The Role of Machine Learning in Exoplanet Classification

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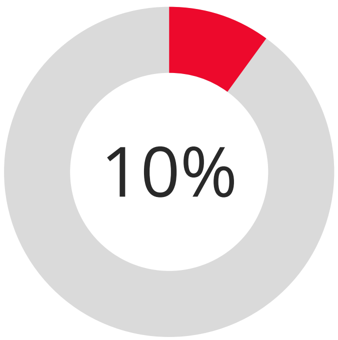
Introduction

As technology advances, the use of machine learning in the field of astronomy, particularly in the study of exoplanets, is becoming more prevalent. This guide provides insights into the fundamentals of exoplanets, and how machine learning is used in their classification.

In this project I trained and used multiple Machine Learning models to accurately classify confirmed Exoplanets vs False Positives based on the Brightness of a star over time. **The Transit Spectroscopy Method.**

Basic Fundamentals of Exoplanets



Of stars are estimated to have exoplanets in their orbits.

Exoplanets are planets outside our solar system. They orbit stars, vary in size and composition, and some may have potential for life.

The first discovery was in 1995

TRAPPIST-1 System: A star system with seven Earth-sized planets, three in the habitable zone.

Over 5,500 plantes confirmed since 1995

Machine Learning in Exoplanet Discoveries

Kepler Mission

Detecting Exoplanets

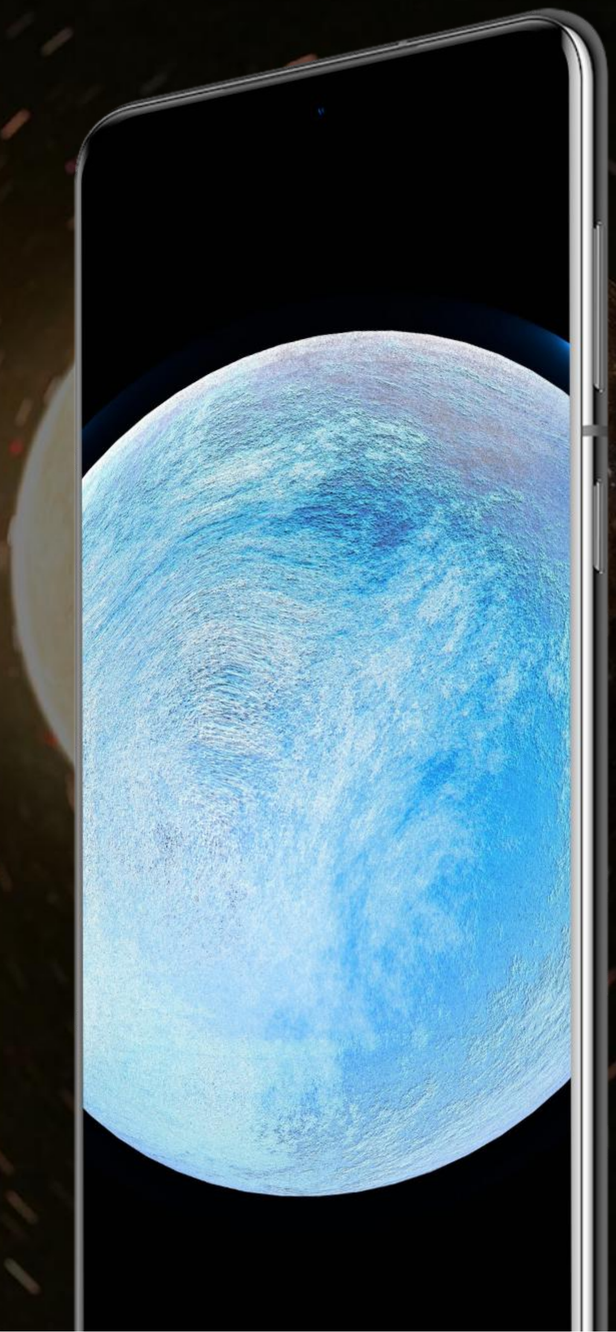
Machine Learning Algorithms

Categorizing Exoplanets

Challenges in Exoplanet Studies

Predicting Exoplanet Features

Determining the Habitability of Exoplanets



Machine Learning in Astronomy

Galaxy Classification

Exoplanet Verification

Machine Learning Algorithms for Exoplanet Classification

Stellar Clustering

Exoplanet Detection

Stellar and Exoplanet Parameterization

Exoplanet Classification and Methods

Transit Method: Observing the dimming of a star as a planet passes in front of it, blocking some of the starlight.

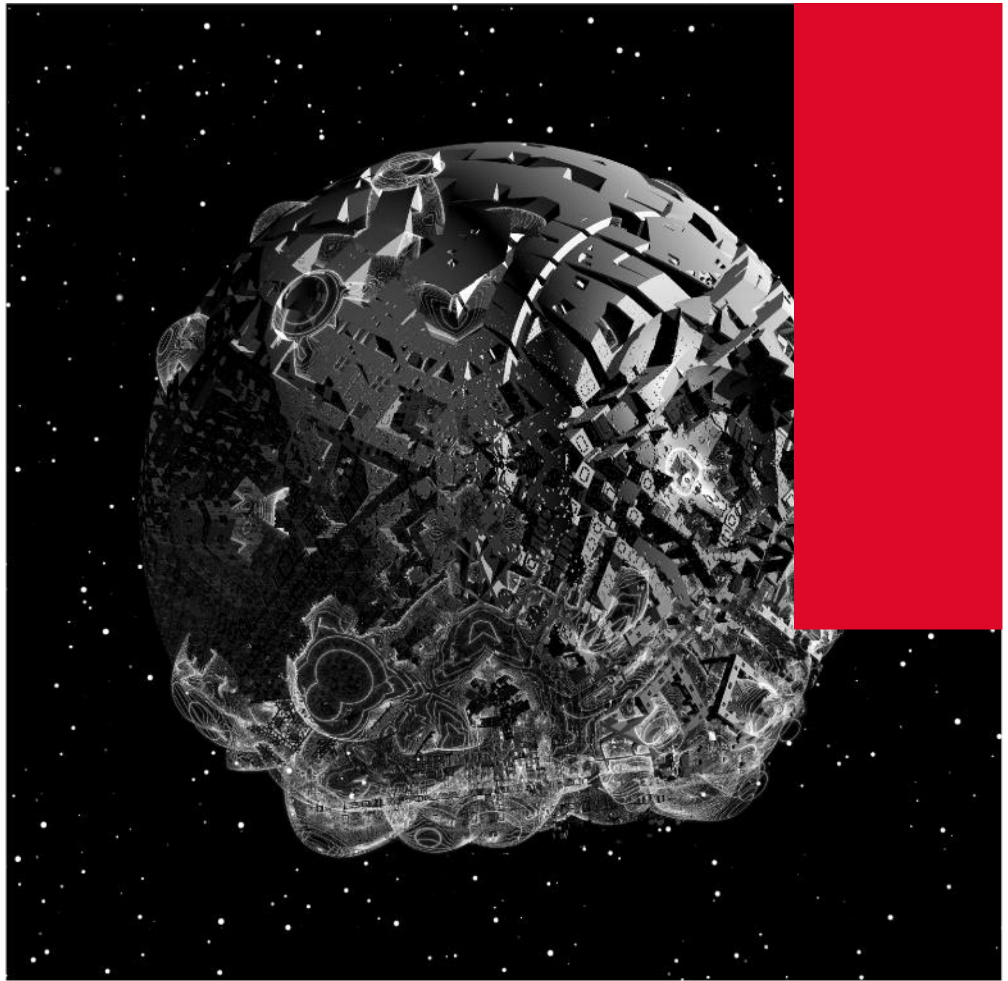
Radial Velocity (Doppler Spectroscopy) Measuring the wobble of a star due to the gravitational pull of an orbiting planet, causing shifts in the star's spectral lines.

Astrometry: Measuring precise changes in a star's position in the sky to detect gravitational influences of orbiting planets.

Direct Imaging Taking pictures of planets by blocking out the star's light,

Gravitational Microlensing: Observing the bending of light from a distant star due to the gravitational field of a planet's star system.

Role of Machine Learning in Exoplanet Studies



This research field focuses on the development and use of ML techniques for the study and understanding of exoplanets.

Kepler Mission

Tess Mission

The Data: Kepler Objects of Interest

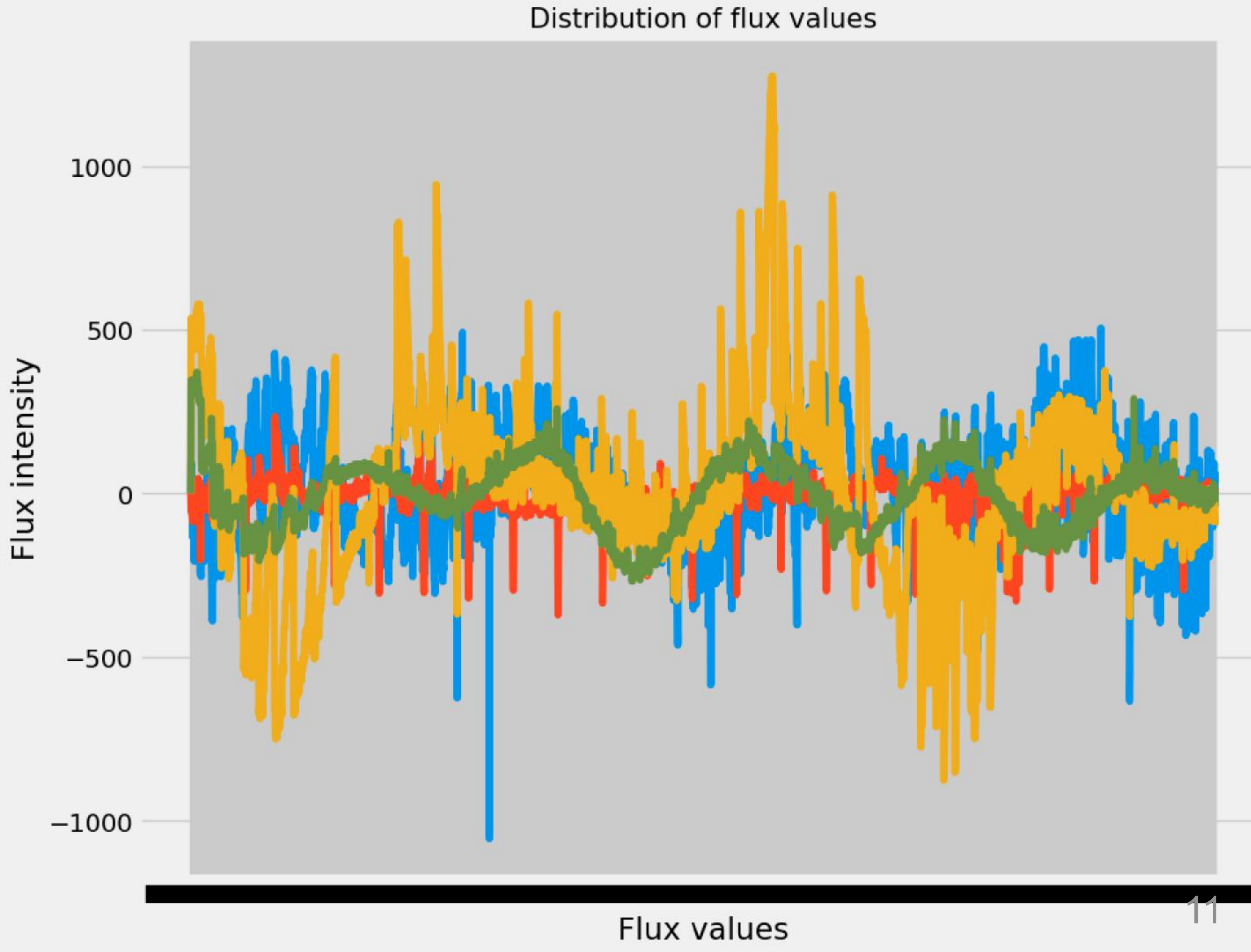
I worked with 2 Datasets with one of those being split in 2. One Dataset focused on the Kepler object of Interest with various values and the other focused primarily on FLUX and its suitability with the Transit Method.

I then trained multiple models on these separate datasets and compared results.

What is Flux?

FLUX is the amount of energy from a luminous object that reaches a given surface or location.

If we have a light detector (eye, camera, telescope) we can measure the light produced. by the star


Distribution of flux values
1000
500
0
−500
−1000
Flux intensity
Flux values

```
Validation accuracy of Decision Tree is 0.9312931293129313

Classification report :
              precision    recall  f1-score   support

           0       0.97      0.89      0.93      1709
           1       0.89      0.97      0.93      1624

    accuracy                           0.93      3333
   macro avg       0.93      0.93      0.93      3333
weighted avg       0.93      0.93      0.93      3333


Text(0.5, 1.0, 'ROC - CURVE & AREA UNDER CURVE')
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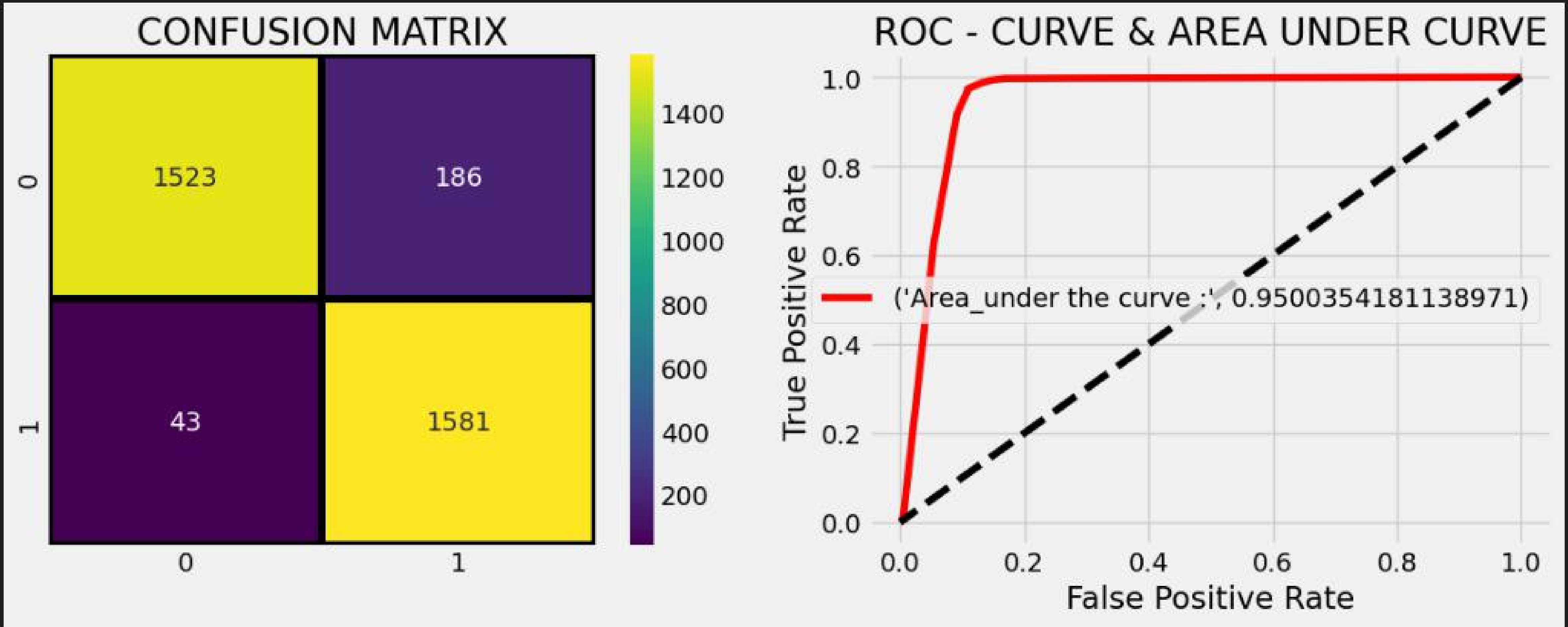

Conclusion

The methods that exist currently work very well to classify exoplanets but what can we do to detect more of them?

As Machine Learning capabilities and AI improves then surely the speed at which we can correctly identify and discover new exoplanets increases which can bring us further to understanding the universe we are a part of.

The Future of Exoplanet Research and Machine Learning

With rapid advancements in technology, the future of exoplanet research and the utilization of ML in its studies is very promising.