AstroScope – Interactive Exoplanet Detection Platform

NASA Space Apps Challenge 2025

Celestial V

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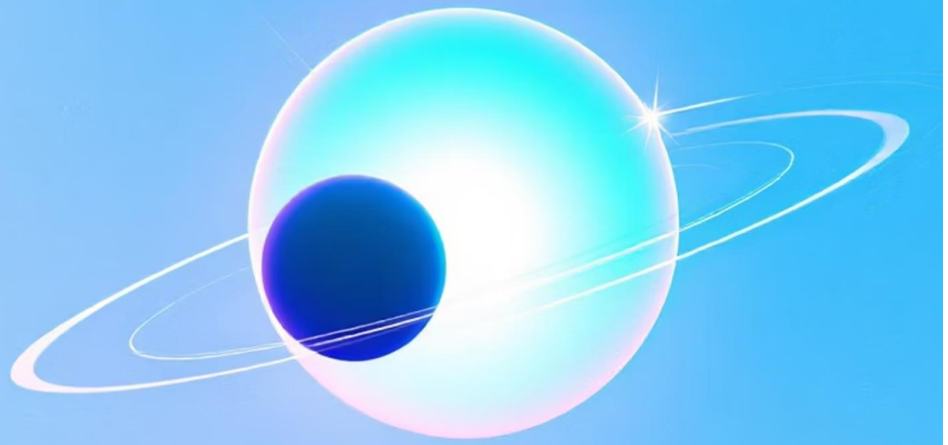
NASA Space Apps Challenge 2025

> **AstroScope is a comprehensive platform for exploring, analyzing, and accurately predicting exoplanets using advanced machine learning and interactive visualization techniques.**



The Challenge: Navigating Astronomical Data

Data Deluge

Modern astronomical missions like Kepler and TESS generate millions of high-resolution observations annually, surpassing manual analysis capacity.

Signal vs. Noise

Identifying genuine exoplanet transit signatures is extremely challenging due to high noise levels, instrumental errors, and common stellar false positives.

The AstroScope Solution

We combine robust machine learning models, predictive accuracy, and user-friendly data visualization to deliver accurate, confirmed exoplanet detection.

Core Technology Stack

Python Ecosystem

- **Pandas, NumPy for high-performance data manipulation.**
- **Scikit-learn for robust ML model construction.**
- **Matplotlib/Seaborn for exploratory data analysis.**

Machine Learning Engine

A high-performing Random Forest Classifier is employed, combined with Permutation Feature Importance for model interpretability.

Interactive Dashboard

Streamlit provides the framework for a fast, responsive, and interactive web application for data exploration and prediction visualization.

Leveraging the Kepler Exoplanet Candidate Data

Our predictive model is trained and validated using a subset of the official NASA Kepler Exoplanet Candidate Dataset, comprising approximately 8,000–10,000 distinct candidates.

- Target Variable: Confirmed Exoplanet (Binary: 0/1)
- Key Numeric Features: Orbital Period, Transit Time, Kepler Magnitude.
- Key Boolean Flags: Not Transit-Like Event, Stellar Eclipse, Centroid Offset, Ephemeris Contamination.

Feature engineering and interpretation of these specialized. astronomical indicators are crucial for maximizing model accuracy and reducing false positives

Methodology: From Data to Prediction

Data Processing

Model Training

Evaluation & Visualization

Deployment

Data Preprocessing

Normalization of all numeric features and handling of missing values to ensure model stability and optimal performance.

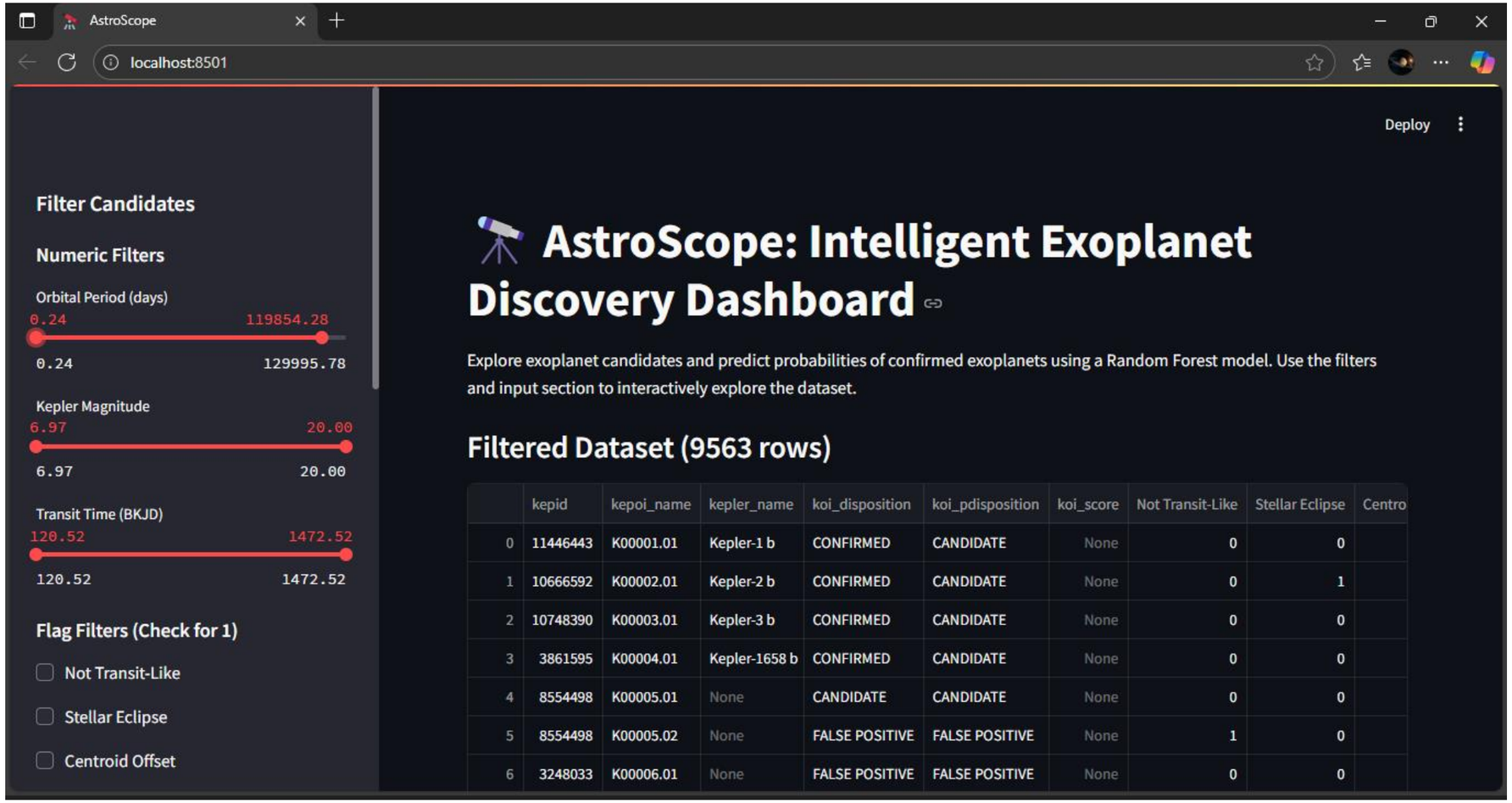
Model Evaluation

Rigorous evaluation using metrics like AUC, precision, and recall; feature importance visualization for model validation.

Classifier Training

Training the Random Forest model using stratified splitting and class weighting to handle the inherent imbalance in confirmed exoplanet data.

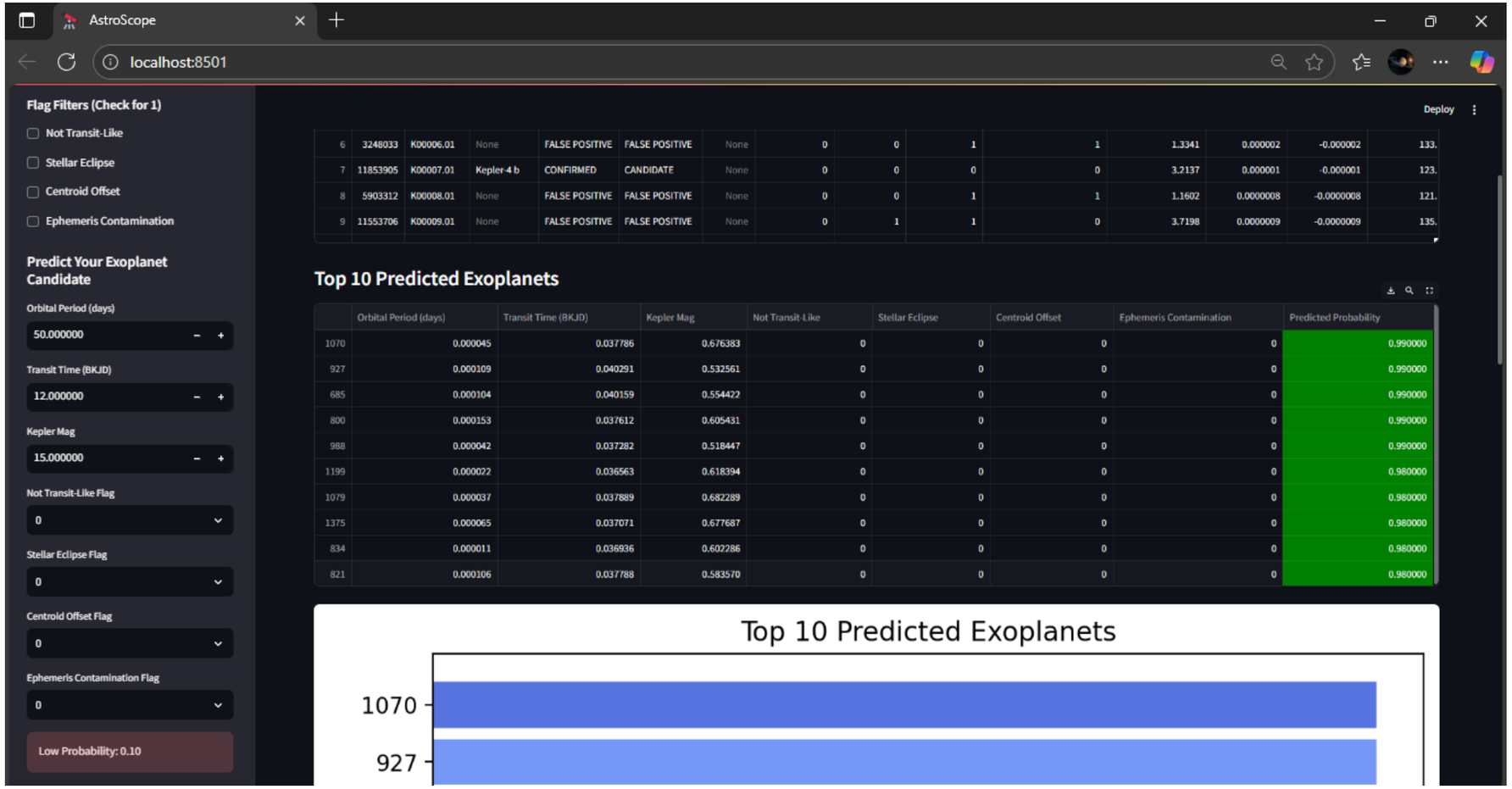
Interactive Detection Dashboard



	kepid	kepoi_name	kepler_name	koi_disposition	koi_pdisposition	koi_score	Not Transit-Like	Stellar Eclipse	Centro
0	11446443	K00001.01	Kepler-1 b	CONFIRMED	CANDIDATE	None	0	0	
1	10666592	K00002.01	Kepler-2 b	CONFIRMED	CANDIDATE	None	0	1	
2	10748390	K00003.01	Kepler-3 b	CONFIRMED	CANDIDATE	None	0	0	
3	3861595	K00004.01	Kepler-1658 b	CONFIRMED	CANDIDATE	None	0	0	
4	8554498	K00005.01	None	CANDIDATE	CANDIDATE	None	0	0	
5	8554498	K00005.02	None	FALSE POSITIVE	FALSE POSITIVE	None	1	0	
6	3248033	K00006.01	None	FALSE POSITIVE	FALSE POSITIVE	None	0	0	

The Streamlit application allows users—from researchers to students—to dynamically analyze model predictions, explore feature distributions, and gain insight into the detection process.

Interactive Detection Dashboard



Users can upload new transit data or select a candidate from the existing catalog to receive instant, interpretable exoplanet predictions.

Impact & Future Trajectory

Reliable Predictions

AstroScope provides accurate and interpretable predictions, significantly streamlining the initial screening phase for exoplanet candidates.

Education & Outreach

The interactive nature makes complex data science and astrophysics accessible for educational purposes and broader public engagement.

Scalable Research

By automating the detection process, AstroScope enables researchers to focus their valuable time on novel discoveries rather than manual triage.

Future Enhancements

Advanced ML Models

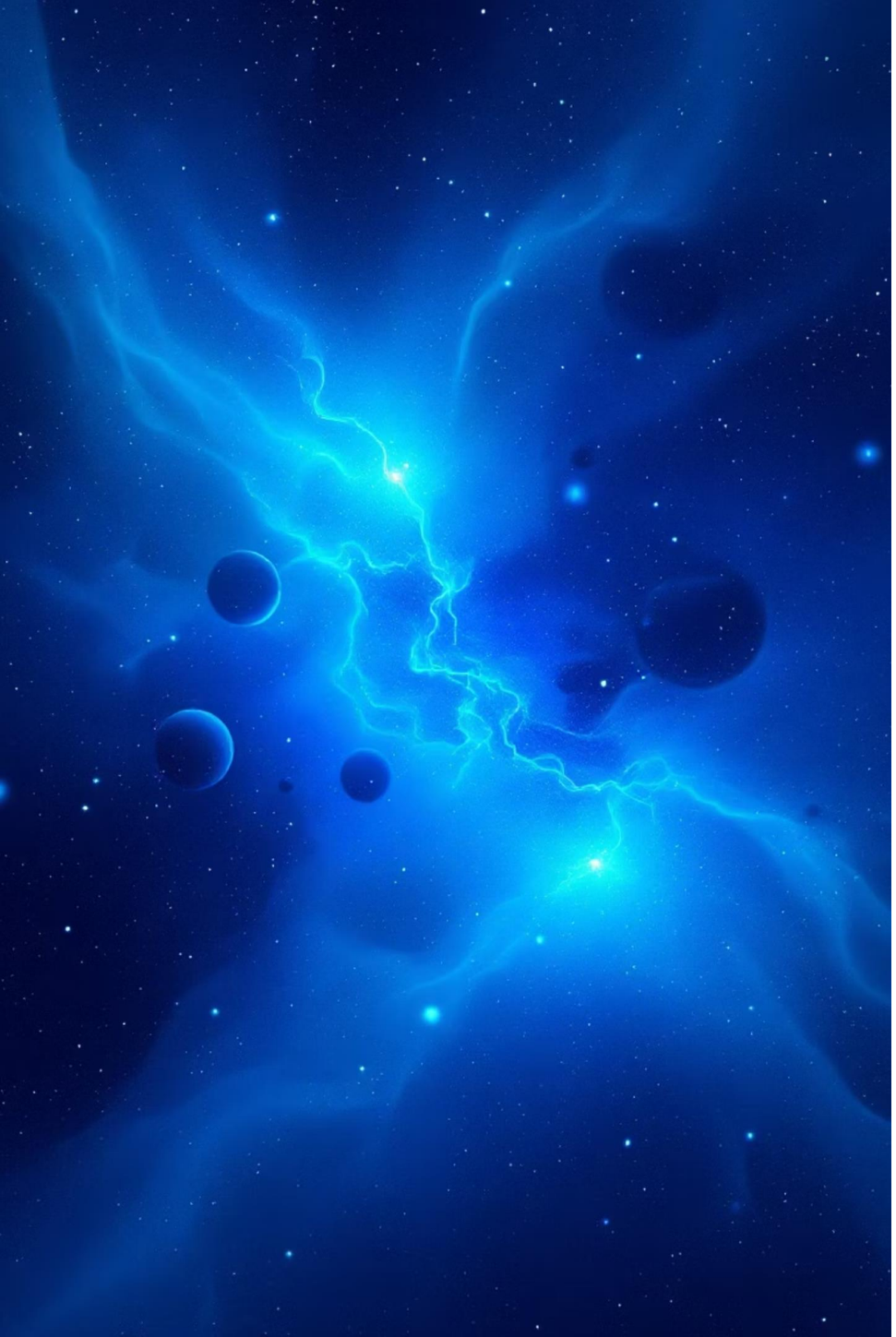
Integration of Gradient Boosting or sophisticated Neural Network architectures to further enhance prediction accuracy.

Cloud Deployment

Full cloud hosting to ensure global, 24/7 accessibility and real-time processing capabilities for new data streams.

Enhanced Visualizations

Development of advanced visual elements, including 3D orbital simulations and feature heatmaps.



Thank You

The Celestial Voyagers Team appreciates your time and consideration.

AstroScope – Mapping the Cosmos, One Exoplanet at a Time.