Storytelling Exploratory Visual Analytics for Counter-Improvised Explosive Device Incidents

Valérie Lavigne
Defence R&D Canada
2459, route de la Bravoure,
Québec (QC)
CANADA
valerie.lavigne@drdc-rddc.gc.ca

Shivas Jayaram
BrainCradle
322 Birchwood Dr
Hartsville, SC 29550
UNITED STATES
shivasj@gmail.com

Marius Panga
Microsoft
Microsoft Campus
Thames Valley Park, Reading
UNITED KINGDOM
marius.c.panga@gmail.com

ABSTRACT

In order to better understand the dynamics of Counter Improvised Explosive Devices (C-IED), we developed an exploratory visual analytics tool coupled with storytelling techniques. Analyzing datasets about incidents can help derive activity level assessment, perform trend analysis and gain better situation awareness.

Exploratory visual analytics allows a user to explore a dataset and discover interesting patterns. Visual analytics tools can offer complex interactions, but they may be intimidating to a new user. Storytelling techniques has the potential to help new users get started with an interactive visualization application.

The use of our exploratory visual analytic tool allowed the discovery of interesting patterns in the C-IED incidents dataset produced by the NATO Counter-IED Center of Excellence (NATO C-IED COE), and we conveyed those insights to users by applying storytelling techniques as part of the interactive visualization tool. After the users have explored the provided insights, they are invited to continue exploration on their own, allowing them to make more discoveries.

This paper explains the exploratory visual analytics capabilities implemented into the tool, as well as how storytelling techniques were applied to convey insights to a user and subtly teach them how to use the tool. Then, we provide an overview of the insights discovered with the tool about C-IED events.

INTRODUCTION

We developed an exploratory visual analytics application that was coupled with storytelling techniques.

The collection and analysis of datasets about incidents can help analysts derive activity level assessment, perform trend analysis and gain greater insight about the problem they are monitoring. In order to better understand the dynamics of Counter Improvised Explosive Devices (C-IED), we decided to apply an exploratory visual analytics approach with storytelling elements.

Exploratory visual analytics is meant to allow a user to explore a dataset and discover interesting patterns and insights. Some visual analytics tools afford complex interactions that can be intimidating to a new user. Storytelling techniques can help a new user get started with a new interactive visualization application in order to understand what a dataset contains and how to leverage the exploratory visual analytics' tool capabilities to perform new analyses on the dataset.

We found that the use of an exploratory visual analytic tool allowed the discovery of interesting patterns in the Ukraine C-IED incidents dataset produced by the NATO Counter-IED Center of Excellence (NATO C-IED COE), and we conveyed those insights to users by applying storytelling techniques as part of the interactive visualization tool. Once, the users have started exploring the provided insights, they are invited to continue their exploration allowing them to make additional discover from the data.

After presenting the related work, this paper explains the exploratory visual analytics capabilities implemented into the tool, as well as how storytelling techniques were applied to convey insights to a user and subtly teach them how to use the tool. Then, we provide an introduction to the C-IED events analysis and the insights discovered with the tool are presented for this application domain.

DATASETS DESCRIPTIONS

NATO Ukraine IED Incidents Data

This is a NATO Unclassified IED events spreadsheet from the NATO C-IED COE. It contains 665 events, with 15 in 2001-2013, about 230 in 2014 and the rest in 2015. It contains the following column headers: Date, Type, KIA (Killed in Action), WIA (Wounded in Action), City, Region, Country, Details, and Remarks. There are missing values in the dataset.

Ukraine Census Data

We also included various statistics about Ukraine to see if we can find patterns between the IED events and these statistics. The data was cleansed and transformed in order to have use the same common attributes as our primary data set (the NATO IED dataset). Transformations applied in order to facilitate the data merge with the other datasets: removed irrelevant data from the data set, converted all fields to the correct type, and translated the region names to the ones used by the primary data set.

EXPLORATORY VISUAL ANALYTICS STORYTELLING TOOL

Design Goal and Approach

This project's goal was to allow the exploration of over 600 IED incidents in Ukraine mostly over the past 2 years for the purpose of highlighting and better understanding the temporal, geographical and political patterns in that data. We also considered additional census data and election statistics to uncover potential regional patterns, as well as publicly available data about the existing conflict in Eastern Ukraine. Our intent was to employ interactive visualization to generate better insights about the Ukraine IED situation. We documented how we gathered and transformed the data, our interactive visualization design process and inspirations, and user feedback evaluations in our process book [1].

In order to drill down into different aspects of the dataset, we decided to split it in an overview introducing the purpose of the tool (why) and leading to three specialized views aiming at answering the where, what and how questions about IED incidents.

We repeated the timeline banner and the storytelling boxes at the top of each view, and reused the same casualties icons across the visualizations as a way to keep consistency and help user orientation in the tool. Each

perspective offers multiple coordinated views that can be filtered temporally with using the interactive timeline.

Dataset Overview

The dataset overview approach aligns with the Visual Information-Seeking Mantra of "Overview first, zoom and filter, then details-on-demand" [2]. It introduces the purpose of the visual analytics tool and provides links to the other perspectives (Figure 1).

Geospatial View

The geospatial view shown in Figure 2 provides insights into the geo-temporal aspects of IED incidents. The user can drill down into each region to see how IED incidents happen over time down to city level. The map display shows of individual incidents are spread over each area and the incidents dots can be coloured according to their type or effect on casualties. We also included additional statistical data about Ukraine that allows the regions to be coloured by population density or Russian/Ukrainian ethnicity in addition to the incidents frequency data.

Incidents Type View

In Figure 3, the incidents types and properties views provide a Sankey diagram that focuses on the incidents type and casualties. Brushing over incidents types with the mouse displays examples of incident of that type to the right of the diagram.

Text Analysis View

The text analysis in Figure 4 view exploits Natural Language Processing (NLP) to analyze the unstructured text descriptions of IED incidents. In the graph, events that share similar words are linked together and the most prominent words in each group are displayed.

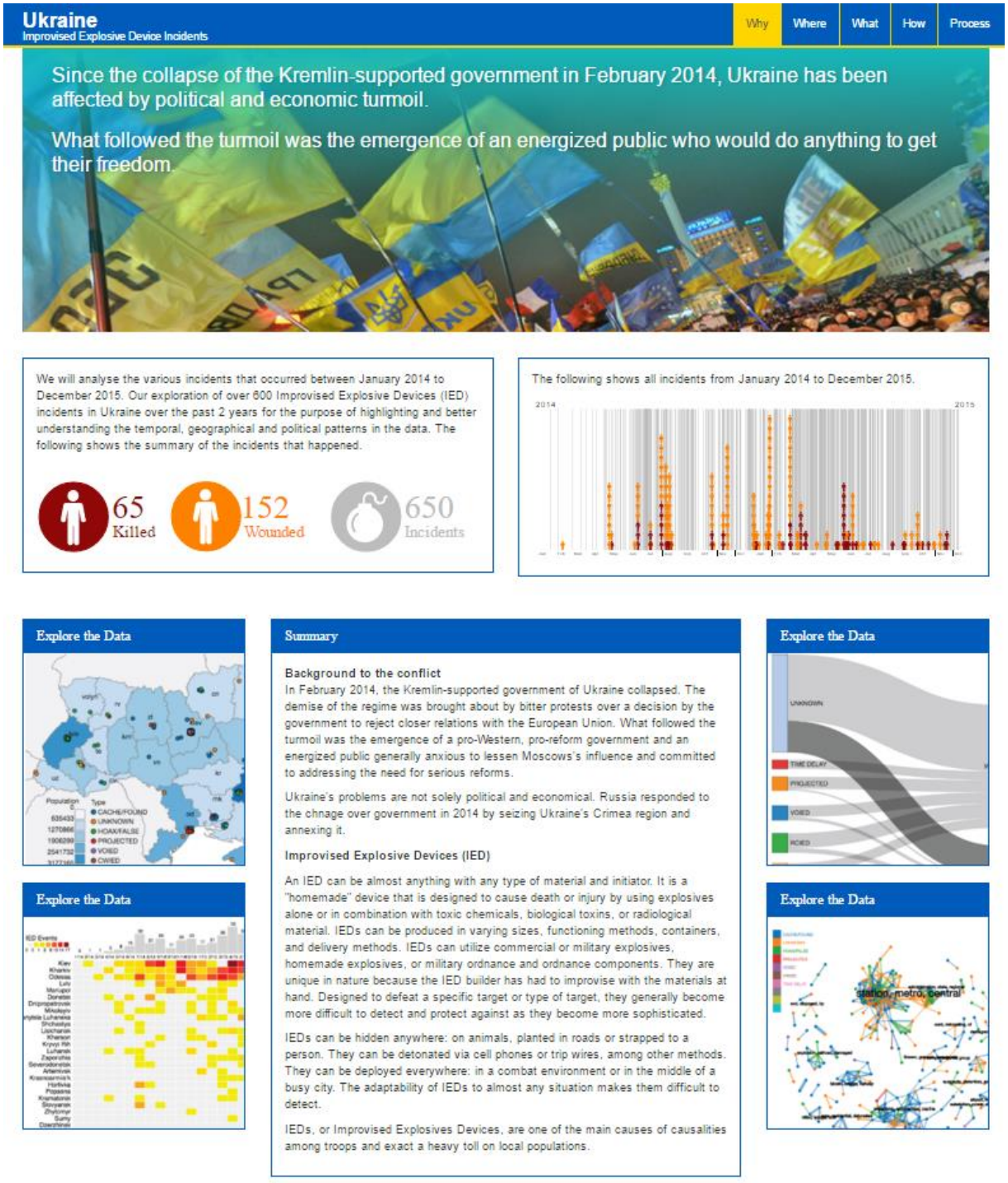

Figure 1: C-IED events analysis tool introduction view.

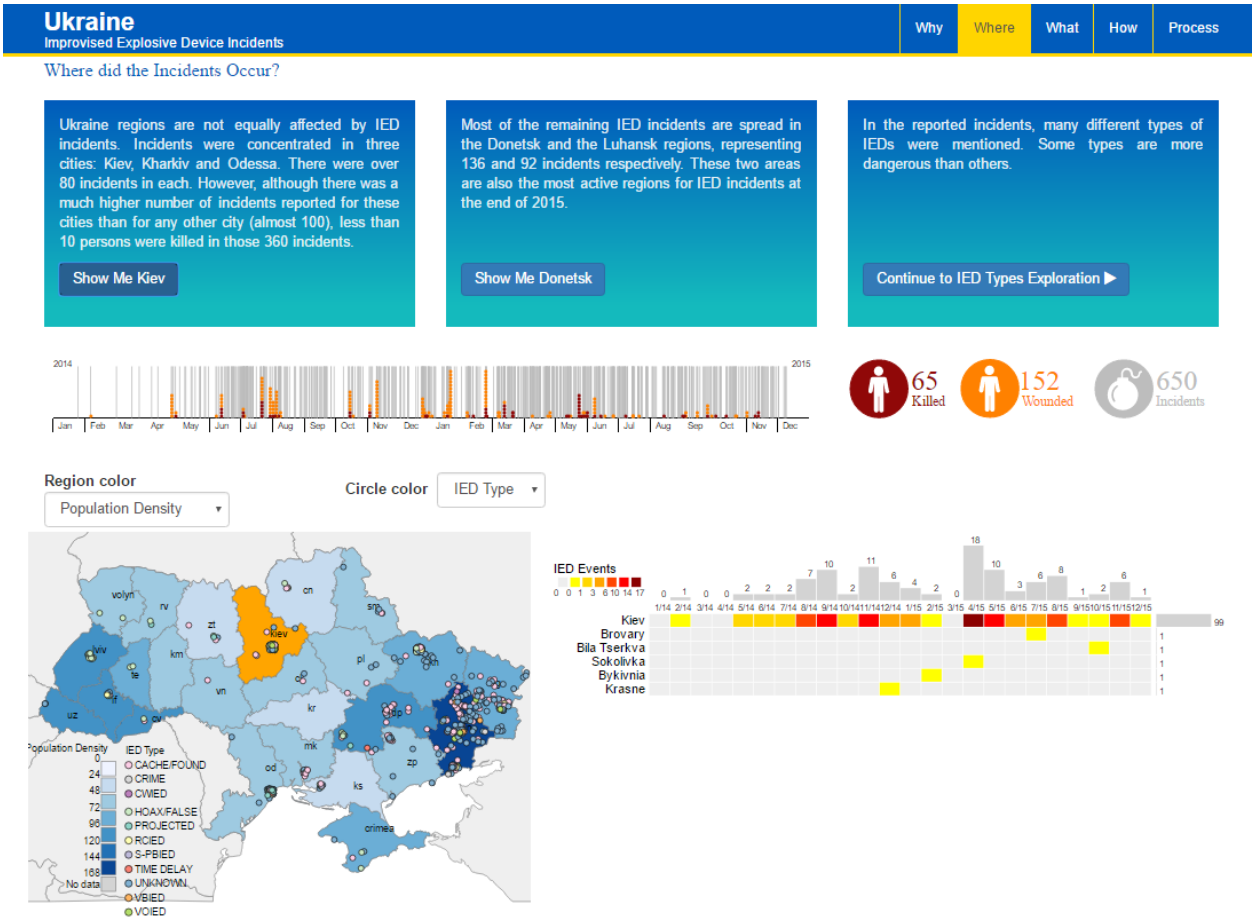

Figure 2: C-IED events analysis tool geospatial view.

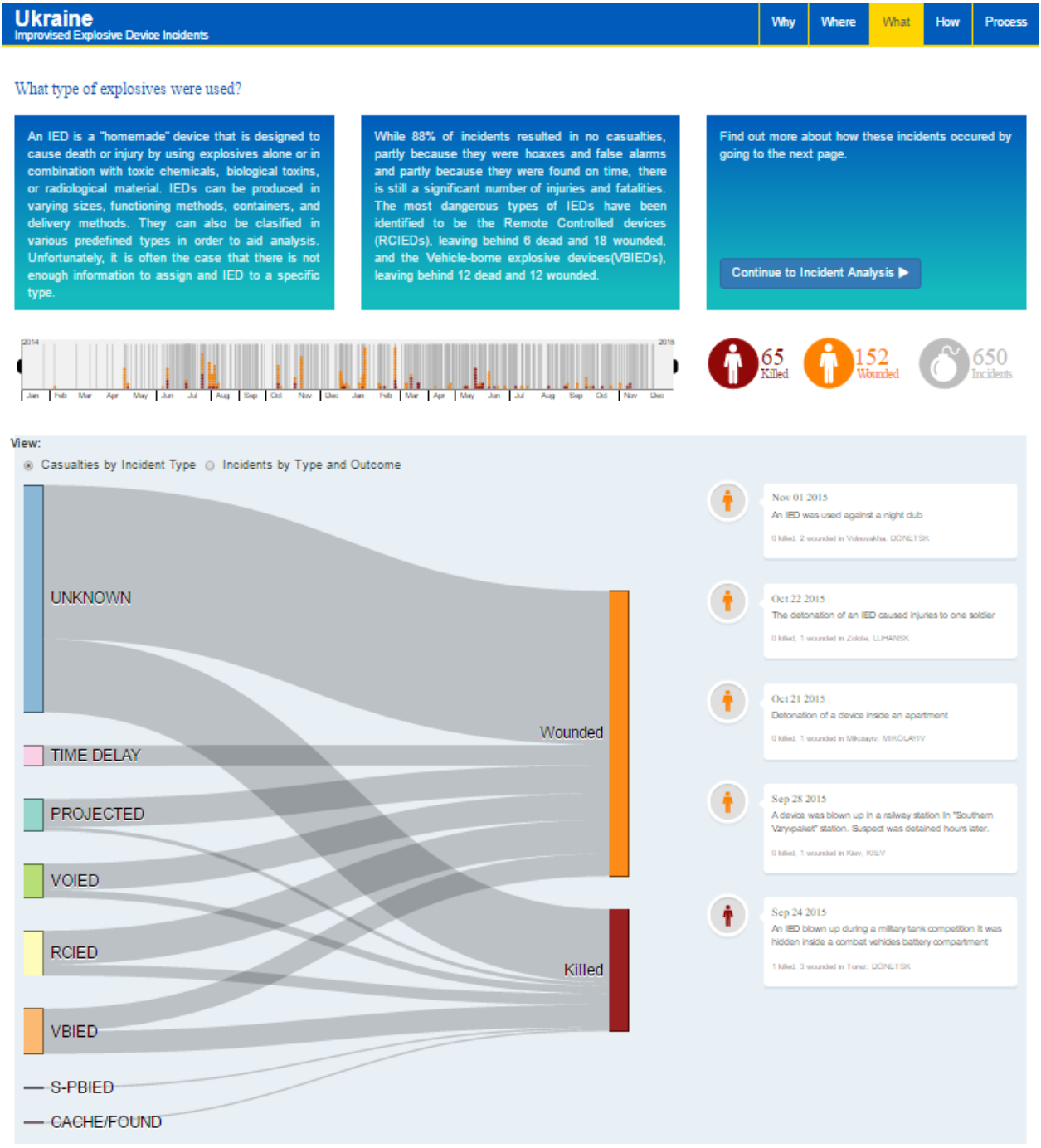

Figure 3: C-IED events analysis tool incident view.

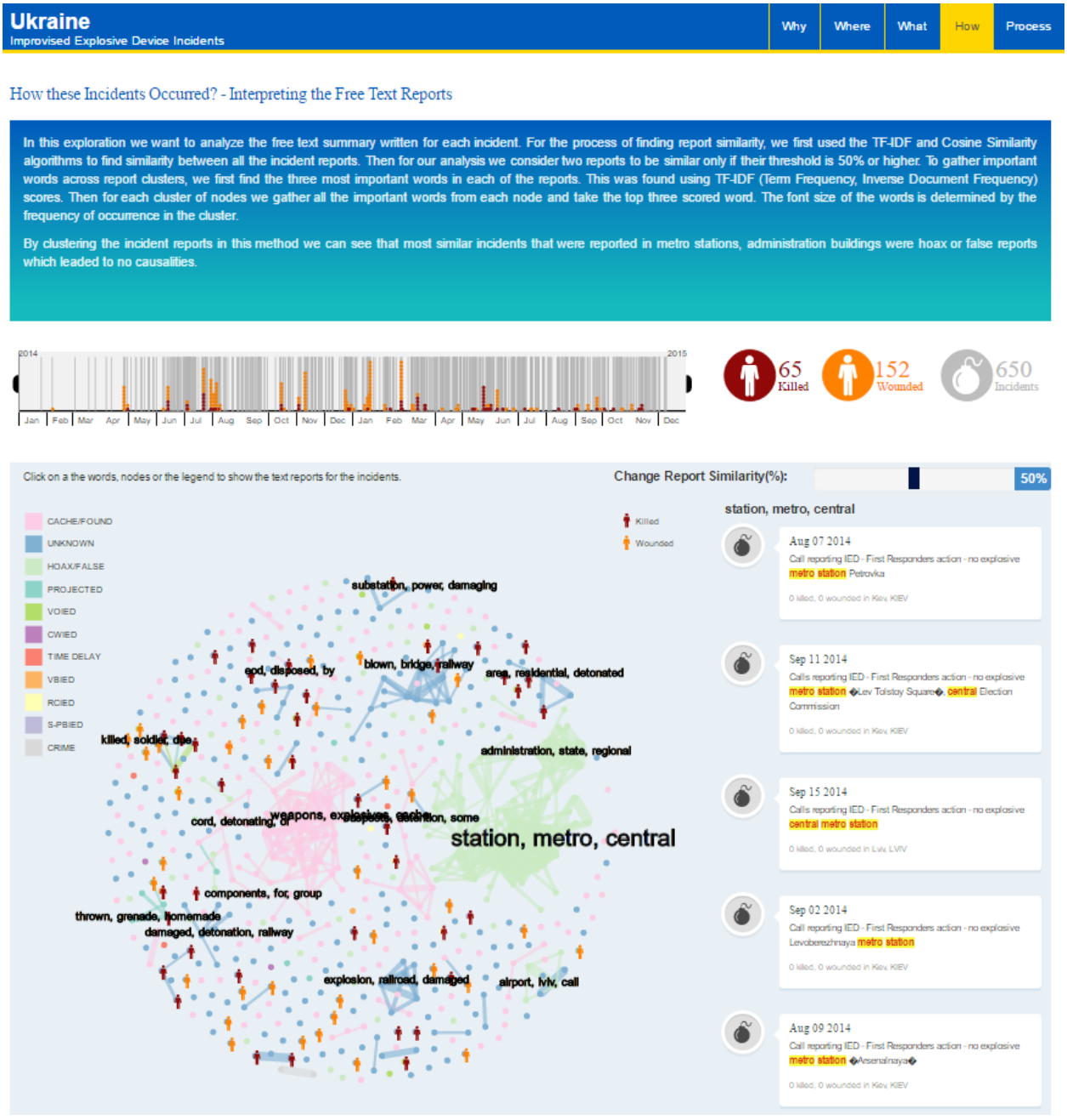

Figure 4: C-IED events analysis tool text analysis view.

STORYTELLING TECHNIQUES

Segel and Heer [3] performed a design space analysis of narrative visualizations. According to this classification, our C-IED events analysis tool uses the following three techniques, to balance between an author-driven and a reader-driven perspective on the dataset:

- Drill-Down Story,
- Martini Glass Structure, and
- Interactive Slideshow.

Drill-Down Story

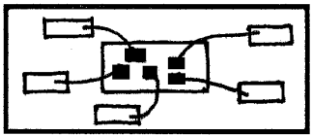

Figure 5: Drill-Down Story [3]

"The Drill-Down Story visualization structure presents a general theme and then allows the user to choose among particular instances of that theme to reveal additional details and backstories." [3]

In our tool, this is what happens in the overview page (Figure 1), which offers a description of the C-IED context and the incident dataset surrounded by small frames that link to more specialized views to explore this dataset.

Martini Glass Structure

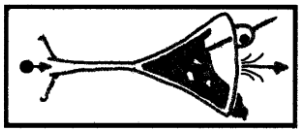

Figure 6: Martini Glass Structure [3]

"The Martini Glass visualization structure begins with an author-driven approach, initially using questions, observations, or written articles to introduce the visualization." [3]

The Martini Glass Structure is very efficient for showing the user how to use the different features of the interactive visualization tool. The top part of Figures 2 contains boxes that offer a text providing insights linked to this view of the data and when the user clicks the corresponding "Show Me", the tool automatically renders the appropriate values and settings to show the insight described with the data.

Interactive Slideshow

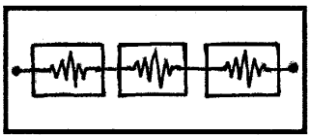

Figure 7: Interactive Slideshow [3]

"The Interactive Slideshow structure follows a typical slideshow format, but incorporates interaction mid-narrative within the confines of each slide. This structure allows the user to further explore particular points of the presentation before moving ahead to the next stage of the story." [3]

This pattern appears at the top part of Figures 2, 3, and 4, where the blue boxes discuss particular aspects of the data that stand out from the current view, before offering to continue to the next view. This technique also facilitates navigation between the different views of the tool, along with the top menu.

INSIGHTS ABOUT C-IED INCIDENTS

The dataset about the Ukraine IED situation was produced by the NATO C-IED COE. The classic way to convey the information from the C-IED dataset employed by the CIED COE is through static visualizations and tables that can be incorporated into MS PowerPoint slides, as can be seen from Figures 8 and 9. Those graphics do not allow an in depth analysis of the dataset and it can be argued that it is not their purpose. Still, it is interesting to explore what are the additional insights that can be extracted from a storytelling visual analytics tool.

Figure 8 makes it obvious which regions have the highest number of IED incidents and provides the total number of incidents for the country. We can see that Kiev(Kyiv) region has a lot of incidents. This is also confirmed in the geospatial view from Figure 10. However, if we choose to color the regions according to the lethality of IED incidents, we quickly realize that incidents that happened in Luhansk and Donetsk were more dangerous than the incidents in Kiev and Odesa. The incidents dots also show how the incidents are spread in each region, showing that incidents in Kiev and Odesa are grouped mostly in the cities of the same name, whereas incidents in Luhansk and Donetsk are spread throughout the area.

In Figure 9, we can see over time how many incidents happened, and how many persons were either wounded or killed. A pie chart of incident types and a table of events by target type are provided. The interactive timeline banner at the top of each view (shown in Figure 12) also provides the information about incidents over time, but using a visual representation. The Sankey diagram shows the relative prevalence of each type of incidents, but adds the information about which ones caused higher casualties. And if we turn the focus around on casualties, we see in Figure 14 the effects of each type of IED. Note that Figure 9 shows data from 2013, which was not available to us, while Figure 13 and 14 are based on 2014/2015 data. Using the interactive timeline filter, we can select a sliding window of a few months and discover that hoaxes incidents increase over time. Also, the relative portion of incidents that killed people is increasingly of unknown type.

Finally, the details of IED incidents are not exploited at all in Figure 8 and 9. Natural language processing allowed us to explore the incidents text descriptions to find out that most hoaxes and false IEDs involve the

words “station, metro, central”.

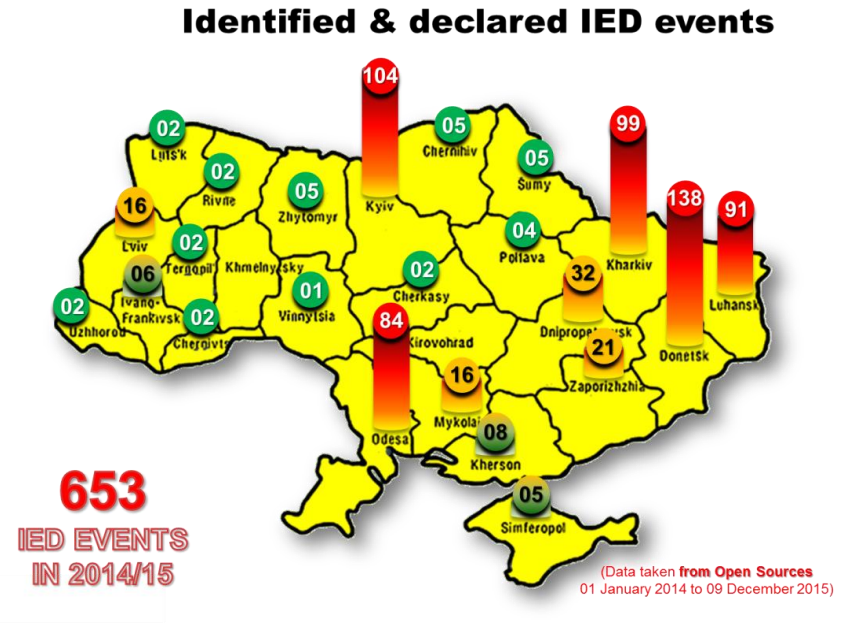

Figure 8: Geospatial summary slide featuring a map of Ukraine IED incidents in 2014- 2015.

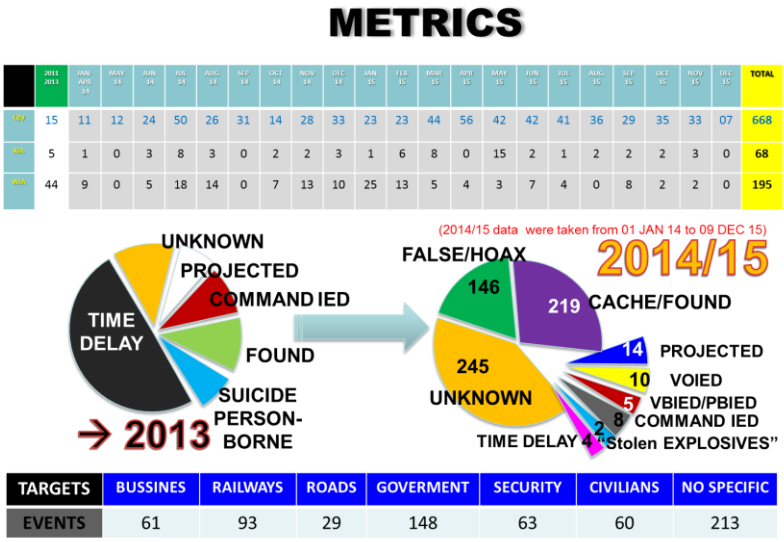

Figure 9: Categorical and temporal summary slides featuring statistical data about Ukraine IED incidents in 2014-2015.

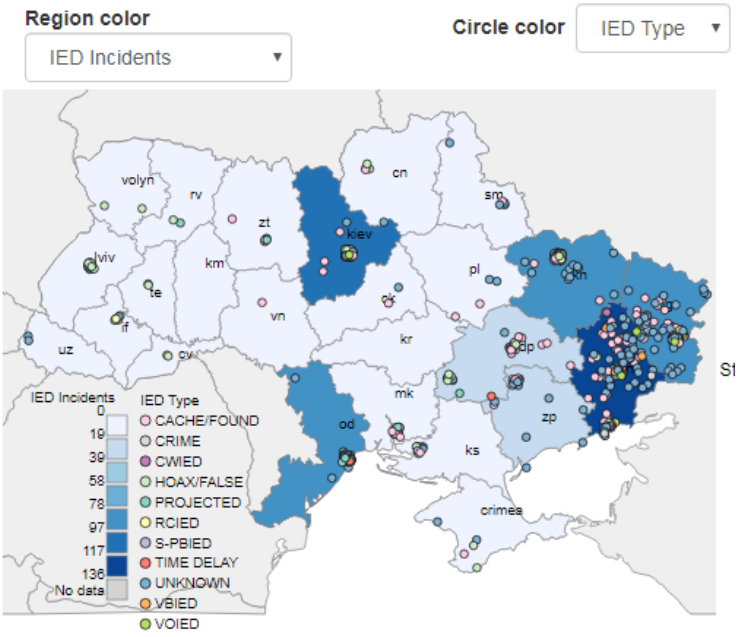

Figure 10: Regions colored according to level of IED incidents.

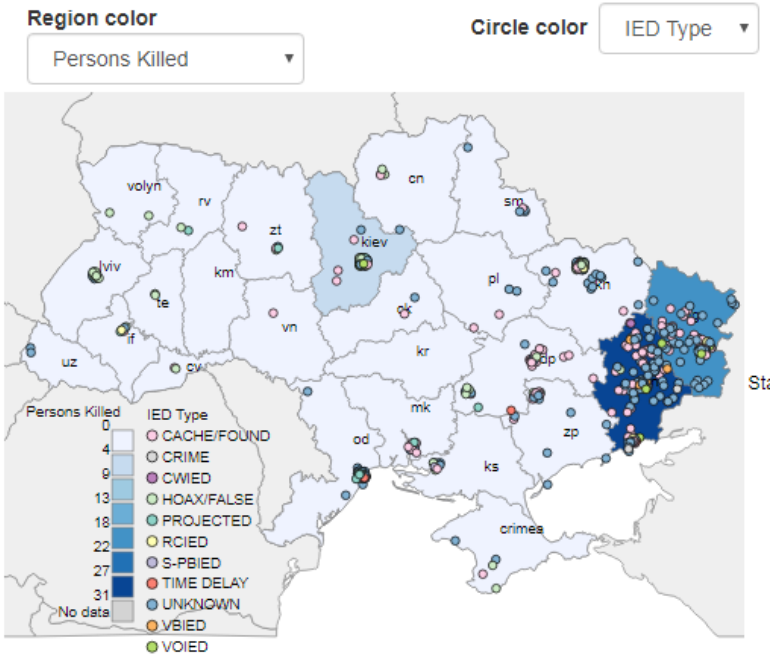

Figure 11: Regions colored according to lethality of IED incidents.

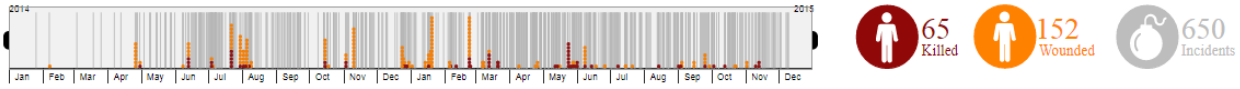

Figure 12: Interactive timeline banner and filter at the top of each view.

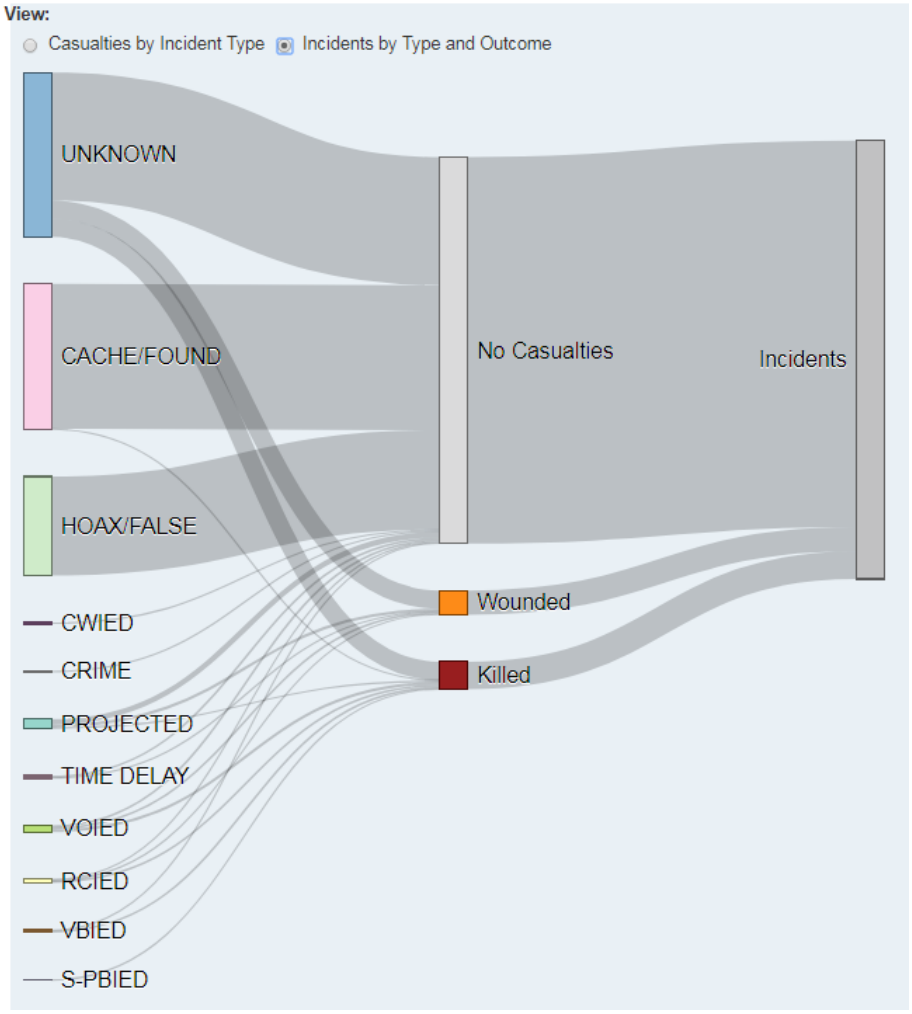

Figure 13: Sankey diagram showing incidents by type and outcome.

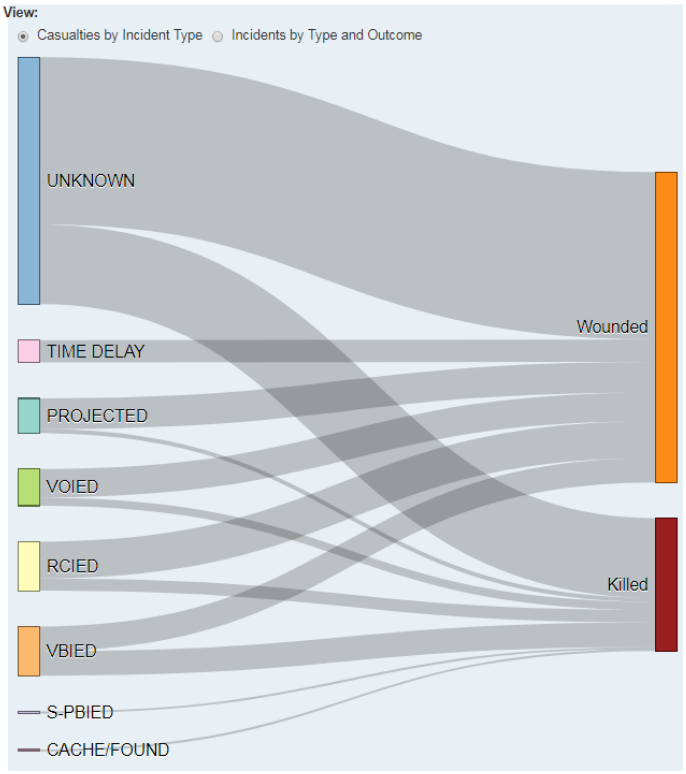

Figure 14: Sankey diagram showing casualties by incident type.

CONCLUSION

In this paper, we described the design approach and storytelling elements behind the exploratory visual analytics tool we developed for analyzing a dataset about IED incidents in Ukraine. We demonstrated that a visual analytics approach can highlight insights that are cannot be discovered from summary tables and the basic visualizations provided in presentation slides. The tool can is web based and accessible at (http://nato-project.github.io/v2/index.html). The code for the tool is also available freely.

REFERENCES

[1] Lavigne, V., Panga, M. and Shivas, J. (2016). Process Book (CS171 Week 13). Project Title: Ukraine Improvised Explosive Devices. http://nato-project.github.io/v2/Process%20_Book.pdf. Accessed on September 9, 2019.

[2] Shneiderman, B. (1996). The eyes have it: a task by data type taxonomy for information visualizations. Proceedings 1996 IEEE Symposium on Visual Languages, 336-343.

[3] Segel, E., & Heer, J. (2010). Narrative Visualization: Telling Stories with Data. IEEE Transactions on Visualization and Computer Graphics, 16, 1139-1148.