ExoHabitAI – Habitability of Exoplanets

A Machine Learning-Based Exoplanet Habitability Prediction System

The Challenge: Identifying Habitable Exoplanets

Vast Discoveries

Thousands of exoplanets identified by space missions, making manual analysis unfeasible.

Complex Parameters

Determining habitability involves numerous intricate astrophysical and planetary factors.

Time-Consuming Analysis

Traditional scientific methods for assessing habitability are labor-intensive and slow.

Lack of Automation

Absence of an intelligent, automated ranking system for exoplanet habitability scores.

ExoHabitAI: Project Overview

AI-Powered Prediction

Leveraging artificial intelligence to predict exoplanet habitability efficiently.

Data-Driven Insights

Utilizes comprehensive astrophysical data and advanced machine learning models.

Score & Ranking

Generates clear habitability scores and ranks exoplanets for focused study.

Full-Stack Application

Deployed as a robust web application for accessible use by researchers.

Core Features of ExoHabitAI

- **Machine Learning-Based Prediction:** Our system uses advanced ML algorithms to determine habitability probabilities.
- **Habitability Score Generation:** Each exoplanet receives a quantitative score indicating its potential for life.
- **Ranking of Potentially Habitable Exoplanets:** Prioritizes planets for further investigation based on their scores.
- **Interactive Data Visualizations:** Explore complex data through dynamic charts and graphs.
- **Exportable Reports:** Download detailed analysis in CSV or Excel format for external use.

ExoHabitAI: Technology Stack

1

FRONTEND

HTML, CSS, JavaScript

Responsive and dynamic user interface development.

Plotly.js: For interactive and rich data visualizations.

2

BACKEND

Flask, SQLAlchemy

Robust server-side logic and database management.

SQLAlchemy: Object-Relational Mapper for seamless database interaction.

3

MACHINE LEARNING

Scikit-learn, XGBoost

Powerful libraries for building and training predictive models.

XGBoost: High-performance gradient boosting for accurate predictions.

4

DEPLOYMENT

Gunicorn, Render

Efficient and scalable application hosting.

Render: Cloud platform for seamless deployment and scaling.

Overcoming Challenges: Solutions Implemented

Incomplete Data

Addressed through rigorous data cleaning and advanced statistical imputation techniques to fill gaps.

Class Imbalance

Utilized the SMOTE (Synthetic Minority Over-sampling Technique) to balance datasets and improve model fairness.

High-Dimensional Data

Managed with feature normalization and extensive Exploratory Data Analysis (EDA) to reduce complexity.

Deployment Issues

Resolved with a robust Flask + Gunicorn + Render setup, ensuring stable and scalable application deployment.

ExoHabitAI: System Working Flow

Data Input

Users provide or select exoplanet data points for analysis.

Backend Processing

Data is fed into the trained ML model on the backend.

Predictive Modeling

The ML model predicts the exoplanet's habitability probability.

Score & Rank

The system calculates a habitability score and assigns a rank.

Interactive Results

Results are presented via interactive charts and visualizations.

User Interface Design: Intuitive & Responsive

Clean & Responsive

A modern web interface designed for optimal viewing across devices.

Dedicated Pages

Clear navigation with distinct sections for prediction, ranking, and data visualization.

Interactive Visuals

Dynamic plots powered by Plotly.js for in-depth data exploration.

User-Friendly Layout

Designed for easy interpretation of complex scientific data by all users.

Measurable Outcomes & Impact

Accurate Classification

High precision in distinguishing habitable from non-habitable exoplanets.

Top 20 Identified

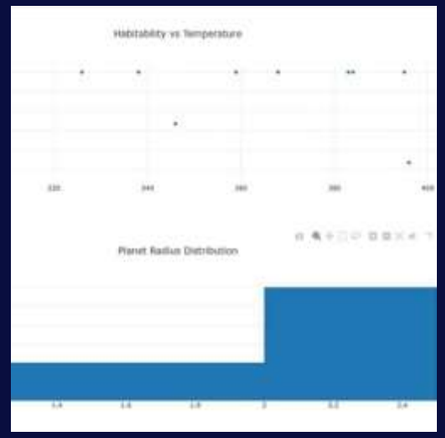
Successfully pinpointed the top 20 potentially habitable exoplanets for further study.

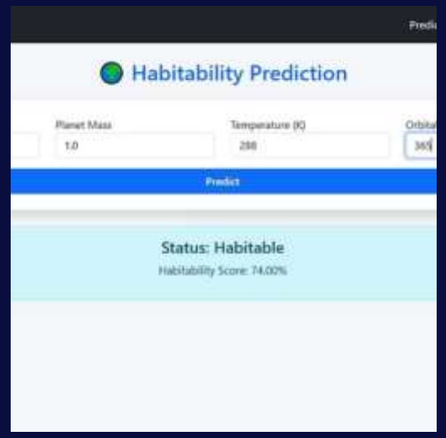
Enhanced Decision-Making

Improved research efficiency through intuitive visual analytics and insights.

Reusable ML Models

Developed robust and transferable trained ML models for future applications.





Future Enhancements & Scope

- **Real-Time API Integration:** Connect to astronomical APIs for live data feeds and dynamic updates.
- **Expanded Parameters:** Incorporate additional astrophysical parameters to refine predictions.
- **Deep Learning Models:** Explore advanced deep learning techniques for even greater accuracy.
- **Advanced Dashboards:** Develop sophisticated dashboards using modern frameworks like React or Dash.
- **Mobile-Responsive UI:** Optimize the user interface for seamless experience on mobile devices.

Project Link

- **Project Demonstration**
- Explore our project on GitHub: [Habitability-of-Exoplanets]

Thank You