)
   print("accuracy :",tree_cv.best_score_)

tuned hpyerparameters :(best parameters)  {'criterion': 'entropy', 'max_depth': 4, 'max_features': 'sqrt', 'min_sam
les_split': 10, 'splitter': 'best'}
accuracy : 0.875
```

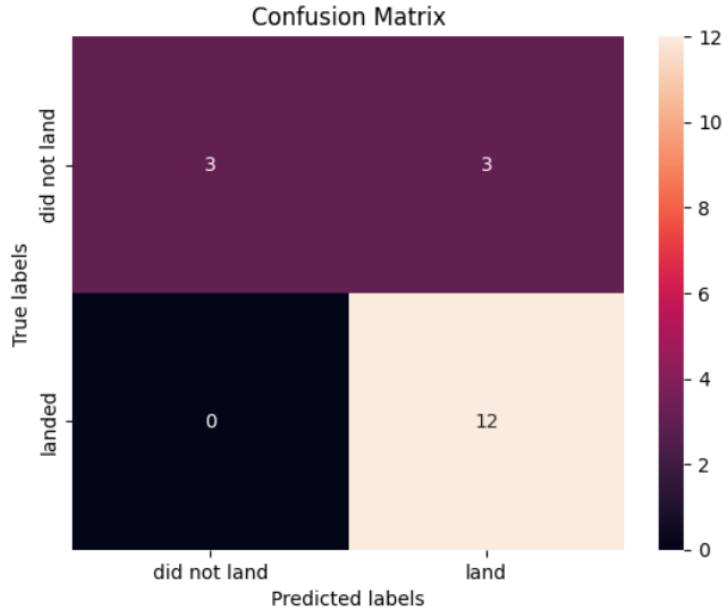
```
[33]: print("tuned hpyerparameters :(best parameters) ",knn_cv.best_params_)
      print("accuracy :",knn_cv.best_score_)

tuned hpyerparameters :(best parameters)  {'algorithm': 'auto', 'n_neighbors': 10, 'p': 1}
accuracy : 0.8482142857142858
```

Predictive Analysis 2/2

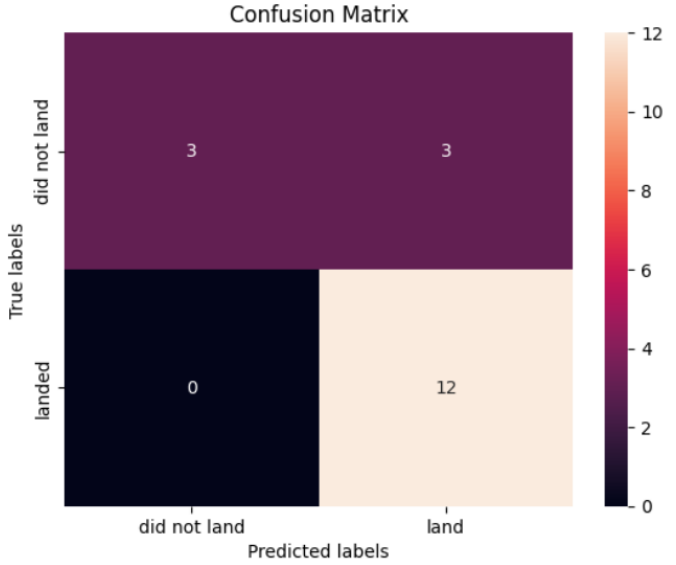
- All modes logistic regression, support vector machine, Decision tree classifier and K-nearest neighbors



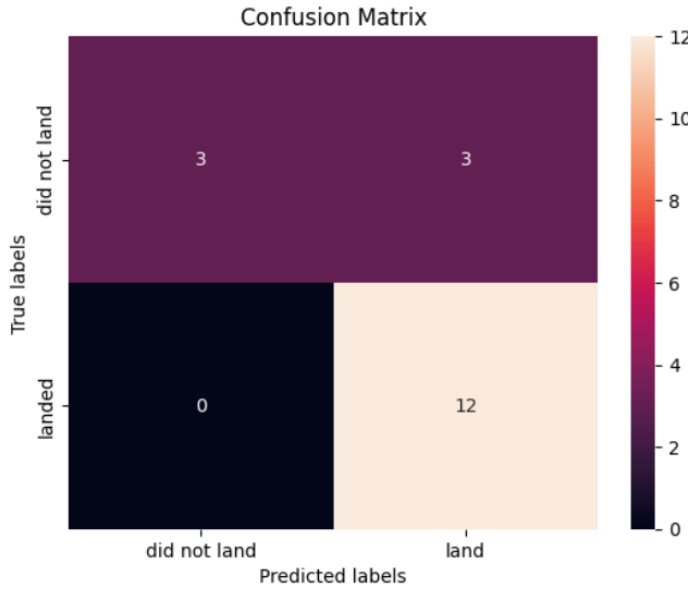
Decision Tree Classifier



SVM Classifier



KNN Classifier



Logistic Regression Classifier

Conclusion

- Success rate increased over more years, and also lower payload mass has higher success rate.
- The lowest success rate is SO type
- If payload range less than 5000kg, it shows best performance
- Classification method show same result for predicting.
- KSC LC-39A is good launch site
- Based on lauch site position in the map (Folium Analysis), launch site will be built closed to water, it is kind of protect debris. And also far away from city. and it is closed to railways and highways, it will be easier for fuel truck