A Brief History of Territorial Exchange

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ABSTRACT

Any territorial change is a significant event in an international system based on the idea of sovereignty–the authority for a state to govern itself. The purpose of this project is to provide an interactive visualization so that anyone studying the history of territorial sovereignty, imperialism, or independence can get a sense of the relative and absolute quantities of land and people being described as well as the methods and events behind these exchanges over time. This visualization relies on the Territorial Change (v6) dataset provided by the Correlates of War Project, an organization dedicated to the open distribution of reliable quantitative data in international relations. This dataset contains tabular info on over 800 territorial changes between 1816-2018. The data include info about the year, month, gaining/losing entity, transfer type, area of the territory, population of the territory, whether or not the entities transferring territorial ownership are continuous, and a few other variables. This visualization hopes to provide a broad perspective on territorial change over the last 200 years as well as the ability for an interested student or researcher to dive deeper into the categories and qualities of individual events or groups of exchanges.

1 INTRODUCTION

Many historians and political scientists view the Peace of Westphalia, a series of treaties and peace talks between May and October of 1648, as the foundation of the modern international system. These negotiations largely ended the European wars of religion, the last large scale war of religion being the Thirty Years' War. The result was a reasonably peaceful coexistence between sovereign states. This concept of state sovereignty is the principle in international law that each state has exclusive sovereignty over its own territory [1]. A territory is reciprocally defined as an area of land under the jurisdiction of a ruler or state.

1.1 Problem and Motivation

Therefore, when jurisdiction over a piece of land changes, a significant event has taken place in the international arena governed by Westphalian sovereignty. How can these exchanges best be visualized? At a high level, how can a user get an understanding of the different magnitudes of territory being exchanged as well as compare these between cases? At a lower level, how can a user get an understanding of the specific acquisitions and losses of individual countries? Among all of this, how can the temporal element be included?

These questions are motivated by the fact that researchers or students would be interested in the state of the world across a time-frame and the individual events within that time-frame. We wanted the user to have as much control and filtering ability as possible to broaden the number of questions they use the system to answer.

1.2 Data

This project relies on the Territorial Change (v6) dataset published as an update on March 27, 2019. It is hosted by Paul Diehl (University of Illinois) and Jaroslav Tir (University of Colorado-Boulder) as part of the Correlates of War Project. This project was started in 1963 by J. David Singer (University of Michigan) with the goal to provide a "systematic accumulation of scientific knowledge about war" [2]. The project freely provides datasets on inter-state conflict, intra-state conflict, alliances, territory, trade, and other topics relevant to international affairs. The Territorial Change (v6) dataset is "the result of an effort to identify and code all territorial changes involving at least one nation-state (as defined by the Correlates of War project) for the period 1816-2018" [3].

This dataset contains 842 individual records in tabular form with the following features:

1. *year* – year of the event
2. *month* – month of the event
3. *gainer* – state or political entity that gained the territory
4. *gaintype* – homeland territory or dependent territory for the gainer
5. *procedure* – the process of the exchange (Conquest, Annexation, Cession, Secession, Unification, Independence, Mandated Territory)
6. *entity* – land that is being exchanged
7. *contgain* – whether the land being exchanged is contiguous with the gainer
8. *area* – land area in square kilometers being exchanged
9. *pop* – total population of the land area being exchanged
10. *portion* – whether part or all of the entity being transferred was involved
11. *loser* – state or political entity that lost the territory
12. *losetype* – homeland territory or dependent territory for the loser
13. *contlose* – whether the land being exchanged is contiguous with the loser
14. *entry* – whether the gainer entered the international system in this event
15. *exit* – whether the loser exited the international system in this event
16. *number* – unique numerical identifier for the record
17. *indep* – whether this involves the termination of a colonial rule of a dependency
18. *conflict* – whether there was a military conflict between organized forces from both sides (unorganized violence, such as riots, does not count)
19. *version* – the version of the dataset in which the record was added

Of all these features, we narrowed down the list that we would use to *year*, *gainer*, *procedure*, *entity*, *area*, *pop*, and *loser* because we felt like these were (1) the most relevant features to visualize and (2) the features which could actually be visualized. For example, we chose not to include the congruity features in our visualization because there is not an easy way to do so without geographic data for borders which is not included in this dataset.

To clean the data, we removed any records that was missing any of the fields listed above. That brought us to 678 valid records. We also added to the dataset by including two more features:

1. *c-a3-g* – International Organization for Standardization (ISO) alpha-3 code for the gainer state
2. *c-a3-l* – ISO alpha-3 code for the loser state

This was necessary for our map features, which is explained in the Methods section.

All of these data were combined with geographical data using three external files. The first file was of the continents, which was used to draw the actual map in d3. The second was of the countries, which yielded the geographical locations of each country. The countries were labeled by unique IDs that were mapped to country names using an additional file which also included the continent each country belonged to and the alpha-3 code associated with the country. This bridging file permitted us to link the exchange data to the geographical data.

2 Related Work

This project is related to our third assignment (A3) in the 6.894 Data Visualization class. In that assignment, we used the same dataset but focused only on territorial exchange through conquest and had the goal of displaying the anarchic nature of the international space. That was accomplished through a chord diagram which the user is able to interact with through pre-determined time-frame button selections and hover-over capabilities. This project differs from the A3 because it intends to allow exploration of the data including drill-downs unlike the A3 which told a compact narrative about international relations.

A brief survey of visualization of territorial change like we are attempting to do in this project yields few results. On one side, there are some examples of maps which show borders color-coded by their age [4]. However, this fails to convey the events behind these borders. Probably the most relevant work related to this project is a spatial history project about World War II and its lead-up created by Michael Groot, an undergraduate research assistant at Stanford's Spatial History Lab [5]. This project uses a slider across the timeline to show borders moving in Europe. A bar chart with a similar slider then shows the amount of land being transferred. This project is interesting, but it is looking at a much smaller time frame and a much narrower set of countries than our project intends to capture. Also, that Stanford project had the visuals embedded in a paper as supplemental material while our project hopes to be a standalone tool.

3 Methods and Design

Our system allows a user to start a high level, showing the entire time range, all possible exchange types, and the entire world presented geographically. Interaction with the system then allows a user to "dive" into whatever they desire to explore using the filters, map exploration, and country selection.

3.1 Filters

There are four types of direct filtering available to a user. The first method is via the timeline. Beneath the map in the visualization, a timeline bar chart from 1815 to 2018 displays the number of exchange events per year. We chose this metric over the total quantity of land or people exchanged because it better allows a user to see what trend of events might be worth diving into rather than biasing towards the large territory shifts which are already encoded in the map. We considered putting the raw quantities on a log scale, but it was still difficult to bridge the immense scale difference between certain events. Similarly, a log scale on a bar chart seemed somewhat deceptive. The interaction with this bar chart is that a user can brush over certain time windows filtering all the data below by whether it is included in that brush. By default, the brush includes the entire range. Several online examples of how to implement brushing over a chart were very helpful in implementing this feature [6].

The second filter is a drop-down menu allowing the user to select which type of exchange they want to look at. By default, this shows all types of exchange.

The third filter is a button allowing a user to select whether they want to view quantities in terms of areas of land exchanged or population sizes of the land exchanged. We wanted to include both features because world events where two piece of land of the same size are exchanged are radically different is one of those has nobody living in it (such as a deserted island) versus a place with a million residents.

The fourth filter is a button allowing a user to select whether they want to view gains, losses, or net. We decided to make this filter and the previous filter both buttons because that is the most intuitive way to make a selector between a few exclusive options.

3.2 Map Exploration

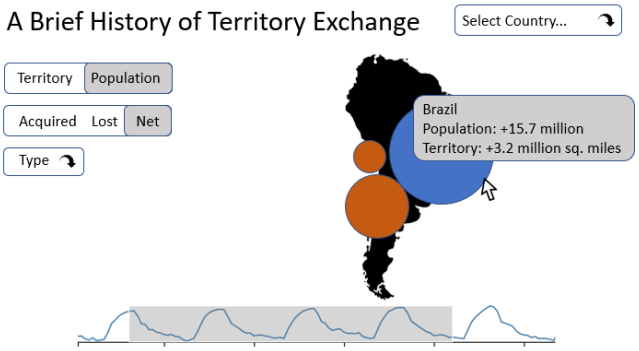

Figure 1: Prototype of our filters/map/timeline view. In this prototype, the final cluster has bubbles grouped by continent represented atop the map for the continent. In the final version, the map is not shown in the clustered view to reduce distraction, and the continental groups are united to form a global cluster.

The map is designed for high-level exploration that, in combination with the filters, helps reveal underlying patterns globally. Each bubble represents the exchange amount (land or people) of a country, with a size proportional to the magnitude of the area or amount of people exchanged, respectively. Since we binned the data to yield distinct, more differentiable bubble sizes, the radii correspond to a log scale of the land or population amount in question. The bubble's fill indicates whether the total amount of exchange for that country was positive (light blue) or negative (light red). These colors were chosen because red broadly symbolizes the negative while blue is perceived as a more positive color. Both colors are not heavily saturated in order for the bubbles' borders to display well. These borders group the bubbles' countries by continent by using color. The legend, shown in Fig. 3, helps the user understand these multiple encodings. Meanwhile, the map has tooltips for the bubbles that each display the country's name and the amounts of population and land gained or lost. This way, the viewport is neither crowded with overlapping names of bubbles since the text is usually larger than the size of the bubble, nor is the text displayed too small

in order to fit on the bubble.

The map supports panning and zooming, and has two possible viewing methods. In the geographical view of the map, each bubble is displayed over the center of its country's location. The user, however, can toggle to the "Comparison View", which clusters all the bubbles in the center of the page. The initial view is designed for broad exploration and seeing trends spatially, whereas the second view allows the user to more easily visually compare bubbles that could be very far away from each other on the map or overlapping. While the first view makes it easier to find countries in some ways, the overlap of the bubbles can make them difficult to select. Since the clustering is spatially-aware, however, it preserves much of the neighboring relationships of a given country and the continents so that it is still easy to find the country in the grouped view. The color-coded outlines of the bubbles further facilitate finding the desired countries in the cluster. When a country is selected, the outline becomes a thicker, bright red border to identify the bubble in both clustered and unclustered modes.

The clustering itself works by using d3 force simulation algorithms to move the bubbles, and comprises of three phases: "declumping", continent grouping, then final grouping. "Declumping" entails creating a repulsive force among the bubbles to spread them out and prevent overlap. This step also removes the world map from the background to prevent distraction from the clustered nodes, since they are not tied directly to the geography of the map in this view. Continent grouping uses the center of each continent as a focus to which all of the bubbles gravitate. In grouping this way, relative positions of countries are preserved by simply pulling them together. Then, in final grouping, the continent clusters are pulled toward the center of the page to form one big cluster with all the continents positioned appropriately relative to each other. In addition to the repulsive and gravitational forces generated to move the bubbles, collision forces were also used to prevent the bubbles from re-overlapping.

Other ways to visualize the amount of exchange on a map were considered. A choropleth map would be able to show the magnitudes, but would be difficult to compare individual countries across the map and would have to rely on modern borders. If it relied on borders specific to a time, each map drawing would have to be tied to how the world looked that year, and thus would not be extensible to ranges of years. Meanwhile, a Dorling map makes comparing the bubbles somewhat easier, but because the bubble sizes are unrelated to the total area of each country, the map would be very distorted to a point at which the map may not be easily readable. The reason the geographical-comparison map view design was selected was because it can overcome the shortcomings of both methods.

3.3 Country Selection

Users can select a particular country in two ways, either from searching in the drop-down menu or by clicking on its bubble in the bubble map. By selecting a country, a Sankey diagram appears below the timeline displaying all territorial change flows into and out of that country given the time range and exchange type filter selected. To alert the user that this diagram is now available for viewing, the page automatically scrolls down to show the Sankey once a country selection is made. A user can then hover over any of the exchanges to get a tooltip that displays the year, type of exchange, quantity of exchange, and the entity being exchanged.

A difficulty in implementation of the Sankey diagram was how to deal with the vast scale differences. If the vertical height of the diagram were fixed, country selections with dozens of exchanges

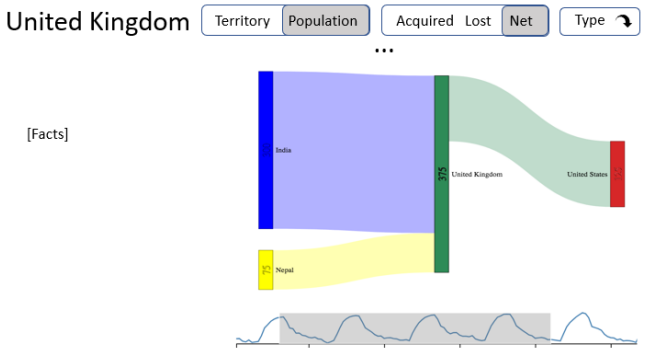

Figure 2: Prototype of our filters/Sankey/timeline view for a particular country.

(e.g. the United Kingdom) failed to render. If the vertical height of the diagram were proportional to the amounts of exchanged land/people, that would have created some very small diagrams and some very large diagrams. To try to find a middle ground, our design scaled the height of the Sankey by the number of entities involved in the exchange.

Implementing the Sankey diagram was made possible by an example shared on bl.ocks.org [7].

4 Results

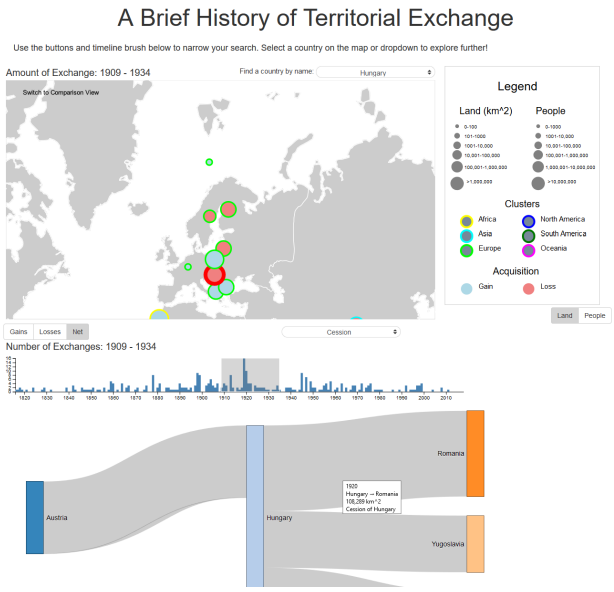

Figure 3: Example use of our design. Here, a user has zoomed in on Europe during between 1909 and 1934 and is inspecting the country of Hungary (in particular a cession of almost 200,000 square kilometers to Romania).

The user is given a large degree of control to navigate through the visualization. After being shown the entire range of territorial exchanges initially, the user is permitted to use the various filters to view changes over time. The user is additionally able to either select a country directly from the drop-down menu or through clicking it on the map, which displays a sankey diagram based on different types of territorial exchanges within a particular time period. There are tooltips provided to offer more specific details regarding the gains

and losses of land/people for each exchange. As such, the user is able to observe a broad history of global territorial exchanges, and explore further based on personal interests. This defined combination of guidance and interaction makes for an informative yet engaging experience.

5 Discussion

After interacting with this visualization, a user should gain a deeper understanding of global territorial exchanges within given time periods through direct engagement. This project should fill in the void that currently exists in the visualization space for history or political science students. While not an orchestrated user study, the project was presented to audience members during a poster session. Users claimed that the clustering and transitions were natural, and the use of size/stroke encodings and tooltips were effective and informative. Certain users suggested changes or additions to the project, such as detailing more information about exchanges, including disputed territories in the geographical view, or using larger datasets to convey more information. Nonetheless, the feedback was largely positive as a whole, and the objective of setting a foundation in the field of interactive visualization for territorial exchanges was achieved.

6 Future Work

One interesting way this project could be extended is with the diving-into specific events. Currently, the furthest someone can drill down is to hover over an individual exchange in the Sankey diagram which provides a tooltip of the year, type of exchange, entity exchanged, and quantity of exchange. It would take some time to manually add this to the dataset, but allowing a user to click on a particular flow and opening a Wikipedia page for the associated event would be really cool.

Separately, there are other datasets in which a brushed timeline and world-bubble map would be an interesting interactive capability for a visualization. This code could be adapted for other data sources to explore other problems.

Acknowledgments

The authors wish to thank Professor Arvind Satyanarayan and Soya Park for their instruction and help throughout the semester. We would also like to thank our peers for their critiques and feedback during the milestone presentations.

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