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Visualization as Communication with Graphic Representation

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INTRODUCTION

This text discusses a field of visualization and selected implementations of visualization techniques that involve graphics and visuals, mostly described as data visualization, information visualization (IV), and knowledge visualization (KV). At present, visualization means using the computer, which transforms data into information, and then visualization converts information into picture forms and creates graphic images and symbols to convey and express meaning; this lets us comprehend data and make decisions. Thus communication through visualization is at the same time pictorial and linguistic. It is socially and culturally conditioned, based on familiar linguistic patterns, as in a 'pie chart' metaphor for market shares or a 'starry night' metaphor showing data in 3D (Bertschi & Bubenhofer, 2005).

The cross-disciplinary, interactive culture of knowledge visualization requests that the visual content analysis would be applied to data and knowledge. Visualization enhances communication through information display with the use of letters, numerals, art, graphic design, visual storytelling, signs, symbols, and application software. Drawing basic shapes like squares, triangles, and circles connected by lines and arrows, and then inserting simple drawings inside of these shapes creates visualization of our concepts. Graphs, diagrams, or animations can visualize messages as well. Examples of the non-visual creations are multimodal interactive data presentations, sonifications, and haptic/touch interfaces, for example pressure sensitive interfaces. As productive thinking in whatever area of cognition takes place in the realm of imagery, visual perception should be considered a cognitive activity. Visualization has also been considered a semiotic process because of the use of signs to present ideas.

The object of this article is to present selected concepts, methods, and tools related to visualization of data, information, and knowledge. The further text presents selected approaches to the concept of visualization and the ways it mediates between the user and the physical world. It overviews selected methods and tools such as data mining, clustering technique, concept mapping, knowledge maps, network and web-search result visualization, open source intelligence, visualization of the semantic web, visual analytics, and tag cloud visualization.

BACKGROUND

Visualization: Concepts and Applications

Information is usually presented in numerical, graphic, or diagrammatic form; it may be shown as a sketch, drawing, diagram, plan, outline, image, geometric relationship, map, music and dance notation, object, interactive installation, or a story. Diagrams visualize information in a pictorial yet abstract (rather than illustrative) way, as plots, line-graphs and charts, or the engineers or architects' blueprints. Complicated presentations of data organization and interpretation, for example governmental statistics are easier to comprehend in a graphic than in a numerical form, when they serve as explanatory tools for the data sets.

Visualization means the communication of information with graphical representations. With visualizations, we can design interactive visual representations of abstract data (Bederson & Shneiderman, 2003) using easy-to-recognize objects connected through well-defined relations. Possibly, visualization is the best way of learning, teaching, or sharing the data, information, and knowledge because it amplifies cognition, outperforms text-based sources and increases our ability to think and communicate. There is a wide range of visualization techniques, still growing along

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with the developments in computing and information technology. They help explore and understand complex data (such as one-, two-, three-dimensional data, temporal and multi-dimensional data, tree and network data), communicate, and navigate on the web. Visualization serves as an efficient tool that assists graphic designers, artists, professionals performing scientific research and presentations, practitioners creating communication media-art, installations, animated video or film, architectural projects, designing newspapers and magazines, or working on website design. Users apply visualizations to understand how data analyses and queries relate to each other. From simple charts and data graphics to 3D multi-user virtual reality environments happening in real time with human interaction possible, visualizations let us fly around the organized data, comprehend, and make decisions (Chen, 2010).

Visualization techniques are the powerful cognitive tools useful in our everyday life, as they integrate several domains with no defined boundaries. Graphic presentation shows how something works or explains the relationship between the parts of a whole. Surfing the web, data mining, and manipulating the data are easier when the data is shown as interactive information visualization. Visualizations have been present in different disciplines and in various modes since early days of civilization. Tables of the past acted as visualization modalities (Marchese, 2011). Many kinds of tables preserved since ancient times; the Near East Akkadian clay tablets, Sumerian accounting tables, Aztec calendars, or the Egyptian stele Rosetta Stone, as well as the medieval chronicles, canon tables, and calendars are representations of early genres in information visualization. Analysis of these tables demonstrates the constant need to visualize information.

Metaphorical Language of Visualization

Visual metaphors make a basic structure in visualization because they describe relations among data, organize information in a meaningful way, and combine creative imagery with the analytic rationality of conceptual diagrams. A metaphor indicates one thing as representing another, difficult one, thus making mental models and comparisons. Instead of developing a nomenclature specific for computing, we apply metaphors – names of familiar items and actions for organizing computing-related items and activities: we open a new *window* or a *file* with a *mouse*, put them in a *folder*, we *cut, copy,* and *paste,* place *icons* on a *desktop*, use *tools* and search *engines*, *canvas, mailbox, documents, in*-and-*out boxes,* and a web *portal*. The desktop metaphor is now fading because cell phones and tablets are replacing PCs as the main gateway to the Internet. We may use graphics or show virtual environments, often shaped by artist's fantasy; the success and quality of any visualization depend on imagination, the retrieval of necessary data, the choice of a metaphor, and the delivery method: whether to apply animation, interconnection, or interaction. Visual metaphors can either be natural objects or phenomena (e. g., mountains, tornados) or artificial, man-made objects (e. g., a bridge, a temple), activities (climbing), or concepts (war, family). Metaphors organize, structure information, and convey an insight through characteristics or associations. Metaphors may convey topics such as theological events or encyclopedias' tables of contents, and serve as classification systems (Lima, 2011).

Communication involves language and pictures need a caption. Because language is metaphorical, our thoughts are mostly metaphorical. To communicate knowledge in a dynamic, interactive way, often in real-time, visualizations provide two-dimensional and tree-dimensional metaphors, familiar and understandable in social and cultural terms. Metaphors traditionally used in visualizations show programs or data as natural objects, such as a solar system, or man-made objects, for example a city, architecture, house, parking lot, metro, library, street, but also they map the data to facial expressions, video games, or nested boxes. A city metaphor may represent a software package; navigating through software may enhance program understanding or lessen costs and effort of software production and maintenance.

THE MOST IMPORTANT DOMAINS IN VISUALIZATION

Data Visualization

Data Visualization means information abstracted in some schematic form to provide visual insights into sets of data. Data may be 1D linear, 2D, 3D, and