Multiple Coordinated Views Supporting Visual Analytics

Bianchi Serique Meiguins
Universidade Federal do Pará
Belém – Pará - Brazil
bianchi@ufpa.br

Aruanda Simões Gonçalves Meiguins
Centro Universitário do Pará
Belém – Pará - Brazil
aruanda@redeinformatica.com.br

ABSTRACT

This paper proposes the use of multiple coordinated views to support visual analytics. The Information Visualization tool PRISMA includes the implementation of three coordinated visualization techniques (treemap, parallel coordinates and scatterplot) and other auxiliary charts. The coordination is supported by filter, brushing, visual representation and other mechanisms. The mini –challenge 4 (Evacuation Traces) from IEEE VAST 2008 Challenge was used as a case study on this paper.

Categories and Subject Descriptors

H.5.2 [**Information Interfaces and Presentation**]: User Interfaces – *Interaction styles (e.g., commands, menus, forms, direct manipulation).*

General Terms

Design, Human Factors

Keywords

Information Visualization, Multiple Coordinated Views.

1. INTRODUCTION

Information Visualization (IV) aims to analyze data quickly, interactively and intuitively. IV takes advantage of human cognitive capacity to extract information from data using visual representations. Datasets grow in volume and diversity constantly – or sometimes exponentially. IV techniques are therefore challenged to cope with larger and larger datasets in terms of data representation, interaction and performance. Multiple coordinated views have been more frequently supported in IV tools since a single view of the dataset may be unable to identify potentially interesting relationships.

An Information Visualization tool should minimally support the following features: overview, zoom, filters and details-on-demand [1] [2] [3].

Additionally, the tool should provide interactive mechanisms that allow the user to easily and efficiently manipulate graphical representations of the data in order to better understand characteristics and relationships of the dataset. [3] [4] [5].

Multiple coordinated views, when not excessive in number, may considerably improve the quality of user perceptions of a given dataset. This approach allows the user to perform correlation of different views of the same dataset [9].

Coordination ensures that changes made in one data view are propagated to all other views in order to keep the analyzed data consistent between the views. Coordination options include data filters, visual attributes and sorting criteria, among other mechanisms [10].

2. PRISMA

PRISMA is an information visualization tool based on multiple coordinated views to explore multidimensional datasets using treemap, scatterplot and parallel coordinates as its main interactive techniques [6].

The main characteristics of PRISMA are:

- PRISMA is an extensible, portable and easy to maintain Java-based tool.
- The graphic interface is automatically customized to data types and to the range of data values in each dataset.
- The filter components are adapted to the characteristics of each dataset.
- Coordination is supported in filter, color, shape, size and details-on-demand components.
- Provides support to many different data sources, such as relational databases, XML files and pre-formatted text files.
- Pie, bar and line charts and automatically-generated reports are additional coordinated features.

The tool implements three information visualization techniques, each favoring a different kind of data analysis: parallel coordinates, treemap and scatterplot [7] [8]. PRISMA allows the user to analyze data either individual or simultaneously in all views.

PRISMA stores user interaction history including manipulation and configuration data and allows the user to save the state of an explored visualization.

3. A CASE STUDY: EVACUATION TRACES

The mini-challenge “Evacuation Traces” from IEEE VAST 2008 Challenge [11] describes the evacuation of employees and visitors from a hospital building after a bomb explosion. Everyone in the building wore a RFID badge that enabled their location to be recorded during the time of the incident. In order to help the police department during the investigations, five main questions should be answered:

- Where was the device set off?
- Identify potential suspects and/or witnesses to the event.
- Identify any suspects and/or witnesses who managed to escape the building.
- Identify any casualties.
- Describe the evacuation.

The dataset included spatial information related to the movement of each person in the building and a representation of the building itself (solid and open space mappings).

The following sections will answer the questions indicated in questions using PRISMA screenshots to support each analysis.

3.1 The explosion Time Question

The time the bomb was set off was not included among the questions. It may be identified by the simultaneous movement of people in the building, indicating panic. As presented in Figure 1, up to time 373 very few persons were moving, including the following Person IDs : 29 (red), 56 (blue), 44 (green), 21(black) and 28 (orange).

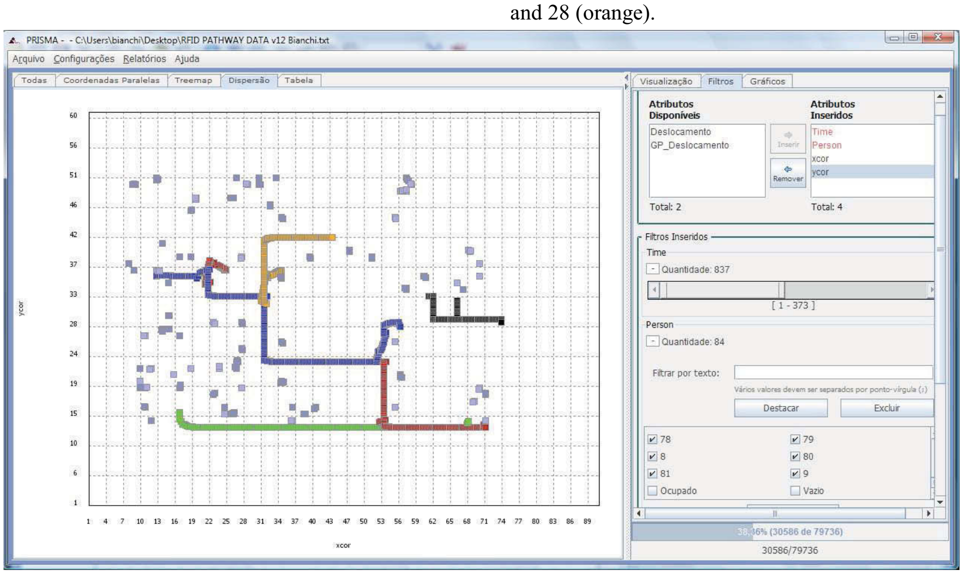

Figure 1. Movement before time 373

After the moment represented in Figure 1, many people moved simultaneously, indicating this was the time the bomb was set off (Figure 2)

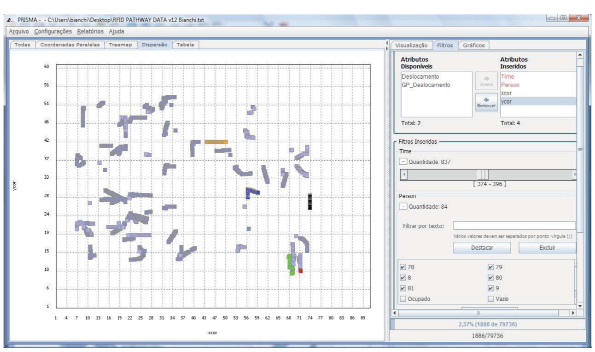

Figure 2. Movement after time 374

3.2 The Casualties Question

In order to identify potential casualties we highlighted the persons who stopped moving soon after the explosion or did not move too far. The total distance between the initial and final points was calculated for each person and included as one of the dataset attributes. Two distance groups were then assigned: less than 10, and 10 or more distance units.

The parallel coordinate technique was used to indentify individuals with the least absolute distance values. Alternatively, the treemap technique was used to select only the items that moved less than 10 distance units. The brushing technique then allowed the analysis of three different groups on the scatterplot view.

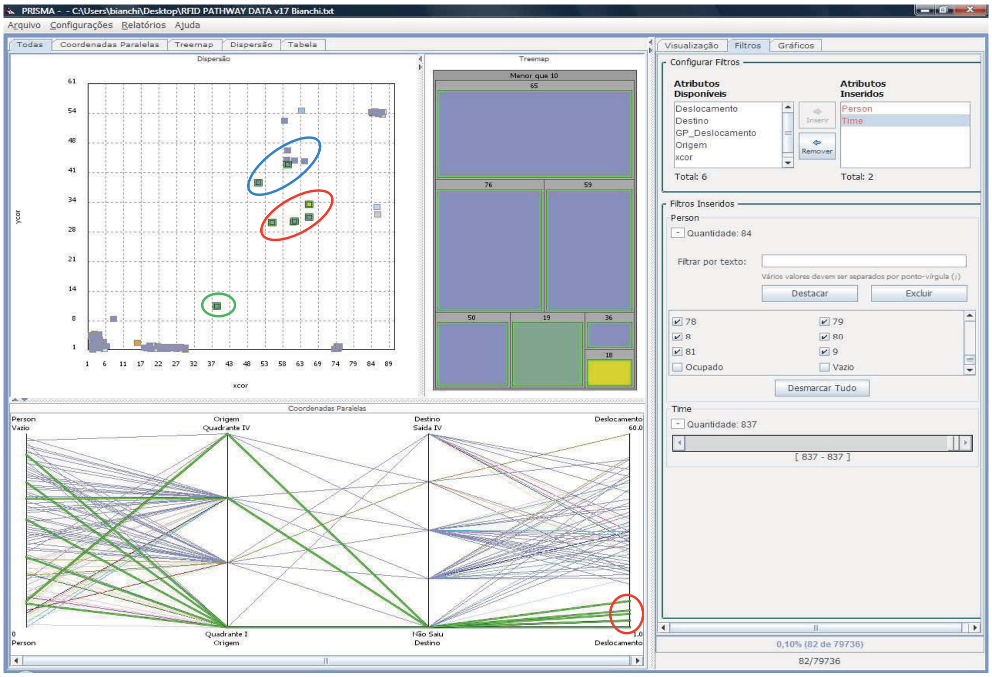

Figure 3. Three distance groups

Analyzing the blue group (Person IDs 65 and 36), the first moved up to time 600, a considerable time after the explosion. Person 36 does not move before or after the explosion. In the green group, person 59 moves during the whole period of captured information and the total distance is not very large returning to a point close to the initial point. The red group (19, 76, 5 and 18) moves very little after the explosion. When we analyzed the red group area, an additional person was identified: number 56 (yellow item in Figure 4). This person moved a long way before the explosion and was next to the red group on the moment the bomb was set off.

Therefore possible casualties are represented by Person IDs 18, 19, 50, 56 and 76.

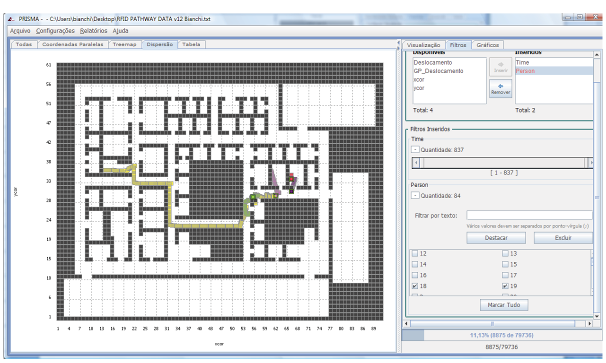

Figure 4. Possible Casualties

3.3 The Suspect Question

Potential suspects or witnesses are those who move next to the casualties location before the explosion and left this perimeter quickly afterwards. Figure 5 presents the preliminary suspects: 29 (purple), 56 (among the casualties), 44 (yellow), 21 (red) and 28 (pink). Person 21 was the only one that had been to the probable bomb location area previously to the explosion. The probable bomb location area is where people moved very little after the explosion and is highlighted in red in Figures 3 and 5. After leaving this area, Person 21 seems to be unable to find the way out. This person therefore presents the most suspect behavior.

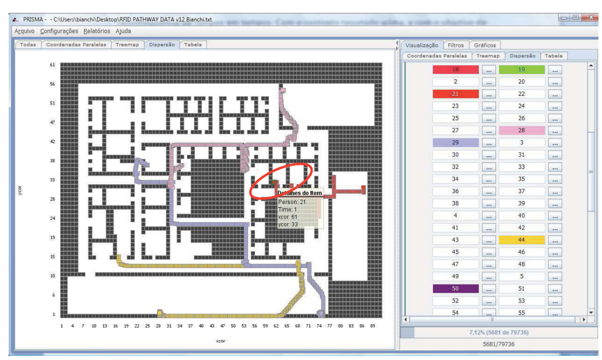

Figure 5. The Potential Suspect – Person 21 (red)

The potential witnesses list included Person IDs 80, 28, and 1. Person ID 1 (blue) was probably the main witness, since he/she crossed the main suspect (21 – red). Person ID 80 (yellow) was in the room next to the victims and Person ID 28 (purple) moved next to the casualties' area (in white) and came back. The witness behavior was filtered in Figure 6.

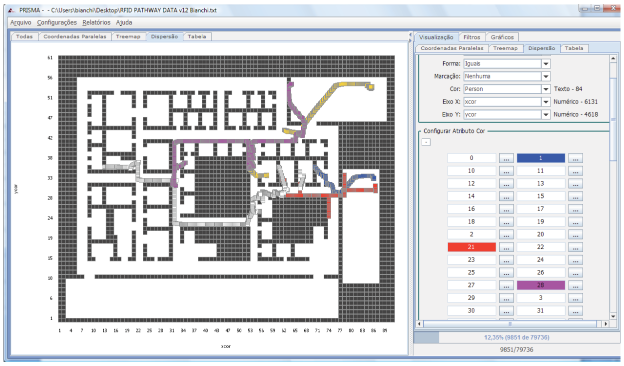

Figure 6. Main Witnesses

Therefore, the main suspect is 21 and the main witnesses are 1, 80 and 28.

3.4 The Bomb Location Question

Considering as the main suspect Person ID 21 and that the victim that moved the less after the explosion was Person ID 18 we assumed the suspect entered the room where Person 18 was and set the bomb off on that location. The coordinates are 61x33, the farthest position of the suspect into the room.

3.5 The Escaping Witnesses Question

The main exit locations are highlighted by a red circle in Figure 7, which also included the complete movement of each person in the building. Neither suspect 21 nor witness 1 have passed these locations so only witnesses 28 and 80 did leave the building.

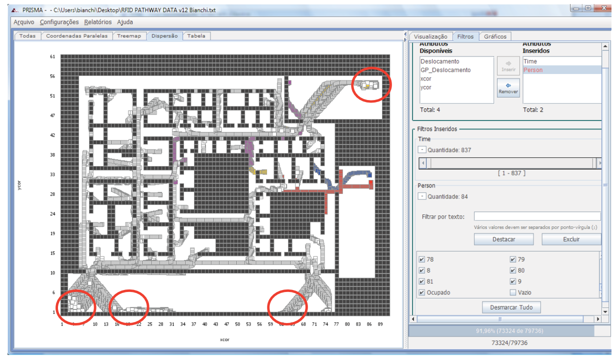

Figure 7. Escaping Witnesses

4. DESCRIBING THE EVACUATION

Using coordination between the visualization techniques, filter and brushing, it was possible to describe the evacuation process.

Additional information was generated for a better analysis of the building evacuation process. One of the generated attribute was the original quadrant occupied by each person (origin attribute). The building was split into four sub-areas as illustrated in Figure 8. Another generated attribute was the destination, which indicated the exit used by each person to leave the building. The four possible building exits were identified by the number of people that eventually moved to the same position.

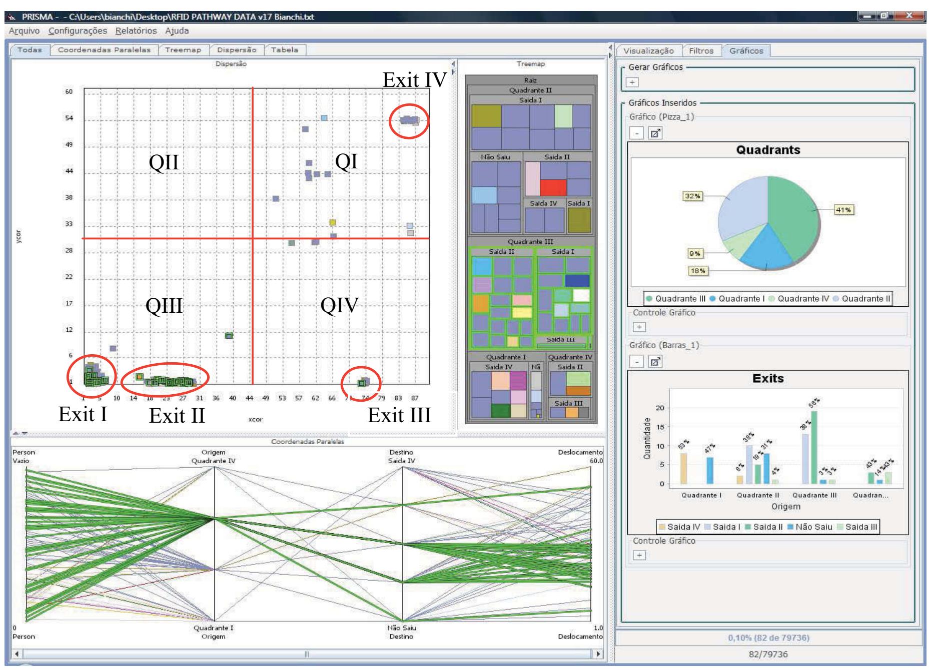

Figure 8. Use of coordination to analyze the evacuation routes.

Using the additional information, it was possible to realize, for example, that 96% of those originally in quadrant III used exits I and II and more than 50% of those in quadrant II used these same exits, with absolute distance from medium to low.

The evacuation was concentrated on the south and west areas of the building (Figure 9). The two main escape routes were the halls identified by green arrows in Figure 9. At some point the right corridor was crowded and some people changed directions and moved to the adjacent hall on the left. People located at the center of the building followed the evacuation route indicated by the blue arrow. People on the north of the building were directed to a northeast exit represented by the red arrow.

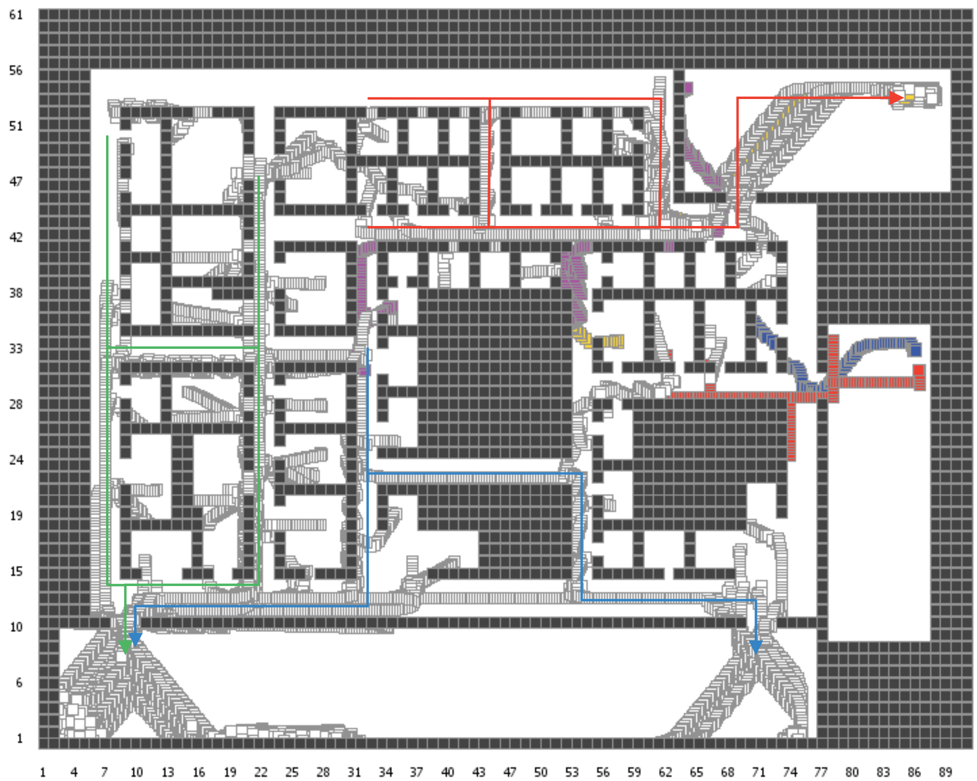

Figure 9. Evacuation Routes

5. FINAL REMARKS

The use of PRISMA to solve mini-challenge 4 focused on the scatterplot technique. It was necessary to perform some preprocessing and to create some new columns in original dataset. The main new information for the analysis was the distance calculation which helped to use the main coordination features of the tool.

The task was facilitated fundamentally by coordination, the use of filter and color mechanisms. The use of the interval filter to analyze temporal information was also very important. It was possible to analyze simple animations which were very helpful to understand people behavior and the evacuation routes.

As future work we believe that the coordination features may be enhanced by the development of new visualization techniques.

6. REFERENCES

[1] Berry, B.; Smith, J.; Wahid, S. Visualizing Case Studies. Technical Report TR-04-12, Virginia Tech, 2003.

[2] Carr, D. A. Guidelines for Designing Information Visualization Applications. Proceedings of ECUE'99. Stockholm, Sweden. December 1999.

[3] Keim, D. A. Information Visualization and Visual Data Mining. IEEE Transactions On Visualization And Computer Graphics, January-March 2002.

[4] Oliveira, M. C. F; Levkowitz, H. From Visual Data Exploration to Visual Data Mining: A Survey. IEEE Transactions on Visualization and Computer Graphics, vol. 9, no. 3, pp. 378-393, July-September 2003.

[5] Spence, R. Information Visualization: Design for Interaction. Barcelona: Acm Press. Second Edition, 2007.

[6] Godinho, I; Meiguins, B.;Gonçalves, A.; Carmo, C.; Garcia, M.;Almeida, L.; Lourenço, R. PRISMA – A Multidimensional Information Visualization Tool Using Multiple Coordinated Views. Proceedings of the 11th International Conference on Information Visualization, pp. 23-32. Zurich, 2007.

[7] Spence, R. Information Visualization. Addison Wesley - ACM Press, 2001. 459 p.

[8] Card, S. K.; Mackinlay, J. D.; Shneiderman, B. Readings in Information Visualization—Using Vision to Think. Morgan Kaufmann, 1999.

[9] Baldonado, M. Q. W.; Woodruff, A.; Kuchinsky, A. Guidelines for using multiple views in information visualization. Proceedings of the working conference on Advanced Visual Interfaces, pp. 110 – 119. Palermo. Italy. 2000.

[10] Pillat, R. M.; Freitas, C. D. S. Coordinating Views in the InfoVis Toolkit. Proceedings of Advanced Visual Interface. pp. 496-499. Venezia, Italy. 2006.

[11] Grinstein, G.; Plaisant, C.; O'connell, T.; Laskowski, S.; Scholtz, J.; Whiting, M. VAST 2008 Challenge: Introducing Mini-Challenges. Proceedings of IEEE Symposium on Visual Analytics Science and Technology (2008).