SpaceX Falcon 9 First Stage Landing Prediction

PERFECTING PROPULSIVE LANDING

SEPTEMBER 2013   HARD IMPACT ON OCEAN

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13.02.2022

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OUTLINE

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EXECUTIVE SUMMARY (Abstract)

- The task is to predict if Falcon 9 first stage lands successfully.

- What we do
  - Collect data from the wiki page of SpacX
  - Click to add Text on the data to predict some trend
  - Train machine learning models (support vector machines (SVM), LogisticRegression, and Decsision Tree).

- Findings
  - The sucess rate since 2013 kept increasing till 2020
  - Different orbits have different success rates.
  - DecisionTree achieves 90% accuracy and outperforms the other examined ML model.

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INTRODUCTION

- We aim at predicting if the Falcon 9 first stage lands successfully.

- 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.

METHODOLOGY

- Gathering the data including a class label to say if a landing is successful or not.
  - We do webscraping methods to collect such data from Wikipedia.
  - We deal with missing values of an attribute by replacing its NaN values with the mean of its values for other examples.

- We explore the data using some Exploratory Data Analysis (EDA) methods to find some patterns in the data.
  - We study these patterns using data visualization methods

- We conduct a feature engineering to understand what attribute in the data is distinctive between successful and unsuccessful landings.

- We build different types of machine learning methods such as (decision trees, logistic regression, and SVM) to predict if a landing is successful or not.

RESULTS

- We collected examples of landings represented with 16 different attributes and 1 class label that shows if a landing is successful or not.

- The values of PayloadMass and LandingPad attributes are missing for 5 and 26 examples, respectively. The rest of attributes have values for any example.

- 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%.

- The VAFB-SLC launchsite there are no rockets launched for heavypayload mass (greater than 10000).

- Orbits SSO, HEO, GEO, and ES-L1 have high sucess rate > 0.80.

- There is no relationship between flight number when in GTO orbit.

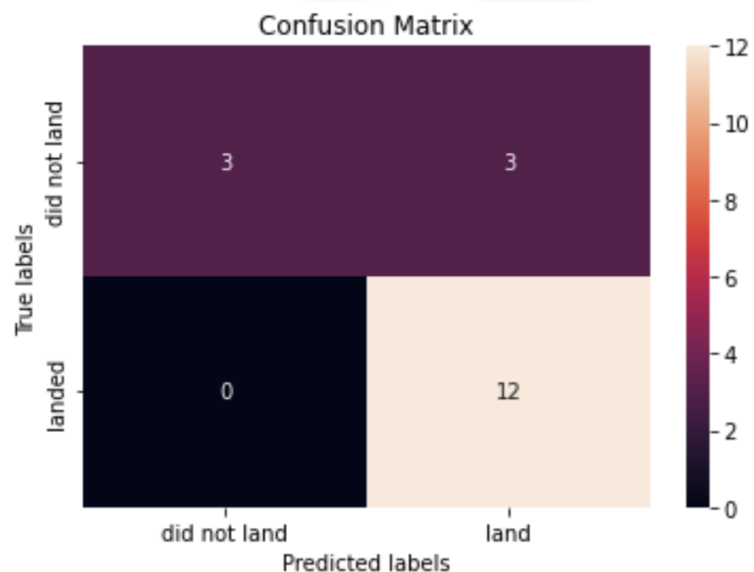- the sucess rate since 2013 kept increasing till 2020

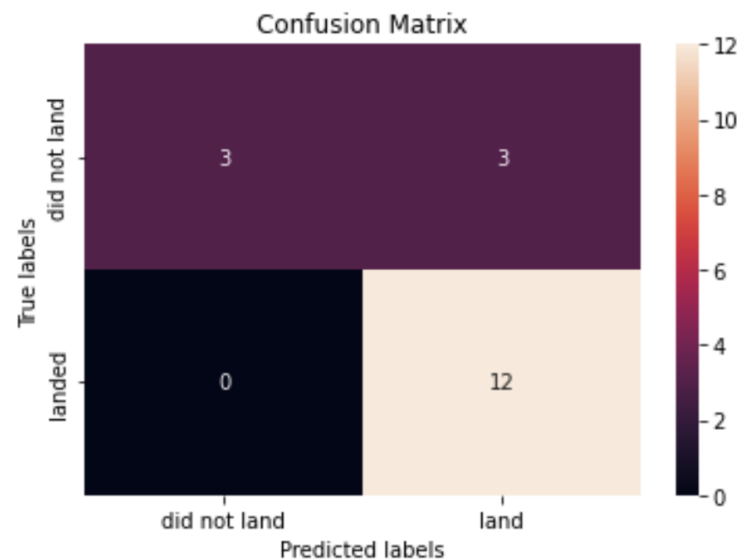# The sucess rate since 2013 kept increasing till 2020
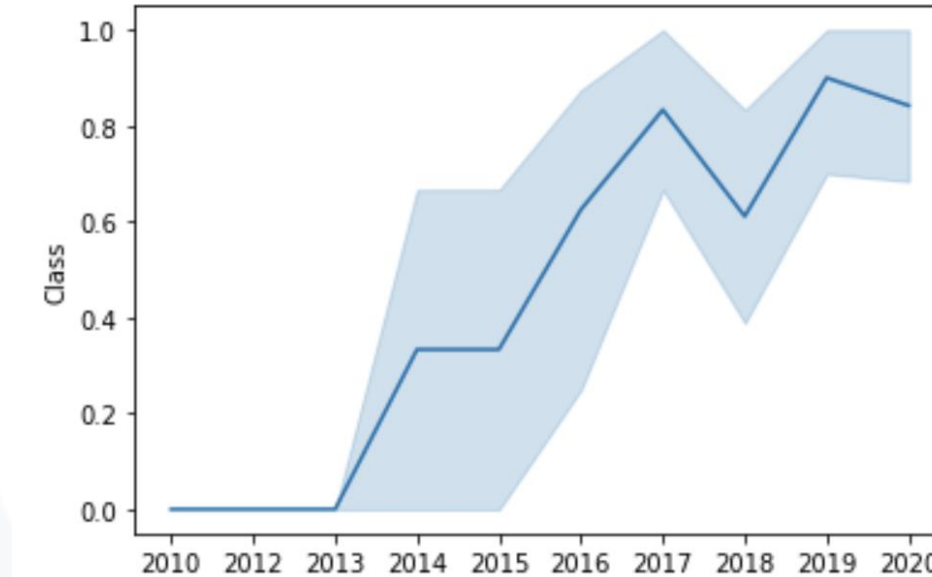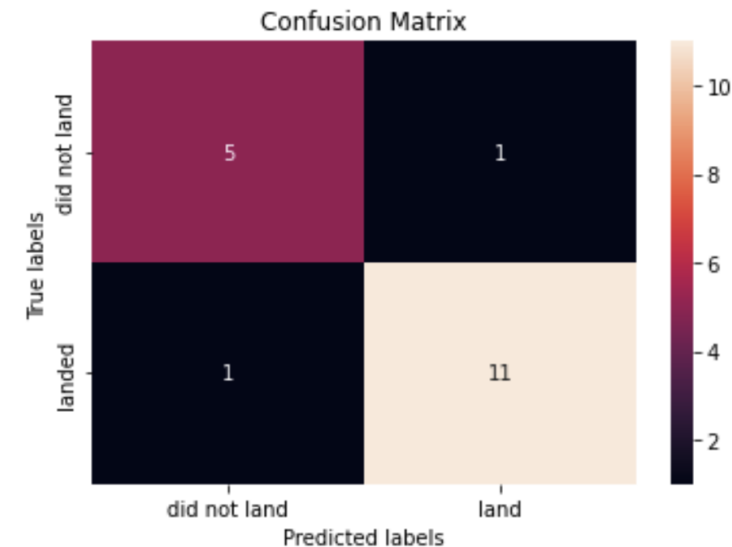
The success from different orbits
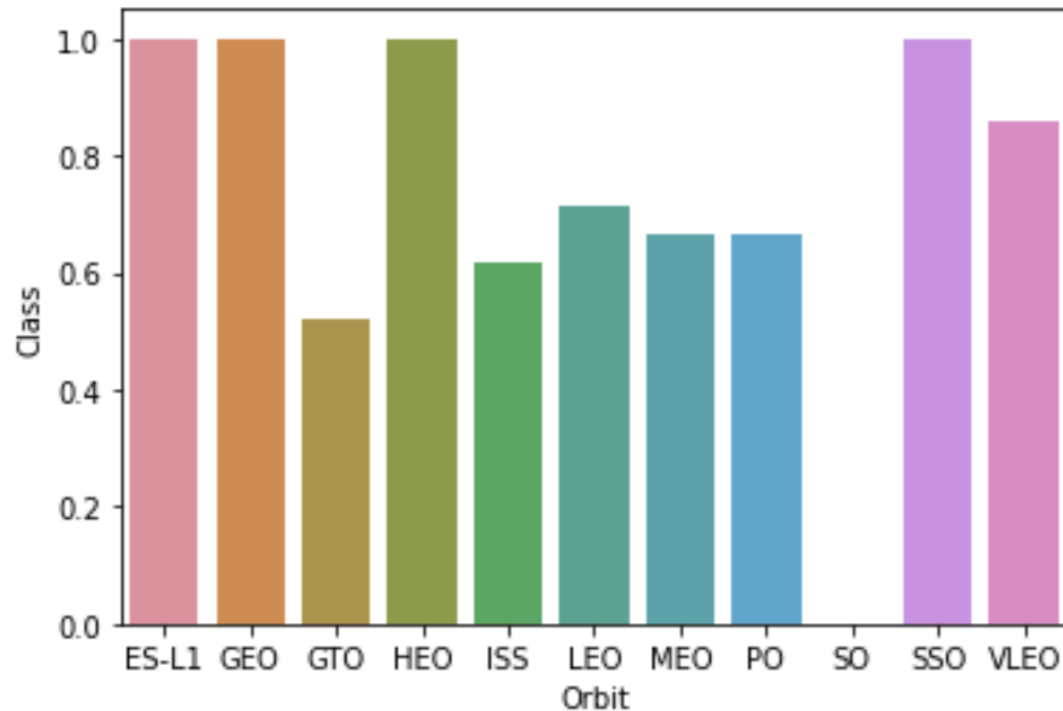
Confusion Matrices of Different Models

LogistcRegression

SVM

Decision Tree

Accuracy of Different Models on 18 unseen examples

Model	Accuracy (%)
LogisticRegression	84.64
Support Vector Machines (SVM)	84.82
Decision Tree	**90.18**

DISCUSSION

- The DecisionTree model achieves the best accuracy compared with LogisticRegression and Support Vector Machines.

- So if we use our DecsisionTree model, we can predict if a future landing can be successful with about 10% error rate.

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CONCLUSION

- Our goal was to predict if the Falcon 9 first stage lands successfully.

- We collected data from SpaceX wiki page.

- We then extracted several distinctive features.

- We find out the decision tree is the best performing model for achieving our goal.

APPENDIX

- The repository of this project is here:
- https://github.com/MMesgar/tutorial-data-science/tree/main/capstone