Data Visualisation Report

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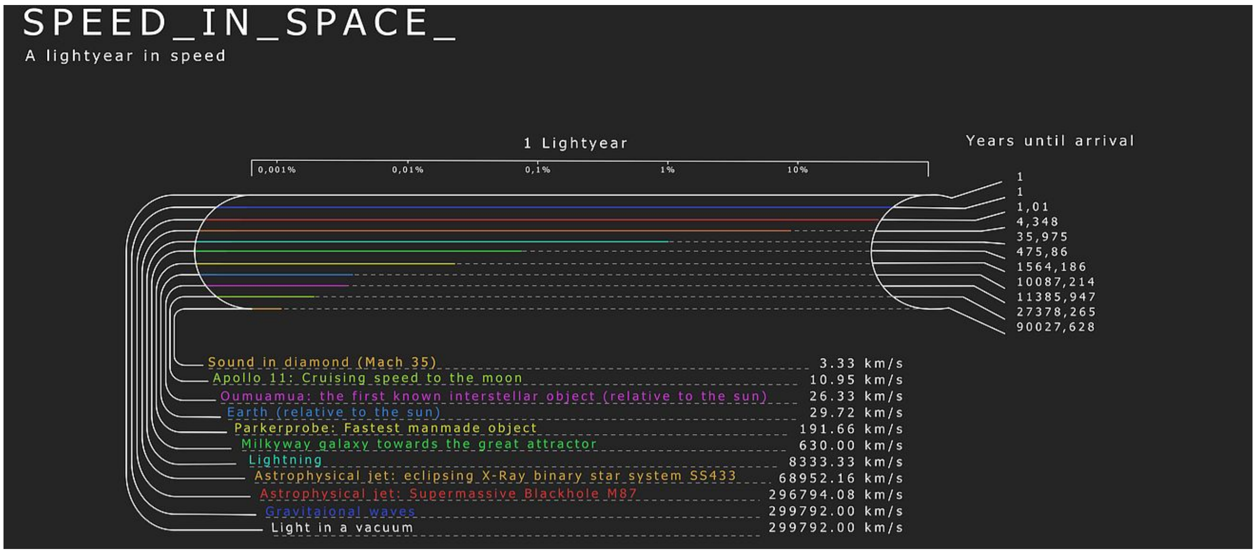
Link to visualisations (Best viewed in Chrome):
https://wzhao26796.wixsite.com/wzh-portfolio/data-visualisation-final-project

Speed and scale in space

The topic aims to explore the unbelievable dimensions of space and tries to visualize them in a way to give the user a sense of scale to set the stage for the following visualisations.

Visualization 1: Speed in Space

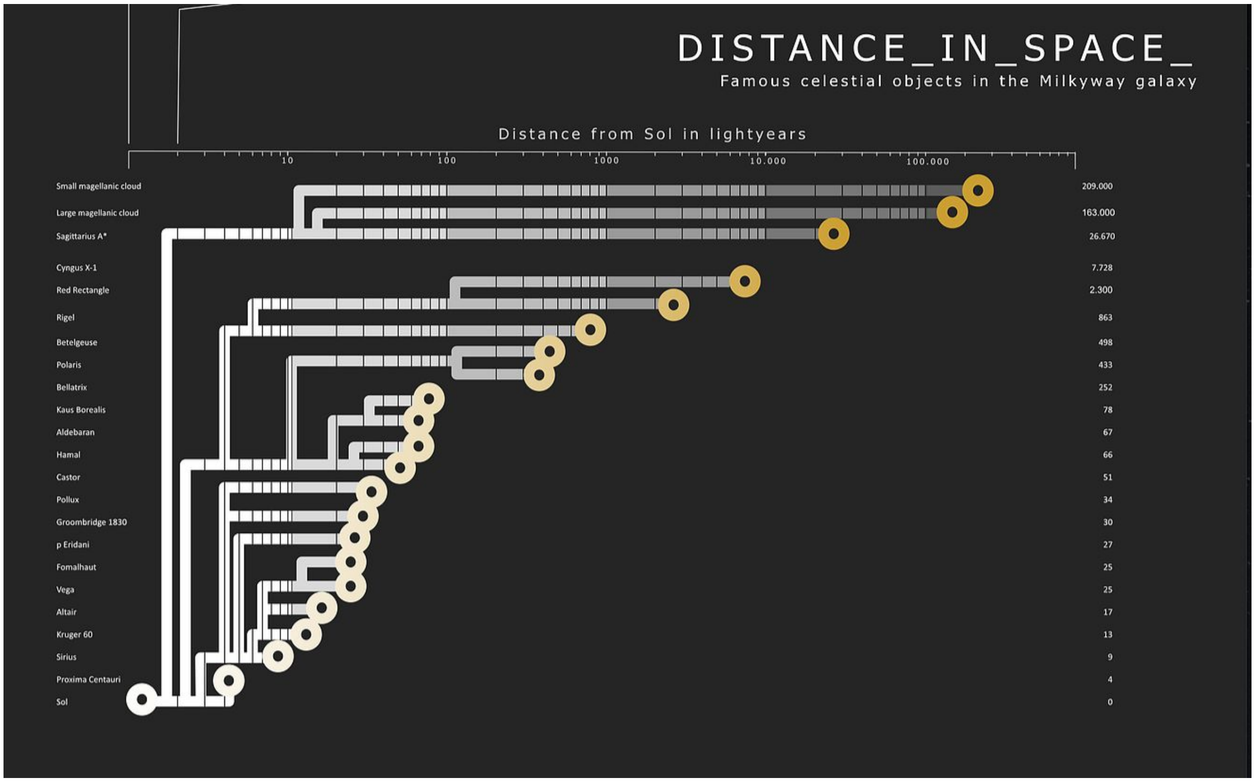
Made with tableau and Affinity Designer



The visualization shows on a logarithmic scale how fast different celestial or manmade objects are on the scale of a lightyear. It also provides information about their speeds and their estimated time to pass a lightyear. As there was no complete database on the speed of these objects the information was researched and calculated by hand. The data was then put into a table and visualized with tableau before being translated to Affinity designer.

Visualisation 2: Distance in Space

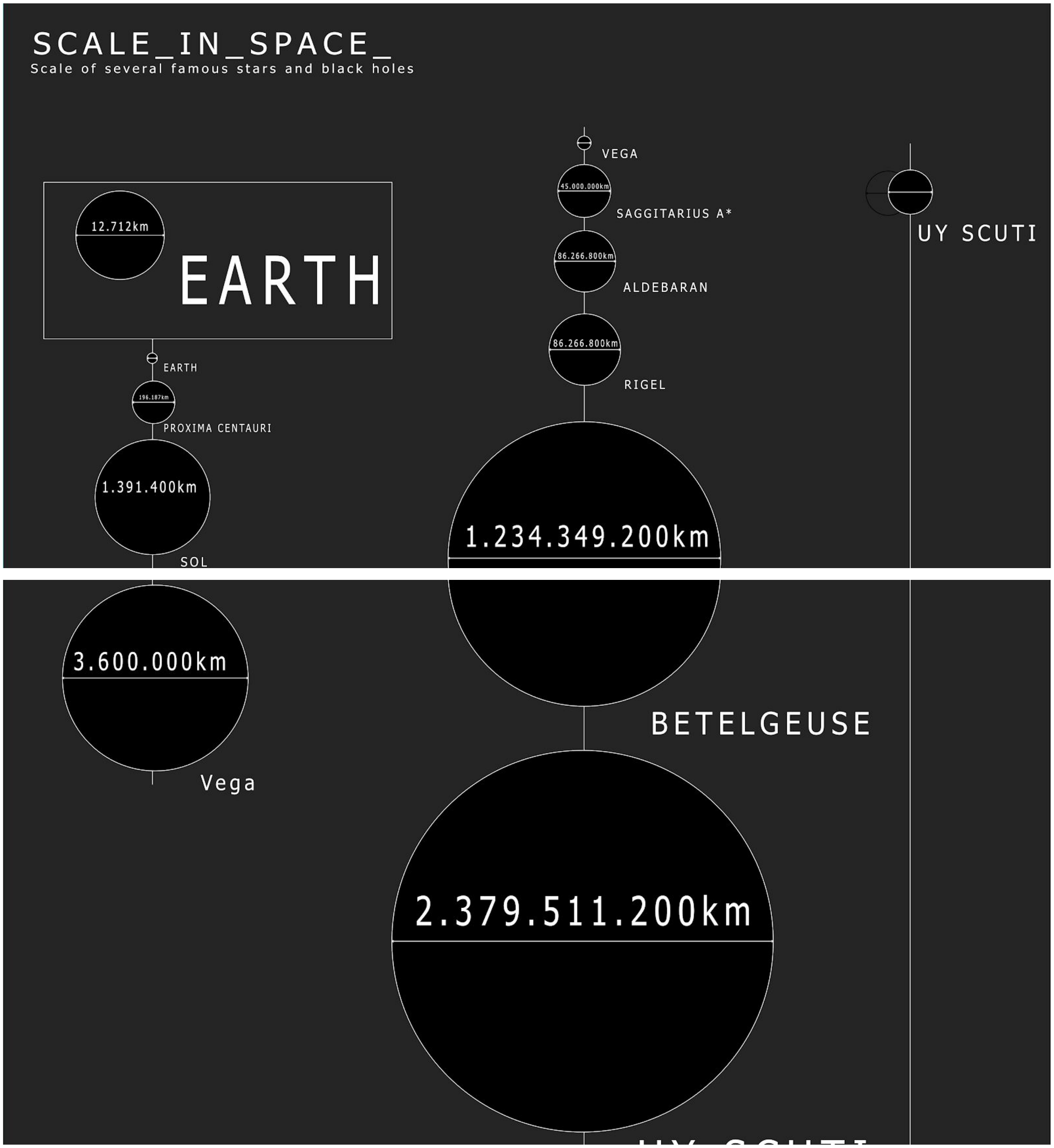
Made with tableau and Affinity designer



This visualization shows the distances between famous celestial objects and the sun on a logarithmic scale. It also implements the previously introduced scale of a lightyear. This visualization used the HYG Database which was refined using open refinery and visualized with tableau and translated to affinity designer. The Database was adjusted with some updated values and and objects.

Visualization 3: Scale in Space

Made with tableau and Affinity designer



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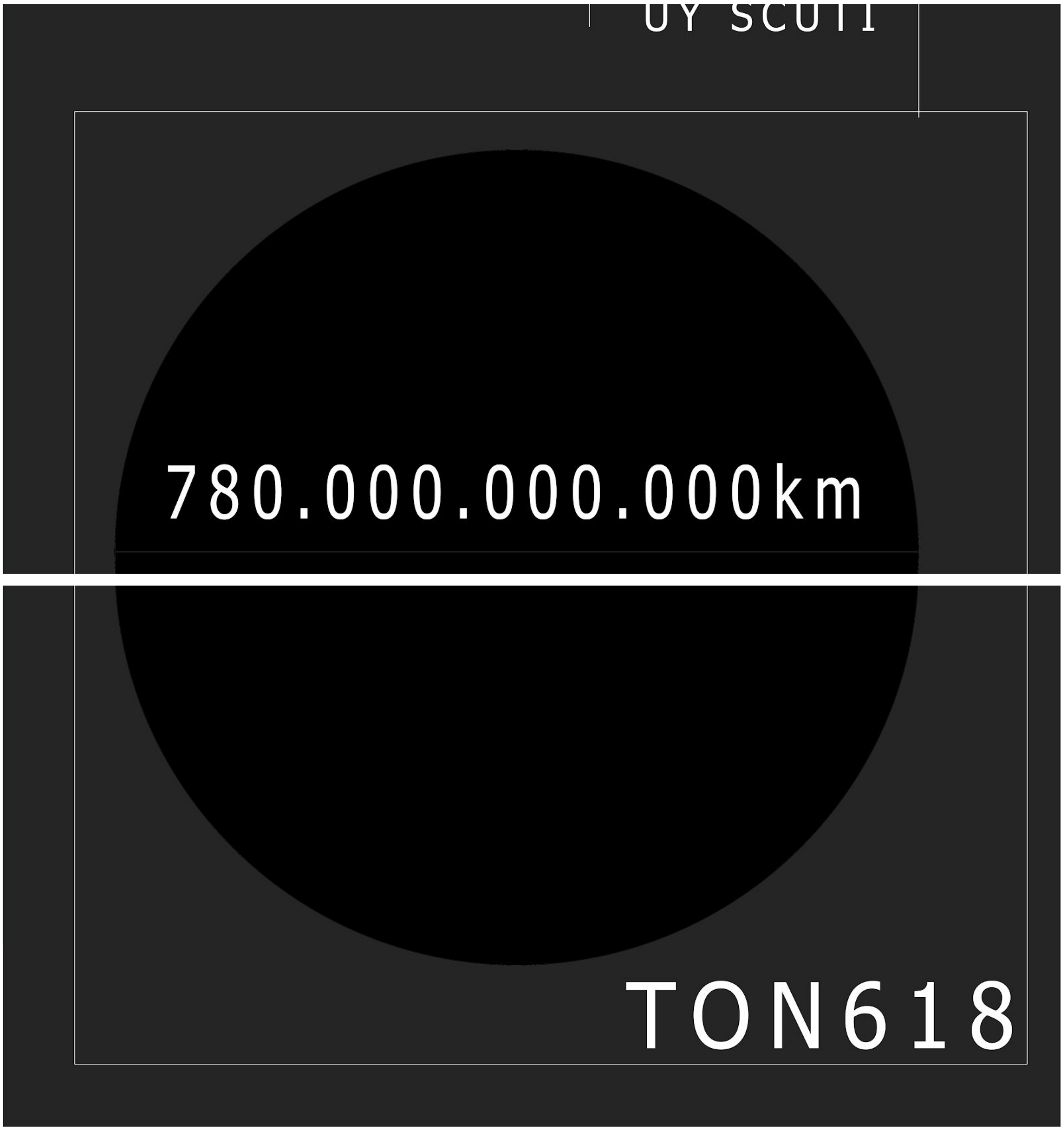


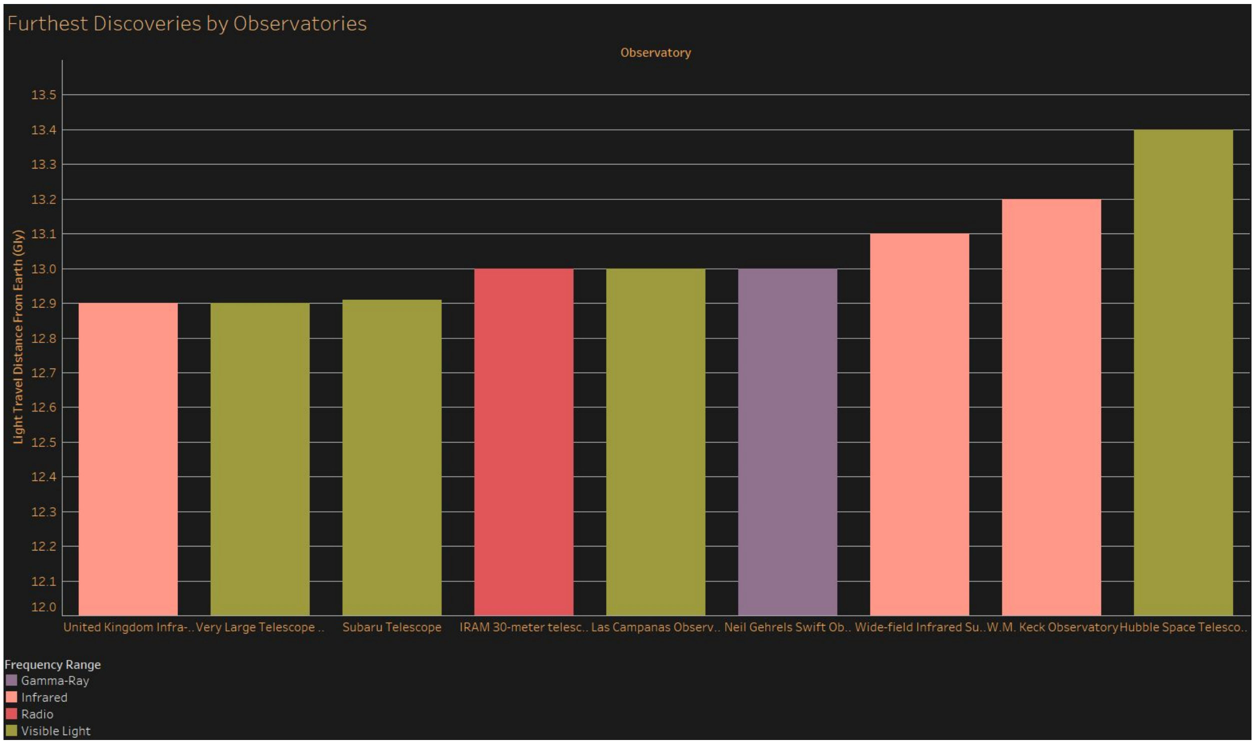
This visualization shows the relative scale of the biggest celestial objects we know of that are not nebulae or galaxies, relative to each other. As no comprehensive database on this topic was found, research was done by hand and a table was created which was visualized in several instances in tableau and translated into affinity designer.

The Observable Universe: The Edges of What We See

Here we explore the furthest reaches of the known universe and explore what are the furthest objects that we have observed and identified, as well as explore the boundaries to how far we are able to see, and the scale of it all.

Visualisation 1: Farthest Discoveries by Observatory

Made with Tableau



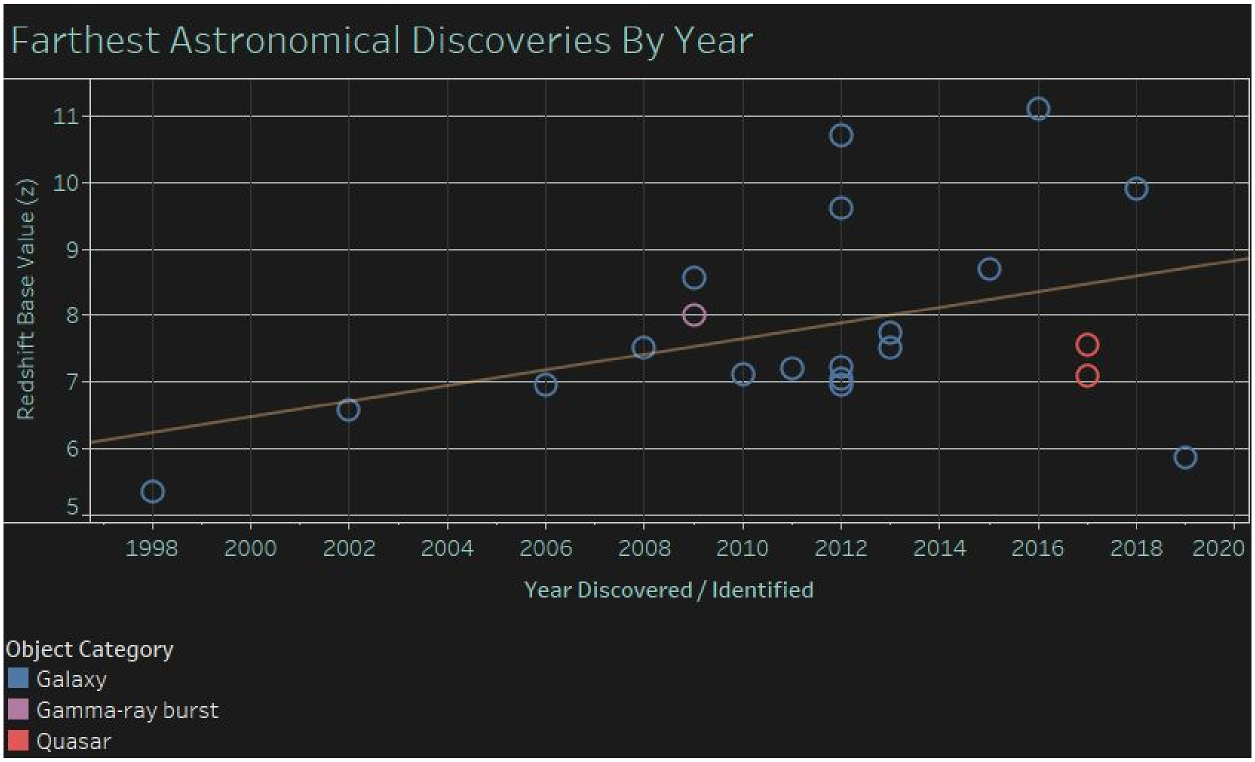
This graph shows the light travel distance of the farthest astronomical discoveries of objects to Earth by the observatory that discovered it. The data also includes the category of the object as well as the method used to discover it. Through this we can see which telescope was the most efficient at viewing deep into space, as well as which methods were most useful.

It should be noted, however, that different methods are more effective at detecting different types of celestial objects, and detecting the most distant object is not the goal of astronomy. This visualisation however simply explores how far different telescopes (and us as humanity) have seen into space, as well as which frequency ranges were most useful for detecting different objects.

A dark theme was chosen in keeping with the theme of space.

Visualisation 2: Farthest Discoveries by Year

Made with Tableau

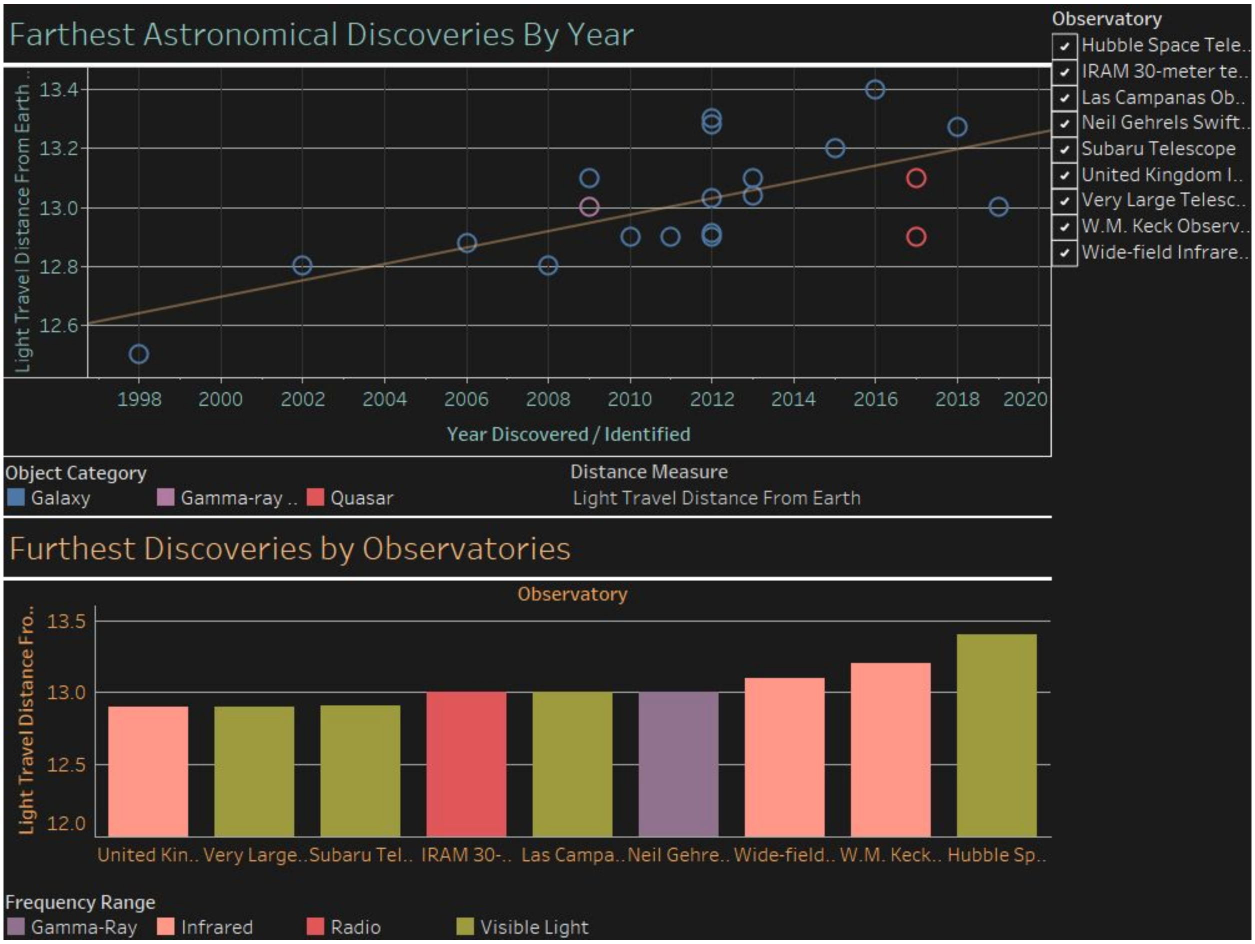


This graph shows the distance of the farthest astronomical discoveries of objects to Earth by the year they were discovered. This distance is Light Travel Distance (not Comoving or Proper Distance) in 1 billion light years, which is the time it took light from the object to reach Earth. You can also change the measure to the redshift value, which is a more accurate and scientific way of identifying how far the object is but does not provide a solid number. The data also includes the observatory that first discovered the object and the category of the object.

In this case, we can see that galaxies comprise the vast majority of the most distant astronomical objects discovered.

Visualisation 1 & 2: Farthest Astronomical Discoveries

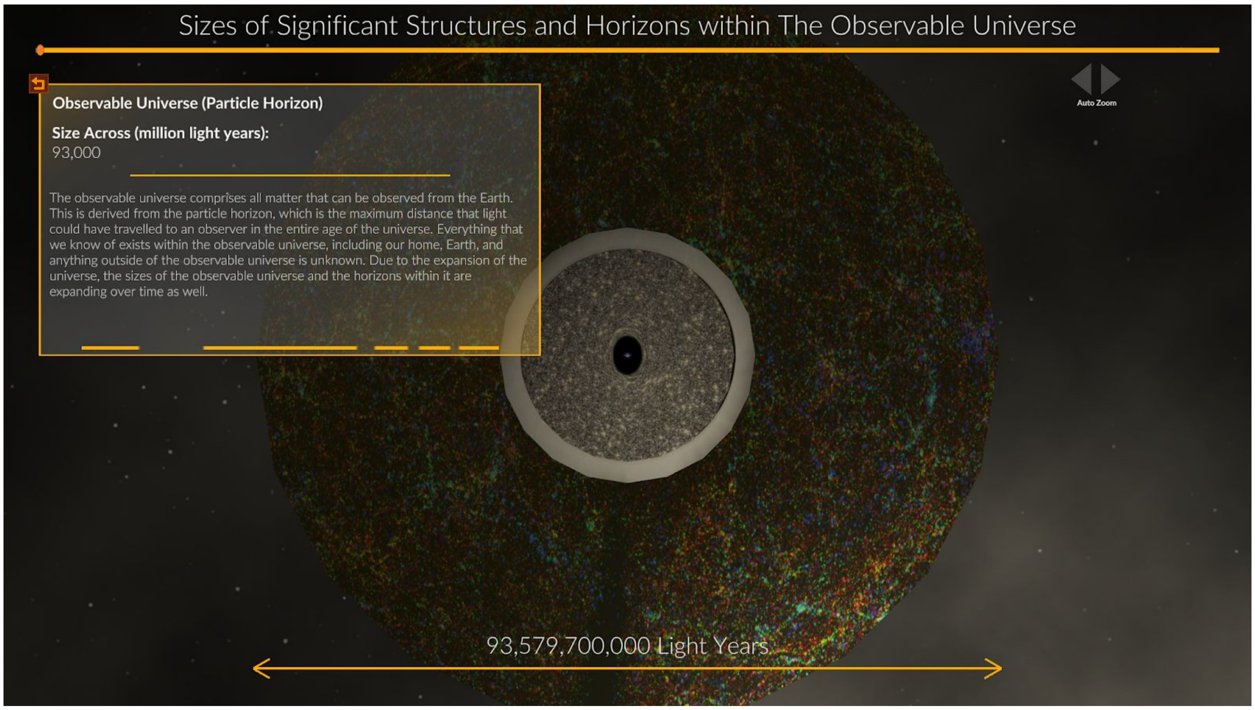
Made with Tableau



This is a dashboard and is an interactive visualisation of Visualisations 1 and 2. You can filter both by the object category and the observatory that detected or identified it. This allows greater insight into the topics of Visualisation 1 and 2 together.

Visualisation 3: Sizes of Significant Structures and Horizons within the Observable Universe

Made with Unity



This visualisation is a to scale representation of the observable universes, as well as some of the cosmic horizons that limit our view into space and the largest and most significant structures that we know of. Along with this are explanations of each data point and what they mean, and their size across (not the radius). Through this visualisation, I hope to show just how massive and vast space is, as well as how limited we are in what we are able to see and explore compared to the true size of the universe, which is still unknown and may never be known.

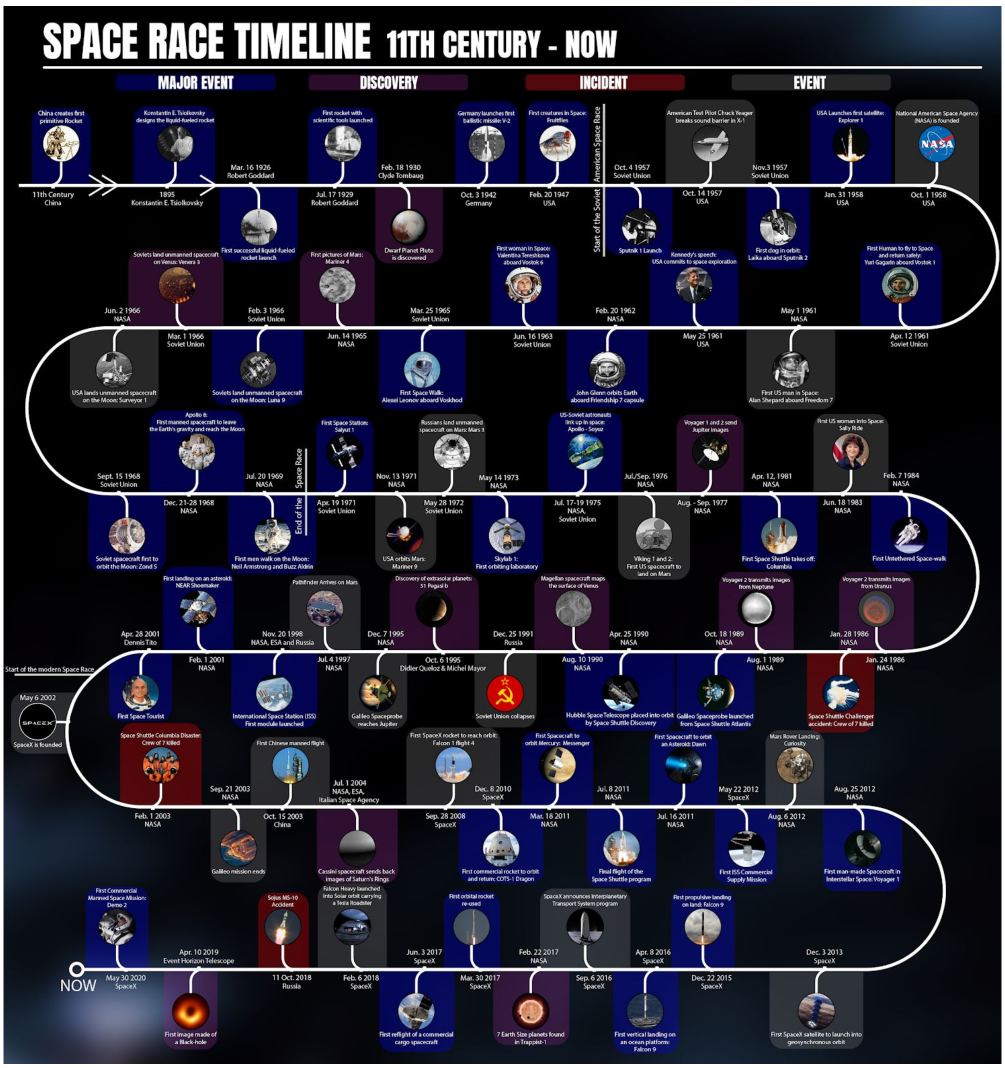
This visualisation is highly interactable, and you are able to use the slider above to zoom in all the way to the Milky Way. You can also use the mouse to scroll or the keyboard left and right arrows to auto zoom in and out. Each horizon or structure is represented with a different texture to better differentiate them, and can be clicked on to display information about them. The unobservable universe can also be clicked on by clicking outside of the observable universe, even though it does not flash when hovered over.

Space Race

Visualization 1: Space Race Timeline 11th Century - Now

Made with Adobe Illustrator

This timeline shows how far we’ve come from a primitive rocket, to the commercially manned crew mission by SpaceX only a few weeks ago. A lot of care was put into making sure major events were included, some other events may have not made the cut. Data was mainly collected from Space-related websites, which were during the research compiled into a self-made dataset.



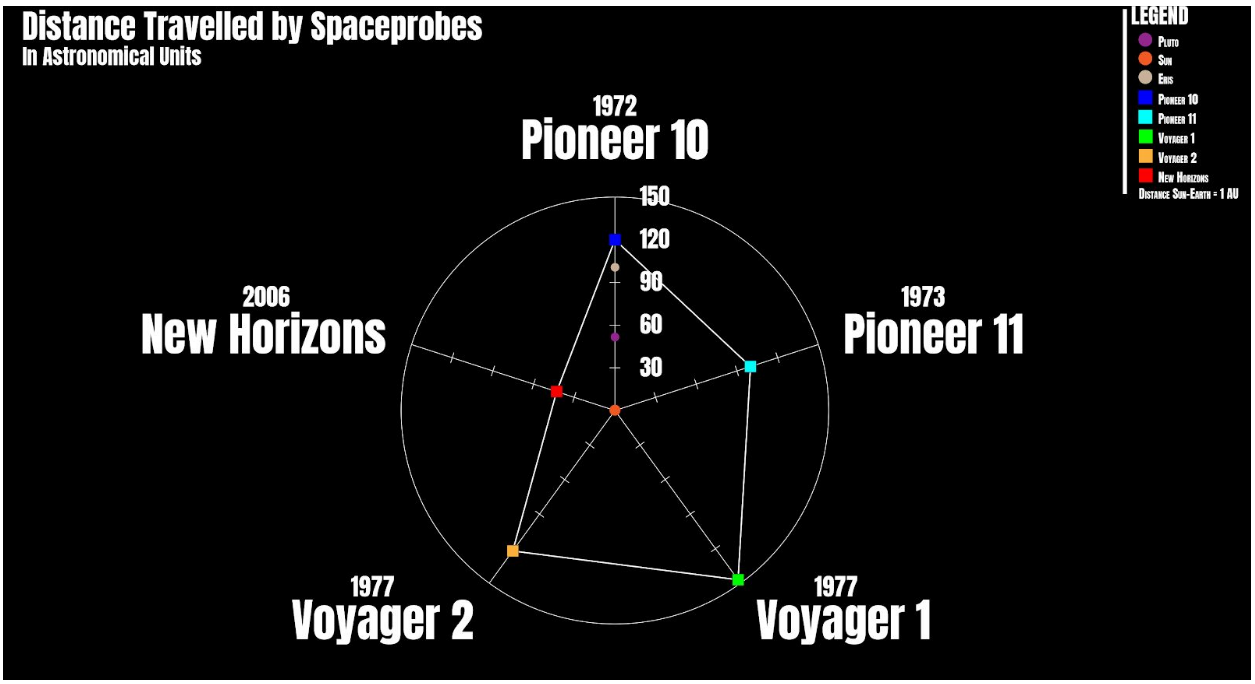
As for the design choices, clean white lines were choses to fit with a dark space themed background. Labels were added to highlight and categorize events. Images were added to give context and visuals to the discoveries and milestones.

Visualization 2: Distance Travelled by Spaceprobes

Made with Adobe Illustrator

This visualization shows the distance travelled by the NASA space probes, starting with the Pioneer 10 launched in 1972. Other celestial bodies were added from our solar system to give a context to the scale. However, it should be noted that these show their travelled distance, not their distance relative to the Sun.

Data was retrieved from an article written by a Space Scientist, answering the question how far each probe has travelled, their primary destination and whether they are still online. These values are from the year 2019.

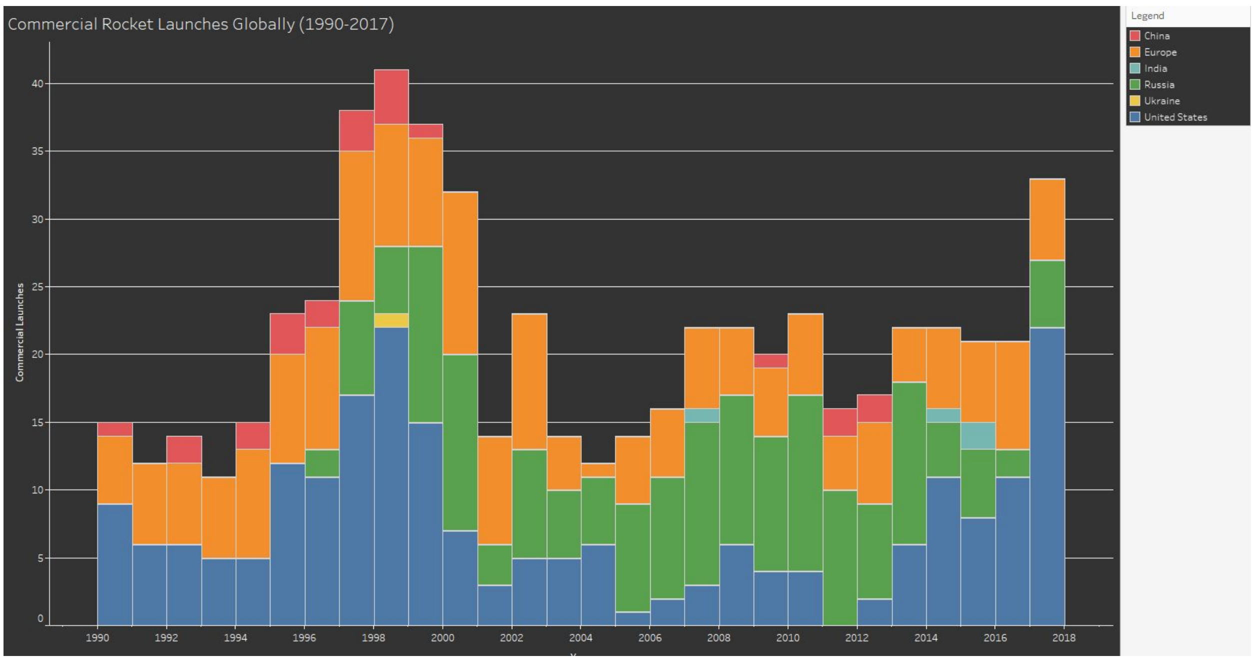


A black background was chosen to fit with the space theme. A Radar graph was chosen to display several probes but also in a space-like fashion. Again, white colors to keep the visualization clean, with colors reserved for displaying probes and celestial bodies.

Visualization 3: Commercial Rocket Launches Globally

Made with Tableau

This visualization shows the progression of the Commercial "Space Race". A clear peak around 1998 is visible, which can be explained by an increase of satellites being placed into orbit because of the increase in popularity of phones, the internet and gps. This data was retrieved from a database by the US government transport statistics division.

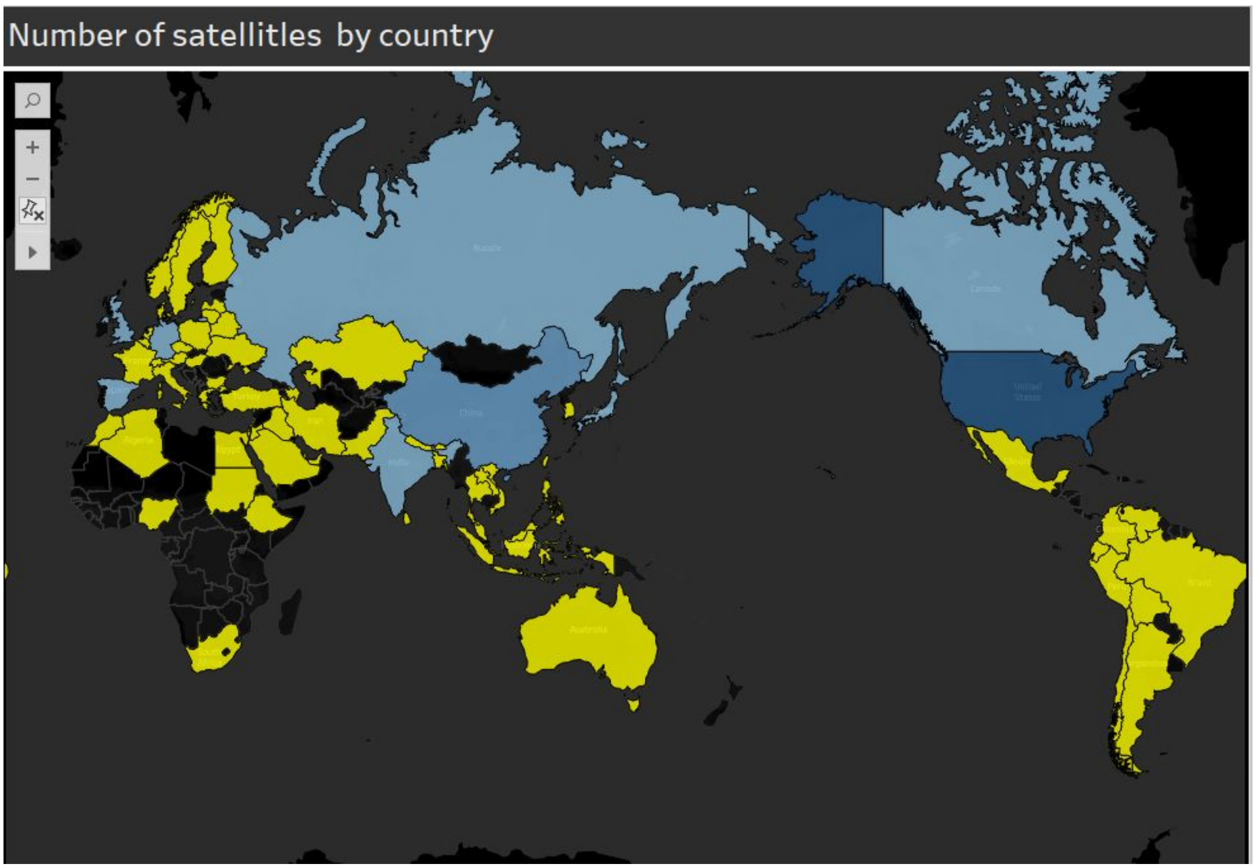


Again, black background to fit the space theme. Colors of the bars were selected by looking at the national colors of the respective countries. A stacked bar chart was chosen, so the total of the amount of launches is visible next to the individual values.

Space Travel

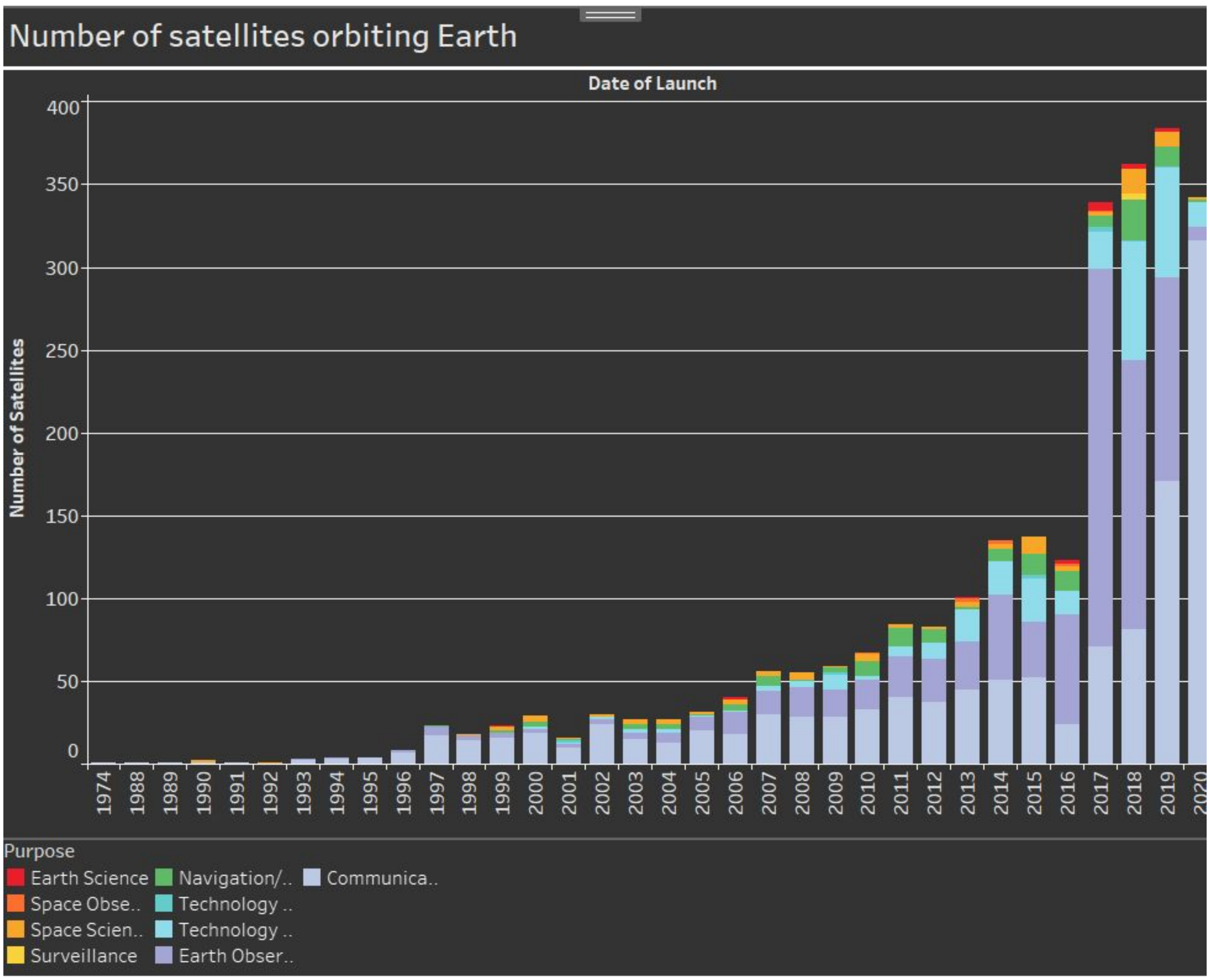
Visualization 1: Number of satellites per country

This visualization shows the amount of satellites per country. It is important to note that only 11 countries have the ability to launch orbit vehicules (Russia, USA, France, Japan, China, UK, India, Ukraine, Israel, Iran and North Korea) but there are more than 40 countries that operate satellites.



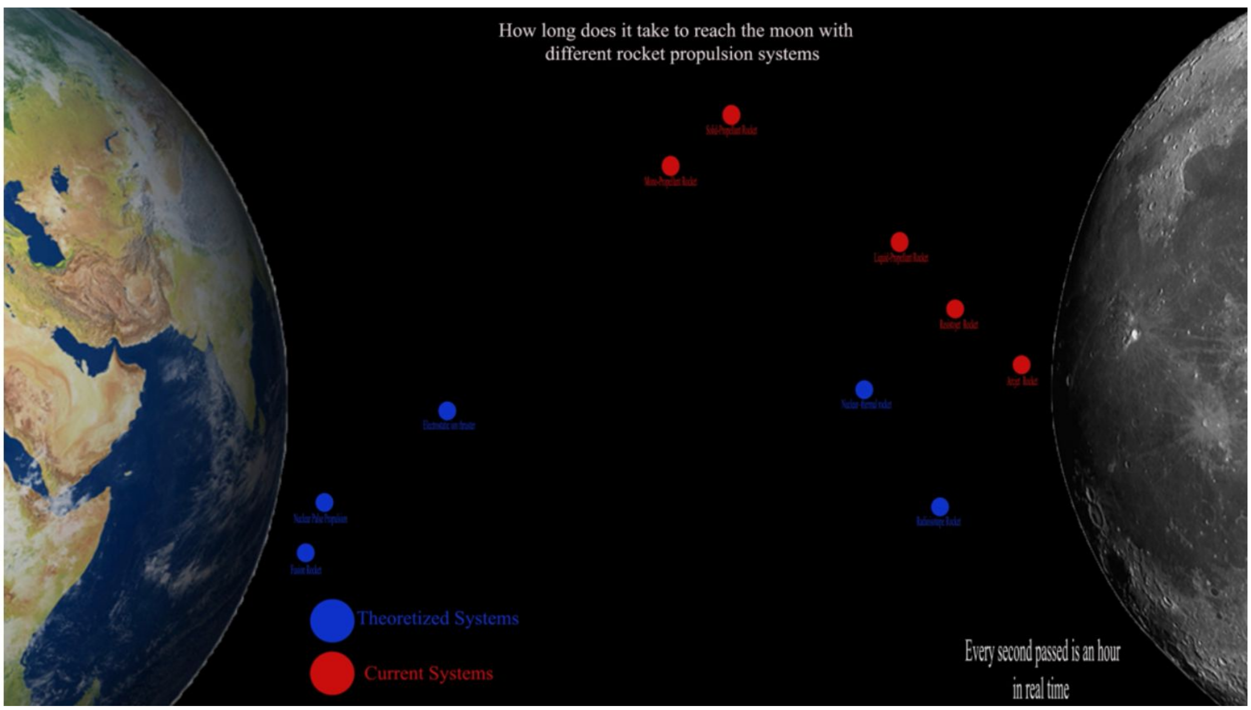
Visualization 2: Purpose of satellites orbiting Earth

This visualization shows where the effort of space travel is put into. The largest focus is dedicated towards communications and global positioning. Over half of all satellites orbiting Earth have the purpose to allow us to communicate. In recent years we can see that focus has shifted towards observing earth and space. In 2017 two quarters of the satellites launched were aimed to observe the Earth.



Visualization 3: How space travel can look like with different propulsion systems

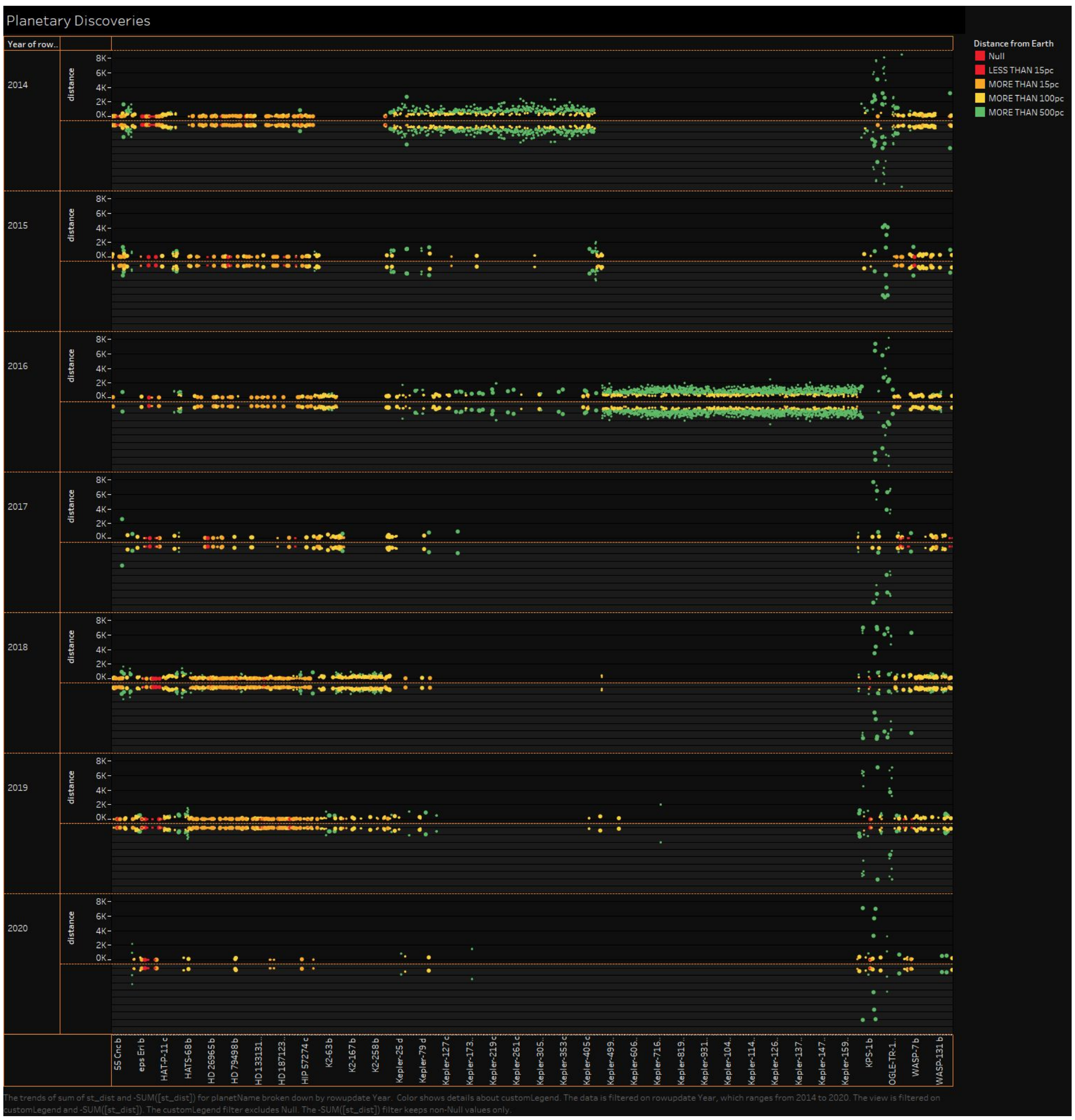
This video shows what the future can look like with new propulsion technologies. One of the problems that we face with current systems like the solid-propellant rocket is that despite being relatively slow, they require huge mass which makes the whole rocket need more fuel to be able to escape Earth's orbit. This makes the payload cost skyrocket as more fuel= more mass = less payload weight. Theoreticized systems could not only allow us to increase the payload weight by reducing the amount of fuel mass needed but could triple our speed for travelling in space. For example, a nuclear fusion rocket could make travelling to the moon take less time than travelling from London to Madrid.



Exoplanets

Visualisation 1: Planetary Discoveries

Here we can dive a bit deeper into the current state of art of exoplanets exploration. It is important to not confuse an exoplanet with a planet with possibly ideal conditions to host carbon based life. An exoplanet is any planet, discovered through a series of different techniques, which orbits stars of other solar systems around the universe. In the figure below we try to do a first analysis of the direction in which the planet discovery is heading. By sorting all the currently discovered exoplanets and stretching them over the past six years, we can gain some insight about the amount of planets being discovered yearly.



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Since the database of the exoplanets IDs is sorted alphabetically, we can also clearly see which families of exoplanets are being discovered (i.e. Kepler, K2, HD, etc). We can see that the year 2016 was the most populated with discoveries, where a good section of the discoveries is in the Kepler family. Since there are a lot less data points in 2020, we assume it is due to the fact that the data is only covered only until end of May of the current year. The color indicates the different ranges of distance of those planets from Earth.The few blue points on the visualization represent the planets that are closer than 15 Parsec from earth, or 48,9 light years, which could be theoretically reached by humans in case we discover light speed travelling.

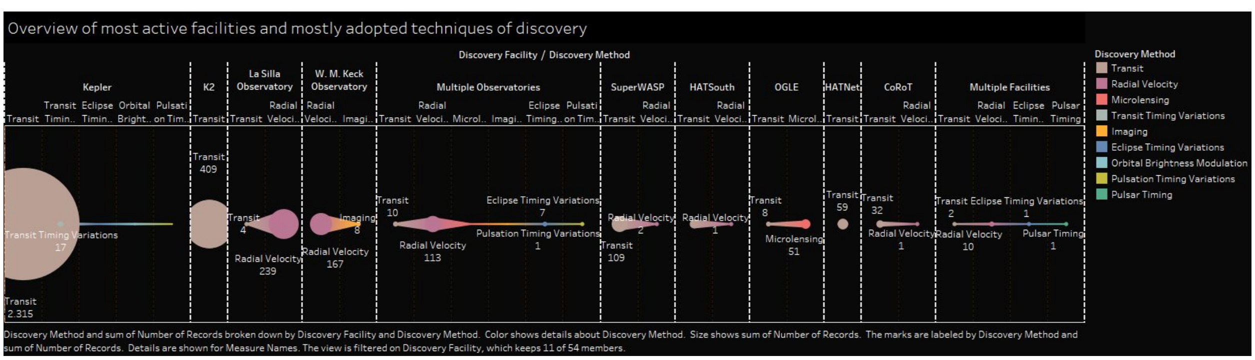
Visualisation 2: Most active astronomic facilities and most common exoplanets hunting techniques

The next valuable step to take in the study of human space race development seemed to be to analyze the common techniques used today to find these worlds.If we, as human race, decide to migrate to another planet similar to earth, we will need to find it first. Since we want to lower the uncertainties as much as possible, we will need to find lots and lots of planets.

Some of the search techniques used today to spot new planets are:

- Transit
- Radial Velocity
- Direct Imaging
- Gravitational Microlensing
- Astrometry

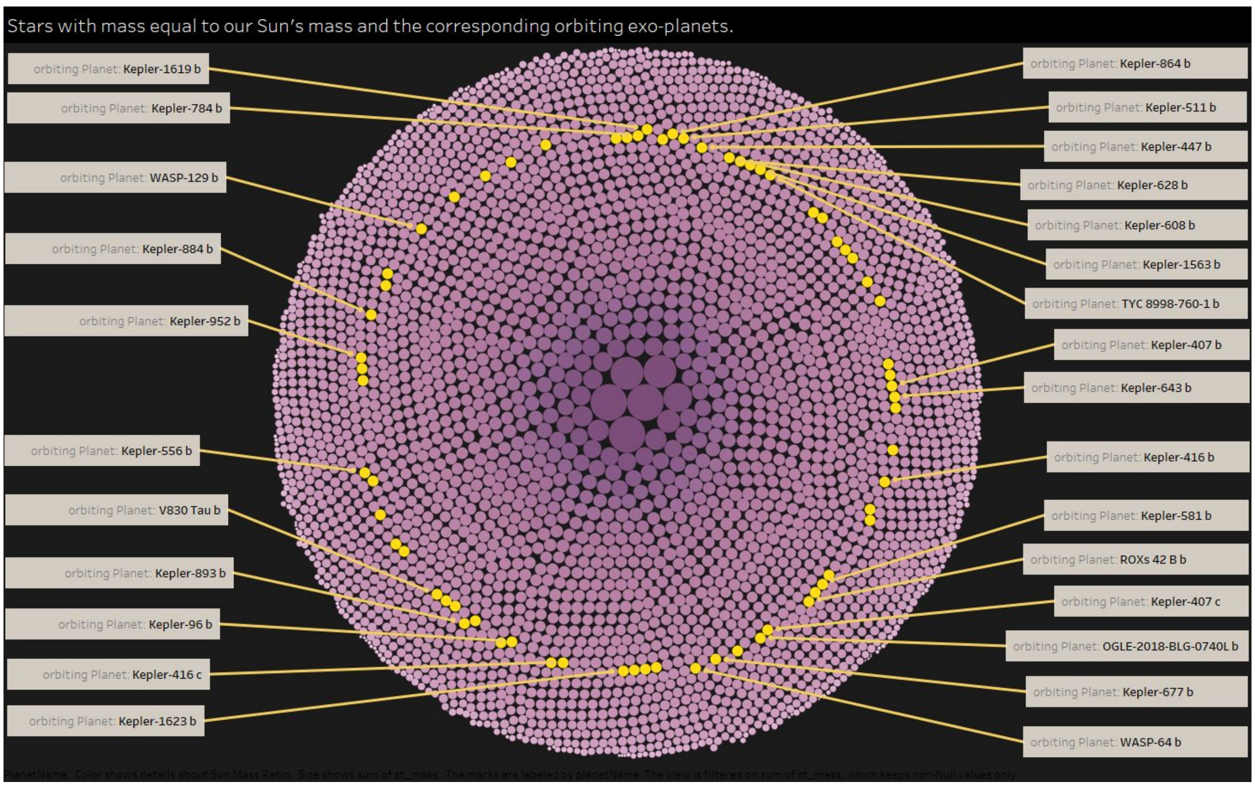
We tried to visualize how the planets discovered until today and which observatories are the leading in the exoplanet research.



We can immediately observe from the figure above that an absolute dominant technique is the **Transit technique**, followed by Radial Velocity and Gravitational Microlensing.

Out of more than 4700 current records, 2315 were discovered with the Transit technique, with the Kepler telescope only! We observe also that every facility has its own “array” of techniques adopted, which is probably due to the fact that all the facilities specialize in specific tasks in the astronomic research, and do not really focus on exoplanets discovery, which was the main aim of the Kepler telescope (retired since 2018). As the leading facilities we have Kepler, K2 (related to Kepler), La Silla Observatory, and W.M. Keck Observatory. Thus, it is also quite clear that the majority of the discoveries are done from the orbit, and not from the earth surface.

It was also interesting for our study to compare the sizes of the stars which the currently discovered exoplanets are orbiting. By using the packed bubbles, we were able to nicely visualize the overall masses of the stars around which we know there might be rocky worlds orbiting. We represented the stars of equal mass of our Sun's mass with a yellow color. The result was a ring showing a separation between stars of smaller mass (towards the outside) and stars of bigger stars (towards the inside).



We can observe, however, that the vast majority of the stars orbited by exoplanets are after all quite similar to our Sun in terms of mass. Another pattern that comes to the eye is the fact that most of the planets orbiting the Sun-like stars, are part of the Kepler family, which, sadly, is located in the third farthest distance range from Earth, as we also observed in the first visualization (gray bands).

Sources

Observable Universe

Visualisation 1

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Visualisation 2

Light Travel Distance & Redshift:
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Visualisation 3

Size of horizons & structures
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Exoplanets

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Space Race

Space Race Timeline
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