AI-Powered Exoplanet Detection: From Data to Discovery

NASA Global Challenge 2025

A World Away: Hunting for Exoplanets with AI

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The Challenge: Finding Exoplanets in the Cosmic Noise

Subtle Signals, Vast Data

Detecting tiny dips in starlight caused by transiting exoplanets requires advanced pattern recognition amidst immense cosmic noise.

Decades of Observation

Missions like Kepler, K2, and TESS have provided nearly a decade of invaluable data, creating publicly available datasets ripe for analysis.

The Promise of Automation

Promising research shows that automated analysis, with careful data preprocessing and model selection, can achieve high-accuracy exoplanet identification.

Our Solution: A Machine Learning Model for Exoplanet Classification

Advanced ML Techniques

Our model leverages the power of Multi-Layer Perceptrons (MLP) and Neural Networks for robust classification.

Kepler Object of Interest (KOI) Data

We trained our model on the comprehensive Kepler Object of Interest (KOI) dataset, a gold standard for exoplanet research.

Rich Feature Set

The dataset includes critical variables such as orbital period, transit duration, planetary radius, and many more, crucial for accurate identification.

Training Highlights: Refining Our Model for Precision

Data Cleansing

Basic ML techniques were employed to meticulously clean and prepare the dataset, ensuring optimal input for the model.

Label Encoding

The target variable underwent Label Encoding, transforming categorical labels into a numerical format suitable for machine learning algorithms.

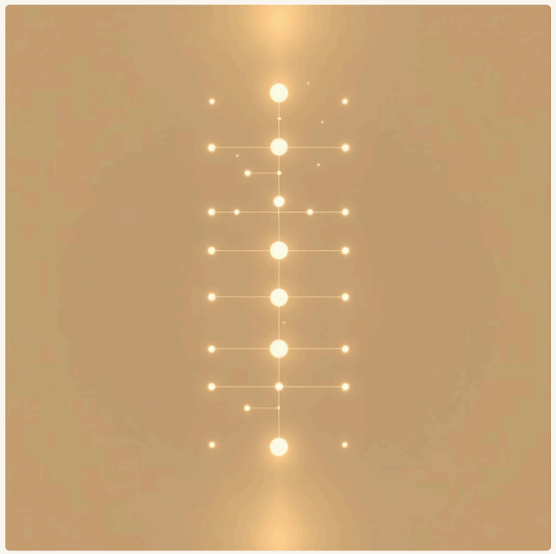
Validation & Optimization

We implemented Cross-Validation and Grid Search to systematically tune hyperparameters and achieve the best possible performance and generalization.

Model Architecture: Building the Brain for Discovery

Multi-Layer Perceptron (MLP)

Our MLP design features a simple yet effective structure with two hidden layers, enabling efficient learning of complex patterns in the data.

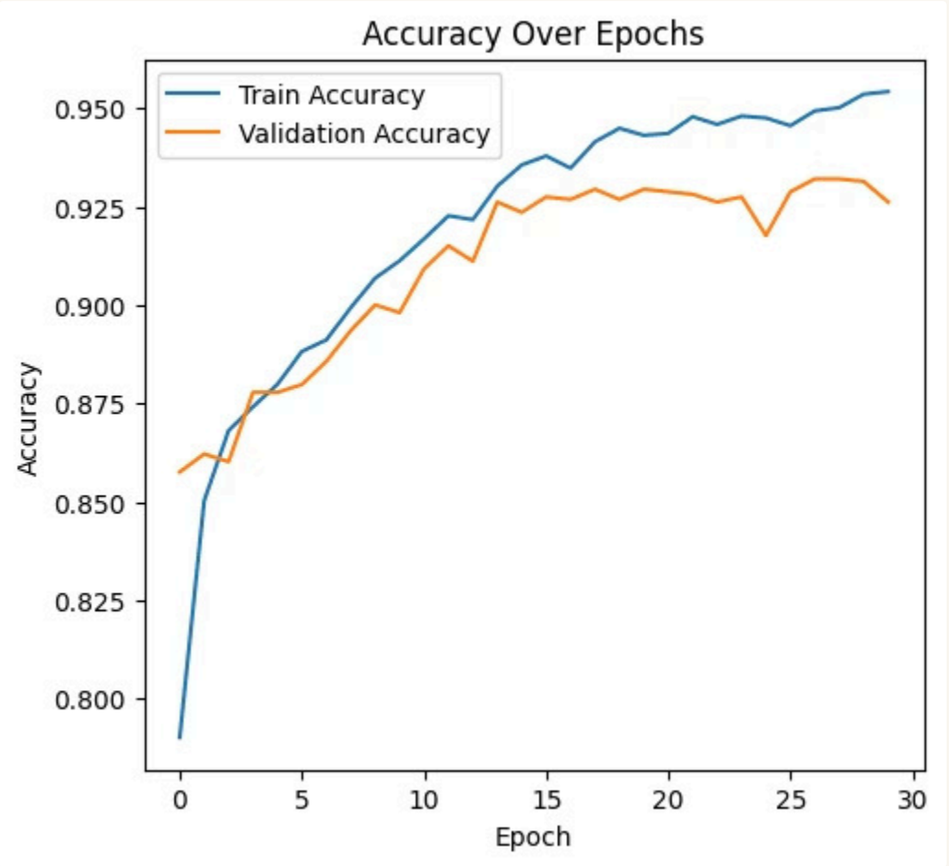


Tensor Neural Network

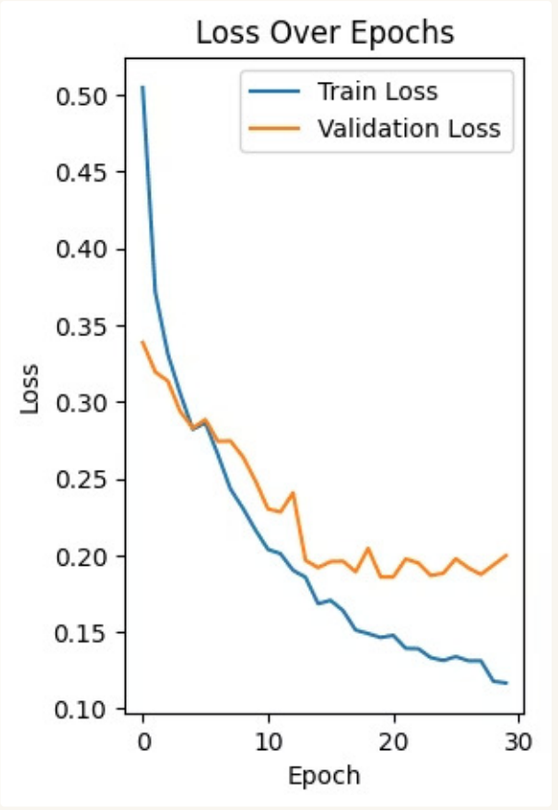
For enhanced accuracy, we incorporated a Tensor Neural Network with multiple dense and dropout layers, capable of handling intricate data relationships.

Model Metrics: Quantifying Our Success

Accuracy Over Epochs



Loss Over Epochs



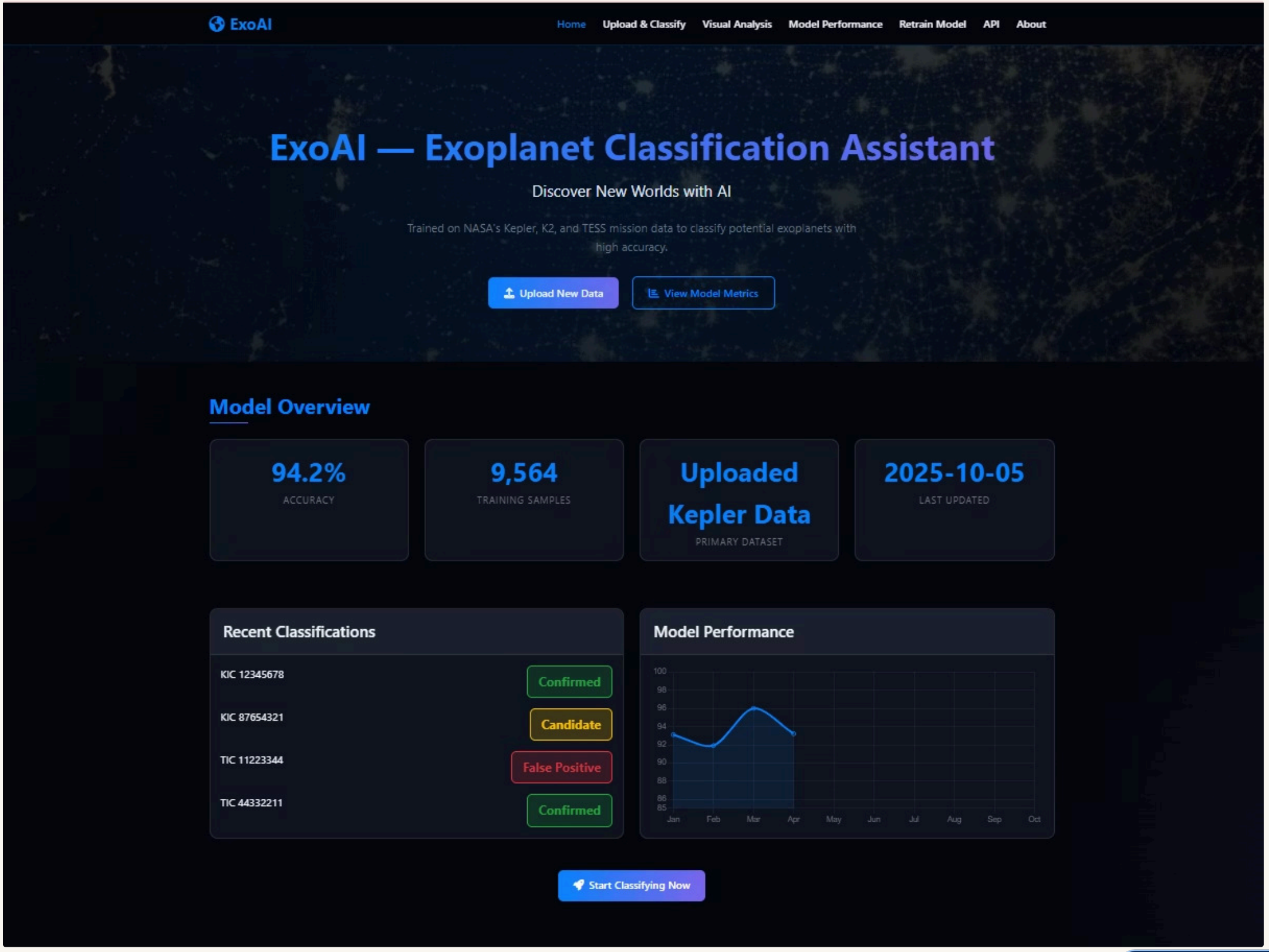
MLP Accuracy

After rigorous cross-validation (cv=5), our Multi-Layer Perceptron model achieved an average accuracy of **0.90**.

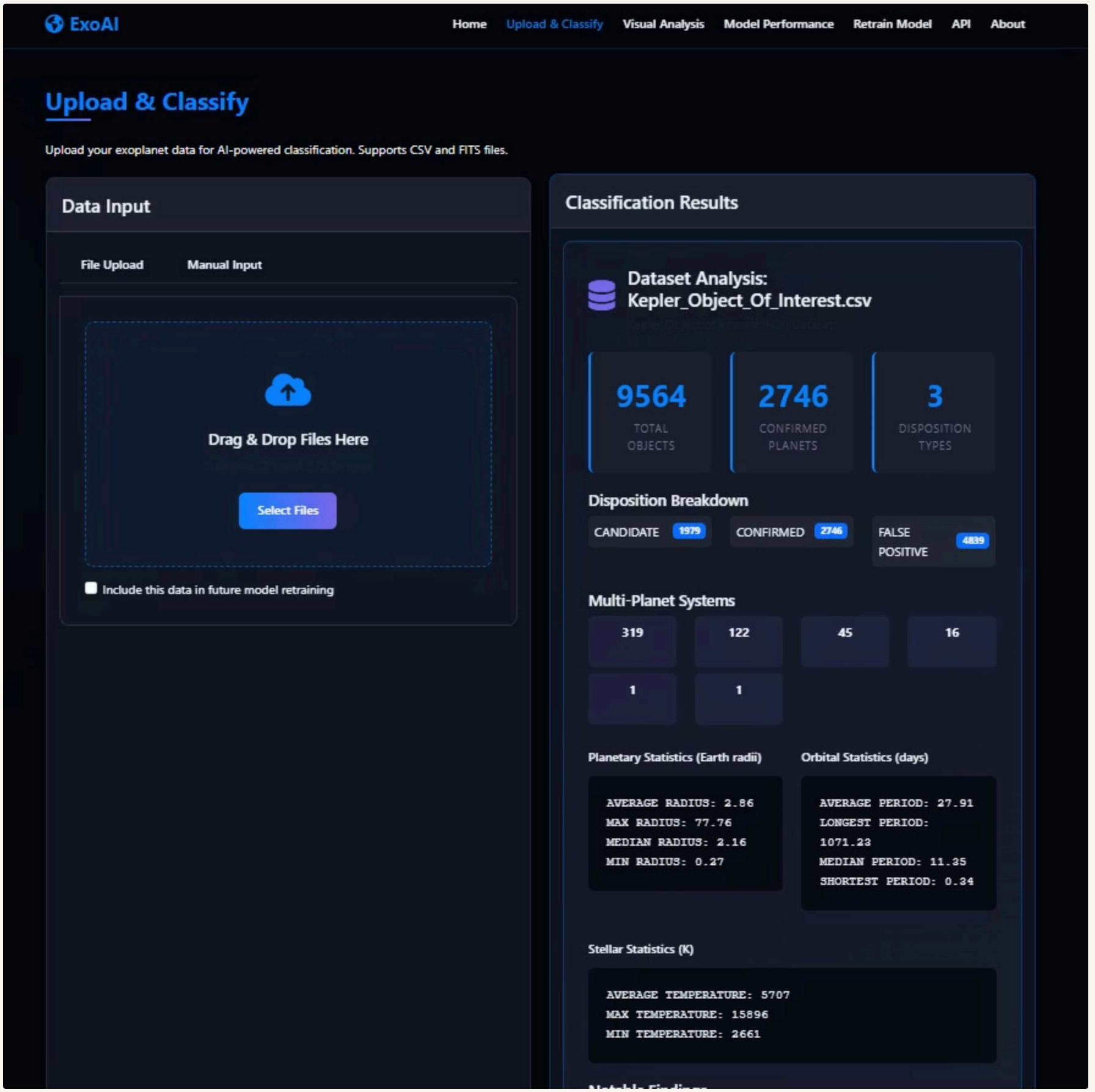
Tensor Neural Net Accuracy

The Tensor Neural Network further elevated performance, reaching an accuracy of **0.93**.

Web Interface Demo



Upload & Classify Interface



The Upload & Classify interface shows the data input section and the classification results panel.

Interactive Web Interface: Empowering Exploration and Improvement

Upload Your Data

Seamlessly integrate your own datasets in CSV format for personalized analysis and model retraining.

Visualize Metrics

Gain deep insights with interactive visualizations of accuracy, recall, precision, confusion matrices, and ROC curves.

Retrain & Refine

Empower yourself to retrain the model with your labeled data, continually improving its performance on new or specialized datasets.

Tweak Hyperparameters

Fine-tune model behavior by adjusting learning rate, batch size, and number of epochs through intuitive controls.

Real-World Impact: Accelerating Exoplanet Discovery

Rapid Candidate Screening

Our model slashes computation time from weeks to minutes, enabling rapid screening of potential exoplanet candidates.

Optimized Telescope Usage

By prioritizing observation targets, we save invaluable and costly telescope time, maximizing research efficiency.

Predictive Discovery

The model supports the discovery of new planets by predicting system architectures even from partial data.

Democratizing Research

We empower citizen scientists and researchers to contribute data and insights, fostering a collaborative exoplanet research community.