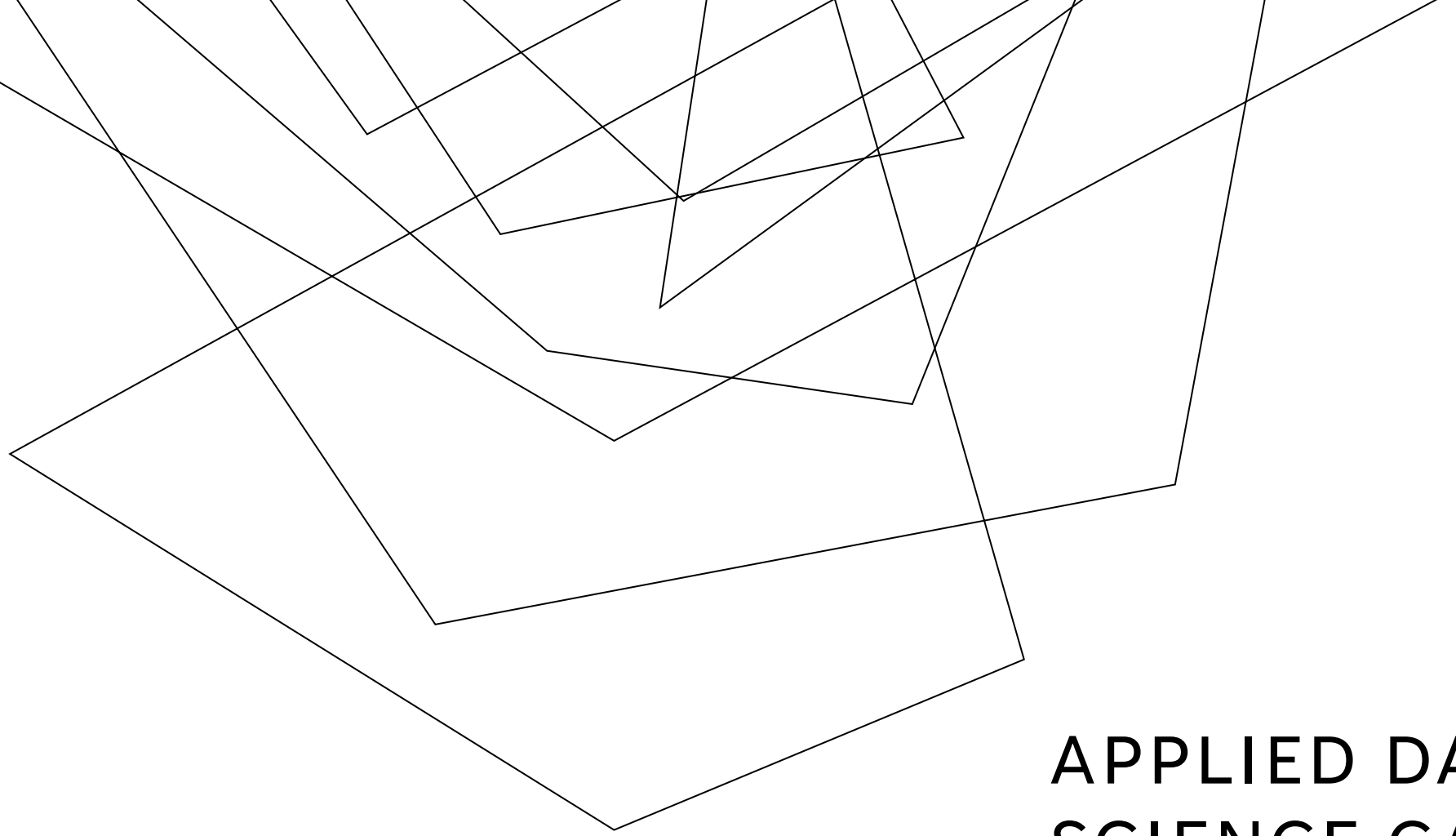

APPLIED DATA SCIENCE CAPSTONE PRESENTATION

BY TREVOR WHITESIDE

OVERVIEW

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Data Collection/Wrangling

EDA/Visual Analytics

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EDA/Visual Results

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EXECUTIVE SUMMARY

This capstone project applied the complete data science lifecycle to analyze and predict SpaceX rocket landing outcomes. The work progressed through four integrated modules from data collection/wrangling to Exploratory Data Analysis, interactive dashboards, and predictive modeling.

Key Findings

- All four machine learning models achieved strong performance, with test accuracies between **83% and 89%.**
- The Decision Tree Classifier delivered the highest accuracy **(88.89%)** and the most balanced error profile across landing outcomes.

Overall, this project demonstrates how end-to-end data science can generate actionable insights for a private space launch company and support data-driven decision-making in mission planning

INTRODUCTION

Project Objectives

- Collect and prepare SpaceX launch data from multiple sources.
- Explore key variables and relationships using statistical and visual analysis.
- Build interactive dashboards for dynamic exploration of launch performance.
- Develop predictive models to estimate landing success and evaluate model accuracy.

DATA COLLECTION METHODOLOGY

API-Based Data Collection

- Retrieved launch and landing records directly from public APIs.
- Converted JSON responses into structured dataframes.
- Ensured field consistency and extracted key variables for downstream use.

Web Scraping

- Collected supplemental launch information from HTML tables and web pages.
- Parsed and transformed scraped content into tabular format.
- Integrated scraped data with API data to enhance completeness.

Data Wrangling

- Cleaned and prepared all collected datasets by handling missing values, correcting inconsistencies, and standardizing formats.
- Engineered additional fields where needed and ensured schema alignment across sources
- Exported finalized datasets as CSV files for use in EDA and visualization modules.

EXPLORATORY & VISUAL ANALYSIS METHODS

EDA with SQL

- Queried the processed datasets using SQL to explore relationships, distributions, and trends.
- Performed grouping, filtering, joins, and aggregations to identify patterns in data.
- Used SQL magic within Jupyter to integrate SQL queries directly into the analysis workflow.

EDA with Visualization

- Applied Pandas, Matplotlib, and Seaborn to visualize correlations, payload distributions, and success rates.
- Used scatter plots, bar charts, and line graphs to reveal relationships between payload mass, launch site, booster version, and landing success.
- Prepared insights that informed feature selection and guided predictive modeling.

PREDICTIVE ANALYSIS METHODOLOGY

Model Development Workflow

- Encoded categorical variables and scaled numerical variables to prepare for machine learning
- Split data into training and test sets to ensure unbiased model evaluation.
- Selected four supervised classification algorithms for comparison: Logistic Regression, Support Vector Machine (SVM), Decision Tree, and k-Nearest Neighbors (KNN).

Hyperparameter Optimization

- Applied GridSearchCV with 10-fold cross-validation to tune each model’s hyperparameters.
- Evaluated candidate configurations using cross-validated accuracy to identify best settings.
- Ensured model robustness by preventing overfitting and validating performance across multiple folds.

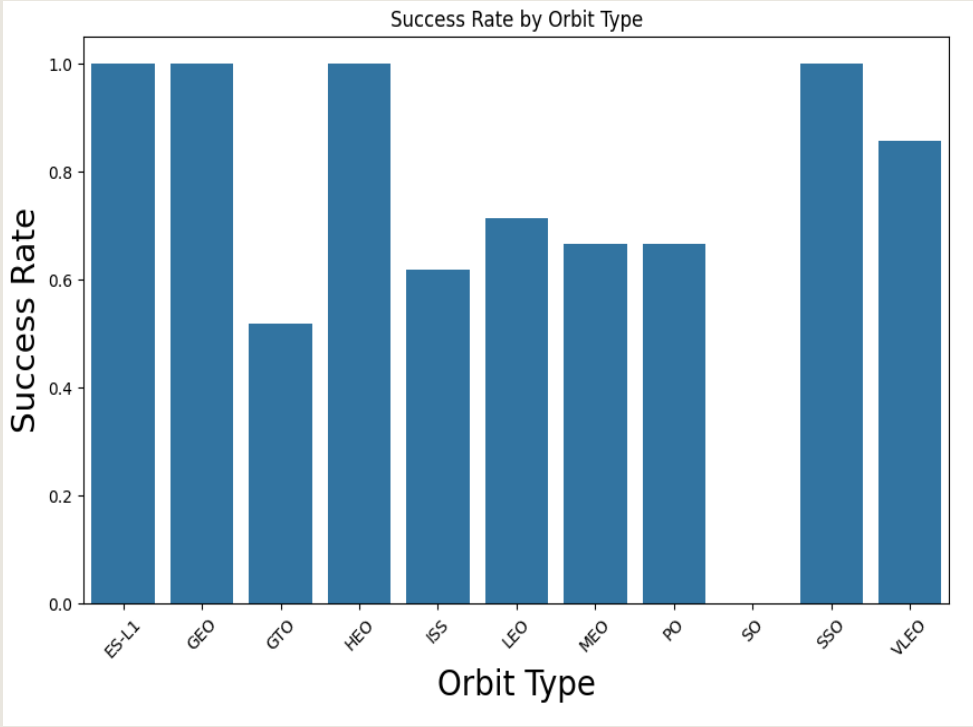
Model Evaluation Approach

- Assessed final model performance on the held-out test set using accuracy scores.
- Generated confusion matrices to analyze classification behavior and error types.
- Compared models based on generalization performance and predictive reliability.

RESULTS OF EDA WITH VISUALIZATION

Key Insights

- Payload mass showed a non-linear relationship with landing success.
  - Moderate payloads achieved highest success rates.
- Launch site analysis revealed significant variation in performance.
- Booster version category strongly correlated with outcome.
  - Newer booster variants achieved higher success rates.
- Orbit type influenced landing probability.
  - Certain orbits were associated with higher success rates than more demanding mission profiles.



RESULTS OF EDA WITH SQL

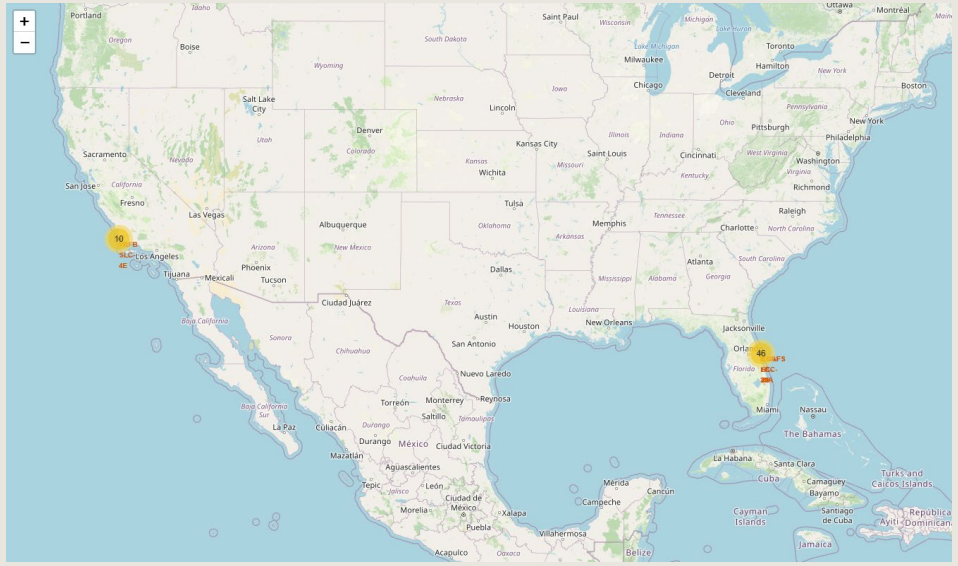
Key Insights

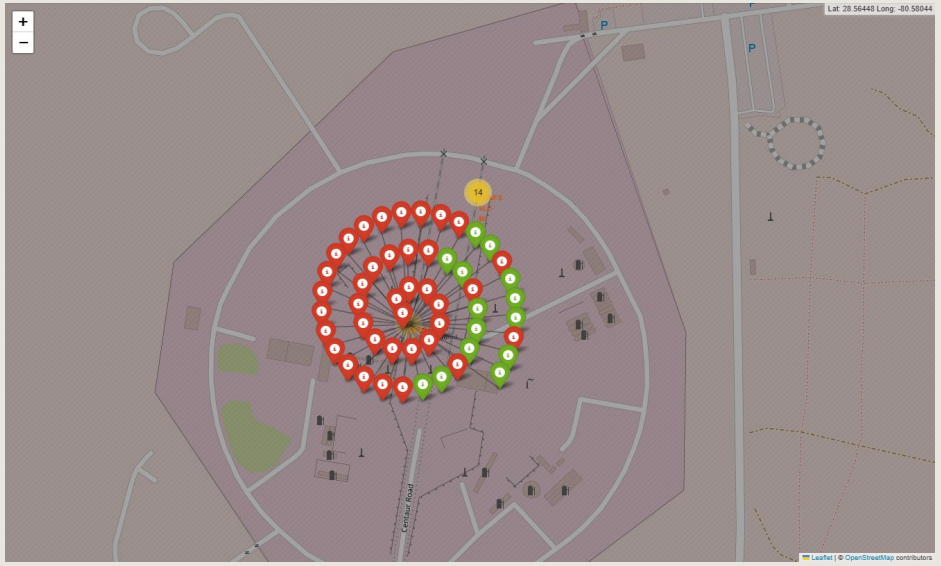
- Launch success rates varied significantly by launch site.
  - Some sites showed consistently higher landing performance based on aggregated successes.
- Payload mass influenced landing outcomes.
  - SQL group-by queries revealed higher success rates within certain payload ranges.
- Booster version categories showed clear performance differences.
  - Newer variants achieved higher success rates in the SQL-based summaries.
- Orbit type impacted landing probability.
  - SQL filtering & aggregation highlighted which mission profiles were associated with lower and higher success rates.
- Temporal analysis showed improvement over time.
  - SQL queries on launch year indicated increasing success as SpaceX refined booster technology.

INTERACTIVE MAP WITH FOLIUM RESULTS

Key Insights from Geospatial Analysis

- Launch sites showed distinct success patterns
- Marker color-coding highlighted outcome distribution
- Payload and orbit filters revealed spatial trends
- Geospatial clustering illustrated operational concentration
- Interactive map enabled intuitive exploration

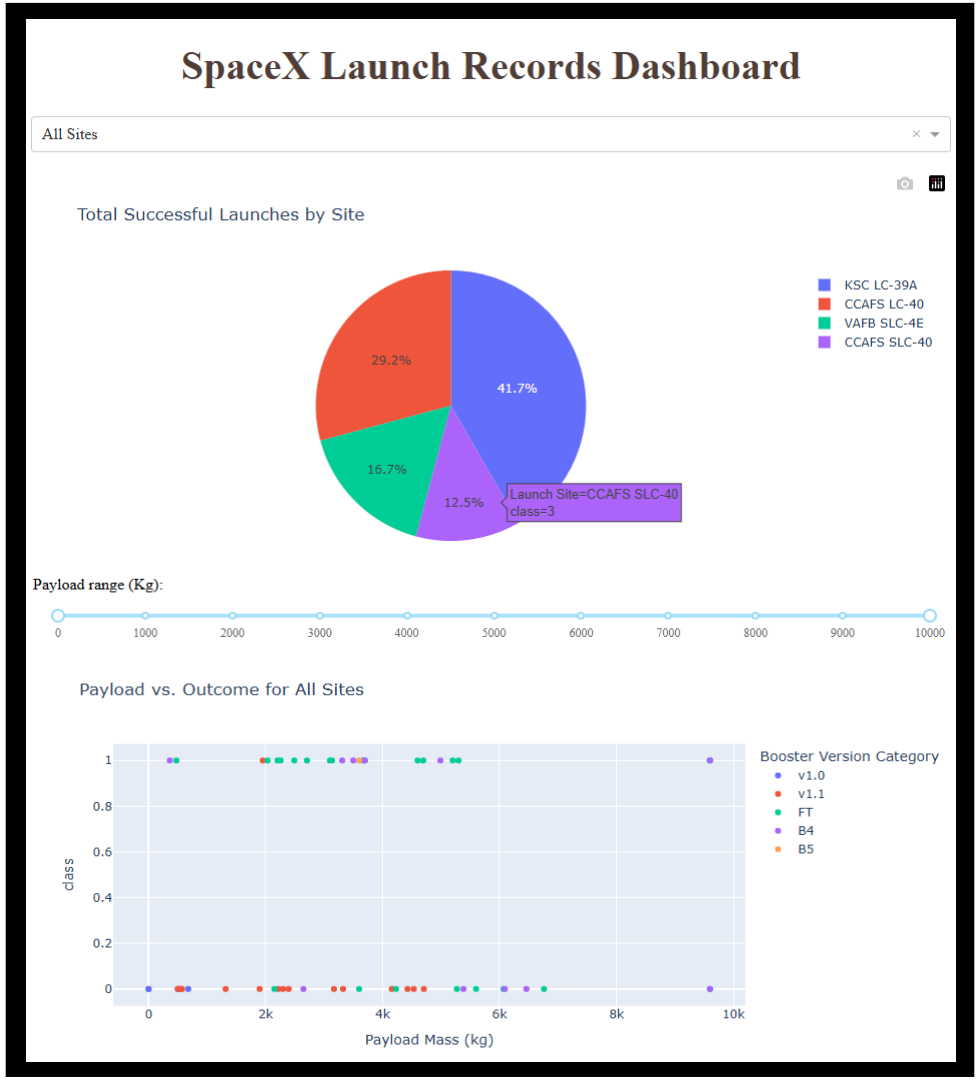




PLOTLY DASH DASHBOARD RESULTS

Key Insights

- Dynamic filtering revealed clear relationships.
  - Allowed users to isolate patterns that were less obvious in static charts.
- Interactive success-rate visualizations highlighted performance differences.
  - Reinforced findings from earlier EDA.
- Payload-vs-success scatter plots updated in real time.
  - Made it easy to observe mission characteristics.
- User-controlled dropdowns and callbacks enabled scenario exploration.
  - Supported deeper insights into the individual variables.
- Dashboard interactivity improved interpretability.
  - Provided an intuitive, hands-on way to explore the dataset.



PREDICTIVE ANALYSIS RESULTS

Key Insights

- Decision Tree Classifier delivered the highest test accuracy and demonstrated balanced error rates.
- Most models produced zero false negatives, reliably identifying successful landings.
- False positives were the most common error type, indicating occasional over-prediction of success.
- Hyperparameter tuning via GridSearchCV improved stability and reduced overfitting in all models.

MODEL	CROSS-VALIDATED ACCURACY	TEST ACCURACY	FALSE NEGATIVES	FALSE POSITIVES
Logistic Regression	84.6%	83.33%	0	3
Support Vector Machine	84.8%	83.33%	0	3
Decision Tree	87.5%	88.89%	1	1
K-Nearest Neighbors	84.82%	83.33%	0	3

CONCLUSION

This project demonstrated the full power of the data science lifecycle, which applied to real-world SpaceX launch and landing data. Through each phase of the lifecycle, raw mission records were transformed into actionable insights.

Takeaways:

- Clear relationships between payload mass, launch site, booster version, orbit type, and landing success.
- Interactive tools that enabled intuitive exploration of operational patterns.
- Strong predictive performance across multiple machine learning models, with the Decision Tree emerging as the most effective classifier.

Overall, this end-to-end analysis highlights how data-driven methods can support mission planning, improve operational understanding, and enhance decision-making for a private space launch company.

THANK YOU

Trevor Whiteside

All work published at:

https://github.com/twhizzz/Applied-Data-Science-Capstone.git