Planet Explorer

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https://github.com/ljmoyn/dataviscourse-pr-planetexplorers

Background and Motivation: The main motivation of the project is to set the framework for better understanding which exoplanets may exhibit signs of life. We do not currently have the data on whether these planets show signs of life, but by exploring these exoplanets further using our current methods and recording the data on the ones that do show signs of life, we can better understand the attributes that contribute to life being formed. If we are able to draw a correlation between exoplanets that are shown to have signs of life and certain aspects of the data we are working with, we can get a better idea of which exoplanets are most likely to also show signs of life.

It's important to note that the ability to understand the attributes of exoplanets that foster life is not very useful if we aren't able to discover new exoplanets that exhibit these attributes. This is why it is important to also study the correlations between the methods of discovery and the attributes of the exoplanets. This gives us a better understanding of which methods should be invested in for the purpose of discovering life. We can even go a step further and rank the institutions that discover these exoplanets based on different weighting factors.

New data is coming in every day on the discovery of these exoplanets, so it is becoming more and more important to be able to narrow down on the specific attributes that correlate with life being present.

Project Objectives: With this project, we hope to analyze technological improvement over time and current limits in exoplanet discovery. The key questions will include:

- Which scientific methods (Radial Velocity, Imaging, Transit, etc) are most commonly successful?
- What are the smallest discovered exoplanets? How far away can we identify planets?
- Are some of the scientific methods better than others for pushing those upper limits?
- Similarly, how do different telescopes compare with each other? Are there specific facilities which are most prolific in exoplanet discovery? Do different types of telescopes (space vs ground) have significantly different capabilities?
- How has all of the above changed over time?

The visualization should guide the user through the answers to those questions with a storytelling format. It should include basic scientific information to allow people who are unfamiliar with astronomy to understand the data.

Our dataset also includes a wide variety of details about the planets themselves, their stars, and their orbits. A final objective is for our visualization to be flexible enough for the user to explore relationships in the data beyond what we have considered above.

Data: The data will come from the NASA Exoplanets archive, Confirmed Planets table.
https://exoplanetarchive.ipac.caltech.edu/

Data Processing: The dataset contains information about 4000 confirmed exoplanets, downloadable as a csv. We will probably want to convert to JSON for easier handling in javascript.

Many rows are missing specific data, such as mass. We will need to consider filtering these out, or otherwise handling them, depending on how useful they will be for the visualization. Many values also have errors associated with them. We can either ignore these to simplify things, or include them in the visualization. Either way will involve slight adjustments to the design of the JSON object.

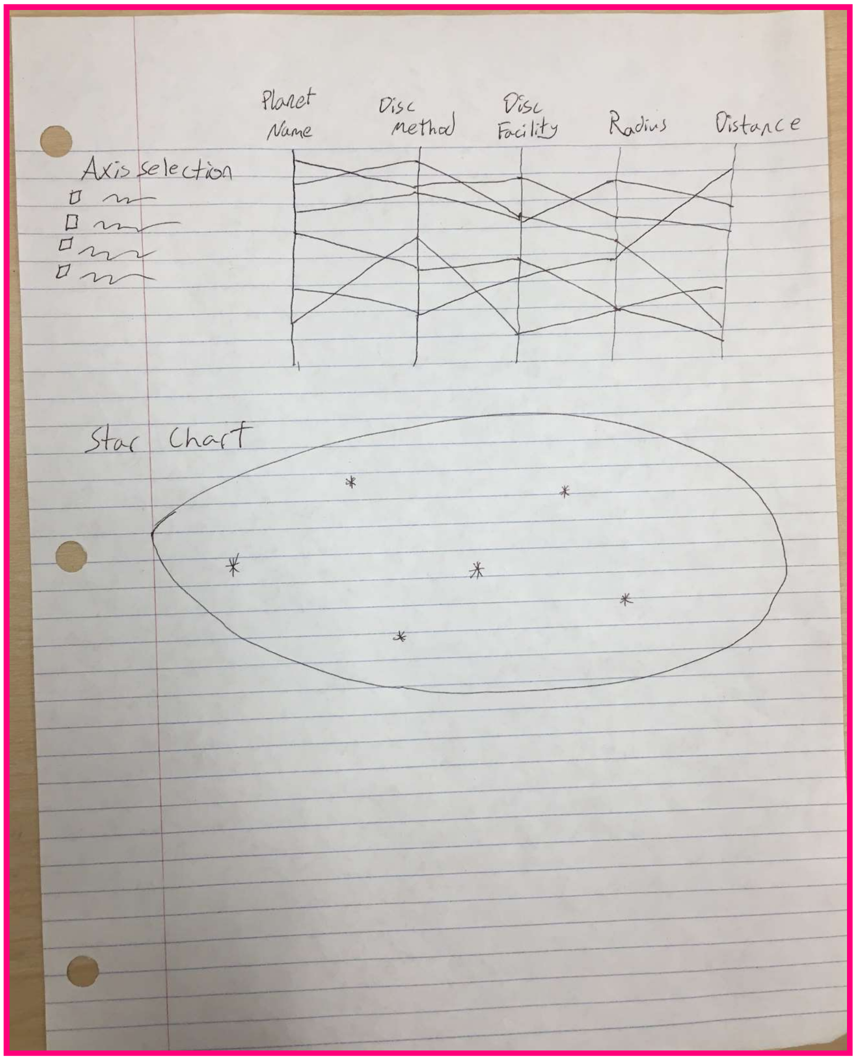
If we choose to develop the star-map plots described below, we'll need to do calculations to convert Right Ascension and Declination data into pixel positions

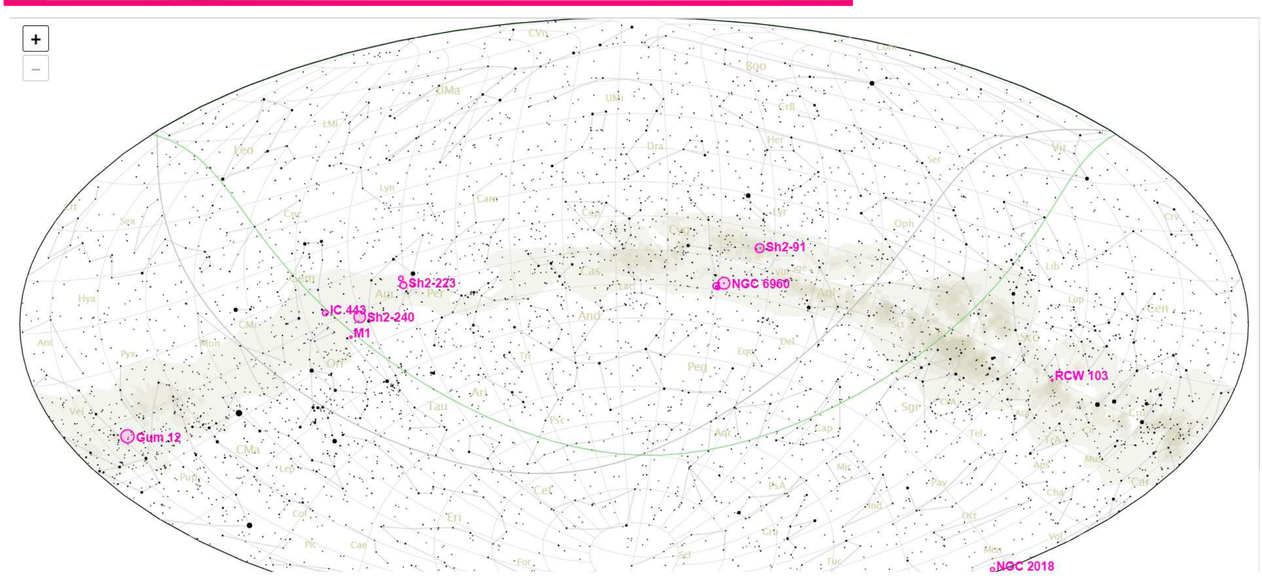
Lastly, the data includes information on the facility that discovered each object, and the scientific method used. It will be useful to classify the facility types and add additional information for each discovery method. The will require additional research on our part to supplement the dataset.

Visualization Design:

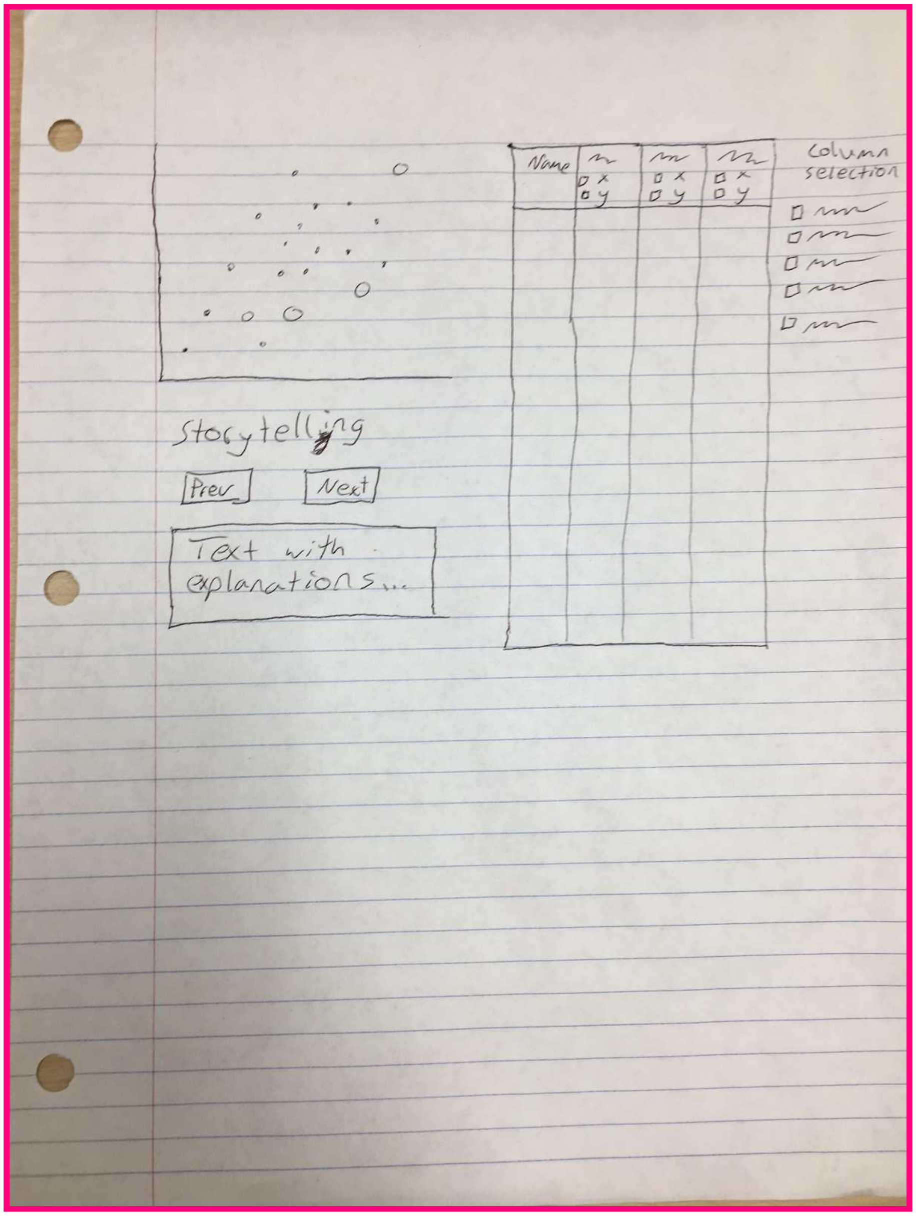
1. This sketch has two views.
    a. A parallel axis plot which starts with key data columns: Planet Name, Discovery Method, Discovery Facility, Radius, Distance, Date. Axes can be reordered by dragging, and additional axes can be added from a list of checkboxes to the side. Use Voronoi geometry for highlighting of individual lines
    b. A star chart that plots well known stars (sirius, betelgeuse, etc) for reference as well as the stars in the dataset. Linked highlighting with the

parallel axis. Would use this d3 package
https://github.com/ofrohn/d3-celestial

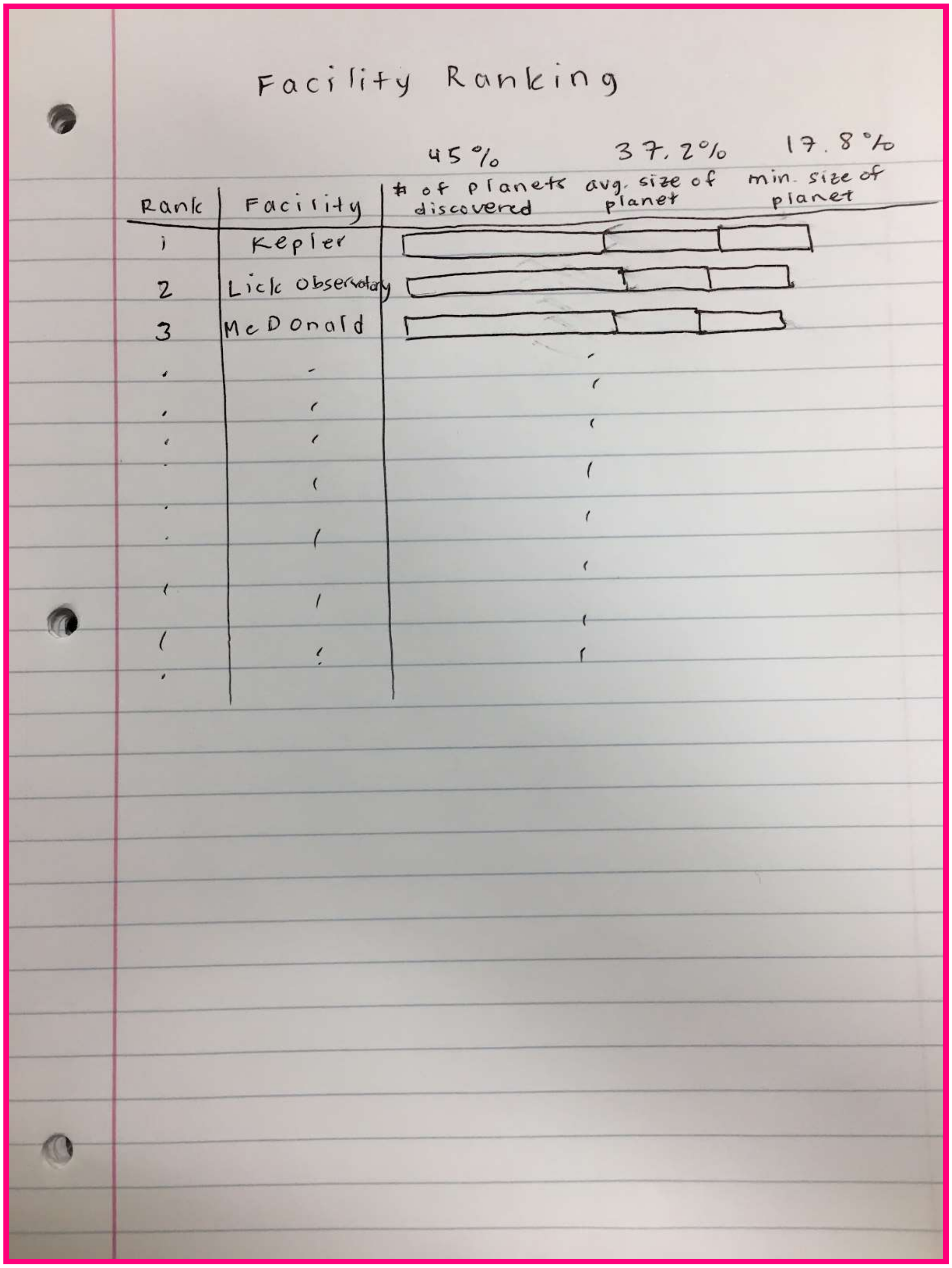




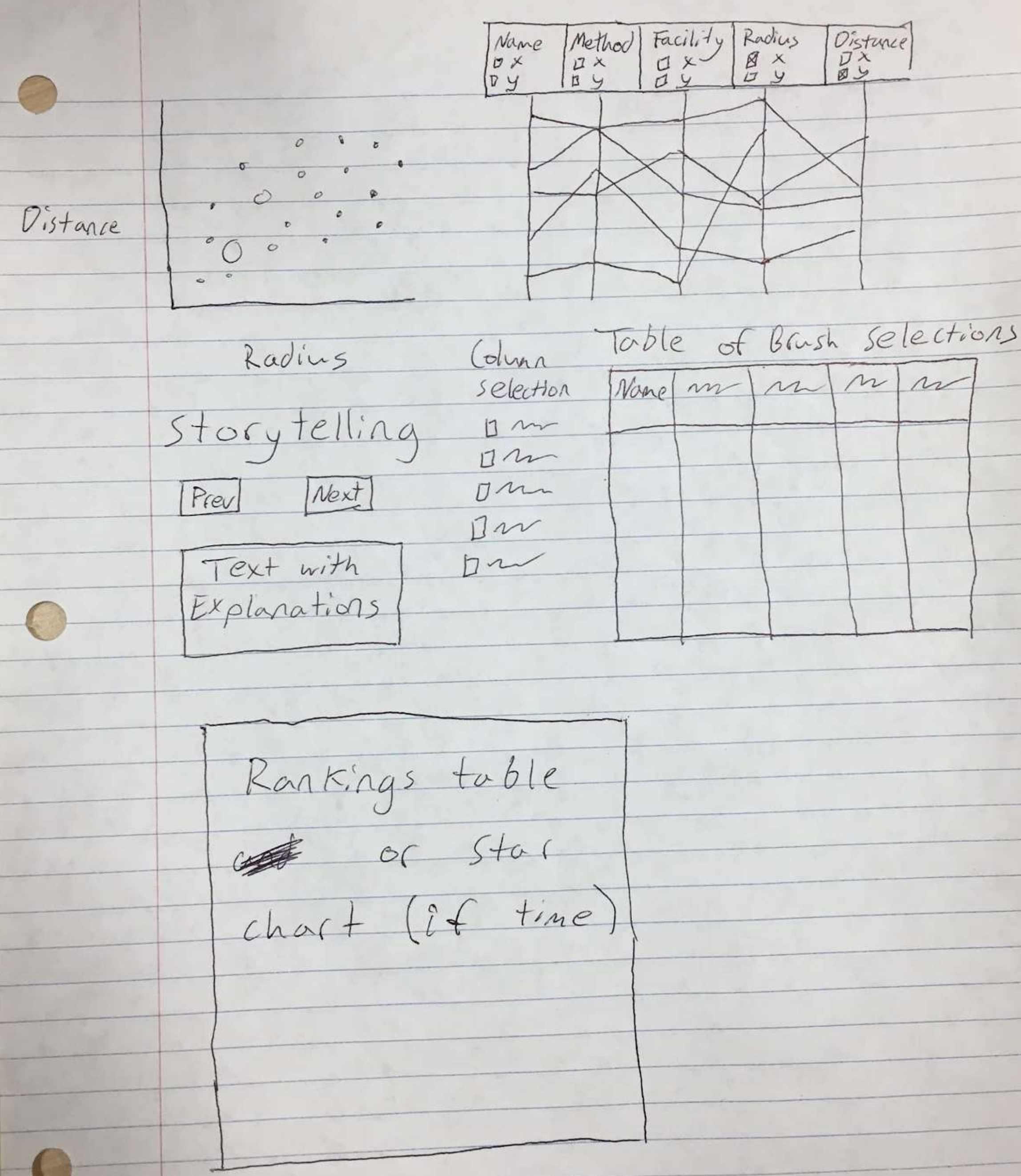
2. This is a scatterplot and linked table. The x and y axes of the plot can be selected via checkboxes at the top of each column in the table. There is linked highlighting between plot and table. The scatterplot has a selection brush which allows filtering of the rows in the table. Table columns are sortable, and columns can be added/removed.



3. This is a facility rankings table. We select number of planets discovered, average size of planets, and minimum size of planets as the three components that contribute to a facility's success. The percentages represent the weighting of each particular component and can be adjusted based on the relative importance of the user.



4. Final Design: this will have 4 views
    a. Parallel Axes plot. Axes are movable, use Voronoi for highlighting based on mouse position. Also when specific lines are hovered, popup with data for the two nearest axes. A list of checkboxes beside the plot to allow adding additional columns.
    b. A scatterplot next to the parallel axes. Axes for the scatterplot can be changed with checkboxes in the parallel axes plot. A brush in the scatterplot allows filtering of the parallel axes lines. There is linked highlighting between the two plots. Popup with data when hovering over points.
    c. Storytelling section.
        i. Explain basic astronomy concepts.
        ii. Show relevant views related to types of discovery methods. Explain what they are.
        iii. Show views related to types of telescopes, and planets discovered by them. Explain differences between telescopes.
        iv. Show views comparing early years of exoplanet discovery with 2019
        v. Slow transitions between different views, so user can see what is being changed in the ui (tutorial functionality)
    d. (Optional) Data table, populated based on brush selection in scatterplot
    e. (Optional) Star chart with plotted locations of planets
    f. (Optional) Ranking chart of facilities


Name
x
y
Method
x
y
Facility
x
y
Radius
x
y
Distance
x
y
Distance
Radius
Storytelling
Prev
Next
Text with Explanations
Column selection
Table of Brush selections
Name
Rankings table
or Star
chart (if time)

Must-Have Features:
1. Parallel Axes with pre-selected columns
2. Voronoi highlighting in parallel axes
3. Scatterplot with x- and y-axis determined by columns of parallel axes
4. Show planet details on hover in Scatterplot/Parallel Axes
5. Storytelling section with basic functionality
6. Brush selection in scatterplot filters parallel axes

Optional Features:
1. Ability to shift order of Parallel Axes
2. Check boxes for Parallel Axes determining which attributes to compare
3. Star map with highlighting features to show where the selected exoplanets live
4. Ranking facilities
5. Implement table for group of highlighted points in Scatterplot to display additional details

Project Schedule:

Week 1:
- Data importing and cleaning up.
- Basic scatterplot
- onhover popups for scatterplot
- Research discovery methods

Week 2: (Project Milestone Due End of Week):
- Basic Parallel Axes
- Linking between parallel axes and scatterplot (select xy on scatterplot from parallel axes)
- Framework for storytelling. Buttons and layout exists, may not actually do anything

Week 3:
- Voronoi Highlighting
- Flesh out storytelling
- Filter parallel axes by brush selection in scatterplot

Week 4 to 4.5
- Shift order of parallel axes
- Add additional data axes using checkboxes
- Optional view (starmap, ranking facilities, or table with brush selection details)