"Interstellar Odyssey: Future Rockets and the Data Science Revolution"

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INTRODUCTION

Fasten your Seat Belt

- Embark on a stellar journey where science and data converge! In a near future, humanity explores new galaxies, guided by the power of data science. Join us as we challenge the laws of physics and our understanding of existence in this epic quest into the unknown. Welcome to a journey where the future meets the infinite!

Project Context

- 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 can determine 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. In this prokect, we will collect and make sure the data is in the correct format from an API. The following is an example of a successful and launch.

1.- What is the impact of reusing the first stage on the economics of space launches?

2.- How can data science be leveraged to anticipate the success of first-stage reuse?

3.- What are the key factors in determining the cost of space launches?

METHODOLOGY

METHODOLOGY

- **Data Collection:**
    1. We gathered data through web scraping from Wikipedia and utilizing the SpaceX website API.

1. **Data Wrangling:**
    1. We performed the Data Wrangling process to ensure the quality and consistency of the collected data.
2. **Data Analysis (EDA) using SQL in Python:**
    1. SQL queries were employed for Exploratory Data Analysis (EDA), providing insights into the structure and distribution of the data.
3. **Visual Analysis using Folium and Plotly Dash:**
    1. Folium was implemented for geospatial data visualization.
    2. Plotly Dash was used to create interactive and dynamic visualizations.
4. **Machine Learning Model:**
    1. We developed a robust Machine Learning model to analyze and make predictions based on the collected data.
    2. The model was trained using suitable algorithms relevant to the nature of the data and analysis objectives.

Data Collection:

The data collection process involved several methods. Initially, data was gathered through a get request to the SpaceX API. Subsequently, we decoded the response content as JSON using the .json() function call and transformed it into a Pandas dataframe using .json_normalize().

Following this, we conducted data cleaning by checking for missing values and filling in the gaps where necessary. Additionally, we performed web scraping on Wikipedia to obtain Falcon 9 launch records. This involved using BeautifulSoup to extract launch records as an HTML table, parsing the table, and converting it into a Pandas dataframe for subsequent analysis.

We utilized a GET request to the SpaceX API for data collection, subsequently performing data cleaning, basic data wrangling, and formatting on the obtained data.

Data Collection:

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:

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

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

```
[ ] print(response.content)
```

b'[{"fairings":{"reused":false,"recovery_attempt":false,"recovered":false,"ships":[]},"links":{"patch":{"small":"https://images2.imgbox.com/94/f2/NN6Ph45r_o.png","large":"https://images2.imgbo

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

```
[ ] 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()

```
[ ] response.json()
```

    'landing_success': None,
    'landing_type': None,
    'landpad': None}],
  'auto_update': True,
  'tbd': False,
  'launch_library_id': None,
  'id': '5eb87ce3ffd86e000604b336'},
 {'fairings': None,
  'links': {'patch': {'small': 'https://images2.imgbox.com/ae/3c/yVvE2vVh_o.png',
    'large': 'https://images2.imgbox.com/82/c7/bbs0gt88_o.png'},
   'reddit': {'campaign': None,
    'launch': 'http://www.reddit.com/r/spacex/comments/22zo8c',
    'media': None,

Link: https://colab.research.google.com/github/JorgeJaramilo060892/Testrepo/blob/main/SpaceX_Falcon9_FirstStageLanding_Prediction.ipynb

Data Collection:

More specifically, the launch records are stored in a HTML table shown below:

2020 [edit]

In late 2019, Gwynne Shotwell stated that SpaceX hoped for as many as 24 launches for Starlink satellites in 2020,[490] in addition to 14 or 15 non-Starlink launches. At 26 launches, 13 of which for Starlink satellites, Falcon 9 had its most prolific year, and Falcon rockets were second most prolific rocket family of 2020, only behind China's Long March rocket family.[491]

[hide] Flight No.	Date and time (UTC)	Version, Booster[b]	Launch site	Payload[c]	Payload mass	Orbit	Customer	Launch outcome	Booster landing
78	7 January 2020, 02:19:21[432]	F9 B5 △ B1049.4	CCAFS, SLC-40	Starlink 2 v1.0 (60 satellites)	15,600 kg (34,400 lb)[5]	LEO	SpaceX	Success	Success (drone ship)
	Third large batch and second operational flight of Starlink constellation. One of the 60 satellites included a test coating to make the satellite less reflective, and thus less likely to interfere with ground-based astronomical observations.[433]								
79	19 January 2020, 15:30[494]	F9 B5 △ B1046.4	KSC, LC-39A	Crew Dragon in-flight abort test[495] (Dragon C205.1)	12,050 kg (26,570 lb)	Sub-orbital[496]	NASA (CTS)[497]	Success	No attempt
	An atmospheric test of the Dragon 2 abort system after Max Q. The capsule fired its SuperDraco engines, reached an apogee of 40 km (25 mi), deployed parachutes after reentry, and splashed down in the ocean 31 km (19 mi) downrange from the launch site. The test was previously slated to be accomplished with the Crew Dragon Demo-1 capsule;[498] but that test article exploded during a ground test of SuperDraco engines on 20 April 2019.[419] The abort test used the capsule originally intended for the first crewed flight.[499] As expected, the booster was destroyed by aerodynamic forces after the capsule aborted.[500] First flight of a Falcon 9 with only one functional stage — the second stage had a mass simulator in place of its engine.								
80	29 January 2020, 14:07[501]	F9 B5 △ B1051.3	CCAFS, SLC-40	Starlink 3 v1.0 (60 satellites)	15,600 kg (34,400 lb)[5]	LEO	SpaceX	Success	Success (drone ship)
	Third operational and fourth large batch of Starlink satellites, deployed in a circular 290 km (180 mi) orbit. One of the fairing halves was caught, while the other was fished out of the ocean.[502]								
81	17 February 2020, 15:05[503]	F9 B5 △ B1056.4	CCAFS, SLC-40	Starlink 4 v1.0 (60 satellites)	15,600 kg (34,400 lb)[5]	LEO	SpaceX	Success	Failure (drone ship)
	Fourth operational and fifth large batch of Starlink satellites. Used a new flight profile which deployed into a 212 km × 386 km (132 mi × 240 mi) elliptical orbit instead of launching into a circular orbit and firing the second stage engine twice. The first stage booster failed to land on the drone ship[504] due to incorrect wind data.[505] This was the first time a flight proven booster failed to land.								
82	7 March 2020, 04:50[506]	F9 B5 △ B1059.2	CCAFS, SLC-40	SpaceX CRS-20 (Dragon C112.3 △)	1,977 kg (4,359 lb)[507]	LEO (ISS)	NASA (CRS)	Success	Success (ground pad)
	Last launch of phase 1 of the CRS contract. Carries *Bartolomeo*, an ESA platform for hosting external payloads onto ISS.[508] Originally scheduled to launch on 2 March 2020, the launch date was pushed back due to a second stage engine failure. SpaceX decided to swap out the second stage instead of replacing the faulty part.[509] It was SpaceX's 50th successful landing of a first stage booster, the third flight of the Dragon C112 and the last launch of the cargo Dragon spacecraft.								
83	18 March 2020, 12:16[510]	F9 B5 △ B1048.5	KSC, LC-39A	Starlink 5 v1.0 (60 satellites)	15,600 kg (34,400 lb)[5]	LEO	SpaceX	Success	Failure (drone ship)
	Fifth operational launch of Starlink satellites. It was the first time a first stage booster flew for a fifth time and the second time the fairings were reused (Starlink flight in May 2019).[511] Towards the end of the first stage burn, the booster suffered premature shut down of an engine, the first of a Merlin 1D variant and first since the CRS-1 mission in October 2012. However, the payload still reached the targeted orbit.[512] This was the second Starlink launch booster landing failure in a row, later revealed to be caused by residual cleaning fluid trapped inside a sensor.[513]								
84	22 April 2020, 19:30[514]	F9 B5 △ B1051.4	KSC, LC-39A	Starlink 6 v1.0 (60 satellites)	15,600 kg (34,400 lb)[5]	LEO	SpaceX	Success	Success (drone ship)

In [ ]:
```python
static_url = "https://en.wikipedia.org/w/index.php?title=List_of_Falcon_9_and_Falcon_Heavy_launches&oldid=1027
```

Next, request the HTML page from the above URL and get a `response` object

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.

In [ ]:
```python
response1 = requests.get(static_url)
```

In [ ]:
```python
print(response1.content)
```

Data Collection:

In [ ]:
```python
# We need to use BeautifulSoup() to create a BeautifulSoup object from a response text content
soup = BeautifulSoup(response1.text, 'html.parser')
```

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

In [ ]:
```python
# We nee to use soup.title attribute
print("Title:", soup.title.text)
soup.title
```

```
Title: List of Falcon 9 and Falcon Heavy launches - Wikipedia
```

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

Lets extract all column/variable names from the HTML table header

Next, we want to collect all relevant column names from the HTML table header Let's try to find all tables on the wiki page first. If you need to refresh your memory about `BeautifulSoup`, please check the external reference link towards the end of this lab

In [ ]:
```python
# We need to use the find_all function in the BeautifulSoup object, with element type `table`
# Assign the result to a list called `html_tables`
html_tables = soup.find_all('table')
html_tables
```

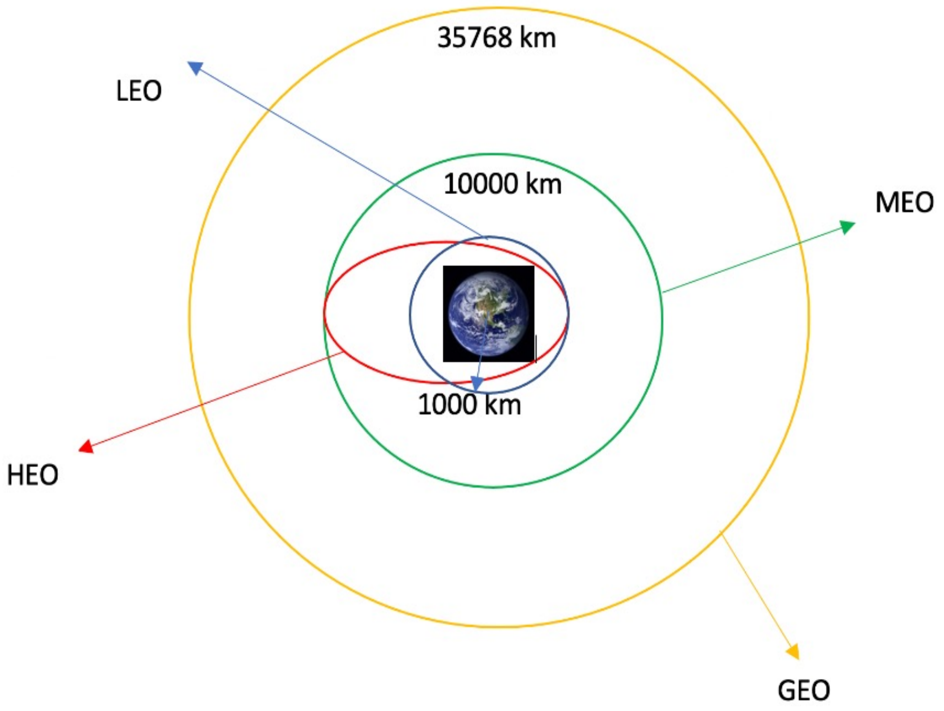
Link:https://github.com/JorgeJaramilo060892/Space-X-Project/blob/main/SpaceX_Falcon9_FirstStageLanding_Prediction.ipynb

Data Wrangling:

As part of the data wrangling process, we are set to conduct Exploratory Data Analysis (EDA) to identify patterns in the dataset. Our objective is to determine the appropriate label for training supervised models.
Within the dataset, there are diverse scenarios where booster landings were not successful. Instances include failed attempts due to accidents. For instance, "True Ocean" indicates a successful landing in a specific ocean region, while "False Ocean" signifies an unsuccessful landing in a designated ocean region. Similarly, "True RTLS" denotes a successful landing on a ground pad, and "False RTLS" indicates an unsuccessful ground pad landing. "True ASDS" represents a successful landing on a drone ship, and "False ASDS" indicates an unsuccessful drone ship landing.
Our primary focus is to convert these outcomes into training labels. Here, 1 signifies a successfully landed booster, while 0 denotes an unsuccessful landing. This labeling scheme will facilitate the training of supervised models based on the identified patterns in the data.

Data Wrangling:

Link: https://github.com/JorgeJaramilo060892/Space-X-Project/blob/main/SpaceX_Falcon9_FirstStageLanding_(EDA).ipynb



Calculate the number and occurrence of each orbit

Create a landing outcome label from Outcome column

Using the `Outcome`, create a list where the element is zero if the corresponding row in `Outcome` is in the set `bad_outcome`; otherwise, it's one. Then assign it to the variable `landing_class`:

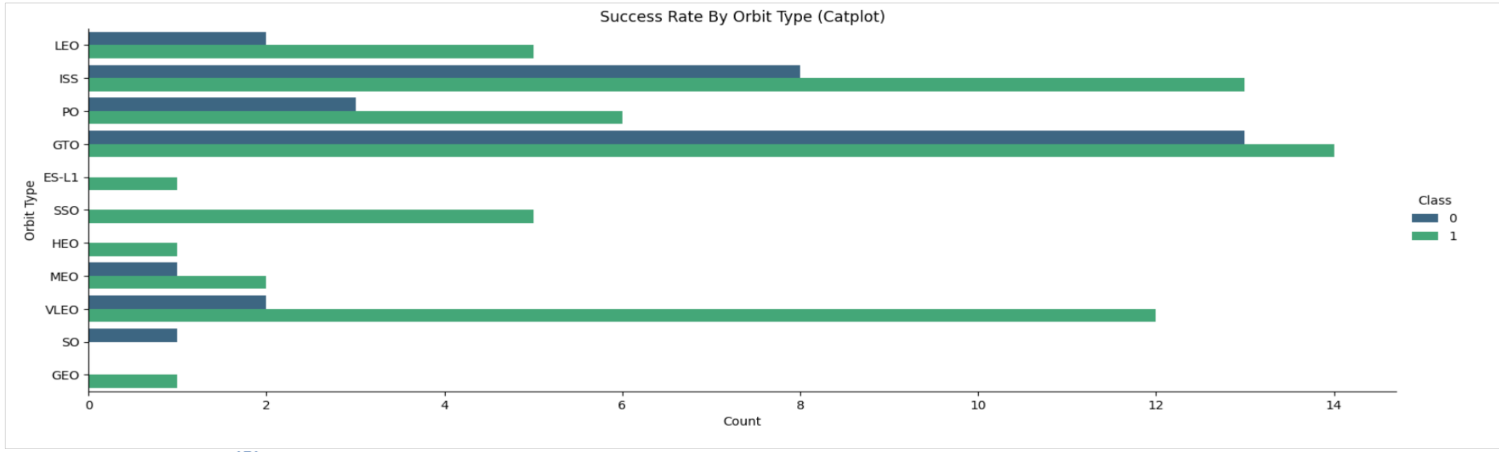
```
landing_class = [0 if outcome in bad_outcomes else 1 for outcome in df['Outcome']]
df['LandingClass'] = landing_class
df
```

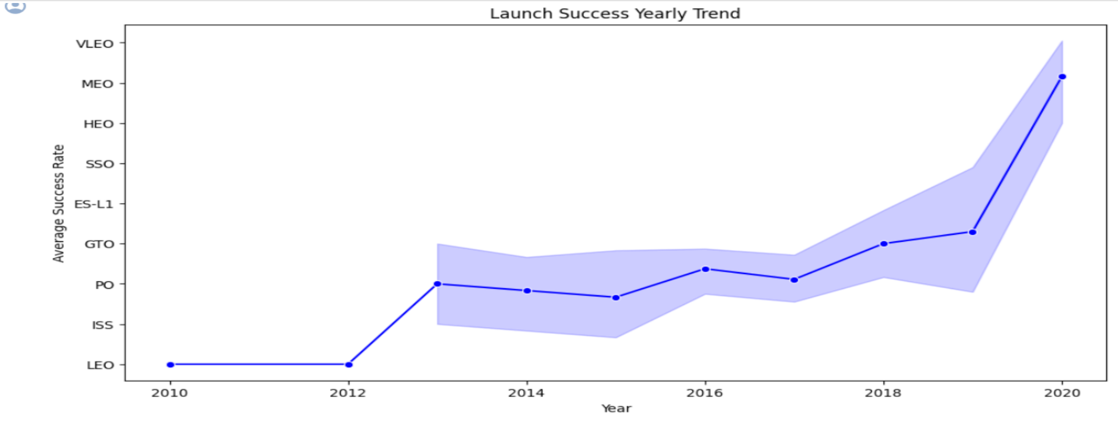
	FlightNumber	Date	BoosterVersion	PayloadMass	Orbit	LaunchSite	Outcome	Flights	GridFins	Reused	Legs	LandingPad	Block	ReusedCount	Serial	Longitude	Latitude	LandingCla
0	1	2010-06-04	Falcon 9	6104.959412	LEO	CCAFS SLC 40	None None	1	False	False	False	NaN	1.0	0	B0003	-80.577366	28.561857	
1	2	2012-05-22	Falcon 9	525.000000	LEO	CCAFS SLC 40	None None	1	False	False	False	NaN	1.0	0	B0005	-80.577366	28.561857	
2	3	2013-03-01	Falcon 9	677.000000	ISS	CCAFS SLC 40	None None	1	False	False	False	NaN	1.0	0	B0007	-80.577366	28.561857	
3	4	2013-09-29	Falcon 9	500.000000	PO	VAFB SLC 4E	False Ocean	1	False	False	False	NaN	1.0	0	B1003	-120.610829	34.632093	
4	5	2013-12-03	Falcon 9	3170.000000	GTO	CCAFS SLC 40	None None	1	False	False	False	NaN	1.0	0	B1004	-80.577366	28.561857	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
85	86	2020-09-03	Falcon 9	15400.000000	VLEO	KSC LC 39A	True ASDS	2	True	True	True	5e9e3032383ecb6bb234e7ca	5.0	2	B1060	-80.603956	28.608058	
86	87	2020-10-06	Falcon 9	15400.000000	VLEO	KSC LC 39A	True ASDS	3	True	True	True	5e9e3032383ecb6bb234e7ca	5.0	2	B1058	-80.603956	28.608058	
87	88	2020-10-18	Falcon 9	15400.000000	VLEO	KSC LC 39A	True ASDS	6	True	True	True	5e9e3032383ecb6bb234e7ca	5.0	5	B1051	-80.603956	28.608058	
88	89	2020-10-24	Falcon 9	15400.000000	VLEO	CCAFS SLC 40	True ASDS	3	True	True	True	5e9e3033383ecbb9e534e7cc	5.0	2	B1060	-80.577366	28.561857	
89	90	2020-11-05	Falcon 9	3681.000000	MEO	CCAFS SLC 40	True ASDS	1	True	False	True	5e9e3032383ecb6bb234e7ca	5.0	0	B1062	-80.577366	28.561857	

EDA:

Link: https://github.com/JorgeJaramilo060892/Space-X-Project/blob/main/Exploring_and_Preparing%C2%A0Data_SpaceX_Falcon_9_First_Stage_Landing_Prediction.ipynb

- We delved into the dataset by visualizing various relationships, including the correlation between flight number and launch site, payload and launch site, success rates for each orbit type, the correlation between flight number and orbit type, and the annual trend in launch success.





you can observe that the sucess rate since 2013 kept increasing till 2020

EDA SQL:

Link: https://github.com/JorgeJaramilo060892/Space-X-Project/blob/main/EDA-SQL-coursera_sqllite.ipynb

- We seamlessly imported the SpaceX dataset into a PostgreSQL database directly within the Jupyter notebook. Employing SQL for Exploratory Data Analysis (EDA), we extracted valuable insights from the dataset. Our queries aimed to uncover information such as:
- Identifying the unique launch sites involved in space missions.
- Calculating the total payload mass carried by NASA-launched boosters (CRS missions).
- Determining the average payload mass carried by booster version F9 v1.1.
- Tabulating the total count of successful and failed mission outcomes.
- Detailing failed landing outcomes on drone ships, including the respective booster versions and launch site names.

BUILD A DASHBOARD:

Link: https://github.com/JorgeJaramilo060892/Space-X-Project/blob/main/Launch_Sites_Locations_Analysis_with_Folium.ipynb

- **Analysis of Launch Site Locations**
- The success rate of a launch is influenced by numerous factors, including payload mass and orbit type. Additionally, the geographic location and proximities of a launch site, representing the initial trajectories of rocket launches, play a crucial role. Determining an optimal location for a launch site involves a multifaceted consideration of various factors, and through our analysis, we aim to uncover some of these influential factors.
- In our previous exploratory data analysis, we employed matplotlib and seaborn to visualize the SpaceX launch dataset, revealing preliminary correlations between launch sites and success rates. To deepen our insights, we are now delving into more interactive visual analytics using Folium.
- Objectives:
- **TASK 1:** Plot all launch sites on an interactive map.
- **TASK 2:** Indicate the success/failed launches for each site on the map.
- **TASK 3:** Calculate the distances between a launch site and its proximities to enhance our understanding of the spatial dynamics involved.

MACHINE LEARNING PREDICTIVE ANALYSIS:

1. **Exploratory Data Analysis (EDA) and Training Labels Determination:**
   1. Conduct comprehensive Exploratory Data Analysis to gain insights.
   2. Create a dedicated column for the classification class based on the analysis.
2. **Data Standardization:**
   1. Standardize the dataset to ensure uniformity in feature scaling.
3. **Data Splitting:**
   1. Divide the dataset into training data and test data for model evaluation.
4. **Hyperparameter Tuning:**
   1. Explore and identify the best hyperparameters for Support Vector Machines (SVM), Classification Trees, and Logistic Regression models.
5. **Model Evaluation:**
   1. Evaluate the performance of each method using the test data.
   2. Determine the most effective classification method based on the evaluation results.

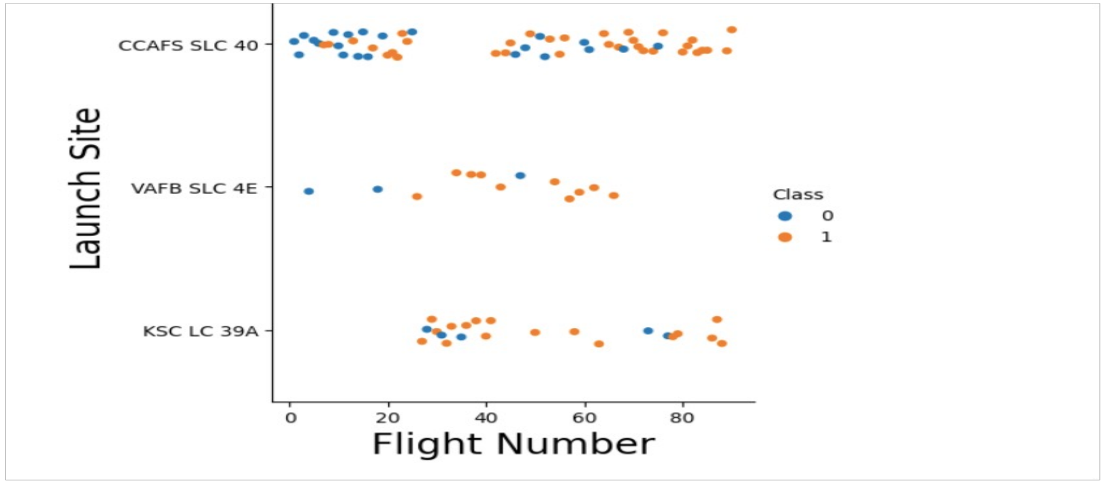
Link:
https://github.com/JorgeJaramilo060892/Space-X-Project/blob/main/Machine_Learning_Prediction_Space_X.ipynb

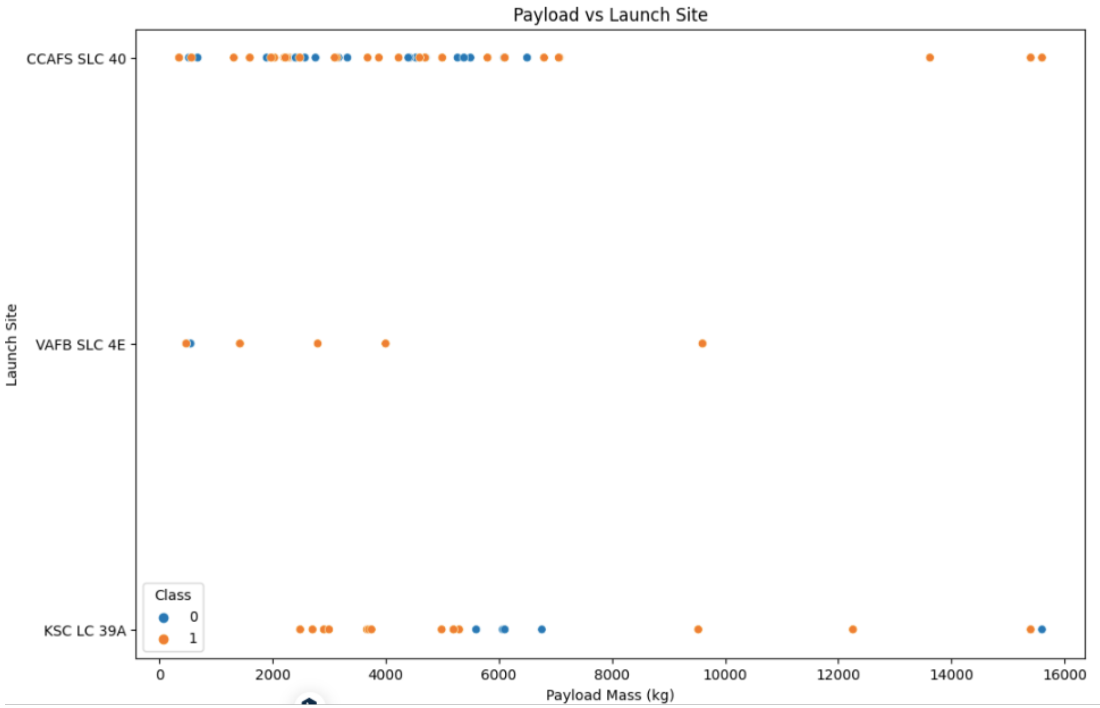
RESULTS

Insights drawn From EDA

Flight Number vs Launch Site vs Payload mass

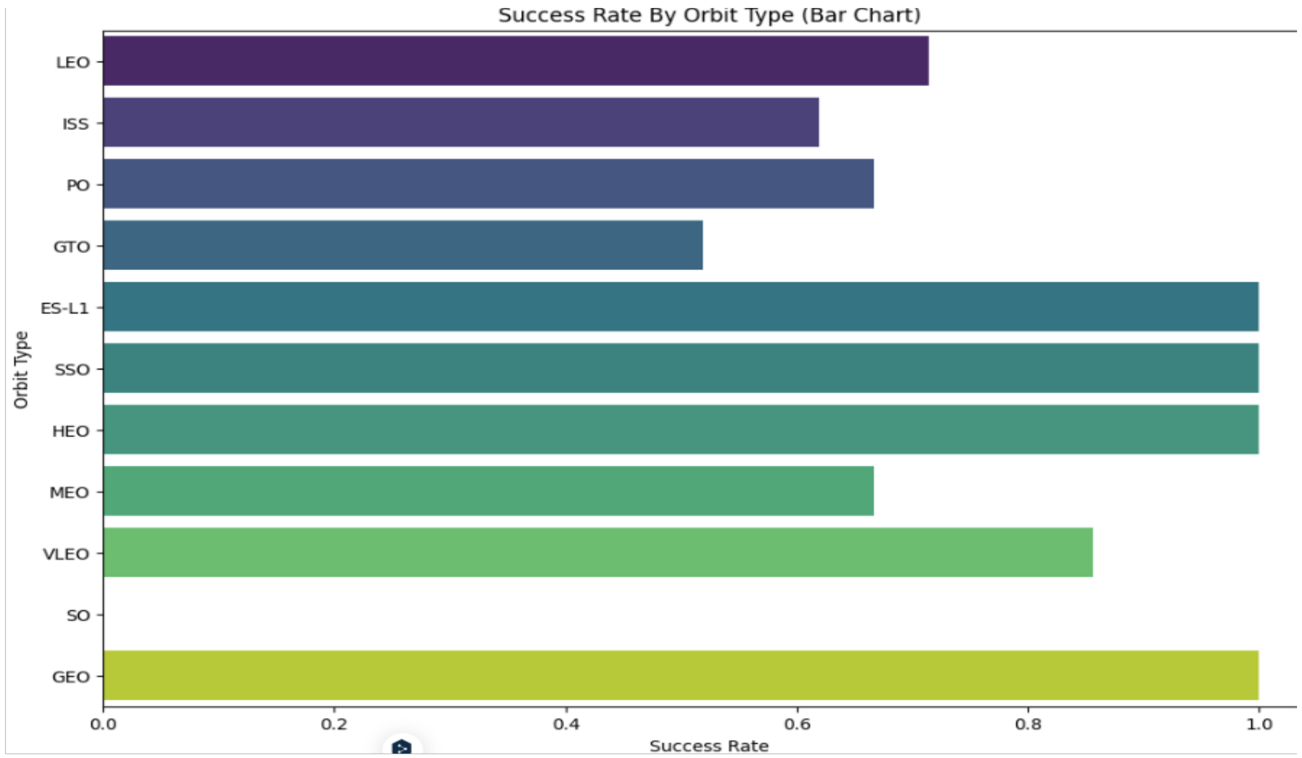
- We can observe from the scatter plot of payload versus launch site, it becomes evident that at the CCAFS SLC 40 launch site, has the higher succes rate.





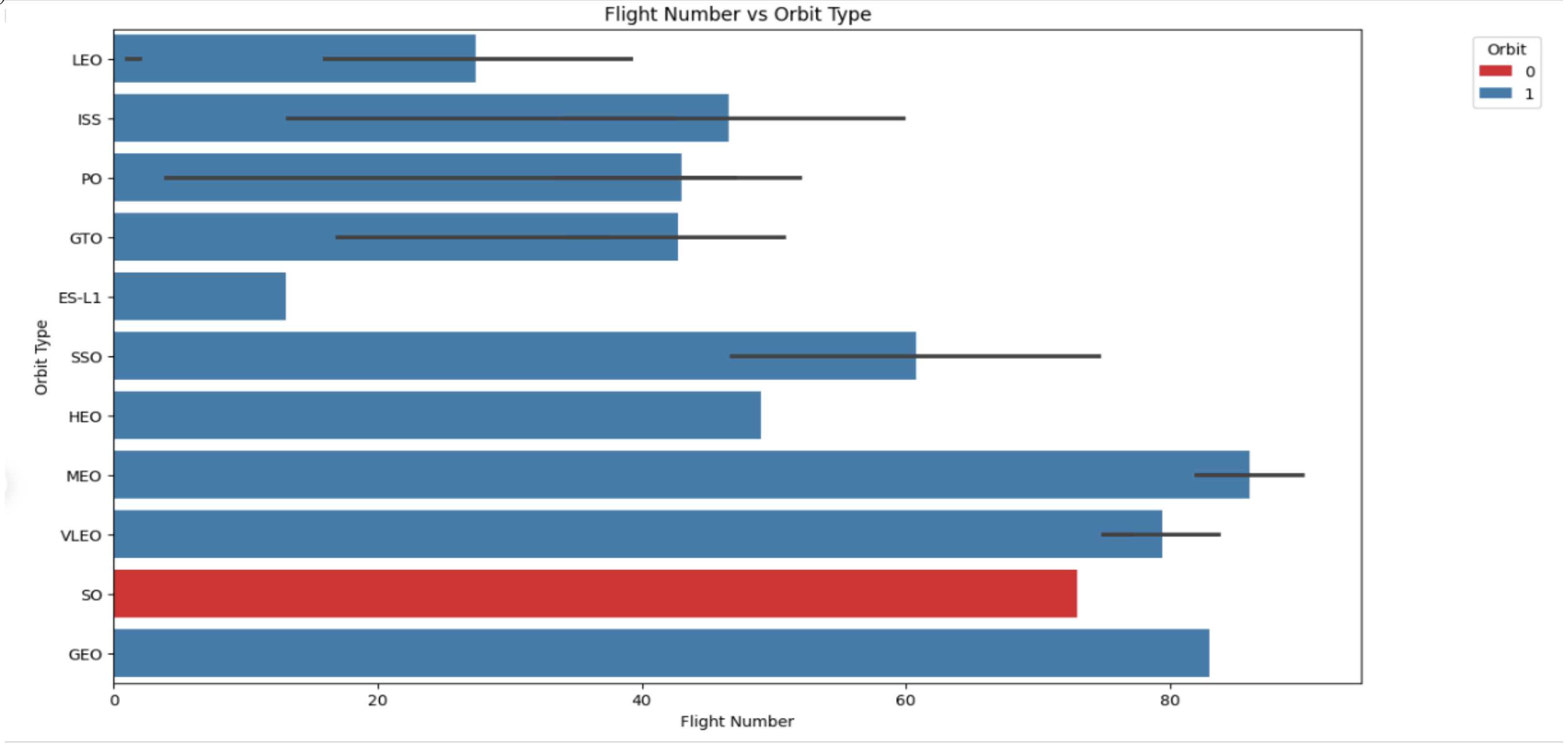
Succes Rate by Orbit

- The Orbit GTO has the highest success rate of 14000, and far below are the ES-L1 and GEO.



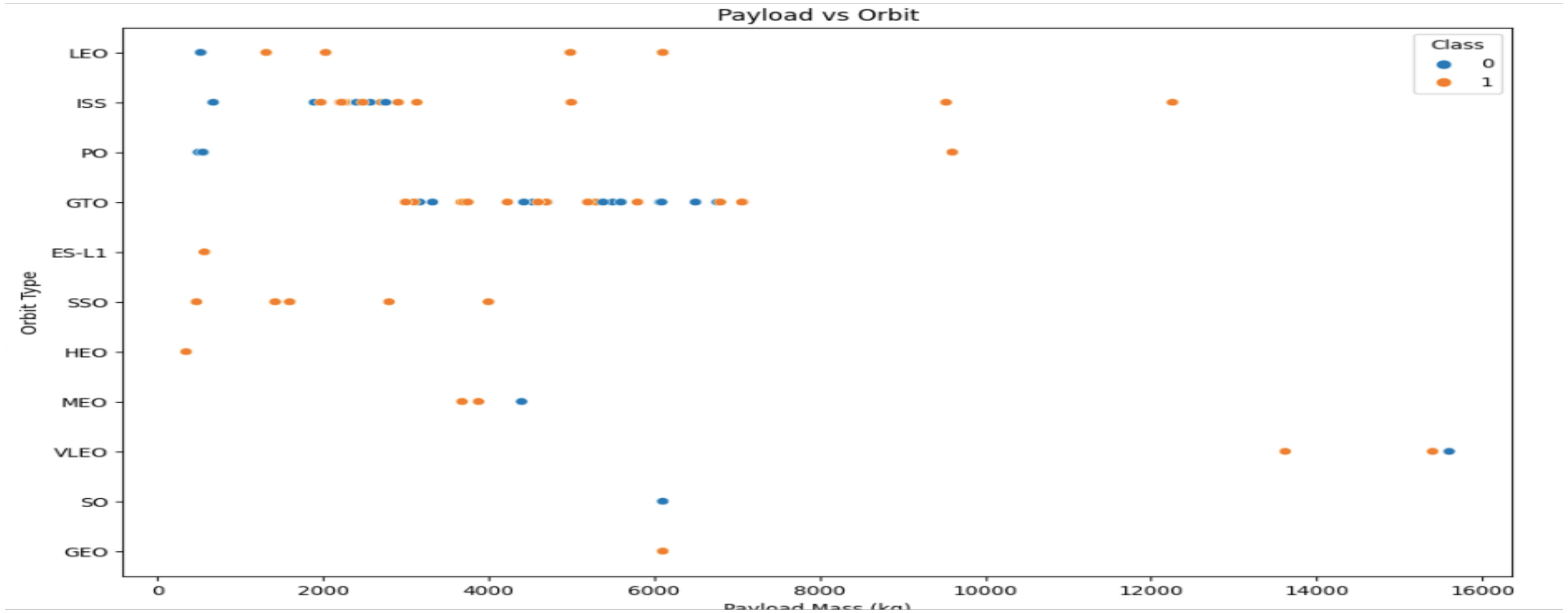
Flight Number vs Orbit Type

- You should see that in the 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.



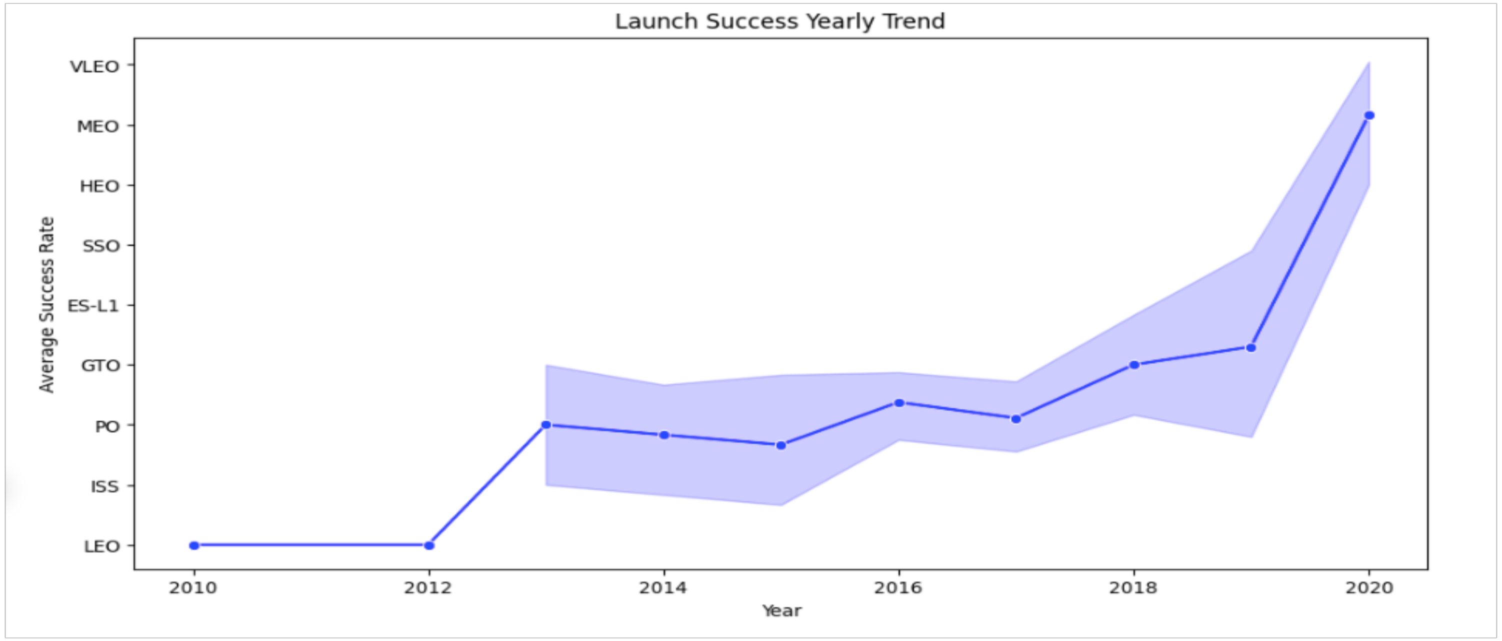
Payloads vs Orbit Type

- With heavy payloads the successful landing or positive landing rate are more for Polar,LEO and ISS.
- However for GTO we cannot distinguish this well as both positive landing rate and negative landing(unsuccessful mission) are both there here.



Launch Success Yearly Tren

- We can observe that the sucess rate since 2013 kept increasing till 2020



Launch Sites Locations Analysis

- The success rate of a launch is likely influenced by various factors, including payload mass, orbit type, and more. Additionally, the location and proximity of a launch base—representing the initial trajectories of rocket launches—play a crucial role. Determining an optimal location for building a launch site involves a complex consideration of many factors. Through our analysis of existing launch site locations, we aim to uncover insights into these influential factors.
- In this context, we are mapping all launch sites to visually explore their geographic distribution.

	Flight Number	Date	Time (UTC)	Booster Version	Launch Site	Payload	Payload Mass (kg)	Orbit	Customer	Landing Outcome	class	Lat	Long
0	1	2010-06-04	18:45:00	F9 v1.0 B0003	CCAFS LC-40	Dragon Spacecraft Qualification Unit	0.0	LEO	SpaceX	Failure (parachute)	0	28.562302	-80.577356
1	2	2010-12-08	15:43:00	F9 v1.0 B0004	CCAFS LC-40	Dragon demo flight C1, two CubeSats, barrel o...	0.0	LEO (ISS)	NASA (COTS) NRO	Failure (parachute)	0	28.562302	-80.577356
2	3	2012-05-22	7:44:00	F9 v1.0 B0005	CCAFS LC-40	Dragon demo flight C2+	525.0	LEO (ISS)	NASA (COTS)	No attempt	0	28.562302	-80.577356
3	4	2012-10-08	0:35:00	F9 v1.0 B0006	CCAFS LC-40	SpaceX CRS-1	500.0	LEO (ISS)	NASA (CRS)	No attempt	0	28.562302	-80.577356
4	5	2013-03-01	15:10:00	F9 v1.0 B0007	CCAFS LC-40	SpaceX CRS-2	677.0	LEO (ISS)	NASA (CRS)	No attempt	0	28.562302	-80.577356

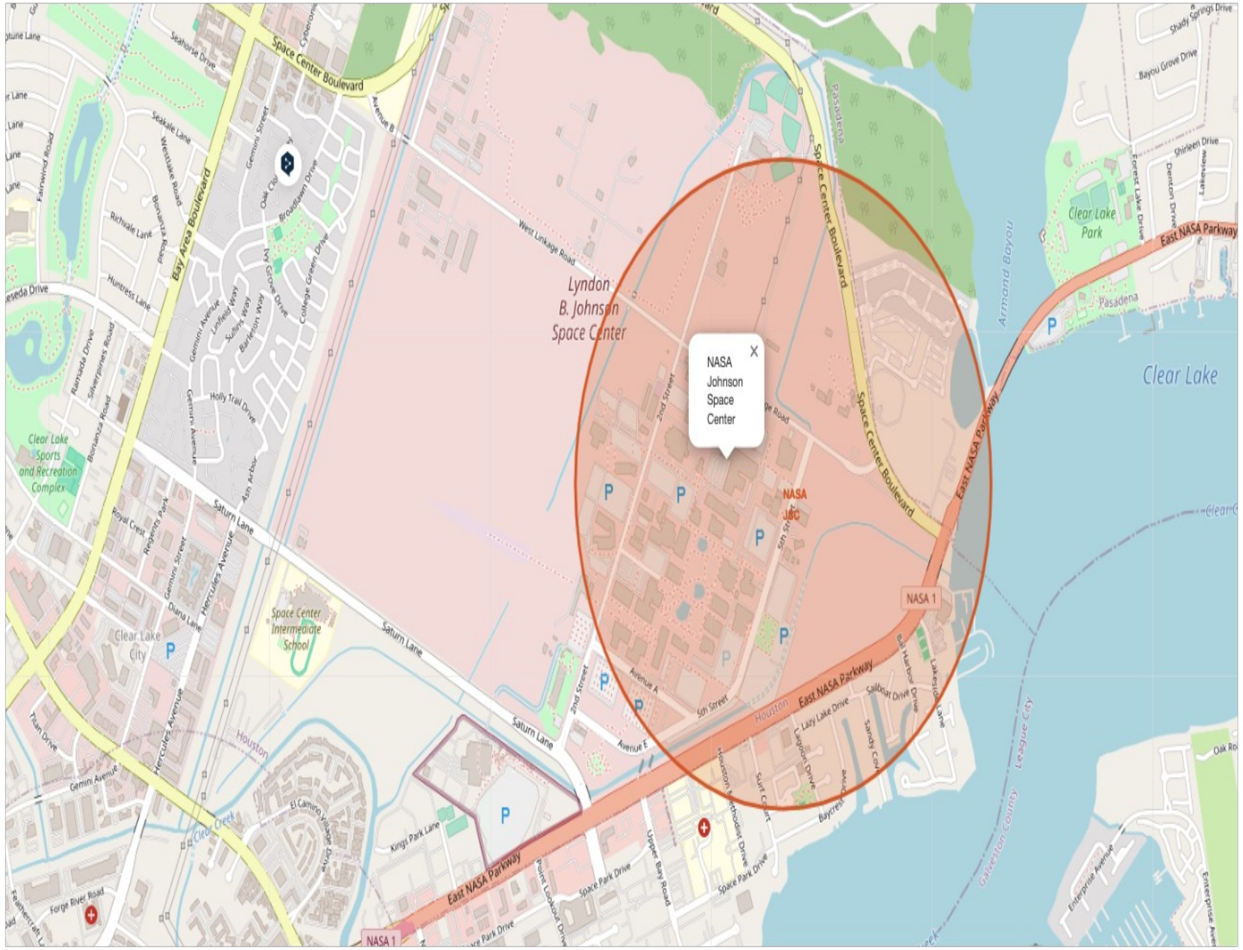
```
# Let's select the relevant sub-columns
spacex_df = spacex_df[['Launch Site', 'Lat', 'Long', 'class']]
launch_sites_df = spacex_df.groupby(['Launch Site'], as_index=False).first()
launch_sites_df = launch_sites_df[['Launch Site', 'Lat', 'Long']]
launch_sites_df
```

	Launch Site	Lat	Long
0	CCAFS LC-40	28.562302	-80.577356
1	CCAFS SLC-40	28.563197	-80.576820
2	KSC LC-39A	28.573255	-80.646895
3	VAFB SLC-4E	34.632834	-120.610745

Coordinates

- In this code snippet, we using the Folium library to create a map and add a circle and a marker at the coordinates of NASA Johnson Space Center.

1. Circle Creation:
   1. we create a circular area using folium.Circle centered at the coordinates of NASA Johnson Space Center (nasa_coordinate).
   2. The circle has a radius of 1000 (assuming the unit is meters), a color of '#d35400' (a shade of orange), and is filled.
   3. A popup label is added to the circle, displaying the text 'NASA Johnson Space Center'.

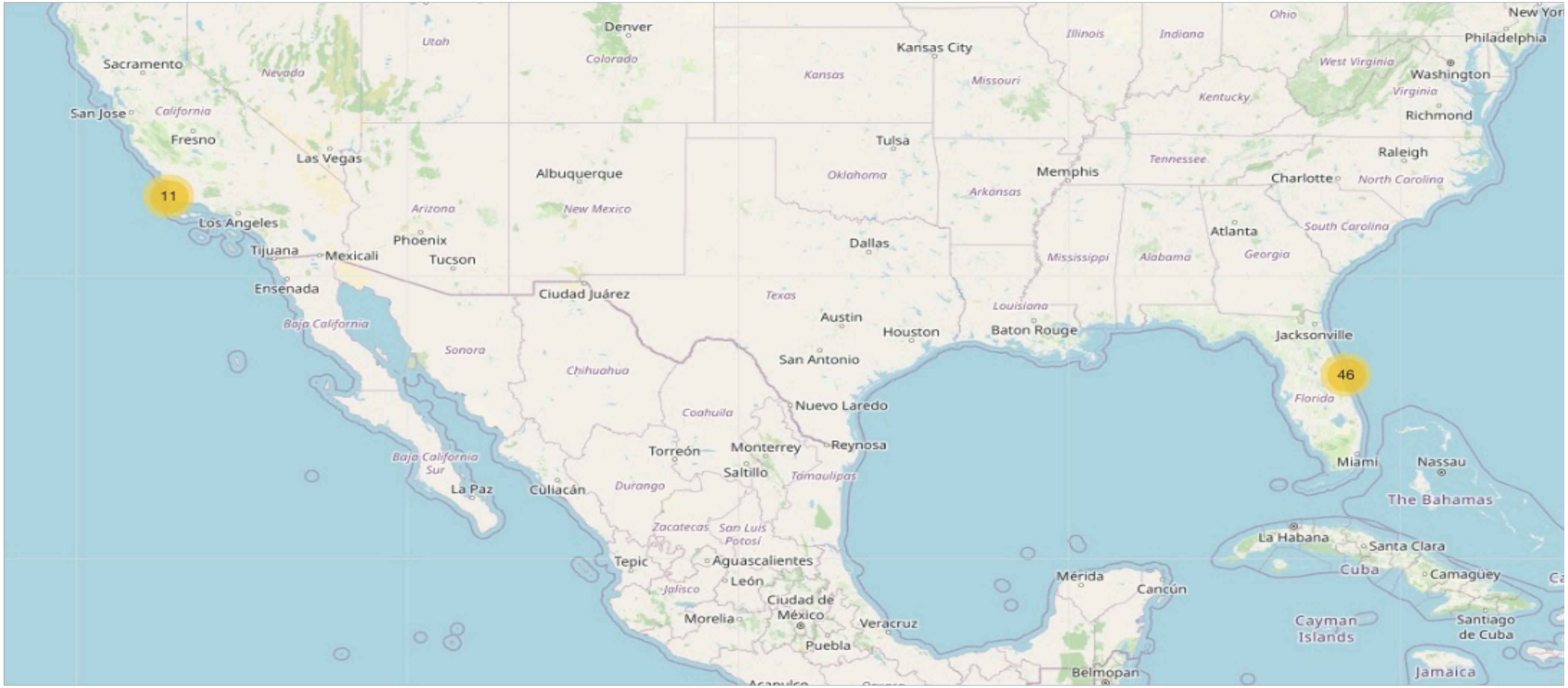


Mark the success/failed launches for each site on the map

- Marking the success/failed launches for each site on the map will provide valuable insights into the performance of different launch sites. To enhance the map, we will leverage the launch outcomes recorded in the spacex_df DataFrame. The class column in the DataFrame signifies whether each launch was successful or not. This additional layer of information will allow us to visually identify which sites have high success rates and gain a more comprehensive understanding of the launch outcomes across different locations.

	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
55	CCAFS SLC-40	28.563197	-80.576820	0

Mark the success/failed launches for each site on the map

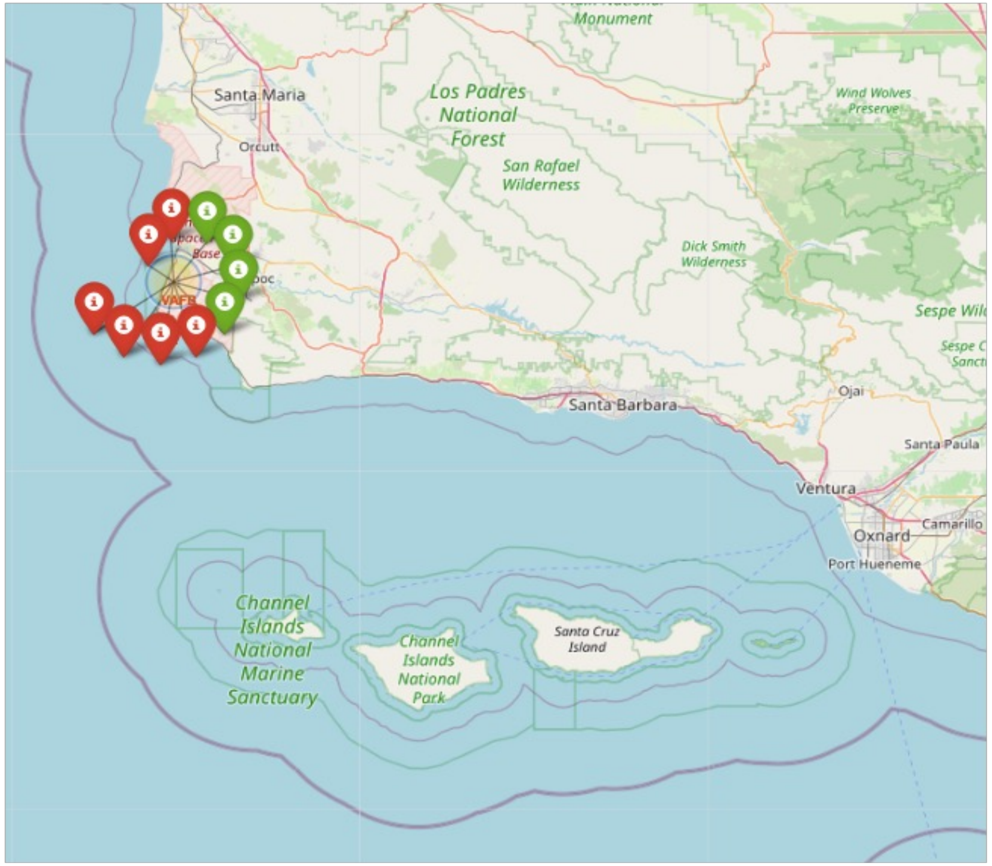


Mark the success/failed launches for each site on the map

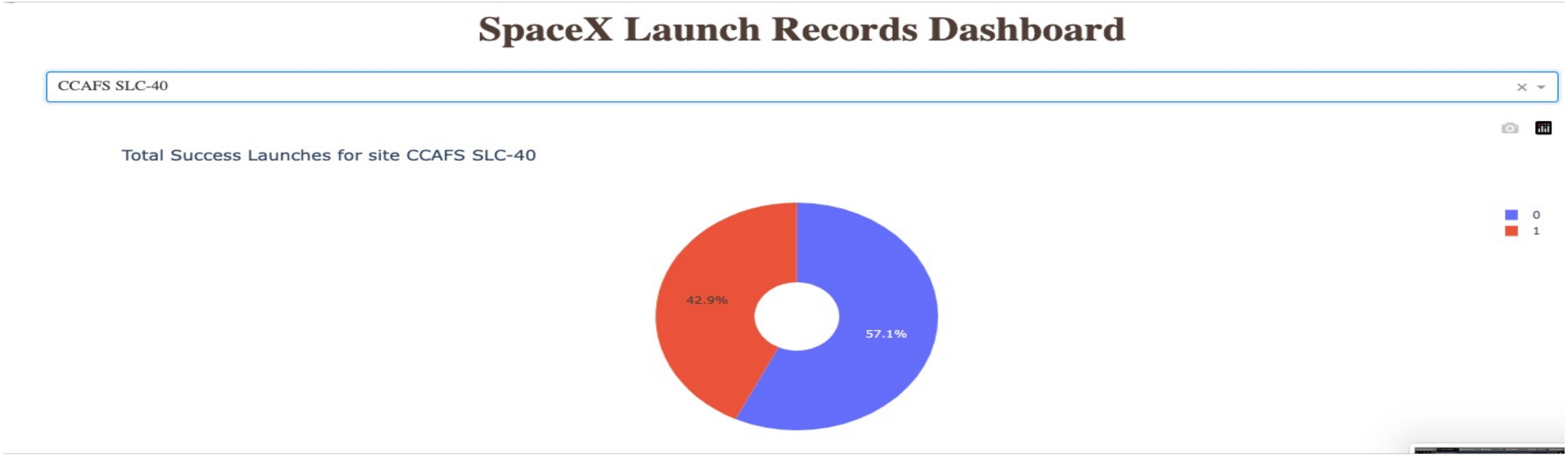
Mark the success/failed launches for each site on the map

Mark the success/failed launches for each site on the map

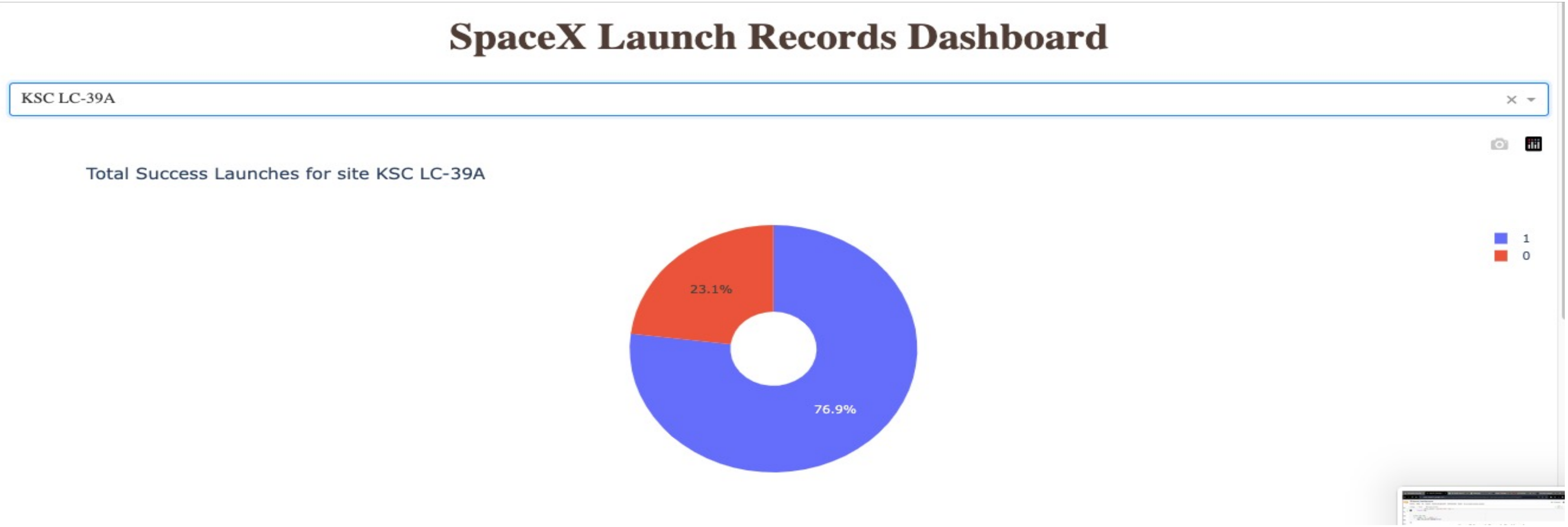
- As we can see the launch sites:
  - 1.- The launch sites are indeed close to the railway lines
  - 2.-The launch sites are indeed near some highways
  - 3.- Launch sites effectively close to the coastline
  - 4.- The launch sites are approximately far from the cities.



Dashboard

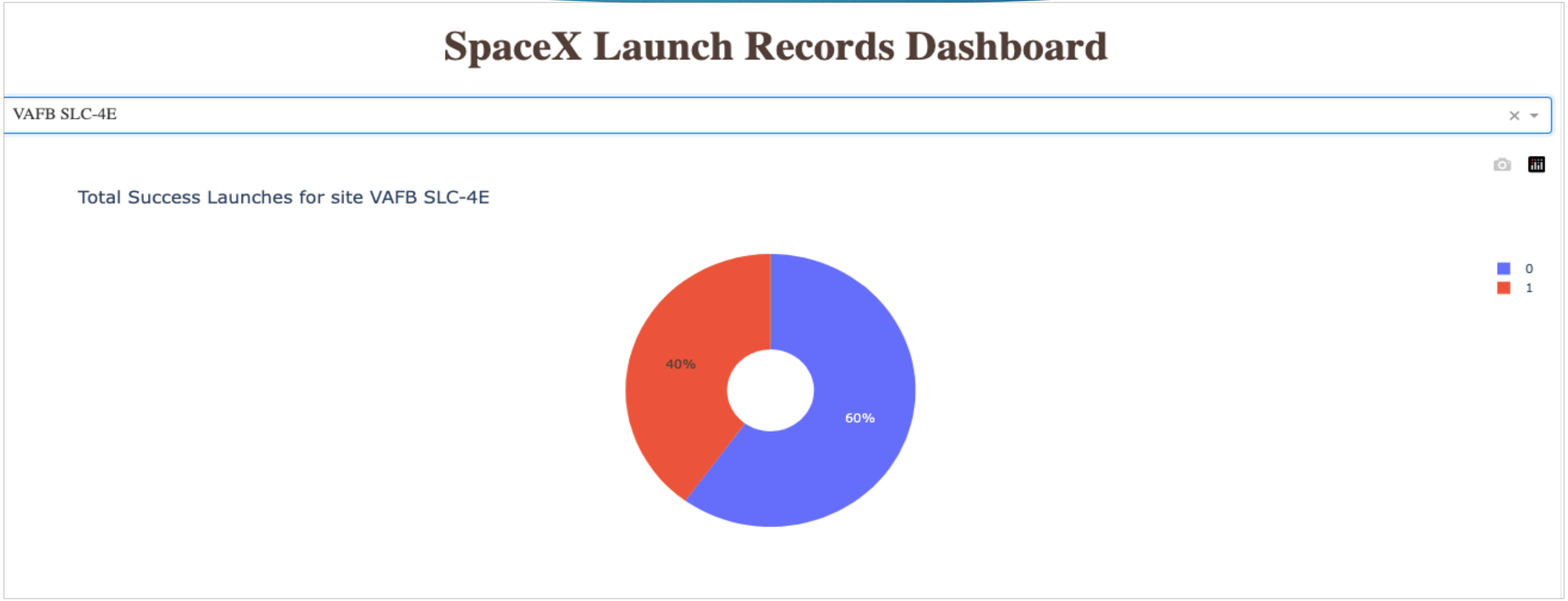

SpaceX Launch Records Dashboard
CCAFS SLC-40
Total Success Launches for site CCAFS SLC-40
42.9%
57.1%
0
1

Dashboard

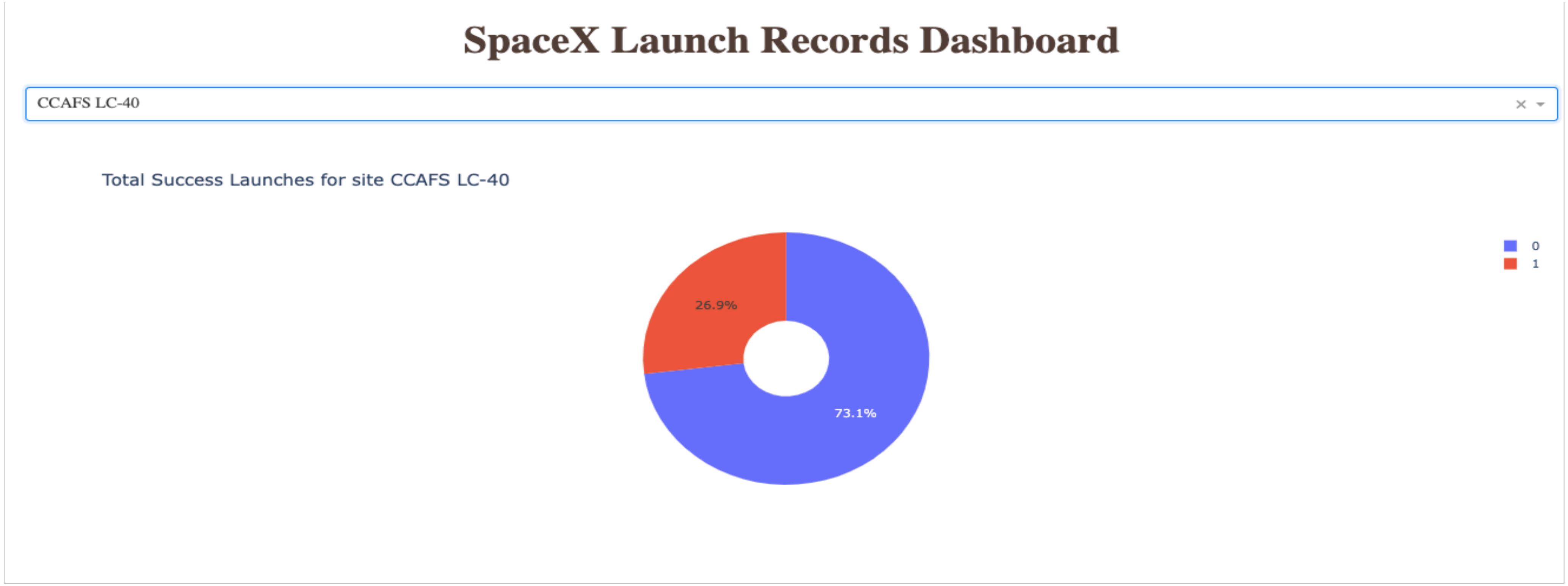


SpaceX Launch Records Dashboard
KSC LC-39A
Total Success Launches for site KSC LC-39A
23.1%
76.9%
1
0

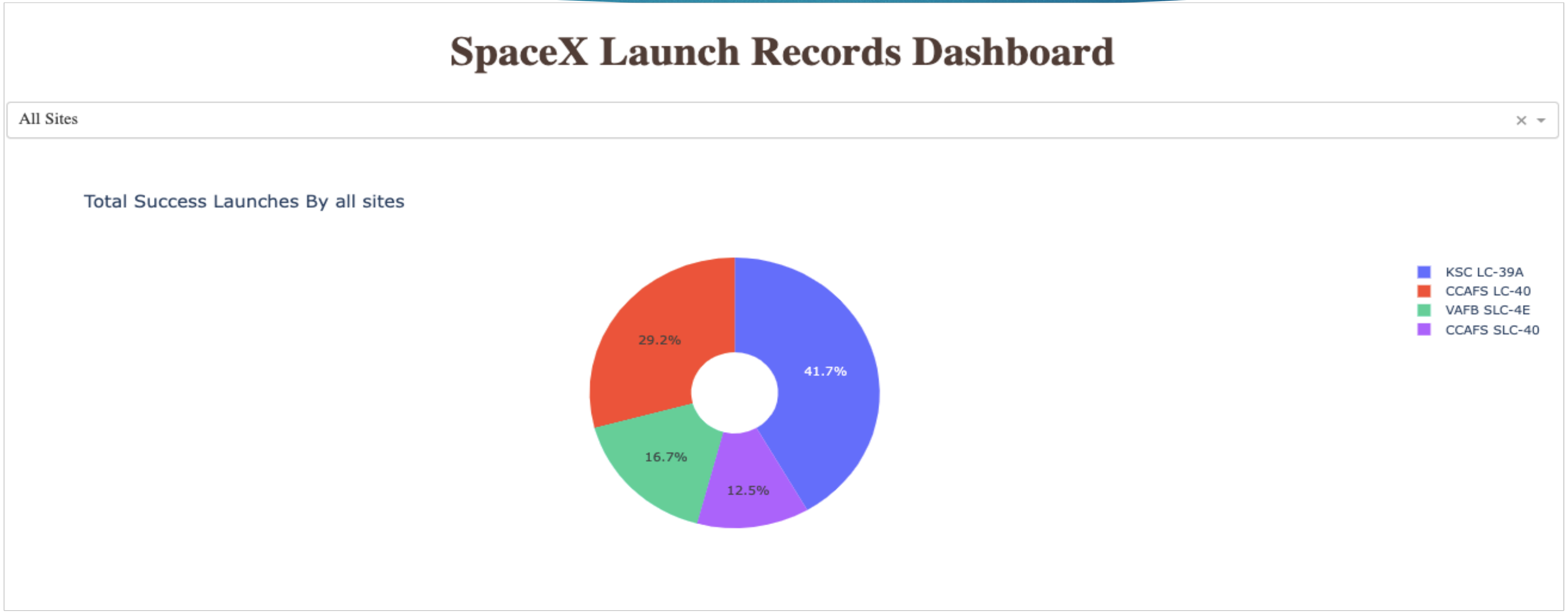
Dashboard


SpaceX Launch Records Dashboard
VAFB SLC-4E
Total Success Launches for site VAFB SLC-4E
40%
60%
0
1

Dashboard


SpaceX Launch Records Dashboard
CCAFS LC-40
Total Success Launches for site CCAFS LC-40
26.9%
73.1%
0
1

Dashboard


SpaceX Launch Records Dashboard
All Sites
Total Success Launches By all sites
29.2%
41.7%
16.7%
12.5%
KSC LC-39A
CCAFS LC-40
VAFB SLC-4E
CCAFS SLC-40

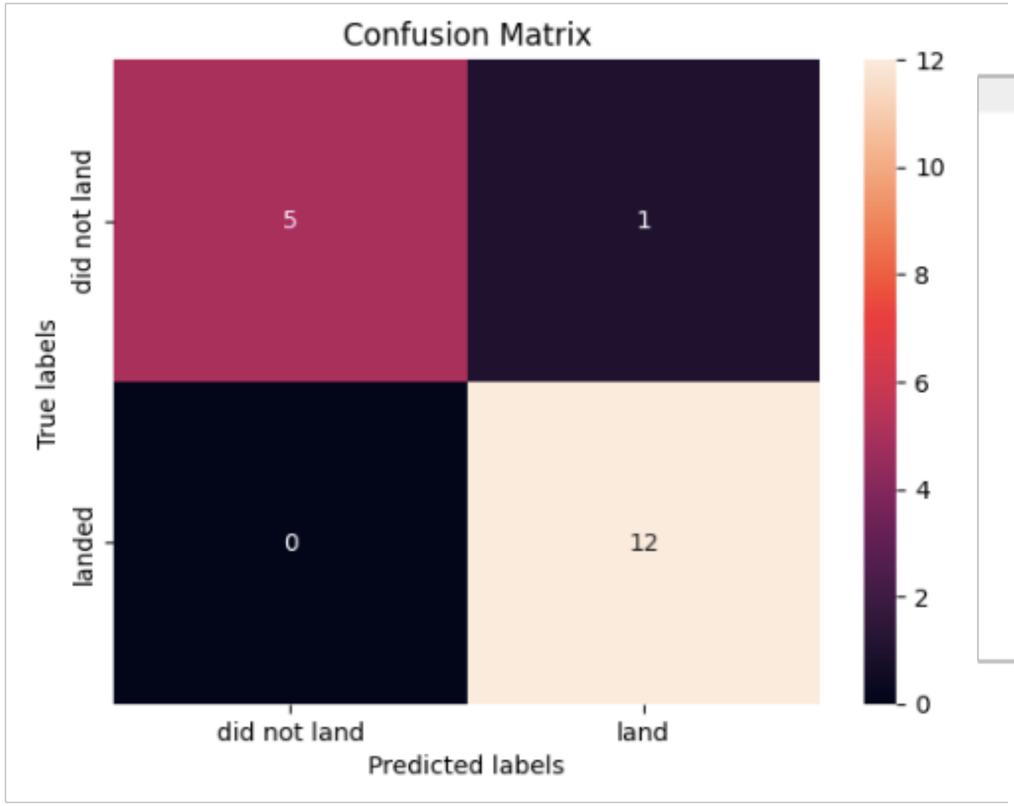
Dashboard

Payload range (Kg):
0 kg
1000 kg
2000 kg
3000 kg
4000 kg
5000 kg
6000 kg
7000 kg
8000 kg
9000 kg
10000
class
1
0.8
0.6
0.4
0.2
0
1000
2000
3000
4000
5000
6000
Payload Mass (kg)
Booster Version
F9 FT B1035.2
F9 B4 B1043.1
F9 FT B1032.2
F9 B4 B1044
F9 B4 B1039.2
F9 B4 B1045.1
F9 B4 B1040.2

Dashboard

- 1.-Which site has the largest successful launches?
- KSC -LC39 A has the highest launching success rate
- 2.- Which site has the highest launch success rate?
- 0.7692307692307693
- 3.- Which payload range(s) has the highest launch success rate?
- 0.4285714285714285
- 4.- Which payload range(s) has the lowest launch success rate?
- ABS-2A Eutelsat 117 West B
- 5.- Which F9 Booster version (v1.0, v1.1, FT, B4, B5, etc.) has the highest launch success rate?
- F9 B4 B1039.1

Machine Learning Model: Predictive Analysis Classification



	Model	Accuracy	Precision	Recall	F1-score
0	KNN	0.833333	0.800000	1.0	0.888889
1	SVM	0.833333	0.800000	1.0	0.888889
2	Decision Tree	0.944444	0.923077	1.0	0.960000
3	Logistic Regression	0.833333	0.800000	1.0	0.888889

Machine Learning Model: Predictive Analysis Classification

- **Conclusion from Model Evaluation:**
- Based on the assessment of various machine learning models, the following points can be highlighted:

1. **Overall Accuracy:**
    1. All models exhibit a high level of accuracy, ranging from 83.33% to 94.44%. This indicates that, overall, the models are capable of making precise predictions regarding the success or failure of launches.
2. **Precision, Recall, and F1-Score:**
    1. The KNN, SVM, and Logistic Regression models showcase identical results in terms of precision, recall, and F1-score. These models demonstrate a balanced performance in predicting both successes and failures in launches.
3. **Best Performance:**
    1. The Decision Tree model stands out with the highest overall accuracy (94.44%), as well as high precision and F1-score. This suggests that the Decision Tree is particularly effective in predicting the success or failure of launches compared to the other evaluated models.

Conclusions:

- <u>Key Conclusions:</u>

1. **Flight Amount and Success Rate:**
   1. There is a positive correlation between the number of flights at a launch site and the success rate. Launch sites with a larger flight history tend to exhibit a higher success rate.
2. **Temporal Trends:**
   1. The launch success rate has shown a consistent increase from 2013 to 2020, indicating an overall improvement in mission outcomes during this period.
3. **Orbit Types and Success Rate:**
   1. Orbits ES-L1, GEO, HEO, SSO, and VLEO demonstrate the highest success rates. This suggests that missions targeting these orbits have been notably successful.
4. **Top Performing Launch Site:**
   1. KSC LC-39A stands out as the launch site with the highest number of successful launches. This emphasizes its effectiveness in achieving mission objectives.
5. **Machine Learning Algorithm Performance:**
   1. Based on our analysis, the Decision Tree Classifier emerges as the most effective machine learning algorithm for predicting launch success. Its robust performance makes it a suitable choice for this task.


Thank you,
I hope you enjoyed the trip!