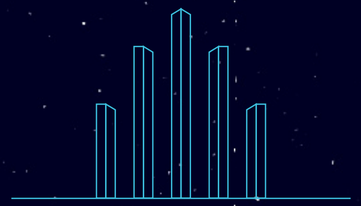
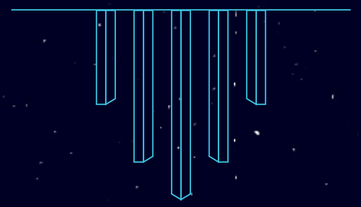
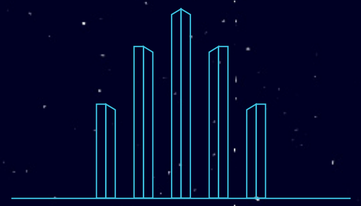


# STARSKOPE

Hunting for Exoplanets in Deep Space



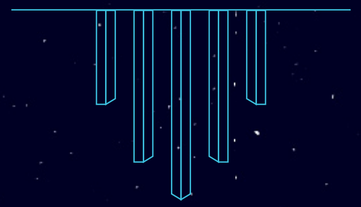


# CAPSTONE PROJECT

Flatiron School Datascience Bootcamp (Full-time)

Author: Ru Keïn

Date: April 7, 2020



# GLOSSARY

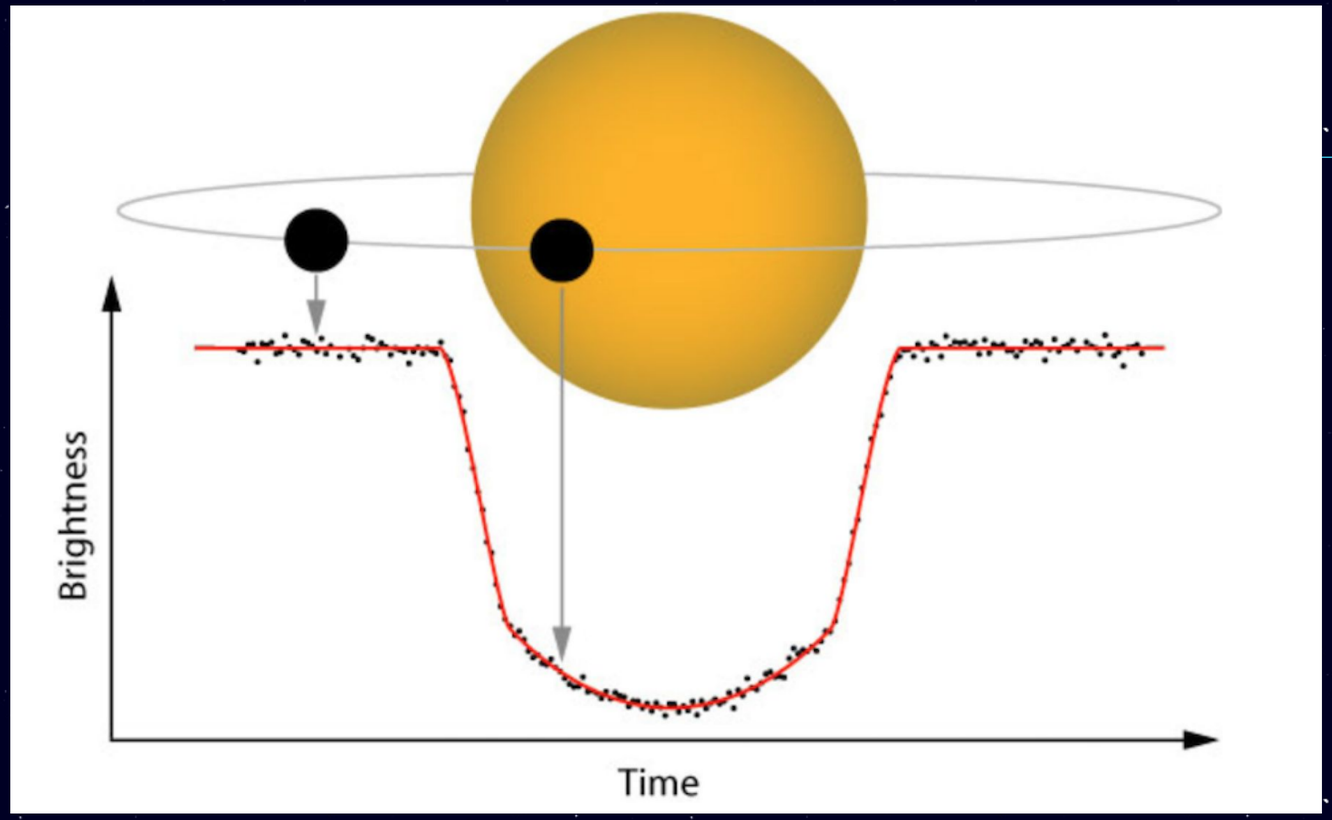



Image Credit: NASA

**EXOPLANET:**

planet outside of our solar system

**FLUX:**

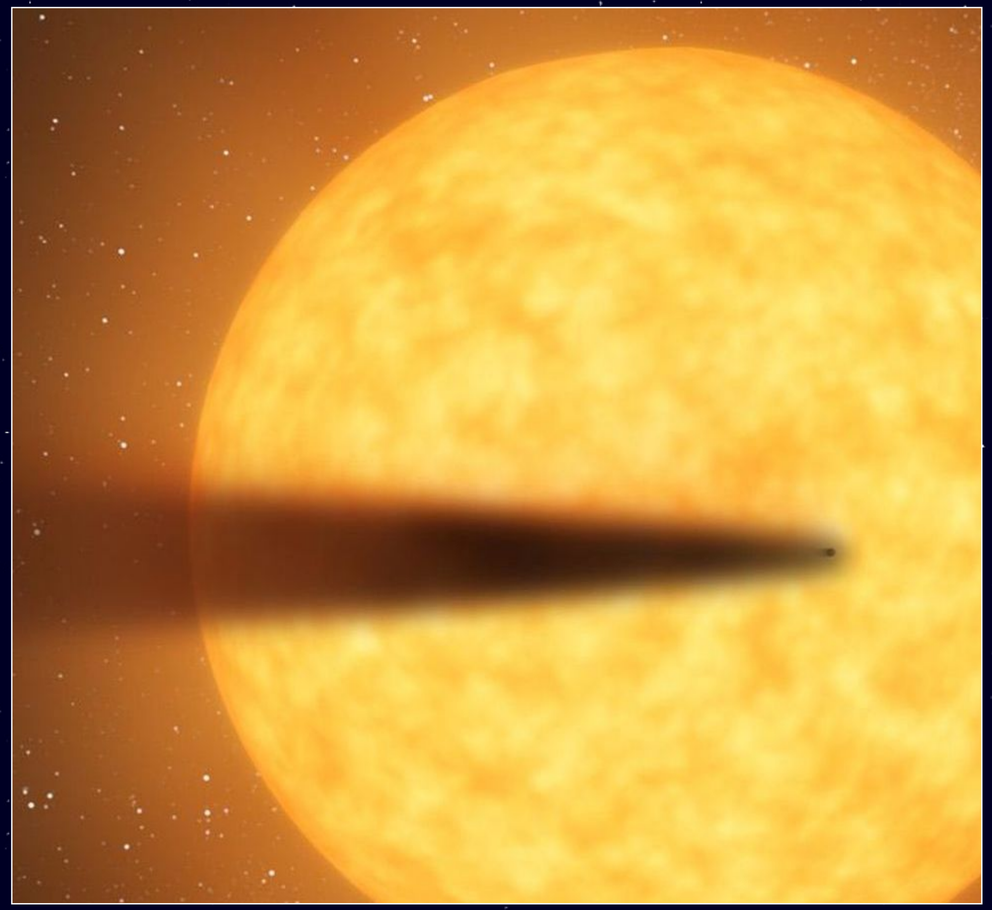
variation or change in light values (of stars)

**TCE:**

threshold crossing event (see image)

# DATASET

- The training data including 3,197 flux observations for 5,087 stars.
- The test data included 570 stars for testing the model.
- All data comes from the K2 (Kepler) space telescope (NASA)



National Aeronautics and Space Administration

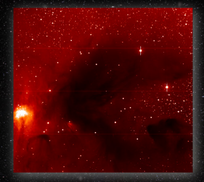
# K2 Science

CAMPAIGN 3

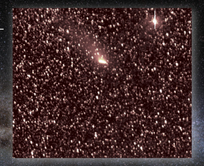
21 CONFIRMED EXOPLANETS
(including K2's first multiple planet system)

RHO OPHIUCHI CLOUD COMPLEX

PLEIADES
(Hubble image)



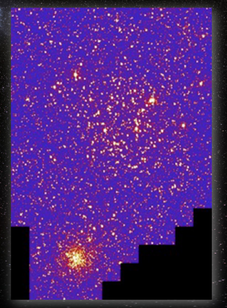
COMET SIDING SPRING FLYBY



ENGINEERING TEST:
K2'S 1ST EXOPLANET
DISCOVERY

PLUTO
WILL BE OBSERVED

NGC 2158 AND M35



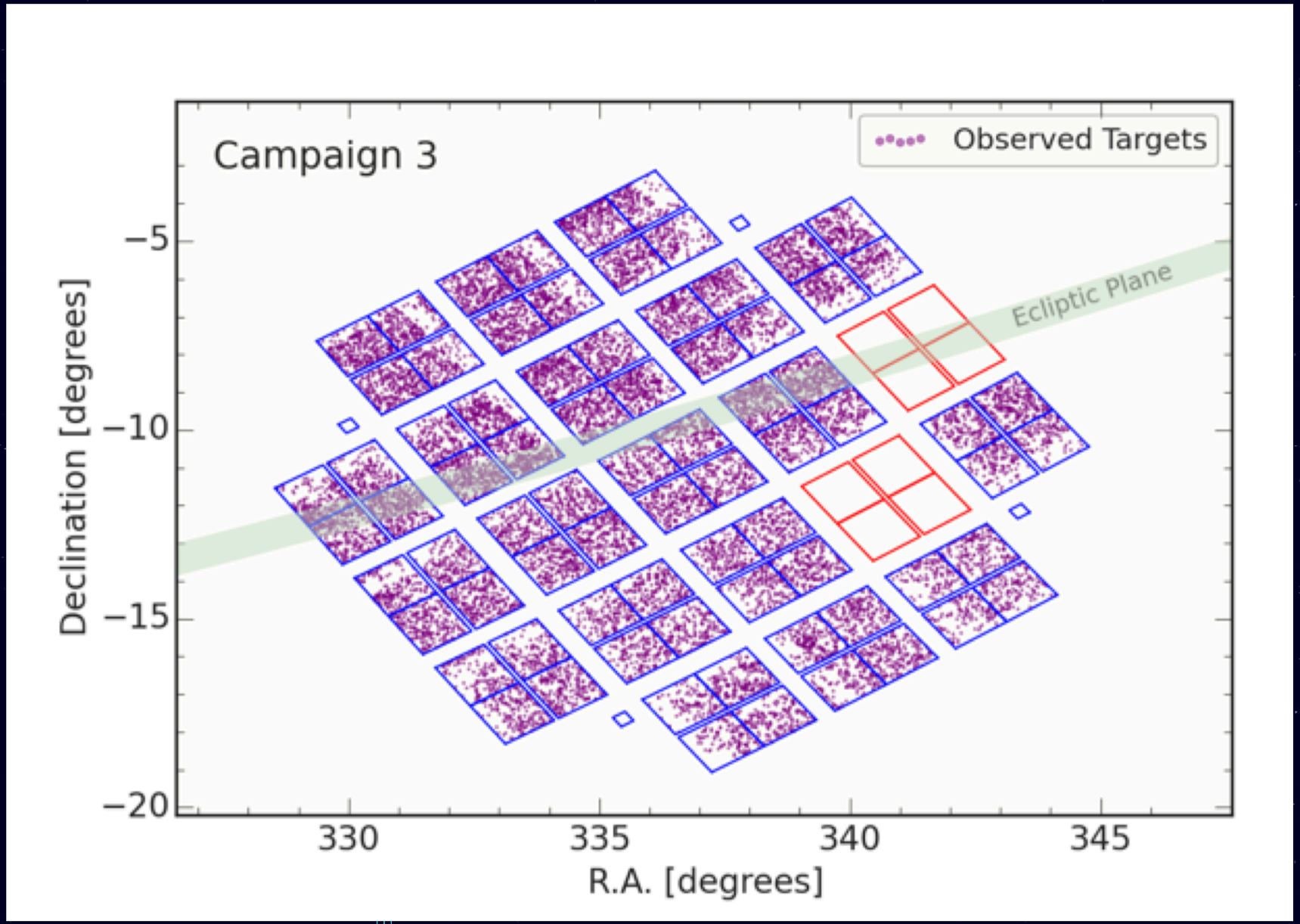
NEPTUNE'S MOON DANCE


www.nasa.gov

For more information, visit www.nasa

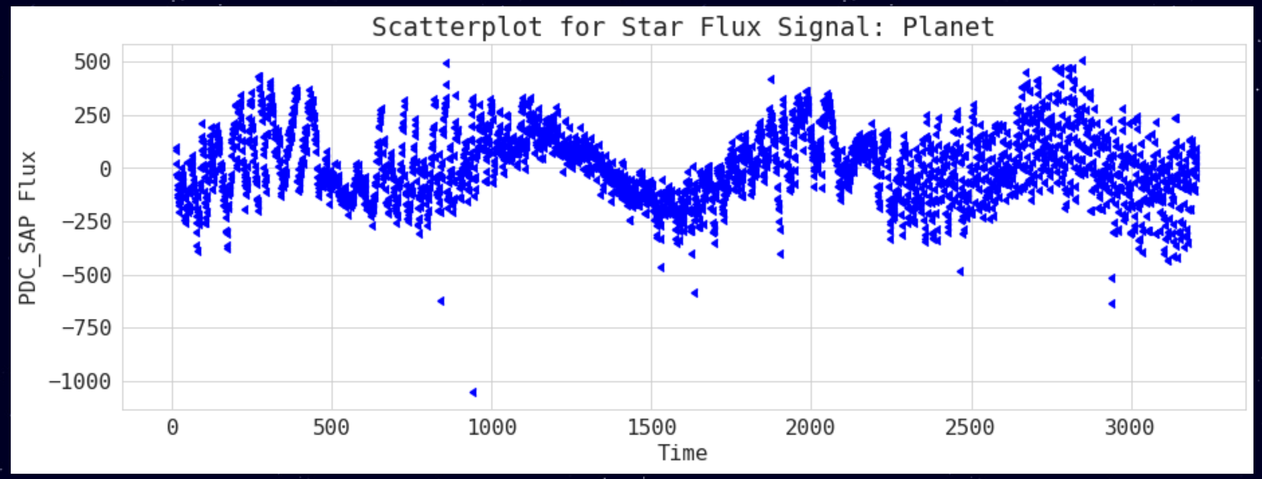
# K2

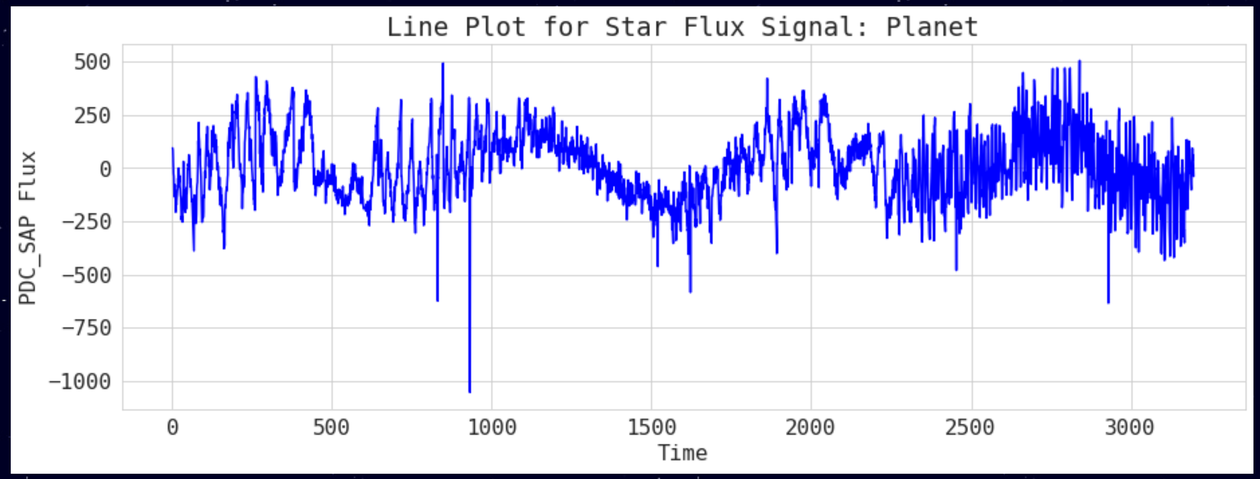
# KEPLER FIELD OF VIEW

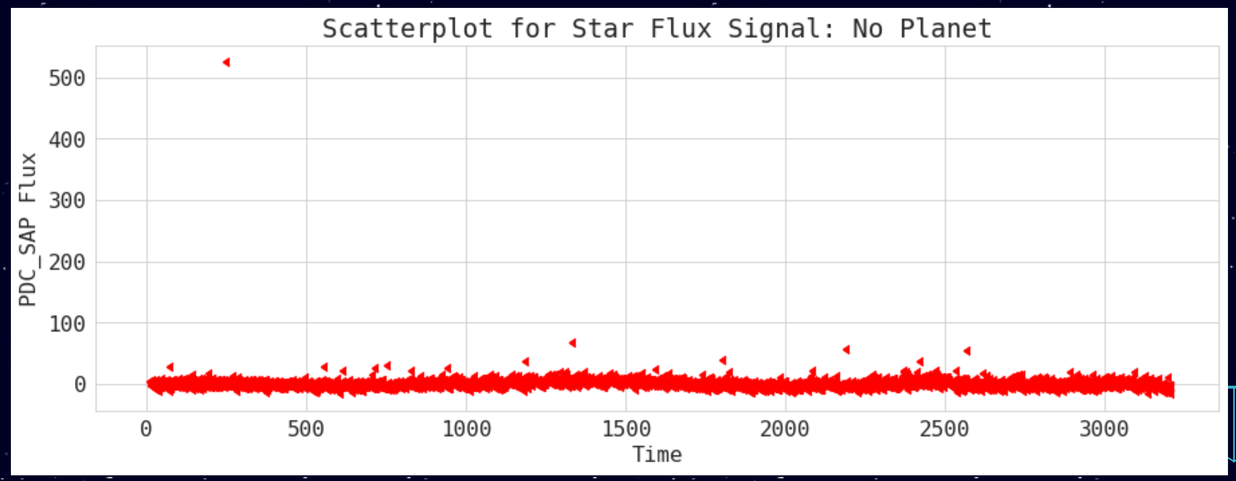


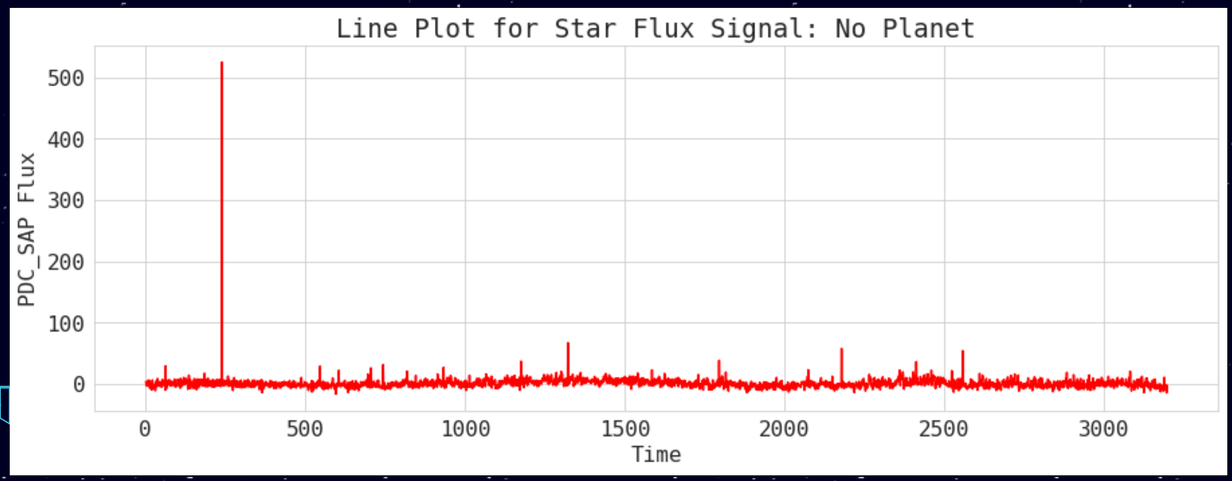
# OBJECTIVE

Looking for “dips” (periodicity) in the light flux of stars



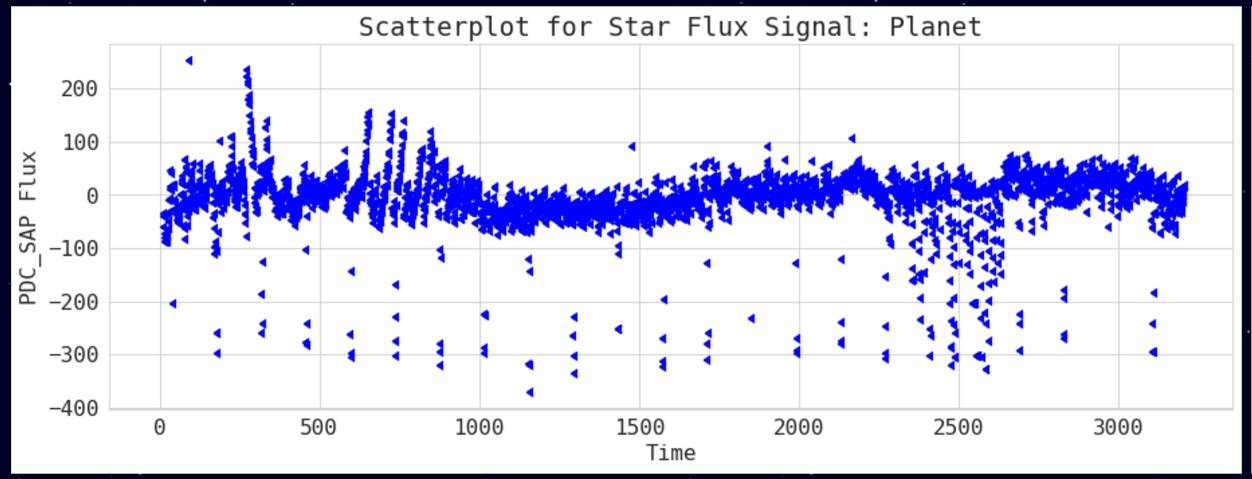



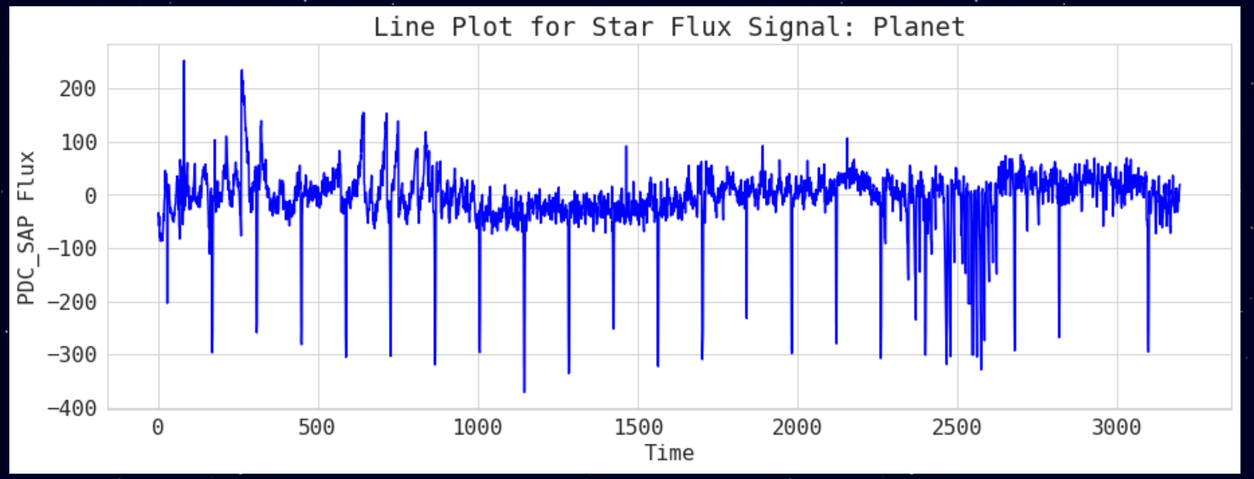



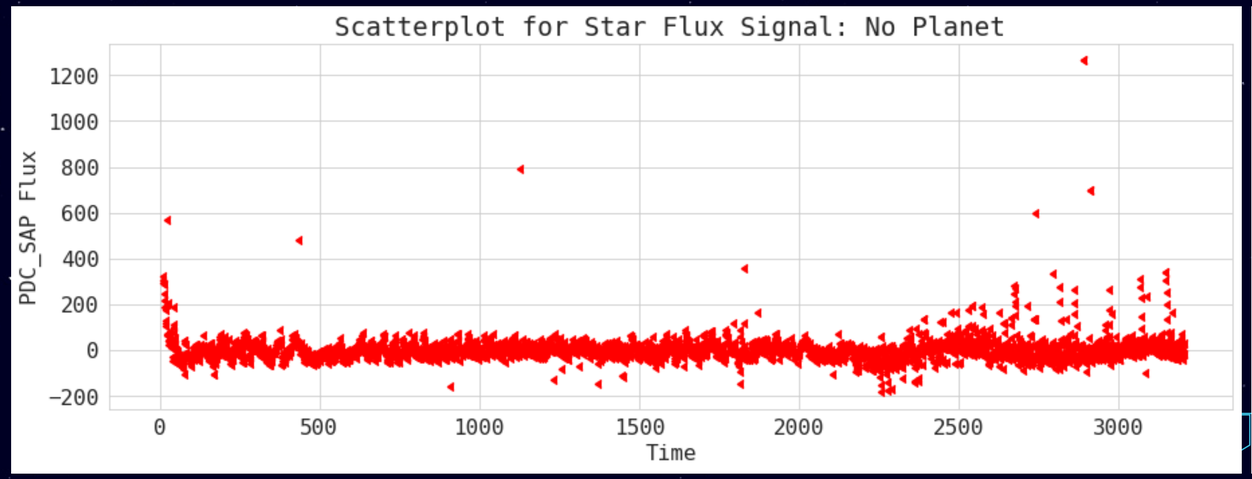



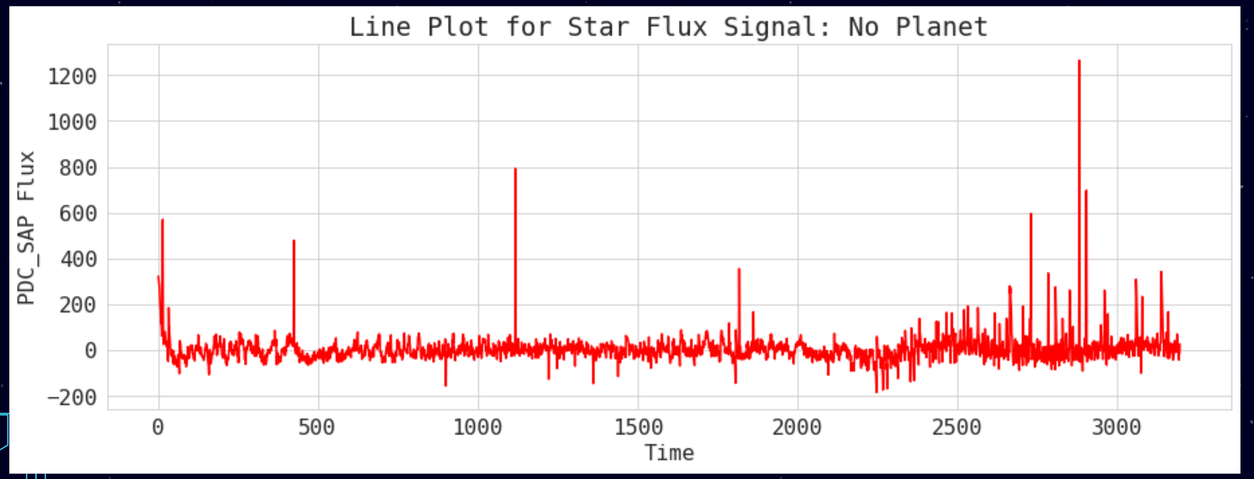
# OBJECTIVE

Looking for “dips” (periodicity) in the light flux of stars



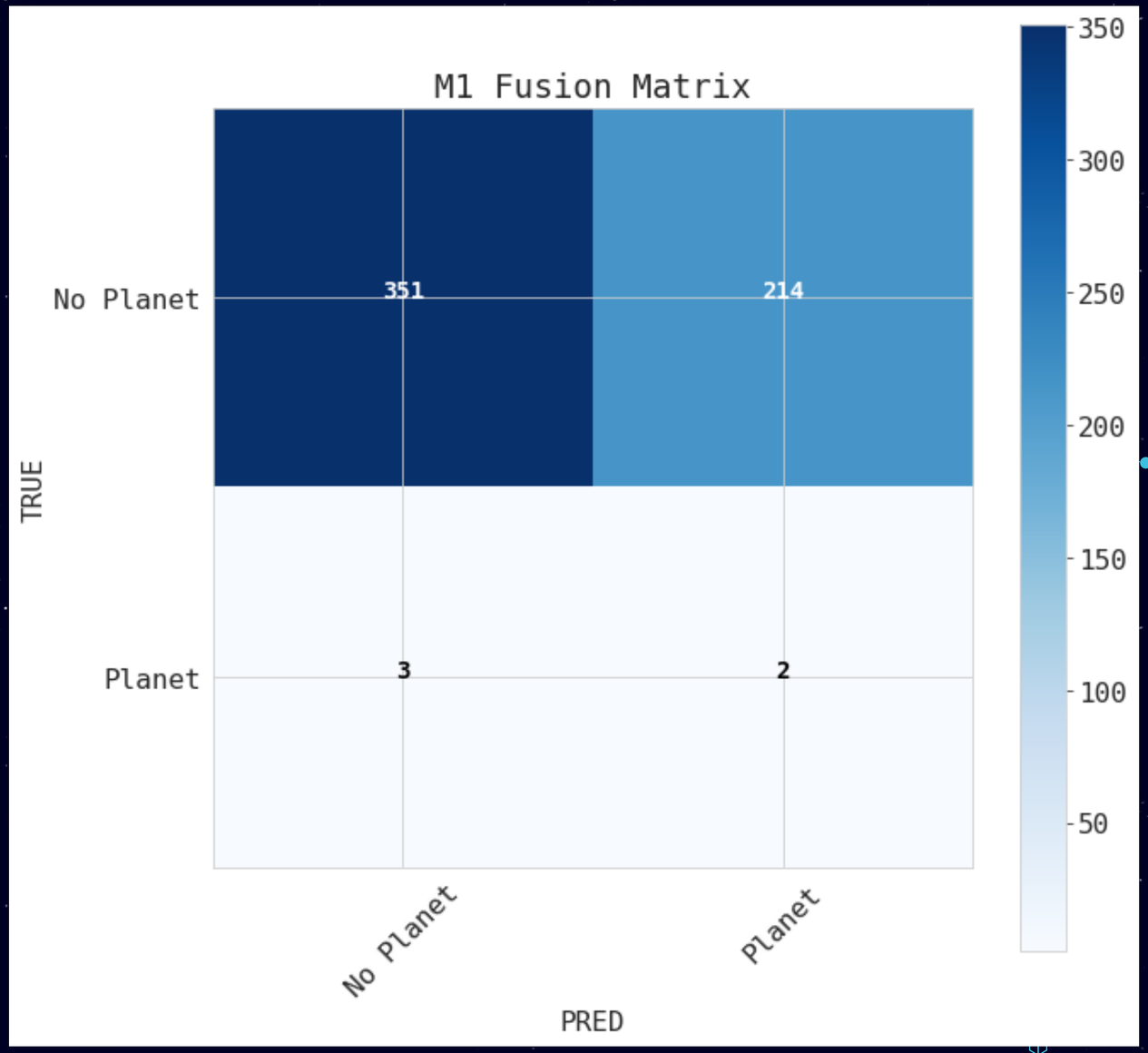



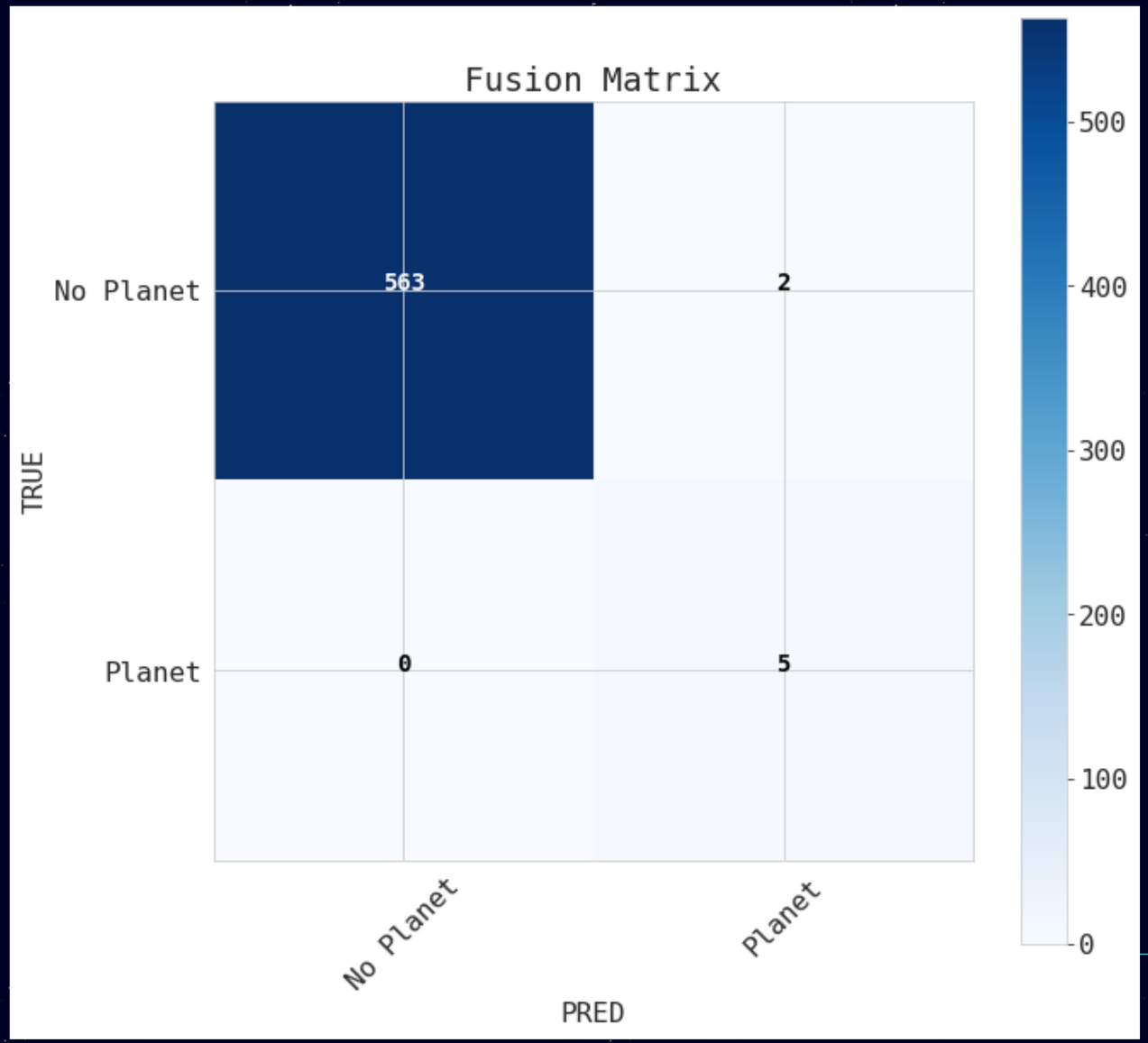
# MODEL

Training a Keras Neural Network




# FIND 5 PLANETS?

- Using a Neural Network machine learning algorithm, the goal was to correctly classify 5 stars as having exoplanets in their orbit.




# MODEL #2

- Out of 4 iterations, the best model classified all 5 planets correctly, with only 2 False Positives and ZERO false negatives.

# RESULTS

Accuracy: 0.9964

Recall: 1.0

---

Jaccard Similarity: 0.71

Fowlkes-Mallows: 0.9964

# RECOMMENDATIONS

#1

1. Use datasets from the MAST website (via API) to incorporate other calculations of the star's properties as features to be used for classification algorithms. Furthermore, attempt other types of transformations and normalizations on the data before running the model - for instance, apply a Fourier transform.

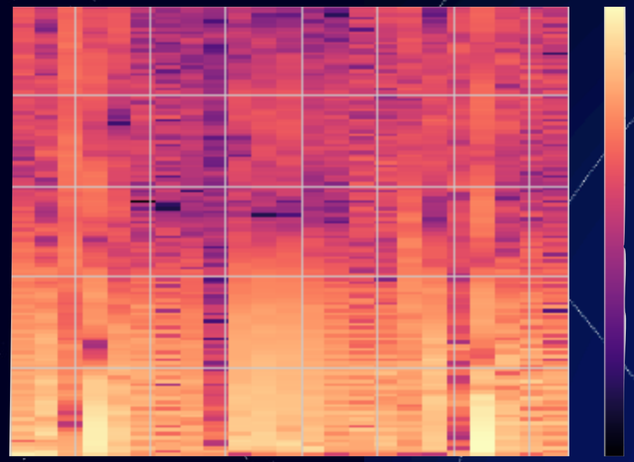
#2

2. Combine data from multiple campaigns and perhaps even multiple telescopes (for instance, matching sky coordinates and time intervals between K2, Kepler, and TESS for a batch of stars that have overlapping observations - this would be critical for finding transit periods that are longer than the campaigns of a single telecope's observation period).

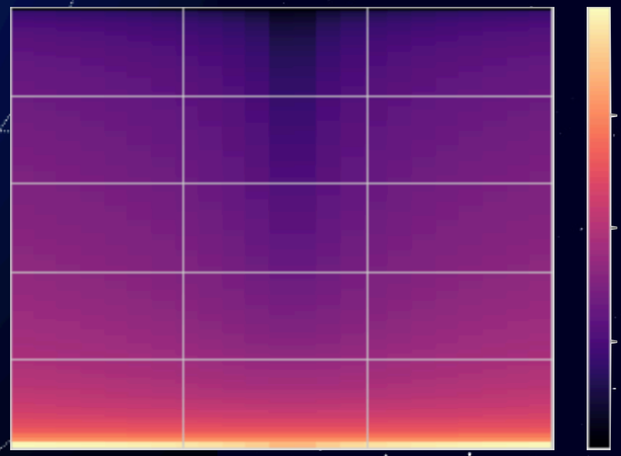
#3

3. Explore using computer vision on not only the Full Frame images we can collect from telescopes like TESS, but also on spectographs of the flux values themselves. The beauty of machine learning is our ability to rely on the computer to pick up very small nuances in differences that we ourselves cannot see with our own eyes.

#4



**FUTURE WORK** To continue this project, I'll take another approach for detecting exoplanets using computer vision to analyze images of spectographs of this same star flux data set. I will use a Restricted Boltzmann Machines neural network model to classify stars as exoplanet hosts using spectograph images of the flux values to find transiting exoplanets. Following this, I will apply the same algorithm to spectographs of Fourier transformed data.




# STARSKOPE

Additional future work following this project will be to develop my "cyberoptic artificial telescope" as a machine learning driven application that any astrophysicist can use to look at a single or collection of stars and have the model classify them according not only to exoplanet predictions, but also predict what type of star it is, and other key properties that would be of interest for astrophysical science applications.


Betelgeuse
Red supergiant star
Also known as α Ori 58 Ori α Ori HD 39801 HR
2061 SAO 113271 HIP 27989
Magnitude 0.50
Distance 497.95 light years
Spectral Type M1-M2Ia-Iab
Ra/Dec 05h 56m 14.9s +07° 24' 27.0"
Az/Alt 247° 32' 03.4" +41° 05' 15.2"
Visibility Rise: 12:52 Set: 01:36
Betelgeuse
137
133
134
μ
66
52 B
φ²
φ¹
λ
60
56
THANK YOU!!
Stars
22:12:34