

CSE 564 Project Prelim Report

Beyond Earth: A Global View of Exoplanet Exploration

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I. INTRODUCTION

This report outlines progress on a data visualization project focused on exoplanet discoveries. The goal is to build an interactive dashboard that allows users to explore when, where, and how exoplanets have been discovered, along with key planetary attributes.

Using a curated dataset from the NASA Exoplanet Archive, the project combines geospatial and physical data on planets and their discovery facilities. The dashboard is being developed with Flask for the backend and React with D3.js for the frontend. At this stage, core data pipelines and early visual components are in place, setting the foundation for a responsive and exploratory interface.

II. PROJECT OVERVIEW AND GOALS

A. Objectives

- Develop a centralized dashboard that visualizes exoplanet discovery efforts across Earth and space.
- Implement interactive features to explore observatory locations and their corresponding planetary findings.
- Integrate multiple forms of data representation including maps, scatter plots, and multivariate charts.
- Ensure responsiveness and usability of the dashboard for both scientific and educational audiences.

B. Technical Stack

- **Backend:** Python + Flask + Pandas
- **Frontend:** React.js, D3.js
- **Data:** NASA Exoplanet Archive

III. IMPLEMENTATION PROGRESS

A. Data Cleaning and Processing

- The raw dataset has been processed to isolate 30 discovery facilities (observatories or missions), each annotated with coordinates and source metadata.
- Non-Earth-based missions (like CoRoT, Kepler, K2) have been flagged and will be treated separately in the visualization.
- Column renaming and correction of header misalignment have been handled using Pandas.

B. Backend Development

- A basic Flask API endpoint (`/api/observatories`) has been implemented to serve the cleaned data in JSON format.
- Data is served with appropriate CORS headers to allow access from the React frontend.
- Static routes for serving geojson or future feature-based filtered data are scaffolded but not yet complete.

C. Frontend Design (React + D3)

- A React-based scaffold for the dashboard has been initialized.
- A functional prototype of the world map using D3's geoMercator projection is in progress.
- Pins representing observatories are displayed on the map; interactions such as tooltip hovers and click events have been partially implemented.
- A modular structure for visual components (MapPlot, BubbleChart, etc.) is in place but still requires deeper integration with backend endpoints.

IV. PLANNED VISUALIZATIONS

The Exoplanet Observatory Dashboard will feature a set of interactive visualizations aimed at exploring discovery patterns and planetary attributes. A primary component will be a world map displaying the geographic locations of observatories and space missions. Clicking on these markers will filter the dataset to show planets discovered by that facility. A bubble chart will visualize key planetary features such as mass, radius, and distance from Earth, using position and bubble size to represent multi-dimensional data.

To explore high-dimensional attributes, a parallel coordinates plot will allow users to compare features like planet size, orbital eccentricity, system multiplicity, and discovery year. Additionally, optional components like clustering and dimensionality reduction (e.g., PCA) may be incorporated later to identify similar planets or reveal hidden structure in the data. These visualizations will together form a responsive dashboard designed for both exploration and insight.

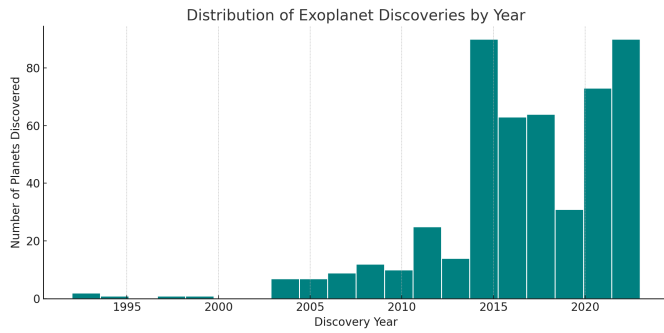


Fig. 1: Distribution of Exoplanet Discoveries by Year

V. CURRENT CHALLENGES

- **Geo-based rendering limitations:** Getting precise coordinates to render correctly in D3.js and integrating with user click events requires tuning.
- **Feature interaction across plots:** Interactivity (e.g., selecting an observatory from the map filters all other charts) is yet to be fully implemented.
- **Data enrichment:** Additional planetary features (like orbital eccentricity or temperature) are not yet joined into the primary dataset for plotting.

VI. NEXT STEPS

A. Short Term

- Finalize observatory selection interaction and integrate with secondary plots.
- Complete styling and layout for the React dashboard.
- Add hover tooltips and dropdowns for filtering planets by year, method, or discovery status.

B. Long Term

- Introduce multi-dimensional exploration using parallel coordinates or PCA.
- Host the dashboard locally with persistent storage and routing.
- Polish user experience and ensure scientific accuracy in data labeling.

VII. SCREENSHOTS

Here are some screenshots of the project and possible visualizations I plan to add in the final dashboard 1 2, ??, 3:

VIII. CONCLUSIONS

At this stage, the Exoplanet Observatory Dashboard is progressing steadily, with key structural decisions implemented and foundational components built out. While much work remains in terms of interactivity, refinement, and advanced analytics, the path forward is well-defined. The integration of geographic insight with planetary attributes offers a direction that bridges data science, astronomy, and user experience.

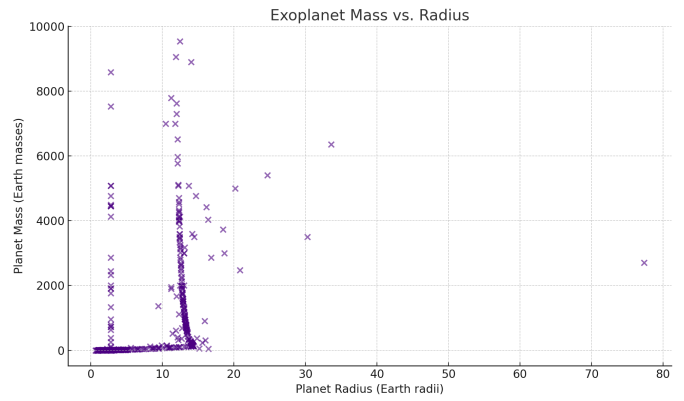


Fig. 2: Planet Mass vs. Radius

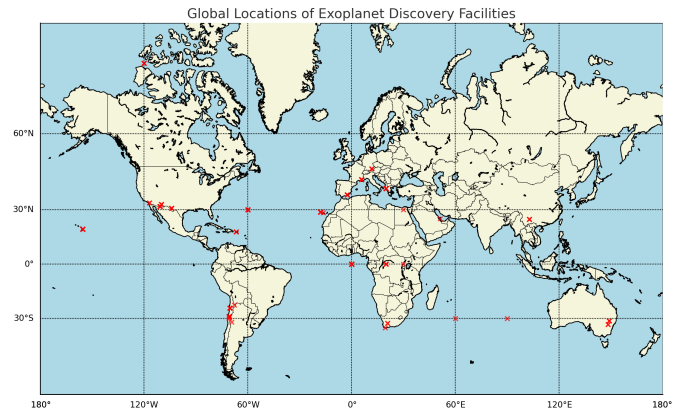


Fig. 3: Global Map of Exoplanet Discovery Facilities

IX. DATA LINKS

NASA Exoplanet Archive, a comprehensive and publicly accessible collection of data related to exoplanets and their star systems: [NASA Exoplanet Archive](https://exoplanetarchive.nasa.gov/)

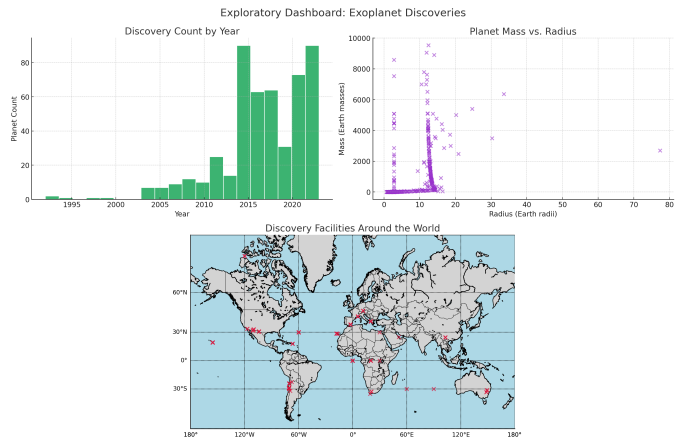


Fig. 4: Discovery Facilities Around the World