INFORMATION VISUALIZATION TECHNIQUES USAGE MODEL

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ABSTRACT. The evolution of information visualization tools has been positively influencing the essence of making sense from large and multidimensional datasets, and adequately supporting decision making process. However, information visualization tool must be appropriately used in context of the data to be visualized, and the information intended to be conveyed in order not to mislead or confuse the users. In view of guiding designers of information visualization tools in making appropriate choice with regards to visualization and interaction techniques that fit in, this study employs content analysis of past researches on information visualization to present a usage model for information visualization techniques.

Keywords: information visualization, usage model, decision making, large dataset, multidimensional dataset

INTRODUCTION

Information visualization is a research domain that is interested in data discovery and analysis through visual exploration (Fekete & Plaisant, 2002). As Meyer (2012) and Stasko (2008) shortly put it, information visualization centers on how to make sense of data. Making sense of data is however dependent of how understandably represented and visually presented is the data to the users. Stasko (2008) further asserts that researchers have the responsibility of transforming raw data to meaningful information that will assist in decision making and creation of knowledge and wisdom. Transformation of large and multidimensional datasets to support decision making through visualization have been responsible for the continuous creation of novel visualization techniques, most especially, visual dynamic queries' mechanism, visual encoding methods and visualization algorithms (Rogers et al., 2011; Sheinerderman & Plaisant, 2010; Spence, 2007).

Notably, Tan et al. (2006) pointed that the research need in attending to the challenge of data transformation and creating novel visualization technique is making appropriate choice in combining visual data mining algorithm, dynamic queries' mechanism with the visualization techniques. This is because the data type, its correlations and the pattern of events to be visualized highly determine the novel visualization technique to be created. This fact suggests that for every data visualization project, research must be conducted to aid befitting selection and combination of techniques to be used to achieve an understandable visual data presentation and dynamic exploration. It is the appropriate choice of visualization technique that will realize efficient information visualization tool in terms of conveying explicit and undistorted information to the users.

Information visualization tools are software products that can be used in various fields of study and specialization for visualizing complex and multidimensional datasets. In designing and developing these tools, visualization techniques, the type of the data to be visualized and interaction and distortion techniques must be well-mapped, with due consideration to the prospective users (Keim, 2002; Roth et al., 2010; Robinson et al. 2005). Figure 1 shows the classification of information visualization techniques, illustrating the data to be visualized, interaction and distortion technique, and the visualization techniques.

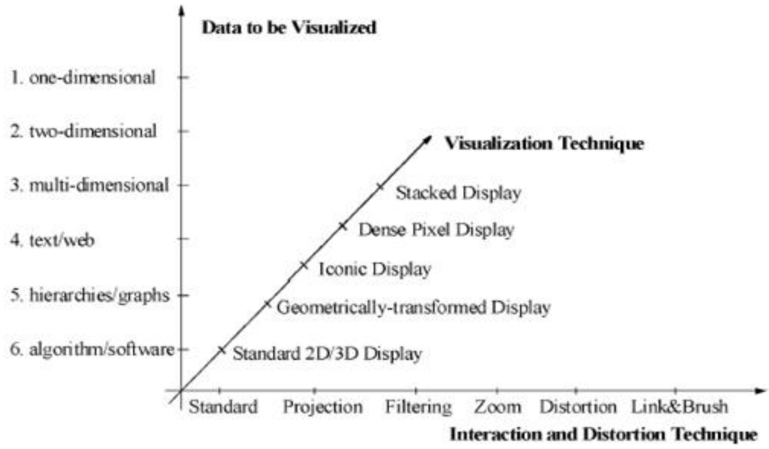

Figure 1. Classification of Information Visualization Techniques (Keim, 2002)

Keim (2002) emphasizes that the three dimensions of the information visualization techniques' classification are assumed to be orthogonal. This means that any of the visualization techniques can be used together with any of the interaction technique, and also with the distortion technique for any type of data. It is the specific need and function of the system that determines the combination of the visualization and interaction techniques.

In avoidance of inappropriate matching of interaction and visualization techniques with the functions of the information visualization (IV) tool, its domain of usage, and consequent misleading or confusing information representation, this study presents information visualization technique usage model that will duly guide designers and as well as users.

METHODOLOGY

This study employs content analysis of past research papers on information visualization as a method of actualizing the information technique usage model. As Babbie (2010) rightly asserts, content analysis is the study of recorded human communication, instances where these pre-recorded human communication are in form of books, magazines, web pages, poems, and bullet in posting. The unit of the analysis is a research paper. Figure 2 shows the methodological framework.

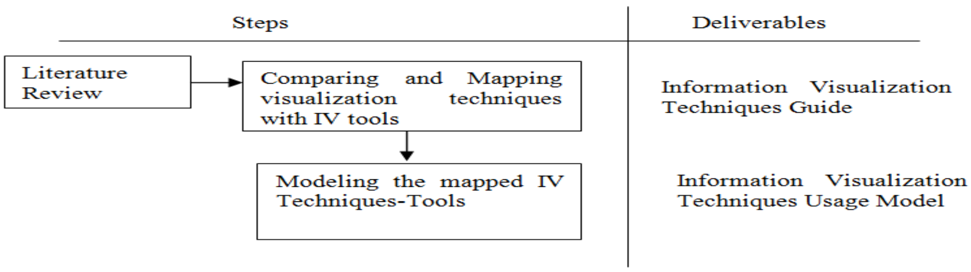

Figure 2. The methodological framework

This study analyses the following past research papers: Robinson et al. (2005), Roth et al. (2010), Mansmann et al. (2009), Meyer (2012), Pinto et al. (2012), Wang et al. (2012), Lirong et al. (2011), Simon et al. (2011), Kohlhammer et al. (2010), Schaefer et al. (2011), Stoffel et al. (2010), Oelke et al. (2009), Wanner et al. (2009), Ziegler et al. (2008) and Krstajic et al. (2012) to realize a mapping of data type with the interaction and visualization techniques appropriate, applied in specific domains with their respective functions.

RESULT

From the past research papers analyzed, an information visualization technique guide is realized, and then the Information Visualization technique model is conceptualized and presented. The Information visualization guide is represented in table 1 below:

Table 1. Information Visualization Technique Guide

Domain of Usage	Nature of the Data	Function of IV tool	Interaction Techniques	Visualization Techniques
Geographical Information Science	Multidimensional	To explore geographic health data in order to gain insight into the complex and interdependent factors that cause epidemics.	Brushing, Selection, classification, and colour scheme	Scatter plot, bivariate map, time series plot, and parallel coordinate plot.
		For spatiotemporal crime analysis. Used to explore geographical data on criminal activity for crime detection and prevention purposes	Linear and Composite animation functions, temporal legend, zooming	Scatter plots, interactive geographical map
	Geospatial data	To convey research information in an interactive manner to wide audience of different background.	Explore, Selection, View	Interactive geographical map,
Network Security	Hierarchical/ Graph	To analyse network traffic and detect intrusion events	Filtering, classification, selection, Colour Scheme, Drag and Drop, Threshold	TreeMap layout, Line chart, grouped line-wise pixel plots
Crime Prevention[1]	Spatial and Temporal Data	To understand crimes statistics in cities	Zooming, Selection, Filtering	Scatter plot, Map
Risk Management[2]	Multidimensional	A multi-functional platform for data discovery and visual analytics		TreeMap
Biology/ Bacteriology	Graphs, Table, and Tree	To explore molecular biological data	Selection, Filtering	Spatial encoding, Line chart, Curve map
		To detect overlapping genes in bacterial genomes	Selection, Filtering, Zooming	Dense Pixel Display
Higher Education Institutions	Multidimensional	It is used as a classification tool of Higher Education Institutions.	Filtering, Selection, Explore, Boolean Selection, Drag and Drop	Sunburst layout, Multiset bar chart, Ring bar chart
		A global multi-ranking tool that is used to select Higher	Filtering, Selection, Explore, Boolean	Sunburst layout, Stacked Bar charts, Pie

[1] http://oakland.crimespotting.org/map/
[2]http://www.hivegroup.com/

		Education Institution's performance indicators.	Selection, Drag and Drop	Chart
		To compare the Higher Education systems regarding their academic, organisation, financial and staffing autonomy.	Explore	Sunburst layout, Multiset bar chart, Ring bar chart
Aircraft Engineering	Table, Tree, Text	To manage information regarding Aircraft Product Development and evolution	Filtering, Selection, Translation, Zooming	Stacked TreeMap
Commerce: Credit Information	Text	To crawl and analyse credit related web pages, and present the information according to the users' selection.	Browse, Zooming, Drag and Drop, Colour Scheming	TreeMap, Dense Pixel display of Radial Graph
Online Shop		To support the analysis of products' review	Selection	Dense Pixel Display. Colour Scheming
Banking	Multidimensional	To detect fraud in mortgage accounts	Selection, Filtering	Line Chart, Colour Scheme
Governance and Policy Modelling	Text	To analyse opinions and interactively simulate policy decisions	Filtering, Selection, Analysis	TreeMap, Hierarchical
News Reporting	Text	To analyse sentiment in News feed	Selection, Filtering	Bar chart, Colour Scheming
		To analyse sentiment in News feed and emotional content of RSS news feed	Zooming, Details on demand, Similarity search, Filtering	Colour Scheming, Geometrical shape, Lines
		To show the temporal characteristics of news story with its detail, allows incremental updates of the display, and sorts out news based on the time of its release.	Selection, Filtering, Zooming	Geometrical object display
Library and Archives	Text, Image	To retrieve and visualize books, images, file cards and other documents kept in the archive	Selection	Colour Scheming
Financial Market	Multidimensional Time-Series Data	To visualize financial data and support analysts in making long term investment decision	Zooming, Selection, Filtering	Dense Pixel Display, Colour mapping, Line
Software Development	Software code in Hierarchical compound graph	To visualize relational information representing large software views.	Perspective zooming, Explore, Multi-level views	Graph model, Glyphs

Figure 3 depicts the Information Visualization Technique Usage Model

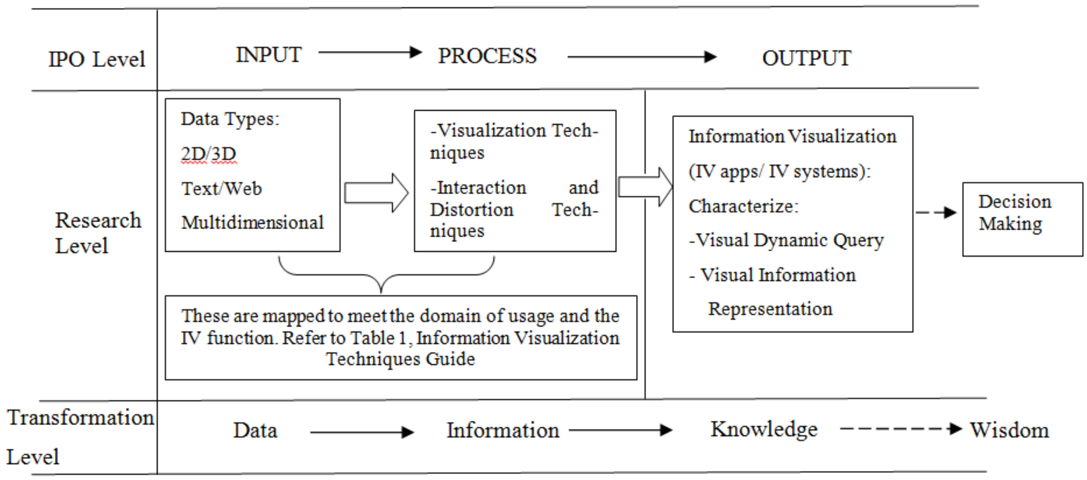

Figure 3. Information Visualization Technique Usage Model

Table 1 gives a description of the combination of interaction and visualization techniques that are compatible with the domain of usage. Also noted are the nature of the data to be visualized and the functions of the information visualization (IV) tool. However, this list is not exhausted. The listed are to emphasize the essence of compatibility in the interaction-visualization techniques combination in order to achieve well represented information that will not distort the meaning and confuse the readers.

Information Visualization Technique Usage Model represented in figure 3 gives a holistic diagrammatic representation of the concept that guides interaction-visualization techniques combination. The IPO level explains the general information processing perspective: the input is processed to give the output. This aligns with the transformation level: the data fed into the IV tool is the input, processed to become information. This information, if well represented and presented will give knowledge to the users of the IV tool. This is expected to support decision making by giving wisdom to the IV tools' users. The process of feeding the datasets into the IV tool, choosing the appropriate visualization, distortion and interaction techniques for the data processing (information) and subsequent representation (knowledge) is the core interest of the research level.

CONCLUSION

The unending need to manage the vast growing data and making sense of it has become a challenge to all fields that interact with large and multidimensional data sets. It is to this end that information visualization systems/tools are being developed, employing appropriate combination of interaction and visualization techniques that will well-present the information visualized, and subsequently support decision making. This paper presents the model usable for Information Visualization technique usage. The model with the information visualization technique guide presented in tabular form are to serve as guiding framework in combining interactive and visualization techniques when designing information visualization methods employable in developing IV tools. This approach will avoid distortion of the information presented, and solve the problem of information overload.

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