CS373 Group 12

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Website Name:

- HomePlanet.me

Motivation:

HomePlanet most practically can be a resource for teachers and students to quickly access basic information about celestial objects. In this way, we are motivated to help spread knowledge and interest in the general population about space and astronomy. The easier it is to access this kind of information, the more likely people are to learn about it. For this reason, our motivation is to make it easier to access some of the information provided by NASA and other organizations about space. The website may also be useful for scientists and the general population for recreation or research, as it will provide quick and easy access to an array of basic sortable and searchable information about planets, moons, and stars.

User Stories - Phase I Received:

1. Search and sort by star type and age:
    a. As an astronomer, I would like to be able to search, sort and/or filter stars by their age and stage in their lifecycle (eg: Solar Type, Hot Blue, Red Dwarf, Red Giant, White Dwarf, Neutron Star, maybe Black Holes). I think it would be interesting to see how this star age attribute maps to the habitability of the planets that orbit them (Black Holes and Neutron Stars probably don't have many nearby habitable planets because of how exotic they are). I want to make sure when I'm looking at habitable planets that they orbit around relatively stable stars using this feature.
2. Planet/Exoplanet distance from home star:
    a. I would like for each Planet/Exoplanet to include information regarding the distance it orbits from its own star in terms of a standardized unit (miles, km, etc). I would also like these values in terms of AU (1 AU is roughly the distance of Earth to our own Sun), so it is easier to understand the numbers. I think this would be great if it could possibly be incorporated into the model diagram of the planet's orbit that was mentioned in the project proposal.
3. Orbit eccentricity and stableness:
    a. As an Astronomer, I would like to be able to view information about the eccentricity of planets' and moons' orbits. Ideally I would like this to be presented in a fashion able to be understandable by an average person for educational purposes. I would also like the stableness of the orbit to be communicated in some way (it might even be fine to just rank the stableness of the orbit as

"stable", "slightly unstable", and "very unstable" for the user to see and hide the more complicated numbers under the hood; I just want a general idea of the stableness, exact numbers aren't necessary).

4. Planet and moon rotation:
    a. I would like information about the local rotation of planets and moons. For example, Uranus rotates about an axis nearly at a 90 degree angle to its orbit around the Sun. Ideally, this rotation would be relative to the orbital plane of the galaxy the planet is in or planet the moon is rotating about respectively.
5. Grouping based on solar system and galaxy:
    a. As someone without much knowledge of constellations or planet names, I would like to be able to view what solar systems and/or galaxies different planets, moons, and stars reside in (Andromeda, Milky Way, etc). If a star or planet is not associated with a system, I would like to see that too. For instance, Betelgeuse is a "rogue star" that has run away from its system and is not associated with any star system, but it would still be listed as a part of the "Milky Way" galaxy as a whole.

Response to Stories - Phase I Received:

- Stories #1, 2, 4, and 5:
    - Certainly! We are still in the early development stages of the website at the moment, but we plan to include all of the information that we can reliably find about all of our celestial objects. As you all mentioned, we hope to include information about star types and their ages, about the distances of planets - and moons - from the bodies that they orbit (or if they are rogue), about the rotation plane of all bodies, and about the galaxies and solar systems that each object resides in. We'll include everything we can, but we'll keep an extra special eye out for what you all requested!
- Story #3:
    - While your request is about information to include (we will focus on orbit eccentricity and stability), you touched on a point that is very important. There are many terms in astronomy that are possibly not readily understood by someone who doesn't study the subject. We will look into providing explanations about the various types of data that we provide. That way someone who is using our website for education can learn about what all of the different measurements actually mean. Furthermore, providing a way to simplify some of the numbers into more understandable terms is something we will look into. If it is feasible, performing automatic general transformations of raw numeric data into more descriptive terms like "stable", "unstable", etc. could be very helpful to users who don't have a reference for what normal would look like for all of the data we provide. Either way, the raw data will still be provided.

Updates On Progress Towards Phase I User Stories In Phase III:

- Story #1:

    - We have implemented searching stars by name. We have also implemented sorting stars by age. So this user story is partially implemented. We will see if we can find the remaining information in the final phase, but it will be dependent on what information our APIs can provide.
- Story #3:
    - This user story seems potentially doable, but so far it's been low on our priority list. Now that most of the website's functionality has been implemented, we will definitely at least try to automatically present the information in a way that is generally understandable to everyone regardless of their background. The logistics of how this will work are somewhat unknown, so it may end up not being implemented in the end. However, we will give it special emphasis in Phase IV to see if it can be done.
- Stories #2, 4, and 5:
    - We will implement these stories if we can find the information, but it may simply not exist for anything outside of our solar system.

User Stories - Phase II Received:

1. Alf Cen A lacking a Luminosity Class:
    a. Alf Cen A is lacking a luminosity class. I would like to know what luminosity class Alf Cen A is. If it doesn't have one, I would also like to have the reason why explained on its instance card.
2. Better Units of Measurement:
    a. I would like more or better units of measurement that are easier for a lay-person to understand. For instance, it's hard for me to conceptualize "Jupiters" as a unit for the radius on the planets model page (or Kelvin, light years, what is UNITS for star age too?). "Earths" or other more normalized units might make more sense for the average person to understand these different numbers.
3. Better resizing of text to window size on splash page:
    a. When I resize the browser window on homeplanet.me, the text on the splash page gets cut off (specifically, "Your go-to source for all things astronomy" gets cut off on the ends). I would like the splash page to have better resizing of text so that it looks cleaner in a smaller window size. This could be achieved either through shrinking font size or moving text to a newline when it is cut off (it seems like you already do this on your model pages so maybe you could just copy that behavior over to your about page).
4. Formatting of developer cards on About Page:
    a. Related to #46 [Better resizing of text to window size on splash page] on the about page when I shrink my browser window size, the developer about cards overlap with each other, cutting off large portions of each developer's picture. I would like this to be cleaned up so that in a small browser window each developer card is fully visible and legible. This would probably be achieved by automatically moving each card to a new line when the window size is shrunk.
5. Multiple photos of planets, stars, and moons:

a. I would like to be able to see a gallery of photos for each model instance when I click on its respective image. Many planets look different through different filters or angles (for instance: the dark side of the moon AND the light side of the moon). It would be nice to have more than just 1 photo available for a model instance without it cluttering up the instance's page.

Response to Stories - Phase II Received:

- Story #1 - Alf Cen A lacking a Luminosity Class:
  - We are still working on the website at the time of writing this. We believe that we may be able to implement displaying luminosity for all of our stars before phase II is finished. If not, then we will implement this in phase III.
- Story #2 - Better Units of Measurement:
  - Similarly to the third user story from phase I, we do believe this is a good idea. Making it so the units of measurement we provide are more readily understandable for everyone would better serve to educate people about our universe. This feeds into our overall motivation for the project, so we do want to implement this. This specific request is easier than the requirements from the related phase I request, so we will likely implement it in phase III. The only reason we have not implemented this in phase II is the time constraint.
- Stories #3 and #4:
  - *#3: Better resizing of text to window size on splash page*
  - *#4: Formatting of developer cards on About Page*
  - While phases III and IV do add additional features, we anticipate that we will have more time in them for polishing our site. These stories are related to polishing our site, and so we will implement them in phase III. The reason we have not implemented these in phase II is the time constraint on turning in our project. However, we do view these stories in particular as strictly necessary for the final version of our site.
- Stories #5 - Multiple photos of planets, stars, and moons:
  - Unfortunately, space is a very big place. Astronomers have cataloged a lot of celestial objects, but it's difficult to achieve different angles of observation for anything outside of our solar system. Furthermore, there aren't very many images of celestial objects in different filters/spectrums of light. Therefore, this particular story is probably impossible for us to implement. We will keep an eye out in case a solution presents itself.

Updates On Progress Towards Phase II User Stories In Phase III:

- Stories #1, #2, #3 and #4:
  - We have completed these stories in Phase III.
- Story #5:
  - This story is impossible for us to implement. There just aren't very many pictures of specific distant stars, planets, or moons for us to draw from.

User Stories - Phase III Received:

1. I would like to see a description of the media on the instance pages of the planets and moons. The media on these instance pages seem to be a graphs, but it is a bit difficult to understand exactly what they are supposed to be showing. This would be very helpful for users who are quickly looking around the website to understand what information is being shown.
2. I would like to see a list of related model recommendations instead of just a single one at the bottom of each model instance page. It doesn't have to be dynamic, fixed is fine, but I would just like to see multiple potential related models to choose from. This would be very helpful with stars, as it would allow me to be able to choose between multiple planets or moons within their solar system, rather than just a single one.
3. I'm not sure if this is just an issue with the fact that you guys still have a small database size, but I would like to see more relevant recommendations between model instances at the bottom of each model instance page. For instance, right now HIP 5862 recommends me Callisto, which doesn't make much sense as the two are completely unrelated (not even in the same solar system). I think these recommendations could be improved to allow much better traversal of the site through jumping between model instances using the "related instances" feature.
4. I would like to see a photo included next to the hyperlink for each related other model instance linked on the page for each instance of a model. For instance, for HIP 5862, I would like to see an image of the moon Callisto next to it's name at the bottom of the page. Perhaps other information (within reason), could be included next to the name as well (such as the habitability, since that is the main focus of the site after all)
5. I would like to see better formatting of the luminosity class field for star instance pages. As it stands, I'm not really sure what the units mean (cgs?). Possibly a explanation of the unit, or at least the unabbreviated unit name next to it would help with this issue.

Response to Stories - Phase III Received:

- Story #1 & Story #5
    - We were able to address these issues in the latest phase. If you click on any of the metrics that are listed, you will be able to see a description of the measurement and the units that it is in.
- Story #2
    - This is great feedback, and I definitely agree that we should have more connected instances on each model page in order to provide a better user experience. We will be looking into adding this for Phase 4.
- Story #3
    - We will look into implementing this in Phase 4. Our original plan/goal was to have the models be connected by orbit or solar system. However, with the APIs and the data we have available, this might not be possible. First of all, the planets we have are only exoplanets (not in our solar system) but we only have moons in our solar system, so there is an unfortunate discrepancy in data there. In the future, we are looking to find an API that has data about planets in our solar system,

which would fix this issue. We are also looking to link the models by galaxy when possible.

- Story #4
    - We have completed this recommendation during Phase 3.

Phase I User Stories - Given:

1. Safety information:
    a. I am a parent of a 16 year old girl who is about to get her drivers license. I am very nervous about her driving, as car accidents are one of the leading causes of death in teenagers. I would love if your website had information about safety ratings for different cars, and if I could sort the list to see the safest cars.
2. Pricing:
    a. Hi, I am a full time student who works a minimum wage job. I need to buy a car to drive to work, but I can barely afford my tuition as it is. I would like to be able to see a list of the cheapest cars. Gas is also expensive, so I would like to be able to see the gas stations around me and be able to compare their prices.
3. Charging Stations:
    a. Hi, I recently bought a Tesla Model X. I love this car, but I have been nervous to drive it because I am worried I will run out of charge and not be able to find a charging station. It would be very handy to be able to search charging stations by their location, so I can plan my trips and make sure I'm never stranded without a way to charge my car.
4. User Story: Car Listings:
    a. Hello, I have been trying to buy a Honda Civic for some time now, but I can't seem to find any dealership that has them in stock. It would be great if your website had a list of car listings I could search through to find a Civic for sale. Thanks!
5. Electric vs Gas:
    a. Hi, I want to buy a car but I'm torn on if an electric or gas-powered car is better for my situation. I would love to be able to compare the attributes of different electric and gas-powered cars so I can make an informed decision.

Phase II User Stories - Given:

1. Work car concerns:
    a. Hi, I am buying a car for daily life. I mainly use it to work, and I do not travel often. I wonder what kind of cars would suit me better. Based on my daily usage, I would prefer a vehicle with lower fuel costs and more convenience to fix if there's something wrong. Would your website provide information on that?
2. ADAS:
    a. Hi, I am a new driver and this will be my first car. I've learned that ADAS is pretty important. I wonder if your website is going to be providing any information on that?
3. New customer:

    a. Hi, I am completely new to the car-buying process. Is your website going to provide customer service or any crash course on car buying?
4. Car price in the past and future:
    a. Due to the pandemic, I figure car prices have been fluctuating a lot. Would your website be providing the car price during the past based on different dealers as well? Also, I think a model to predict the future car price will help the customer to make an easier decision.
5. Ranking for the car:
    a. Hi, I wonder if your website is going to be providing a ranking based on horsepower, capacity, and swept volume?

Phase III User Stories - Given:

1. Adding Specification for Flexibility
    a. As an avid negotiator, sometimes I am not willing to pay the listing price for a vehicle. I would love to filter down the pool of available listings to only those with people who are willing to negotiate. Would this functionality be possible?
2. Last Time Data Was Updated
    a. I want to avoid cars that have been recalled often, due to bad experiences in the past. I don't want to buy a car just to have it recalled. Is there a way to sort or filter the cars by the number of recalls they have had, so I can find the cars with the fewest recalls?
3. Adding Your Own Ratings
    a. As an indecisive teen looking to buy my first car, I would love to be guided by the experts at FindACarFor.Me. Is there some type of overall rating that could be included so that I can buy the best rated car? This could be based on a combination of factors such as price, safety, etc.
4. Sorting by Number of Recalls
    a. As electric cars become more common, there has also been an explosion in the availability of electric chargers. Could you include information about the last time your data was refreshed? That way I know I am not missing any chargers that were recently built.
5. Filtering by Stations only Open Now
    a. Similar to Google Maps, it would be cool to have the functionality of finding which stations are open at the current moment. Is this filtering step that could be implemented? If not, is it possible to sort by which stations are open the longest?

Phase IV User Stories - Given and Received :

- No further phases, so there is no need for more user stories. We have given and received no stories for this phase.

Updates On Progress Towards Phase III User Stories In Phase IV:

- Stories #1, 4, and 5:
    a. These stories have already been addressed.
- Story #2:

    a. We were not able to implement this story in phase IV. Our focus was held more on cleaning up the code and refactoring, as well as implementing new features.
- Story #3:
    a. We were only able to partially implement this story due to the lack of necessary data provided by the APIs we found. We connected planet and star instances based on planets being within the orbit of stars. We were unable to do this for moons.

RESTful API:

We've documented the RESTful API we are using for our website using Postman. This is where we are drawing the information about stars, moons, and planets from: https://documenter.getpostman.com/view/20771905/2s83tFHWkc

Endpoints:

- https://api.homeplanet.me/api/all_planets?page=1&per_page=15
    - returns a list of json of planets that belong to the current page
    - optional parameters: page, per_page, filter, search, sort_rade, sort_masse, etc.
- https://api.homeplanet.me/api/all_stars?page=1&per_page=15
    - returns a list of json of the stars that belong to the current page
    - optional parameters: page, per_page, filter, search, sort_rade, sort_masse, etc.
- https://api.homeplanet.me/api/all_moons?page=1&per_page=15
    - returns a list of json of the moons that belong to the current page
    - optional parameters: page, per_page, filter, search, sort_density, sort_gravity, etc
- https://api.homeplanet.me/api/recommand/star?star=462
    - recommends a planet and a moon for the star with index 462
- https://api.homeplanet.me/api/recommand/planet?star=100
    - recommends a star and a moon for the planet with index 100
- https://api.homeplanet.me/api/recommand/moon?star=100
    - recommends a star and a planet for the moon with index 100
- https://api.homeplanet.me/api//star?index=462
    - returns information about the star with index 462
- https://api.homeplanet.me/api//moon?index=100
    - returns information about the moon with index 100
- https://api.homeplanet.me/api//planet?index=100
    - returns information about the star with index 100

Models:

While our website could be expanded to as many models as there are measured celestial bodies, we have decided to focus the scope of this project on three models: stars, moons, and planets. We are able to sort these bodies based on attributes such as mass and radius. We are able to search through the models based on name. A list of all currently planned attributes can be found below, as well as in the GitLab readme: https://gitlab.com/NathanSuss/group12-cs373

Tools:

- Frontend
  - React: A tool for developing a frontend GUI
  - MUI: A UI library for react to assist the frontend development process
  - Bootstrap: A css framework used to make websites look more appealing
  - Jest: A frontend testing library
  - Selenium: A frontend testing library
  - Recharts: A frontend library used to create visualizations
- Backend
  - Postman: A tool used for developing and documenting APIs
  - EC2/AWS: A web hosting service provided by Amazon
  - Namecheap: A domain name registrar that offers free domain names
  - Flask: A tool for connecting the backend database to the frontend where it is displayed through URL routes
  - Nginx: A proxy that allows us to access the flask routes
  - SQLAlchemy: A Python framework that allows us to easily make SQL queries via Python
- Data
  - Serp API: A web scraping framework that we used to scrape some moon orbit images
  - API Ninja: A RESTful API that provides data about moons within our solar system
  - NASA Exoplanet Archive: RESTful/TAP APIs that provide data about stars and planets outside of our solar system.
  - Beautiful Soup: A web scraping framework that interfaces easy with Python to parse HTML documents
  - Wikipedia: Source for moon images
  - exoplanetkyoto.org: Source for exoplanet and exostar images

Hosting:

We are still hosting on AWS, but we switched to EC2 for backend deployment instead of Amplify. We decided to use it instead because it acted as a remote machine, and it made the implementation of the backend server easier. The frontend server is still deployed on Amplify.

Phase II Features:

- Database Implementation:
  - We implemented the database using Python and SQLAlchemy. We also used MySQL to initialize the database. We created a schema, and then wrote a python script that filled the rows and columns of the database with the data we had previously pulled from RESTFUL API's in Phase 1. We also implemented a handful of image scrapers from the web, and included the links that these scrapers returned in the database
- Flask Implementation
  - The implementation of the flask is based on Python and SQLAlchemny. Depending on the MySQL we set up in advance, we use the ORM model to read

the data from the database, collect them, and return them to the user. In the backend we provide 10 APIs, including one just used for testing, to provide different data to users on their requirements. All APIs require to GET requests because we don't allow the user to modify the data we store in the database.

- Pagination explanation:
    - For each of our models, we get a JSON with a list of all of our instances where the related attributes are held in a dictionary. For example, we could get a list of all of our stars. For each item in that list, we create a star page that displays all of the information in the dictionary. This ends up being a lot of stars, and we limit the number of stars displayed on a page to 12. We used a react template for implementing the actual pages.

Phase III Features:

- Sorting
    - On our model pages, we added a Dropdown menu with the choices for sorting. These added a hash to the page's url (such as #/sort-mass-exponent). Then, this URL was parsed and the sorting value was passed into our API.
    - All of our models have at least 5 sortable attributes, so we did not implement any filtering.
- Searching
    - Each model page has a search bar. We use a text field form that, on input, sets a searchVal variable. When we make the API request, we check if this searchVal is empty, and if it isn't, then we append that value to our API call. We also pass this value into the React Highlighter element in order to highlight the necessary parts of the text.
    - Our General search page performs 3 separate API calls, one to moons, stars, and planets. Then it displays each of the results it gets separately.
- Filtering
    - We added one filter per model to allow users to narrow down their results.
    - For planets, we can filter by temperature range. Because our website focuses on habitability of exoplanets, these ranges are "too cold", "habitable zone", and "too hot". This integrates well with our temperature visualization.
    - For moons, we can filter by host planet. For example, if you only want to see Jupiter's moons, all you would have to do is click the filter button and select Jupiter.
    - For stars, we can filter by the Luminosity class of each star, either Main Sequence or Giant. This also integrates well with our pie chart visualization for stars.
    - To actually implement this filtering, in the frontend we added a dropdown menu to allow the user to easily choose what filter they want to apply. We then called our API and passed the chosen value in using the 'filter' param. Our backend returned data that met the specifications provided by searching, sorting, and filtering.
- Backend

    - For phase III, we developed our backend based on the work of phase II.
    - Our platform supports the return of the ordered and sorted results for the searching API. The frontend needs to add corresponding parameters in the requested path, and the backend will try to find them in the arguments. If that works, the backend will return data in the format the user requested. The backend supports sorting, filtering, and searching. All of them are developed based on the same API of phase II, so we try our best to keep the new API compatible with the original, and the frontend still performs well on the latest version.
    - The implementation strategy is as follows. We have two options to update our new API. First, we can implement them in the SQL codes, using keywords like `order by` and `like`. Otherwise, we can choose to do that in the Flask framework. It reads all data from the SQL database and operates the Python objects to implement the above functions. We think the first one will have better performance because it saves time transmitting data with the database. However, it limits the potential flexibility of these functions, because Python supports more functions than SQL such as regex, slice, and so on, and we don't think it will increase too much workload for our backend because the size of data is limited in our database, so we choose the second one.
    - As for the data, we collect more data from different sources and use them to update our database. Most of the default images are replaced by their real ones.

Phase IV Features:

- Our Visualizations
    - We used the Recharts library to create our visualizations for this phase.
    - Our first visualization is a histogram that shows the distribution of planets in each temperature range, including the specific range of 277-312 Kelvin that could potentially be habitable for humans.
    - Our second visualization is a scatterplot that shows the correlation between gravity and volume of a moon, as well as which host planet each moon belongs to. We noticed that Jupiter had the biggest moons.
    - Our third visualization is a pie chart comparison between the number of Main Sequence stars and Giant stars.
- Provider Visualizations
    - We also created visualizations for our provider, findacarfor.me.
    - Our first provider visualization is a scatterplot comparing the number of complaints and the safety rating of each car. We then color-code these depending on if the car has been recalled or not. This shows that cars with a high number of complaints or a low safety rating are more likely to be recalled, which makes sense.
    - Our second provider visualization is a histogram showing the average listing price for the ten most common car brands on their site. This can allow users to choose a car in their price range.

    - Our third provider visualization is a pie chart showing the spread of some important gas station amenities, including convenience stores, restaurants, and atms. This is done as a percentage out of all the gas stations.

NOTE:

- Previously we had run out of gitlab pipeline minutes for our Jest and Selenium tests. For this phase we had enough by the end, and pipeline results can be found here: https://gitlab.com/NathanSuss/group12-cs373/-/pipelines/latest