616 Programming Interactive Viz
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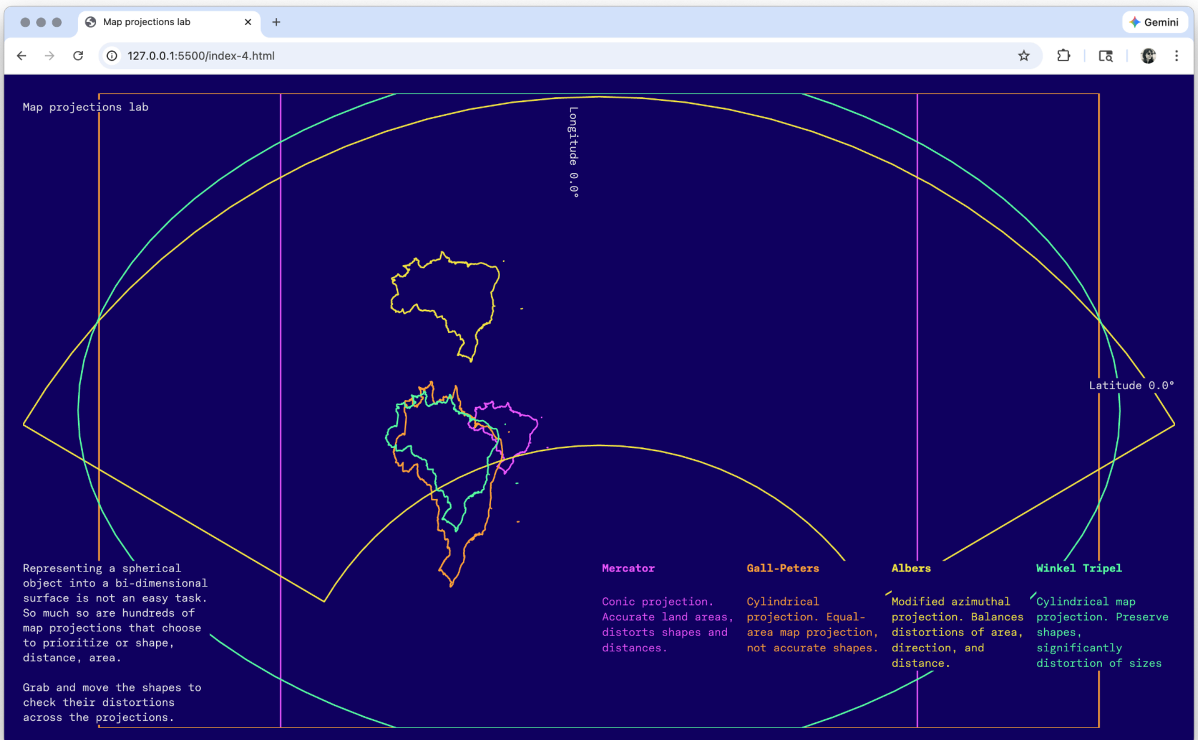
Final project
Map projections lab

Click here to check the visual comparison among several of Brazil's map projections
Click here to access the GitHub repository.



Project Overview

The Map Projections Lab is an interactive data visualization that demonstrates how map projections distort geometrical shapes depending on their coordinates. What starts with a trivial geometrical issue, representing real objects on a two-dimensional surface, can reveal a more conceptual and political statement. The project addresses the fundamental representation challenge in cartography while providing a tool for further questioning regarding historical conventions and how a geometrical decision can imply an international imbalance.

Each one of the several projections that exists consider a trade-offs between preserving distance, area, shape, and combinations of them. By allowing users to manipulate the same shape, Brazil boundaries, across different projections on the fly, the visualization helps these abstract distortions to be more tangible and comparable.

Projections

For the interactive visualization four major map projections were selected as representatives of the main types of distortion models: Mercator, that preserves shapes but distorts areas severely; Gall-Peters, which maintains accurate area ratios but distorts shapes; Albers, a conic projection that work best for intermediary latitudes, and Winkel Tripel, that purposes to minimize overall distortions across all three properties.

To emphasize the projection effects over geographic context, the Brazil country shape was detached from the rest of the globe, focusing attention on the geometric transformations rather than spatial relationships. The boundaries of the globe were also represented, so it's possible to verify the limits of each projection. All of them maintain identical relative positions and scales, enabling direct comparison.

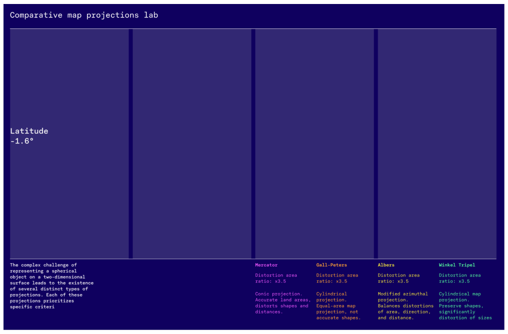
Interactions

The final implementation centers on three key interactions. First, users can drag shapes both vertically (latitude) and horizontally (longitude) to observe on the fly distortion changes. As shapes move across the coordinate system, their forms transform according to each projection's mathematical logic. To reinforce the idea of grabbing the shape to shift it around the projection surface, dynamic latitude and longitude labels were added, following the cursor.

Second, the outline representation and multiply blend mode allows all four projections to overlay simultaneously, creating a visual comparison where differences in shape and position become immediately apparent through color interactions.

Construction

The project is built basically with D3.js, adopted for either its extensive possibilities to manipulate elements in a map and allow a high level of customization and layout responsiveness. Each projection uses D3's built-in geographic projection methods with manual calibration for each specificity. For instance, the Albers projection uses standard parallels at -5° and -35° to optimize the representation of Brazil's geographic extent. The dragging mechanism transforms the user's mouse movements into coordinate instructions. This creates the illusion of moving shapes across the globe while actually shifting their coordinate values.

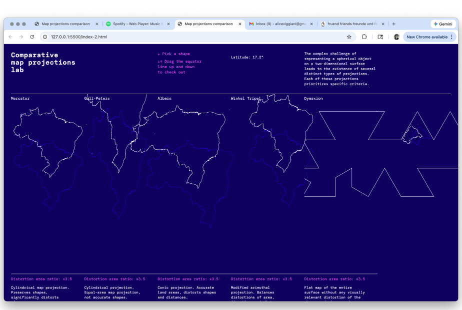


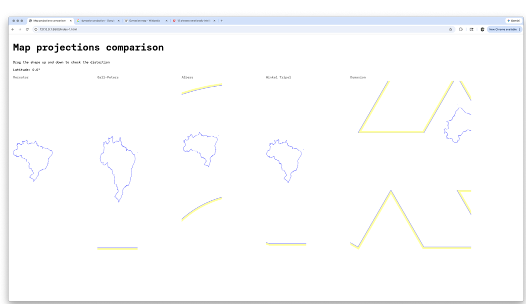
The layout was built using CSS grid with a 24-column system, providing precise control over element positioning. The page uses a fixed viewport approach with calculated heights to ensure the responsive visualization, shifting the limits for any screen dimensions, either width or height. A custom crosshair cursor, implemented as a 64×64px SVG, reinforces the coordinate-based interaction model. The dataset used in the project was the geometrical file itself, a .geojson file containing Brazil's country boundaries.

Challenges

A major technical challenge was the management of coordinate systems, specifically the real-time transmutation. For instance, initially, shapes appeared to "jump" when dragged because the offset calculations didn't properly account for the base projection state. This was resolved by storing the original geometry and applying cumulative offsets to it, rather than modifying the already-transformed coordinates.

Coordinating the dragging feature with a responsive layout was also challenging and was resolved by overlaying the four projections within the same frame space in the layout, rather than placing each one in a separate block, as in the first attempt.





In terms of design, it took a few versions to achieve a more sophisticated version, always trying to evaluate the balance between providing more information and options versus cleanliness and focus on the matter.

The final project was a further development from the previous version, using Vega to build it. In comparison, it was implemented a higher interactiveness aspect was implemented, which represented a significant improvement in functionality and overall layout.

User research input

The user was asked in two moments: the previous, darker version and the final one. In fact, the adoption of a fifth projection, significantly divergent from the others in shape and behavior, was disrupting the clarity of the comparisons. The adoption of colors for each projection, in accordance with their legends, was a solution that came from the user's observations to facilitate comprehension.

Next steps

Future enhancements could include additional shapes, such as Greenland, Chile, and China, chosen for their distinctive geometries. In addition, a feature to toggle the coordinate grid for each projection can improve understanding of the mathematical logic. The layout could also include the Dymaxion projection, developed by Buckminster Fuller, and present an original flattened version of the globe.