

TERRORVIS: Global Terrorism Analysis Tool for the Academic

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ABSTRACT

Terrorism is a serious international social problem and is a topic that is widely dealt with in various fields such as politics, sociology, psychology, and history. Each terror event is composed of various kinds of details that are closely related to each other. However, visualization tools to comprehensively analyze terrorism are insufficient. In this work, we propose a visualization framework for analyzing the relationship of each terror event and information about each simultaneously and comprehensively.

Keywords: Global Terrorism, Visualization, Representation, Interaction, User Experience, Analysis, Academics

1 INTRODUCTION

Global terrorism is an important issue in that it can be an event that affects many people across society. Regardless of the purpose, there is a possibility of social and human damage through these events. However, most of these events have their background, and most of them have been related to social problems at the time and in the region. In addition, the method is naturally strongly related to the era and region.

Therefore, by analyzing terror events, it is possible to obtain not only information about the terror, but also information about a specific era and region, and an intuition about social problems. To analyze these efficiently, we need an effective visualization tool that can comprehensively consider and analyze each detailed information.

There are some prior visualization tools. Ourworldindata.org[1] supports slider, then we can easily see the trend change over time. Also, help understanding of each terror events by inserting a rich description of terrorism as text. However the number of deaths, number of incidents by country and change of incidents are visualized separately. In addition, it is difficult to obtain intuition from detailed information because the visualizations that are far apart are not linked. Global Terrorism Index by Knoema[2] expresses various information in a gathered variety of visualization methods, it helps users understand and provides more integrated information. In addition, it provides interactions such as slider, hovering, and zoom. But it visualizes only the number of events and omitting other features, it is difficult to

determine what context each event contains. Also, there is no linkage between each visualization.

In this project, we propose TERRORVIS, the global terrorism visualization tool to help analysing or studying global terrorism. Our visualization provides 4 linked and interactive visualization and summary. In this way, users can obtain detailed information about each terror event and the relationship between them according to spatiotemporal information.

2 DOMAIN SITUATION

In this section, we briefly describe our domain situation. This consists of describing target users and design goals.

2.1 Target users

Our visualization targets user who is specialists, or students studying political science. Our work especially focuses on studying politics related to geographical information, and certain political group or influences. Therefore, we focused on representing summary and related information mainly selected by region user choose.

2.2 Design Goals

We focused on fulfilling several goals listed below.

- Focusing on variety of terrorism information details and trying to consider each of them in a best way so that users can effectively grasp the context
- Enabling users to get comprehensive information about certain time period and region they select
- Enabling users to explore the website with ease
- Enabling users to handle and analyze the vast terrorism dataset freely and actively so that they can get new insights
- Enabling users to compare and visualize multiple regions at a glance

3 DATA AND TASK ABSTRACTION

In this section we introduce Global Terrorism Database[3] which we used in this project. And explicate our task abstraction.

3.1 Dataset

We use Global Terrorism Database(GTD) dataset as source of our visualization. The dataset can be obtained on University of Maryland START project website. GTD includes terror events from 1970 to 2016 with various detail for each event. There are a total of 180,000 cases and 135 details (columns) in each case.

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However, all 135 details are not completely filled. Therefore we pick 27 useful columns (detail) from the total columns. Selected columns are 'Eventid', 'extended', 'country', 'region', 'provstate', 'city', 'latitude', 'longitude', 'summary', 'multiple', 'success', 'suicide', 'attacktype1', 'targettype1', 'targetsubtype1', 'nativity1', 'gname', 'motive', 'weaptype1', 'weapsubtype1', 'weapdetail', 'nkill', 'nwound', 'dbsource', 'ishostkid', 'ransom'.

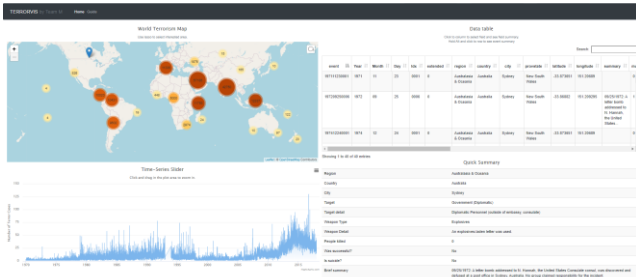


Figure 1. Overview of TERRORVIS, (a) Lower left is Time-Series Slider, (b) Upper left is World Map, (c) Upper right is Data Table, (d) Lower right is Summary Board

3.2 Task Abstraction

We can divide the process of using our visualization tool into 2 parts, event selection and event summary extraction. In the first part, user selects events filtering by time period, using time-series slider or selecting group of events using lasso from the world map. When group of events are selected, users decide across which columns they wish to see summary and analysis.

3.3 Data Selection in a Specific Period and Region

To visualize terror events efficiently, we encode each terror events into spatiotemporal information. Because terrorism is closely related to social issues in the time and region. By providing terrorism selection in a specific era and region, it would help to analyze social issues, background, and relationship between terrorisms. It is also helpful in grasping the trend of terror occurrence according to the times and regions.

3.4 Analyze and Summarize

About selected data in 3.2.1, we provide detailed information of each terror event. And by summarizing each attribute of terrorism, the user can be provided properties of terrorism in that time and region.

3.5 User-Friendly Usability

To improve usability, we provide user guideline in starting page of our tool. Furthermore our tool is independent of the size of the display, then users can use our tools regardless of the situation.

4 VISUALIZATION DESIGN

TERRORVIS is composed with 4 sections which are World Map, Time-Series Slider, Data Table and Summary Board. In this section we introduce each section of visualization.

4.1 Time-Series Slider

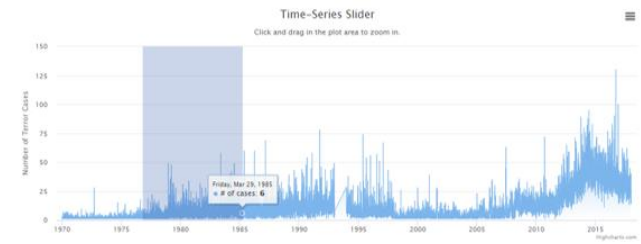


Figure 2. Time-series slider with line graph which enables brushing and hovering to select or see specific data

The Time-Series Slider (figure 1.a) shows the number of cases by time. The number of cases is encoded with the height of the graph. You can see the exact date and the number of cases by hovering over the Time-Series slider. By brushing on the Time-series slider, you can zoom in to a specific time-term (figure 2). If you want to back initial state, just click 'Reset zoom' button in the upper right corner of the map. The World map shows cases that belong to the selected time-term.

4.2 World Map



Figure 3. Event ID when putting a cursor on a data point

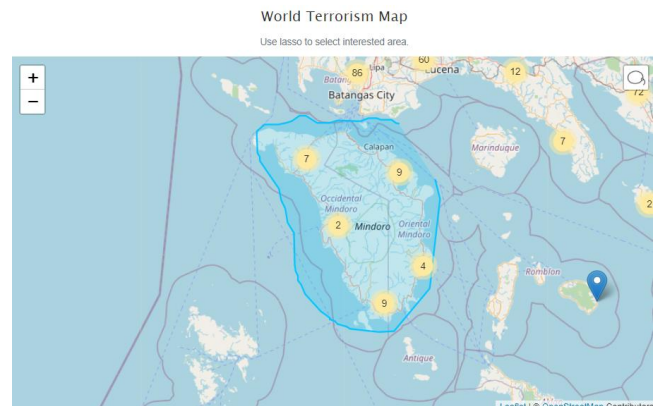


Figure 4. World map in lasso mode to designate a specific area

The World Map (figure 1.b) shows the number of cases by region. The number of cases in the region is encoded with the color (yellow to red) and size (small to large) of each circle. Users can see the event id by putting a cursor on a data point (figure 3). Zoom in or out on the map by using the mouse scroll, 'plus/minus' button in the upper left corner of the map, or click by a specific region. In a zoomed-in view, each cluster is split into smaller ones to represent a more precise location of cases and you can move the region by mouse swiping. By clicking the 'lasso' button, you can select a specific region on map (figure 4). Detailed data of the cases in the designated region are displayed in a table (figure 5).



Figure 5. Selected single event summary

4.3 Data Table and Summary Board

By Time-series slider and World map, we can designate interested time-term and region to analysis. Data Table (figure 1.c) and Summary Board (figure 1.d) show detailed data and interesting features of selected cases. Each case is encoded on each row of the table, and columns of the table represent properties or information of terrorism. By clicking the header of the table, rows are sorted by the value of the selected header's column. Because too much data to show, you can move the displayed part of the table by using the scroll bar.



Figure 6. Summary bar chart of "kills" by "attack type" columns

By toggle a specific column, the chart show statistic of toggled columns. Figure 6 shows example chart when selecting "attack type" column. This chart compares count of terrorism by each cases mentioned in column. User can pick at most two columns, which consists of one single column and kill or wound column.

When user choose a column with kill/wound column, it counts entire kills or wounds occurred by the case in selected column, and summarizes the count into chart. Figure 7 shows example chart when selecting "attack type", and "kill". By comparing Figure 6 and 7, we can see that despite "Bombing/Explosion" terror case is happening at most in selected region, "Armed assault" is causing much more casualty. Because other secondary selected columns doesn't show meaningful charts or data summary, we choose not to generate graph for such selections.

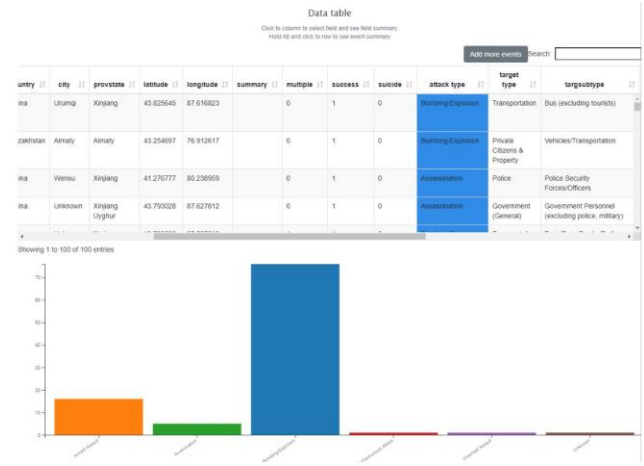


Figure 7. Summary bar chart by number of "attack types"

5 IMPLEMENTATION

In this section we introduce implementation goals and details of our visualizations. Each sections inside visualization are implemented by different person. We first implemented each part of visualization with D3.js[4] and other libraries mentioned at subsections below. Then, we integrated entire codes through git and tested our implementation using Node.js[5] runtime server.

5.1 Implementation Goals

We set our implementation goals as follows to encourage rich user experience and support more information with efficiency..

- Processing large amounts of information in a short time providing users quick responses.
- Aggregating terror cases with summary information like type of weapon, attack target, organization responsible etc, as well as representing summary for single terror case.
- Aggregating terror cases with cause of terror, attacker of terror, etc.
- Indicating certain information about terror on a map.

5.2. Time-Series Slider

Time series slider is used to filter out event day range from the map. When user selects time period from time-slider, events falling into the given range redraw on the map.

Time-Series slider is implemented using highchart.js[7] library that allows to easily zoom time period. Event timestamp and event counts preprocessed by the server from original dataset and sent to client in json format.

5.3. World Map

World map is implemented similar to heatmaps, so users can easily estimate what areas on the global map have more terror event cases. Initially, all the event cases plotted on top of Openstreetmap[8] map using Leaflet.js[9] open source library. Events then clustered based on current zoom level using Supercluster, greedy algorithm, as explained in [10]. When zoom level is small (close to the ground) cluster radius, that groups point events is small as well, and when zoom level is big (far from the ground) the cluster radius becomes bigger. By clustering events on the map into classes we turn the map into a heatmap. Cluster marker radius, the point on the map that represents a cluster, and color depends on the number of events it contains.

Thus, clusters with more events would have bigger radius and its color would be closer to brown on yellow-brown[11] color scheme. For this, we have developed a function that maps number of points to 0~1 scale for colors and 35~70 pixels for radius. When cluster contains more than 20k events it is mapped to 1 (brown) and 70 pixel radius points.

Users can select group of points from a map using lasso tool for getting summary report for the selected events. When events are selected, Data Table appears with selected events on the right of the map. Users can then select new events or add more events by toggling “Add more” button on Data Table chart.

5.4. Data Table and Summary Board

Data Table is implemented by using DataTables[6] and D3.js library. When the user selects a region in World Map with the lasso tool, Data Table is updated with data which is corresponded event id of a selected terror event.

By selecting columns or row at Data Table, entire data of selected columns or row is passed to the function that generates summary or chart. Each function then, generates their own visualization summary with D3.js. When using chart function, it first removes unnecessary columns inside data, and count each cases. Then, it generated bar chart with selected column data as axis. If this function notices that the number of selected columns is two, it alternatively counts kill/wound numbers and generates the chart with D3.js.

6. EVALUATION

We progressed user study to evaluate our visualization tool, TERRORVIS. Three people majoring in sociology or international studies participated in the user study. Each interview was conducted by video conferencing for at least 15 minutes. The interviewer showed the TERRORVIS and introduced its features with Q&A session so that interviewees can freely give their opinion at any time. We synthesized their feedbacks as below.

Our tool has high degree of freedom to analysis data. In sociology, data analysis is very important but it is often expressed only as a statistical chart. On the other hand, our tool provides interactive era and region selection and various summaries of selected data automatically.

However, there are some weaknesses. First, user want more explicit criteria for clustering. Second, users want more clear meaning of each column of the data table. This might make the beginners who just started their terrorism study feel difficult to use.

7. DISCUSSION

The purpose of the visualization tool developed in this project is to effectively combine spatial, temporal, and category information to extract desired information. Therefore, when pay attention to information of one attribute such as the type of weapon used in terrorism and the reason for terrorism, or if information other than spatiotemporal information is important, it may not be the best visualization tool.

Nevertheless, our tool would be a good choice to analyze various terror events occur in similar era or region. Also, compared to the existing approach to terrorism DB visualization, it enables more diverse and active interactions, allowing users to select and combine data and derive new insights.

8. CONCLUSION

As to summarize entire terrorism data and to help analyze information related to terror, we implemented TERRORVIS with D3.js library as base and other libraries. Our tool shows great freedom for exploring data with geographical information and good visualization summaries. But, our tool still needs more improving with map clustering, generating more graph for diverse column selections, and clearance for each column meaning. Still, our work can be used for various terror study cases and study about regional information related to terror.

REFERENCES

- [1] <https://ourworldindata.org/terrorism>
- [2] <https://knoema.com/zafqchc/global-terrorism-index>Peter
- [3] Global Terrorism Database (1970-2016) @ START, University of Maryland, <https://start.umd.edu/gtd/>
- [4] D3.js, <https://d3js.org/>
- [5] Node.js, <https://nodejs.org/en/>
- [6] DataTables, <https://datatables.net/>
- [7] Highchart.js, <https://www.highcharts.com/>
- [8] Leaflet.js, <https://leafletjs.com/>
- [9] Openstreetmap, <https://www.openstreetmap.org/about>
- [10] <https://blog.mapbox.com/clustering-millions-of-points-on-a-map-with-supercluster-272046ec5c97>
- [11] D3 color scheme, <https://github.com/d3/d3-scale-chromatic>