Into Space with Data Science

Applied Data Science Capstone Project

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Executive Summary

The rapid advancements in space exploration, coupled with the explosive growth of data science, have revolutionized how we study, understand, and utilize space. "Into Space with Data Science" explores the pivotal role of data science in modern space exploration. By leveraging massive datasets collected, analyzed and presented the information to enables more efficient space mission planning, real-time data analysis, predictive modeling, and enhanced decision-making.

Introduction

SpaceX exploration has evolved significantly with the integration of data science, which plays a crucial role in analyzing vast amounts of data from missions. By applying techniques like machine learning and predictive analytics, data science helps researchers better understand the universe, optimize mission operations, and make informed decisions.

Problem Statement

In this capstone, we are trying the analysis how data science can help to transform space exploration, enabling more accurate predictions, improved safety, and faster discoveries based on large datasets available on public.

Methodology

The methodology focuses on systematically gathering, processing, analyzing, and visualizing data to extract valuable insights. Below is an outline of the key components involved in this methodology:

1. Data Collection:

Data collection is the foundation of any space-related research. This data often comes from a variety of sources for this capstone, data was first collected using SpaceX API (a RESTful API) by making a get request to the SpaceX API.

Task 1: Request and parse the SpaceX launch data using the GET request

To make the requested JSON results more consistent, we will use the following static response object for this project:

```
static_json_url='https://cf-courses-data.s3.us.cloud-object-storage.appdomain.cloud/IBM-DS0321EN-SkillsNetw
```

We should see that the request was successfull with the 200 status response code

```
response.status_code
```

```
200
```

Now we decode the response content as a Json using `.json()` and turn it into a Pandas dataframe using `.json_normalize()`

Methodology Cont.

2. Web Scraping

Web scraping is a method used to extract data from websites that host space-related information, performed web scraping to collect Falcon 9 historical launch records from a Wikipedia using BeautifulSoup and request, to extract the Falcon 9 launch records from HTML table of the Wikipedia page, then created a data frame by parsing the launch HTML.

TASK 1: Request the Falcon9 Launch Wiki page from its URL

First, let's perform an HTTP GET method to request the Falcon9 Launch HTML page, as an HTTP response.

```
# use requests.get() method with the provided static_url
# assign the response to a object
response = requests.get(static_url)
```

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

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

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

```
# Use soup.title attribute
soup.title
```

```
<title>List of Falcon 9 and Falcon Heavy launches - Wikipedia</title>
```

Methodology Cont.

3. Data Wrangling

Once the data is collected, it often comes in an unorganized or messy format. Data wrangling (also known as data cleaning) is essential to prepare the data for analysis.
This process includes handling missing values, removing duplicates, correcting data inconsistencies, and converting data types as needed.
Performed some Exploratory Data Analysis (EDA) to find some patterns in the data and determine what would be the label for training.

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

Use the method `.value_counts()` on the column `Outcome` to determine the number of `landing_outcomes` .Then assign it to a variable landing_outcomes.

```
# landing_outcomes = values on Outcome column
landing_outcomes = df['Outcome'].value_counts()
landing_outcomes
```

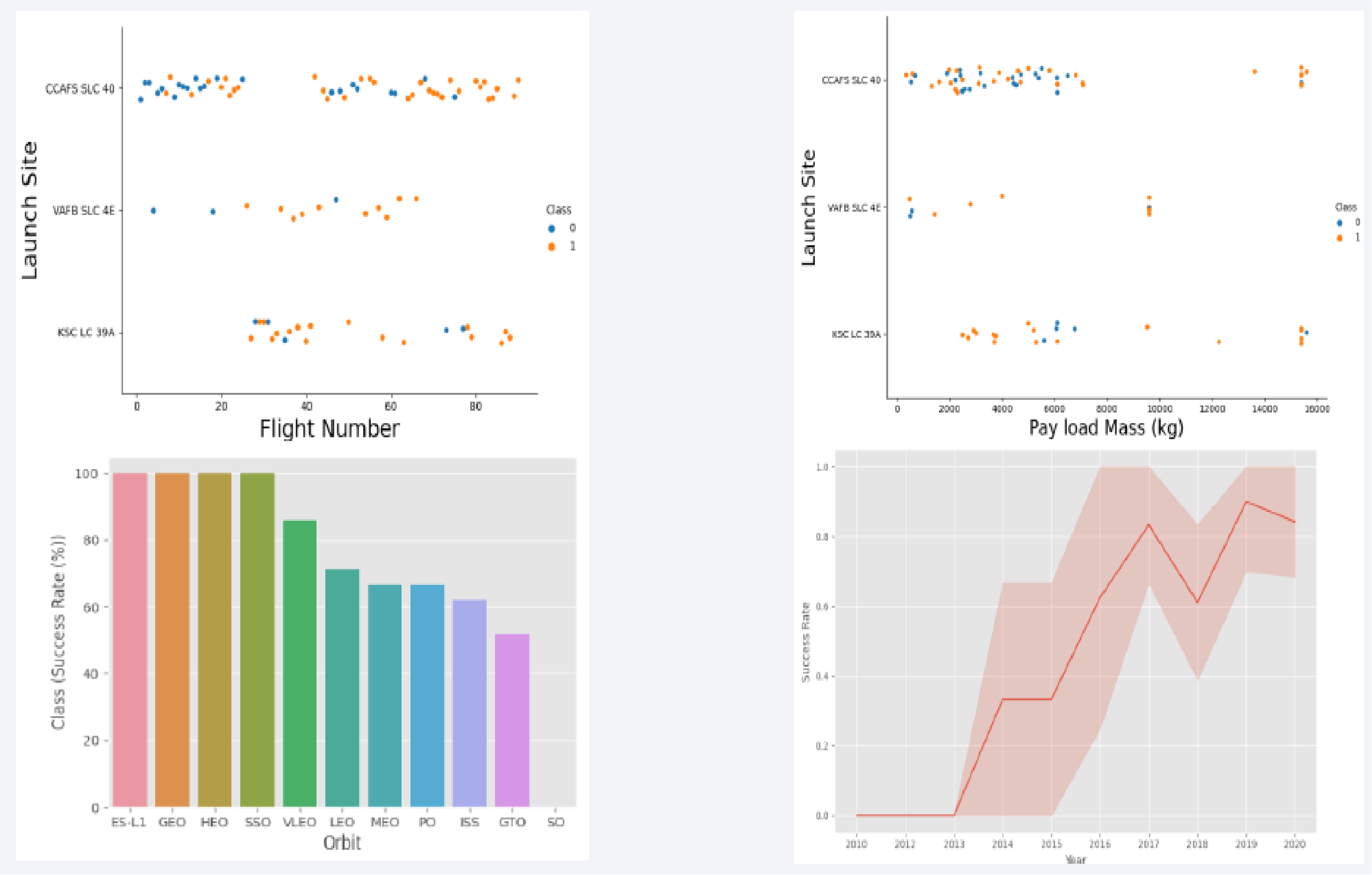
```
True ASDS      41
None None      19
True RTLS      14
False ASDS      6
True Ocean      5
False Ocean     2
None ASDS       2
False RTLS      1
Name: Outcome, dtype: int64
```

Methodology Cont. - EDA with visualization results

4. Data Visualization and Dashboard

Data visualization and creation of dashboard are crucial for translating, reporting and presenting.

- Used EDA for data visualization.
- Used scatter plots to Visualize the relationship between Flight Number and Launch Site, Payload and Launch Site, Flight Number and Orbit type, Payload and Orbit type.
- Used Bar chart to Visualize the relationship between success rate of each orbit type
- Line plot to Visualize the launch success yearly trend.



Methodology Cont. -EDA with SQL results

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

```
%sql SELECT DISTINCT LAUNCH_SITE as "Launch_Sites" FROM SPACEXTBL;
```

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

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

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

```
%sql SELECT SUM(PAYLOAD_MASS__KG_) as "Total Payload Mass(Kgs)", Customer FROM 'SPACEXTBL' WHERE Customer = 'NASA (CRS)';
```

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

```
%sql SELECT AVG(PAYLOAD_MASS__KG_) as "Payload Mass Kgs", Customer, Booster_Version FROM 'SPACEXTBL' WHERE Booster_Version L
```

Interactive map with Folium Results

- Created folium map to marked all the launch sites, and created map objects such as markers, circles, lines to mark the success or failure of launches for each launch site.
- Created a launch set outcomes (failure=0 or success=1).

```
spacex_df.tail(10)
```

	Launch Site	Lat	Long	class
46	KSC LC-39A	28.573255	-80.646895	1
47	KSC LC-39A	28.573255	-80.646895	1
48	KSC LC-39A	28.573255	-80.646895	1
49	CCAFS SLC-40	28.563197	-80.576820	1
50	CCAFS SLC-40	28.563197	-80.576820	1
51	CCAFS SLC-40	28.563197	-80.576820	0
52	CCAFS SLC-40	28.563197	-80.576820	0
53	CCAFS SLC-40	28.563197	-80.576820	0
54	CCAFS SLC-40	28.563197	-80.576820	1
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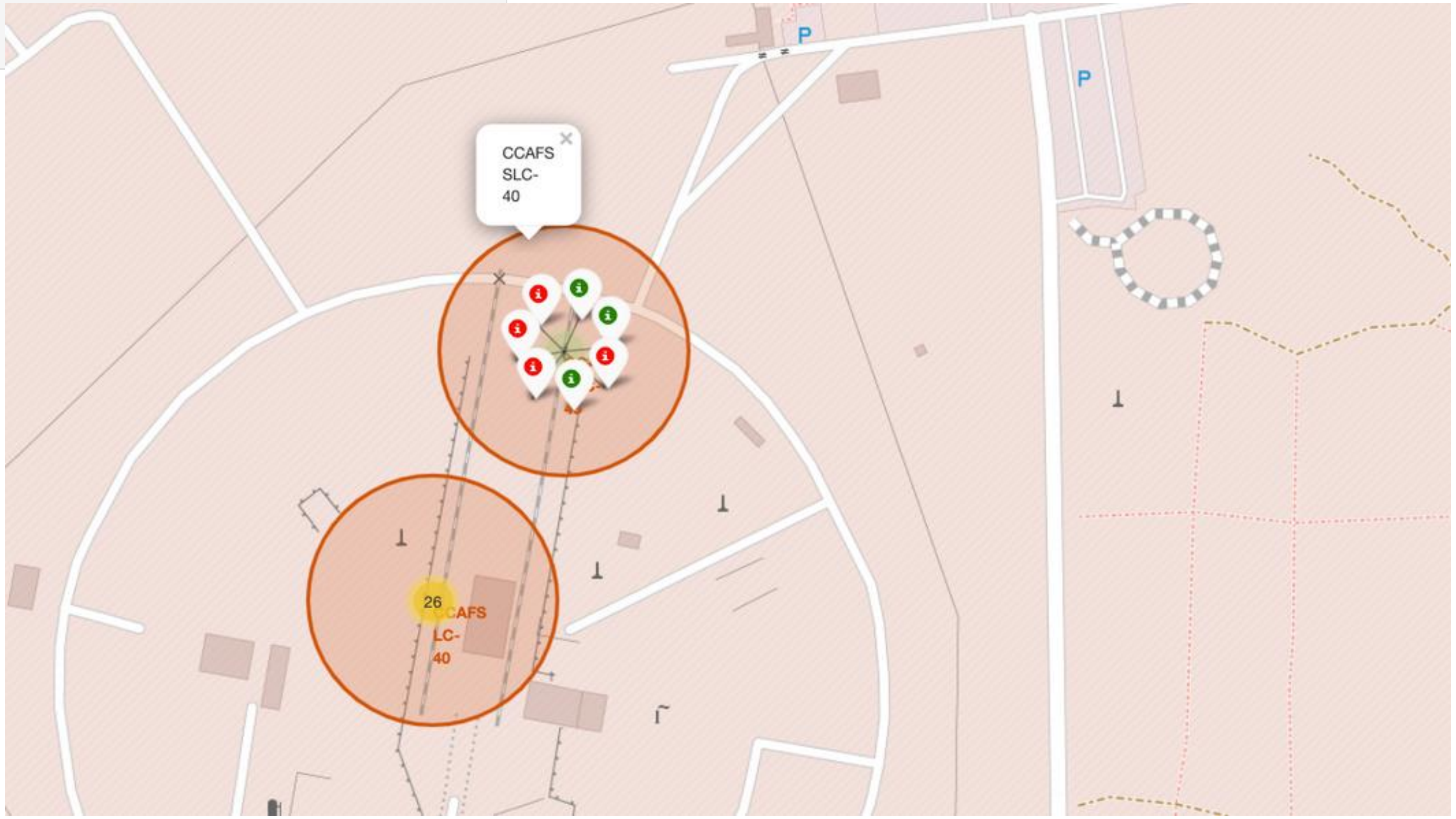
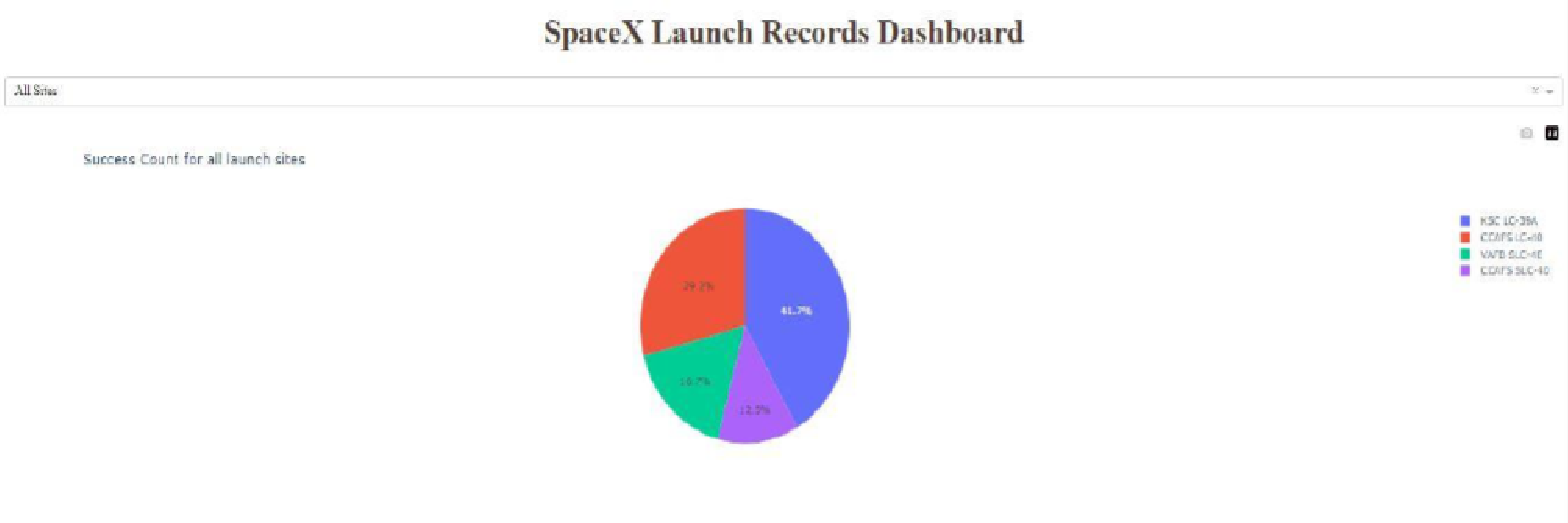


Plotly Dash Dashboard Results

Built an interactive dashboard application with Plotlydash by:

- Adding a Launch Site Drop-down Input Component
- Adding a callback function to render success-pie-chart based on selected site dropdown
- Adding a Range Slider to Select Payload
- Adding a callback function to render the success-payload-scatter-chart scatter plot

Pie-Chart for launch success count for all sites



- Launch site KSC LC-39A has the highest launch success rate at 42% followed by CCAFS LC-40 at 29%, VAFB SLC-4E at 17% and lastly launch site CCAFS SLC-40 with a success rate of 13%

Predictive Analysis (classification) Results

A type of machine learning technique used to predict categorical outcomes based on input data. The table below shows the test data accuracy score for each of the methods comparing them to show which performed best using the test data between **SVM**, Classification **Trees**, **k nearest neighbors** and **Logistic Regression**.

```
Report = pd.DataFrame({'Method' : ['Test Data Accuracy']})

knn_accuracy=knn_cv.score(X_test, Y_test)
Decision_tree_accuracy=tree_cv.score(X_test, Y_test)
SVM_accuracy=svm_cv.score(X_test, Y_test)
Logistic_Regression=logreg_cv.score(X_test, Y_test)

Report['Logistic_Reg'] = [Logistic_Regression]
Report['SVM'] = [SVM_accuracy]
Report['Decision Tree'] = [Decision_tree_accuracy]
Report['KNN'] = [knn_accuracy]




Report.transpose()
```

	0
Method	Test Data Accuracy
Logistic_Reg	0.833333
SVM	0.833333
Decision Tree	0.833333
KNN	0.833333

Conclusion

Different launch sites have different success rates. CCAFS LC-40, has a success rate of 60 %, while KSC LC-39A and VAFB SLC 4E has a success rate of 77%.

We can deduce that, as the flight number increases in each of the 3 launch sites, so does the success rate. For instance, the success rate for the VAFB SLC 4E launch site is 100% after the Flight number 50. Both KSC LC 39A and CCAFS SLC 40 have a 100% success rates after 80th flight.

If you observe Payload Vs. Launch Site scatter point chart you will find for the VAFB-SLC launch site there are no rockets launched for heavy payload mass(greater than 10000).

Orbits ES-L1, GEO, HEO & SSO have the highest success rates at 100%, with SO orbit having the lowest success rate at ~50%. Orbit SO has 0% success rate.

LEO orbit the Success appears related to the number of flights; on the other hand, there seems to be no relationship between flight number when in GTO orbit.

And finally, the success rate since 2013 kept increasing till 2020.

Thank You