Executive Summary

The analysis conducted on the SpaceX Falcon 9 launch data has provided key insights into the factors influencing the success of rocket landings, which are crucial for optimizing costs and increasing the reusability of the first stage. The exploratory data analysis (EDA) and predictive modeling revealed the following:

1. Launch Site Performance:
- CCAFS LC-40 stands out as the launch site with the largest number of successful landings.
- KSC LC-39A exhibits the highest success rate, making it the most reliable launch site.

2. Payload Mass Impact:
- Payload ranges between 4000-6000 kg demonstrate a notably higher success rate, whereas extremely light or heavy payloads tend to have a lower success rate.

3. Booster Version Efficiency:
- The F9 B5 series boosters, particularly B1048.4 and B1051.3, have successfully carried the heaviest payloads and consistently achieved successful landings.

4. Model Accuracy and Precision:
- The predictive model achieved an accuracy of 78%, with an F1-Score of 86%, indicating a strong balance between precision and recall. However, the model still faces a moderate level of false positives, with a precision rate of 75%.

In conclusion, the analysis confirms that certain launch sites and booster versions significantly contribute to the success of Falcon 9 landings. This information can be strategically used by companies to optimize launch bids against SpaceX, ensuring cost-effective and successful space missions.

Introdution

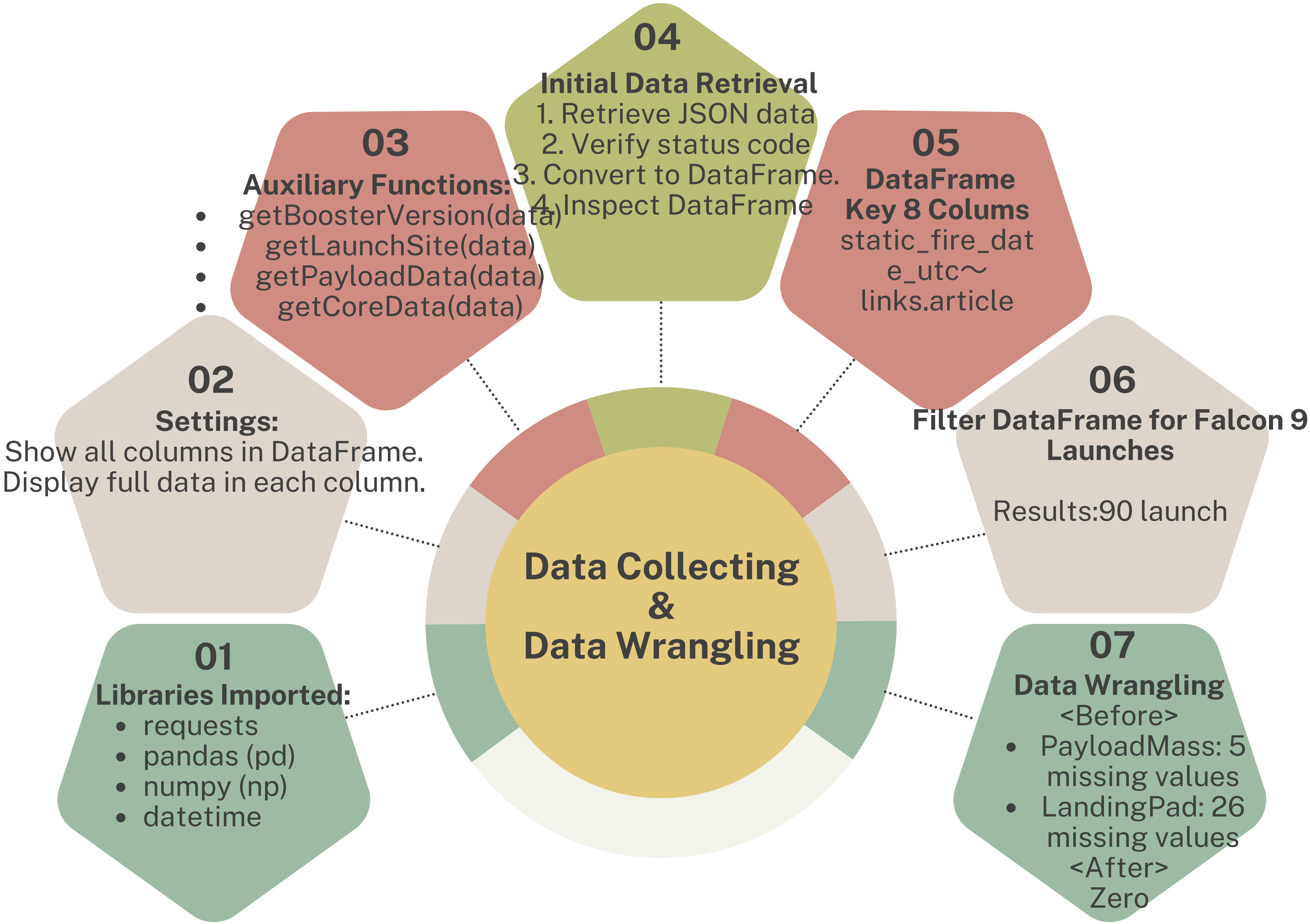
SpaceX has revolutionized the space industry by significantly reducing the cost of rocket launches through the reusability of its Falcon 9 first stage. Each successful landing of the first stage allows SpaceX to reuse the rocket, lowering the cost of subsequent launches. While SpaceX advertises a launch cost of $62 million, competitors' costs can soar as high as $165 million per launch. This cost advantage is primarily due to SpaceX's ability to recover and reuse the first stage.

Given the critical role of successful landings in cost reduction, this analysis seeks to predict whether the Falcon 9 first stage will land successfully based on historical launch data. Understanding the factors that influence landing success not only helps in predicting launch outcomes but also provides valuable insights for other companies looking to compete with SpaceX in the launch market.

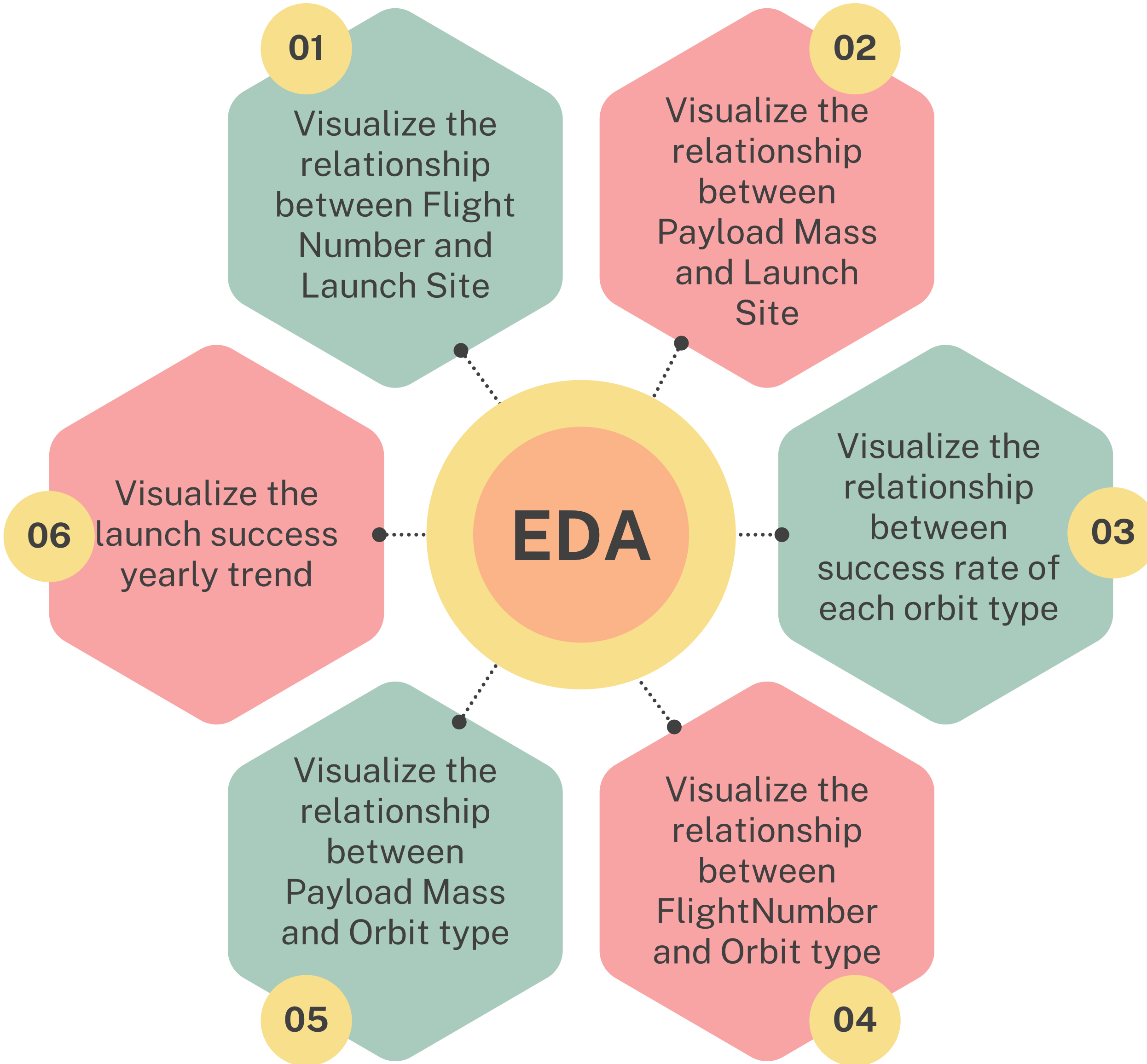
In this analysis, we will:
1. Collect and preprocess the necessary data from SpaceX's launch history.
2. Explore the relationships between different factors, such as launch site, payload mass, and booster versions, to understand their impact on landing success.
3. Develop predictive models to forecast the likelihood of a successful landing.

The goal is to identify key predictors of success and provide actionable insights that can be used to enhance launch strategies, whether by SpaceX or its competitors.

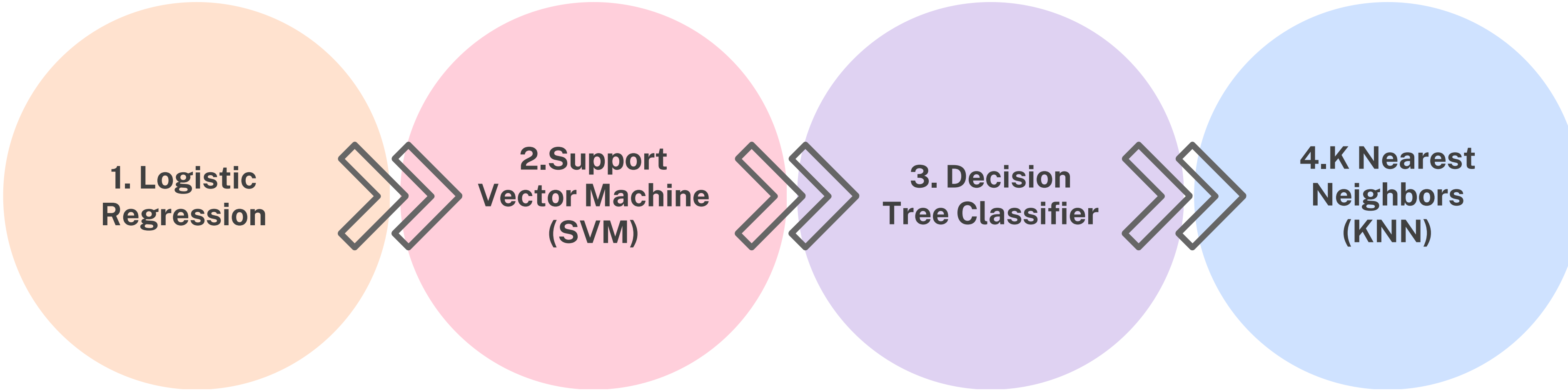
Data Collection & Data Wrangling



EDA and Interactive Visual Analytics Methodology

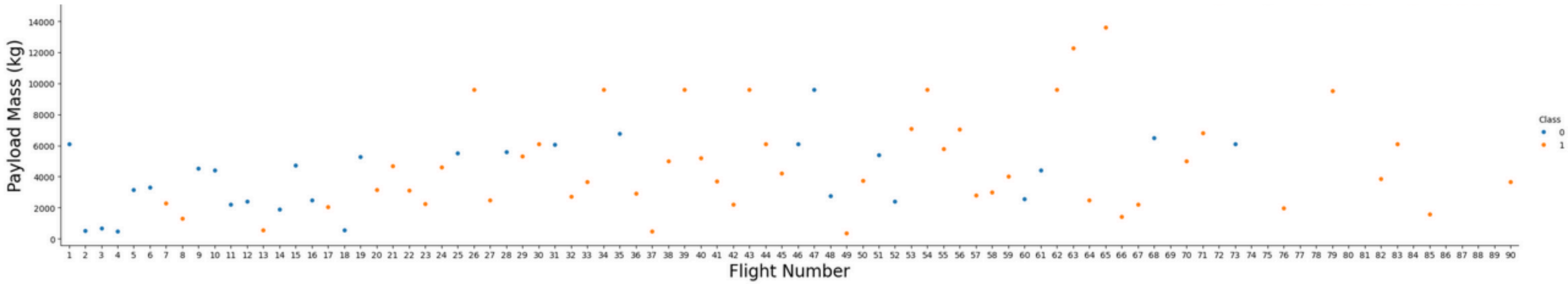


Predictive Analysis Methodology

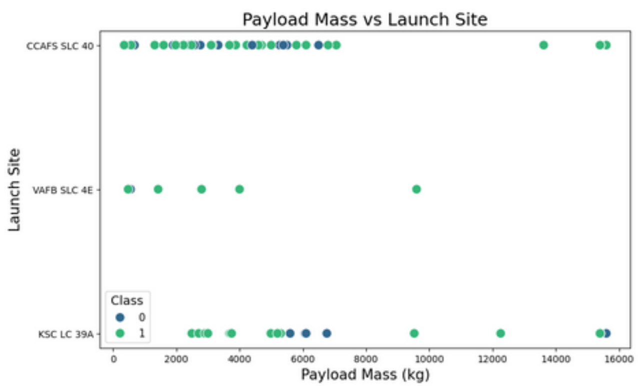


EDA with Visualization Results

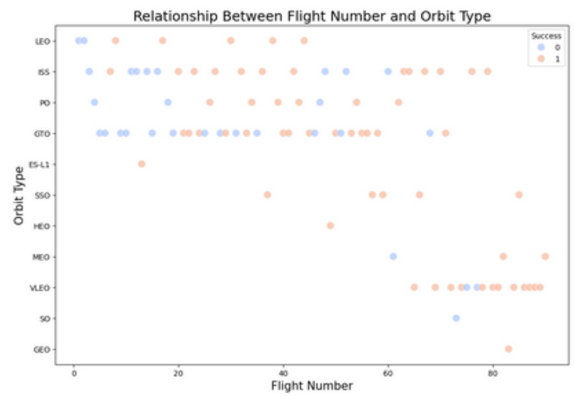
①Relationship between Flight Number and Launch Site



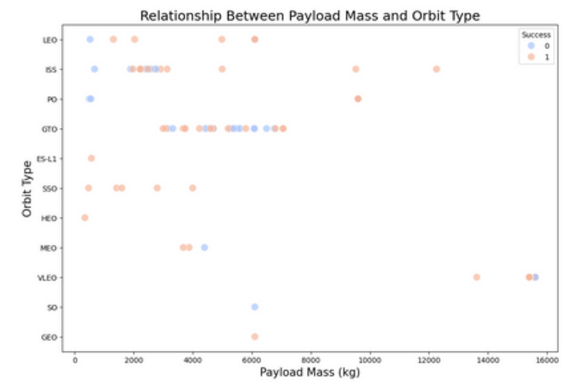
②Payload Mass and Launch Site



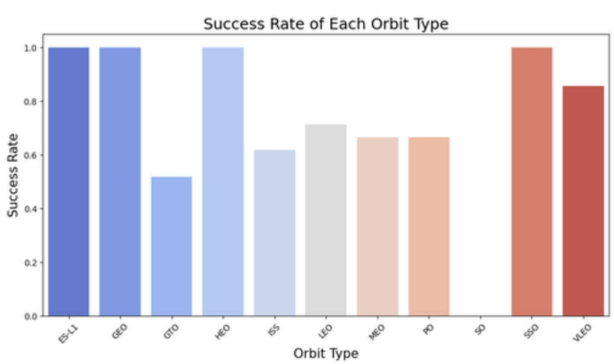
④FlightNumber and Orbit type



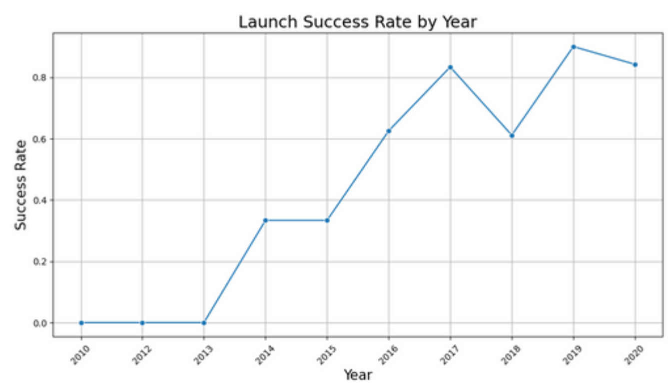
⑤ Payload Mass and Orbit type



③Success rate of each orbit type



⑥ launch success yearly trend



EDA with SQL Results

1

THE UNIQUE LAUNCH SITES

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

3

TOTAL PAYLOAD MASS BY NASA

45596

4

AVERAGE PAYLOAD MASS

2928.4

5

THE FIRST SUCCESFUL LANDING

2015-12-22

6

SUCCESSFUL DRONE SHIP LANDINGS & PAYLOAD MASS BETWEEN 4000 AND 6000 KG

'F9 FT B1022' 'F9 FT B1026' 'F9 FT B1021.2' 'F9 FT B1031.2'

7

TOTAL NUMBER OF SUCCESSFUL AND FAILURE

Success: 98
Failure: 1

8

THE BOOSTER_VERSIONS WHICH HAVE CARRIED THE MAXIMUM PAYLOAD MASS

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
F9 B5 B1060.3
F9 B5 B1049.7

9

2015 WITH FAILURE LANDING OUTCOMES IN DRONE SHIP

Januar:
F9 v1.1 B1012', 'CCAFS LC-40
April:'
F9 v1.1 B1015', 'CCAFS LC-40

10

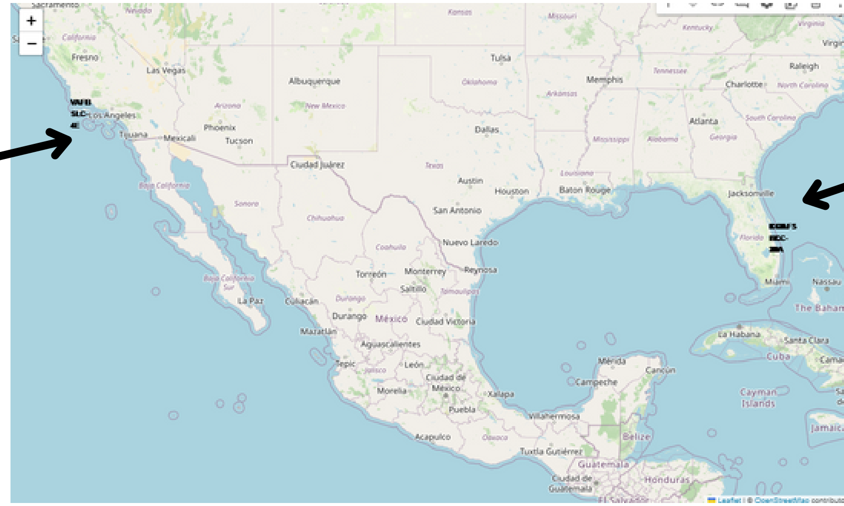
RANKED LANDING BETWEEN 2010-06-04 AND 2017-03-20

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

Interactive Map with Folium Results Slides

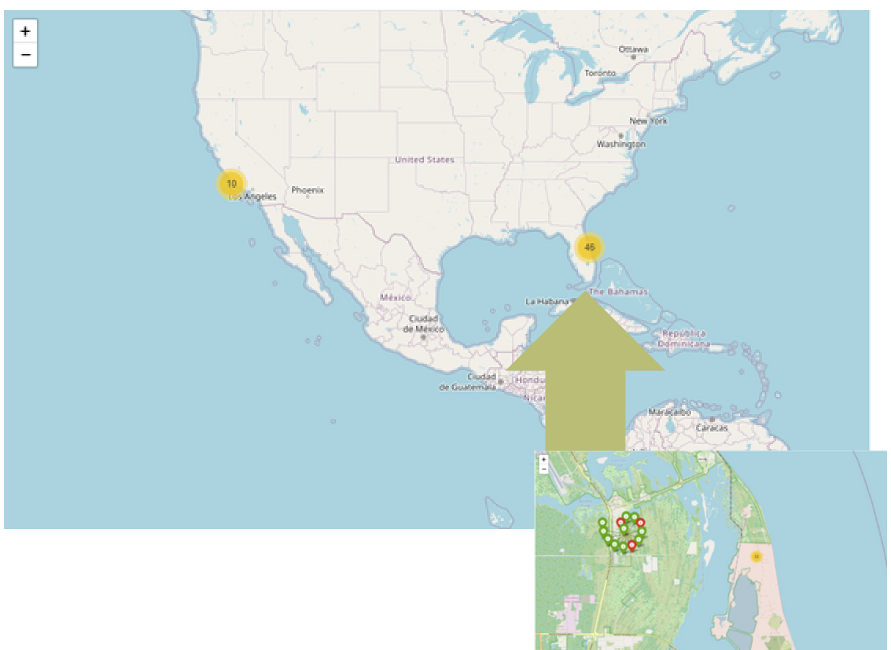
TASK 1: Mark all launch sites on a map

CCAFS LC-40
KSC LC-39A
CCAFS SLC-40

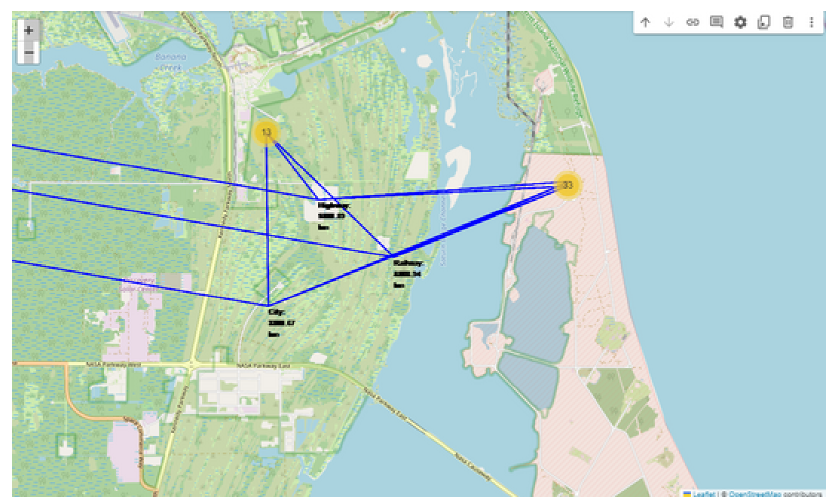


VAFB SLC-4E

TASK 2: Mark the success/failed launches for each site on the map

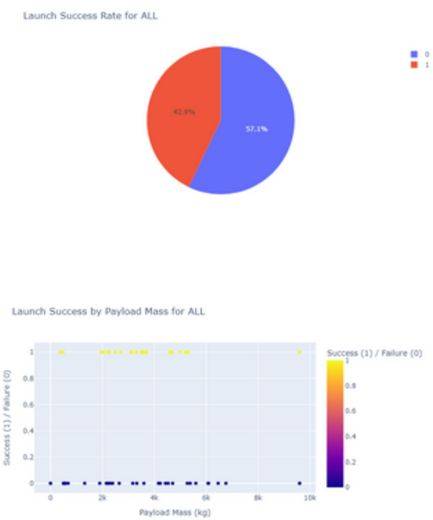


TASK 3: Calculate the distances between a launch site to its proximities

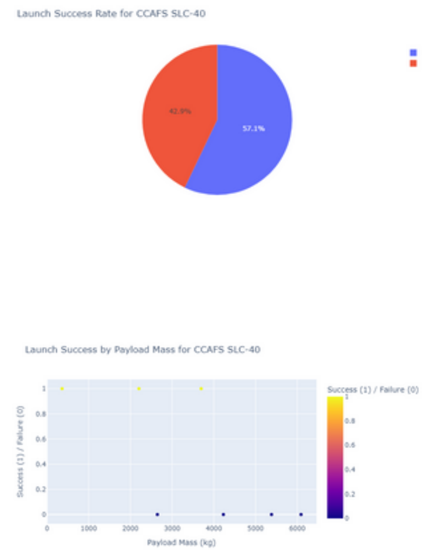


Plotly Dash Dashboard Results

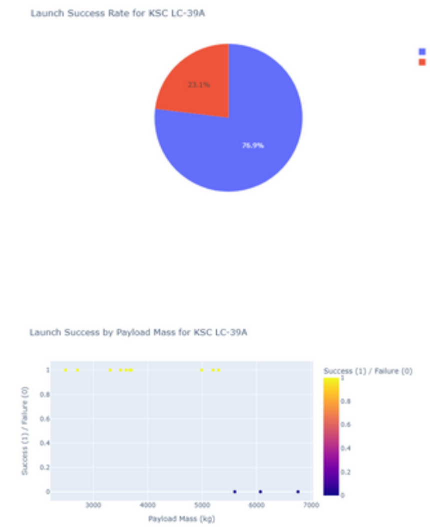
ALL



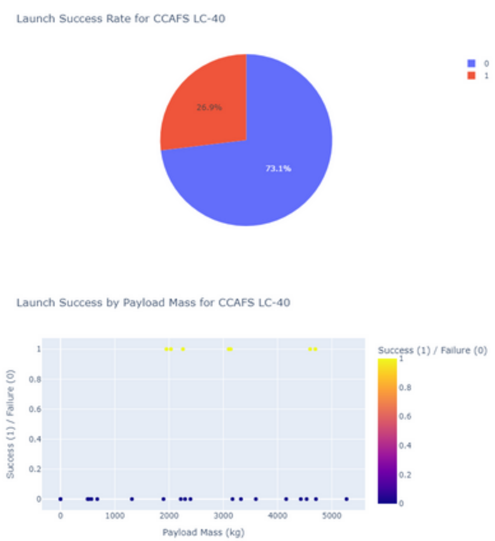
CCAFS-SLC40

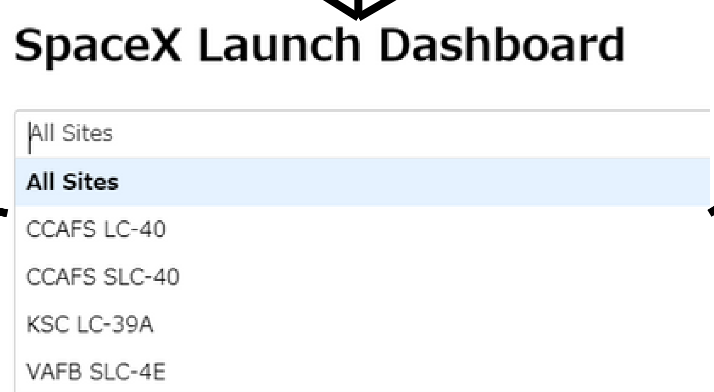


KSC LC-39A

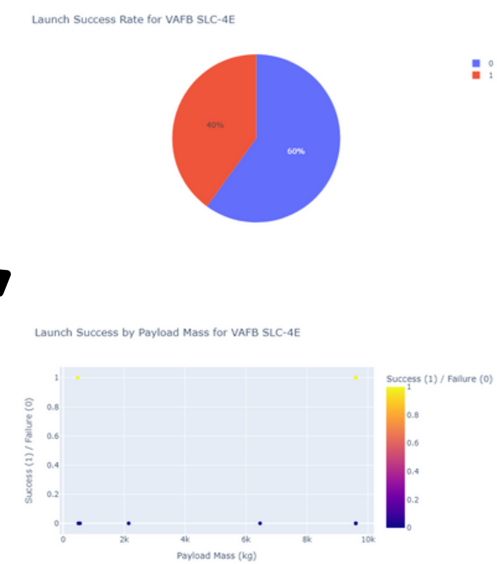


CCAFS-LC40



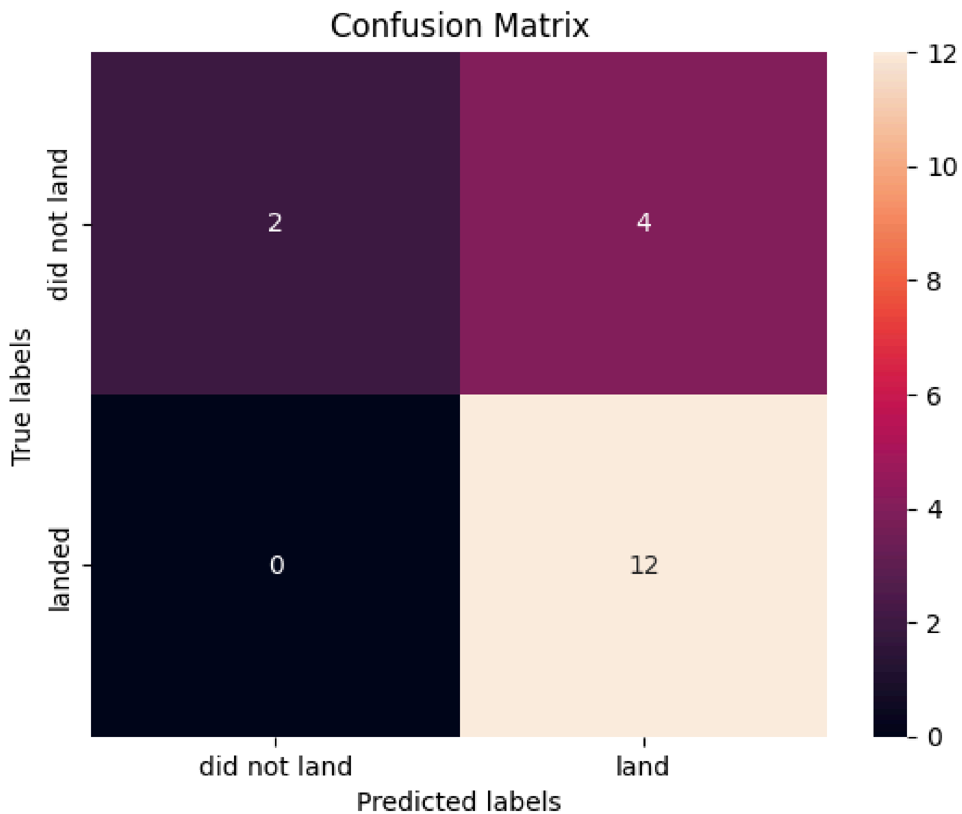


VAFB SLC-4E



Predictive Analysis (Classification) Results

Results
(1)Tuned hyperparameters (best parameters): {'algorithm': 'auto', 'n_neighbors': 3, 'weights': 'uniform'}
Best score: 0.7785714285714285
(2)Accuracy on the test data: 0.7777777777777778



-High Recall (100%): The model correctly identifies all actual landing events, making it very reliable in predicting landings.
-Moderate Precision (75%): While the model is good at predicting landings, 25% of its landing predictions are false positives.
-Accuracy (78%) is a general measure, but F1-Score (86%) provides a better understanding since it balances precision and recall.

Conclusion

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