Visualising global AI state actors

Data Visualization Project Milestone 3
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GROUP MEMBERS

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I. PROJECT OVERVIEW

In the previous milestone, we laid the foundation for a project aimed at visualizing the ranking of countries in AI-related technologies using various indicators. Our initial design centered around an interactive choropleth map, augmented with additional graphs and data to enhance user experience. This milestone introduces significant enhancements, including the addition of a splash page and improved interactivity for the graphs.

A. Splash Page

To provide users with a comprehensive overview and key insights, we have added a splash page as the initial landing page of our website. This page includes:

- A brief introduction to the project and its objectives, as well as the sources for the dataset.
- An element of storytelling in the form of recent news headlines, reminding of the recent development of the AI sector.
- Two interactive graphs triggered by a scrolling action, that show a very broad overview of the data.
- A call-to-action button leading to the interactive map and detailed analysis.

The splash page aims to engage users from the outset, providing them with a clear understanding of what to expect and encouraging them to explore further.

B. Storytelling and Narrative Approach

While AI remains a significant buzzword, it is also a highly debated topic, making it challenging to take a definitive stance on its impact and development. Our project aims to present the data in an objective manner, acknowledging the complexity and diversity of perspectives surrounding AI.

Given the geographic nature of our data, it is difficult to adopt a specific position on the development of AI technologies. However, our visualizations reveal clear trends: global leaders in the tech sector, such as the United States and China, also dominate the AI landscape. Despite this, there are some unexpected leaders and noteworthy performances from smaller nations, which add intriguing dimensions to the global AI narrative.

Our approach is to let the data speak for itself, providing users with the tools to explore and draw their own conclusions. By highlighting both the dominant players and the surprising standouts, we aim to invite a deeper understanding of the global AI landscape.

C. Enhanced Interactivity

Building on our initial design, we have increased the interactivity of our visualizations to provide a more engaging and informative user experience:

- **Interactive Map:** Users can now hover over countries to see information on all indicators. Clicking highlights the selected country's position in each indicator distributions.
- **Dynamic Graphs:** The bubble graph is interactive. Hovering over different bubbles opens tooltips.
- **GDP/Political Mode:** Users can select bubble sizing depending on GDP or polical regime, which updates the graph dynamically.

D. Overall Structure and Interaction Flow

The structure of our website and the user interaction flow has been designed to be intuitive and seamless:

1) **Splash Page:** Users are greeted with a visually appealing splash page providing an overview and key statistics. A clear call-to-action button directs users to the main interactive map.
2) **Interactive Map:** The main page centers around the interactive choropleth map. Users can explore different indicators and visualize detailed information by clicking on countries.
3) **Filter Menu:** An interactive menu allows users to select and switch between different indicators. The menu is easily accessible via a side button.
4) **Dynamic Graphs:** Dynamically updated graphs provide additional context and insights into the data. Users can interact with these graphs to view detailed statistics and compare different factors.

E. Technical Implementation

To achieve the enhancements described above, we have utilized the following tools and frameworks:

- **FastAPI:** Serving as the backend framework for efficient data handling and deployment capabilities.
- **Tailwind CSS:** Ensuring a responsive and aesthetically pleasing design across all components.
- **Leaflet.js and D3.js:** Implementing the interactive choropleth map and dynamic graphs, respectively. These libraries allow for seamless integration of interactive features and advanced data visualization techniques.

II. Design Process

A. Splash Page

During the initial design phase, the focus was on creating the main interactive map. However, it became evident that directly presenting users with the map would be overwhelming. Additionally, the map occupies a significant portion of the screen, necessitating the creation of a more user-friendly splash page.

The design of the splash page (Figure 1) began with the goal of making it visually appealing upon user arrival, featuring a clear and engaging title. Utilizing the ScrollMagic library, an intriguing scrolling experience was implemented to entice users to explore further. To enhance the storytelling aspect, color coding for each indicator in the dataset was integrated. Inspired by numerous news articles about the AI sector, the storytelling was built around recent and relevant headlines. These headlines were incorporated into the front page using a responsive Tailwind CSS grid, creating a spatially interesting layout.

The splash page follows storytelling with a powerful and eye-catching graph, showcasing the top 15 countries (Figure 2). This graph displays short ISO 3 codes of the countries and large numerical values to highlight the clear divide between the US, China, and the rest of the world.

Following this, a bubble chart (Figure 3) provides a global overview of the dataset. The Y-axis was selected using GDP per capita data from a Kaggle dataset, cross-referenced with the AI index data. This chart reveals interesting trends: while low GDP per capita correlates with low AI index scores, a high GDP per capita does not always imply a high AI index score. Additionally, the bubble size can be adjusted based on the country's GDP, illustrating the correlation between higher GDP and higher AI index scores. This combination of a high AI index and high GDP indicates a country's potential influence on global politics and the AI sector. To showcase interactivity and provide additional insights, an additional option to view country sizes by "Government Strategy" score was added. This option displays colouring based on the types of political regimes for each country and allows the bubble size to be adjusted based on the government strategy feature score.

The splash page concludes with a call to action, directing users to view the interactive map for more precise country-specific comparisons.

B. Interactive Map

Figures below illustrate the before and after states of the interactive map (Figure 4). The interactive map underwent significant rework since the previous milestone. The first enhancement was the addition of a menu to select the current targeted indicator from the 7 indicators plus the total score in the dataset. Consistent color schemes were reused for coherence. A stateful system was developed to automatically recolor the map based on predefined color scales for each indicator.

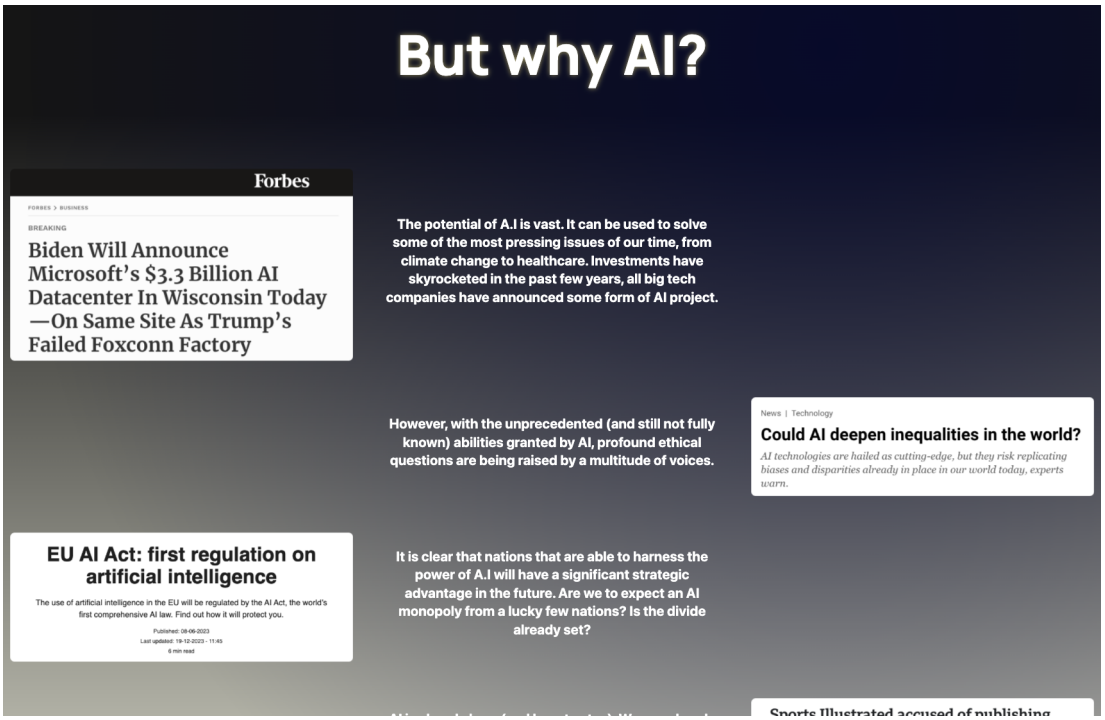

Fig. 1: Splash page layout with headlines for storytelling

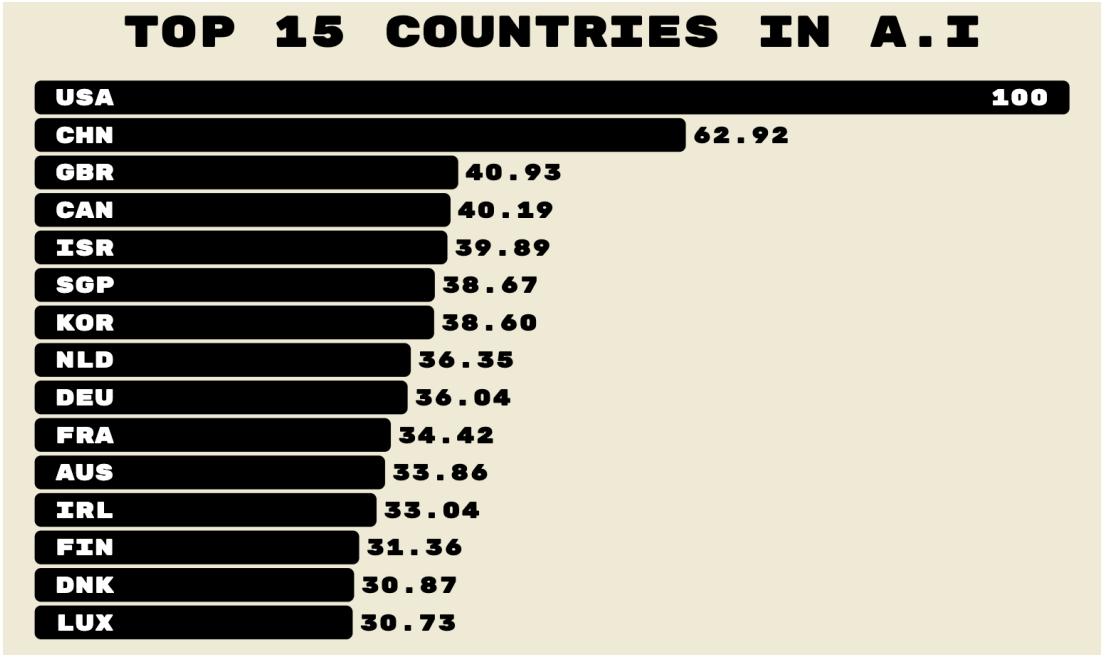

Fig. 2: Graph of the rankings, built for maximum clarity and impact

Leaflet.js was used to define mouse behaviors. On mouse hover, only the indicator results are displayed. On click, the tooltip becomes pinned and larger, generating a density estimation graph for the current selected indicator. This graph employs Kernel Density Estimation (KDE) to estimate and represent how countries generally score. Points for all countries are plotted on this graph using the same color scale, but names are omitted to avoid clutter.

In the tooltip, each country's rankings for each indicator are displayed. Rankings are highlighted in green if the country is in the top 15 for a given indicator and in red if in the lowest 15. Users can change the indicator by clicking the corresponding indicator directly in the tooltip, and a button is provided to close the pinned tooltip.

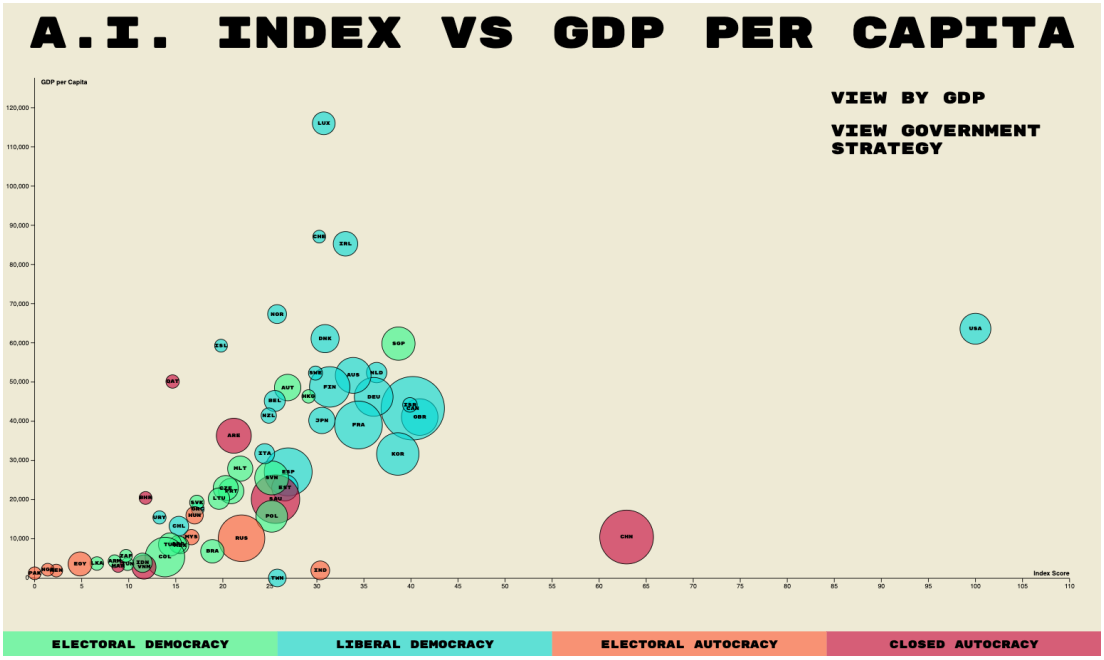

Fig. 3: Bubble graph after selecting ”View Government Strategy”

C. Backend Work

Both pages are served as monolithic HTML pages (index.html for the splash page and map.html for the interactive map). Data is loaded from a static backend built with FastAPI. All data was processed from CSV to JSON for easier loading in JavaScript and is served by the FastAPI server. This server was deployed on a VPS to facilitate demonstrations.

III. Challenges and Solutions

A. Challenges Relating to the Implementation

The primary challenge encountered during the implementation phase was designing a graphically appealing and responsive web page. Creating modern and visually interesting graphs with D3.js posed significant difficulties. The vision involved using full-screen graphs to maximize impact, necessitating extensive efforts to perfect the responsiveness of the webpage. Since D3.js lacks built-in support for this requirement, vanilla JavaScript and Tailwind CSS were employed to ensure expected results.

One of the major issues was adapting the design for mobile phones. Dynamic changes in viewport height, caused by disappearing menu bars on scroll, led to compatibility problems. This was addressed using a new CSS feature, dynamic view height units. Additionally, custom scripts were developed to detect viewport changes and trigger a re-render of all graphs. While exploring more options, such as preserving a specific aspect ratio, might have been beneficial, it would not have fully resolved the differences between portrait mobile screens and landscape desktop screens.

This responsiveness challenge extended to the interactive map. The information tooltip needed to be adaptable to accommodate all data without overflowing the screen on mobile devices. Tailwind CSS was instrumental in responsively enabling scrollbars and defining screen size-based rules.

Animating the first ranking graph also proved complicated. The goal was to animate the index score, starting from 0 and moving to the correct position while maintaining coherent formatting. This was achieved using a D3 tween, which interpolated values and movements based on the animation duration.

B. Challenges Relating to the Data

A significant challenge with the data was its labeling using a 3-character ISO country encoding, whereas most datasets and libraries use a 2-character ISO code. To overcome this, a Node.js library was adapted for use in vanilla

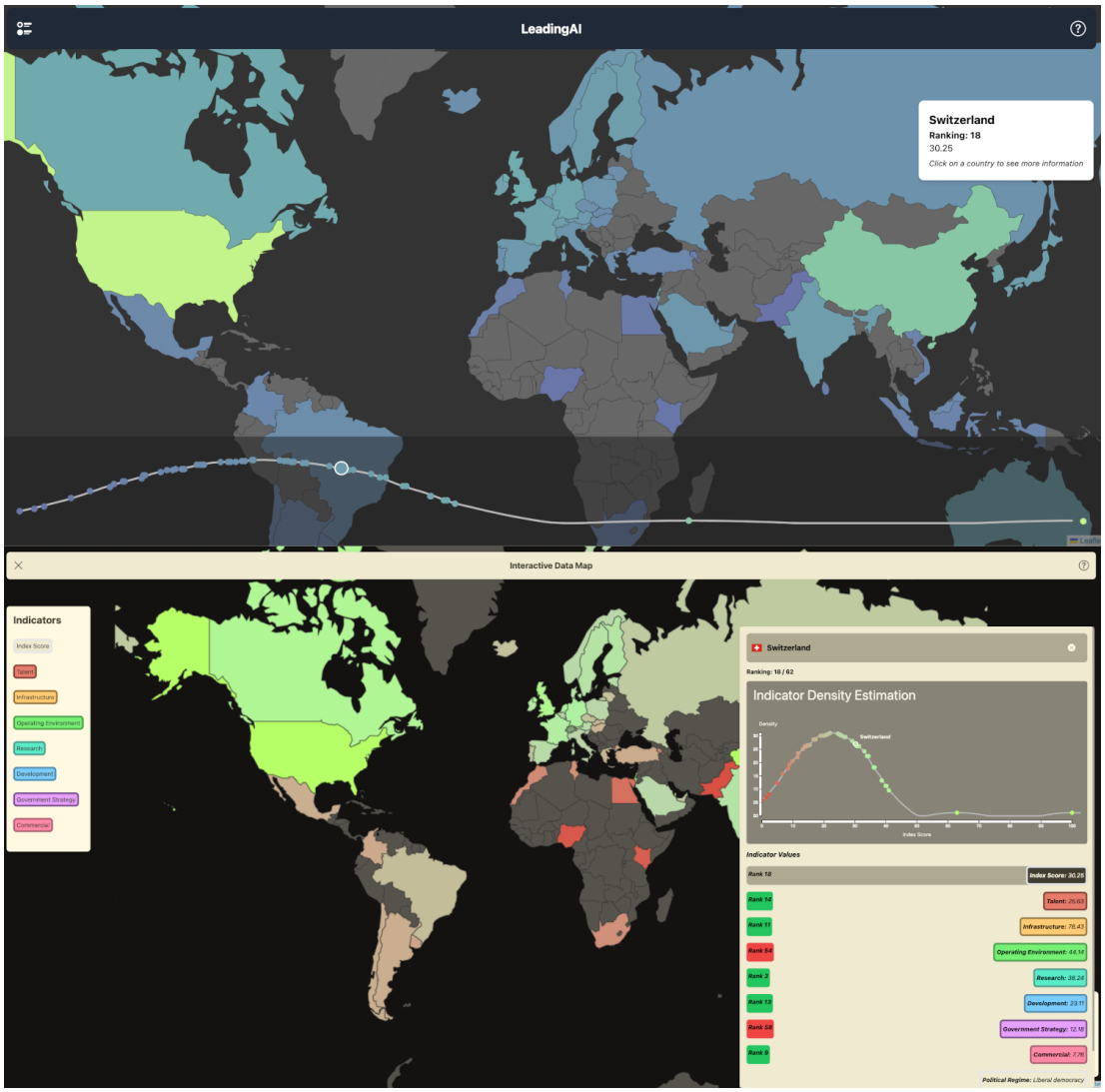

Fig. 4: Interactive Map at milestone 2 (top) and final (bottom)

JavaScript, extending it to create bidirectional mappings. This facilitated cross-referencing the dataset with the GDP dataset and enabled querying country flags for the corresponding countries.

Each indicator in the datasets exhibited non-uniform distributions. This presented two major implications:

1) **Kernel Density Estimation (KDE):** Performing KDE and representing it as a graph was essential due to the interesting patterns revealed by the data. Formulas adapted from the D3.js documentation were utilized for this purpose. Initially, the graph was placed at the bottom of the map, but this cluttered the screen, making it nearly unusable on mobile devices. Consequently, the graph was integrated into the tooltip, which occupies the entire screen on mobile but can be easily closed.
2) **Custom Color Scales:** The non-uniform distribution of indicators necessitated adapting the color scale for the choropleth map. With generally low standard deviation, most countries appeared the same color, except for a few outliers. Custom color scales with high color variation around the highest density of the KDE function were defined for each indicator. A React-style state system was implemented in vanilla JavaScript to manage this, registering a rendering callback upon indicator selection. This callback also handled labeling and the color scale gradient indicator.

These challenges were addressed through innovative solutions, ensuring a seamless and engaging user experience across different devices and screen sizes.

IV. Peer assessment

A. Contributions by Malo Ranzetti

- Design of the graphs (animation, typesetting, data selection)
- Design of the interactive map (obtaining GeoJSON data points, choosing color scales and D3 behaviour scripting)
- Implementing the backend of the server & deploying on a VPS
- Wrote the d3.js code for displaying the graphs
- Adapted KDE for the indicators, design of the KDE graph
- Worked on making the layout responsive
- Storytelling design (finding headlines, write-up of comments on the headlines)
- Debugging the general code
- Write-up of the process book

B. Contributions by Anne Silvestre de Sacy

- Interactive map - indicators filter, data update
- Screencast with a quick demonstration of the website parts and tools

C. Contributions by Quentin Esteban

- General idea for project definition
- Data analysis
- Some storytelling