CS 6630 – Project Proposal

• Basic Info

Project Title: Fireballs, Meteorites, and Future Impact Events

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

Team Members:

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• Background and Motivation

While researching various ideas for this project, I learned that NASA has several databases available online about meteors, meteorites, and possible future impact events. Although astronomy has always been a subject that has interested me, I have never done much research on meteors and impact events. After looking at the data that NASA has available on this topic, I thought that the datasets would make an interesting project. In addition, the project would not only provide a good learning experience about astronomy, but it would also benefit my understanding of how to visualize data by exploring a topic that interests me.

• Project Objectives

The objective of the visualization is to learn about the activity in space surrounding Earth by exploring past and future potential impact events dealing with meteors. The first dataset we plan to use describes meteorites that were recovered after landing somewhere on Earth. The second dataset provides information on bolides, also known as fireballs, which are very bright meteors that usually explode in the atmosphere. These two datasets will allow us to observe past meteor related events. The visualization will help us to see the amount of meteor 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 bolides and fireballs as well as mass and classification for meteorites. Additionally, we can compare the ratio of found meteorites to fallen meteorites.

For potential future impact events, we are using a dataset from the Center for Near Earth Object Studies at NASA's Jet Propulsion Laboratory (JPL). The data describes near earth objects (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 those impacts, the potential threat that these impacts pose, and the year ranges when these impacts might occur. Through the exploration of this data, we can learn the amount

of potential impacts over future years and the amount of danger currently assigned to those impacts. Additionally, we can compare the differences in threat levels between the Palermo technical hazard scale and the Torino impact hazard scale.

- ## 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 (JPL). 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/.

- ## Data Processing

Since the data is already provided through NASA and downloadable in CSV format, we do not expect to do much data cleanup. However, due to the formatting of the year ranges in the impact risk data, we may need to parse the numbers out of their current string format. Similarly, we may need to parse the latitude and longitude values from their current format in the fireball and bolide data in order to display the events on a map.

To give a narrative of events, we plan to derive the quantity of bolide/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.

- ## Visualization Design

In our final visualization design, we will create four 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 will be placed on the map encoding the latitudes and longitudes of each fireball and meteorite event. This will allow us to

visualize where events have occurred around the planet. The timeline gives the number of such events over time using bars which helps visualize the number of events that occurred for a given year on the map. Together, these views will show the narrative of where events have taken place.

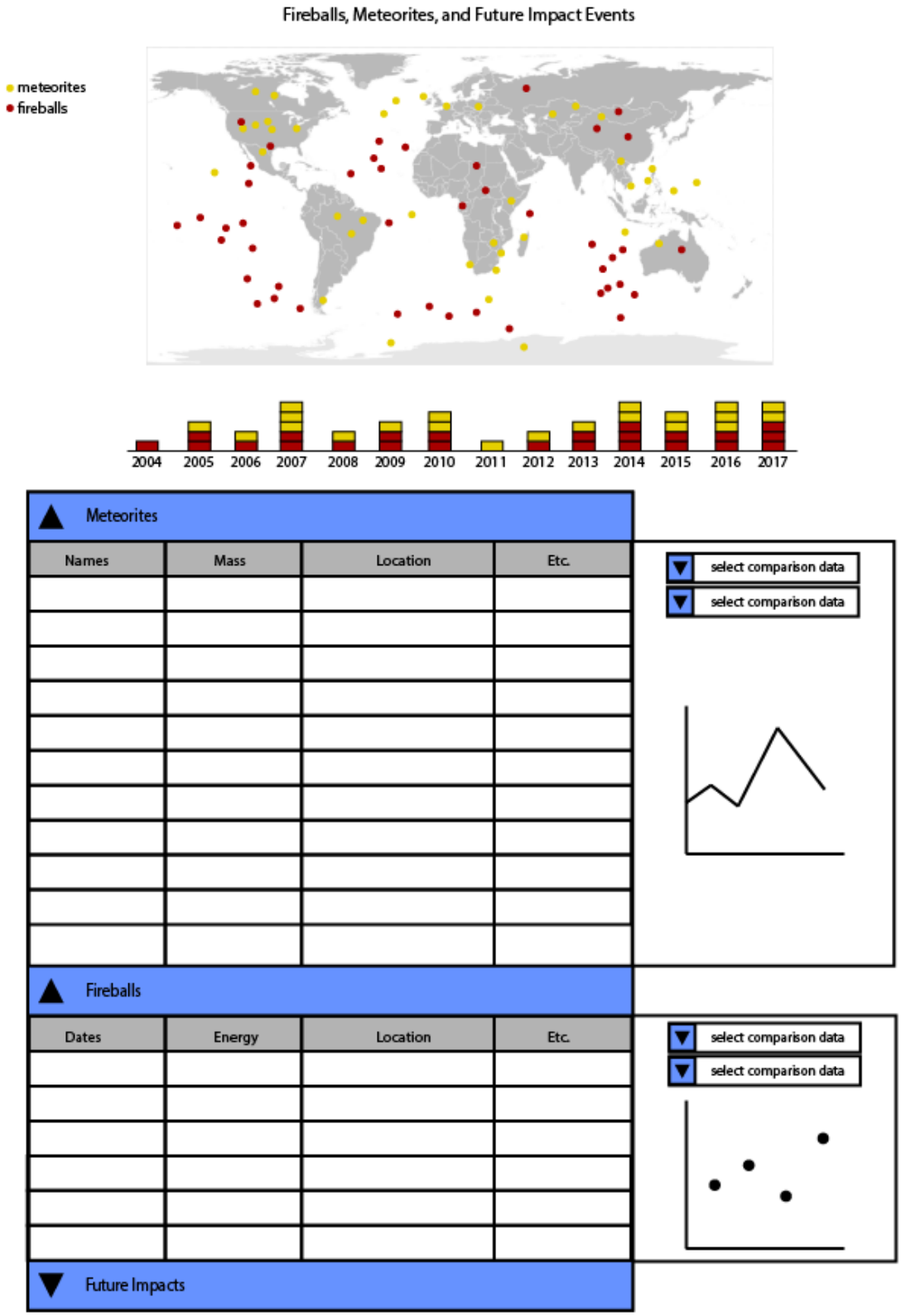
In addition, we will create a table displaying all the numeric data which will incorporate the visualization technique of semantic zooming. The table will comprise of three expandable category rows that correspond to our three main datasets: meteorite landings, fireball and bolide data, and future impact 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 in the chart axes can be selected using the 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 will highlight 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; the map and timeline will only display the categories which are currently expanded in the table. For instance, 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.

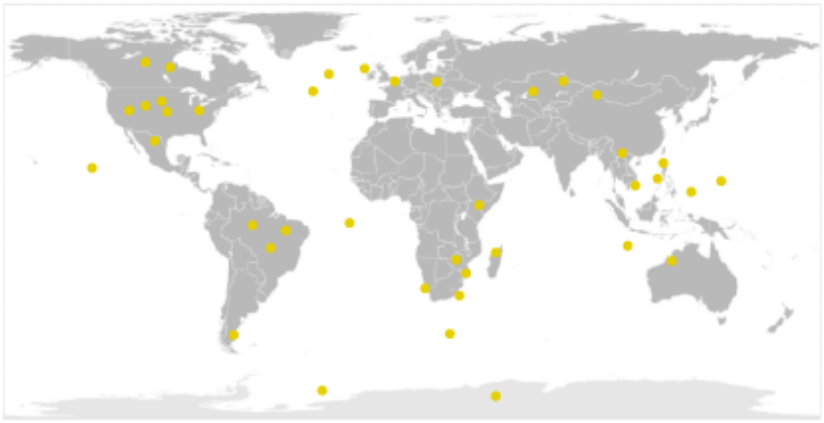
Images of our final design and prototypes can be found on the following pages.

Final Design Images:



Fireballs, Meteorites, and Future Impact Events

meteorites



▲ Meteorites

Names	Mass	Location	Etc.

▼ Fireballs

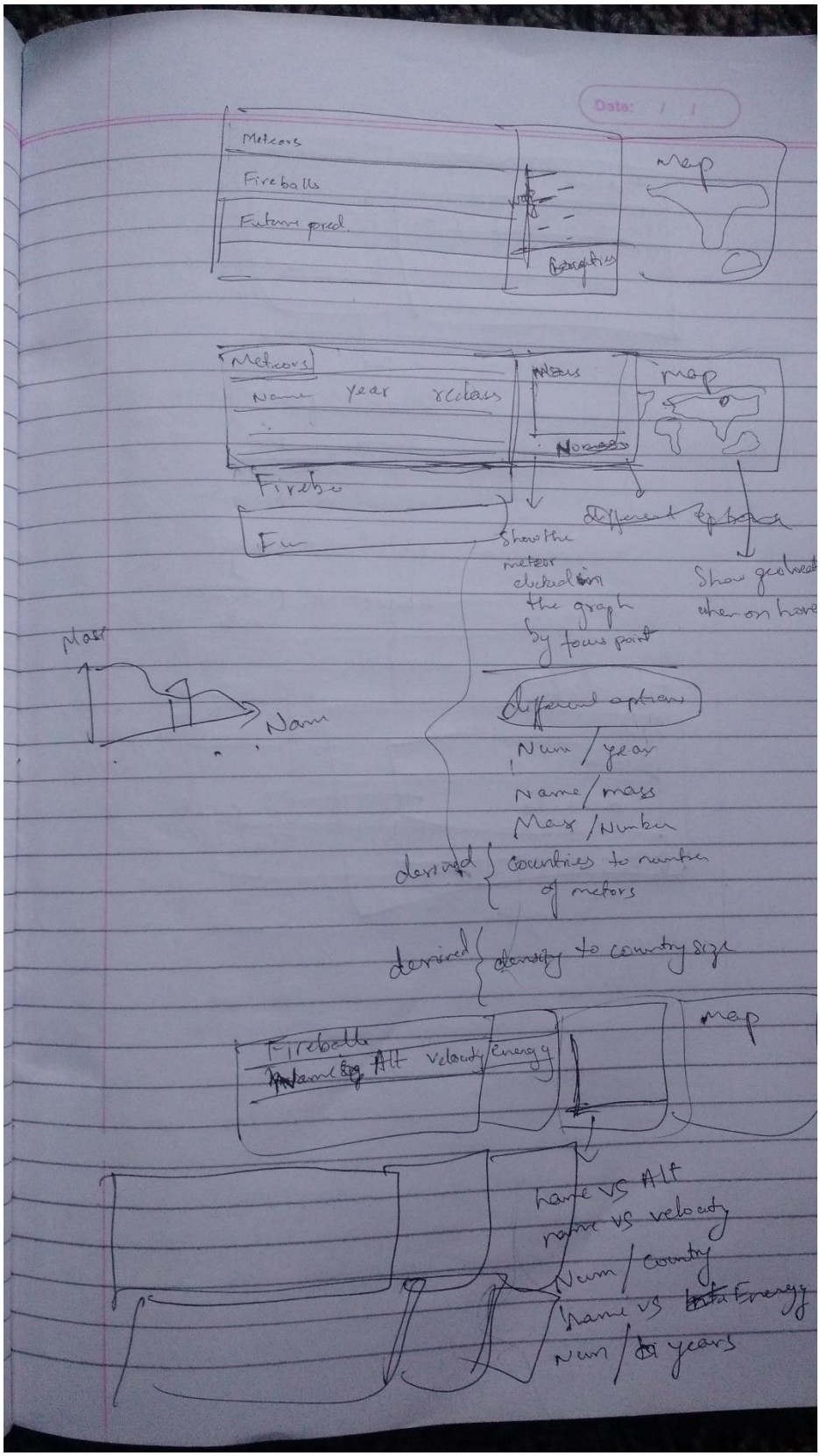
▼ Future Impacts

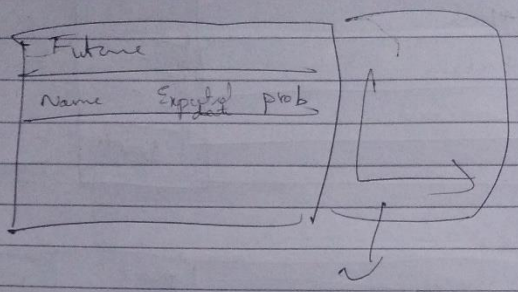
▼ select comparison data

▼ select comparison data

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

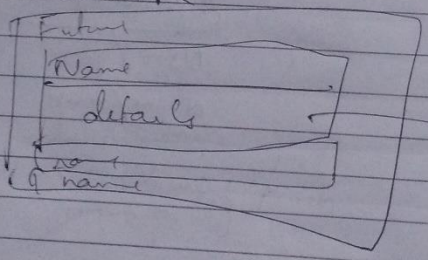
object vs mag

object vs direction

Object vs velocity

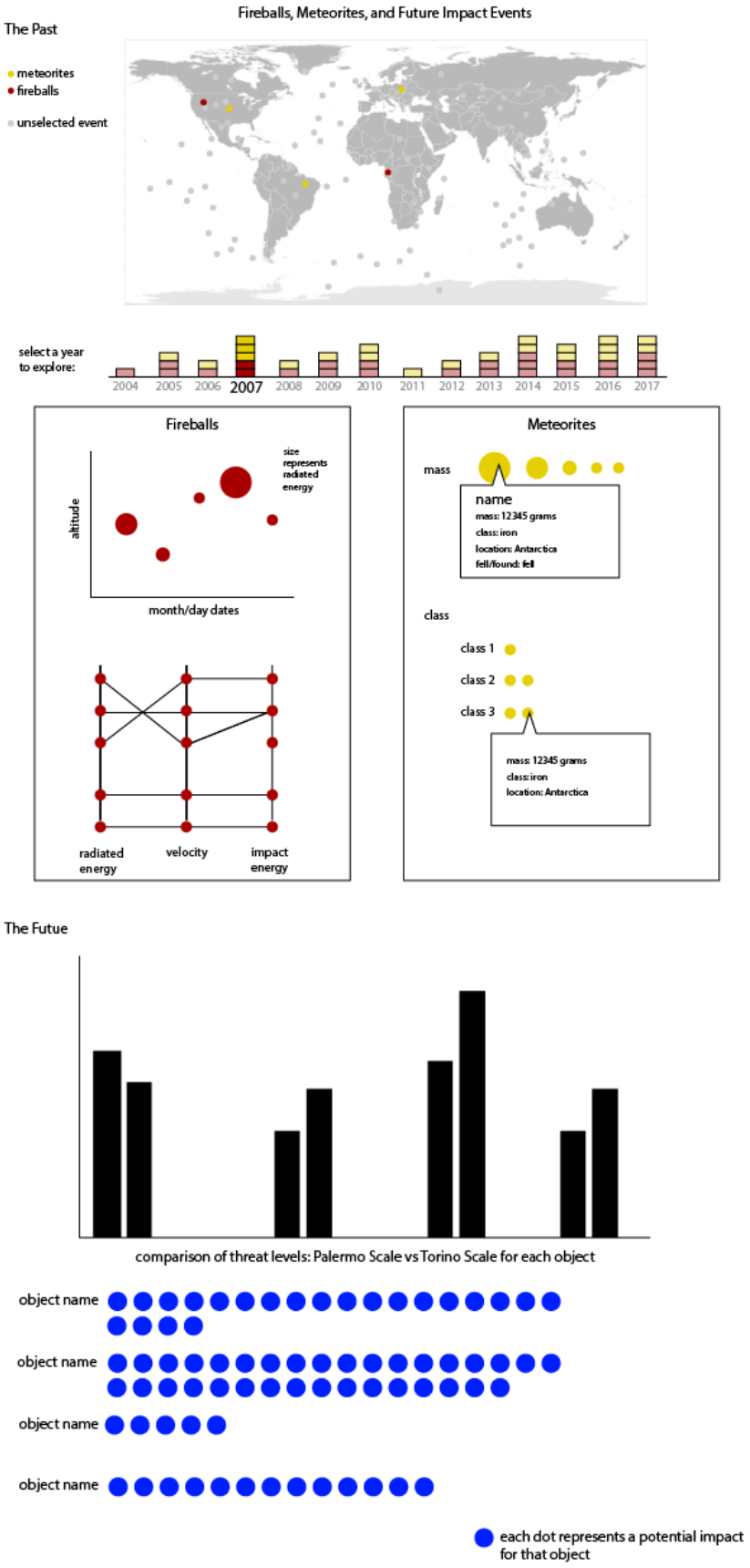
object vs Patterns

one click

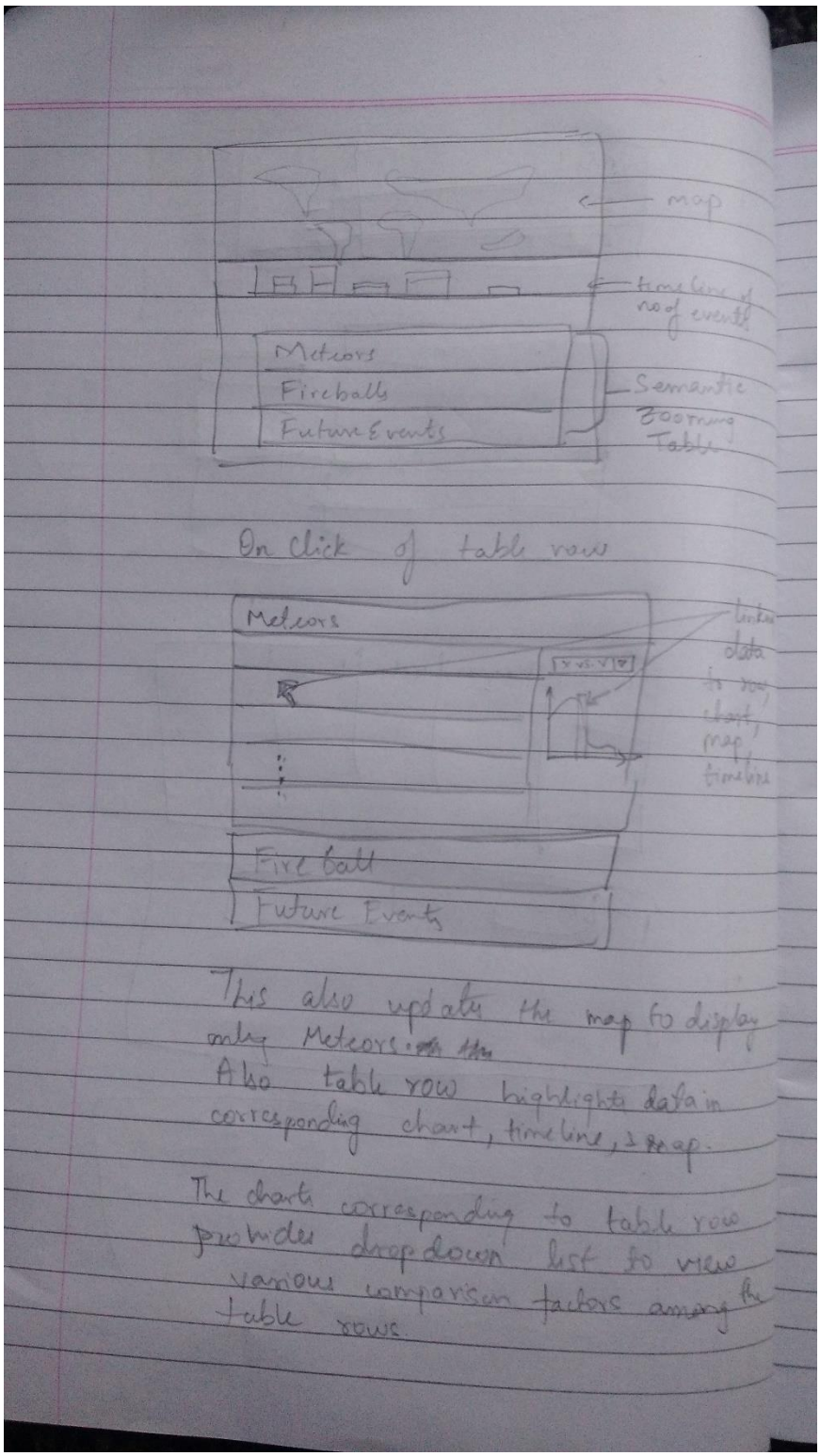


Input Table

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.



- ## Must-Have Features
    - Map displaying the locations of past fireball and meteorite events
    - "Semantic zooming" table with the three categories of data (fireball, meteorite, and future impacts) that each expands to show:
        - Corresponding statistics displayed in a table
        - Comparison chart with filters to select the type of data to visualize
    - Linking between views; Hovering over an item highlights the same item in other views
    - Timeline of past fireball and meteorite events

- ## Optional Features
    - Transitions between selected events and data
    - A "play" feature that plays the timeline narrative of fireball and meteorite events in a video format
    - Additional semantic zooming over each column of data in the expanded category tables

- ## Project Schedule

Week 1: October 30 – November 3

- Oct 31: Peer Feedback
- Deadline: Import datasets, Data processing
    - Diana: Import data into project files
    - Rajath: Data processing

Week 2: November 6 – November 10

- Nov 10: Project Milestone Due
- Deadline: Map
    - Diana: Layout project webpage
    - Rajath: Implement map

Week 3: November 13 – November 17

- Nov 14: Instructor Feedback
- Deadline: Timeline
    - Diana: Visualize timeline
    - Rajath: Timeline interaction

Week 4: November 20 – November 24

- Deadline: Semantic Zoom Table
    - Diana: Table data and functionality
    - Rajath: Table charts and linking

Week 5: November 26 – December 1

- Dec 1: Final Project Due
- Deadline: Finalization
    - Both: Cleanup