Global Terrorism Visualisation (GTV)

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***Abstract*—The Global terrorism database (GTD) [1] includes more than 1,50,000 incidents between 1978 to 2018. Each incident includes spatial information at varying degrees, a time stamp, and several other fields like terrorist group name, their strategic information (attack type, target type etc.), number of fatalities etc. Due to size and complexity of data, summarizing data and identifying trends has been difficult. This paper introduce visualisation system to visualize GTD data that is able to present various types of patterns and thus facilitate explorations of the incident data from different perspectives. With visualisation environement one can visualize spatio-temporal pattern of number of deaths due to terrorism, filter most well known to least kown terrorist group on specific country or all over world and get insights on their startegic patterns of attacks. Finally, system is evaluated based on response from system to some common questions in terrorism intelligence community.**

***Index Terms*—GTD (Global Terrorism Database), spatio-temporal, Terrorism.**

I. Introduction

The terrorism exist in the world since the dawn of recorded history [2]. It becomes global concern to governments and a topic of interest to scholars. With ease of communication technology and availibility of the mass destruction weapons to even small terrorist groups present threat to security of the world. According to Global terrorism database there were more than 44,000 deaths ocurred globally due to terrorism. Given the fact that the terrrorism dominates global news and politics, it is important for investigative analyst and common public to study and understand the underlying trend of terrorist groups and terrorism as whole.

The most dependable source of information right now in market is Global terrorism Database, which has consolidated both domestic and international terrorist activities between 1970 to 2018. With the wealth of information available now from GTD data, the challenge now becomes to understand and uncover patterns and relationships. This paper introduces interactive visualisation system to explore GTD data and find out startegic information of each terrrorist group.

Visualisation is a promising solution to get insight from voluminous data at glance because it takes advantage of the parallel processing capabilities of the human visual system [3]. Moreover, visualization system allows analysts to learn from exploration and to spot outlier and thus unexpected trends.

The design is human-centric that is based on simple interactive bar charts, table view, map view and radar charts. Those visualizations were selected because of their familiarity and ease of use. The contribution of this research can be summarized as follows:

- Exploratory analysis on GTD data and Analyze the startegic pattern of terrorist group in a country or all over world.
- The development of web based tool to explore global terrorism, that can be approachable and informative to the analysts and naive users.

II. Related Work

A. Esri- A map of terrorist attacks

Esri- A map of terrorist attacks [4] is a spatio-temporal visualisation system for global terrorism.

- Interactivity — System allows user to click on country and see the number of fatalities and attacks. It also has option of clicking on recent attacks and seeing where it occured on the map.
- Design — Opacity and color of the proportional circles allows users to see which areas have been heavily attacked easily.

The system do not allow user to find overall startegy of terrorist group like their attack type, most preferred targets or most used weapons etc. Also, analyst cannot find active terrorist group in country or city at a single glance.

B. A world of terror

A world of terror [5] is visualisation tool to analyse all the major terror group by name, geographic spread, total attacks etc.

- Interactivity — Allows user to view detailed information about each terrorist group (i.e. timeline, magnitude of attacks, number of injuries, number of people killed)
- Design — Outstanding color combination used (i.e. red and yellow) to high light certain value.
- Filter function — User can filter data based on timeline if they want to zoom in specific timeline.

C. Visualizing Patterns in a Global Terrorism Incident Database

The system by Guo et al. [6] uses temporal, geospatial, and multivariate aspect of terrorism, but it does not focuses on the relationships between individual entities.

D. Investigative Visual Analysis of Global Terrorism

Investigative Visual Analysis of Global Terrorism is system developed by Wang et al. [7], it proposes interactive visual analytical system that focuses on depicting fundamental concepts in investigative visual analysis, the five W's (who, what, where, when , and why). This system has combined both social network and geo-temporal aspects of terrorist activities into visualisation.

III. System Overview

The system is divided in four views —temporal view (shows overall trend of terrorism), geo-spatial view (color coded based on number of deaths), table view (summarization of country/cities/ terror group) and Radar chart view (to show terrorist group activities.).

A. Total deaths over time due to terrorism

This view shows the trend of number of deaths over time. It has a two way slider to select the range of year through which one can filter the data on all the other views. The trend is shown using Line chart as well as Bar chart. The line chart is an important feature to display the trend, first introduced by Playfair in 1785 [8].

It shows whole trend from 1978 to 2018 as well highlights selected year range through color coding.

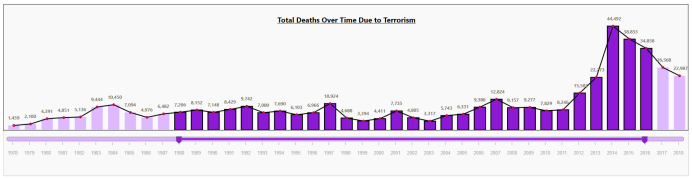

Fig. 1. Bar graph,Line graph with X axis depicting time and Y axis number of deaths. The X axis has two way slider to emphasise only selcted span of time.

B. Map view

Maps are one of the easiest and most intuiive visualizations to understand [9]. Map view in Fig. 2. is use to display the spread of terrorism across the world in selected year range on time slider. The number of deaths due to terrorism is color coded. More the deaths darker the color shade. To view the exact number of deaths during that period in any of the country one can hover over the region in map and tooltip will show the figure.

On top of map there is a searchable country selection dropdown, thus it is not necessary for user to scroll the list country to select the required one. One can simply type the initials of country and all the country matching initials will be auto-suggested. On right side of countery selector their is text views which summarises necessary information for further analysis such as total deaths, total incidents and total number of terror groups for selected country and year range.

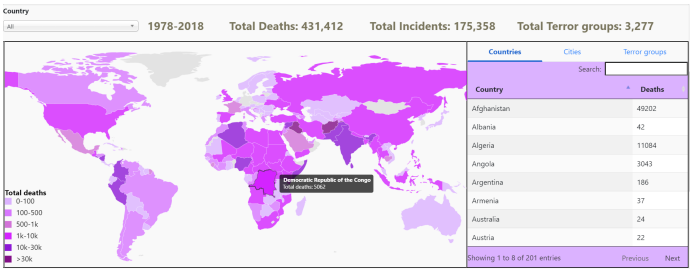

Fig. 2. Map view (on left) and table view (on right) with with 3 panes (Countries, Cities, Terror groups). Searchable country filter (on top left).

C. Table view

Table view as a whole can be seen in Fig. 2 on right side. It consist of three panes Fig. 3. Each pane shows the aggregate of number of deaths for selected country. Each table is searchable, thus user can find specific city or terror group. The number of deaths column in city table and killed column in terror group table can be sorted on clicking arrows in column name. The sorting helps analyst to find top places which are hard hits by terrorist. Analyst can also find most notable terrorist group using sorting option.

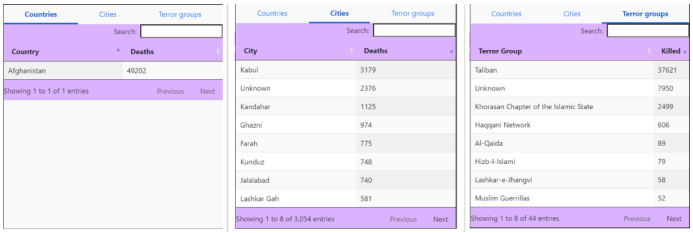

Fig. 3. Three panes inside table view (countries, cities, Terror group).

D. Radar charts

This view shows startegy used by selected terror group using searchable dropdown, which is sorted based on number of people killed by that terror group. Sorting allows analyst to investigate most relevant terrorist group first.This view is correlated with other view discussed above. Fig. 4. shows startegy of 'Tawhid and Jihad' terror group in Iraq. First part shows target type selected by terror group, on hovering the dots one can find 28.57% times selected target is 'Military'. Middle chart shows percentage (%) distribution of attack types on Radar chart [10]. Third chart shows weapon types used by terror group.

IV. Demonstration

A. Test Case 1: Finding top five affected countries or cities due to terrorism

Analyst can easily find top five affected countries by terrorism during selected time range. First user has to set time range using slider, then just select 'All' countries in dropdown, this will populate all the three panes discussed above in table view. On sorting death column in countries/cities/terror group

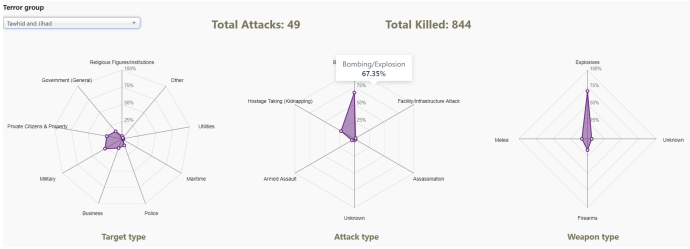

Fig. 4. Radar charts for selected targets, attack type and weapons used by terrorist group selected in sorted searchable dropdown (top left).

table in descending order,one can easily find top five countries, cities affected by terrorism. It is also possible to find top five terror gropus in world similarly.

B. Test Case 2: Find startegy of terrorist group based on different parameters

To track the any specific terrorist group for specific country, one can directly select country in searchable dropdown. It will populate terror groups active in that country in table view or if you want to find specific terror group, just search on table view it will auto-suggest the name. On selecting country, selecting terror gropu dropdown in Radar char view also changes dynamically, one can directly search the terror group name and it will show startegy of terror groups in Radar chart of different polygon, with number of catedgories equal to number of axis. The distribution of diffrent strategic attribute is shown in percentage format to avoid different raduis requirement for large data.

V. Discussion

A. Feedback from audience

- Allows user to view detailed information about each terrorist group (magnitude of attacks, number of people killed, target selected, weapon used), if it it could show on timeline one can find trend in terrorist strategy.
- Design — Good choice of color selection, different shades of pink and purple.
- Filter function — User can filter data based on timeline if they want to zoom in specific timeline.
- The map could show total number of attacks along total deaths on tooltip.
- More could be done on map, an interactive zoom could be be introduced to view the city level details for selected filter.
- Sorting and Searching in table is quite a useful feature to quick fast the analysis, though table view could be improved by add checkbox on table rows, and showing comparision of selected terror group on radar chart in single view.
- Adding a text cloud could be interesting feature an changing text cloud dynamically based on filters.
- Another visitor suggested to link the data to database to show the real time updates.

VI. Future Work

A. Visualisation Recommendation

We wish to add Text cloud to show the motivation of terrorist organization, and linking Text cloud to other filters. At the moment it is not achievable as we were not able to keep track of time dimension after breaking words in 'motive' attribute to token. We also hope to add comparison feature betwen startegy of terrorist group in single view, i.e. overlaying maximum five other terror groups on the radar charts. We did add details of individual incident on the map using dot because it will include too many points on map , which will make web page extremely slow and prone to crash. We also wish to add trend of number of deaths by terrorism for each country, right now that information is embedded in panes of table.

B. Dataset Recommendation

One of the reason why we were not able to create text cloud is, dataset has too many irrelevant words or missing data for the motivation column. The attack that caused maximum fatlities often have no records. Most of the motivation records tend to be about violation incidens in United States. To identify the root cause of terrorist attacks, the motivation attribute should be clear and should not be missing. Moreover, dataset has large proportion of unknown or missing records. For example, the classification of international attacks has around 60% of recors unknown. The data needs more update to be more complete.

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