EQviz: A Visualization Tool for Monitoring World Earthquakes

Nitchanan Prapaitrakul

Department of Computer Engineering

Faculty of Engineering

Chiang Mai University, Thailand

nitchanan_p@cmu.ac.th

Santi Phithakkitnukoon

(Corresponding author)

Department of Computer Engineering

Faculty of Engineering
Chiang Mai University, Thailand
santi@eng.cmu.ac.th

Abstract

This paper presents EQviz, a visualization tool for monitoring earthquakes with the magnitude of 6.0 or larger that take place around the world from 2000 to 2015. EQviz provides four modes of display: instant, aggregate, analysis, and selected area modes. Instant mode displays an animation of a series of earthquake instances taking place in different geographical locations globally over time. Aggregate mode displays the aggregate level of instances of the earthquakes over time. Analysis mode provides a yearly graphical information along with some basic statistics for the user's further analysis. Selected area mode extends the analysis mode by allowing the user to look through the world map and examine different geographical areas as the EQviz provides basic statistics such as the average and standard deviation values of the earthquake magnitudes along with the graphical information of the selected area.

Author Keywords
Earthquake, data visualization, interative visualization.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI)

Introduction

Earthquake is one of the natural catastrophes that can cause serious damages or loss of many lives. Currently earthquakes cannot be accurately predicted [1], which is why people are highly concerned about it. For this reason, we see the importance of presenting earthquake information in a form of animation rather than just spreadsheets or tables. EQviz, a visualization tool for monitoring world earthquakes has been developed for the users who can be researchers, experts, or any individuals who are interested in earthquakes to observe and gain knowledge from an interactive graphical information, with the hope of eventually being able to predict the size, location, and time that it will happen.

Related Work

At present, there are still attempts to predict earthquakes. For example, Lee et al. [2] apply the association rule in their prediction of earthquakes by deriving associate relationship between time and magnitude, depth and magnitude, as well as location and frequency. It is also important to understand social response after the earthquake takes place, to improve planning and policies for future emergency situations. Benyounes et al. [3] make use of cellular phone network data to analyze the social response to urban earthquakes in Mexico. Earthquake data visualization thus becomes very important and facilitative for the earthquake data analysis for either modelling or prediction. Our work has been inspired by Nagel and Groß's work on Shanghai metro flow [4] in the way that it represents the data in different dimensions. Our work extends the idea to an interactive visualization tool that also provides some useful statistical information.

EQviz

There are two main parts of EQviz; data and visualization

Data Description

Earthquake dataset used in this study contains information of earthquakes with magnitude of 6.0 or larger that took place around the globe from January 1, 2000 to May 6, 2015. The dataset contains eight attributes; year, date, time, latitude, longitude, place, depth of the epicenter, and magnitude of the earthquake. The data was gathered from the USGS website[1].

Visualization

EQviz was developed with the Processing Development Environment (PDE)[2]. There are four modes including Instant Mode, Aggregate Mode, Analysis Mode and Selected Area Mode. EQviz uses the color to represent the level of magnitude of the earthquake, from yellow (lowest) to red (highest). The magnitude is categorized into four groups of ranges: 6.0 to 6.4, 6.5 to 6.9, 7.0 to 7.9, 8.0 and higher (Figure **1**).

Figure 1: Representative color and magnitude ranges.

INSTANT MODE
The initial mode of EQviz when it's started is the Instant mode. A screen shot of the EQviz user interface in the Instant mode is shown in Figure **2**. In this mode, an animation of earthquake instances taking place in

---

[1] http://www.usgs.gov

[2] https://processing.org

different locations around the world from January 1, 2010 to May 6, 2015 is displayed. Geographical location of the earthquake is presented with a circle, where its size and color correspond to earthquake magnitude, on a zoomable world map.

Figure 2: A snapshot of EQviz user interface in Instant mode.

Here are the descriptions of the EQviz user interface (Figure **2**):
(1) *Timestamp*: this box displays the instant time of occurring earthquake event on the map.
(2) *Name box*: this area displays the name of our visualization tool and years of coverage.
(3) *Display mode*: a drop-down list that allows the user to select the mode of display (instant, aggregate, analysis, selected area).
(4) *Control buttons*: the user can control the display by clicking restart (|<), pause (||), or finish (>|) buttons. The restart button takes the animation back to the beginning (Jan 1, 2000), while on the other hand, the

finish button takes us to the end date of the visualization (May 6, 2015), which helps the user to see the total earthquakes accumulated overtime in the aggregate mode of display.
(5) *Geo-location*: this shows the geo-location (latitude, longitude) of the mouse on the world map.
(6) *Magnitude levels*: it window shows the amount of earthquakes at different magnitude levels (Figure **3**).
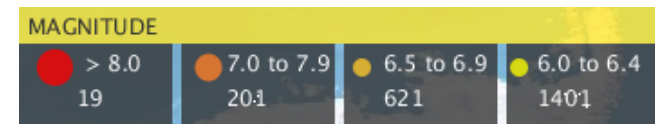

Figure 3: Amount of earthquakes in each magnitude level.

(7) *Bar charts*: this area shows bar charts of the total number of earthquakes with respect to their magnitude ranges. Each chart displays statistics of one year from 2000 to 2015. A snapshot of year 200 to 2005 is shown in Figure **4**.

AGGREGATE MODE
In aggregate mode, it's similar to the instant mode, except that each instance when it appears on the map it stays on the map until the end of the animation, so that the user is able to observe the trends and patterns of the locations of the earthquakes that already have taken place (Figure **5**). The user can move the mouse over the position of the occurred earthquake (color circle) to see the detailed information that includes magnitude, time of occurrence, depth, gap, and place (an example is shown in Figure **6**).

ANALYSIS MODE
The analysis mode provides some statistical information. Figure **7** shows a snapshot of the analysis mode. In Figure **7**, (1) displays the earthquake
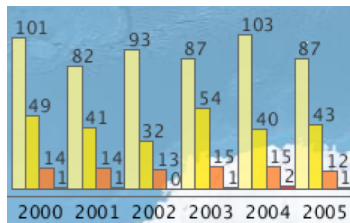
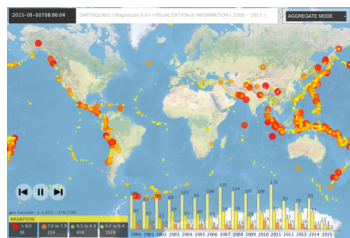**Figure 4**: Bar charts showing the amount of earthquakes taken place

Figure 5: A snapshot of user interface in the aggregate mode
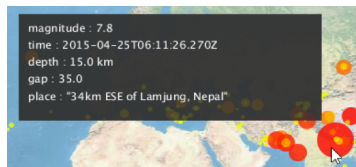

Figure 6: The detailed information box (with mouse rollover)

occurrences in a yearly timeline, to help the user to observe and perhaps uncover some temporal patterns and trends. When the user move the mouse over each of the yearly timelines, it displays more detailed information of that year on the right side of the screen. This right-hand side area displays a statistical information, which consists of values of the average and standard deviation of each magnitude range of the highlighted year (Figure **7**(2)). The graphic in Figure **7**(3) area is the visual representation of its statistical data in Figure **7**(2) to help the user to get the sense of the information at glance. There are three lines each representing the magnitude range. The position of each ellipse is determined by the average and the width of the ellipse is determined by the values of the standard deviation. In the (4) area in Figure **7**, bar charts (similar to Figure **4**) are displayed (amount of earthquakes in each month of the selected year.
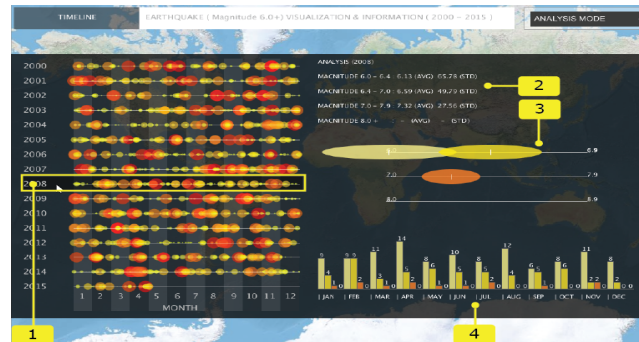

Figure 7: A snapshot of user interface in the analysis mode

SELECTED AREA MODE
This mode is similar to the analysis mode, but differs in that the selected area mode displays the result based on the occurred earthquakes in the selected area. A

dark circle with a radius of 4,000 km centered at the mouse location and moves with the mouse to allow the user to highlight the area of interest. Figure **8** shows a snapshot of the selected area mode, where statistical information (1), bar charts (3), along with the aggregate locations and magnitudes of occurred earthquakes are provided for the highlighted area (2). The information and graphics in areas (1) and (3) area vary spontaneously as the user moves the mouse location.
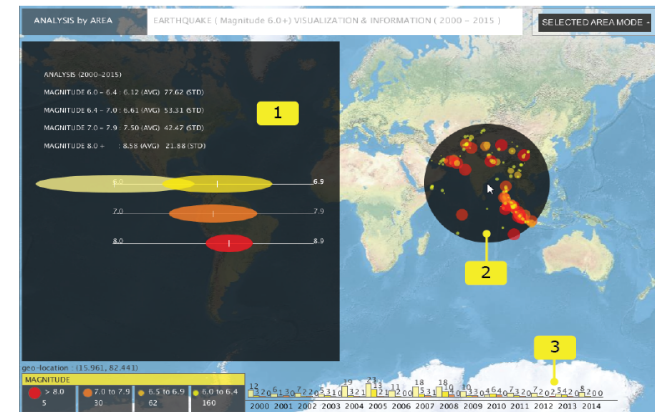

Figure 8: A snapshot of user interface in the selected area mode.

Demo
A video clip for demonstrating how the EQviz works is available at
https://www.youtube.com/watch?v=2mLxvP6s4Wk

User Experience
EQviz was put on a test for its first evaluation from the real users. To get the feedbacks of users, we prepared a user experience survey study based on the theory of four elements of user experience [6]. Our survey was conducted with randomly selected subjects who were

27 males and 23 females, among which were two private company workers, six academics, and 42 students. We asked them to use the EQviz then give an answer how much they agree on each of the four statements: It is useful; It is easy to use; It easy to start using and It is fun and engaging. The level of agreement is between 1(lowest) to 7(highest). Overall, the result of average scale is shown in Figure **9**.
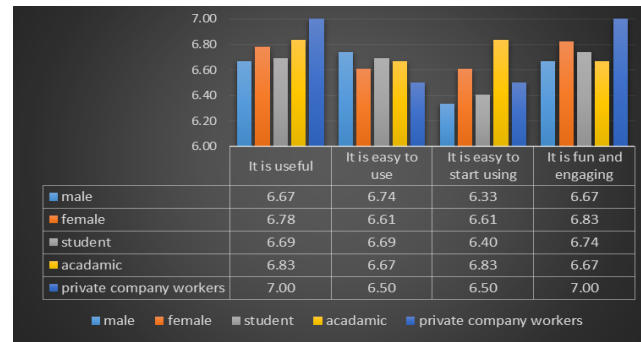

	It is useful	It is easy to use	It is easy to start using	It is fun and engaging
■ male	6.67	6.74	6.33	6.67
■ female	6.78	6.61	6.61	6.83
■ student	6.69	6.69	6.40	6.74
■ acadamic	6.83	6.67	6.83	6.67
■ private company workers	7.00	6.50	6.50	7.00

■ male ■ female ■ student ■ acadamic ■ private company workers

Figure 9: User experience survey result

The overall result in Figure **9** shows that EQviz has high agreement scales for "It is fun and engaging" and "It is useful". This suggests that EQviz appears to be an interesting and useful tool for the users in general. For example, a comment from a private company worker was that "The interface looks interesting and useful for understanding the pattern of earthquakes". The scales for "It easy to start using" are on average the lowest. This suggests that we need to improve on "easy to start using" aspect of the EQviz. It should be simpler to understand its features and functionalities, especially for the first time users.

Conclusion

In this work, we developed a visualization tool for monitoring world earthquakes, and we call it EQviz. EQviz allows the user to interact with it by for example, selecting from four different modes of display, choosing the yearly timeline to display its statistics, and highlighting area on the map to display statistical information. It presents the earthquake information in a form of animation. It displays locations and magnitudes of the earthquakes along with some basic statistics in numerical and graphical forms. We believe that EQviz is a useful tool for exploratory analysis of world earthquakes that facilitates researchers in monitoring and observing emerging trends or patterns that can lead to more in-depth analyses that are useful for prediction of earthquakes in the future. Moreover, we hope that EQviz will beneficial to the public to get access to information and knowledge about earthquakes. As our current version of EQviz is a stand-alone application (platform-independent) that runs on a local machine, our future work will include the development of the online EQviz (web application) that will increase accessibility and usability.

References

1. USGS. Earthquake Facts & Earthquake Fantasy. 2015. Retrieved June 1, 2015 from http://earthquake.usgs.gov/learn/topics/megaqk_ffact_fantasy.php

2. Lee, J. A., Han, J. G., Chi, K. H. Mining Quantitative Association Rule of Earthquake Data. International Conference on Convergence and Hybrid Information Technology (2009), 349-352.

3. Moumni, B., Frias-Martinez, E., Frias-Martinez, V. Characterizing Social Response to Urban Earthquakes using Cell-Phone Network Data: The 2012 Oaxaca Earthquake. Pervasive Urban Applications-PURBA (2013), 1199-1207.

4. Nagel, T., Groß, B. Shanghai Metro Flow - Multiple perspectives into a subway system. In Proceedings of the IEEE VIS 2014 Arts Program, VISAP (2014), 137-138.