Launch Bids Ignition Space X with Data Science

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Executive summary

➢ We use PACE framework

Data Analysis PACE Steps:

1. Plan/Prepare - import the relevant libraries and data

   Align project with business needs, requirements and contraints. Select an approriate machine learning model based on the problem and business context. KDD: Selection, Data Wrangling (Pre-processing and Transformation).

2. Analyze - Explarotary Data Analysis (EDA)

   Understanding data for accurate predictions, focus on the response variable (what the model predicts) and leverage exploratory data analysis to uncover patterns and address irregularities. KDD: Data Mining.

3. Construct - model

   Construct and evaluate model. KDD: Evaluation.

4. Execute - share

   Interpret model and share the story. KDD: Communicate to stakeholders.

➢ The recommended model

1. The test data was small, with test data on 18 samples, required more sample
2. Explore other models

	Model	Train Score	Test Score
0	KNN	0.875000	0.944444
1	Decision Tree	0.875000	0.944444
2	SVM	0.861111	0.944444
3	Logistic Regression	0.875000	0.944444

Introduction: Business case and Objective

Business Case

Space X offers competitive price since its first successful landing in 2015 by reusing the rocket, more than half of its competitors’ cost

Opportunity/Problem Statement:

- Space x has been operating since 2010 and the landing success rate continue to increase
- Launch sites have an average success rate below 70%

Goals

Improve the success rate of successful landings, currently averaging below 70%, to achieve a competitive bid proposal cost of $62 million compared to our competitors

Project Objective:

Increase Revenue from Rocket Launch

KPI:

Successful landing launch rate (%)

Primary metric:

- Improve **landing success rate** by 10% by identifying best launch site, orbit, pay load mass etc.

Analytics Objective

Explore and compare **various machine learning models** and **find one** with **the best performance** to improve rockets landing

Machine learning models:

- Predict the best successful landing site.
- The best option for customers launching on the landing site that offers the most value, considering factors such as from orbit, location etc.
- Determine the cost of the launch

Hypothesis :

Machine learning models delivers **more incremental value** of **landing success** relative to **the current systems**

Section 1. Methodology

PACE Framework

Plan

Align project with business needs, requirements and contraints. Select an approriate machine learning model based on the problem and business context. KDD: Selection, Data Wrangling (Pre-processing and Transformation).

Plan

Selection - data collection

- Takes the dataset and uses required features column to call the API and append the data to the list. https://api.spacexdata.com/v4/launches/past
- Request and parse the SpaceX launch data. https://.../API_call_spacex_api.json

Link

- Task008-P01-DS-SpaceX-Falcon-20240409 in Kaggle (The complete version with outcome and code cell)
- 01. jupyter-labs-spacex-data-collection-api.ipynb (github.com)

Data collection from API - Flowchart

Request and Parse to SpaceX API

response

data

Keep the important features
Remove multiple rows
Correct the data type
Restrict the date etc.

requests.get (spacex_url)

pd.json_normalize (response.json())

Create a function, a list and apply the function

 # Call getBoosterVersion
getBoosterVersion(data)
BoosterVersion[0:5]

 # Call getLaunchSite
getLaunchSite(data)

 # Call getPayloadData
getPayloadData(data)

 # Call getCoreData
getCoreData(data)

Create the dataframe

launch_dict

data_falcon9

Plan

Data collection from API - Flowchart

data_falcon9
3 launch sites
Flight No. 90

	FlightNumber	Date	BoosterVersion	PayloadMass	Orbit	LaunchSite	Outcome	Flights	GridFins	Reused	Legs	LandingPad	Block	ReusedCount	Serial	Longitude	Latitude
4	1	2010-06-04	Falcon 9	NaN	LEO	CCSFS SLC 40	None None	1	False	False	False	None	1.0	0	B0003	-80.577366	28.561857
5	2	2012-05-22	Falcon 9	525.0	LEO	CCSFS SLC 40	None None	1	False	False	False	None	1.0	0	B0005	-80.577366	28.561857
6	3	2013-03-01	Falcon 9	677.0	ISS	CCSFS SLC 40	None None	1	False	False	False	None	1.0	0	B0007	-80.577366	28.561857
7	4	2013-09-29	Falcon 9	500.0	PO	VAFB SLC 4E	False Ocean	1	False	False	False	None	1.0	0	B1003	-120.610829	34.632093
8	5	2013-12-03	Falcon 9	3170.0	GTO	CCSFS SLC 40	None None	1	False	False	False	None	1.0	0	B1004	-80.577366	28.561857
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
89	86	2020-09-03	Falcon 9	15600.0	VLEO	KSC LC 39A	True ASDS	2	True	True	True	5e9e3032383ecb6bb234e7ca	5.0	12	B1060	-80.603956	28.608058
90	87	2020-10-06	Falcon 9	15600.0	VLEO	KSC LC 39A	True ASDS	3	True	True	True	5e9e3032383ecb6bb234e7ca	5.0	13	B1058	-80.603956	28.608058
91	88	2020-10-18	Falcon 9	15600.0	VLEO	KSC LC 39A	True ASDS	6	True	True	True	5e9e3032383ecb6bb234e7ca	5.0	12	B1051	-80.603956	28.608058
92	89	2020-10-24	Falcon 9	15600.0	VLEO	CCSFS SLC 40	True ASDS	3	True	True	True	5e9e3033383ecbb9e534e7cc	5.0	12	B1060	-80.577366	28.561857
93	90	2020-11-05	Falcon 9	3681.0	MEO	CCSFS SLC 40	True ASDS	1	True	False	True	5e9e3032383ecb6bb234e7ca	5.0	8	B1062	-80.577366	28.561857

90 rows × 17 columns

Plan

Align project with business needs, requirements and contraints. Select an approriate machine learning model based on the problem and business context. KDD: Selection, Data Wrangling (Pre-processing and Transformation).

Plan

Data Scrapping

- Collect Falcon 9 historical launch records from wikipedia.

  https://en.wikipedia.org/wiki/List_of_Falcon_9_and_Falcon_Heavy_launches

Link

- Task008-P01-DS-SpaceX-Falcon-20240409 in Kaggle (The complete version with outcome and code cell)
- 02. jupyter-labs-webscraping.ipynb

Scrapping from Wikipedia- Flowchart

Request and Parse to WIkipedia

response

requests.get (static_url)

soup

BeautifulSoup (response, 'html.parser')

Extract all column/variable names from the HTML table header

Create a function, a list and apply the function

def det_time(table_cells)

Def booster_version(table_cells)

etc

launch_dict

extracted_row = 0

for table_number,table in enumerate(soup.find_all('table'," wikitable plainrowheaders collapsible")): etc.

Create the dataframe

data_falcon9

Plan

Data collection from Wikipedia- Flowchart

data_falcon9
5 launch sites
Flight No. 121

Data from the API differs from that on Wikipedia. We are adhering to the data outlined in the IBM capstone assignment.

	Flight No.	Launch site	Payload	Payload mass	Orbit	Customer	Launch outcome	Version Booster	Booster landing	Date	Time
0	1	CCAFS	Dragon Spacecraft Qualification Unit	0	LEO	SpaceX	Success\n	F9 v1.0B0003.1	Failure	4 June 2010	18:45
1	2	CCAFS	Dragon	0	LEO	NASA	Success	F9 v1.0B0004.1	Failure	8 December 2010	15:43
2	3	CCAFS	Dragon	525 kg	LEO	NASA	Success	F9 v1.0B0005.1	No attempt\n	22 May 2012	07:44
3	4	CCAFS	SpaceX CRS-1	4,700 kg	LEO	NASA	Success\n	F9 v1.0B0006.1	No attempt	8 October 2012	00:35
4	5	CCAFS	SpaceX CRS-2	4,877 kg	LEO	NASA	Success\n	F9 v1.0B0007.1	No attempt\n	1 March 2013	15:10
116	117	CCSFS	Starlink	15,600 kg	LEO	SpaceX	Success\n	F9 B5B1051.10	Success	9 May 2021	06:42
117	118	KSC	Starlink	~14,000 kg	LEO	SpaceX	Success\n	F9 B5B1058.8	Success	15 May 2021	22:56
118	119	CCSFS	Starlink	15,600 kg	LEO	SpaceX	Success\n	F9 B5B1063.2	Success	26 May 2021	18:59
119	120	KSC	SpaceX CRS-22	3,328 kg	LEO	NASA	Success\n	F9 B5B1067.1	Success	3 June 2021	17:29
120	121	CCSFS	SXM-8	7,000 kg	GTO	Sirius XM	Success\n	F9 B5	Success	6 June 2021	04:26

Plan

Align project with business needs, requirements and contraints. Select an approriate machine learning model based on the problem and business context. KDD: Selection, Data Wrangling (Pre-processing and Transformation).

Plan

Data Wrangling (pre-processing and transformattion)

- Convert outcomes training labels with 1 means the booster successfully landed, 0 means it failed

Link

- Task008-P01-DS-SpaceX-Falcon-20240409 in Kaggle (The complete version with outcome and code cell)
- 03. labs-jupyter-spacex-Data wrangling.ipynb (github.com)

Wrangling- Flowchart

df
3 location sites
90 flight numbers

Calculate the number of launches on each site → Calculate the number and occurrence of each orbit → Calculate the number and occurrence of mission **outcomes** of the orbits → Assign to the variable landing_class

Orbit	LaunchSite	Outcome	Flights	GridFins	Reused	Legs	LandingPad	Block	ReusedCount	Serial	Longitude	Latitude	Class
LEO	CCAFS SLC 40	None None	1	False	False	False	NaN	1.0	0	B0003	-80.577366	28.561857	0
LEO	CCAFS SLC 40	None None	1	False	False	False	NaN	1.0	0	B0005	-80.577366	28.561857	0
ISS	CCAFS SLC 40	None None	1	False	False	False	NaN	1.0	0	B0007	-80.577366	28.561857	0
PO	VAFB SLC 4E	False Ocean	1	False	False	False	NaN	1.0	0	B1003	-120.610829	34.632093	0
GTO	CCAFS SLC 40	None None	1	False	False	False	NaN	1.0	0	B1004	-80.577366	28.561857	0

Plan

Analyze

Exploratory Data Analysis

Understanding data for accurate predictions, focus on the response variable (what the model predicts) and leverage exploratory data analysis to uncover patterns and address irregularities. KDD: Data Mining.

Analyze

df_1
4 location sites
101 flight numbers

SQL

- In this SQL data, 4 launch sites. **Unfortunately it differ from data in wrangling phase.**
- Lunch sites begin with the string 'CCA’
- There are 53 Customers
- Total payload mass carried by boosters launched by NASA (CRS)
- Average payload mass carried by booster version F9 v1.1
- The first successful landing outcome 22th Dec 2015
- List the total number of successful and failure mission outcomes
- 12 booster_versions which have carried the maximum payload mass.
- Rank the count of landing outcomes between the date 2010-06-04 and 2017-03-20
- List the failed landing_outcomes in drone ship, their booster versions, and launch site names for in year 2015

Link

- Task008-P01-DS-SpaceX-Falcon-20240409 in Kaggle (The complete version with outcome and code cell)
- 04. jupyter-labs-eda-sql-coursera_sqllite.ipynb (github.com)

Understanding data for accurate predictions, focus on the response variable (what the model predicts) and leverage exploratory data analysis to uncover patterns and address irregularities. KDD: Data Mining.

df
3 location sites
90 flight numbers

Analyze

EDA Data Visualization

- Scatterplot to observe relationship between variables.
- Bar plot to visualize the success rate of each orbit.
- Line chart to track the trend of the success rate over each year.
- Pie chart to analyze the success rate of each launch site.

Link

- Task008-P01-DS-SpaceX-Falcon-20240409 in Kaggle (The complete version with outcome and code cell)
- [05. edadataviz.ipynb (github.com)]

Understanding data for accurate predictions, focus on the response variable (what the model predicts) and leverage exploratory data analysis to uncover patterns and address irregularities. KDD: Data Mining.

df
4 location sites
56 flight numbers

Analyze

Interactive Map with Folium

- First, create a Folium Map object with an initial center location set to NASA Johnson Space Center in Houston, Texas
- Use folium.Circle to add a highlighted circle area
- Add marker using folium.Marker
- Mark each site using MarkerCluster()
- Add a MousePosition on the map to get coordinate for a mouse over a point on the map
- Calculate the distance and add distance marker
- Create lines using folium.Polyline

Link

- Task008-P01-DS-SpaceX-Falcon-20240409 in Kaggle (The complete version with outcome and code cell)
- 06. lab_jupyter_launch_site_location.ipynb (github.com)

Understanding data for accurate predictions, focus on the response variable (what the model predicts) and leverage exploratory data analysis to uncover patterns and address irregularities. KDD: Data Mining.

df
4 location sites
56 flight numbers

Analyze

Dashboard with Plotly Dash

- Add a dropdown list to enable Launch Site selection
- Create pie chart to show the total successful launches count for all sites
- Add a slider to select payload range
- Create a scatter chart to show the correlation between payload and launch success
- Add a callback function for `site-dropdown` as input, `success-pie-chart` as output
- Add a callback function for `site-dropdown` and `payload-slider` as inputs, `success-payload-scatter-chart` as output

Link

- Task008-P01-DS-SpaceX-Falcon-20240409 in Kaggle (The complete version with outcome and code cell)
- spacex_dash_app.py (github.com)

Construct

Models and Findings

df
3 location sites
90 flight numbers

Construct

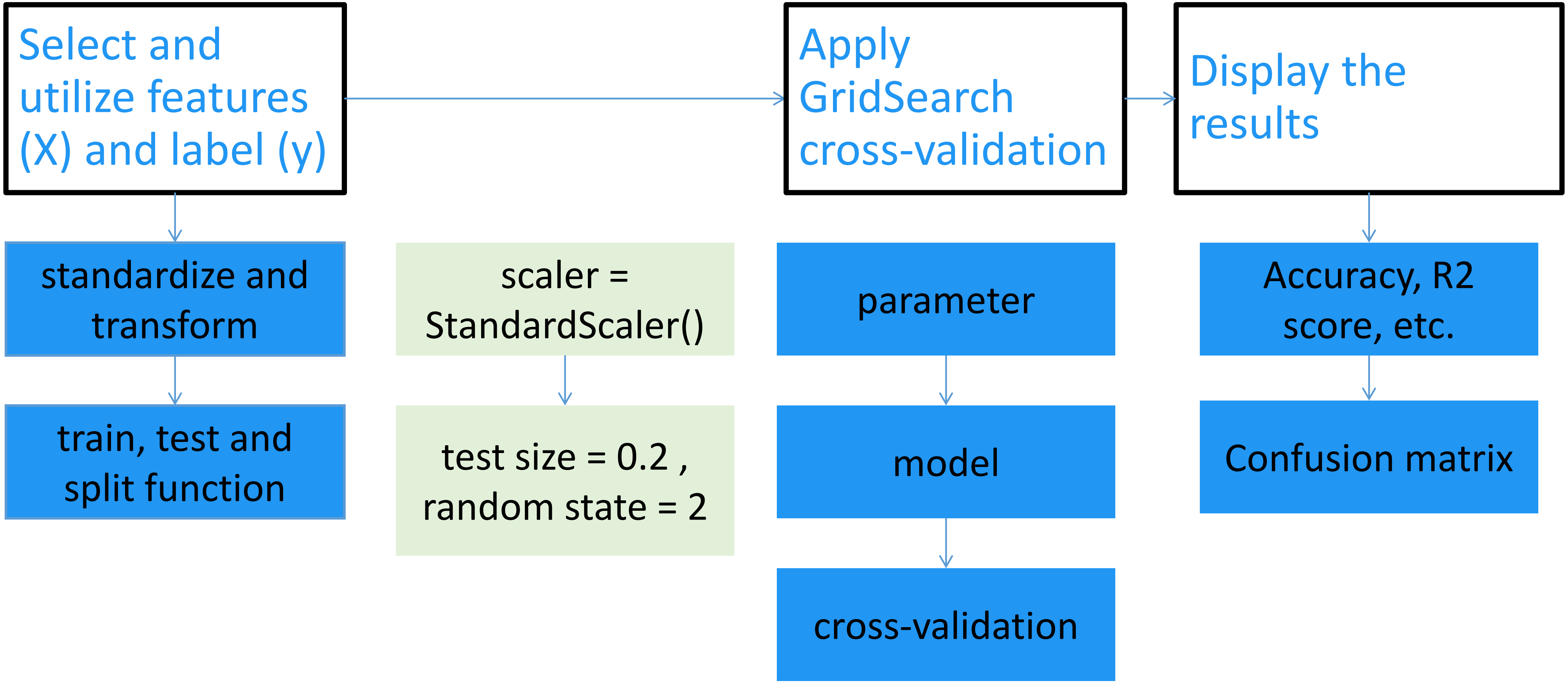
Predictive Analysis (Classification)

- Choose the relevant features
- Perform One hot encoding for the object or string values data
- Select the features (X) and label (y)
- Standardize the data in X and then reassign it to the variable X
- Utilize the function train_test_split to split in the data X and Y into training and test data. Set the parameter test_size to 0.2 and random_state to 2.
- Determine the parameter and apply the training and test datasets to logistic regression, SVM, Decision tree and KNN model
- Employ GridSearch with the model, cross-validation with a value of 10 and the parameter
- Display the results including accuracy, R^2 and confusion matrix

Link

- Task008-P01-DS-SpaceX-Falcon-20240409 in Kaggle (The complete version with outcome and code cell)
- 07. SpaceX_Machine Learning Prediction_Part_5.ipynb (github.com)

Predictive Analysis- Flowchart



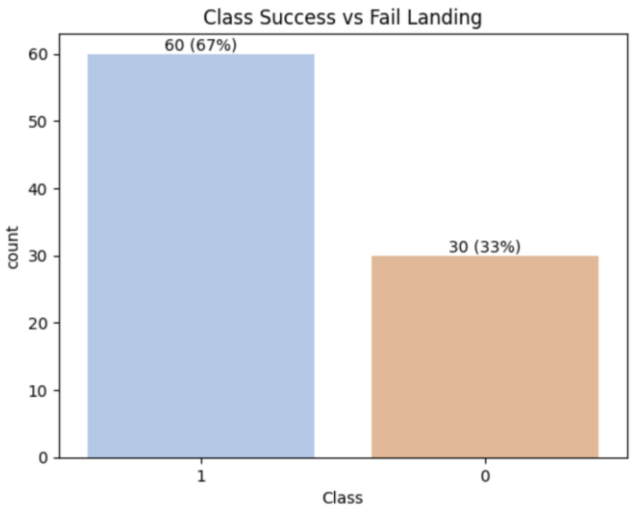
Construct

Section 2. Insight Drawn from EDA

Analyze

EDA - Data Visualization

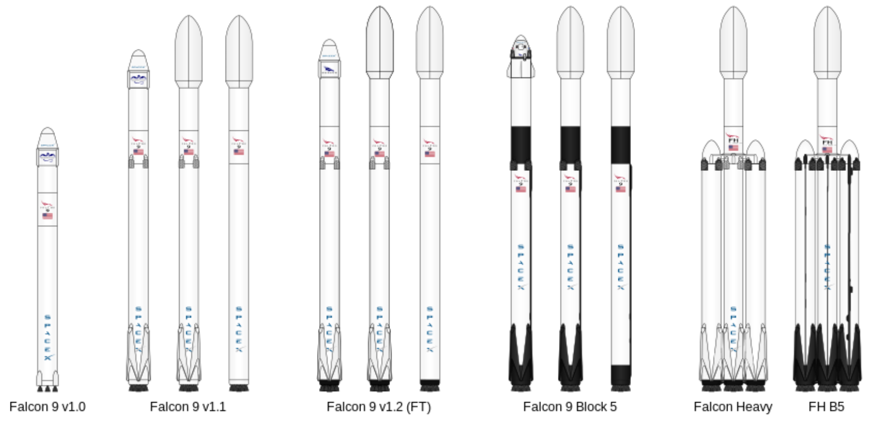
The first landing

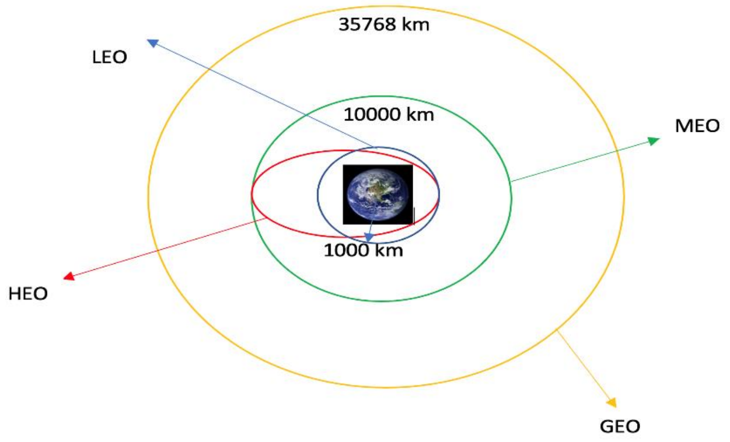


Success
(Class = 1)

Failure
(Class =0)

The rockets and orbits





Heavy Launch

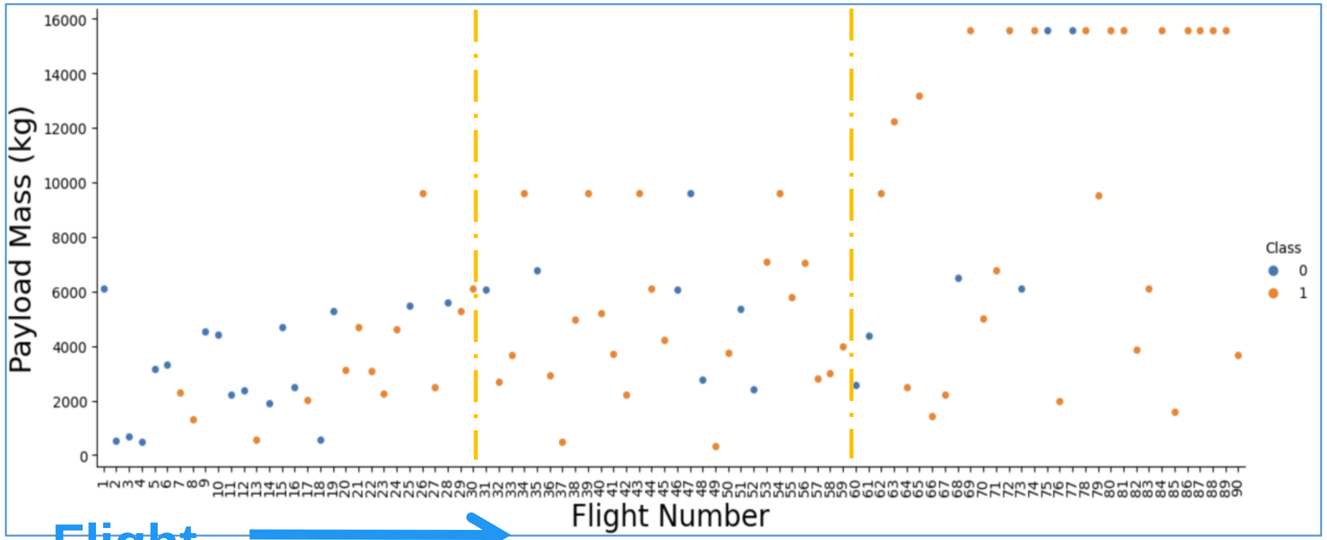
Orbit

Flight number vs Payload mass

From 2010 to 2020, we have had 90 flight numbers

- Flight numbers increases, the first stage more likely land successfully

Payload Mass



Flight numbers

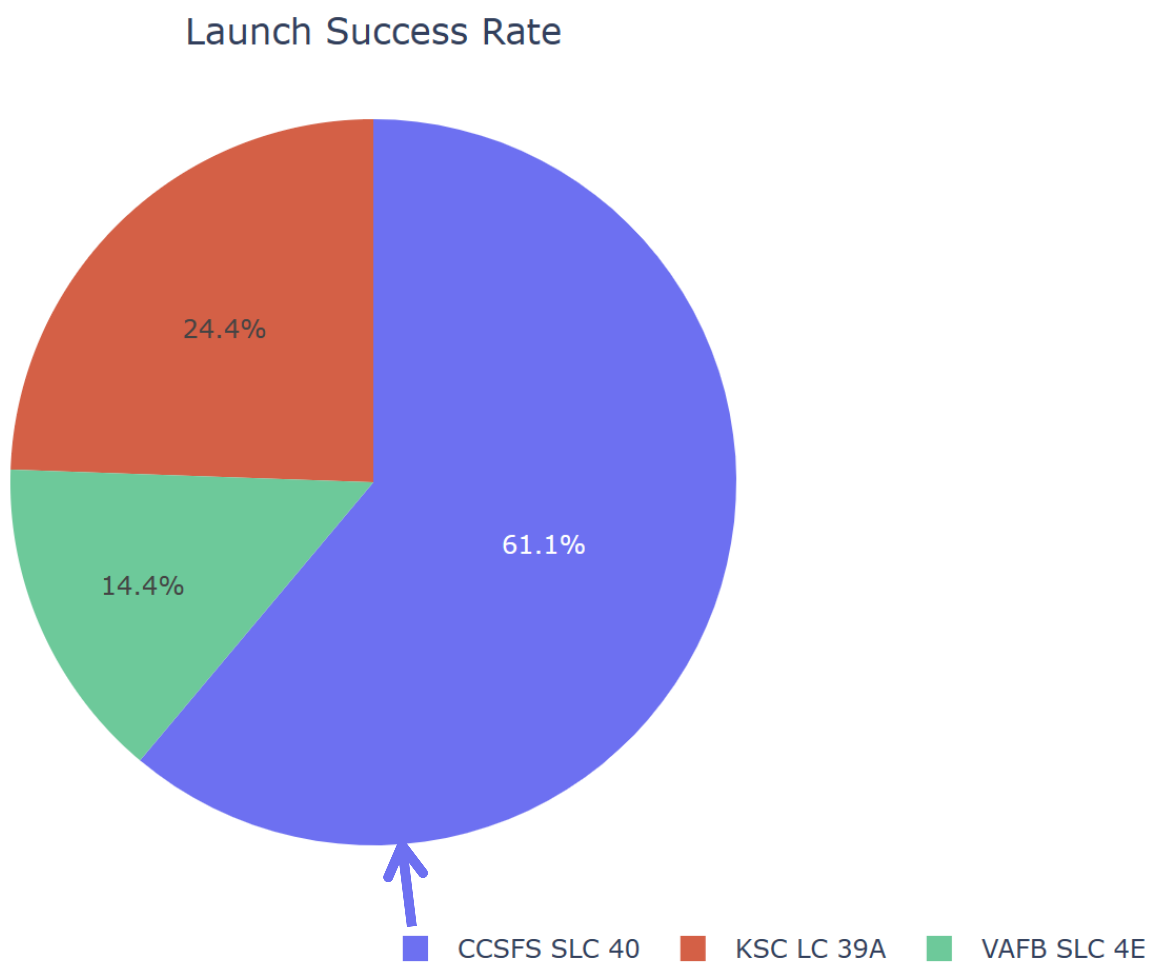
df
3 location sites
90 flight numbers

Analyze

Launch Success Rate Contribution

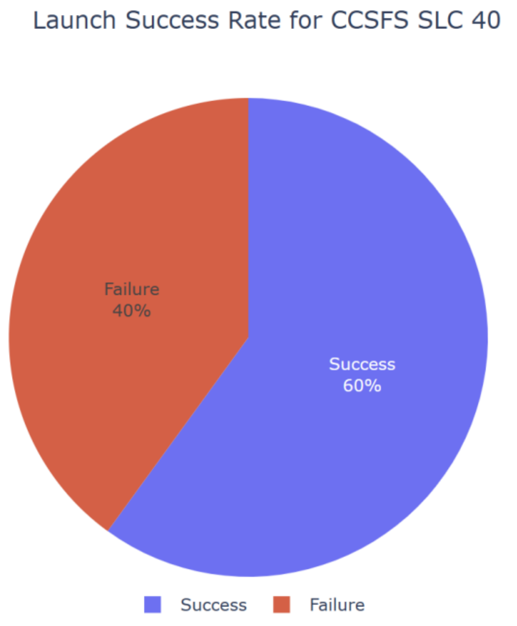
2010 to 2020 we have to 90 flight numbers

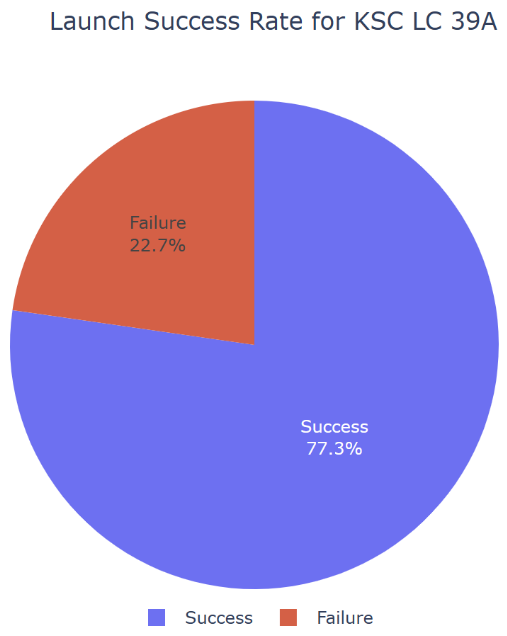
- `CCSFS SLC 40` contributed the highest launching success, more than 60% of total (its first launched in 2010)
- `KSC LC 39A` followed second place with nearly 25% of total. (launching in 2013)
- The youngest launch site in 2017, VAFB SLC 4E has less than 15% of the total launches.

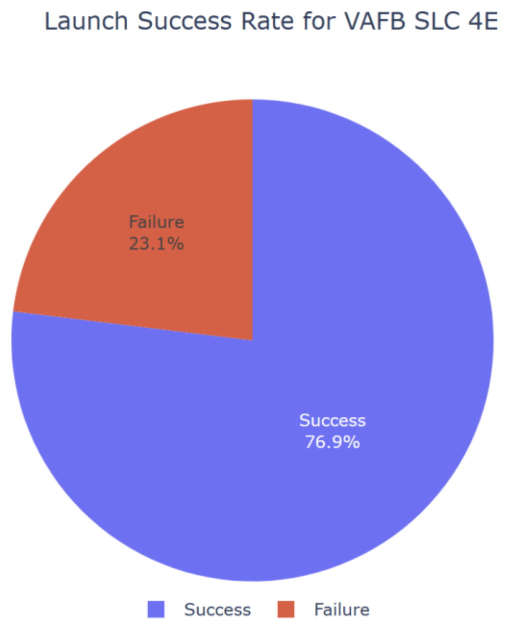


Analyze

Launch Success Rate







2010 to 2020 we have to 90 flight numbers

- `KSC LC 39A` and `VAFB SLC 4E` has success rates of more than 75%
- `CCAFS SLC 40` has a success rate of 60% (the oldest launch site)

*It should be CCAFS instead of CCSFS

Analyze

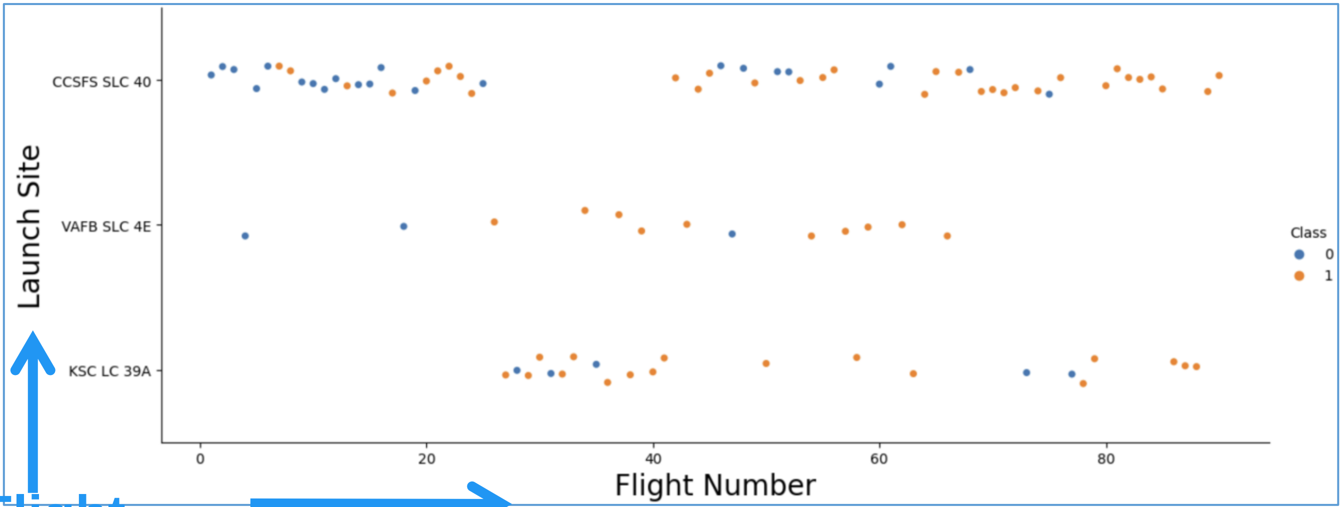
Flight number vs Launch site

Analyze

2010 to 2020 we have to 90 flight numbers

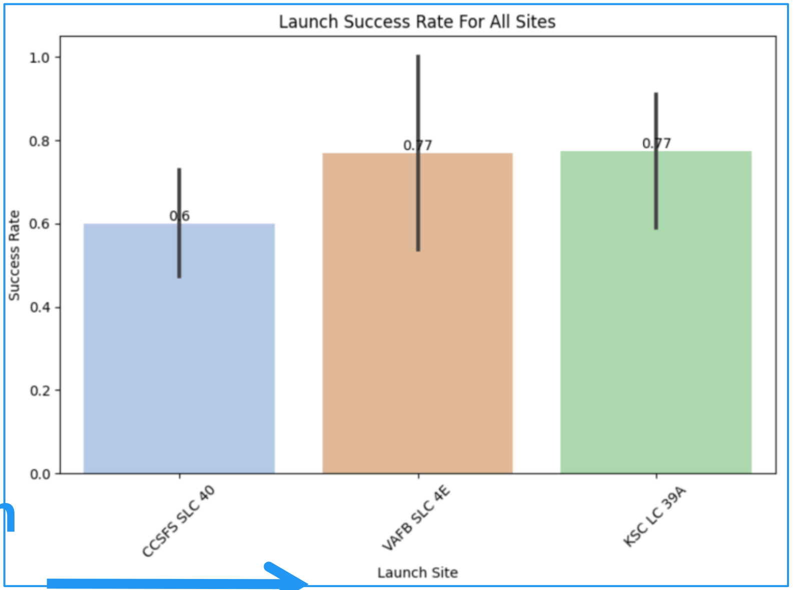
- As the flight number increases, the success rate of the first landing improves across all launch sites

Launch Site



Flight numbers

Success Rate



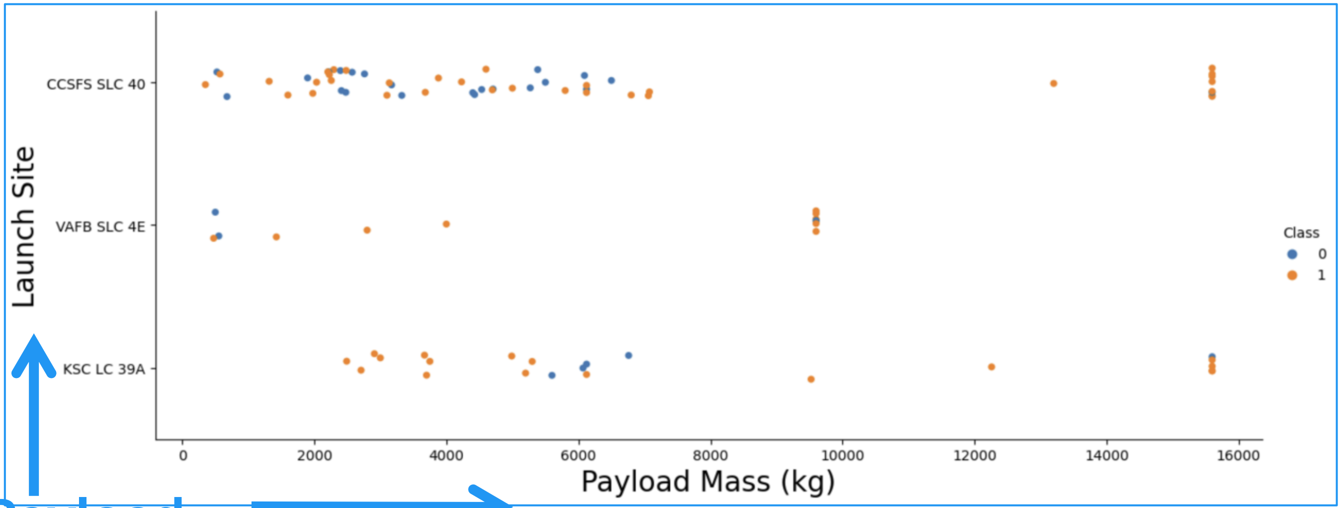
Launch Site

Payload Mass vs Launch site

2010 to 2020 we have to 90 flight numbers

- As the flight number increases, the success rate of the first landing improves across all launch sites

Launch Site



Payload Mass

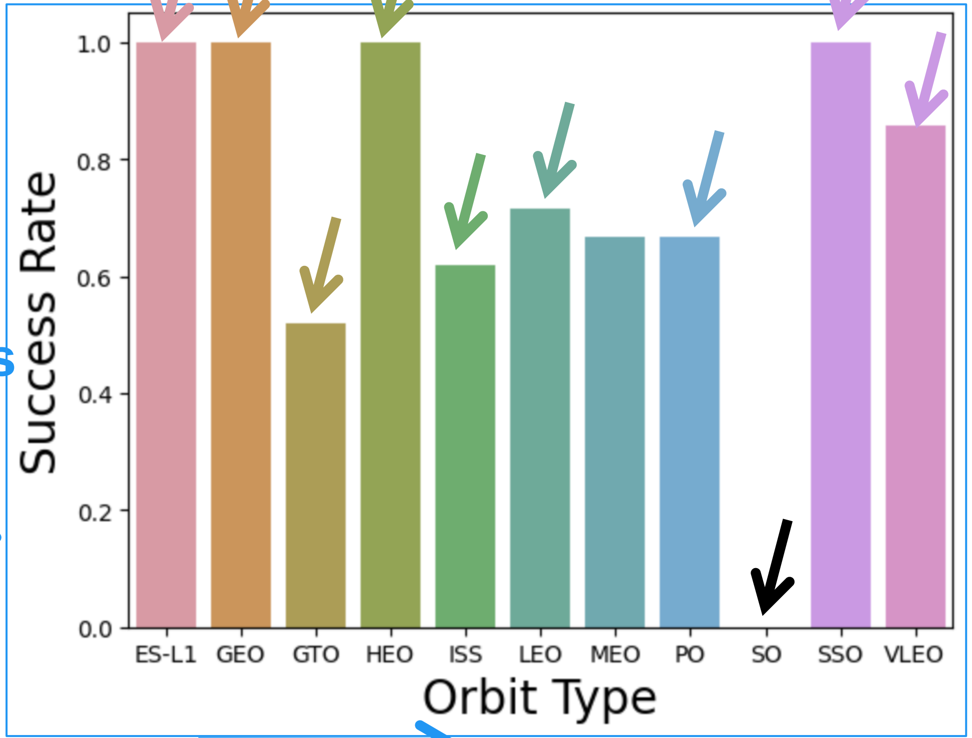
Analyze

Success Rate vs Orbit Type

2010 to 2020 we have to 90 flight numbers

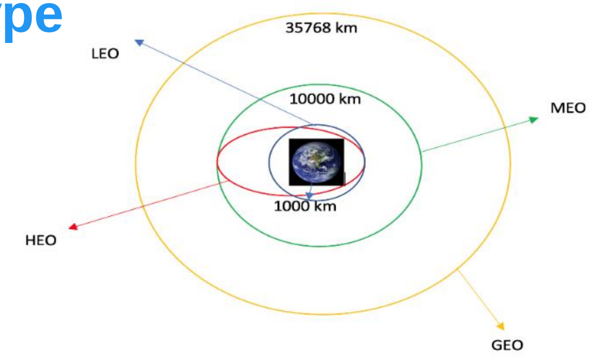
- The orbit which launches before 2015, with more than 2 launches have a success rate below 80%
- The orbit that has a 100% has only been launched once except for SO, which failed in the first launch
- SSO has 5 launches with 100% and VLEO has above 80% success rate

Success Rate



Orbit Type

Orbit	Min_Date
LEO	2010-06-04
ISS	2013-03-01
PO	2013-09-29
GTO	2013-12-03
ES-L1	2015-02-11
SSO	2017-08-24
HEO	2018-04-18
MEO	2018-12-23
VLEO	2019-05-24
SO	2020-01-19
GEO	2020-07-20




```
Orbit
GTO      27
ISS      21
VLEO     14
PO        9
LEO       7
SSO       5
MEO       3
ES-L1     1
HEO       1
SO        1
GEO       1
Name: count  'int64
```

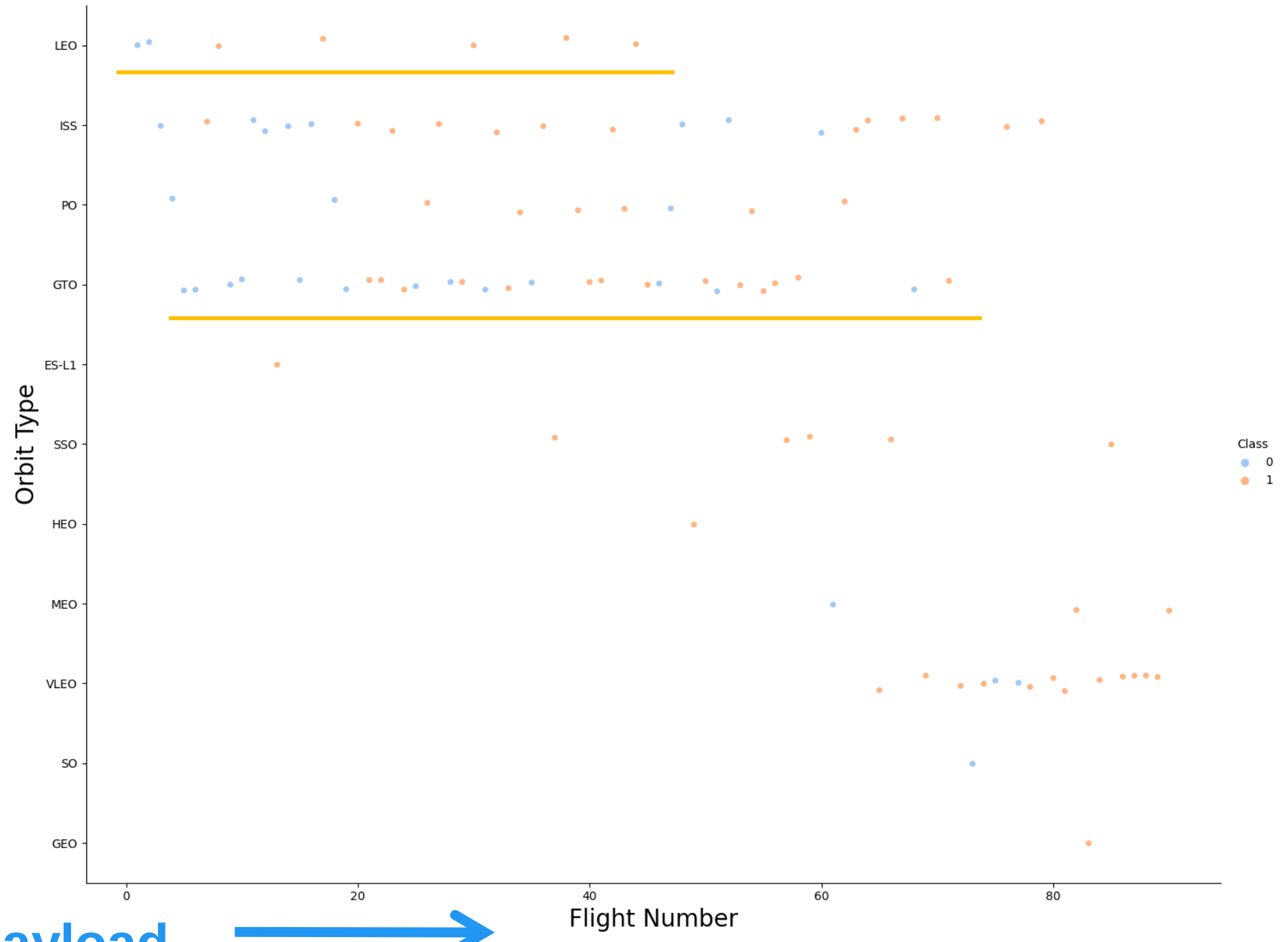
Analyze

Flight Number vs Orbit Type

2010 to 2020 we have to 90 flight numbers

- 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

Orbit Type



Payload Mass

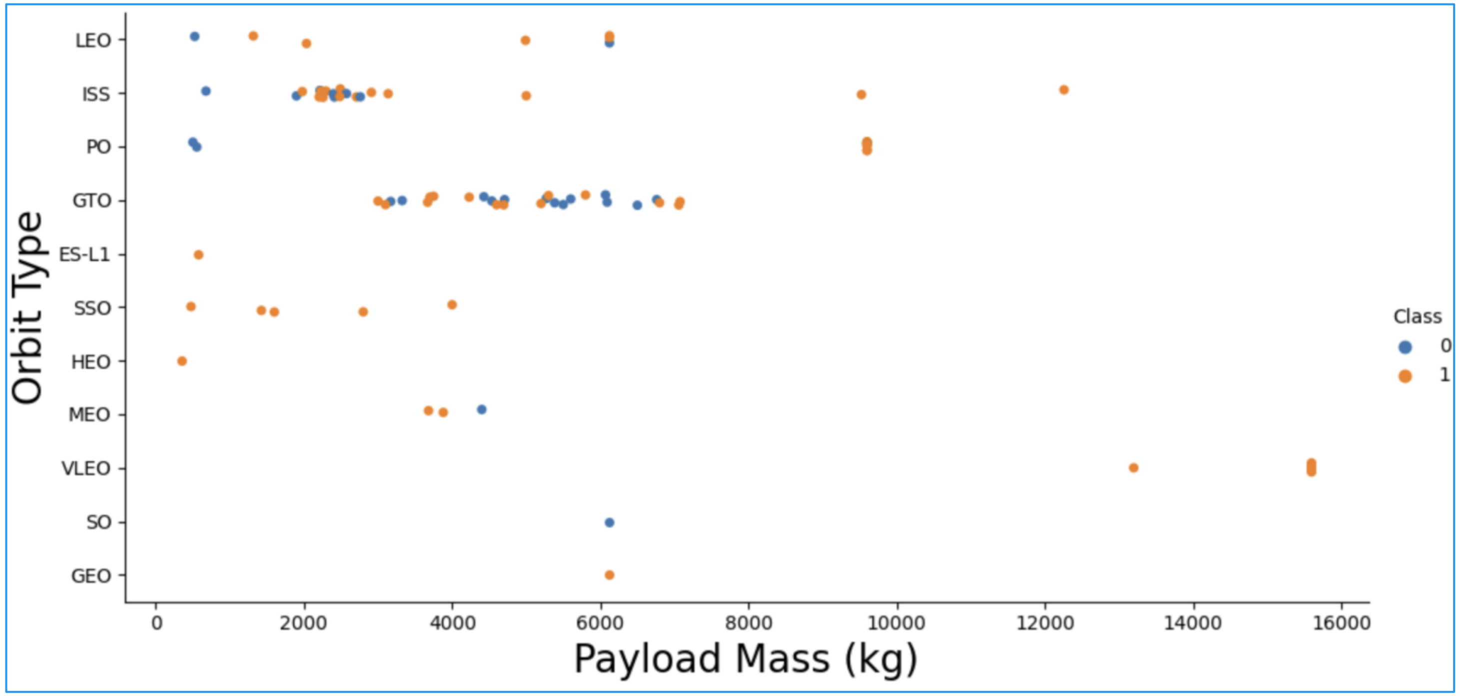
Analyze

Payload vs Orbit Type

2010 to 2020 we have to 90 flight numbers

- With heavy payloads the successful landing or positive landing rate are more for `Polar`,`LEO` and `ISS`
- `GTO` we cannot distinguish this well as success and failure landing

Orbit Type



Payload Mass

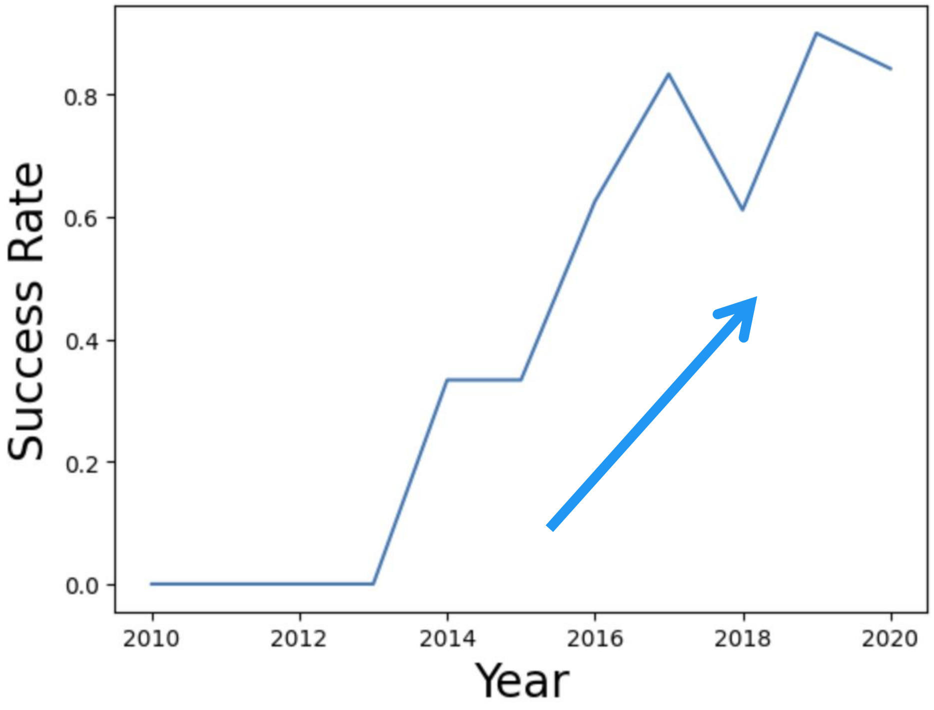
Analyze

Launch Success Yearly Trend

2010 to 2020 we have to 90 flight numbers

- The success rate have been increasing since 2013 to 2020

Success Rate



Payload Mass

Analyze

Analyze

Analysis with SQL

All Launch Site Names

df_1
4 location sites
101 flight numbers

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

Kaggle

```
df_q = pd.read_sql('select distinct Launch_Site from spacexdata', conn)
df_q
```

SQL

```
%sql select distinct(LAUNCH_SITE) from SPACEXTBL
```

```
* sqlite:///my_data1.db
```

- Using SQL Data, we acquire 4 Launch Sites from spaceX data 2010 to 2020
- The data in SQL differ from data during wrangling phase. (following the assignment instructions)

Analyze

Launch Site Names Begin with ‘CCA’

SQL

```
%sql select * from SPACEXTBL where LAUNCH_SITE like 'CCA%' limit 5
```

```
* sqlite:///my_data1.db
```

Kaggle

```
df_q = pd.read_sql("select *  from spacexdata where Launch_Site like 'CCA%' limit 5", conn)
df_q
```

	index	Date	Time_(UTC)	Booster_Version	Launch_Site	Payload	PAYLOAD_MASS__KG_	Orbit	Customer	Mission_Outcome	Landing_Outcome
0	0	2010-06-04 00:00:00	18:45:00	F9 v1.0 B0003	CCAFS LC-40	Dragon Spacecraft Qualification Unit	0	LEO	SpaceX	Success	Failure (parachute)
1	1	2010-12-08 00:00:00	15:43:00	F9 v1.0 B0004	CCAFS LC-40	Dragon demo flight C1, two CubeSats, barrel of Brouere cheese	0	LEO (ISS)	NASA (COTS) NRO	Success	Failure (parachute)
2	2	2012-05-22 00:00:00	7:44:00	F9 v1.0 B0005	CCAFS LC-40	Dragon demo flight C2	525	LEO (ISS)	NASA (COTS)	Success	No attempt
3	3	2012-10-08 00:00:00	0:35:00	F9 v1.0 B0006	CCAFS LC-40	SpaceX CRS-1	500	LEO (ISS)	NASA (CRS)	Success	No attempt
4	4	2013-03-01 00:00:00	15:10:00	F9 v1.0 B0007	CCAFS LC-40	SpaceX CRS-2	677	LEO (ISS)	NASA (CRS)	Success	No attempt

- The 5 rockets launched from CCSFS LC-40 began their launches in June 2010. Two rockets were launched in 2010, and two were launched in 2012. The displayed data only shows 5 launches
- All 5 launches had a Low Earth Orbit (LEO) trajectory, and all of them were successful

Analyze

Total Payload Mass

	Customer	Total_Payload_Mass
0	NASA (CRS)	45596

Kaggle

```
df_q = pd.read_sql("select Customer, sum(PAYLOAD_MASS__KG_) as Total_Payload_Mass from spacexdata where Customer='NASA (CRS)' group by Customer", conn)
df_q
```

SQL

```
%sql select sum(PAYLOAD_MASS__KG_) from SPACEXTBL where CUSTOMER = 'NASA (CRS)'
```

```
* sqlite:///my_data1.db
```

- For NASA (CRS), the total payload was 45,596 kg

Analyze

Average Payload Mass F9 v.1.1

	Booster_Version	Avg_Payload_Mass
0	F9 v1.1	2928.4

Kaggle

```
df_q = pd.read_sql("select Booster_Version, avg(PAYLOAD_MASS__KG_) as Avg_Payload_Mass from spacexdata where Booster_Version='F9 v1.1' group by Booster_Versio
df_q
```

SQL

```
%sql select avg(PAYLOAD_MASS__KG_) from SPACEXTBL where BOOSTER_VERSION = 'F9 v1.1'
```

```
* sqlite:///my_data1.db
```

- The average payload mass served by F9 v.1.1 Booster was 2,928.4 kg

Analyze

First Successful Ground Landing Date

min(DATE)
2015-12-22

Kaggle

```
df_q = pd.read_sql("select *, min(Date) as min_date from spacexdata where Landing_Outcome='Success (ground pad)'", conn)
df_q
```

SQL

```
%sql select min(DATE) from SPACEXTBL where Landing_Outcome = 'Success (ground pad)'
```

```
* sqlite:///my_data1.db
```

- The first successful ground landing occurred in December 2015

Analyze

Successful Drone Ship Landing with Payload between 4000 and 6000

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

Kaggle

```
df_q = pd.read_sql("select distinct Booster_Version from spacexdata where Landing_Outcome='Success (drone ship)' and PAYLOAD_MASS__KG_ between 4000 and 6000",
df_q
```

SQL

```
%sql select BOOSTER_VERSION from SPACEXTBL where Landing_Outcome = 'Success (drone ship)' and PAYLOAD_MASS__KG_ > 4000 and
```

```
* sqlite:///my_data1.db
```

- For payload masses between 4,000 and 6,000 kg, the Falcon 9 FT Booster with version B10 includes series of 22, 26, 21.2, and 31.2

Analyze

Total Number of Successful and Failure Mission Outcomes

	Mission_Outcome	count(*)
0	Failure	1
1	Success	100

Kaggle

```
df_q = pd.read_sql("select substr(Mission_Outcome,1,7) as Mission_Outcome, count(*) from spacexdata  group by 1", conn)
df_q
```

SQL

```
%sql select case  when Mission_Outcome like 'Success%' then 'Success' else Mission_Outcome end as outcome,COUNT(*) as total_count from S
```

```
* sqlite:///my_data1.db
```

- Total Successful mission 100 and 1 is a failure mission

Analyze

Booster Carried Maximum Payload

Booster_Version
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

Kaggle

```
df_q = pd.read_sql("select distinct Booster_Version from spacexdata where PAYLOAD_MASS__KG_ = (select max(PAYLOAD_MASS__KG_) from spacexdata)", conn)
df_q
```

SQL

```
%sql select BOOSTER_VERSION from SPACEXTBL where PAYLOAD_MASS__KG_ = (select max(PAYLOAD_MASS__KG_) from SPACEXTBL)
```

```
* sqlite:///my_data1.db
```

- The Falcon 9 B5 Booster which carried maximum payload version B10 includes series of 48 to 60

Analyze

2015 Launch Records

	Month	Landing_Outcome	Booster_Version	Launch_Site
0	01	Failure (drone ship)	F9 v1.1 B1012	CCAFS LC-40
1	04	Failure (drone ship)	F9 v1.1 B1015	CCAFS LC-40

Kaggle

```
df_q = pd.read_sql("select distinct Landing_Outcome, Booster_Version, Launch_Site from spacexdata where Landing_Outcome='Failure (drone ship)'", conn)
df_q
```

SQL

```
%sql select substr(Date, 6, 2) as Month, substr(Date, 0, 5) as Year, Landing_Outcome, Booster_Version, Launch_Site from SPA
```

```
* sqlite:///my_data1.db
```

- In 2015 there was two failure (drone ship) launches, both in CCAFS LC-40 with booster version v1.1 B10 serie 12 and 15

Analyze

Rank Landing Outcomes Between 2010-06-04 and 2017-03-20

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

Kaggle

```
df_q = pd.read_sql("select Landing_Outcome, count(*) from spacexdata where Date between '2011-06-04' and '2017-03-20' group by Landing_Outcome order by 2 desc
df_q
```

SQL

```
%sql select Landing_Outcome, count(*) from SPACEXTBL  where Date between '2011-06-04' and '2017-03-20' group by Landing_Out
```

- The most landing outcome occurance of 10 due to no attempt
- Drone ship has success and failure tied in 5 times
- Success landed in ground pad also draw to Controlled in ocean with 3 times

Analyze

Section 3. Map

Launch Sites Proximity Analysis

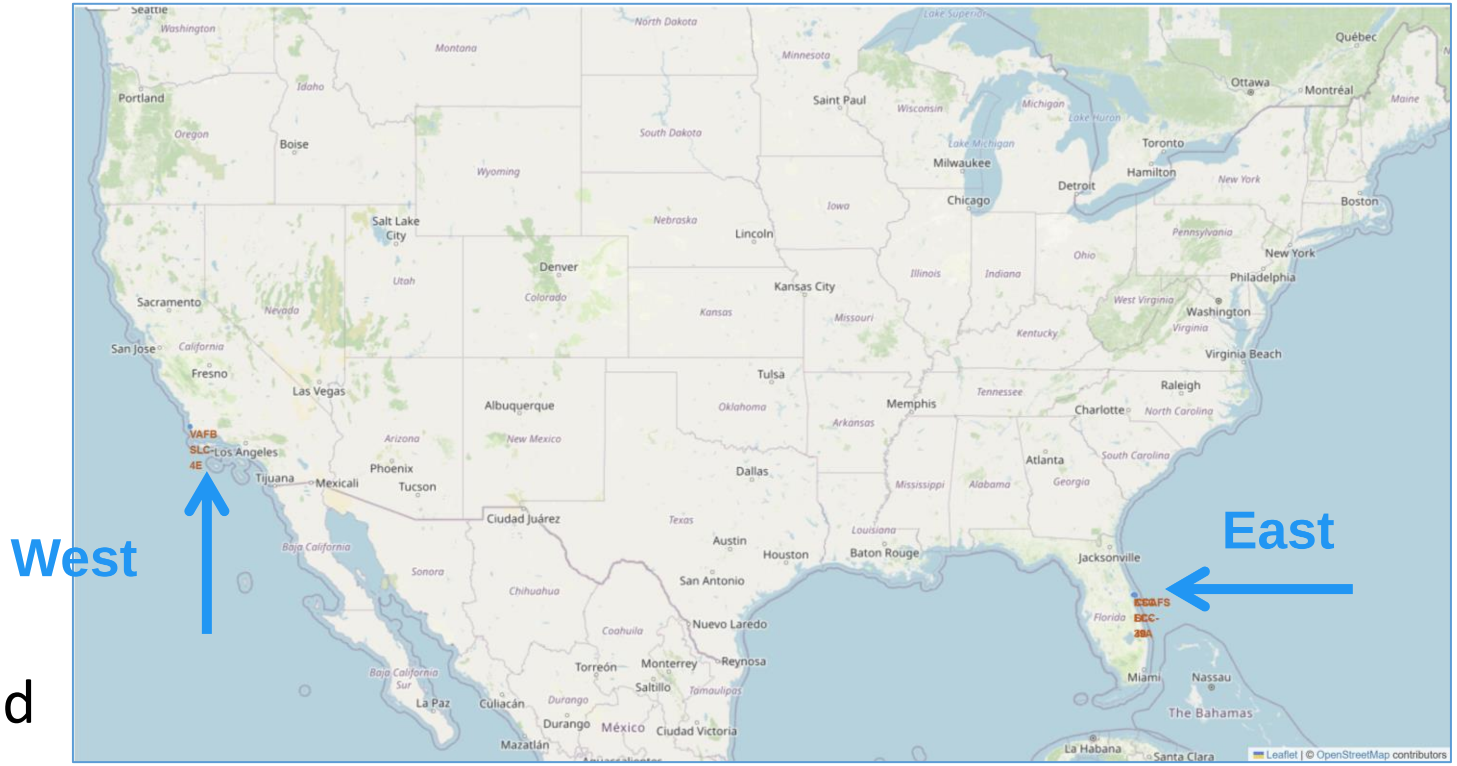
Analyze

Map Visualization

Launch Site Map

We identify 2 Launch Area

- West, VAFB SLC-4E on Vanderberg State
- East, KSC LC-39A on Kennedy and the CCAFS SLC-40 and CCAFS LC-40 on Cape Canaveral



df
4 location sites
56 flight numbers

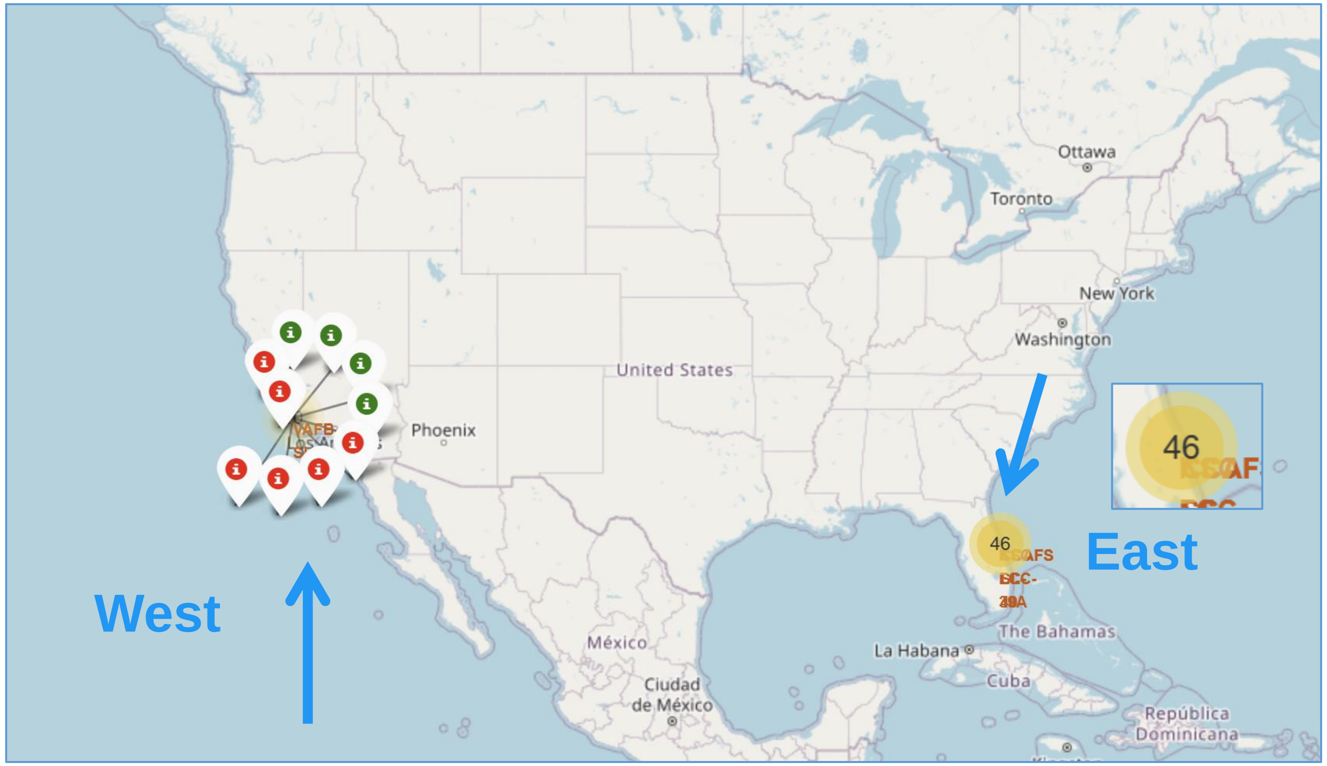
Analyze

West Launch Site Map

In the West Area (VAFB SLC-4E)

- The map shows there is 10 launches
- 4 successful first landing or 40% success rate

It shows 46 launches occurred in East Area

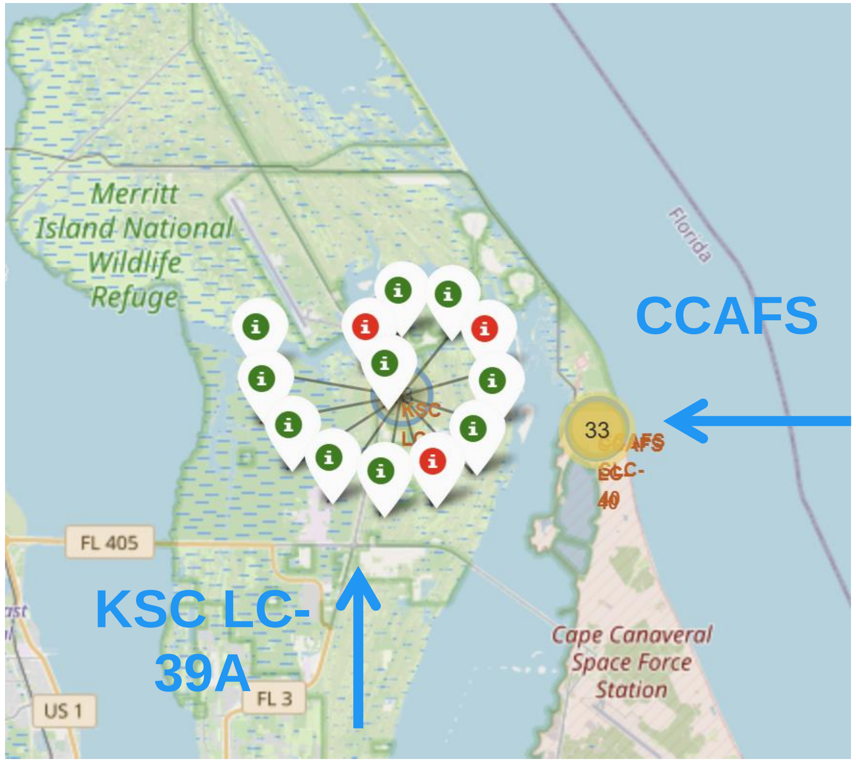


Analyze

East Launch Site Map

In the East Area (KSC LC-39A)

- 10 successful first landing or more than 70% success rate



Analyze

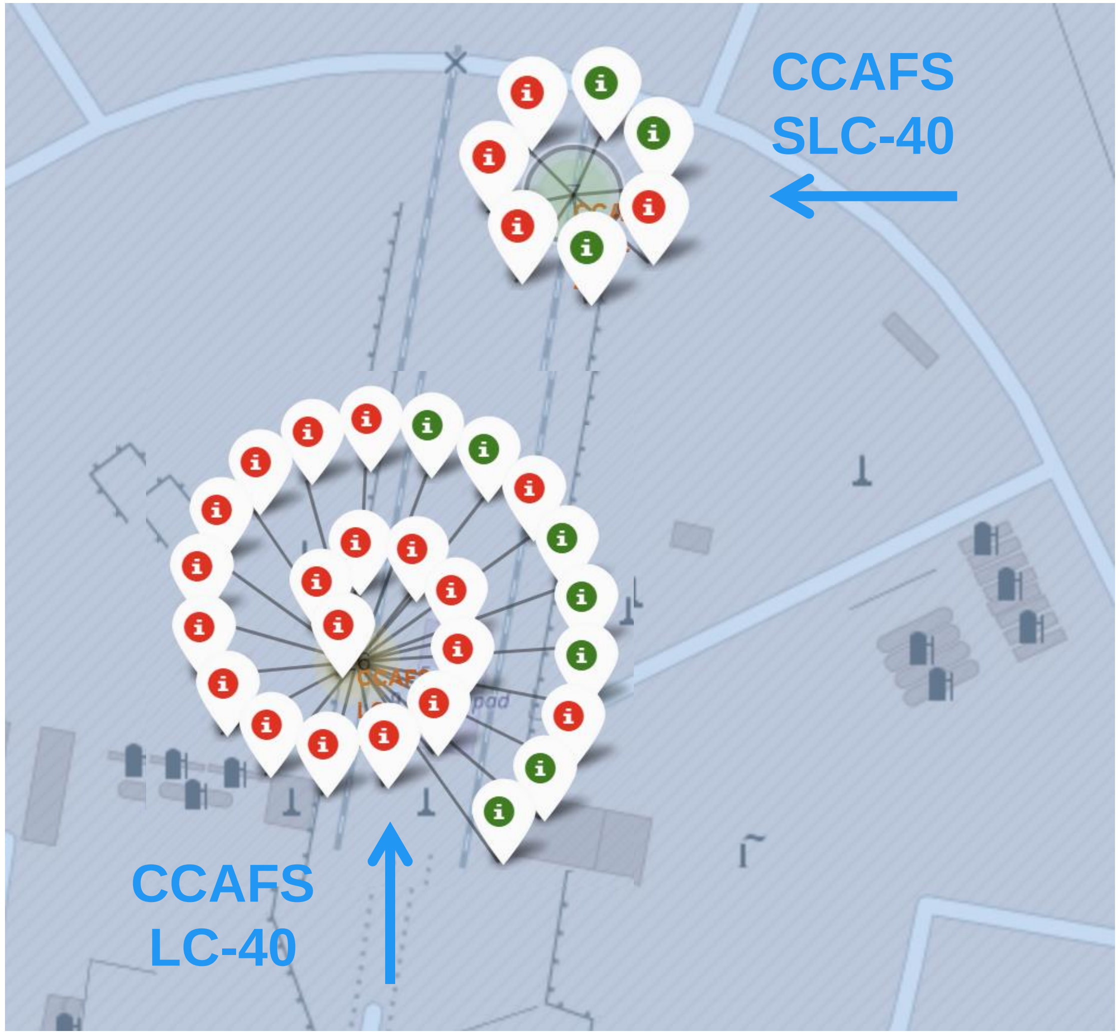
East Launch Site Map

In the East Area (CAFS LC-40)

- 7 successful first landing or less than 30% success rate

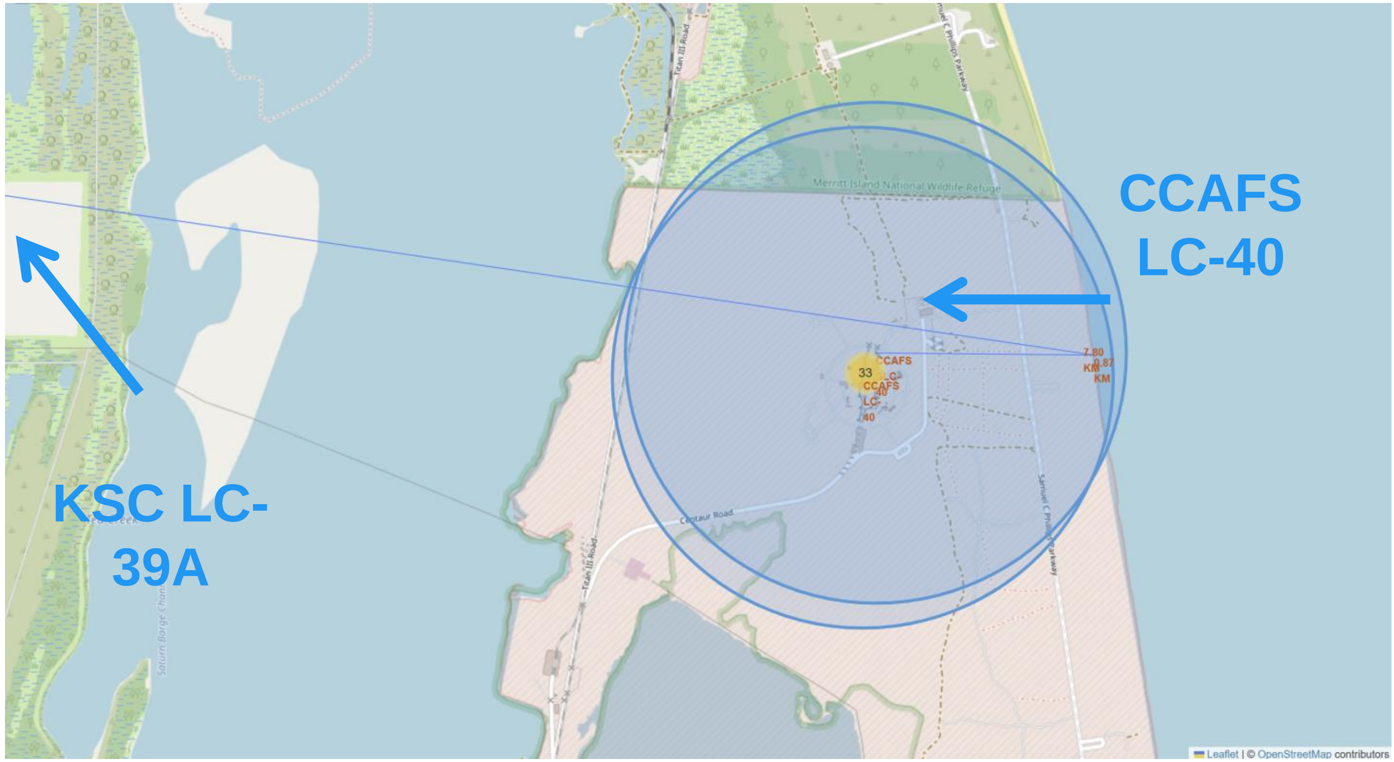
In the East Area (CAFS SLC-40)

- 3 successful first landing or less than 50% success rate



Analyze

East Launch Site Map



In the East Area (KSC LC-39A)

- The distance 7,8 km to the CAFS SLC-40 nearest Coastline

In the East Area (CAFS SLC-40)

- The distance 0,87 km to its nearest coastline

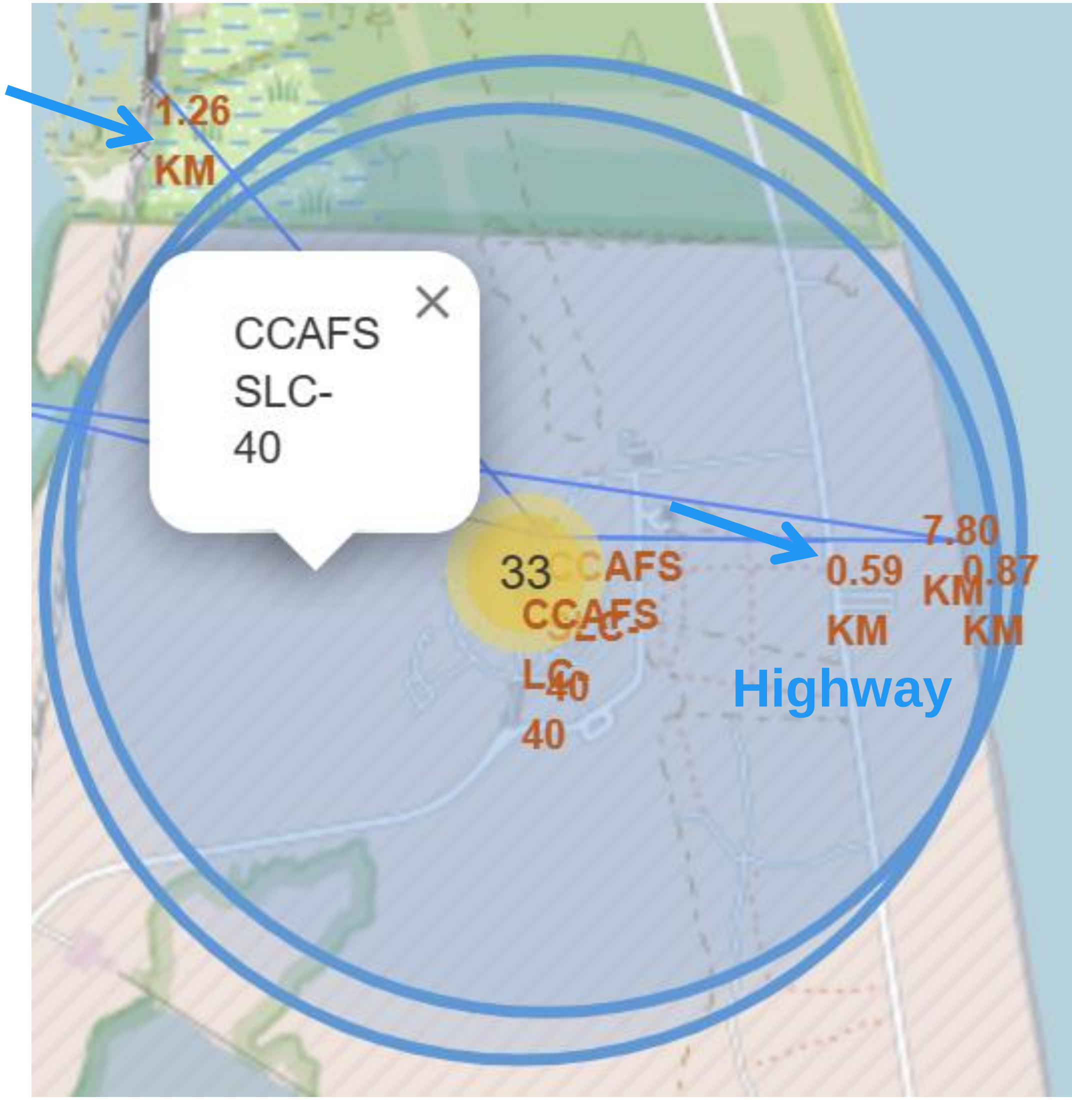
Analyze

CCAFS LC-40 Launch Site Map

In the East Area (CAFS SLC-40)

- The distance 1,26 km to its nearest **railway**, 0,59km to its nearest **highway** and 23,47 km to its nearest **city**

Railway



Analyze

Section 4. Dashboard

Build a Dashboard with Plotly Dash

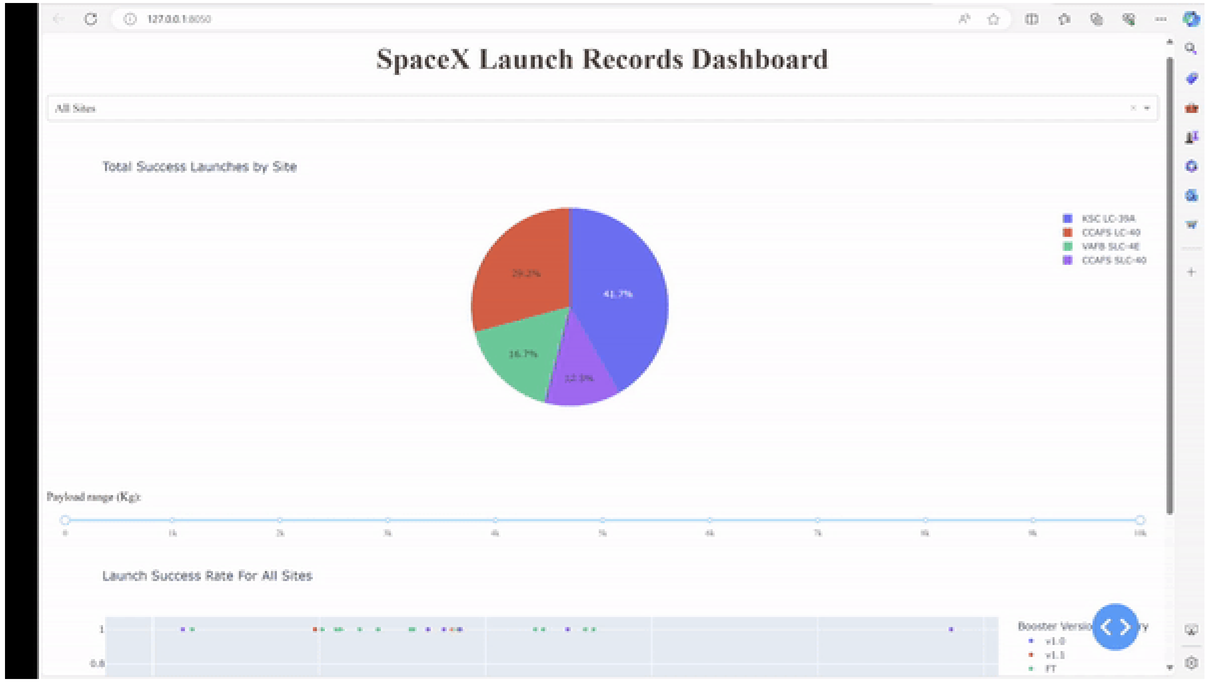
Analyze

Interactive Dashboard

All Site Success Launches

Total Success Launches by Site

- KSC LC-39A has the highest success 40% of total launches compare the others



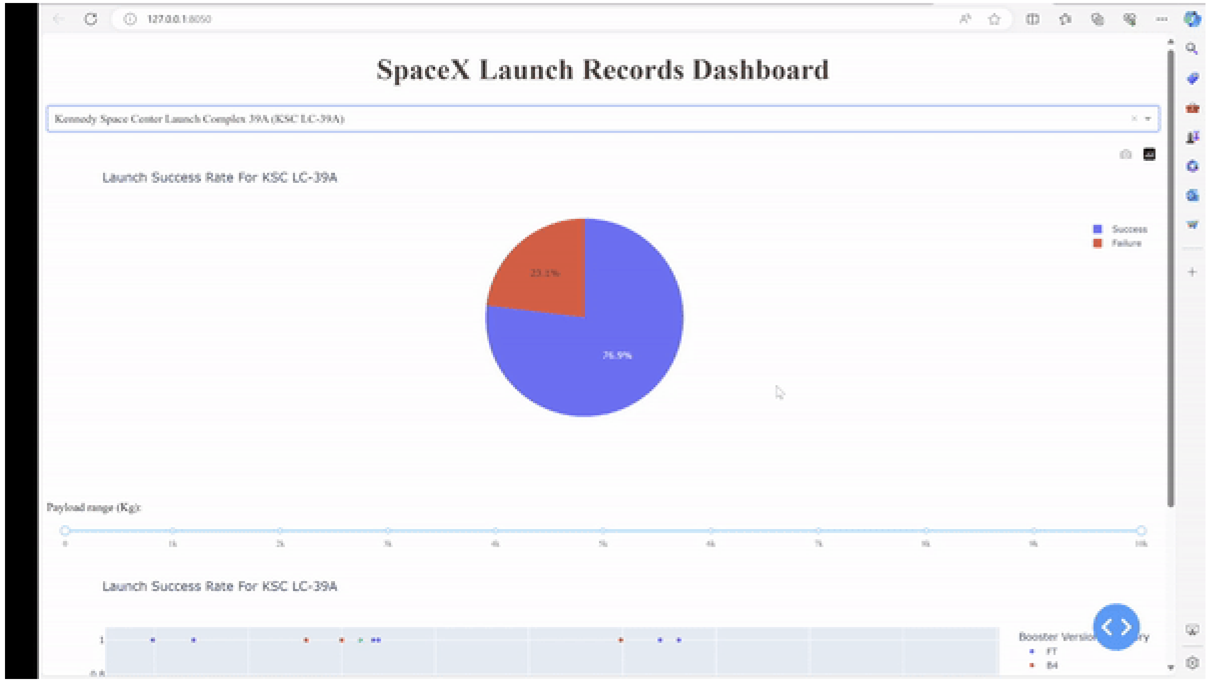
df
4 location sites
56 flight numbers

Analyze

The Highest Success Launches

Total Success Launches by Site

- KSC LC-39A has the highest success rate of 70%



Analyze

Payload vs Launch Outcome

In regards to payload mass

- FT and B4 have more successful landing
- Range from 0 to 6K and above 8K, the number of successful landing and failure is almost equal.
- Between 6k to 8k, 3 fail launches.
- No correlation to landing success

Analyze

Section 5. Model

Predictive Analysis (Classification)

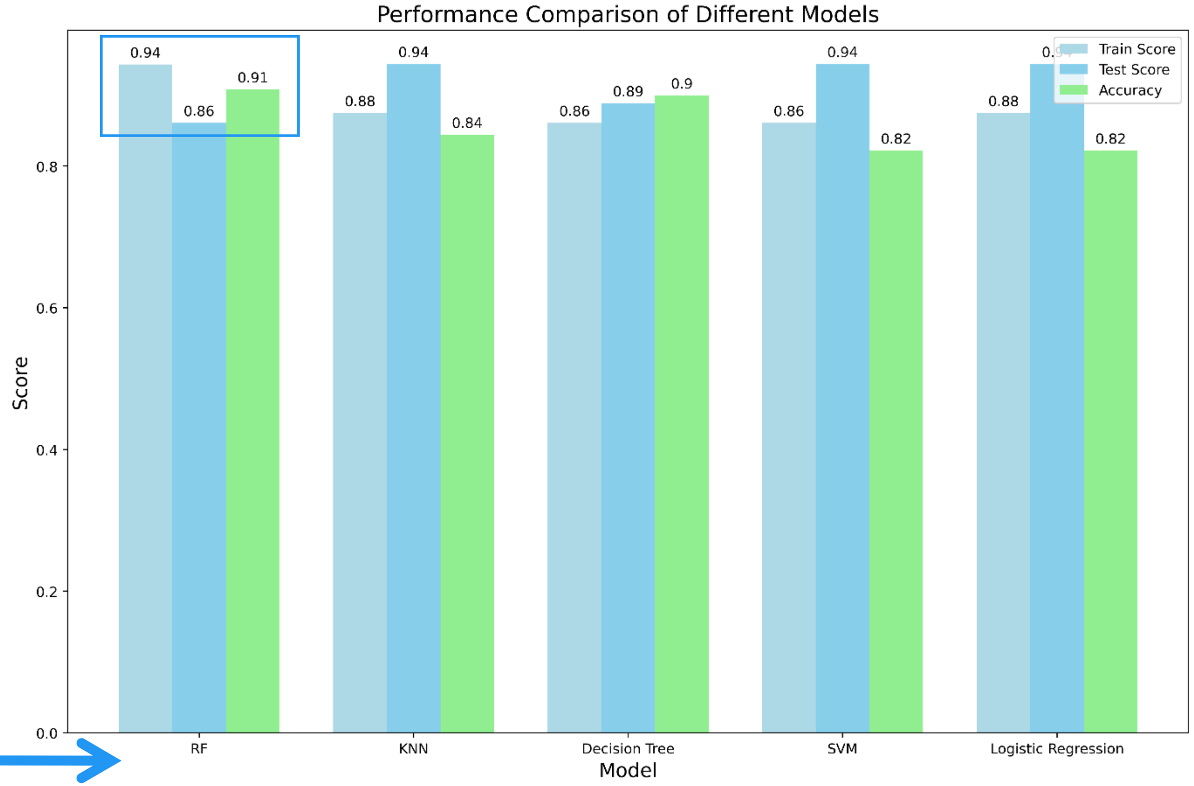
Models and Findings

Classification Accuracy

df
3 location sites
90 flight numbers

Score

Model



1. KNN, SVM and Logistic Regression performs reasonably well on the test set with a high score. However, the accuracy is slightly lower compared to some other models.
2. KNN, SVM and Logistic Regression have high test scores but may be overfitting.
3. Decision Tree and Random Forest have balanced performance.

Analyze

Confusion Matrix

df
3 location sites
90 flight numbers

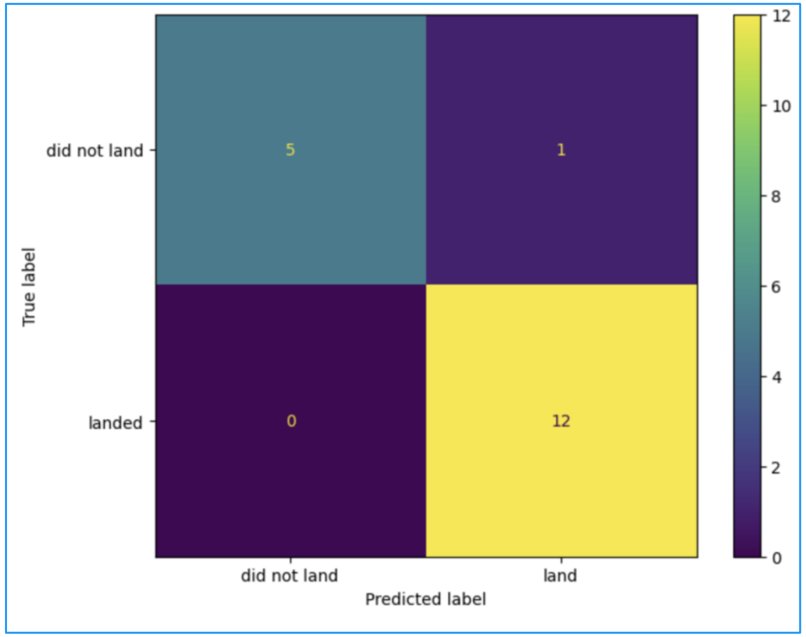
```
              precision    recall  f1-score   support

did not land       1.00      0.50      0.67         6
        land       0.80      1.00      0.89        12

    accuracy                           0.83        18
   macro avg       0.90      0.75      0.78        18
weighted avg       0.87      0.83      0.81        18

[[ 3  3]
 [ 0 12]]


Accuracy Score: 0.83
Mean Cross-Validation Accuracy: 0.82
ROC AUC: 0.87
```



Confusion Matrix:

- In this case, there are 3 instances of "did not land" correctly classified as such, 3 instances incorrectly classified as "land,"
- 12 instances of "land" correctly classified as such, with 0 instances incorrectly classified as "did not land.“

Overall, a good performance with high precision and recall for the “land” class and slightly lower performance for the did not “land class”

Evaluation Metrics:

1. The accuracy 83% of instances were correctly classified
2. 82% suggesting consistent performance across subset data
3. Good discrimination between positive and negative classes to 87%

The model performs well overall and generalizes effectively to unseen data.

Analyze

Conclusion

Conclussion

We decided to choose **Random forest** which performs well on the test set 94% with the highest accuracy 91% score among all models. The feature importance of the Random forrest as follows:

1. Reused count
2. Legs
3. Grid fins
4. Flight number
5. Payload mass
6. Block
7. Orbit GTO
8. Landing pad with last 3 numbers or letters 7ca

Next Steps

- Considering XGBoost and Kmeans
- Analyze the feature importance from random forest further
- Review the hyperparameter tuning

Appendix

Appendix

Documents:

- https://www.kaggle.com/code/wahyuardhitama/Task008-P01-DS-SpaceX-Falcon-20240409
- https://github.com/whyzie/Task008-P01-DS-SpaceX-Falcon-20240409