A World Away: Hunting for Exoplanets with AI

SWAI

SILENT WATCHER ARTIFICIAL INTELLIGENCE

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Subject

The search for exoplanets has established itself as one of the most dynamic and fascinating fields in modern astronomy. Each new discovery brings us closer to answering fundamental questions about our place in the universe. In this context, analyzing the vast datasets generated by NASA missions such as Kepler, K2, and TESS requires the use of advanced technologies to process the information efficiently and accurately. Artificial intelligence (AI) is emerging as an indispensable strategic tool for identifying the subtle signals of distant worlds hidden in the cosmic noise.
This document formally introduces the **SWAI (Silent Watcher Artificial Intelligence) project** , an innovative solution that integrates machine learning models with NASA's open data. SWAI is not just a classification tool, but an interactive platform designed to democratize access to scientific discovery.
The project was born to address a key challenge in contemporary science: how to convert massive volumes of complex data into accessible and actionable knowledge for a broad and diverse audience.

Scope

SWAI is positioned as a comprehensive and accessible solution that transforms the complex process of exoplanet analysis and classification into an interactive and educational experience. The project merges a powerful machine learning model with an intuitive web interface, allowing users not only to observe the results but also to actively participate in the discovery process.

SWAI is an interactive project that combines artificial intelligence with NASA's open datasets to classify and explore exoplanets. Its purpose is to make cutting-edge space science accessible to foster curiosity, learning, and engagement in the search for new worlds beyond our solar system.

The name of the project encapsulates its mission:
The name SWAI stands for Silent Watcher Artificial Intelligence. It suggests the idea of an AI system that quietly and consistently observes stellar data, searching for the faint signals that reveal hidden worlds.

Key Objectives

The project is based on four key objectives to achieve its vision:
• **Intelligent Classification:** Implement a robust machine learning model for supervised classification of stellar data, accurately distinguishing between planet candidates, confirmed planets, and false positives (signals that appear to be a planet but are caused by other astrophysical phenomena).

• **Universal Accessibility:** Deploy a universal and intuitive web interface that allows users to explore data, test new data points in real time, and clearly visualize classification results.
• **Fostering Curiosity:** Transforming cutting-edge space science into a tangible and engaging experience, designed to inspire a new generation of enthusiasts and future scientists to engage in the search for new worlds.
• **Educational Visualization:** Demonstrate in an educational way how exoplanets are detected and confirmed, with a special focus on the interpretation of light curves and transit methods, making data science and astronomy concepts accessible.

Target Audience

SWAI is designed for a broad and diverse audience, primarily including:
• **Students:** High school and college students, who can use the tool to understand complex astronomy and data science concepts in a practical way.
• **Researchers:** Who can simplify the way they explain/divulge/spread their findings in the exoplanet area.
• **Space enthusiasts:** Hobbyists and curious people who want to actively participate in the frontiers of space exploration from their own devices.
The viability of this solution is based on a modern and scalable technical architecture, designed for performance and ease of use.

Features

SWAI's architecture was designed to be robust, modern, and scalable. The selection of technologies focused on ensuring high performance and a fluid user experience, leveraging the Python ecosystem for its mastery in data science and Streamlit for its ability to rapidly prototype interactive web applications. This synergy ensures the project's maintainability and ability to evolve.

Fundamental Components

The project is structured around two main components that work together:
• **Machine Learning Model:** At the heart of the system is a **supervised classification model** trained with real-world science data provided by **NASA** and the **Exoplanet Archives** . This model is capable of analyzing light curve data to classify observations into "planetary candidate," "confirmed planet," or "false positive" categories with a high degree of accuracy.
• **Interactive Web Interface:** An accessible web application that acts as the gateway to the AI model. It allows users **to test new data points in real time** , visualize results graphically, and actively participate in the classification process. The interface is designed to be intuitive, educational, and run directly in any modern web browser without the need for complex installations.

Technology Stack

The selection of tools and libraries reflects a pragmatic and efficient approach, leveraging the Python ecosystem for data science and lightweight web development.

Area	Technologies and Libraries
Programming Languages	Python (65.5%), HTML (34.5%)
Machine Learning / Data Science	TensorFlow, Scikit-learn, Pandas, NumPy, Joblib
Data Visualization	Matplotlib
Web Development (Frontend/Backend)	Streamlit (local interface), Render (static hosting)
Development Environment	Jupyter Notebook/Lab, Virtual Environments (venv)
CI/CD and Deployment	GitHub Actions
Model Persistence	Joblib, ONNX (skl2onnx, onnx, onnxruntime)

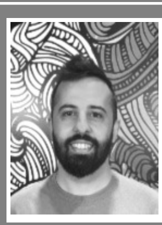
Challenge

The central challenge this project addresses is the growing gap between the vast amount of stellar data collected by NASA space missions and the ability to process it and make it accessible beyond the specialized scientific community. As space telescopes capture more information, the bottleneck shifts from observing hardware to analysis software and the interfaces that connect these findings to the public.

This challenge is made up of two main elements:
• **Volume of Data:** The Kepler, K2, and TESS missions have generated enormous volumes of stellar light curve data. Analyzing this information to detect tiny planetary transits requires efficient computational tools capable of distinguishing complex patterns and correctly classifying planetary candidates.

• **Accessibility:** Cutting-edge science often remains encapsulated in technical language and on platforms that are inaccessible to the general public. There is a fundamental need to create bridges that make these discoveries understandable, engaging, and participatory for students, emerging researchers, and space enthusiasts, thus fostering the next generation of scientists and explorers.
This is precisely the gap that SWAI has been designed to fill.

Team members

Brian	Lauriane	Tomás	Patricia	Luis	Hala
					
Developer	Developer	Developer	Developer	Developer	Engineer
Visuals Story Telling	Designer	3D Modeling	Documentalist	Project Manager	Technical Support

Management

The SWAI project was conceived and developed within the framework of the **NASA Space Apps Challenge 2025** , the world's largest global hackathon. This origin underscores the spirit of collaboration, innovation, and open science that drives the project. It was born as a direct response to NASA's challenge titled *"A World Away: Hunting for Exoplanets with AI* ," which called on teams from around the world to use artificial intelligence to advance the exploration of new worlds.

The project was developed by **"Team SWAI, from 42 Bcn** ," a multidisciplinary team comprised of software developers, a designer, and an engineer. This diversity of backgrounds was key to approaching the challenge from a holistic perspective, merging the algorithmic rigor of the developers and engineer with the user-centric vision of the designer, ensuring that the solution was as powerful as it was intuitive.

Principles of Development

Since its inception, SWAI has adhered to the principles of open source and collaborative science. Development was guided by two fundamental practices:

• The use of digital tools to analyze large data sets and identify patterns and trends.

• Incorporating existing code and libraries, always citing the original source, to build on the collective knowledge of the developer community.

This origin and these principles not only validate the project's viability, but also lay the foundation for its future impact.

Final results

SWAI has the potential to generate a transformative impact in the fields of science education and astronomy outreach. Beyond being a technical tool, the project is conceived as a bridge connecting NASA's elite research with the innate curiosity of the general public, democratizing access to one of the most exciting scientific adventures of our time.

Strategic Impact

Project value can be assessed across three key dimensions:

1. **Educational:** SWAI functions as an interactive learning tool that demystifies complex concepts in data science and astrophysics. It allows students and educators to practically explore how AI is applied to make real-world scientific discoveries, turning theory into a tangible experience.

2. **Scientific and Outreach:** By fostering public engagement and curiosity, the project directly contributes to the goals of NASA's exoplanet exploration program. It serves as an outreach vehicle that can inspire scientific vocations and increase social support for space exploration.

3. **Technological:** The project is an excellent use case that demonstrates the effective application of artificial intelligence and machine learning to solve scientific problems with large volumes of data. It serves as a replicable model for other challenges in the field of citizen science and data analytics.

Roadmap and Future of the Project

SWAI's modular architecture and use of standard technologies like Python and TensorFlow make it extremely easy to maintain and expand in the future. The project is poised for growth and evolution. The future roadmap includes incorporating new public NASA datasets as they become available, as well as iteratively improving the accuracy and capabilities of the classification model through new training and architectures.

In conclusion, SWAI is a functional and high-impact project, poised not only to democratize exoplanet discovery, but also to inspire the next generation of explorers who will take our search for new worlds to the next frontier.

Webgraphy and references

Documentation & Open-Source Principles

- ➢ https://k12cs.org/navigating-the-practices/
- ➢ Principle of Citation/Code Use: Incorporate existing code, media, and libraries into original programs while citing their source.
- ➢ Use of Digital Tools: Employ digital tools (e.g., computers) to analyze very large datasets for patterns and trends.

Scientific Data & Exoplanet Context

- ➢ https://exoplanetarchive.ipac.caltech.edu/
- ➢ https://es.wikipedia.org/wiki/Planeta_extrasolar
- ➢ https://es.wikipedia.org/wiki/M%C3%A9todos_de_detecci%C3%B3n_de_planetas_extrasolares
- ➢ https://www.esa.int/Science_Exploration/Space_Science/Cheops/How_to_find_an_exoplanet

Hackathon & NASA Resources

- ➢ https://www.spaceappschallenge.org/
- ➢ https://exoplanets.nasa.gov/

Repository & video links

- ➢ https://github.com/LLuisPP/Hunting_for_Exoplanets_with_AI
- ➢ https://drive.google.com/file/d/1naw4lbMAdlfVvRZBHh5gEUPbNW4uuqKs/view?usp=drive_link