Cluster Bomb: Uncovering Patterns in Terrorist Group Beliefs and Attacks

COM-480 Data Visualization: Course Project - Process book

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1 Introduction

In this data visualization project, we will unravel the different characteristics that define and differentiate terrorist groups. Through data visualization techniques we aim to investigate how terrorist groups from different ideologies differ. This project will discuss geographical patterns, ideological affiliations, evolution over time, weapons, targets, and operational strategies of terrorist groups. By focusing on the differences between ideologies, we aim to explore how distinct beliefs shape the objectives and modus operandi of various terrorist groups.

The report is divided into 5 parts. We will first discuss which data we analyzed, the related work which depicts the studies previously made on the subject, and why our project is innovative. Thirdly, the main body of the report is represented by the website structure and the different plots we have chosen. The fourth part is the website layout and how this was developed. Finally, we will break down the group collaboration to the project.

2 Data

Our work will revolve around the extensively studied and impressively rich Global Terrorism Database (GTD). This publicly available dataset was collected and is still maintained by the National Consortium for the Study of Terrorism and Responses to Terrorism (START) at the University of Maryland in the United States. The GTD includes data on over 200,000 international terrorist attacks since 1970. Described as "the most comprehensive unclassified database on terrorist events in the world" **?**, the GTD contains information on over 100 features for each terrorist attack, including the location, date, attacker(s), target(s), weapons used, casualties and terrorist organization.

We aim to direct our analysis at the group behavior of terrorist organizations. To do so, we pair the GTD with another complementary dataset by START, called the Profiles of Perpetrators of Terrorism in the United States (PPT-US). This database describes 145 terrorist organizations having engaged in terrorist activity in the United States between 1970 and 2016. From their own description, each organization's "terrorist attacks, its history and base of operations, its ideology and goals, its engagement in political and criminal activities (other than terrorism), its alliances, its network and structure, and its financial resources." A confidence indicator (*high*/*medium*/*low*) is included for each information to reflect the reliability of each information.

The information contained in GTD and PPT-US was analyzed by a large number of researchers (see Section 3 for examples). Both of these datasets are well-established and reliable source of informations and the quality of the data they contain has been reviewed and used by well-known organizations, including the Institute for Economics and Peace. Our analysis therefore requires little data cleaning or pre-processing.

3 Related Work

The GTD was introduced by a paper by Gary LaFree and Laura Dugan **?**, in which they carried exploratory analysis and extracted general trends on terrorism. The same authors then published the book 'Putting Terrorism into Context' **?** offering an interpretation guide for terrorism data and their own analysis on so-called black swan events, which are unpredictable events with an enormous worldwide impact, and how they relate to the context of thousands of less famous attacks happening each year. The authors provide a "comprehensive empirical overview of the nature and evolution of both modern international and domestic terrorism" and describe how "a very small number of terrorist attacks have had an outsized effect on attitudes and policies toward terrorism."

Kaggle also hosts hundreds of notebooks with Exploratory Data Analysis. We will conduct our own so as to align it with our chosen problematic by focusing on group dynamics.

Visualization-oriented research has also been carried out on the GTD. Here are a few examples that inspired us:

1. **GTD WebGL Globe**: A global view of terrorism attacks per country per year around the globe for each year.
2. **A World of Terror** by Periscopic: A visual analysis of terrorist organizations and their respective casualties over time.
3. **Overall Terrorism Index Score** by Vision of Humanity: A simple yet beautiful map of the overall terrorism index per country. **Here** is their related publication.
4. **Hate by the Numbers** by Jigsaw: A beautiful interactive visualisation of white supremacy attacks. This is our principal visual inspiration for our project.
5. **Terrorism** by Our World in Data: An extensive and wide analysis of terrorism attacks around the world.

Our approach is original in that it pairs the event-based GTD with the organization-based PPT-US to focus on terrorist organizations rather than terrorist attacks. We will also strive to produce a simple, aesthetic and clear dashboard to convey key insights. The only example of visual project with the same goal was the one by Jigsaw, but their analysis was restricted to attacks carried out by white supremacists, whereas we want to analyze all terrorist organizations.

4 Structure of the website

Our main research question for this project is: *What are the differences between the characteristics of terrorist groups with different ideologies?* To answer this question, we want to gain an understanding of the differences between terrorist groups, including their respective span of attacks, strategies employed, ideologies, goals and targets. The results will be presented on our website in several parts:

- Geographical analysis of terrorist attacks over time
- Separating terrorist attacks by ideology over time
- The differences between terrorist groups with different ideologies
  - Targets and tactics
  - Group motives
  - Group structure
  - Recruitment strategies

In the following sections of this report, we will discuss these parts in more detail. We highlight the different plots that will be shown in each section, and discuss which challenges we faced and what decisions we made.

4.1 Geographical analysis of group terrorism over time

In the first part of the website, we will present the viewer with a general overview of trends in terrorism. In this part, we present one visualization: an interactive map of terrorist group attacks over time. We will mainly use the material from the lecture on maps (28th of april), which discusses different types of maps, projections and GeoJSON.

- *Interactive map of terrorist attacks over time:* Our main visualization in this part is an interactive map of terrorist attacks around the world, made using the **Kepler.gl** tool. This map contains arcs connecting the country of origin of each terrorist group to the location of their attacks. A snapshot of the map is presented in Figure 1.
- *Technical challenges and improvements:* While making this map, we faced two main challenges. First, we needed to match countries to coordinates on the map, as the PPT-US dataset only provided us with the country of origin of a terrorist group. TO COMPLETE

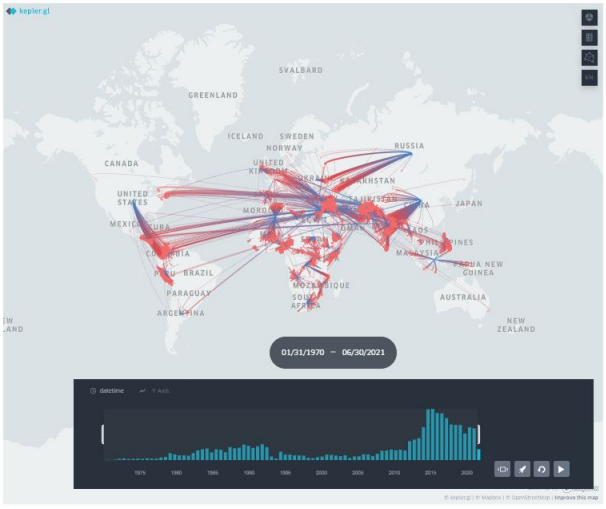


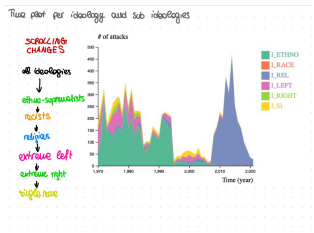
Figure 1: Map of terrorist attacks

4.2 Separating terrorist attacks by ideology over time

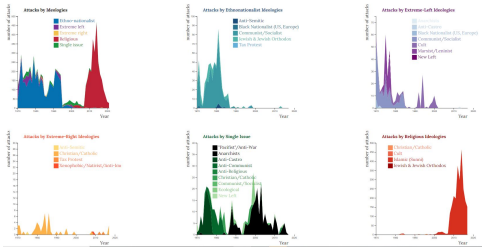
After having presented a general overview in the first part, we now consider the differences between terrorist attacks from groups with different ideologies. In this part, we present a grid of visualizations using **D3.js**.

- *Attack frequency by ideology:* Six D3 **Stacked area chart** plots will show how the yearly frequency of attacks evolves over time for each ideology and sub-ideology. The plots are included into a 3 by 2 grid in order to provide the reader with a clear overview. The first graph seperates the attacks into the four main ideologies (ethno-nationalism, religious, extreme left and extreme right) and the fifth category of single-issue terrorist groups. The other five graphs in the grid each focus on one of the ideologies and break the attacks down into further sub-ideologies.
- *Technical challenges and improvements:* The implementation of the stacked areas with d3.js faced some smaller challenges. However, the main challenge we faced was identify how to display the 6 different plots. Initially the idea was to create a button and have the user choose which plot to display, but we wanted to adopt a more minimalist approach and did not like the need for the user to interact with

the button. Therefore, we were interested in having the plots fade in and out, which is visible in our sketch in Figure 2a. However, this required the 6 graphs to be seen one at a time, which would result in a lot of time for the same type of visualization, which leads to a static website. Hence, the final decision was to include the visualization in a grid which would allow the user to view them together and easily compare the number of attacks, ideologies and sub-ideologies. A snapshot of the final visualization is visible in Figure 2b.
However, this introduced a new challenge, as the grid was not centred on the webpage. This was due to the initial decision we took to adopt Beautiful Jekyll as a template, which resulted in a less modifiable template. We therefore had to understand deeply how the template of Beautiful Jekyll works in order to put the margins as full width and centre the grid of stacked plots.



(a) Sketch of stacked area plot



(b) Final version stacked area plots

4.3 The differences between terrorist groups from different ideologies

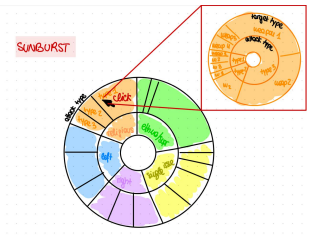
In the last part of the website, we focus on how terrorist groups from different ideologies differ in their attacks and characteristics. Specifically, we discuss the attack types, the targets, their motives, the group structure and the recruitment strategies. For each section, we will present the visualizations and discuss the decisions that were made.

Attack types and targets

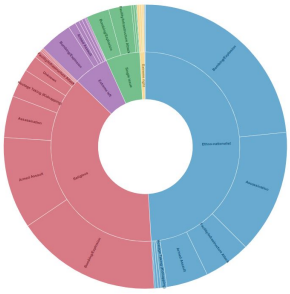
We start by presenting what are the most common types of attacks and targets for terrorist groups from different ideologies.

- A D3 **Zoomable Sunburst** diagram will show how attack strategy differs by ideology. The inner ring will cover the ideologies, the second ring will split the attacks by attack type and the outer ring will separate them by target type. We chose the visualization of of a Zoomable Sunburst because it was a good visualization in order to show hierarchical relationships between the groups and their characteristics.

- *Technical challenges and improvements:* While implementing the Zoomable Sunburst we faced some challenges. Initially, it we had to develop the hierarchical JSON representation of the data. Second, we faced some problems with understanding how to correctly implement the radius arcs in order for it to appear tidy. We then had to understand how to display the text on the plot, because some labels where wider than the arc itself and exit the margin. One initial idea was to make the words go inline, but this was not recommendable when the section is too narrow, therefore we simply decreased the font size of the text. Additionally, we added the root of the labels in the centre of the sunburst in order to make the graph more user friendly.



(a) Sketch of stacked area plot



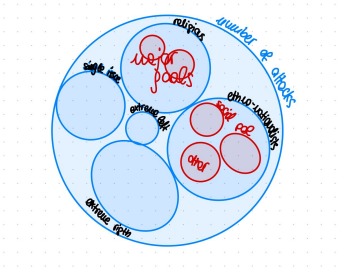
(b) Sketch of zoomable sunburst

Group motives

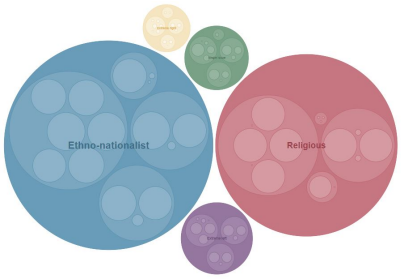
Next, we analyze the different motives of terrorist groups from different ideologies. For this, we have made a circle packing visualization.

- We first analyze the founding philosophy of different terrorist groups. We retrieved the data from the PPTUS data which included major goals divided in Political, Social, Economic and Religious and the sub-goals. Therefore we have some information not only about the dominant ideology, but also the real and true motives that drive the groups of the idoeology to attack. We will then make a D3 **Circle packing chart** based on the ideologies and the founding philosophies of groups. It is interesting to notice that the dominant ideology is not always a unique identifier of the goal of the groups. Indeed, it is striking to notice that religious groups have a greater share of political goals rather than religious ones. This is probably due to the fact that religion has always been used as a justification for more territorial and political reasons. Another example is that extreme-left, which is an ideology which is very distant from religion, is not presenting any religious goal, but does show to have political, economical and social ones.

- *Technical challenges and improvements:* We initially wanted to adopt the model of Observable HQ, however this did not allow us to show a different color per each ideology and therefore we had to change the format of the packing circles. This requires removing the outer circle and add a different color per dominant ideology. However, removing the outer circle did not allow us to return to the initial zoom view of the packing circle and therefore we introduced a white in the background which has the function to reset the graph to the initial view.



(a) Sketch of circle packing

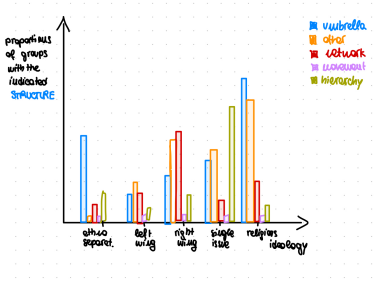


(b) Final version circle packing

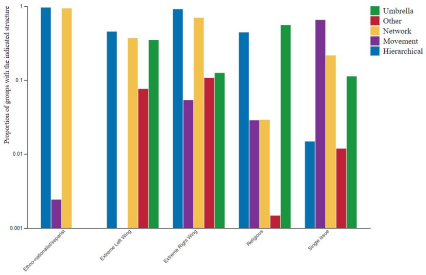
Group structure and recruitment strategies

The last part of the website considers the group structures and recruitment strategies of terrorist groups with different ideologies. For both of these topics, we have implemented a grouped bar chart. Since the visualizations are similar, we will discuss these two parts simultaneously.

- For both the group structures and the recruitment strategies, we have implemented a D3 **Grouped bar charts**. Both plots group the data by the four ideologies and the fifth single-issue category. We have chosen for this visualization, as it is the most appropriate for visualizing data where we want to make two categorical splits (first by ideology, and then by either structure or recruitment strategy).
- *Technical challenges and improvements:* The implementation of the grouped bar charts was relatively straightforward. While making these graphs, we mainly encountered small decision points. For instance, we had to opt for a logarithmic axis to increase the readability of the graphs. Likewise, we opted for tilted axis labels to avoid overlapping labels. Figure 5a and 5b show the sketched grouped bar chart and final grouped bar chart for the recruitment strategies, respectively. One can see that for this visualization, we stuck to our original idea.



(a) Sketch of grouped bar charts



(b) Final version of grouped bar chart for recruitment strategies

5 Website Layout

The website layout relies on the adoption of the **Beautiful Jekyll template**, which provided the header and the footer of the website and allows for a smoother interaction with GitHub. Additionally, we decided to have the text centred on the website. We wanted the website to be interactive, as this will engage the user and draw him or her into the story. Therefore, we have made several interactive visualizations, as described in the sections above. Moreover, we added interactivity through flipping cards. On these cards, we pose a question that can be answered by studying the corresponding visualization. By hovering over the card, it will flip and the user can see the correct answer.

Let us highlight three more choices that were made regarding the layout of the website. First, we opted for the text and visualizations to fade in when the user scrolls down on the website. This adds to the feeling of discovering a story, where the next part unfolds in front of you when you scroll down the page. Second, we have chosen for a color palette of red, green, yellow, purple and blue. Each of these colors corresponds to one of the four main ideologies, or the fifth category of single-issue terrorist groups. We have opted for these colors, as they are contrasting which allows the user to easily distinguish them. One final design choice has been to use a single page to tell this story. A different approach would have been to use multiple pages, where every page covers one aspect. However, by using one page we simplify the process for the user, who only has to scroll down to go through the story.

6 Group collaboration

Table 1 shows the breakdown of the work for this project. We used a system where there is always a peer assessment of each others work, such that potential mistakes can be spotted at an early stage. Furthermore, we met one or two times a week, either in person, online or a hybrid version with 1 member online. During these meetings, we could discuss the work that had been done over the last week and the corresponding challenges that arose. Next, we could set up goals for the next week and divide the tasks accordingly. In-between the meetings, we communicated through Telegram, such that we could ask for help if we could not solve a problem. Overall, the collaboration was smooth and we feel like the work has been divided fairly.

Table 1: Breakdown of group member contributions

Component of project	Group member	Peer assessed by
Map of terrorist attacks	Antoine	Alexander
Stacked area charts	Silvia	Antoine
Sunburst diagram	Silvia, Antoine	Alexander
Circle packing chart	Silvia	Alexander
Grouped bar charts	Alexander	Silvia
Flipping cards	Alexander	Silvia
Text on website	Alexander, Antoine	Silvia
Website layout	All members	-
Report: introduction	Silvia	Antoine
Report: Data	Alexander, Antoine	Silvia
Report: Related work	Antoine	Silvia
Report: Structure of Website	Alexander, Silvia	Antoine
Github README	Alexander	Silvia
Screencast	All members	-