A Visual System for Custom Security Analysis in Cities

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***Abstract*—This paper proposes the use of an interactive visual system to help understanding security data of cities. This system makes use of maps and plots interacting each other and with a previous configuration. The main goal is to promote the understanding of the saturated regions on means of crimes and police action as well as search from relations between these two. Some analysis drives us to non-expected insights like the high level of criminal index in small counties away from the urban centers.**

I. Introduction

As the use of intelligence devices grows, the generation of data grows faster than the capacity of processing such data to generate quality information. To diminish this gap, cities all over the world are making huge investments to became intelligent cities. Researches like Cohen in [1] define intelligent cities as the one who are capable of maintain a economic growth an increase the quality of life of your citizens through the generating of efficiency on urban operations. One way of doing this is to provide easy access to data visualization systems.

A. Motivation

The decrease on the feeling of safety in Rio de Janeiro is highly correlated with the media. Information's broad-casted in these channels may tell only part of the whole data while some small parts of the data could be presented in form of indicators. This happens even because of the amount of time a media has to present the news. This approach could produce miss-interpretation of the whole data as we only have access to a small part of it.

Building a visualization system and making it available gives a tool to the society to explore data and extract informations from an interactive and iterative manner. Therefore, anyone could look forward to testing its premises and have your own conclusions through its analysis over the data.

B. Related Works

An iterative system that helps understanding the security issues of a city is a very desirable tool. The authors in [2] discuss about how to present geographic crime information to the user. They had position (lat, long) of each crime but they decide to demonstrate their results in a choropleth map with crime data. This decision was made in order to ensure more information extraction from the map. A choropleth map was also the visualization choice by [2] and [3] for crime data visualization.

Another paper [4], discusses how crime count analyses can influence on conclusions because a crime occurs when an offender, a victim and a law intersect in time and space. A greater number of people implies a greater number of both potential offenders and potential victims.

The study of visualization and analysis [3] created a new method of visualization and analysis of crime patterns based on geographical crime data by using Formal Concept Analysis, or Galois Lattices, a data analysis technique grounded on Lattice Theory and Propositional Calculus. This method considered the set of common and distinct attributes of crimes in such a way that categorization are done based on related crime types. Thus the data can easily be visualized and intelligently analyzed by computer systems.

Maia in [5] used many graphs types to visualize the criminal data from city Caiacó-RN. Among these types were: time series, bar chart, heat map and pie chart.

In a more specific line of research Patil et al [6] created a system that presents a methodology of recognizing a criminal record by using existing evidences in situations where any witness or forensic clues are not present. The system uses an unambiguous clustering mechanism to fragment crime data into subsets or clusters based on the available evidences. Moreover it uses classification techniques to recognize most possible suspects for crime incidents.

C. Contributions

In this paper we focused in the construction of a visual interactive system to explore the security data of Rio de Janeiro state. The main goal is to ensure the understanding of saturated regions in respect to crimes and police action as well as searching relations between these two. This tool may serve to people as well as to companies like insurance, real state and all the entities somehow interested with quantifying the occurrence of security events related to its business or some personal interest.

The remainder of the text is structured as follows. Section 2 explains our proposal. Section 3 discuss some results. On section 4 presents the conclusions and future works and finally, the references.

II. Proposal

To construct the visual system for custom security analysis in cities we make use of *Bootstrap* [7] for web interface and parameters configuration, *Google Maps* [8] to presentation and interaction with the map, D3.js [9] to plot graphs and interact with it and *JQuery* [10] to handle interface events.

A. Dataset

We use data from ISPDados [11], page with pubic data of Public Safety Institute (ISP) from Rio de Janeiro's state government. We have the number of event occurrence per month (from January 2013 to March 2017) for a group of crimes (Homicide and Attempts, Robberies, Rapes and many kinds of Thefts) and a group of police action (Seizures: drugs, guns, minors, prisons; Vehicle recovery) and the total occurrence records. These data are summed by police station of the Rio de Janeiro state. We also used the county and police station population data provided by that same Institute to allow analysis of the relative value of occurrences. These data were looked in opposition to the absolute number also used on the analysis. We used population estimate data of 2016.

Data were obtained in a spreadsheet format (xls Excel), one file for each event (crime, police action or occurrence records) and one for each year. We convert files to CSV maintaining only the informations that are interest for us. Then the system read these files and construct a dictionary using the identification of the police stations as the key, the value are objects with the following attributes: county, aisp (identification of battalion, an aggregation of police stations) and the three kinds of events (crime, occurrence records and police actions). Each object has another dictionary called years, each year has an array with the data of the events of each type. Each event has an array With the number of events per month and the sum of events on that year. We maintain this dictionary in memory so that the queries could be realized in less than a second.

B. Interface

We built a custom interface to permit the configuration of some parameters:

- **Time window**: could define an interval or define the months or years to be analyzed.
- **Weight table**: determine if an event enters in the analysis and how much it contributes in the indexes of security. We calculate an index for each event type (crime, police action and occurrence records).
- **Mean on time series**: determine the visualization or not of each event mean for a type on the time series that compares the history of each index.

The association of weights to each event create indexes of crimes and police actions taking into consideration what are the events more important to the one who uses the tool to analyze data.

First of all the map of Rio de Janeiro state is shown with a color range using choropleth to represent a quantification of a security index (we use different colors for crime, police action and occurrence records). The group of colors used were the one defined by [12]. A fast look on this map enables some information extraction like what are the most affected regions by the indexes created. A sample of a map is on figure 1 and the information that is presented at a mouse click over a region of the seventh battalion is in figure 2.

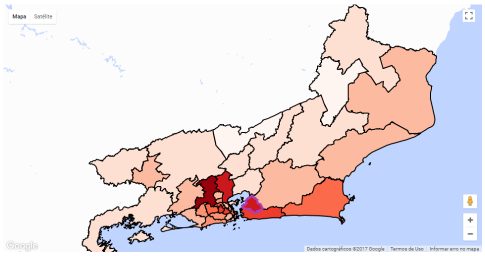

Figure 1. Map configurated with zoom = battalion, event type = occurrence records and absolute quantification with seventh battalion selected.

Figure 2. Additional information of the map on figure 1.

On the map we include some visualization configurations like:

- **Zoom** to determine the territorial limits (Battalion, County or Police station).
- **Type of data** corresponds to indexes configurated on the weight table (separated by Crimes, occurrence records and Police actions).
- **Quantification** indicates if the analysis will be done over the absolute data (crude data weighted summed) or relative (absolute index divided by the size of the population and normalized by the region with bigger index).

C. Interactions

Clicking over a region on the map some specific data about this region will appear on the right side. Bellow the map we show plots with time series data of each index, each kind of event is exhibit in a different time series. With this is possible to search for direct relations between crimes and police action indexes. At the right side of each time series is a bar chart

Table I
RELATIVE RESULTS FOR ALL THE CRIME EVENTS

County	Relative value	Absolute value
Nilópolis	100	22343
Miguel Pereira	91	3186
Buzios	84	3760
São João de Meriti	83	54126
Mesquita	83	20013
Italva	83	1716
Niterói	82	57950

that gives detailed information of the quantity of each event on the region selected on the map. This plot also shows the total (sum of all the events of this analysis). With this one could easily measure which events have more impact on the total numbers of a region.

Its possible to select more than one region through mouse click in the map. Time series present a curve for each selected region allowing the comparison between the indexes of each region and the curve of the mean values of all regions.

A selection made in a time interval of any time series highlight the same interval on the other series to make the search of correlations easier.

As bar chart shows details of each event on the case of all the crimes are considered on the index analyzed (19 in total), we need to use a color palette with more than the 12 colors of [12] we use than the colors of Sasha Trubetskoy [13].

III. RESULTS

Table I presents the counties with the highest relative (index over population) crime index, this analysis includes all crimes events. The state's capital (Rio de Janeiro) have the great absolute numbers with 696,111 occurrences but it's only 76% of the relative index in relation with Nilópolis. The hypothesis was that the biggest indexes will be located at the capital or in an area called baixada fluminense. This analysis shown that some rural and touristic counties represent three of the of the seven counties with worst relative indexes. The unexpected counties are Miguel Pereira, Búzios and Italva.

In a similar analyses, now considering all the police actions the result was also different that the hypothesis placing Itatiaia (again a county away from the huge centers) as the bigger relative index followed by far by Miracema that has only 39% of the relative index related to Itatiaia. Looking to the bar chart, figure 3, is possible to identify that the drug seizure (green bar) is the event that has the most impact regarding this index.

When looking for the occurrence records, Búzios, Itatiaia and Miguel Pereira also appear between the firsts in the relative index.

Taking into account only the most violent crimes (rape, homicides and robbery followed by death) the regions that stands out are also very far from the big urban centers or other areas that this index are expected to be high. The figure 4 shows a map with darkest colors the worst relative index that

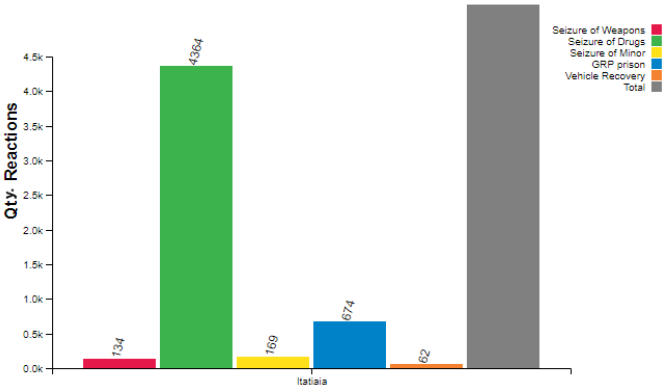

Figure 3. Bar chart of Itatiaia county, event type = police action (all events).

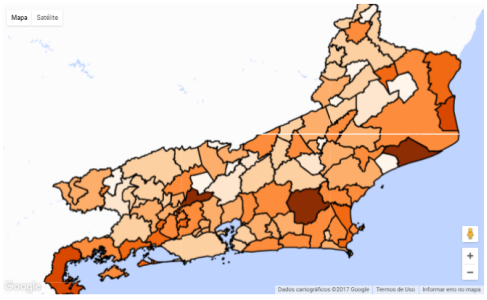

Figure 4. Map with zoom = county, event type = crimes (rape, homicides and robbery followed by death) and relative quantification.

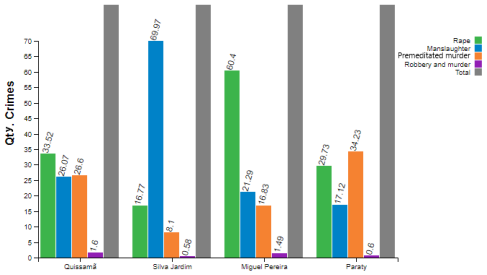

Figure 5. Bar chart with counties presenting the worst indexes, event type = most violent crimes (rape, homicides and robbery followed by death).

corresponds to the counties of Miguel Pereira, Silva Jardim, Quissamã and Paraty. The bar chart of figure 5 however illustrate the difference of pattern of violence in each of these regions. Miguel Pereira present rape as the most frequent event, on Silva Jardim the main event is manslaughter, for Paraty the high numbers are on premeditated murder and rape and Quissamã shows balance between homicides and rape.

Looking for relations between crimes and police actions we consider only the car theft and its recovery. The plot that shows a direct link in the time series in the region of São Gonçalo could be seen in figure 6. The selected area split the graph in three different trends. The first is an uptrend (before the selection), the selected period shows a downtrend and the final interval (year of 2016 on) were the uptrend returns. This pattern occurs both on crimes and police action showing that

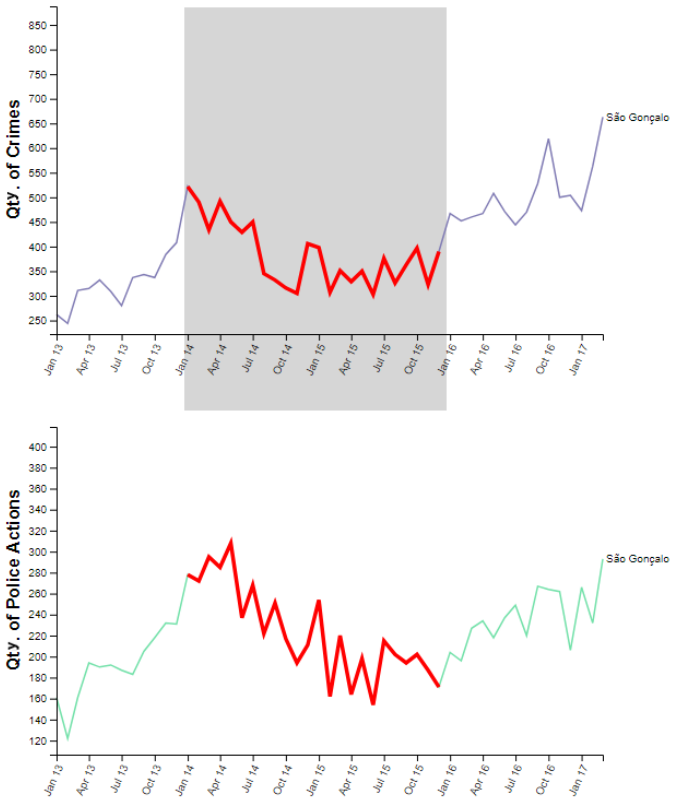

Figure 6. Time series of vehicle theft (top) and recovery (bottom).

the recovery grows with the robbery as expected.

IV. Conclusion and Future Works

We create a visual tool to make custom analysis with security data from cities. Some analysis drives us to non-expected results from crime index in Rio de Janeiro.

The most relevant result is the high level of criminal index in small cites, located far from the urban centers mainly in relative indexes. This kind of result is easily obtained with only a few interactions with our system. Our system permits an easy way to explore data that could serve to decision making considering security information.

For future works we will focus on cases of weights configuration to validate how much this option could better the construction of relevant indexes.

Another important aspect is to look for data of the number of police officers by police station. This is important to ensure analysis of police over-allocations by region.

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