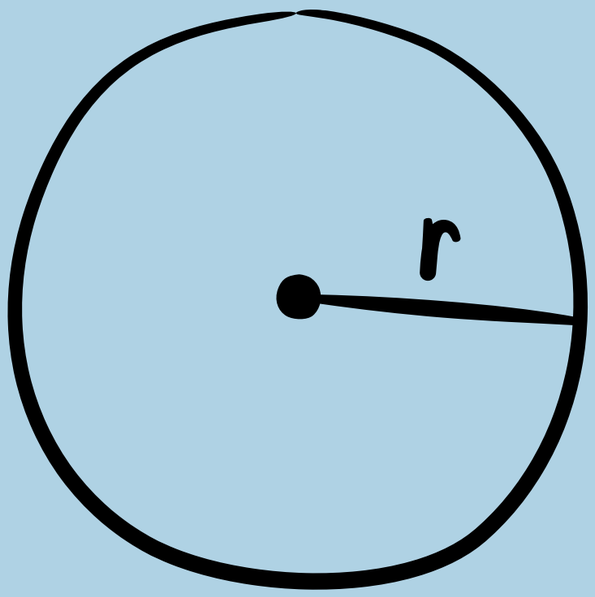
$$f(x)$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

MATHS-OLYMPIVIZ

$$\frac{x}{a} + \frac{y}{b} = 1$$

$$y = mx + b$$



$$a + (b + c) = (a + b) + c$$

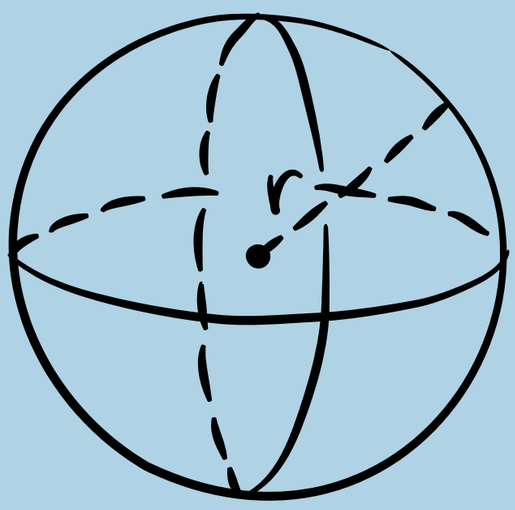
Written by:

Qian Hui Sim

Gabriel Gozlan

Luca Mouchel

$$A = \pi r^2$$



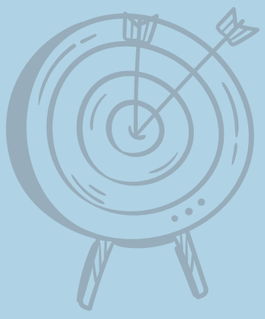
$$M = \left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2} \right)$$

$$V = \frac{4}{3} \pi r^3$$

$$ax^2 + bx + c = 0$$

For a description on how to launch our website,
please head over to the last page

Project Goal



Our aim for this project is to analyse the International Math Olympiad dataset, which consists of historical data over the years of all the participants, their scores, the country they represent and how well their country performed every year. We want to display and visualize how countries rank and more particularly measure how well countries perform based on GDP. In fact, countries with higher GDPs tend to rank highest (e.g., U.S, China, Korea) but how well do countries with lower GDP perform?

Dataset

The dataset that we have chosen is the International Mathematics Olympiad (IMO) scores from Kaggle. It contains scores of the IMO participants from 1984 to 2017, with breakdown of the individual scores for each problem. The dataset has been cleaned, as the records for the years where the scores for the individual problems are not recorded are omitted. This ensures completeness of the dataset and hence, no data-cleaning needs to be done.

The dataset represents the countries in country code (e.g. FRA for France), and a Github repository that provides the mapping of the country code to its name is used together. See the repository on Github via https://github.com/arthurberg/IMO.

Exploratory Data Analysis

In milestone 1, basic statistics we extracted from the data which will be useful for our final visualizations.

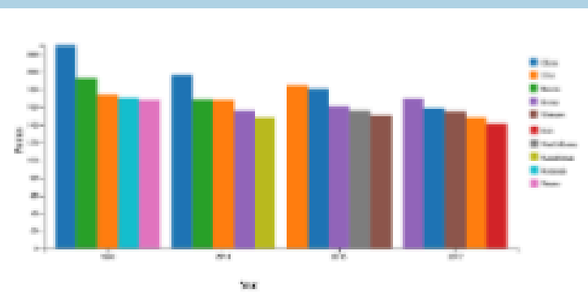


Figure 1: Top 5 best-performing countries in hand-picked years: 1990, 2010, 2015, 2017

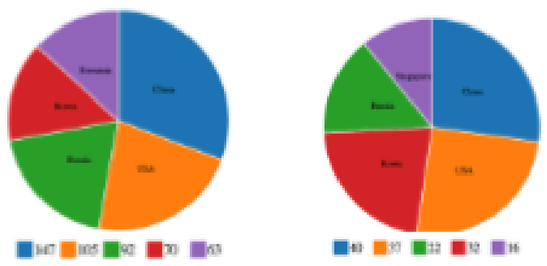


Figure 2: Total number of gold medals in the years 1984-2017 (left) and 2010-2017 (right)

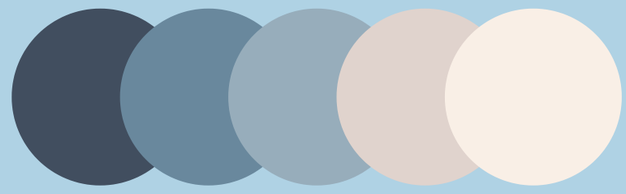
2010	2017
Belgium	Finland
Cambodia	Colombia
Sri-Lanka	Macau
Tajikistan	Switzerland
Austria	Syria

Figure 3: Countries awarded "Honorable mention"

Country	Average points per participant
Korea	28.33
China	26.5
Vietnam	25.83
USA	24.66
Iran	23.66

Figure 4: Average points per participant in 2017 for the top 5 countries

Website Colour Scheme



The primary color used is blue, often associated with intelligence, trust, and calmness, making it a perfect fit for an academic and competitive environment like a Math Olympiad. This modern blue color scheme with good contrast enhances readability and keeps users engaged. Neutral backgrounds (White and gray) with accent colors for highlights and calls to action effectively draw attention to important elements.

Secondary colors include White and various shades of gray. White provides a clean, crisp contrast to the primary blue, signifying purity, simplicity, and clarity, ensuring the content remains the focus. Light and medium grays are used for secondary elements like borders, background shades, and text to maintain a modern, professional look without distracting from the main content.

The header and navigation bar use a darker shade of blue to create a strong, stable foundation for the site. A light gray background is chosen to keep the content readable and clean. Primary text is black for readability, while orange is used for buttons and links to draw attention and encourage interaction.

The map and other interactive elements incorporate shades of blue to align with the primary color scheme, keeping the interface engaging and visually consistent. This cohesive color scheme ensures a smooth visual flow across the website, enhancing both usability and aesthetic appeal.

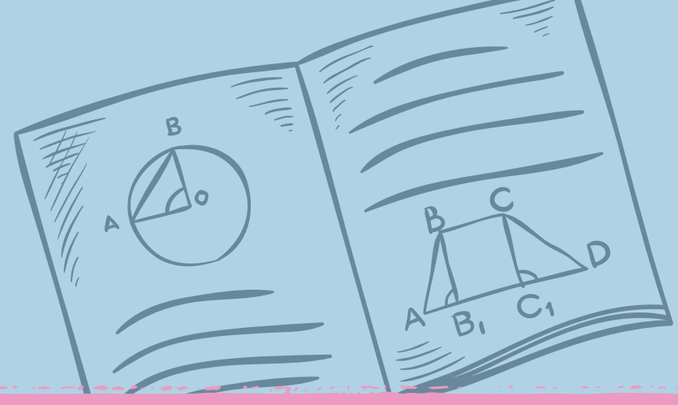
Website Layout

The layout of the website is designed to be intuitive and user-friendly, ensuring that visitors can easily navigate and find the information they need. The layout follows a structured approach, with distinct sections for different types of content.

The navigation bar is positioned at the top of the page, providing easy access to the main sections of the website. Home provides an overview and introduction to the website. Description offers detailed information about the purpose and content of the site. Data presents the datasets used for the visualizations. Team introduces the team members who created the project.

The main content area is divided into several sections, each with a specific focus. A brief introduction to the Math Olympiad and its significance. An interactive world map that displays information about GDP and Math Olympiad results. Line graph to analyse total points from each country as well as total points/GDP. Bar graph to analyse the number of medals and their GDP per capita over the years. Race chart visualizing the number of medals won over time for countries with the strongest correlation between the number of medailles won and GDP growth. Slider showing the progression of notable mathematicians who participated in the Math Olympiad.

The website uses headings and subheadings to create a clear content hierarchy. This helps users quickly understand the structure and find information. The clear typography hierarchy in the website guides the reader through the content and makes the information easier to digest. It also adds to the overall aesthetic appeal of the site.



Storytelling

The website is designed to structure the content and visualizations in a coherent narrative. It guides the users through a logical progression of information, making the IMO dataset more relatable and easier to understand.

The story begins with an introduction to the Math Olympiad, setting the context for the visualizations. This section briefly explains what the Math Olympiad is, highlights notable participants like Terence Tao and Grigori Perelman, and establishes the significance of the competition in the world of mathematics. The introduction also provides links for users who want to delve deeper into the purpose of the site and the source of the data.

The interactive map serves as the central element of the storytelling, allowing users to explore the data themselves. By clicking on different countries, users can see how GDP per capita correlates with Math Olympiad results. This interactive element engages users by letting them uncover patterns and insights on their own, making the story more personal and impactful.

In the data analysis section, the story delves deeper into specific metrics from the IMO dataset. Here, users can see various visualizations, such as bar charts and line graphs, that illustrate trends and correlations between different variables like the number of medals, gender participation, and GDP. This section provides a more detailed and nuanced understanding of the data, highlighting interesting findings and trends.

Finally, the slider section showcases notable mathematicians who have participated in the Math Olympiad, connecting their early achievements with their later contributions to the field. This section highlights the long-term impact of the Olympiad and inspires users by showing the potential future success of current participants.

Visualisations

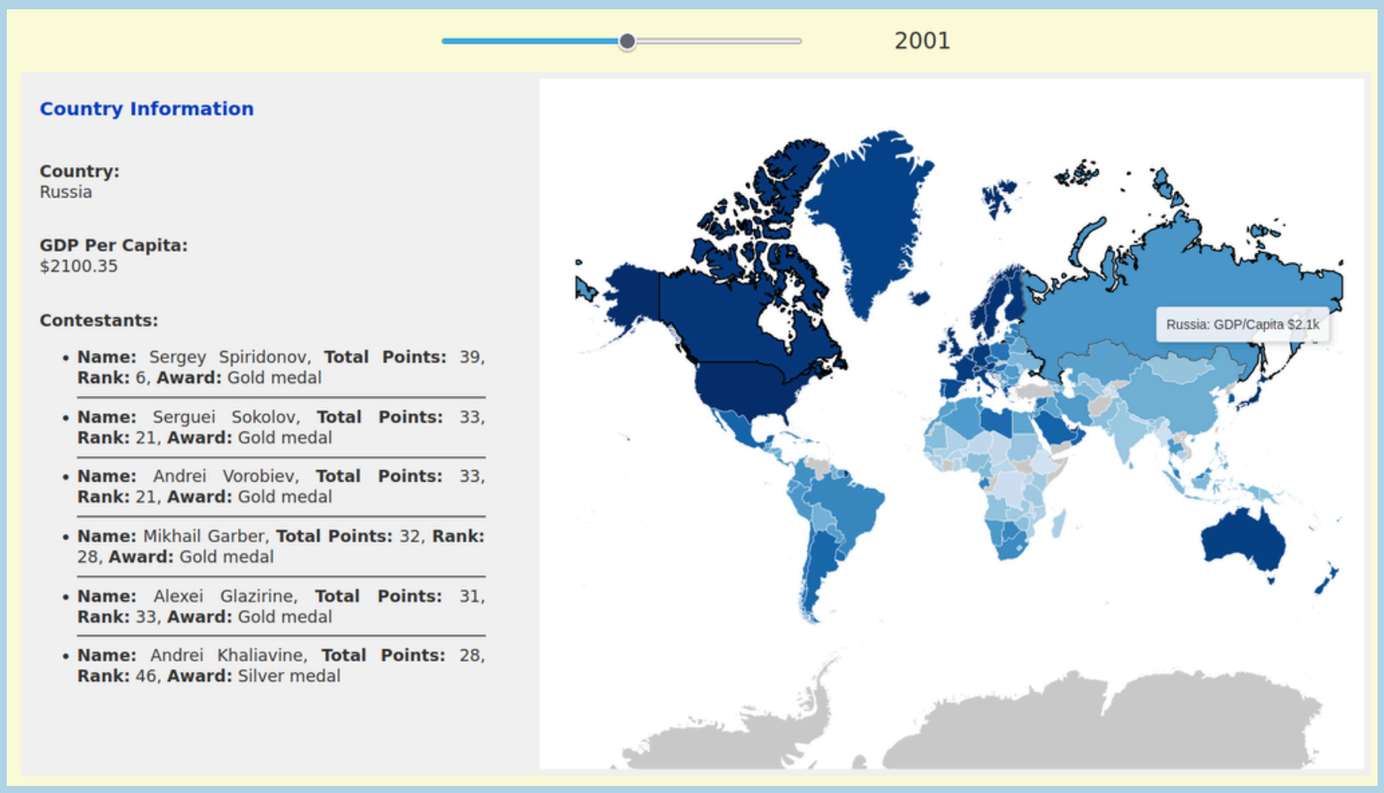


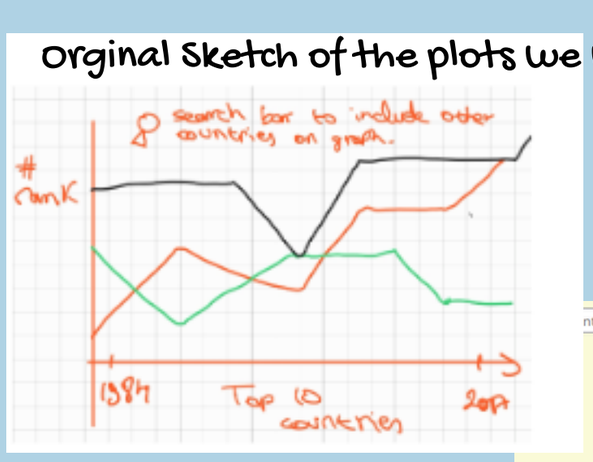
Figure 5: World Map Visualisation

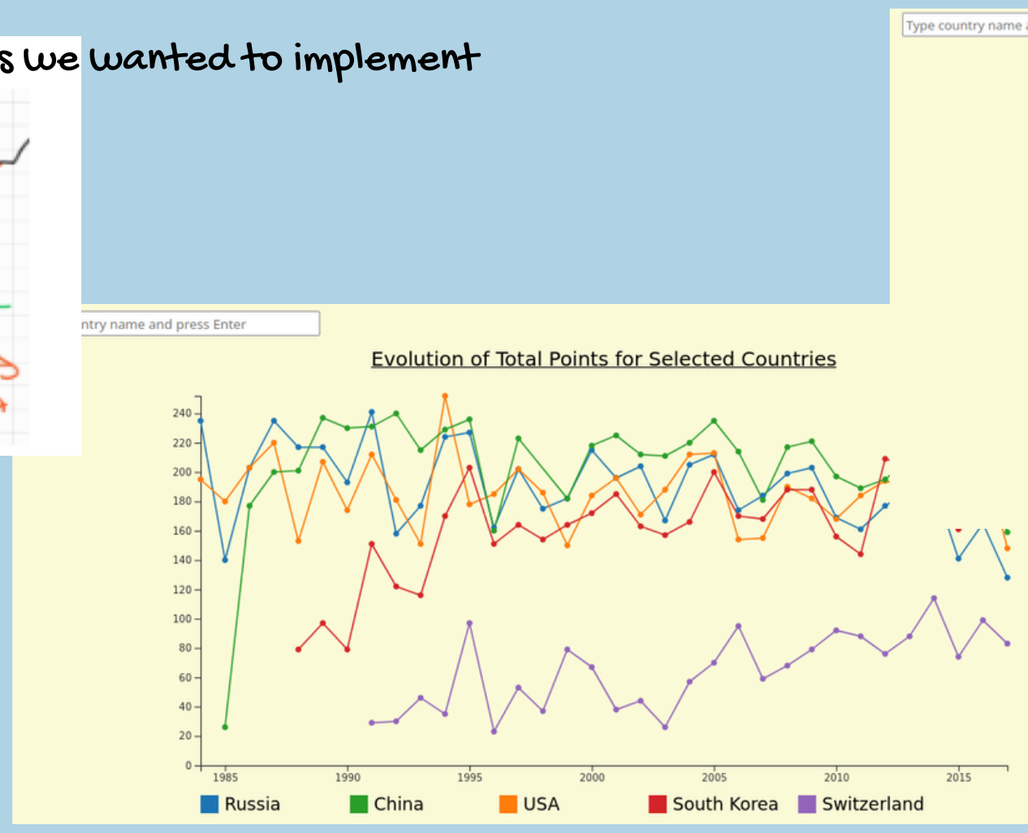
The interactive world map visualization is a cornerstone of our project. It represents complex data in an easily digestible format, enabling users to quickly grasp trends and correlations without needing to analyze raw numbers or read through lengthy explanations.

By combining economic data (GDP) with educational outcomes (Math Olympiad results), the map helps users understand the broader context. This integrated view shows how economic conditions might influence educational performance.

One of the key features of this visualization is its temporal analysis capability. The time axis enables users to explore changes over time, allowing them to manually select specific years. This feature facilitates the observation of trends and patterns, providing valuable insights into how economic and educational factors evolve over time. Users can click on individual countries to display detailed information about GDP, the number of contestants, and other relevant data, offering a granular understanding of the data and enabling deep dives into specific regions.

This interactive element makes the data exploration process more enjoyable and memorable. Additionally, the map provides immediate visual feedback based on user interactions, updating in real-time as users click on different countries or adjust the time slider. This responsiveness enhances the user experience, making the data feel alive and dynamic.





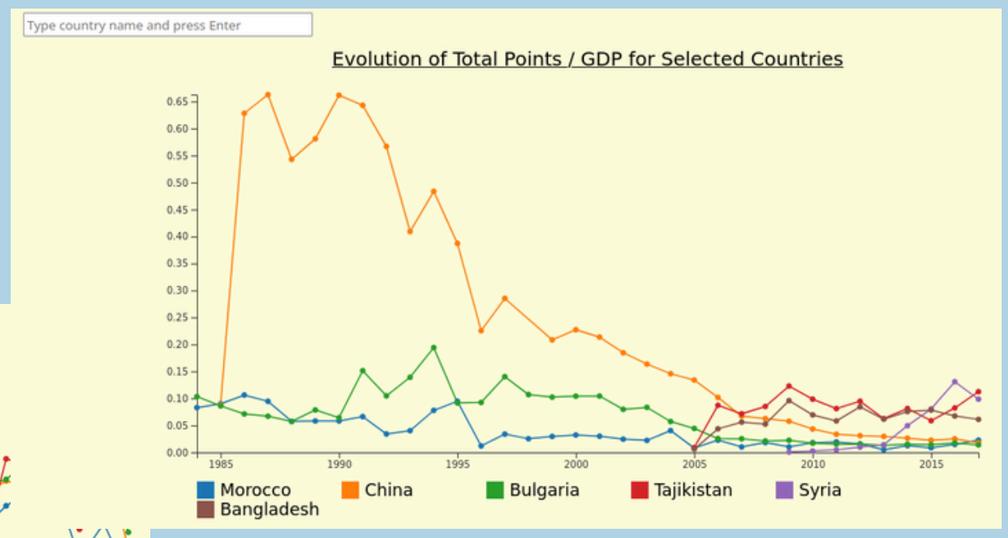


Figure 7: Line Graph Total Points / GDP Visualisation

Figure 6: Line Graph Total Points Visualisation

The second visualization features two related line graphs that illustrate the performance trends of selected countries in the International Mathematical Olympiad (IMO) from 1984 to 2017.

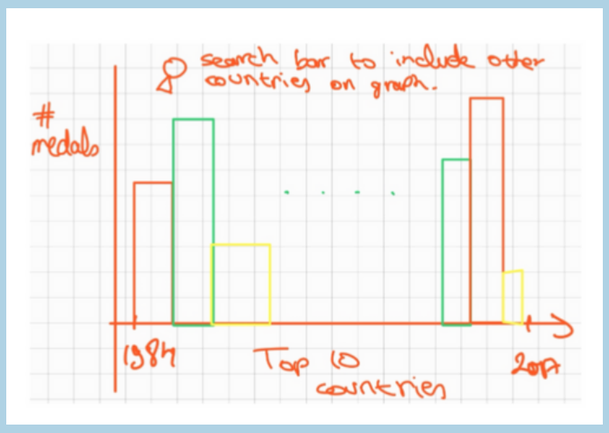
The first line graph plots the total points scored by participants from each selected country over the years. The countries represented include Russia, China, the USA, South Korea, and Switzerland, each depicted by a distinct color. Users can also select other countries they are interested in the comparison using the search bar. Users can observe how the total points for these countries have fluctuated over the years, providing a longitudinal view of performance trends. The x-axis represents the years from 1984 to 2017, while the y-axis represents the total points scored.
This graph is useful for trend analysis and comparative analysis. It allows users to see how the performance of different countries has evolved, highlighting periods of improvement or decline. For instance, China and Russia consistently score high points, indicating strong performance in the IMO. Additionally, the graph facilitates easy comparison of performance across different nations, showing how each country ranks relative to others over time.

The second line graph presents the ratio of total points to GDP per capita for the selected countries from 1985 to 2017. The countries included are Morocco, China, Bulgaria, Tajikistan, Syria, and Bangladesh. Each country is represented by a distinct color, and users can also add countries of their interest into the plot. The x-axis represents the years, while the y-axis shows the ratio of total points to GDP per capita.

This graph is particularly insightful as it highlights the relative performance of countries considering their economic capacity. By displaying the ratio of points to GDP, it provides a normalized view of performance, making it easier to compare countries with different economic strengths. For example, despite having a low GDP in the 1980s, China shows a high ratio of points to GDP, indicating strong performance relative to its economic capacity.

The interactive input feature enhances user engagement by allowing exploration of data for specific countries of interest. This customization makes the visualizations more engaging and relevant to individual users, expanding the scope of analysis beyond the default set of countries.

Together, these graphs provide a comprehensive view of performance both in absolute terms and relative to economic capacity. Users can explore specific years where a country performed exceptionally well or faced difficulties, providing insights into potential factors influencing these outcomes.By displaying multiple countries on the same graph, the visualization allows for easy comparison of performance across different nations. Users can see how each country stands relative to others, highlighting competitive dynamics.



Original sketch of the bar chart we wanted to implement

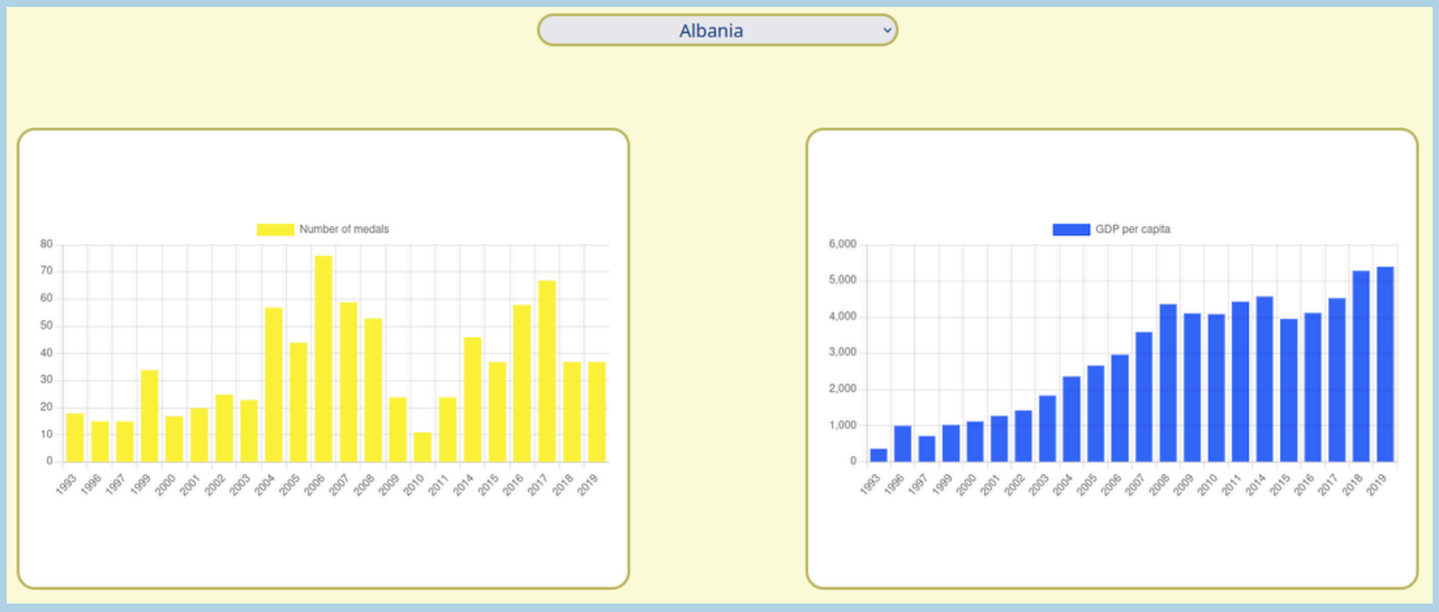


Figure 8: Bar Chart of Specific Country Visualisation

The third visualization consists of two bar charts presented side by side. The left chart shows the number of medals won by participants from a selected country in the International Mathematical Olympiad (IMO) from 1993 to 2019. The right chart displays the GDP per capita for the same country over the same period. This dual-chart setup allows users to explore the relationship between economic performance and educational achievements in a comprehensive and interactive manner.

By displaying both the number of medals and GDP per capita over time, users can observe trends in both educational performance and economic growth. This can help identify whether improvements in economic conditions are correlated with increased success in the IMO. For example, users might notice that a country's medal count increases during periods of economic growth, suggesting a possible link between economic resources and educational outcomes.

The interactive nature of the visualization, where users can select different countries from the drop down menu, makes the analysis more engaging. It allows users to tailor the data exploration to their specific interests, enhancing the overall user experience.

When a different country is selected from the drop down menu, the bars in both the "Number of Medals" and "GDP per Capita" graphs animate by rising from the bottom. This dynamic visual effect not only makes the data more engaging but also helps in emphasizing changes and trends in a more intuitive manner.

The race chart visualization is a dynamic feature designed to display the trend in the number of points won at the International Mathematical Olympiad (IMO) for the 10 countries with the highest correlation coefficient between GDP and performance. This visualization allows users to see the progression of point counts over the years in an engaging and interactive manner.

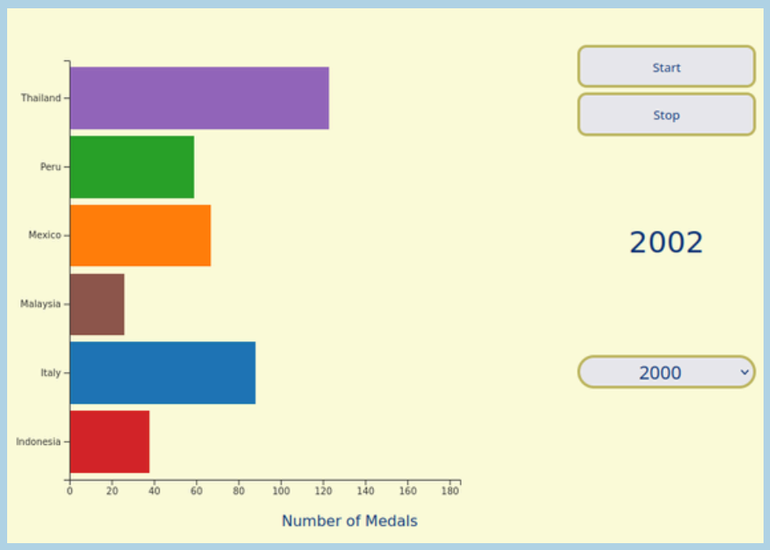
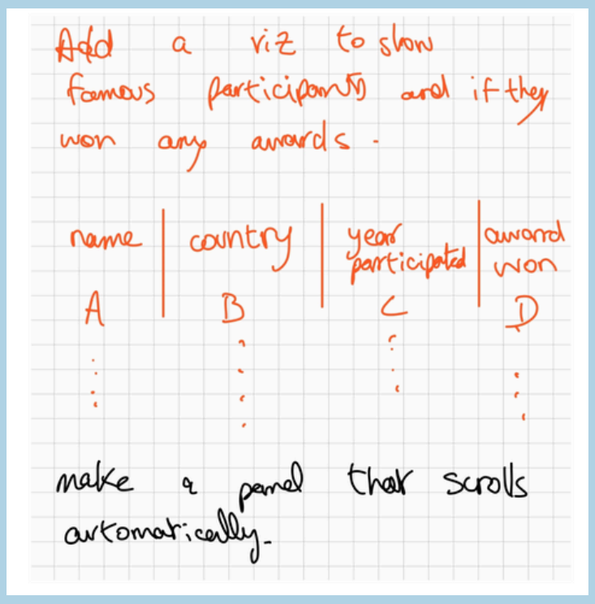


Figure 9: Race Chart Visualisation

The "Start" button initiates the animation, allowing the years to progress automatically. As the years advance, new countries are introduced into the chart, and the bars representing their point counts grow or shrink in real-time. The chart features smooth transitions as new countries and their corresponding bars are added. The length of the bars adjusts smoothly, highlighting the differences in performance among the countries.

The "Stop" button halts the animation at any point, giving users the opportunity to examine the data for a specific year more closely. Users can directly select a specific year from the dropdown menu at the bottom of the chart. This feature allows for immediate access to data for any given year without having to wait for the animation to reach that point, providing flexibility and saving time.

The animated race chart is inherently engaging, capturing users' attention through movement and change. This dynamic presentation is more captivating than static charts. Watching the bars rise and fall in real-time creates a sense of competition and progress, making the data exploration process more enjoyable. Users can observe how the medal counts for different countries evolve over time, and directly compare the performance of multiple countries. The smooth transitions make it easy to see which countries are gaining or losing ground in the rankings.



Original sketch of the panel we wanted to implement

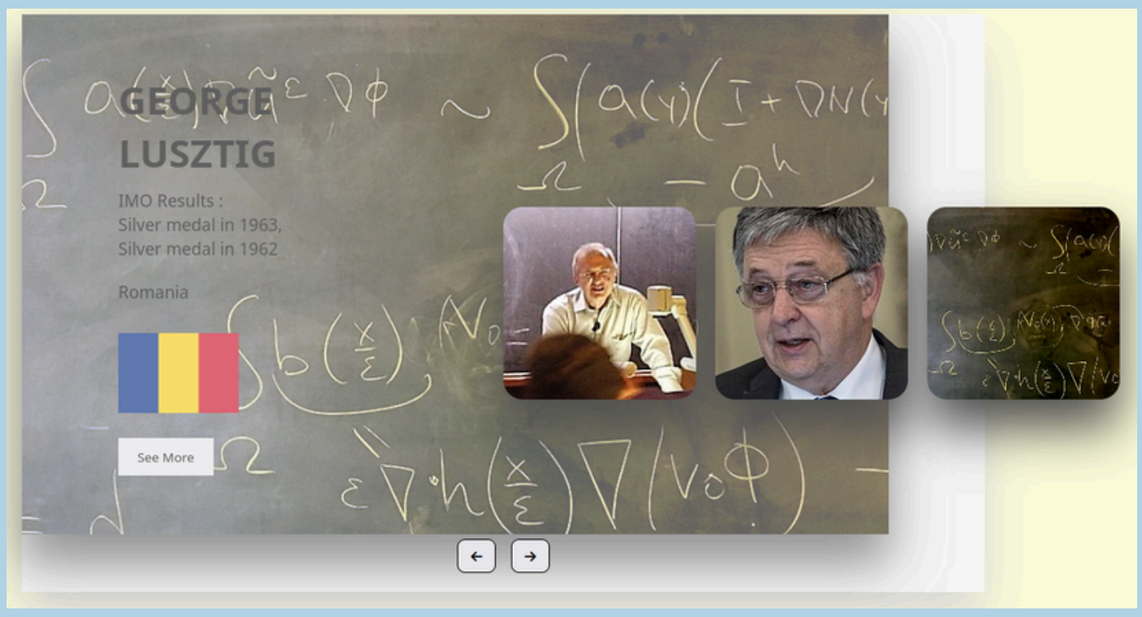
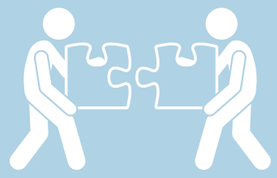


Figure 10: Mathematicians Slider Visualisation

The last visualization features a slider showcasing notable mathematicians who participated in the International Mathematical Olympiad (IMO). The example displayed highlights George Lusztig, a distinguished mathematician from Romania who won silver medals in 1962 and 1963. The slider is interactive, allowing users to navigate through different profiles using arrow buttons. Each slide presents detailed information about a mathematician, including their name, IMO results, and country of origin. In addition to the textual information, there are photographs of the mathematician, enhancing the visual appeal and personalizing the data. The "See More" button brings users to the Wikipedia page of the mathematician to learn more about their background.
This visualization serves to highlight the significant achievements of mathematicians who have excelled in the IMO. By showcasing their profiles, the slider not only celebrates their successes but also provides inspiration for current and future participants.

Challenges



Integrating various datasets, such as GDP per capita and IMO performance data, posed a significant challenge. Ensuring the datasets were accurately combined and aligned over the same time periods and the data for each country matched properly required meticulous attention to detail. For example, China was named as People's Republic of China, so it was imperative for us to align the different data sources. For this and all the other data analysis, we used Python.

We decided to use a standardized format for all datasets and implemented thorough data cleaning procedures. This included normalizing the data formats, handling missing values, and ensuring consistency across different data sources.

Creating interactive elements that are intuitive and responsive was a complex task. Ensuring that the visualizations responded smoothly to user inputs, such as selecting a country from a dropdown menu, required careful planning and implementation.

We utilized modern web technologies and libraries such as D3.js to build interactive and responsive visualizations. These tools provided the flexibility and functionality needed to create dynamic elements. We also incorporated animations, such as the rising bars, to enhance user engagement and provide immediate visual feedback. User testing and iterative design refinements were conducted to ensure a smooth and intuitive interactive experience.

Peer Assessment

Qian Hui Sim:

1. Creating the base skeleton for the website with navigation bar and 4 pages
2. Creating the base skeleton for the map with hovering animation and country names
3. Populate the 3 pages (Description, Data and Team) with content, animations and style
4. Writing and designing the process book

Luca Mouchel:

1. Initial IMO data analysis + extra analysis to properly align different datasets together
2. Embedded the data into the map and several different plots
3. Final screencast

Gabriel Gozlan:

1. Created the bar chart, race chart and slider
2. Participated in the design, paragraphing and layout of the site
3. Performed data analysis (web scrapping for the slider...)

Steps to launch the website

- **git clone https://github.com/com-480-data-visualization/project-2024-Maths-Olympiviz.git**
- Then, **cd web/html/**
- Run the following command **python -m http.server 8000**
- You can now access our website locally by **typing http://0.0.0.0:8000/ into the browser.**