Process Book

CS 6630

Final Project

Fireballs, Meteorites, and Future Impact Events

Table of Contents

- Basic Information
- Overview and Motivation
- Related Work
- Questions
- Data
- Exploratory Data Analysis
- Design Evolution
- **Implementation**
- **Evaluation**

• Basic Information

Project Title: Fireballs, Meteorites, and Future Impact Events

Repository: https://github.com/rajathjavali/cs6630nasaproject

Website: https://rajathjavali.github.io/cs6630nasaproject/finalproject/

Team Members:

Names	Email Addresses	uIDs
Diana Ngo	diana.ngo@utah.edu	u0694440
Rajath P Javali	u1140594@utah.edu	u1140594

• Overview and Motivation

Astronomy provides insight into the phenomena that occurs beyond Earth's atmosphere. Our interest in the subject provided the motivation for this project. The objective of our visualization is to learn about the activity in space surrounding Earth by exploring past and future potential impact events with meteors. The project covers three sets of data that describe the following: meteorites that were recovered after landing somewhere on Earth; fireballs, also known as bolides, which are very bright meteors that usually explode in the atmosphere; and future potential impact events with near Earth objects (NEOs).

The first two datasets allow us to observe past events. The visualization helps us see the number of events per year, and whether there is a pattern in the data such as an increase in events over certain years. Additionally, we can compare and contrast the events by noting differences between the data including altitude, radiated energy, impact energy, and velocities for fireballs as well as mass and classification for meteorites. Additionally, we can discover which countries have had the most recorded meteor activity.

For potential future impact events, we are using a dataset from the Center for Near Earth Object Studies at NASA's Jet Propulsion Laboratory. The data describes NEOs, which are defined as comets or asteroids that have an orbit with a close approach to the Earth. Using this data, we can visualize the number of potential impacts for various NEOs, the probabilities of impact, the potential threat, and the year ranges for when these impacts might occur. Through the exploration of this data, we can learn the amount of potential impacts over future years and the level of danger currently assigned to those impacts.

• Related Work

Inspiration for this project came from personal interest in astronomy as well as the research and projects at NASA. This includes work from the Center for Near Earth Object Studies at NASA's Jet Propulsion Laboratory. Exploring the datasets provided on their website led us to choose the topic of NEOs for the project.

- ## Questions

The main questions we want to answer with this project include the following:

1. How many meteorite and fireball events have occurred over the years?
2. Which countries have had the most meteorite and fireball activity?
3. How do the individual events compare to each other?
4. What does the amount of future impact events look like?
5. How do the probability and threat levels of future impact events compare to each other?

- ## Data

We will be using three datasets: meteorite landings, fireball and bolide data, and impact risk data. The first dataset, which describes meteorite landings, can be found at NASA's Open Data Portal: https://data.nasa.gov/Space-Science/Meteorite-Landings/gh4g-9sfh. The second and third datasets are from the Center for Near Earth Object Studies at NASA's Jet Propulsion Laboratory. The fireball and bolide data can be accessed using the following link: https://cneos.jpl.nasa.gov/fireballs/. The impact risk data comes from the Sentry System at JPL, and the dataset can be found using unconstrained settings for the table at the following location: https://cneos.jpl.nasa.gov/sentry/.

Since the data is already provided through NASA and downloadable in CSV format, we do not expect to do much data cleanup. However, we may need to parse some of the numerical values out of their provided string format.

To give a narrative of events, we plan to derive the quantity of fireball and meteorite events for each year and country by calculating the number of rows for each year and country in the datasets associated with past events. This will also involve determining which countries contain the latitudes and longitudes of each event.

In addition, we plan to compare various data values between the different meteor events to see how the provided data is related to each other. For example, we can compare the velocities and energies of bolides and fireballs to note correlations between the values. Additionally, we can compute the ratio of found meteorites to fallen meteorites per year to see how the amount changes each year. We can also compare and contrast the Palermo technical hazard scale to the Torino impact hazard scales to gain a better understanding of the impact risks posed by various NEOs.

- ## Exploratory Data Analysis

The visualizations we looked at were available at the same locations for our data sources. On the webpage for the fireball data source (https://cneos.jpl.nasa.gov/fireballs/), there is a map that shows each fireball event in the dataset. We built upon this idea by adding additional views that could be linked to the map view in our visualization design. This would allow the data to be more navigable and open to exploration.

In addition, the meteorite landing data provided a generic interface for viewing the data (https://data.nasa.gov/Space-Science/Meteorite-Landings/gh4g-9sfh/data). Selecting certain options allows the user to select columns of data to visualize. This provided the inspiration for the expandable table in our design. However, instead of providing the user with the ability to visualize the data using any chart type, we can tailor our visualization to use the best visual variables for the type of data that users select for comparison. We also simplified the interface to save screen space and make the data easier to navigate.

- **Design Evolution**

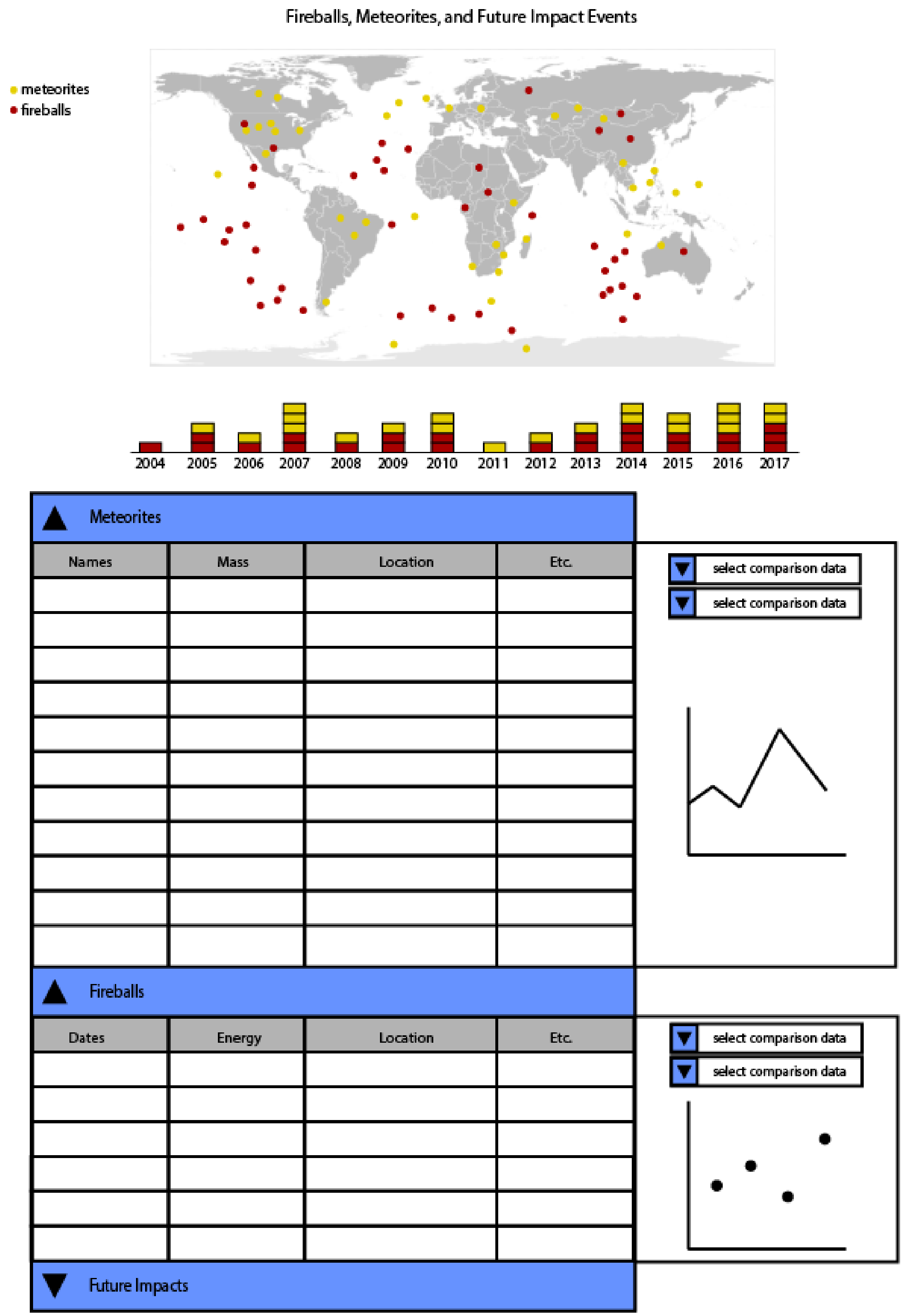
In the final visualization design for our proposal, we had three views: a map, a timeline, and a collapsible "semantic zooming" table with data comparison charts. The map visualizes all past fireball and meteorite events across all of the countries. A point is placed on the map encoding the latitudes and longitudes of each fireball and meteorite event. The timeline gives the number of such events over time using bars. Together, these views show the narrative of when and where events have taken place.

In addition, we included a table to display all the numeric data which will incorporate the visualization technique of semantic zooming. The table will comprise of three expandable category rows that correspond to our three main datasets: meteorite landings, fireball and bolide data, and future impact events. Clicking on any row will expand the table to display the details of that particular category. In addition, this will filter the data displayed on the map and timeline such that only the events corresponding to the expanded categories are shown. Furthermore, we will have a comparison chart associated with every table row. These charts help compare data between columns in the same category. The data can be selected using provided dropdown menus. These charts will include both direct comparisons of existing values as well as comparisons of derived data. Allowing the user to select the data to display on the comparison charts gives users the opportunity to explore the data on their own while preventing clutter on the screen.

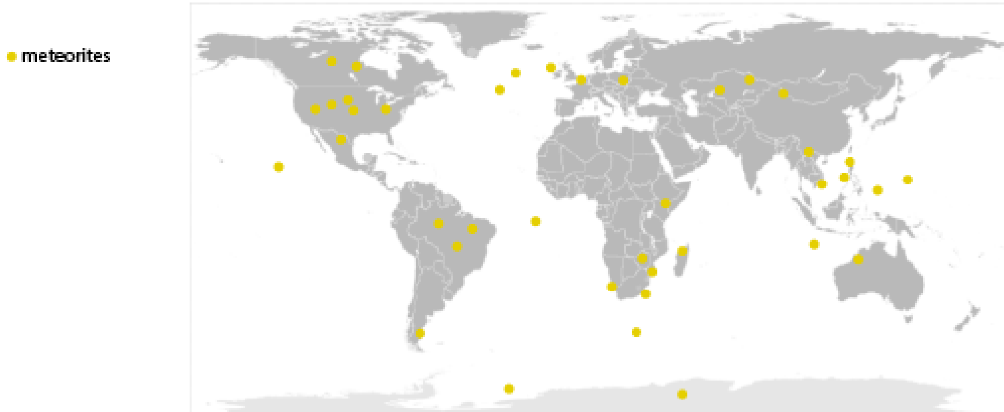
Additional functionality includes an on-hover feature which highlights the same event in all three views (table, timeline, map) when the cursor hovers over any of the events in any of the views. The views are also linked by the expanded categories in the table. For example, if the meteorites category is expanded, only meteorite events will be displayed on the map and contribute towards the counts on the timeline.

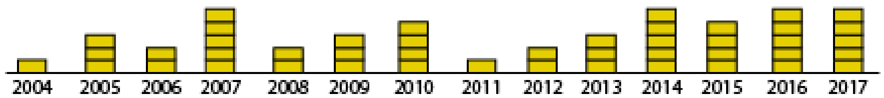
Further optional functionalities include the rescaling of table columns for additional comparison charts for each column and row and a "play" feature that will playback the narrative of the selected categories of past events over the years.

Final Proposal Design Images:



Fireballs, Meteorites, and Future Impact Events



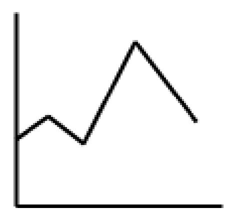


▲ Meteorites

Names	Mass	Location	Etc.

▼ select comparison data

▼ select comparison data

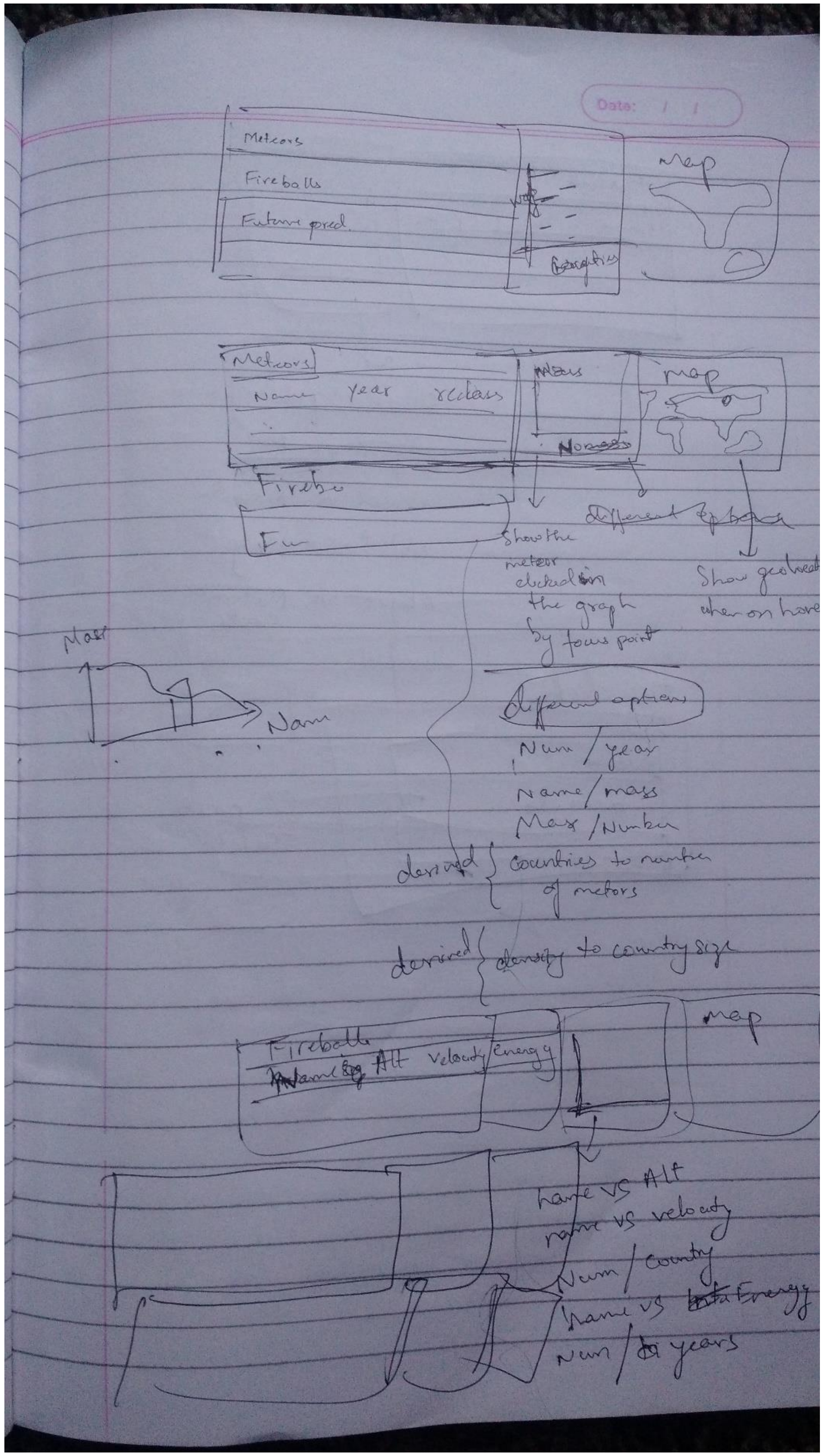


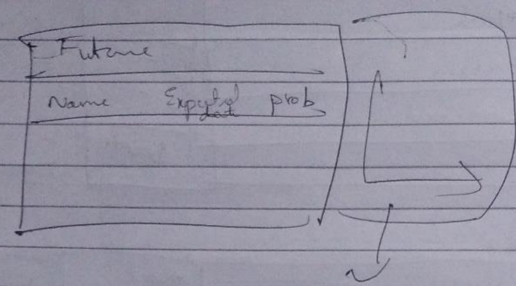
▼ Fireballs

▼ Future Impacts

Prototype Design Images:

One of our prototype designs incorporates the map view into the expandable table. Instead of having one large map that can hold and filter each of the event types, each expandable category of the table has its own map.





Object vs prob

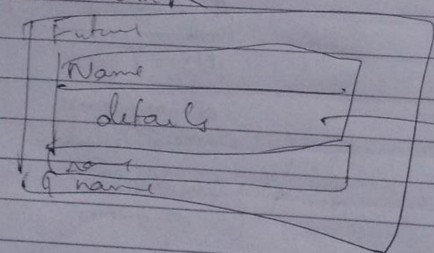
object vs mag

object vs diameter

object vs velocity

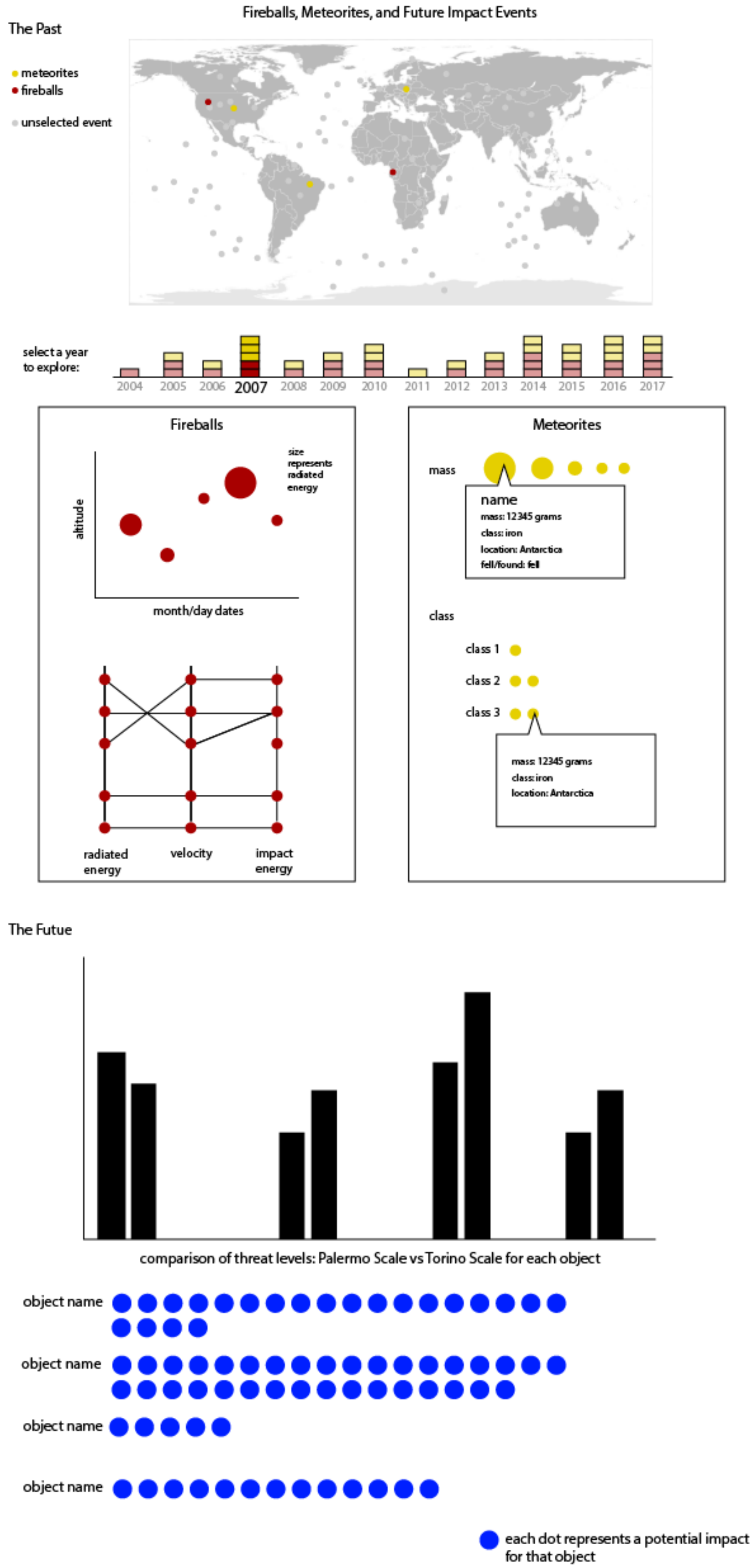
object vs Palermo Scale

one click

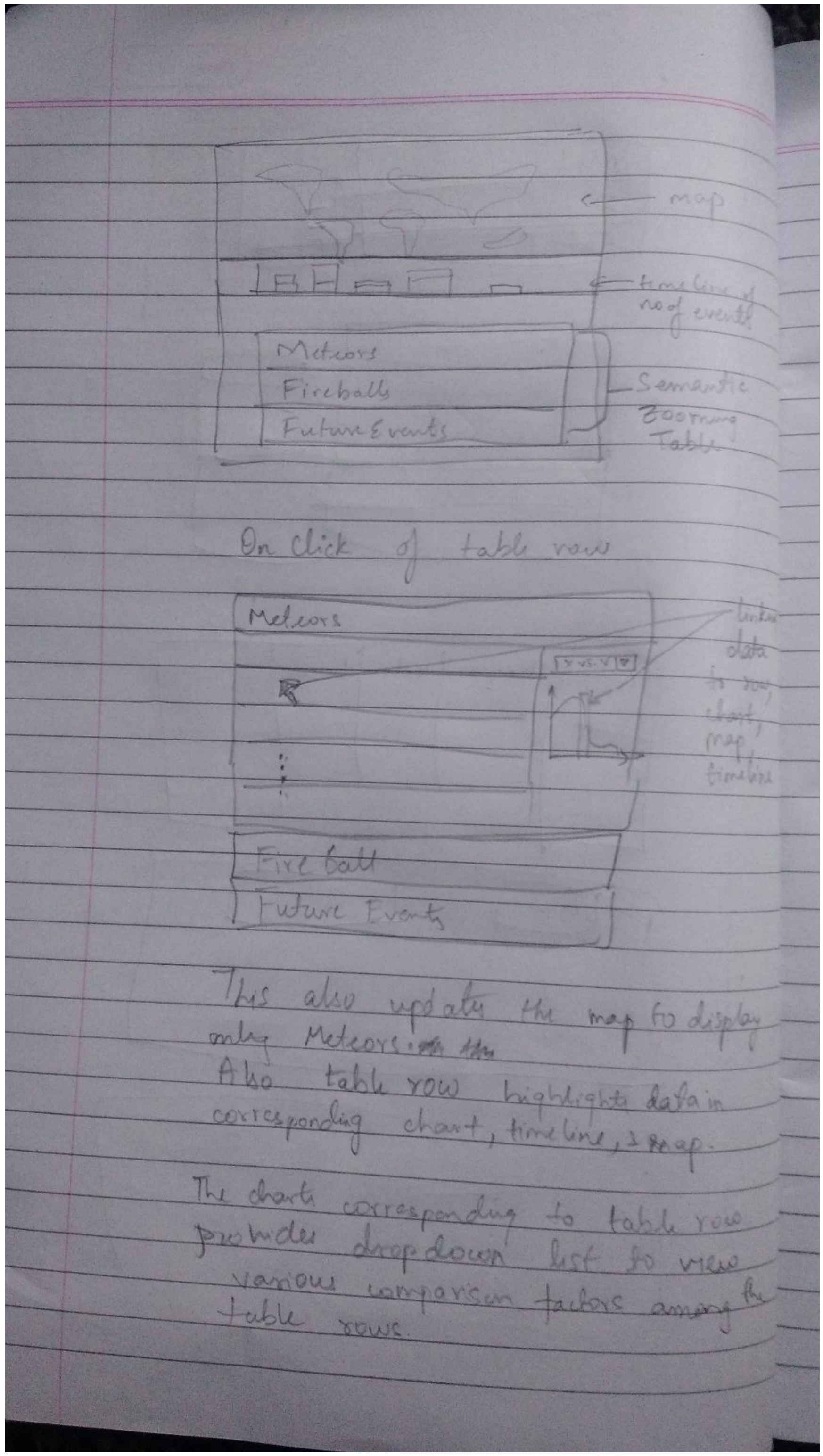


Impact Table

This prototype does not have the table view. Instead, all of the data is split into two sections: past events at the top and future events at the bottom. The past events incorporate a map view, timeline, fireball charts, and meteorite charts. The future events visualize impact threat levels and the amount of potential impact events for each object.



This is an initial sketch combining ideas from our prototypes with a single map view for the entire visualization. It also includes the expandable table view with a chart that can display user selected comparison data.



Peer Feedback:

Peer Team Members: Pablo Napan Molina, Jonathan Bown, Andrew Yang

- Consider sorting the data in the table and the chart representation based on selection of the column header
- Color code the marks on the map based on column header selected and place them into distinct categories eg: mass – place them into buckets 0.1-0.5 g, 0.5-1g... etc.
- Have a plot of projected year for future events, encoding the events in the form of bubbles, where size gives us the potential impact intensity.
- Having various filters to list all potential high impact events.
- Look into having the animation of the map over the years (optional feature) as part of must do.
- Expecting some sort of meaning full visual representation for the future possible events, and not just tabular data format.

Updates to the Design:

We noticed that there is a large number of events that appear on the map after implementing the view. For this reason, we are considering adding brushing over our timeline of past events to help filter the data.