<TITLE>

<NAME>

<DATE>

OUTLINE

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- Results
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EXECUTIVE SUMMARY

- We would like to prove that SpaceX effectively lands the Falcon 9's first stage and is therefore a cheaper option than competitors
- We do this because SpaceX claims that the reason that they do comparably low-cost launches is because of their ability to reuse the first stage

INTRODUCTION

- We analyzed launches since 2010 and classified them as failures or successes by their ability to land the first stage intact
- The problem we tried to solve was knowing if the first stage would land successfully, as if it didn't, SpaceX's prices would go up
- We wanted to answer the question, 'will the first stage land?'

METHODOLOGY

- Data was retrieved from a SpaceX API
- Our mission is to take that data and to find out if rockets landed successfully by predictive analysis via regression methods.
- We consider a successful launch one that successfully recovers the first stage

Summary(SQL)

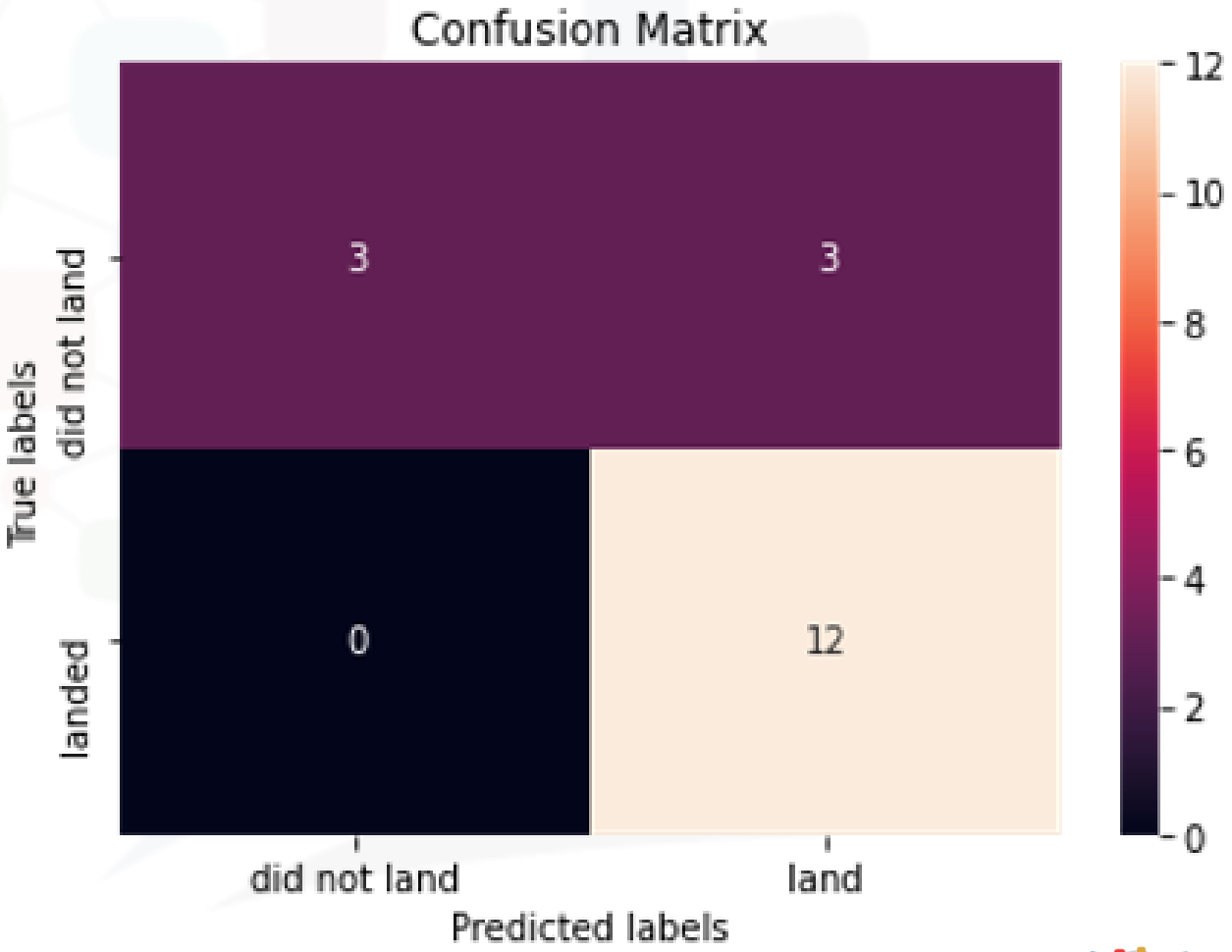
- We made plots involving success rates, orbit types, payload mass, and launch site.
- From this we found which sites performed the best, which orbits gave more successes, and other key features.
- We also wrangled the data using SQL in order to find when the first success was, which booster versions of rockets carried heavy payloads, and the success-failure ratio of rockets among other things.
- We do this to know which sites can handle the heavy payloads as some sites perform better with heavier payloads than others

Summary(Folium)

- From using Folium maps, we found that most launches were made from Florida and calculated distance of the launch sites from structures such as railroads, coasts, and cities as to assess risk a failed launch has on neighbors.
- This proved that an unsuccessful launch would not cause harm to humans.

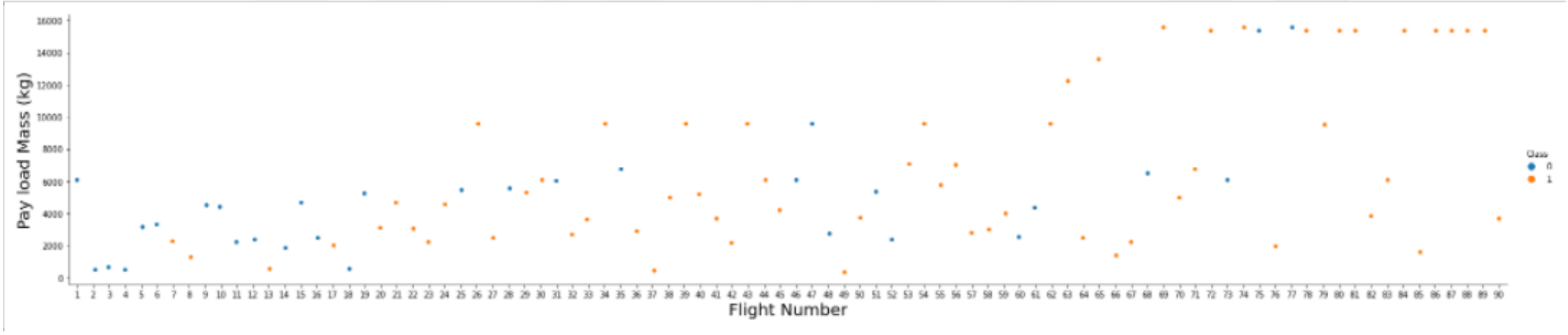
Summary(PredAnalysis)

- We split the data into a training set and a test set
- We then used the training set in order to test predictive models.
- We tweaked parameters in order to find the best ones for the models however, all models performed the same and gave back the same confusion matrix which I will break down later

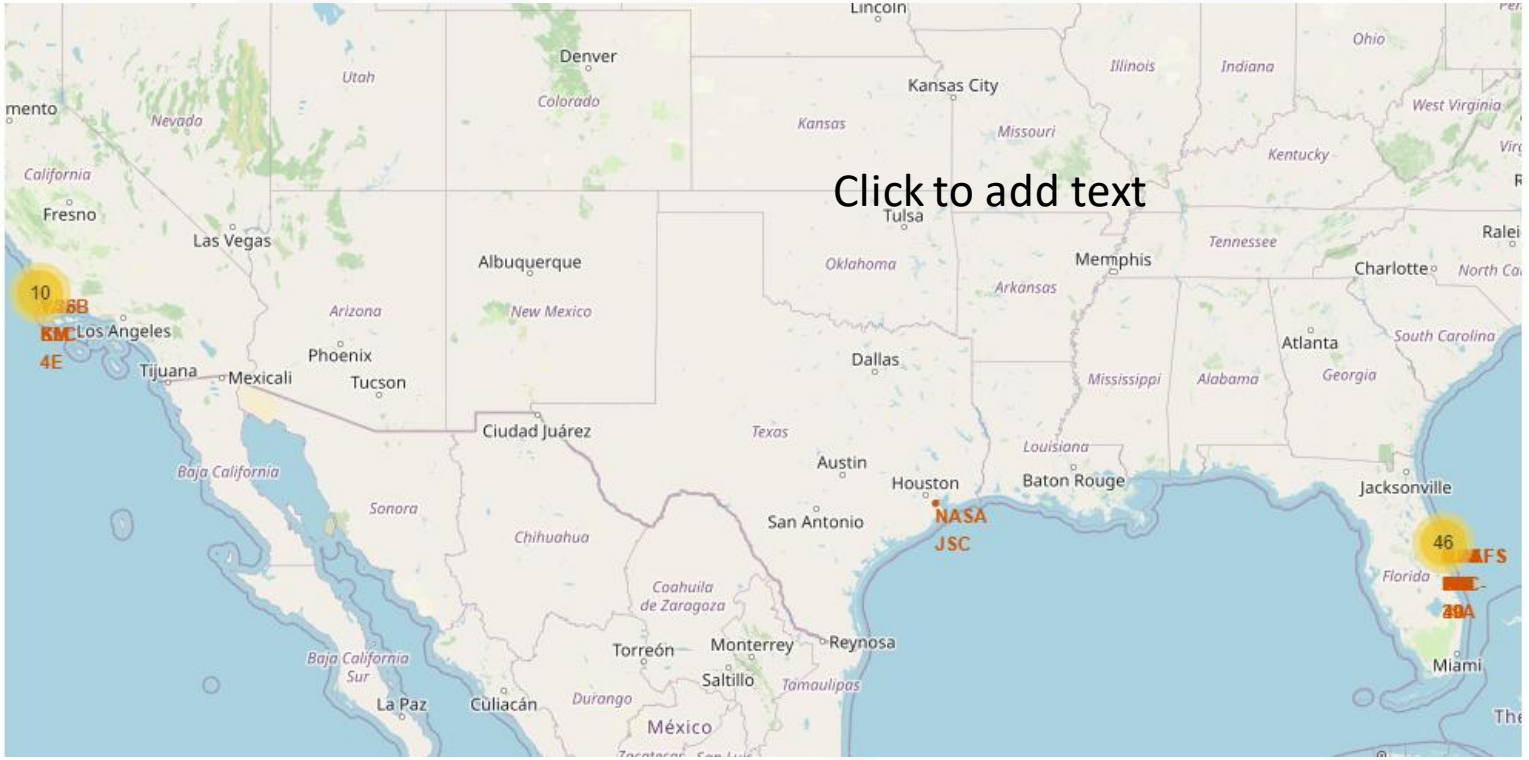


FLIGHT NUMBER VS PAYLOAD MASS

- From this we see that early on, payloads were lighter and would fail often. Over time the payloads were made heavier and success rates would go up with them

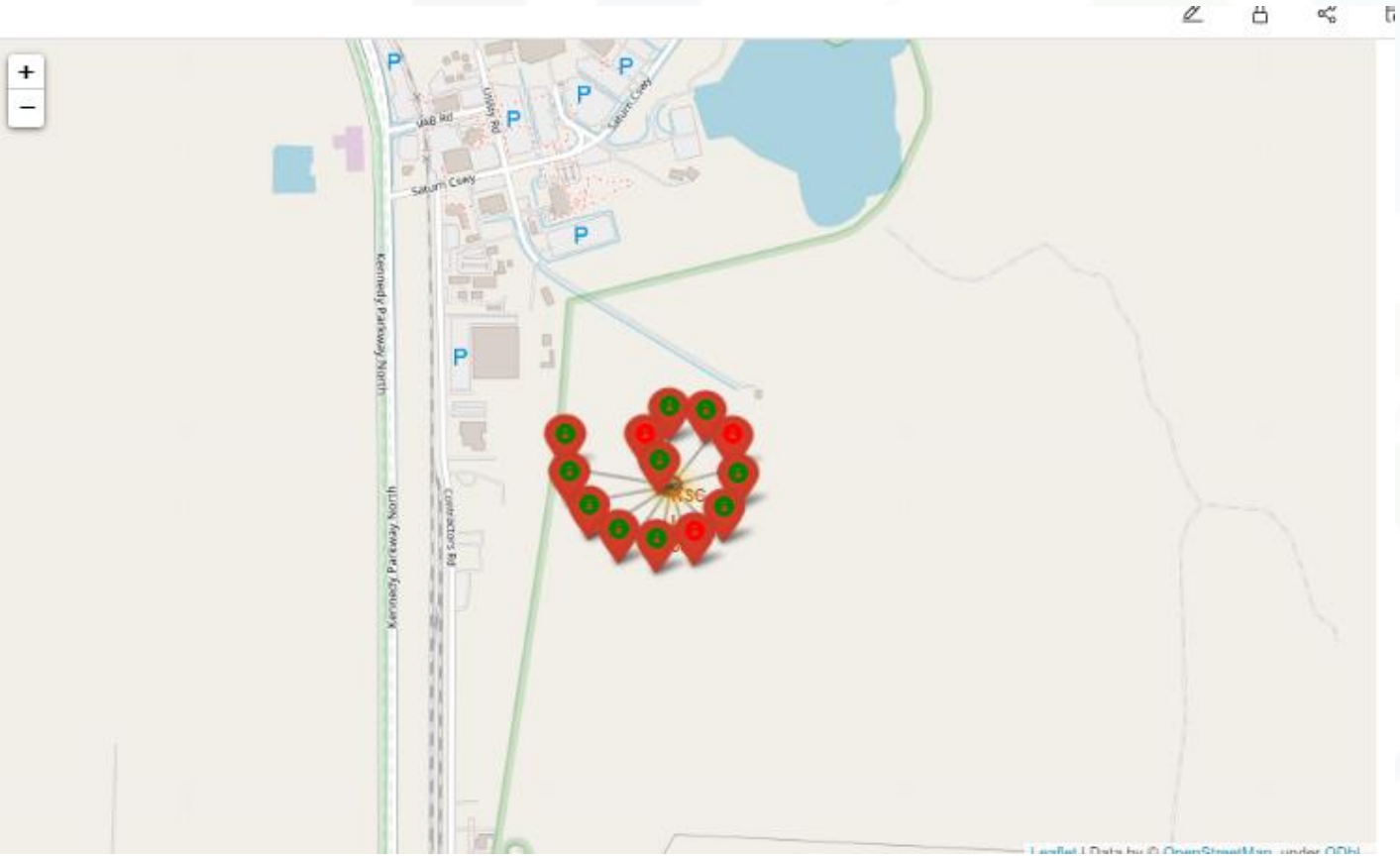


Folium findings(global)



- This shows that most launches were made from the Florida launch sites

Folium findings(per site)



- KSL LC-39A launches perform amazingly, with 10/13 of the launches being successful

Folium findings(per site)

- CCAFS LC-40 performed very poorly, with only 7/26 of the launches being successes

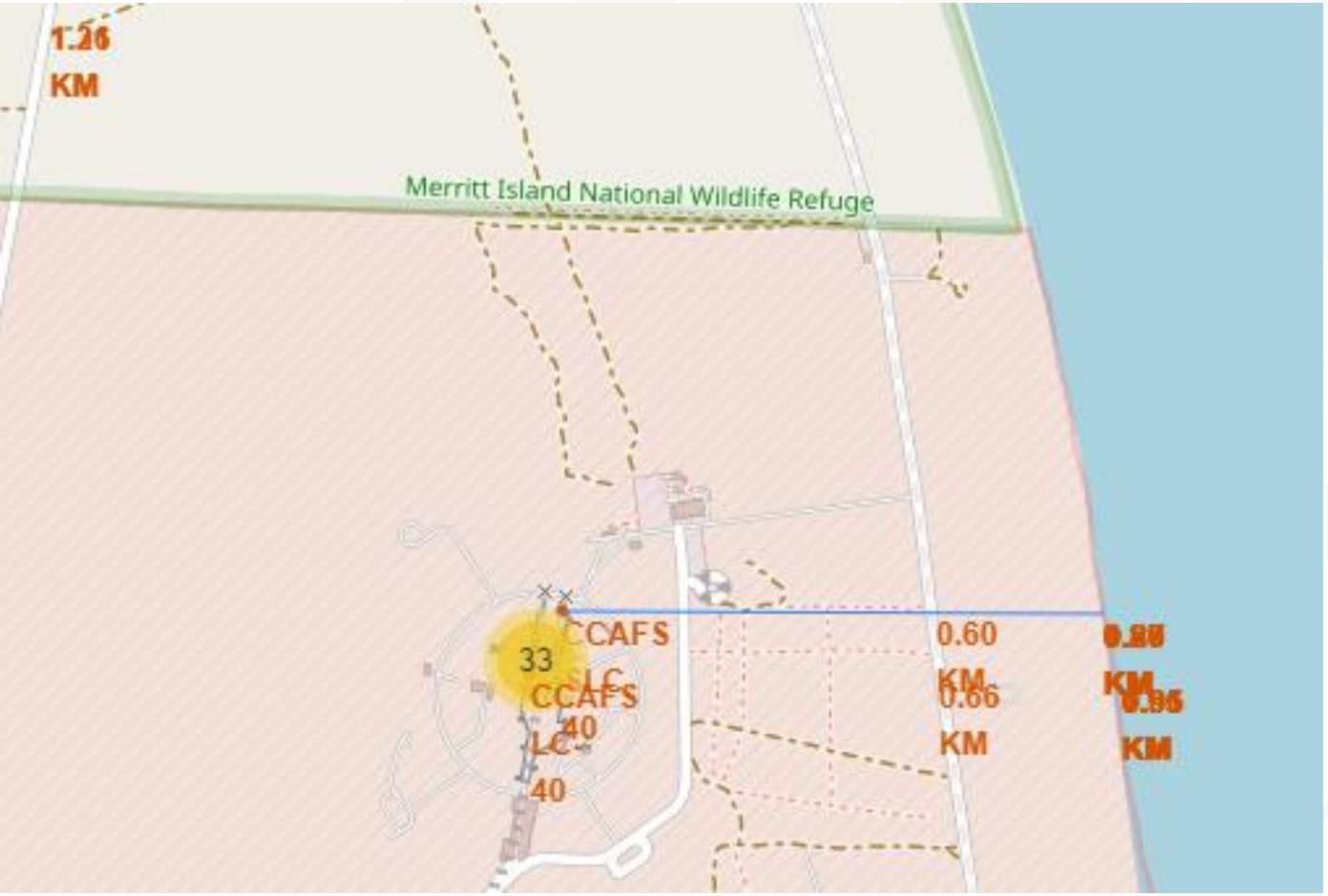
Folium findings(per site)

- CCAFS SLC-40 had a below average performance, given its low-rate of launches with 3/7 launches being successes

Folium findings(per site)

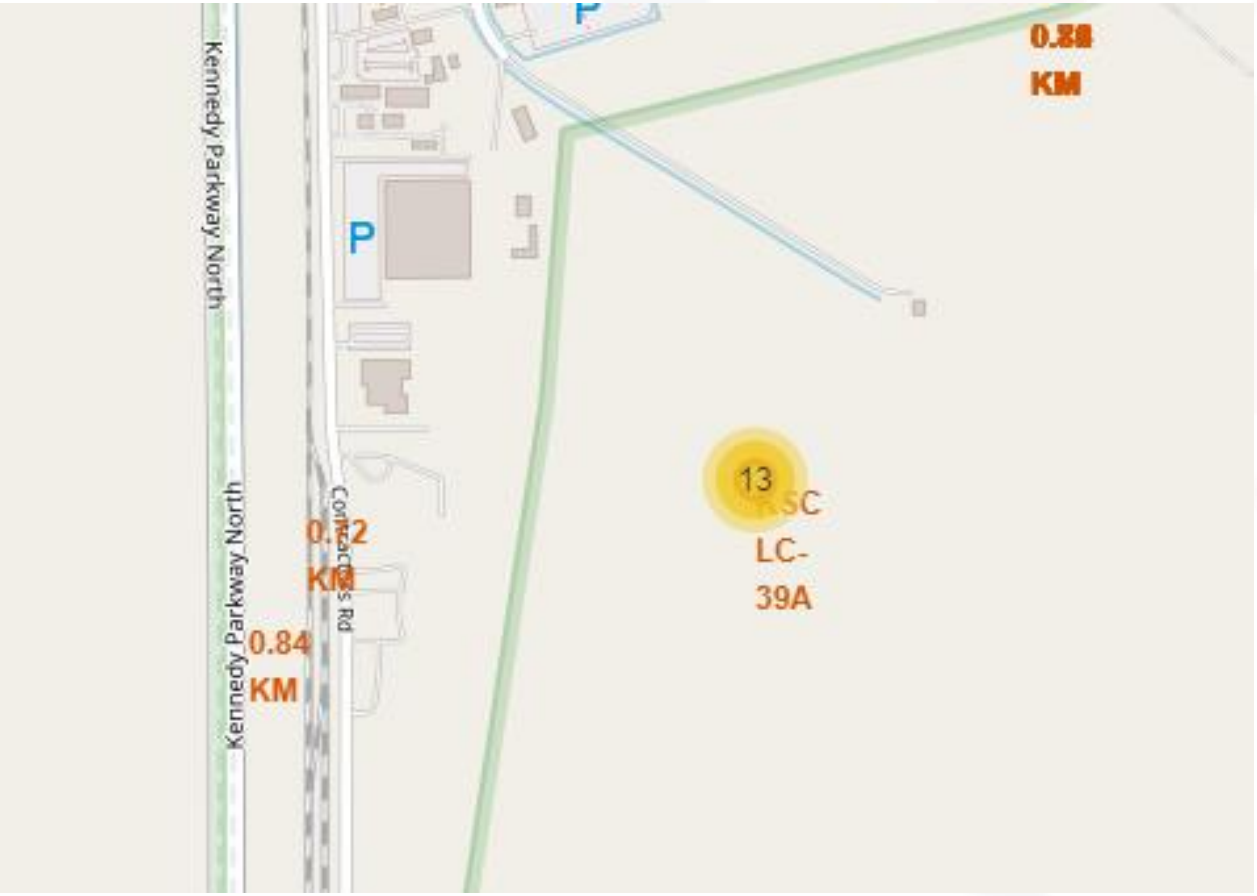
- VAFB SLC-4E had a slightly bad performance with 4/10 launches being successes

CCAFS SLC/LC-40



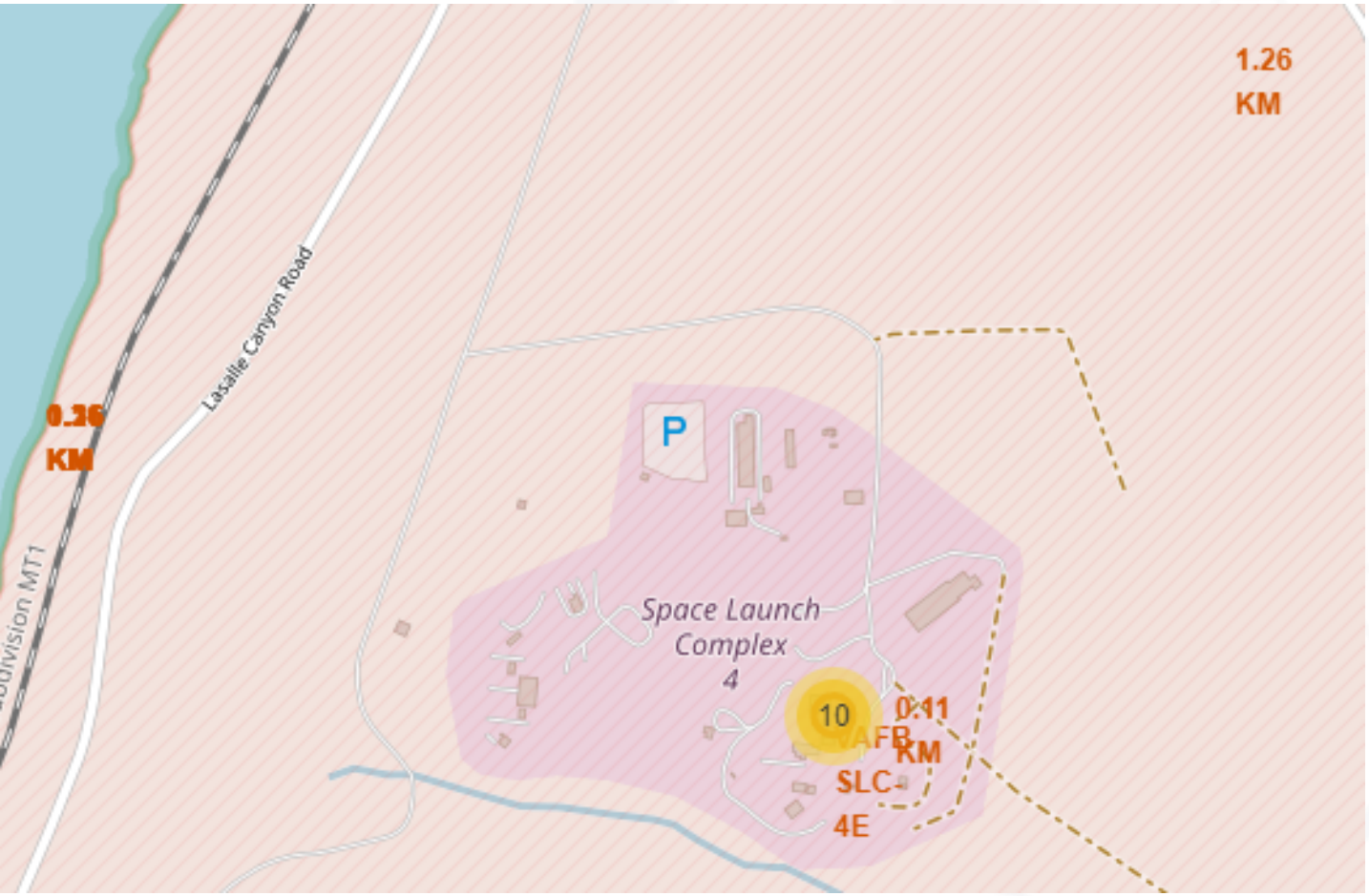
- Sites are near the coast but there is a nearby railroad that should be evacuated when launches happen in case of failures.

KSL LC-39A



- Site is a good distance from anything that would be trafficked by humans, and it is successful at launches. Definitely seems to be safest, best launch site.

VAFB launch site



- There is a highway less than .12KM from this site so it seems to be a danger since it fails launches more than often.

RESULTS

- We took characteristics of the rockets, such as mass, where it went in orbit, and which model it was,etc and used it in order to perform linear regression on it in order to find if a first stage would land.
- This led to us conclude that an unknown F9 rocket has a 83% chance of landing

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

launch_site
CCAFS LC-40
CCAFS LC-40
CCAFS LC-40
CCAFS LC-40
CCAFS LC-40

1
111268

- From this we see that in total, the payloads weighted slightly more than 110,000 kg.
- We also see that at least 5 of the rockets were launched from CCAFS LC-40 and the four sites we will be analyzing.

1
38020

- This is the total mass carried by v1.1 model F9's

DATE
2015-12-22

- The first successful launch was December 22, 2015.

booster_version
F9 B4 B1040.2
F9 B4 B1040.1
F9 B4 B1043.1
F9 B5 B1046.2
F9 B5 B1046.3
F9 B5 B1047.2
F9 B5 B1048.3
F9 B5 B1051.2
F9 B5 B1058.2
F9 B5B1054
F9 B5B1060.1
F9 B5B1062.1
F9 FT B1021.2
F9 FT B1031.2
F9 FT B1032.2
F9 FT B1020
F9 FT B1022
F9 FT B1026
F9 FT B1030
F9 FT B1032.1
F9 v1.1
F9 v1.1 B1011
F9 v1.1 B1014
F9 v1.1 B1016

- Different boosters used by the rockets

failure	success
10	61

- Success-Failure ratio for the F9 launches

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

- Booster versions that carried 15,600 kgs

landing__outcome	booster_version	launch_site
Failure (drone ship)	F9 v1.1 B1012	CCAFS LC-40
Failure (drone ship)	F9 v1.1 B1015	CCAFS LC-40

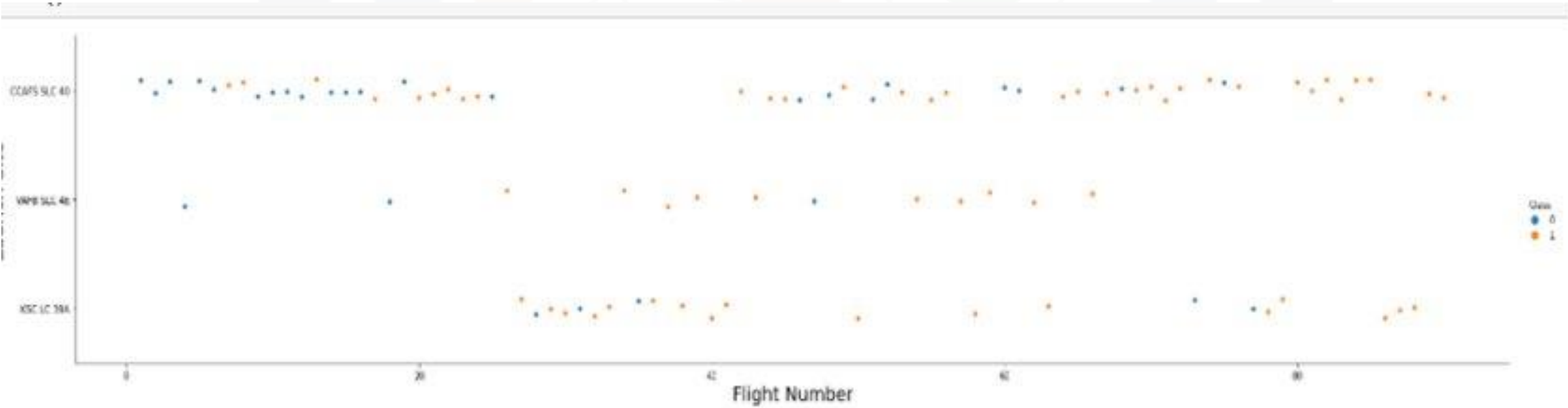
- In 2015, all failed(drone ship) launches were made from CCAFS LC-40

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

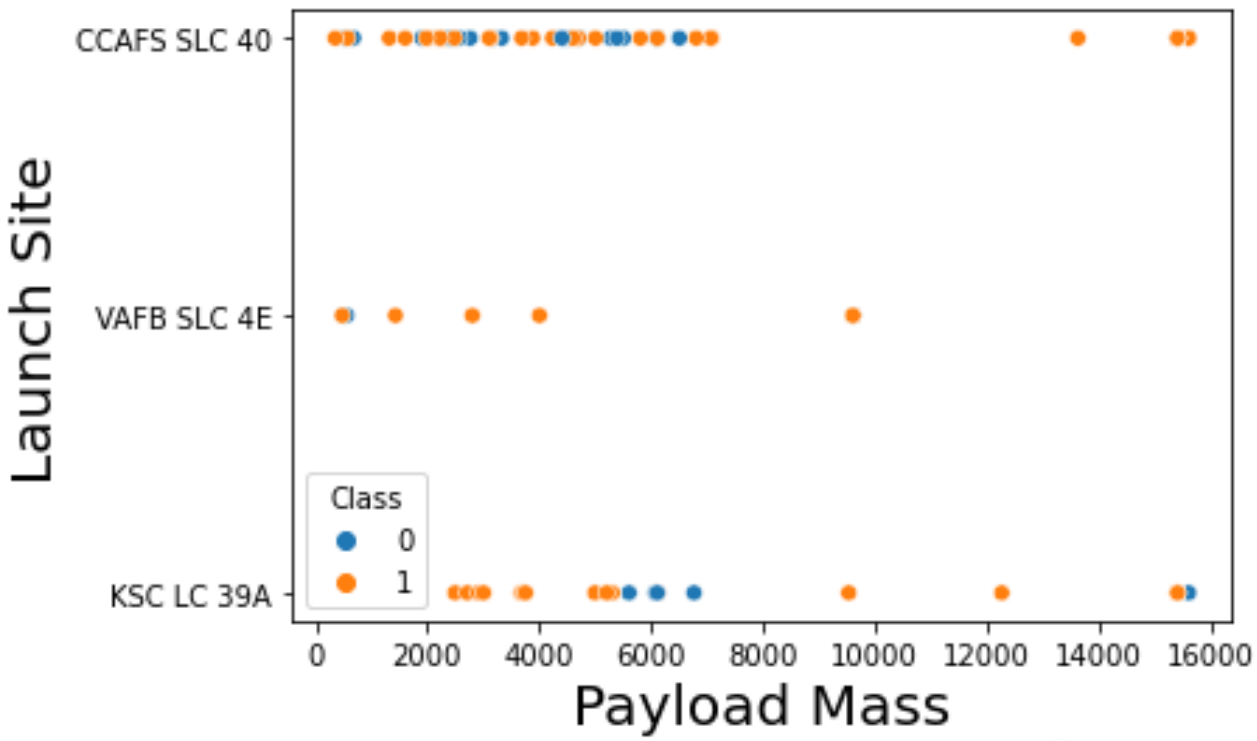
- Between 2010 and 2017, most launches were non-attempts

FLIGHT NUMBER VS LAUNCH SITE

- Most of the launches to have come from CCAFS LC-40 launch site. The last 13 flights have all been successful in landing the first gear

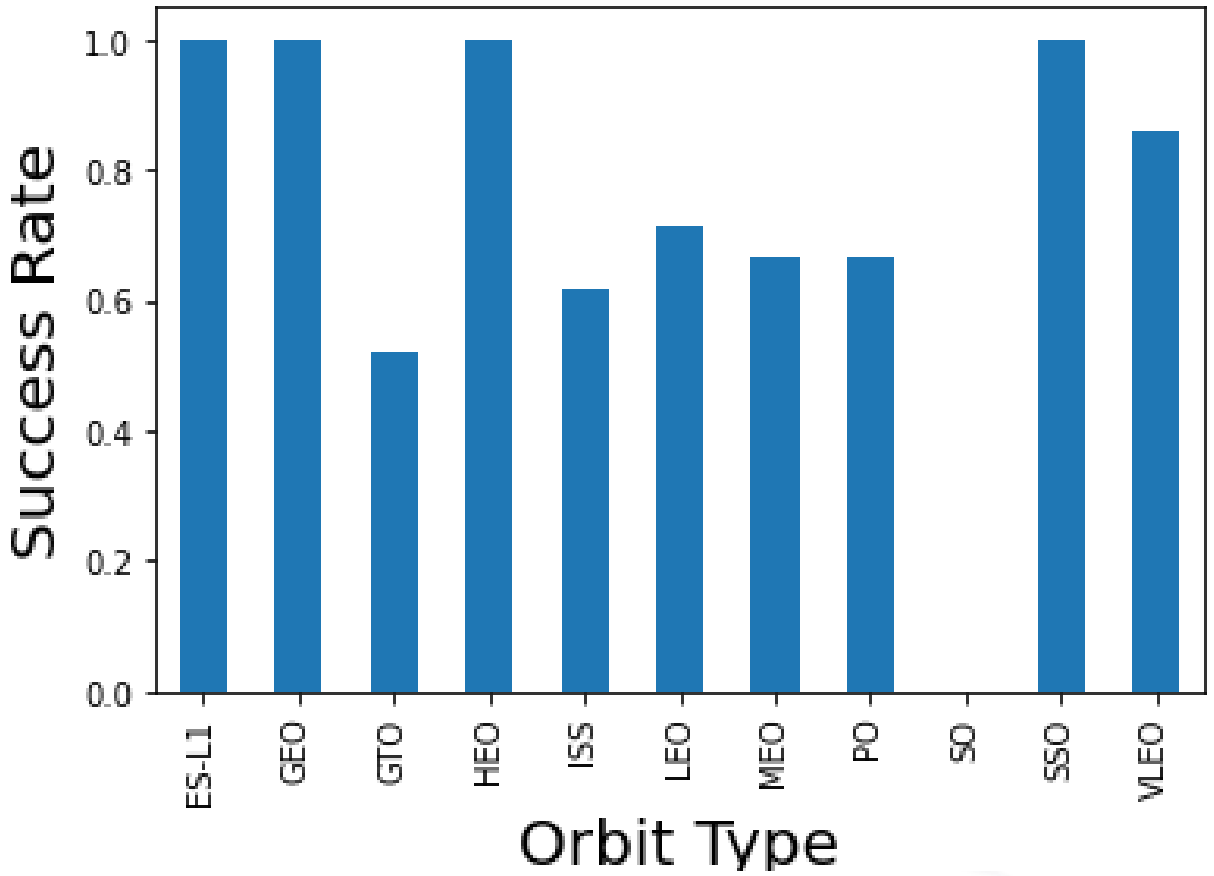


PAYLOAD MASS VS LAUNCH SITE



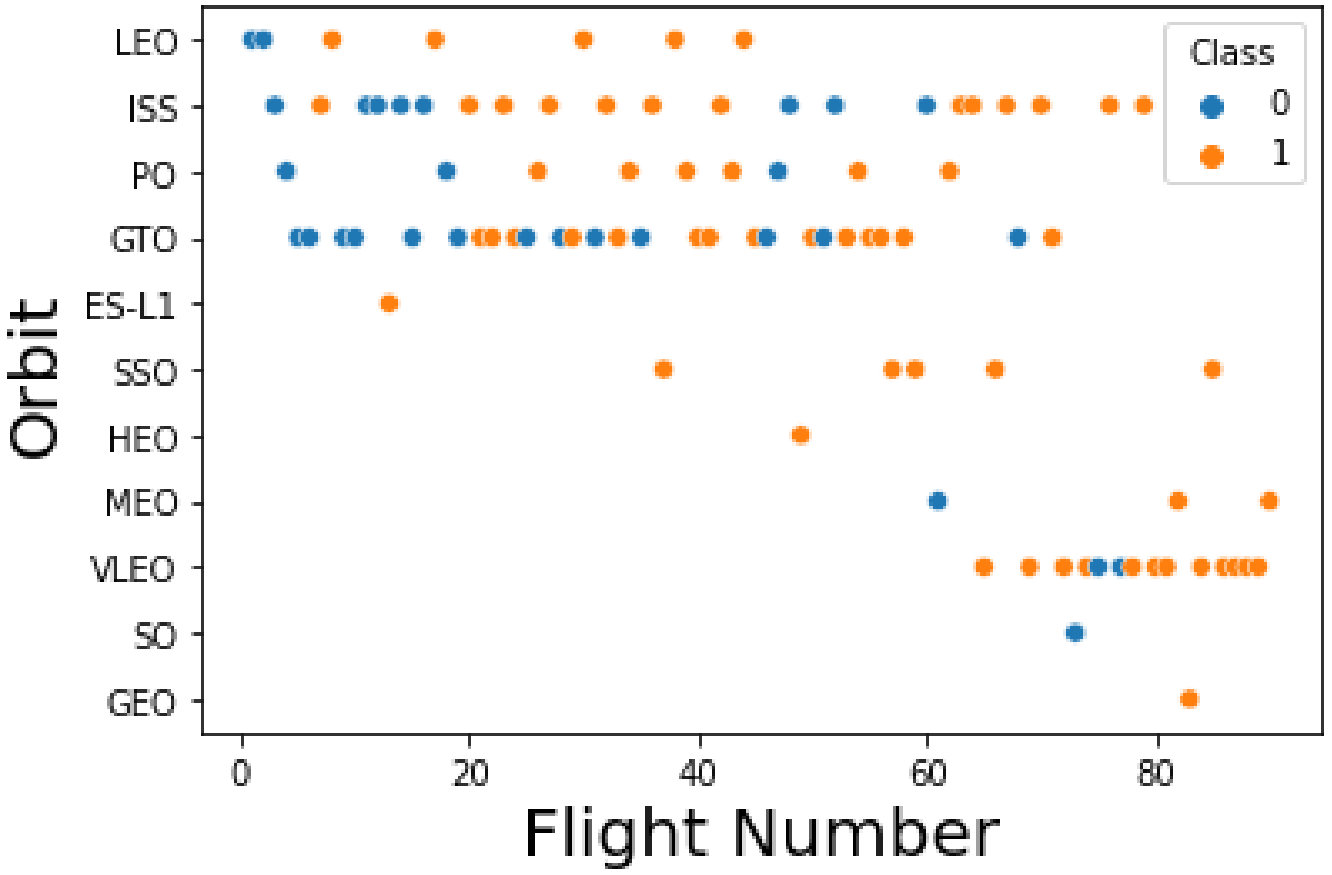
- The VAFB launch site does not handle heavy payloads.
- The CCAFS SLC-40 launch site specializes in launches of varied weights

ORBIT TYPE VS SUCCESS RATE



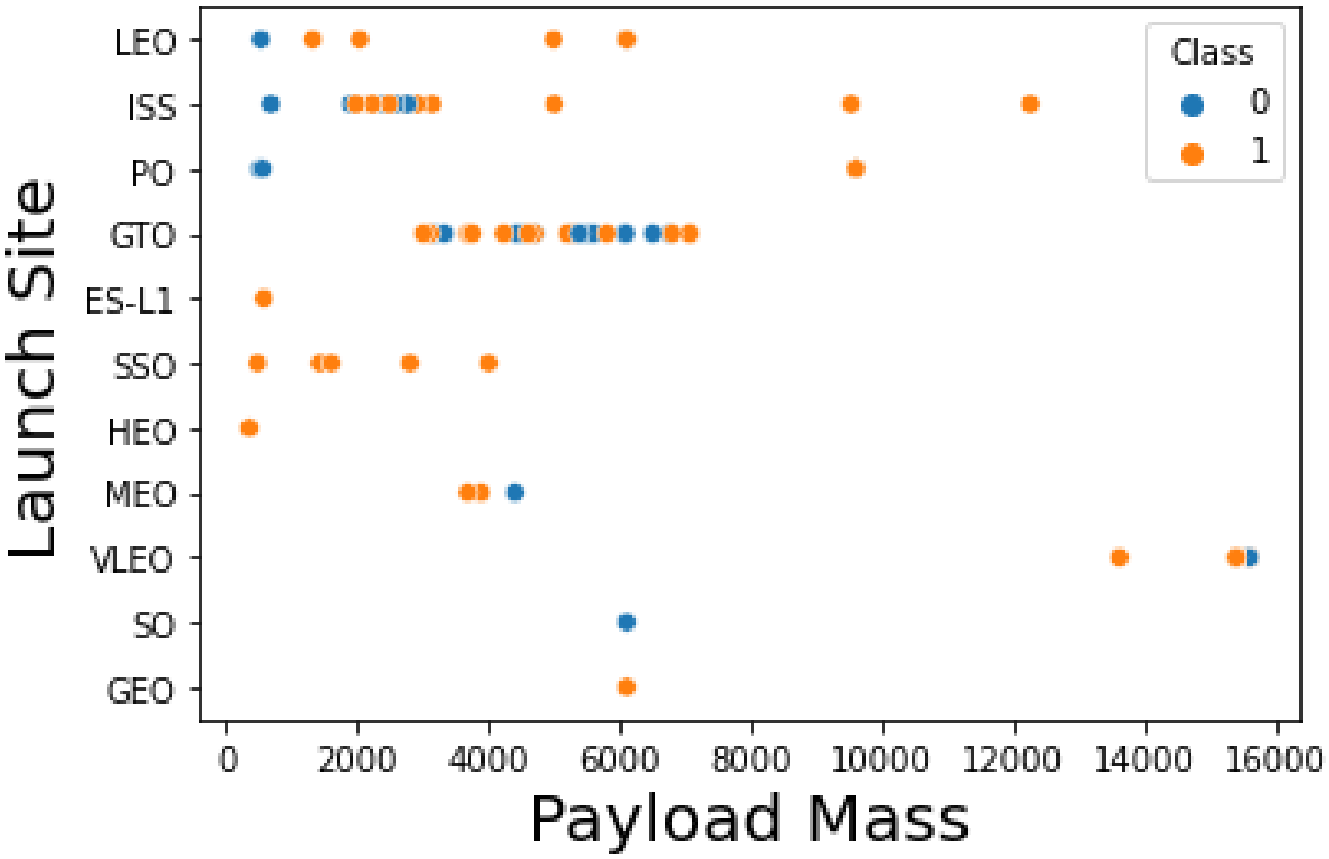
- SO(Sun-Synchronous Orbit) launches are the most unsuccessful while other orbit launches have a 100% success rate.

FLIGHT NUMBER VS ORBIT TYPE



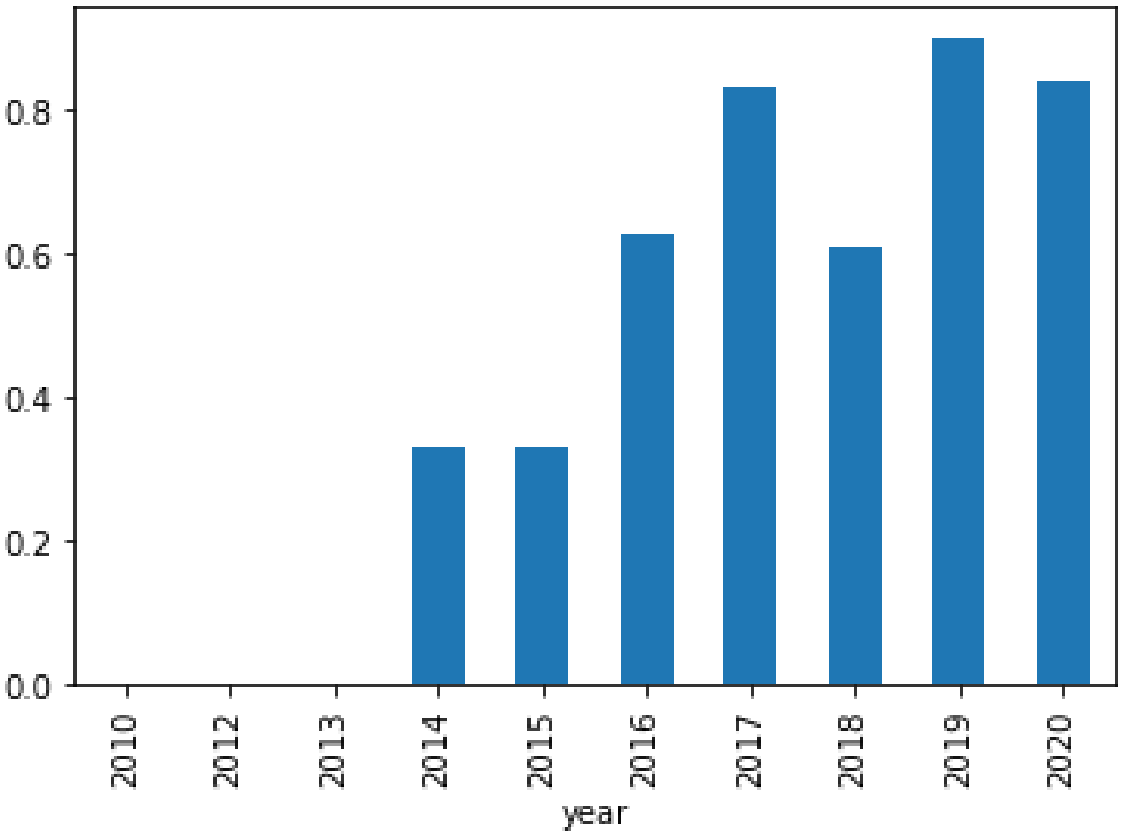
- LEO and VLEO orbit launches have successive successful launches

PAYLOAD MASS VS LAUNCH SITE



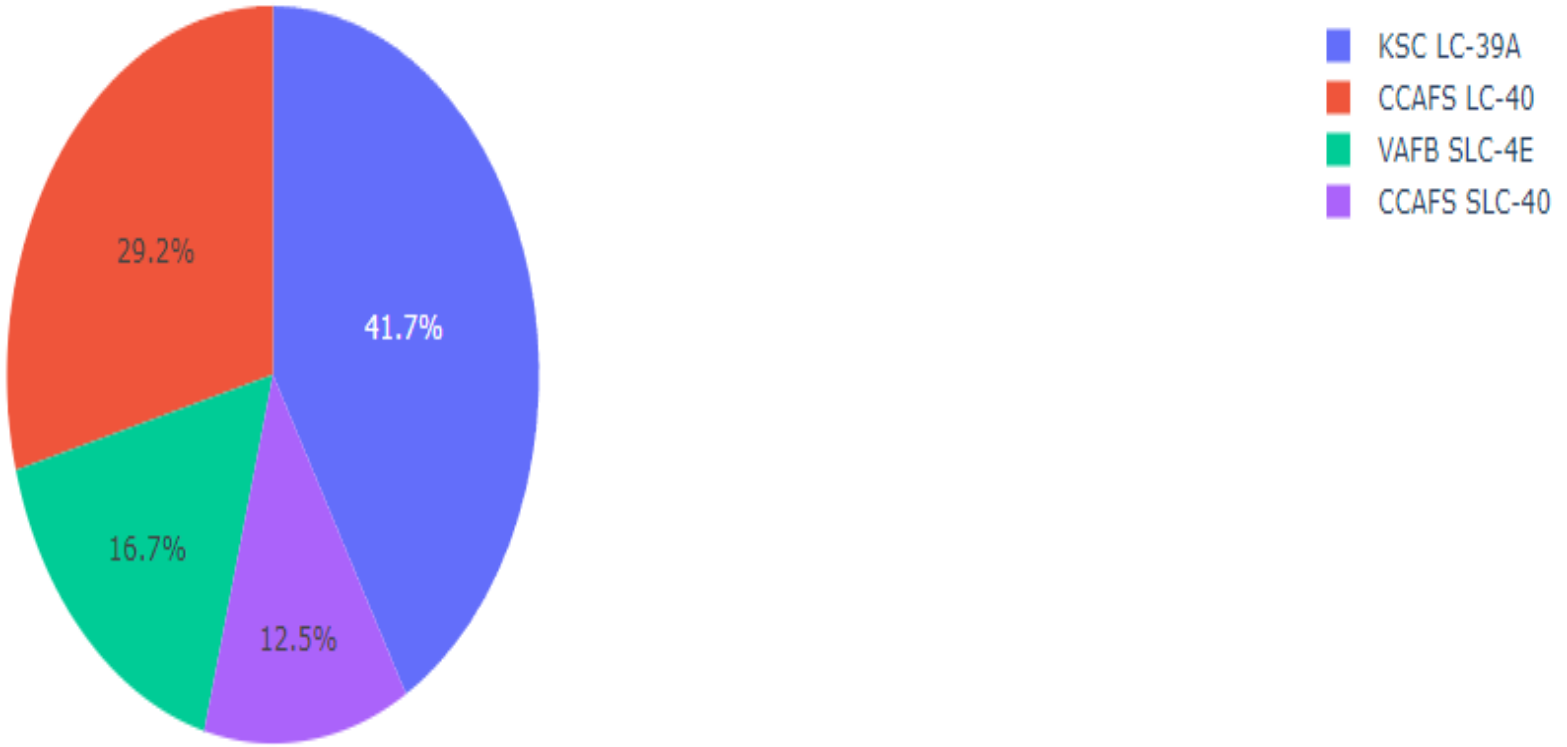
- Polar, LEO, and ISS launches do very well with heavy payload masses

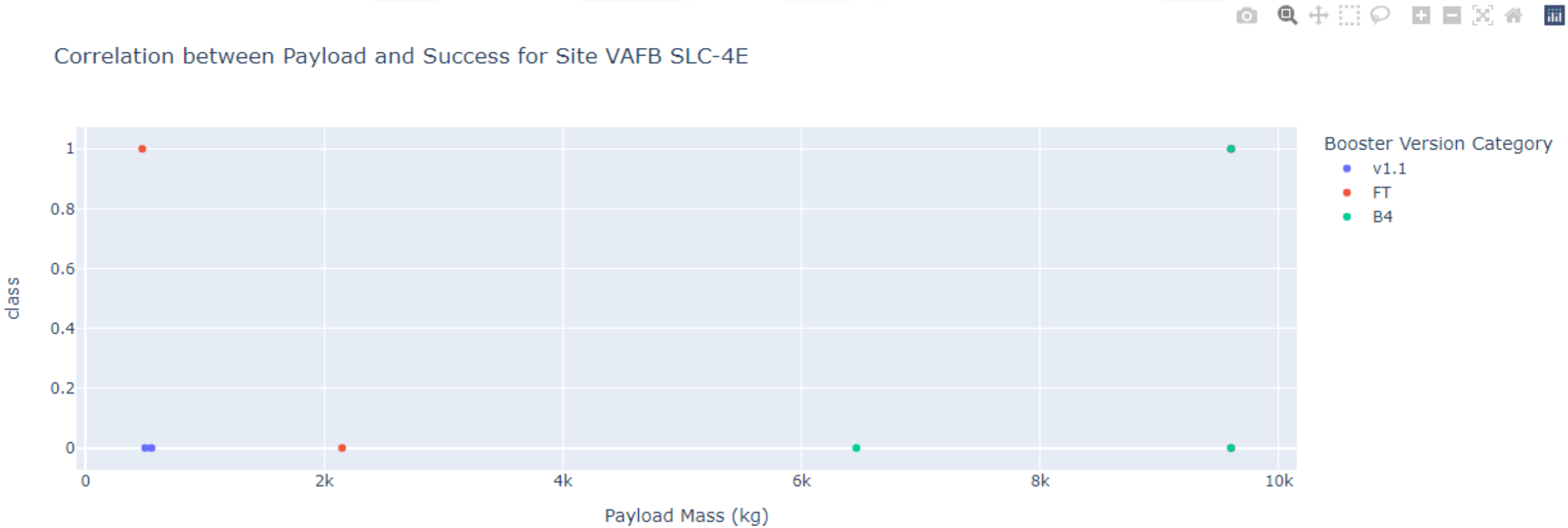
FLIGHT NUMBER VS PAYLOAD MASS



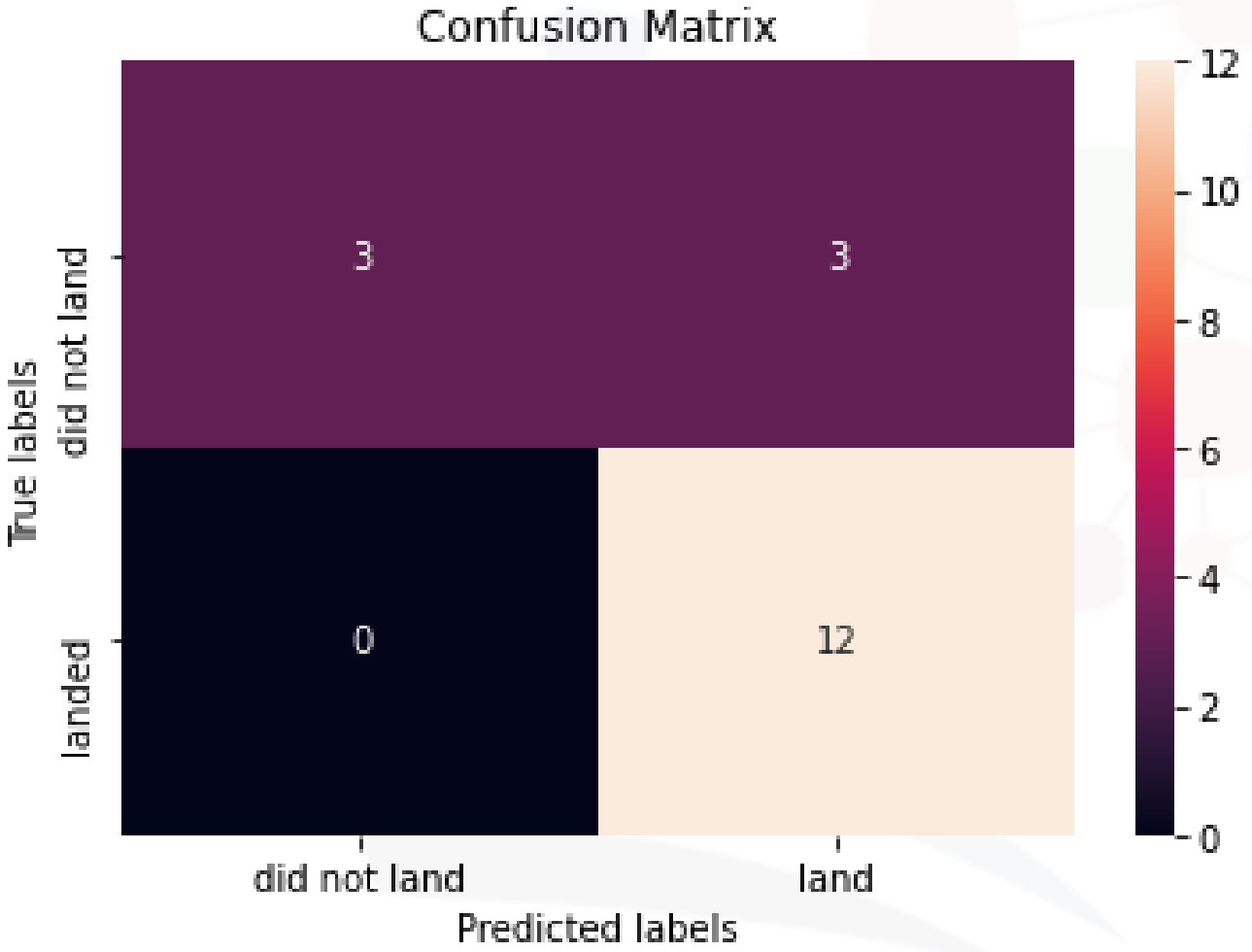
- There appears to be improvement in successful launches over the years

Successful Launches




Correlation between Payload and Success for Site VAFB SLC-4E
class
1
0.8
0.6
0.4
0.2
0
0
2k
4k
6k
8k
10k
Payload Mass (kg)
Booster Version Category
v1.1
FT
B4

Predictive analysis results/Best model



- The confusion matrix on the results slide conveys that our model correctly predicts all launches that actually launch. It has faults in identifying launches as landing the first stage when they in fact did not
- All forms of analysis led to this result but it is easier to explain the mechanisms of linear regression.

Landing TRENDS - FINDINGS & IMPLICATIONS

Findings

- Rockets in the midrange of weight failed the most
- KSC LC-39A made up most of the successful launches

Implications

- Making rockets in this range is unfavorable for SpaceX
- Rockets should be launched from this site

CONCLUSION

- We wanted to know if Falcon9's successfully land their first stage
- We concluded that future rockets have around 83% to land

APPENDIX

- Most launch sites are at close proximity from coastal areas and at least 4 football fields away from any sort of civilization so failure to land rockets would not results in life-loss