Rocket Launch Cost Prediction

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SKILLS NETWORK

OUTLINE

- Executive Summary
- Introduction
- Methodology
- Results
  - Visualization – Charts
  - Dashboard
- Discussion
  - Findings & Implications
- Conclusion
- Appendix

EXECUTIVE SUMMARY

- Forecasting the success rate of Falcon 9 first stage landings
- Identifying key factors that impact the chances of a successful landing
- Calculating the total expenses associated with a launch
- Offering strategic insights for companies aiming to challenge SpaceX
- Creating a predictive model to estimate the probability of successful landings for the first stage

INTRODUCTION

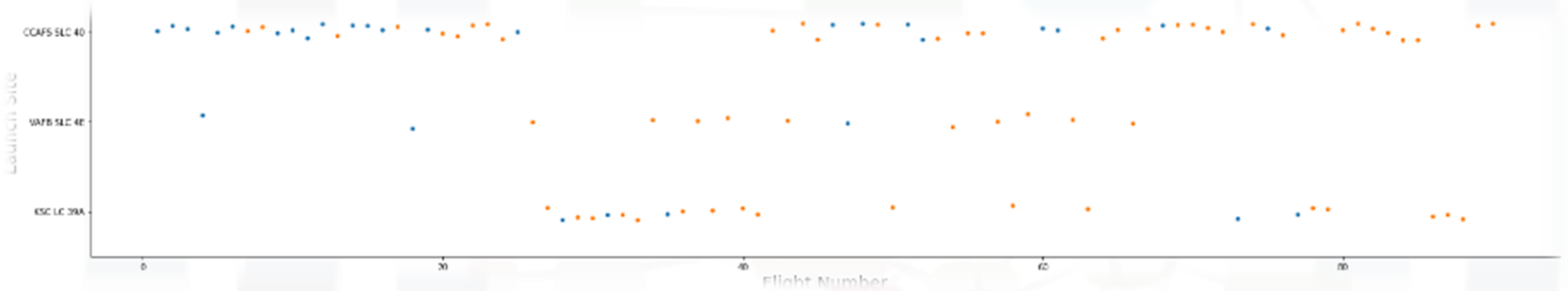
- Traditional rocket providers typically charge $165 million per launch.
- SpaceX's innovative approach of reusing the Falcon 9's first stage has significantly cut down launch costs.
- The Falcon 9 launch price is $62 million.
- Compared to traditional providers, SpaceX's reuse of the Falcon 9 first stage has substantially reduced the cost of launches.

METHODOLOGY

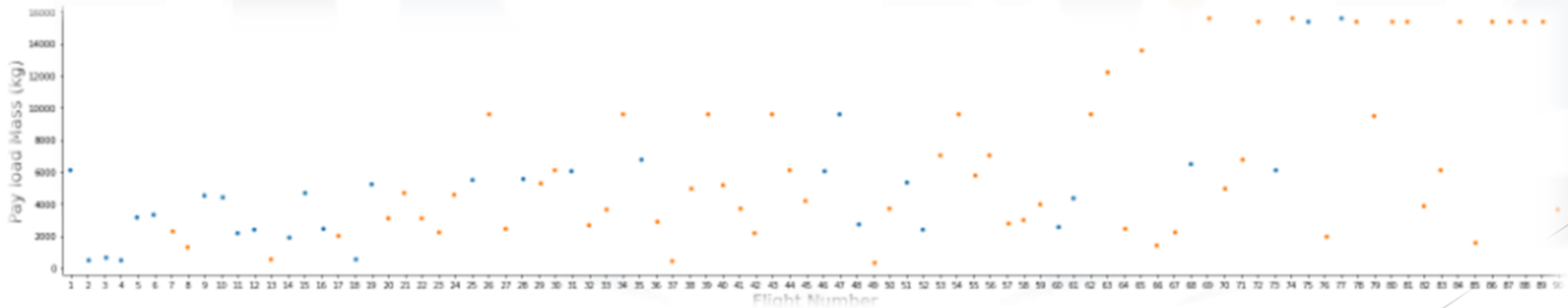
- Collecting Data via:
- SpaceX API
- Web Scraping
- Data Wrangling
- Analyzing and Visualizing Data using:
- SQL
- Pandas
- Machine Learning Prediction for Successful First Stage Landings

METHODOLOGY: EDA & Interactive Visual Analytics (1/3)

- Visualize the relationship between Flight Number and Launch Site

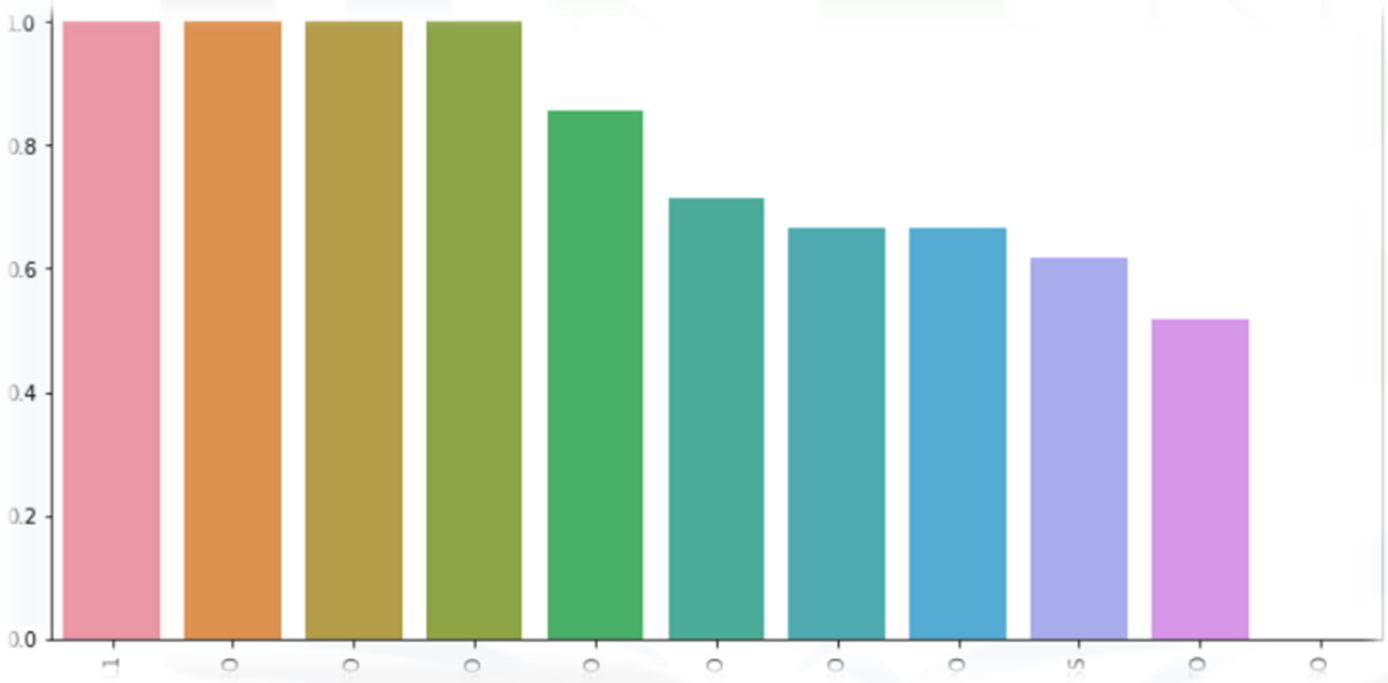


- Visualize the relationship between Payload and Launch Site



METHODOLOGY: EDA & Interactive Visual Analytics (2/3)

- Success rate of each orbit type



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METHODOLOGY: Predictive Analysis

- A higher number of flights at a launch site is associated with a higher success rate at that site.
- The orbits ES-L1, GEO, HEO, SSO, and VLEO had the highest success rates.
- For the LEO orbit, success is linked to the number of flights, while for the GTO orbit, there is no significant correlation between flight numbers and success.

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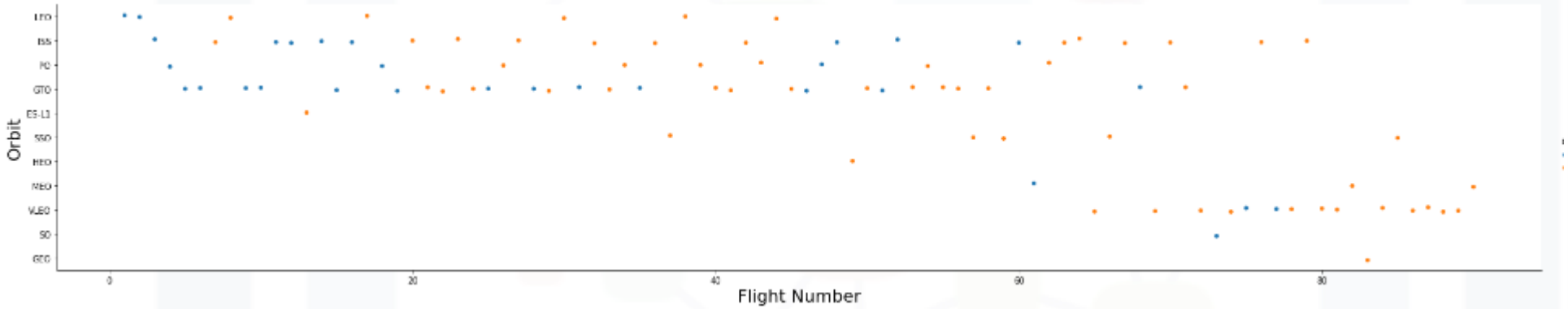
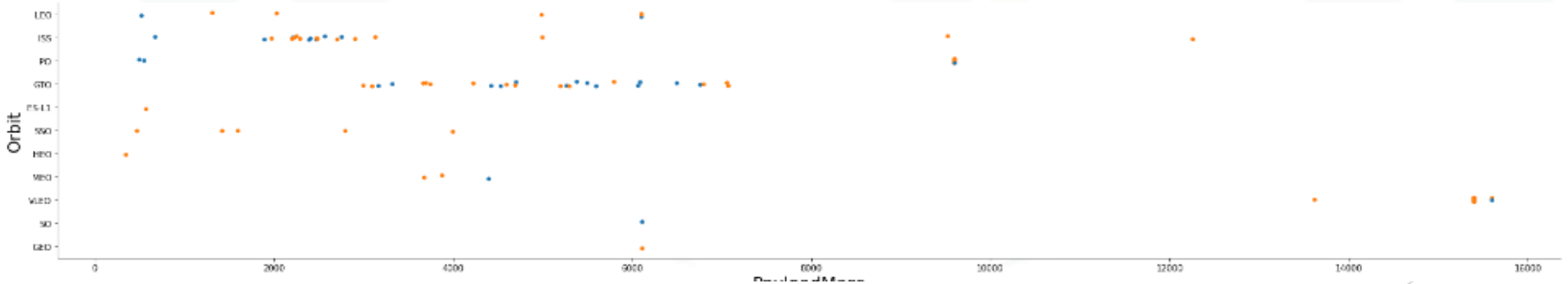
RESULTS: EDA & Interactive Visual Analytics (3/3)

Visualize the relationship between FlightNumber and Orbit type



Visualize the relationship between Payload Mass and Orbit type



RESULTS: EDA With SQL (1/4)

- Unique launch sites in the space mission

	launchsite
0	KSC LC-39A
1	CCAFS LC-40
2	CCAFS SLC-40
3	VAFB SLC-4E

- Total & Average payload mass carried by boosters launched by NASA (CRS)

	total_payloadmass
0	45596

	avg_payloadmass
0	2928.4

RESULTS: EDA With SQL (2/4)

- First successful landing

	firstsuccessfull_landing_date
0	2015-12-22

- Booster_versions

	boosterversion
0	F9 FT B1022
1	F9 FT B1026
2	F9 FT B1021.2
3	F9 FT B1031.2

RESULTS: EDA With SQL (3/4)

- Successful Outcomes

	successoutcome
0	100

- Booster_versions which have carried the maximum payload mass

	boosterversion	payloadmasskg
0	F9 B5 B1048.4	15600
1	F9 B5 B1048.5	15600
2	F9 B5 B1049.4	15600
3	F9 B5 B1049.5	15600
4	F9 B5 B1049.7	15600
5	F9 B5 B1051.3	15600
6	F9 B5 B1051.4	15600
7	F9 B5 B1051.6	15600
8	F9 B5 B1056.4	15600
9	F9 B5 B1058.3	15600
10	F9 B5 B1060.2	15600
11	F9 B5 B1060.3	15600

RESULTS: EDA With SQL (4/4)

- Failed landing outcomes in drone ship

	boosterversion	launchsite	landingoutcome
0	F9 v1.1 B1012	CCAFS LC-40	Failure (drone ship)
1	F9 v1.1 B1015	CCAFS LC-40	Failure (drone ship)

- Count of landing outcomes

	landingoutcome	count
0	No attempt	10
1	Success (drone ship)	5
2	Failure (drone ship)	5
3	Success (ground pad)	5
4	Controlled (ocean)	3
5	Uncontrolled (ocean)	2
6	Precluded (drone ship)	1
7	Failure (parachute)	1

RESULTS: Interactive map with Folium (1/3)

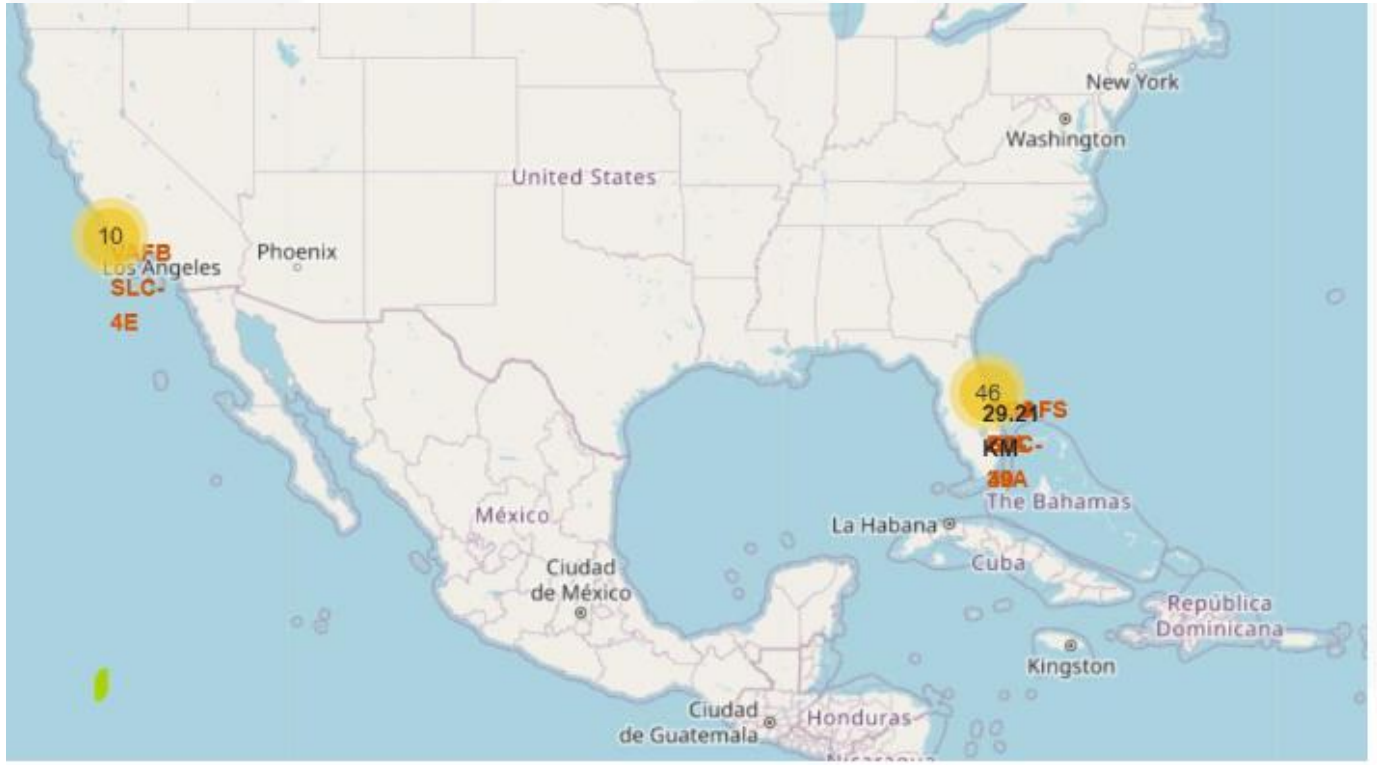
- all launch sites on a map

RESULTS: Interactive map with Folium (2/3)

- Success/Failed launches for each site on the map

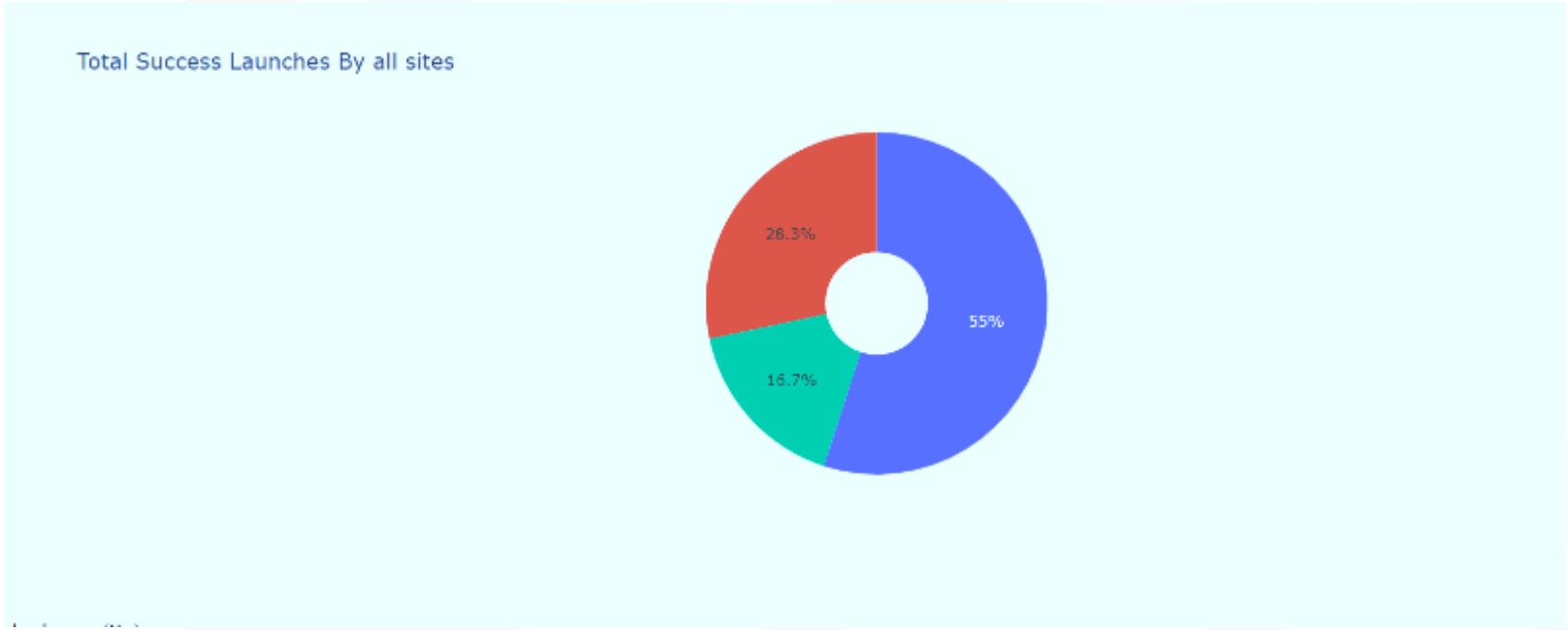
RESULTS: Interactive map with Folium (3/3)

- Distances between a launch site to its proximities



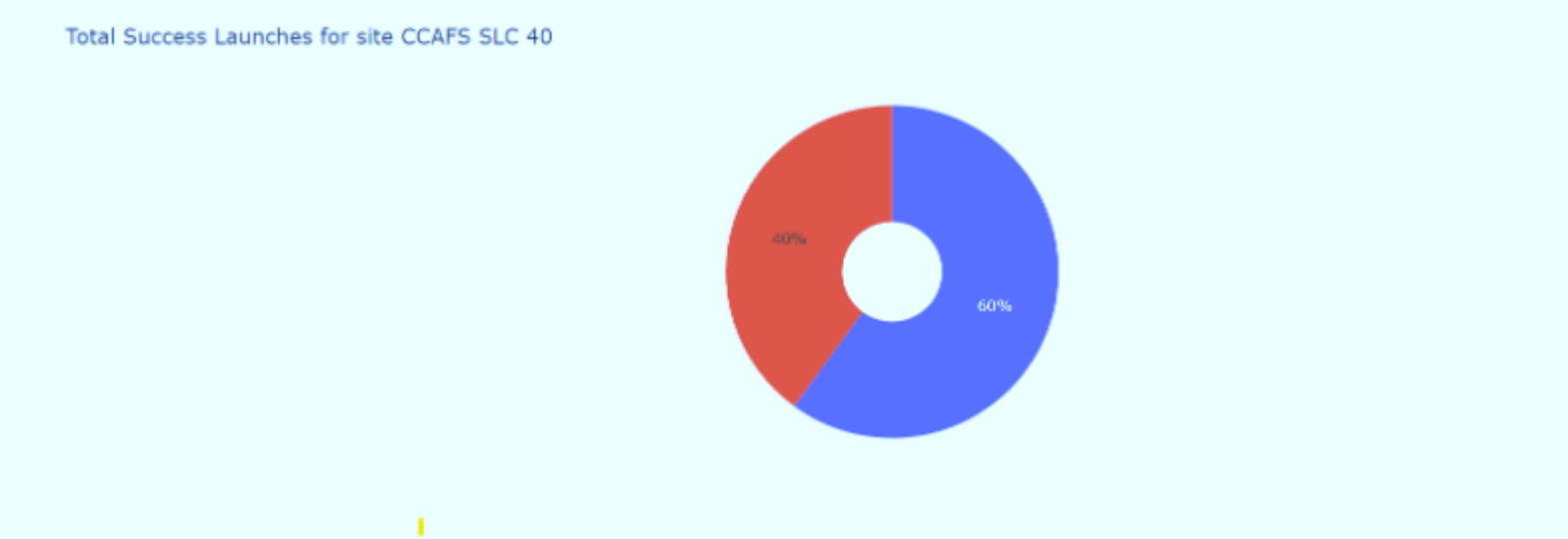
RESULTS: Plotly Dash dashboard (1/3)

- Plotly Dashboard: All sites launch record



RESULTS: Plotly Dash dashboard (2/3)

- Plotly Dashboard: Site CCAFS SLC 40 launch records



RESULTS: Plotly Dash dashboard (3/3)

- Plotly Dashboard: Booster version and Payload

RESULTS: Predictive Analysis Classification Results (2/5) y (1/5)

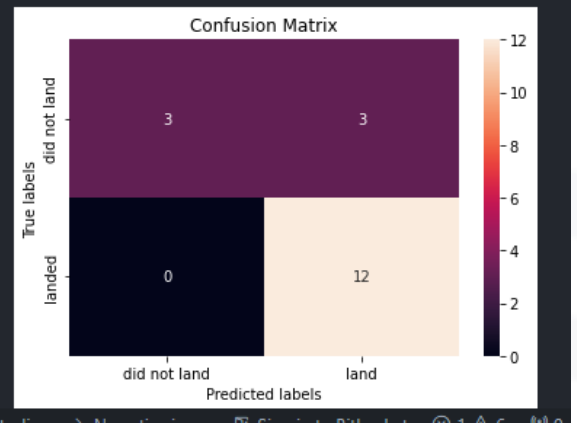
- Support Vector Machine: Accuracy on the test data using the meth

```
svm_cv.score(X_test, Y_test)
```

```
0.8333333333333334
```

We can plot the confusion matrix

```
yhat = svm_cv.predict(X_test)
plot_confusion_matrix(Y_test, yhat)
```

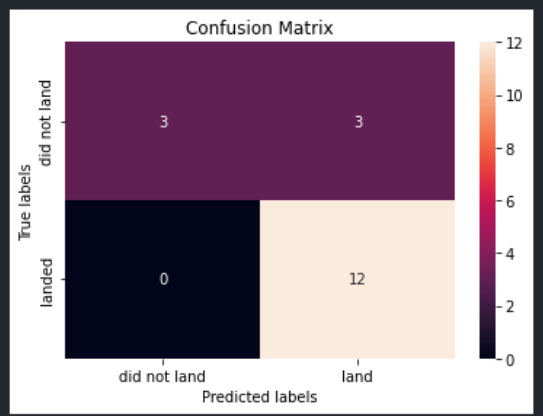


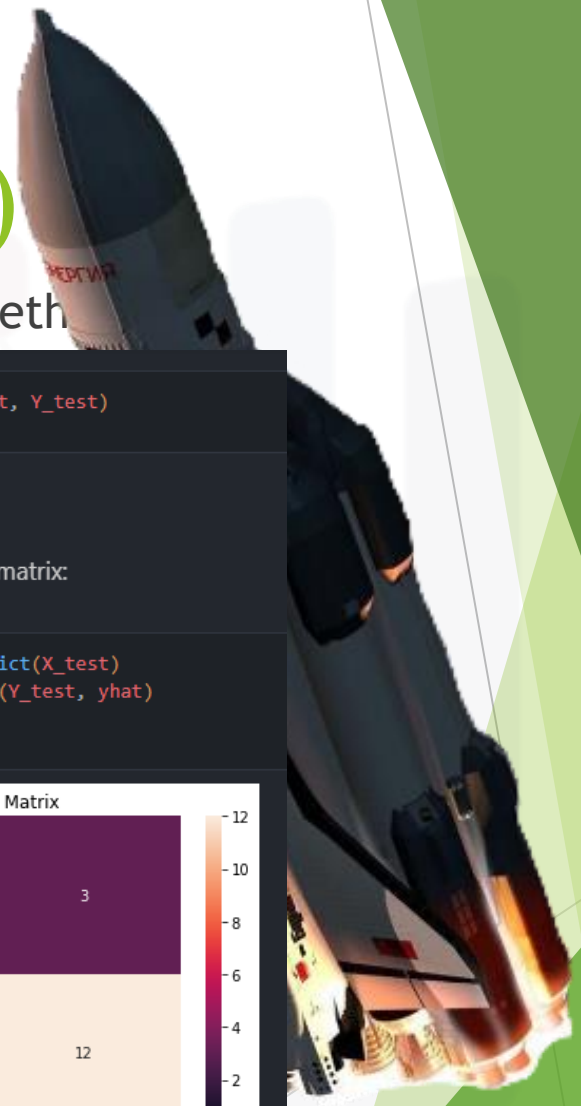

```
logreg_cv.score(X_test, Y_test)
```

```
0.8333333333333334
```

Lets look at the confusion matrix:

```
yhat = logreg_cv.predict(X_test)
plot_confusion_matrix(Y_test, yhat)
```





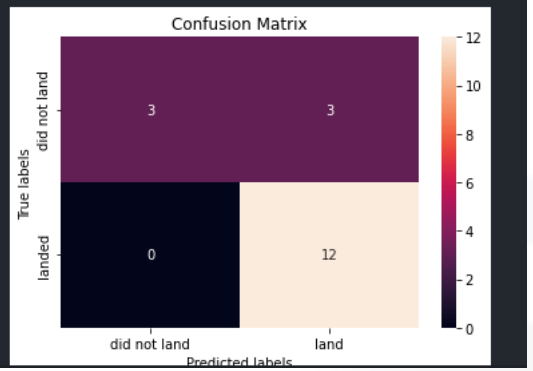
RESULTS: Predictive Analysis Classification Results (4/5) y (3/5)

- K nearest neighbour: Accuracy on the test data using the method

```
[41]  knn_cv.score(X_test, Y_test)
...   0.8333333333333334
```

We can plot the confusion matrix

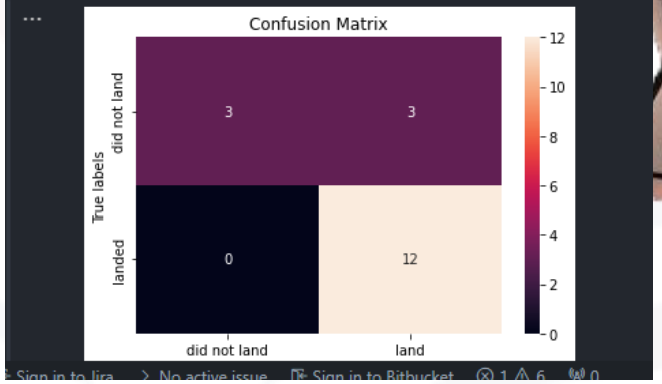
```
[42]  yhat = knn_cv.predict(X_test)
      plot_confusion_matrix(Y_test, yhat)
```




```
[34]  tree_cv.score(X_test, Y_test)
...   0.8888888888888888
```

We can plot the confusion matrix

```
[35]  yhat = svm_cv.predict(X_test)
      plot_confusion_matrix(Y_test, yhat)
```



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RESULTS: Predictive Analysis Classification Results (5/5)

- Best performing Model: Decision Tree (Score=88% aprox)

```
models = {
    "KNeighbors": knn_cv.best_score_,
    "DecisionTree": tree_cv.best_score_,
    "LogisticRegression": logreg_cv.best_score_,
    "SupportVector": svm_cv.best_score_,
}

bestalgorithm = max(models, key=models.get)
print(f"Best model is {bestalgorithm=}, with a score of, {models[bestalgorithm]}")

if bestalgorithm == "DecisionTree":
    print("Best params is :", tree_cv.best_params_)
if bestalgorithm == "KNeighbors":
    print("Best params is :", knn_cv.best_params_)
if bestalgorithm == "LogisticRegression":
    print("Best params is :", logreg_cv.best_params_)
if bestalgorithm == "SupportVector":
    print("Best params is :", svm_cv.best_params_)
```

Python

```
Best model is bestalgorithm='DecisionTree', with a score of, 0.8875
Best params is : {'criterion': 'entropy', 'max_depth': 12, 'max_features': 'sqrt', 'min_samples_leaf': 1, 'min_samples_split': 2, 'splitter': 'random'}
```

CONCLUSION

- A higher number of flights at a launch site correlates with a higher success rate.
- The success rate of launches began to rise from 2013 and continued improving until 2020.
- The orbits ES-L1, GEO, HEO, SSO, and VLEO exhibited the highest success rates.
- KSC LC-39A had the highest number of successful launches among all sites.
- The Decision Tree Classifier is the most effective machine learning algorithm for this task.