Finding Habitable Exoplanets

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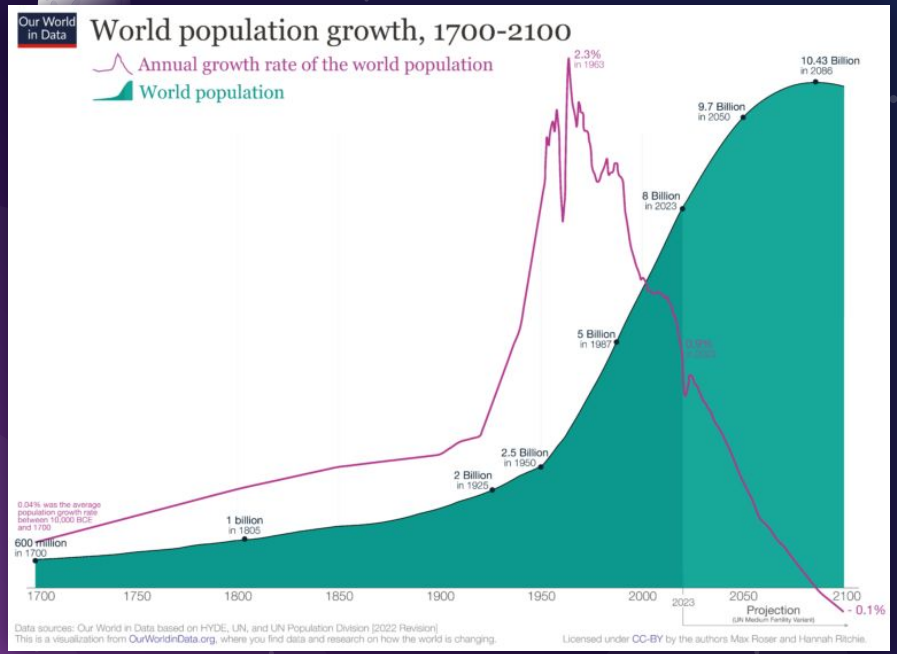
Intro &
Motivation
The “why” behind our project


Our World in Data
World population growth, 1700-2100
Annual growth rate of the world population
World population
2.3% in 1963
10.43 Billion in 2086
9.7 Billion in 2050
8 Billion in 2023
5 Billion in 1987
2.5 Billion in 1950
2 Billion in 1925
1 billion in 1805
600 million in 1700
0.04% was the average population growth rate between 10,000 BCE and 1700
1700
1750
1800
1850
1900
1950
2000
2023
2050
2100
Projection
(UN Medium Fertility Variant)
- 0.1%
Data sources: Our World in Data based on HYDE, UN, and UN Population Division [2022 Revision]
This is a visualization from OurWorldinData.org, where you find data and research on how the world is changing.
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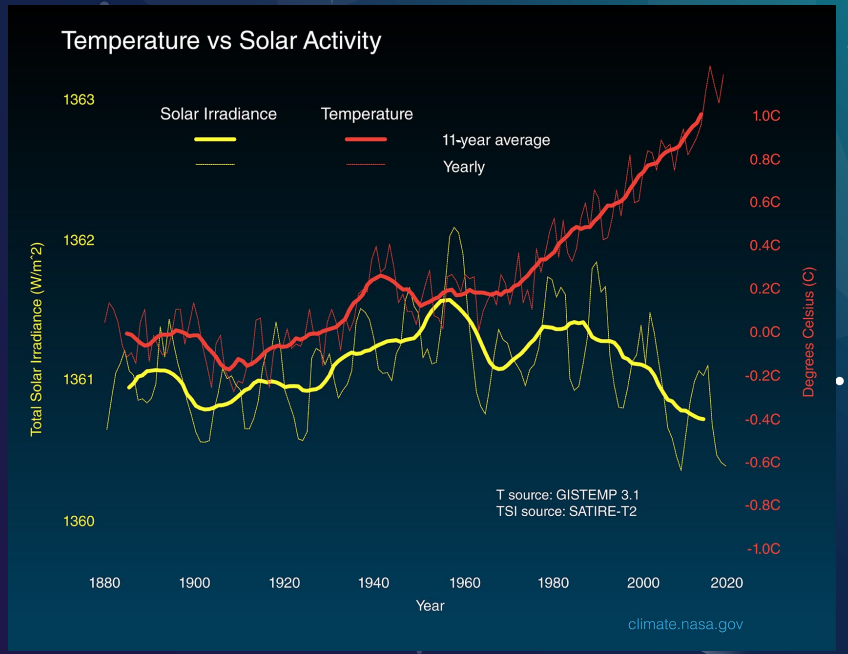
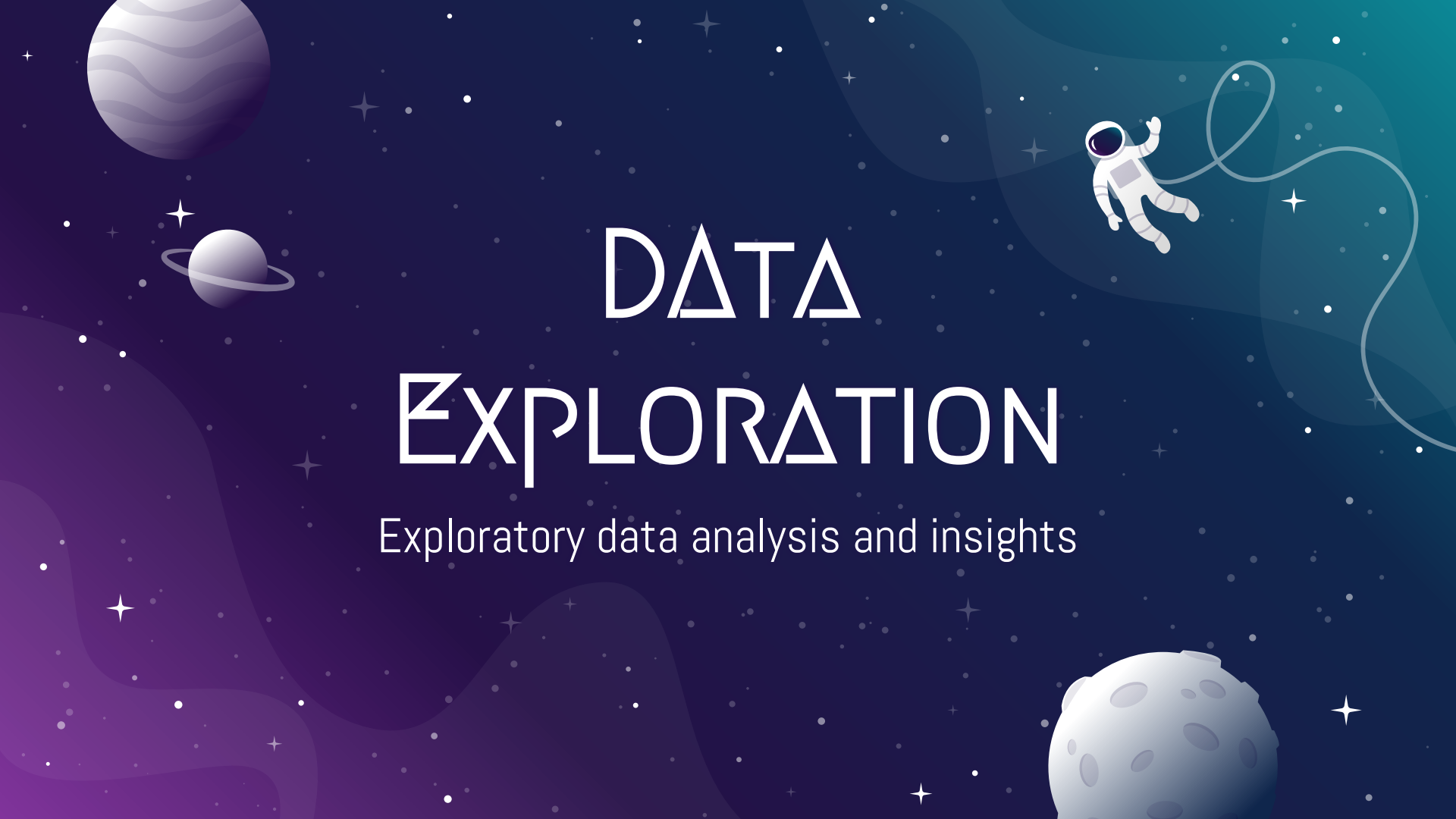

Temperature vs Solar Activity
Solar Irradiance
Temperature
11-year average
Yearly
1363
1362
1361
1360
Total Solar Irradiance (W/m^2)
1.0C
0.8C
0.6C
0.4C
0.2C
0.0C
-0.2C
-0.4C
-0.6C
-0.8C
-1.0C
Degrees Celsius (C)
T source: GISTEMP 3.1
TSI source: SATIRE-T2
1880
1900
1920
1940
1960
1980
2000
2020
Year
climate.nasa.gov

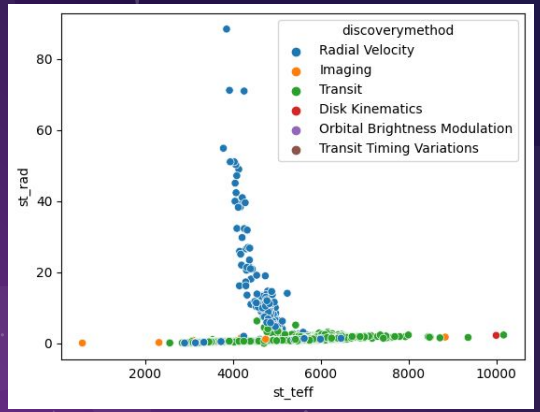

Data
Exploration
Exploratory data analysis and insights

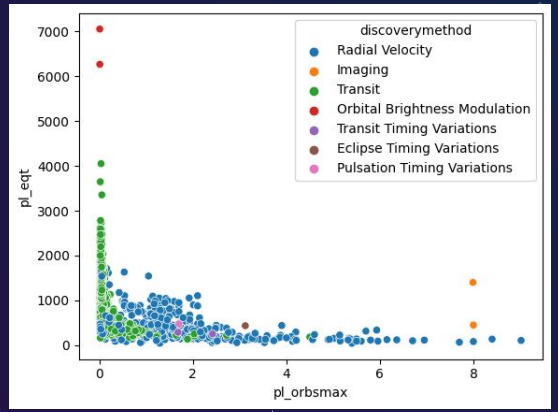
Calculating temperature

- habitable = capable of holding liquid water
  - 180 K < equilibrium temperature < 310 K
- not all planets had temperature information so we did it ourselves ⟶ $T_p = T_\odot (1-A)^{1/4} \left(\frac{R_\odot}{2\,d}\right)^{1/2}$
  - 150 new habitable planets!
- 9 nearest exoplanets ⟶ all within habitable zone
  - suggests our calculations are precise

Method of Discovery

discoverymethod	count	pl_orbsmax	st_teff	st_rad	pl_eqt	sy_dist	habitable
Disk Kinematics	1	130.000000	10000.000000	2.250000	57.948803	183.857000	0.000000
Eclipse Timing Variations	6	3.120000	32375.333333	0.181667	434.794838	516.320167	0.000000
Imaging	12	845.057500	5602.916667	1.305833	718.730648	93.220763	0.000000
Orbital Brightness Modulation	6	0.013667	13236.966667	1.068333	5152.640777	861.393000	0.000000
Pulsation Timing Variations	1	1.700000	29300.000000	0.230000	474.713915	1195.980000	0.000000
Radial Velocity	639	1.488081	5040.159718	4.558091	481.665549	101.257104	0.190923
Transit	3885	0.117606	5427.426914	1.011323	928.180437	646.125970	0.016474
Transit Timing Variations	11	0.569316	5510.181818	1.030909	643.197994	496.481309	0.272727

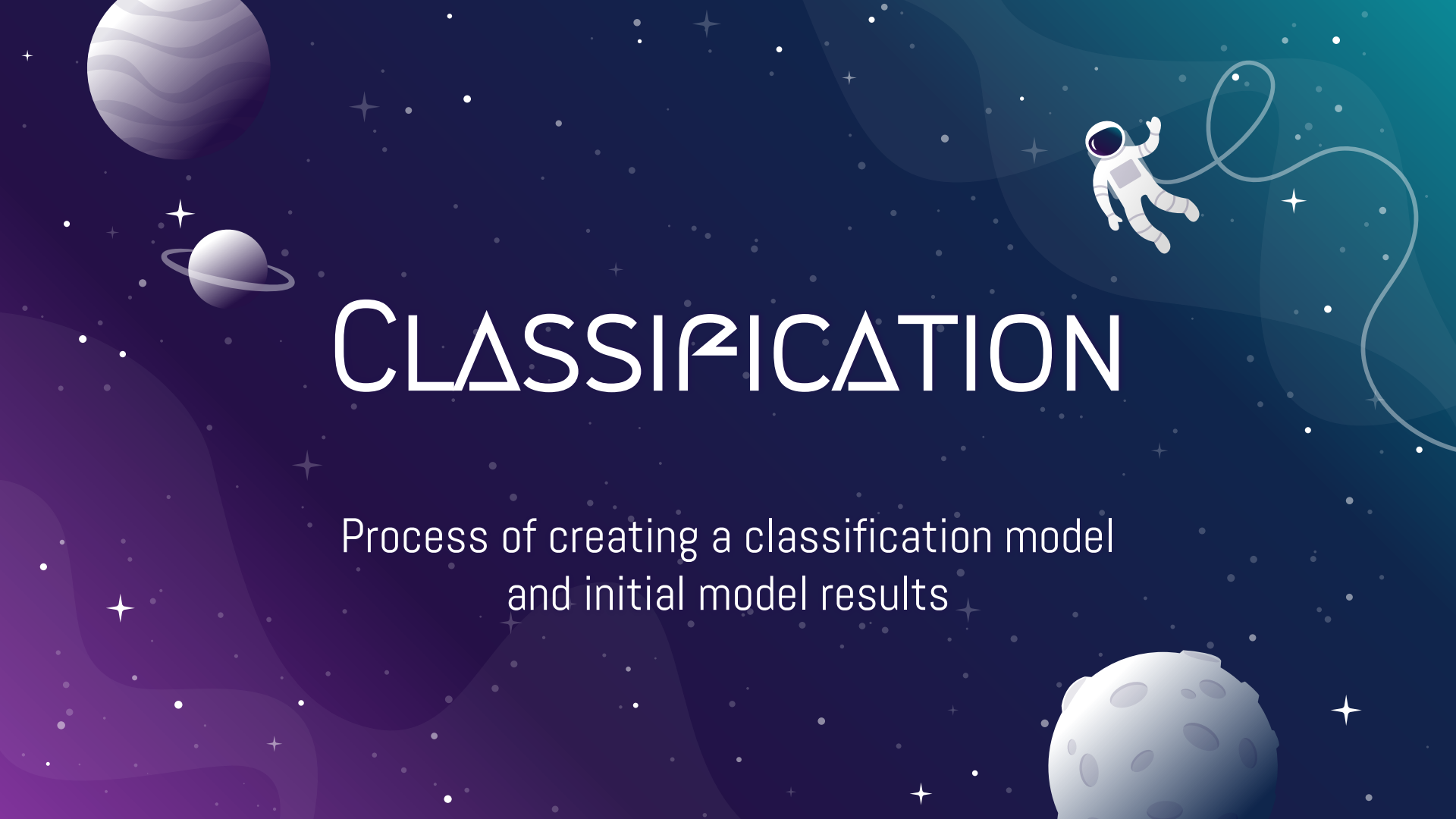




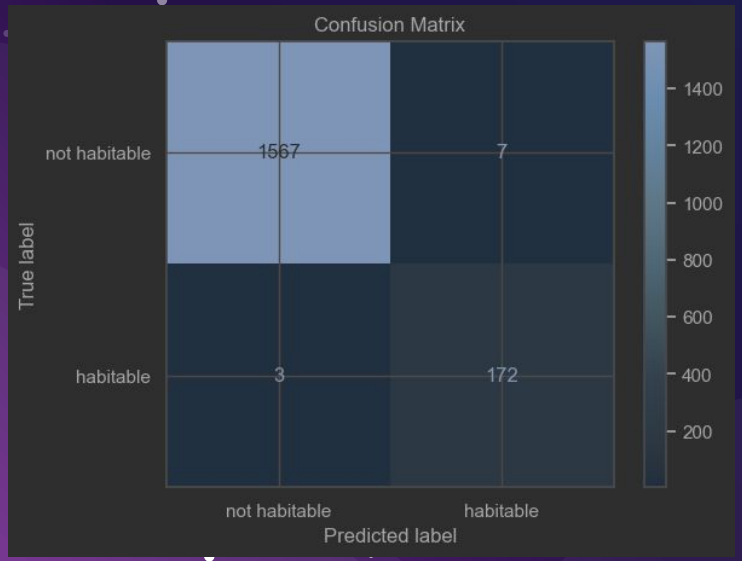
Habitable Planets

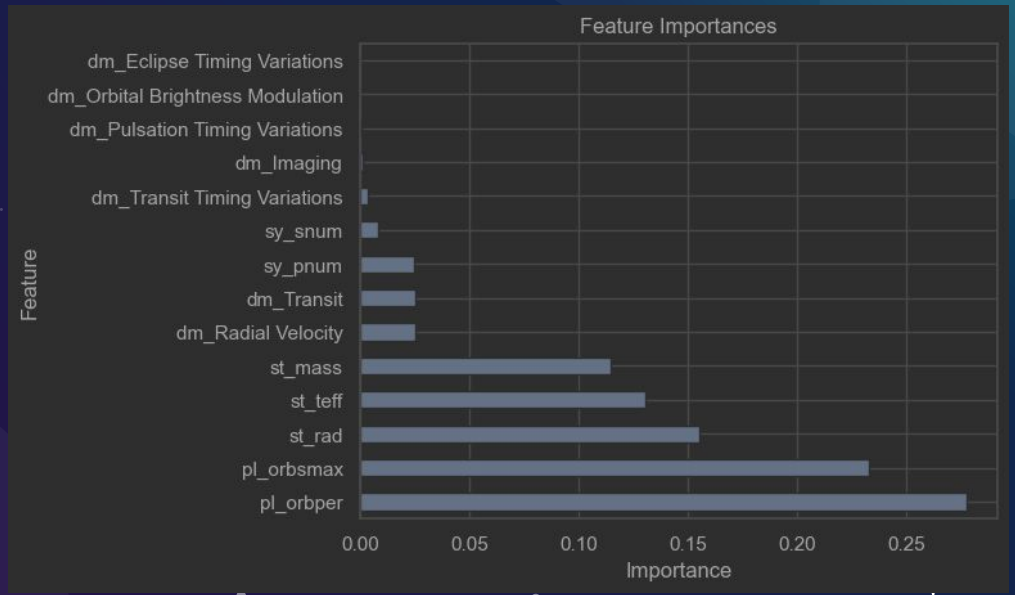
- habitable planets generally orbit near to small, cool stars and are close to Earth
    - probably biased due to efficiency of radial velocity at discovering habitable exoplanets

habitable	count	pl_orbsmax	st_teff	st_rad	pl_eqt	sy_dist
0	4372	4.952196	5449.760968	1.522640	868.816195	583.222597
1	189	1.225823	4871.330529	1.172593	247.893869	175.071919

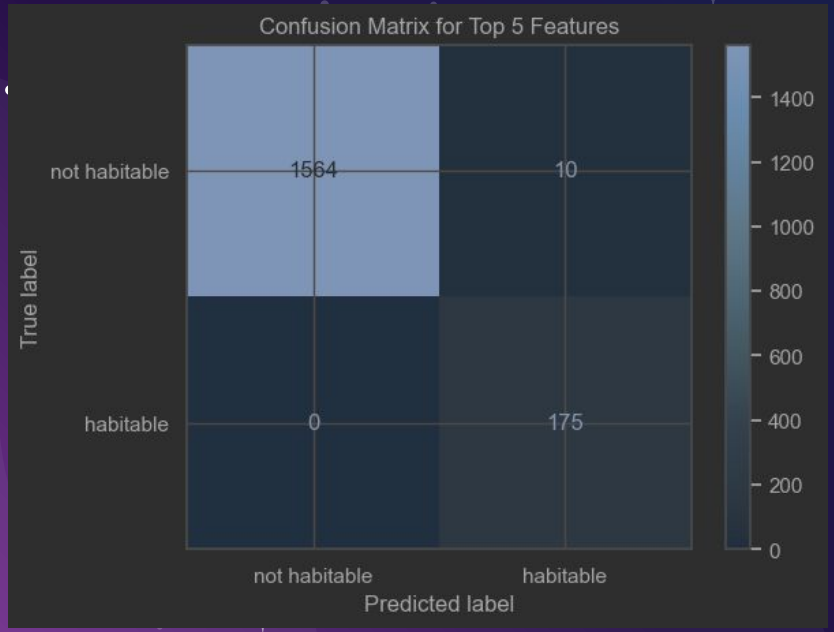

CLASSIFICATION
Process of creating a classification model
and initial model results

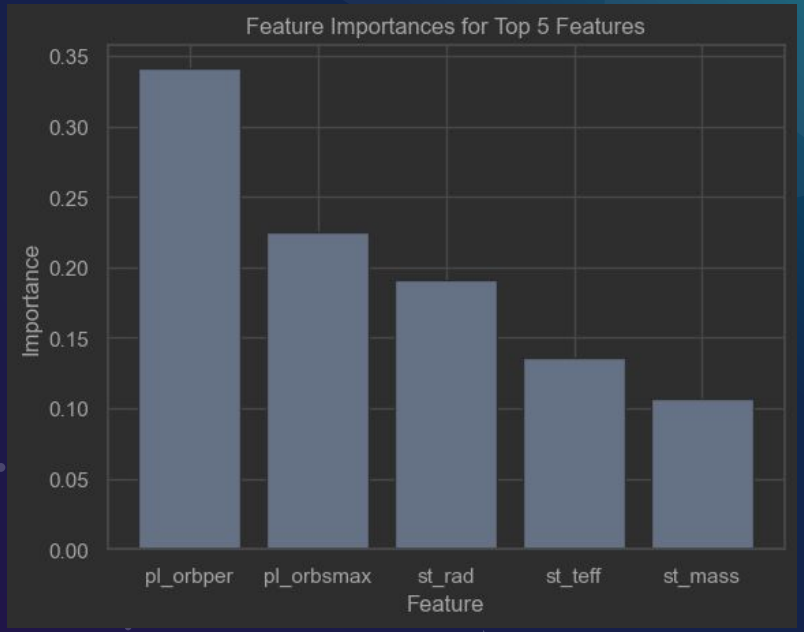
Initial Model Results





Final Model Results





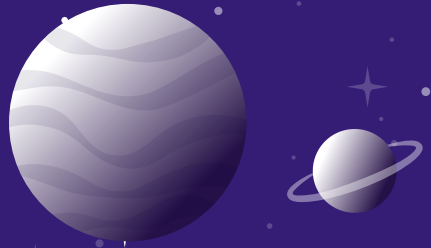

Results &
Direction
Conclusions and future direction

Three Main Takeaways

- Using model to focus on likely-habitable planets
- Best Method: Radial Velocity
- Best Candidate: Proxima Centauri B

Further Analysis

- Data imputation
- Understanding implications of instrumentation
- Adding habitability based on habitable zone per star



THANKS!

ANY QUESTIONS?