

# Project Exoplanet Explorer

Discover Worlds Beyond Our Solar System



An interactive web application making NASA exoplanet data and machine learning concepts intuitive and accessible through 3D visualizations and comprehensive model comparisons.



AI-Driven



3D Visualization



Interactive



Educational

# The Challenge

## NASA Space Apps 2025

"A World Away: Hunting for Exoplanets with AI"

### Challenge Goal

Develop an AI/ML model trained on NASA's open exoplanet data to identify new planets

### Data Source

Extensive exoplanet data from NASA's Kepler mission

### Focus Areas

Advanced algorithms to analyze transit signals and classify potential exoplanets

## Our Focus

While meeting the core requirements of the NASA challenge, we uniquely focused on making the exoplanet discovery process both understandable and interactive for a broad audience.

### AI Transparency

Transform complex ML outputs into visual experiences

### Broad Audience

Make science accessible beyond technical experts

### Interactive Learning

Enable hands-on exploration of exoplanet data

### Educational Bridge

Connect data science with space education

# What We Built

Exoplanet Explorer is an interactive web application that combines NASA data with advanced machine learning to make exoplanet discovery accessible and engaging.

## Technical Architecture

 **Backend:** Python for ML, Flask for web framework

 **Data Integration:** KOI database, LightKurve API

## Machine Learning Models

Gradient Boosting

Random Forest

XGBoost

LightGBM

## Visualization Capabilities

 **3D Orbit Visualization:** Using Matplotlib and Plotly

 **Light Curve:** Real data from PDCSAP API

## Example: Kepler-227



Featured system shows a Neptune-like planet orbiting a G-type star, illustrating our visualization capabilities.

# Interactive Dashboard

## Exoplanet Data Explorer

**1,248**  
Total Records

**42**  
Data Columns

**15**  
Features

Filter Sort

Feature 2

Feature 1

Model Predictions Data Table

Theme: Dark

### AI Model Predictions

Displays predictions from trained models for each exoplanet system, enabling users to compare different AI classifications.

### Filtering & Sorting

Filter and sort data based on various criteria, including different AI models and actual NASA classifications.

### Data Metrics Tracking

Provides an overview of the dataset by tracking total records, data columns, and features.

### Purpose

Gives researchers and enthusiasts a hands-on way to explore NASA's exoplanet datasets visually.

# NASA Data Integration

## Direct Database Integration

The Exoplanet Explorer seamlessly integrates real exoplanet data directly from NASA's extensive databases, ensuring users interact with authentic and up-to-date information.

- ✓ Direct connection to NASA's Kepler Objects of Interest (KOI) database
- ✓ Live updates as new exoplanet discoveries are added to NASA databases
- ✓ Comprehensive dataset covering multiple confirmed exoplanets

## Visual Interface

The visual interface presents crucial planetary details, allowing users to explore and understand exoplanet characteristics.

### Planet Type

Shows classification (e.g., Earth-like, Neptune-like)

### Distance

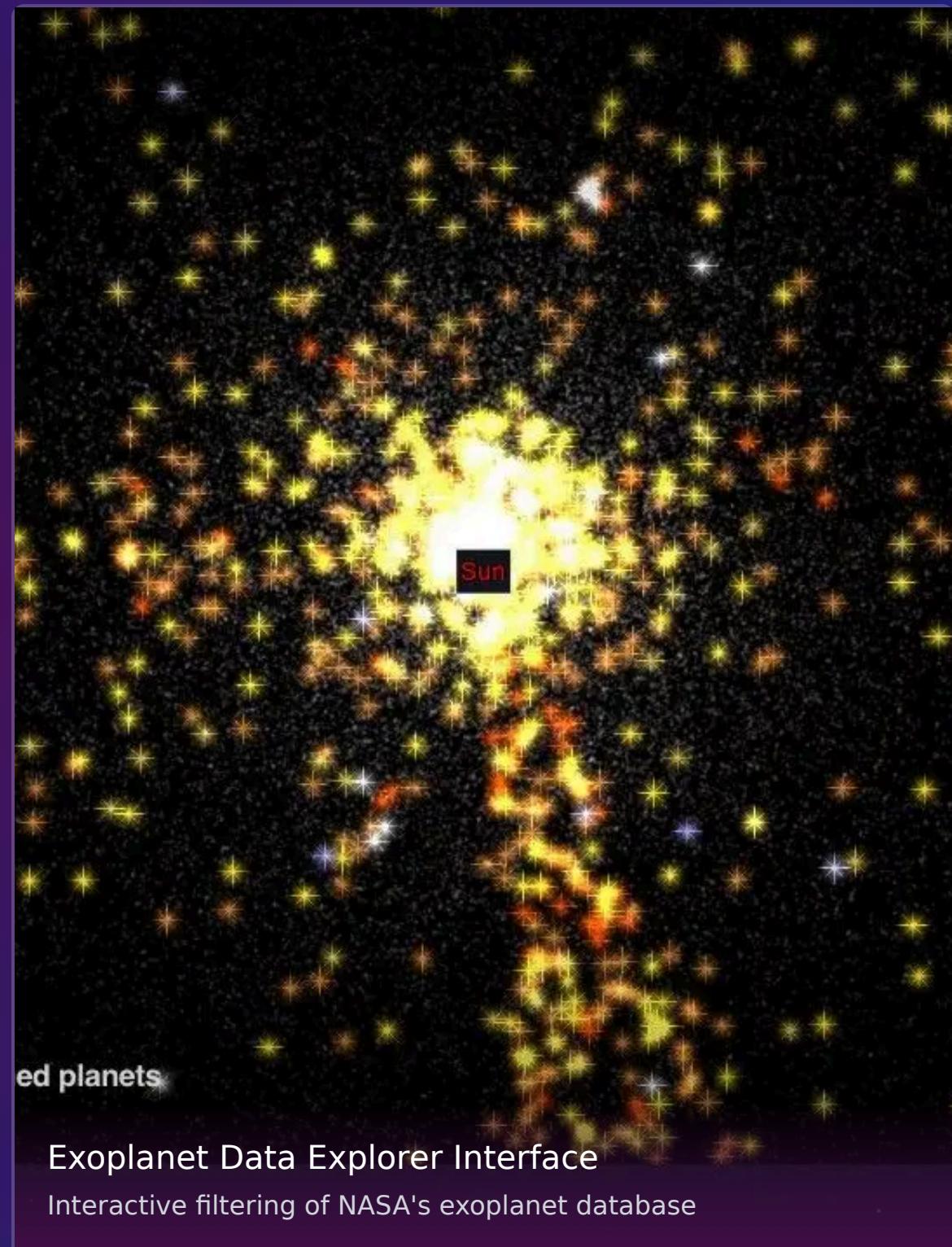
Light-years from Earth

### Star System

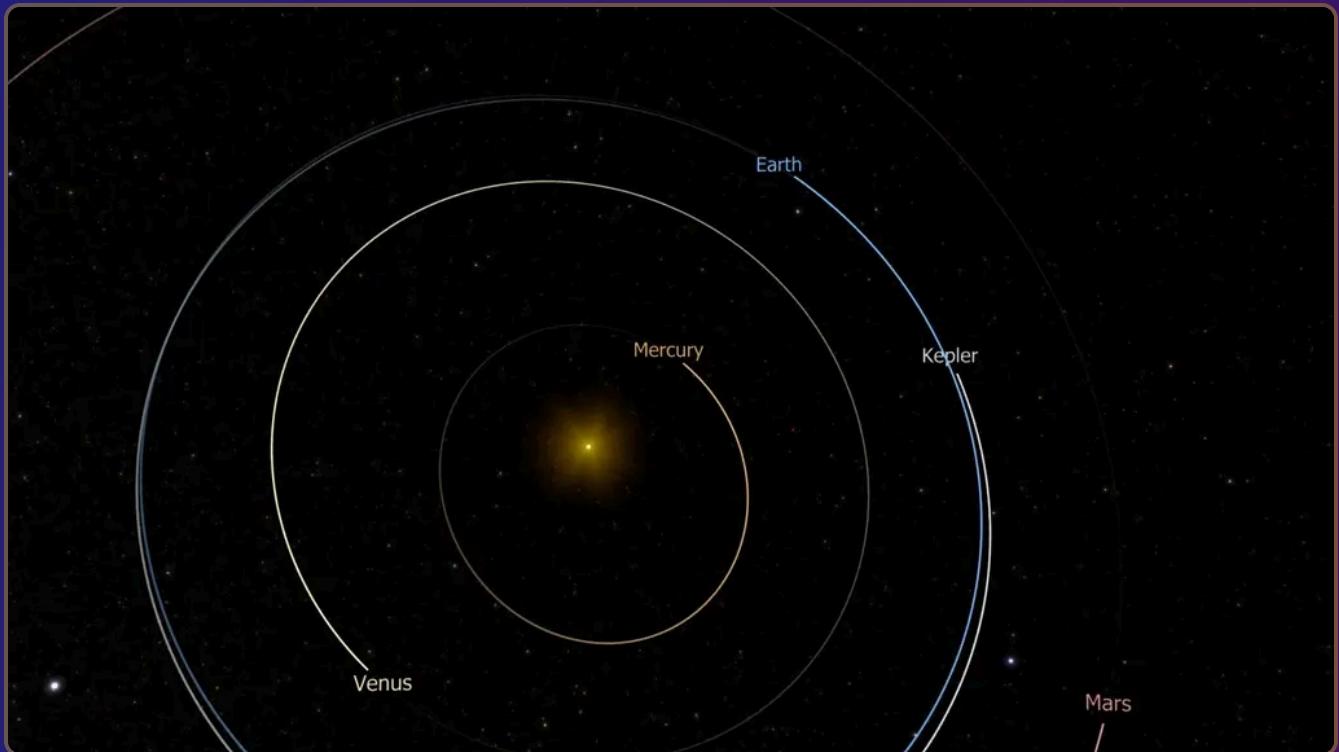
Related stars and planetary bodies

### Transit Data

Light curve measurements



# 3D Orbit & Light Curve Visualization



3D visualization of exoplanet orbits

## Light Curve Example: Kepler-227



## Interactive Visualization

- 3D Orbit Rendering:** Dynamic 3D visualizations using Matplotlib and Plotly
- Real Light Curve Data:** Measured flux data from PDCSAP LightKurve API

## Interactive Controls

▶ Play/Pause

❖ Drag

🔍 Zoom

⟳ Reset

## Purpose

Visually demonstrate how transits reveal exoplanets, showing the relationship between orbital motion and light curve variations.

# Educational & Scientific Impact

The Exoplanet Explorer project delivers significant impact across both educational and scientific domains by making complex exoplanet discovery accessible and engaging.

## Educational Impact

### Accessible AI-Driven Astronomy

Democratizes access to complex astronomical data and advanced machine learning techniques, making AI-driven exoplanet discovery understandable for a broad audience, not just specialists.

### Interactive Learning

Encourages active learning through exploration and interactivity, allowing users to directly engage with data and visualizations, fostering a deeper understanding of exoplanetary science.

## Scientific Impact

### Bridging Disciplines

Connects the fields of data science and space education through visualization and storytelling, offering a unique approach to scientific discovery that inspires future research.

### Scientific Meaningfulness

Provides a robust framework for exploring exoplanet data with scientifically meaningful models. Its open nature encourages further collaboration and development within the scientific community.



Exoplanet Explorer



Broad Audience



Deeper Understanding



Engagement



Inspiration

# Tools, AI & Data Sources

## AI Tools

ChatGPT

DeepSeek

Assisted in model development and documentation

## NASA Data Sources

Kepler Objects of Interest (KOI)

NASA's curated exoplanet candidates

LightKurve API

PDCSAP data for light curve analysis

## Tech Stack

Python (ML)

Flask (Web)

Pandas

Matplotlib

Plotly (3D)

LightKurve

Scikit-learn (Machine Learning)

**Result:** A bridge between machine learning, visualization, and space exploration