Tools for Opportunistic Information Visualization: Visual Analysis with Non-traditional Data Sources

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Abstract—**Information Visualization (InfoVis) often supports the analysis of structured data that is organized in documents with specific formats such as databases, Excel tables, or comma-separated files. Informal analyses that take place without anticipation and away from the desktop, however, might involve the use of data contained in digital artifacts that lack this structure (e.g., photographs, bitmaps, web pages). Such artifacts cannot provide immediate input for most existing visualization systems, as the data they contain does not exist as a set of variables with associated values. This research seeks to explore new opportunities in the design and implementation spaces of InfoVis authoring tools to support visualization in opportunistic scenarios. This document briefly defines the Opportunistic Visualization (OpportuVis) domain and describes iVoLVER, a research prototype that supports the construction of interactive visuals from non-traditional data sources. Future stages of this endeavor include the evaluation of iVoLVER from two perspectives: its analytical support and its usability features.**

I. Motivation

Regardless of our background or what we do for a living, we are constantly surrounded by data. From activities like reading the newspaper, to browsing social networks, to walking inside a venue with posters, we are exposed to objects that present us data in one way or another. Examples include visualizations depicted in the print media, infographics works published in blogs, tabular data contained in web pages, and photographs of statistical charts. Such artifacts commonly encode information whose underlying raw data is not available or included within the artifact itself. In contrast with this, traditional visualization tools often operate on raw data sources structured in specific formats: database-like documents where information is organized in records of variables with associated values. The formality of the data also shapes the situational settings where the analysis usually happens: in front of a computer, with a monitor the display the output, and mouse and keyboard to support the users' input. These conditions, however, are hardly met when the analysis is unanticipated, has to take place in away-from-the-desk situations, and involves the use of digital artifacts that are not traditionally considered data sources (e.g., photographs, web pages, vector files, text documents).

This research seeks to redress the gap described above in the design space of infovis authoring tools. In particular, it aims to develop and study visualization tools in settings that involve: 1) analysis in away-from-the-desk situations, 2) non-traditional data sources, and 3) data points that are not explicitly available. Ultimately, it seeks to propose techniques, methods, new perspectives, and research directions to complement existing InfoVis domains to support visualization in a wider range of situations.

II. Background

Roberts et. al. highlight the importance of adapting InfoVis to new devices and technologies by calling visualization beyond the desktop as "the next big thing" [1]. This principle aligns with the concept of Ubiquitous Analytics, proposed by Elmqvist et. al. as the "interaction of data anywhere, anytime" [2]. The characterization of opportunistic analytical scenarios proposed in this research builds upon these two works. However, it differs in the scale of the data involved (not necessarily big) and qualifies the potential origin of the data involved. This work defines Opportunistic Information Visualization (OpportuVis) as **data analysis anywhere, anytime, from anything**. This definition acknowledges the heterogeneous nature of digital artifacts from which data for unanticipated analyses might be needed. It also expands the *de facto* definition of data sources beyond the rigid structure commonly expected by traditional visualization systems.

In the current InfoVis tool landscape, visualization systems like Transmogrifiers [3] and Tableur [4] partly fit the proposed definition of OpportuVis tools. Both systems allow the construction of visualizations from data encoded in specific types of digital artifacts: images and ink, respectively. Both tools also support interaction beyond the mouse and keyboard [5], implementing mobile and multi-touch environments, which indeed allows for visualization in away-from-the-desk settings. However, the data each of these tools can handle is not heterogeneously typed: transmogrifiers can only be applied to pixel data and Tableur visualizations are only possible from handwritten digital ink. These limitations reduce the number of scenarios where these tools can be used and, in consequence, the OpportuVis support they provide.

III. iVoLVER

iVoLVER[1], the **I**nteractive **V**isual **L**anguage for **V**isualization **E**xtraction and **R**econstruction [6], [7], is our first effort to support OpportuVis. It is a web-based pen and touch system that supports the construction of interactive visualizations and allows the extraction of data from different types of digital artifacts (see Fig. 1). iVoLVER allows informal and lightweight sketching of visualizations

[1] http://ivolver.cs.st-andrews.ac.uk

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through a visual programming environment avoiding the need of traditional input (e.g., mouse and keyboard) that might be unavailable in opportunistic settings.

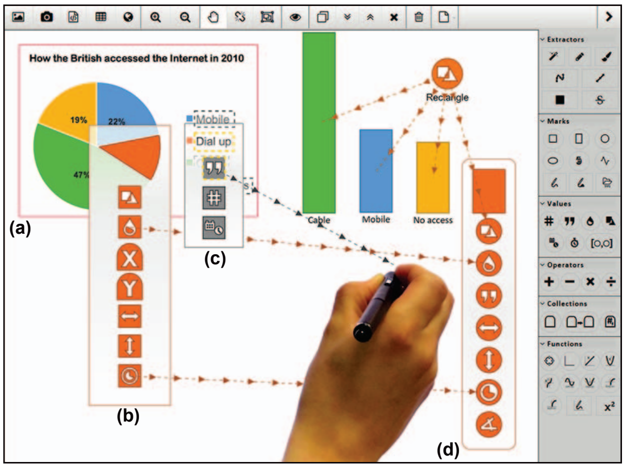

Fig. 1. Using iVoLVER on a multi-touch display to extract data from a raster image of a pie chart. The extracted data is used to build a bar representation of the original chart.

Fig. 2 shows a visualization built from a PNG image (a) depicting an elevation map of Mount Everest. The extracted data is used to generate the altitude profile of a user-defined path to the summit. The user first creates an iVoLVER *color sampler* (b), which extracts the image colors along the traced path. These colors are then converted into numeric values using an iVoLVER *mapper* (c). This mapping represents the legend of the image, whose colors are extracted with a second color sampler (d). The resulting numeric values are finally visualized with a *function* element (e).

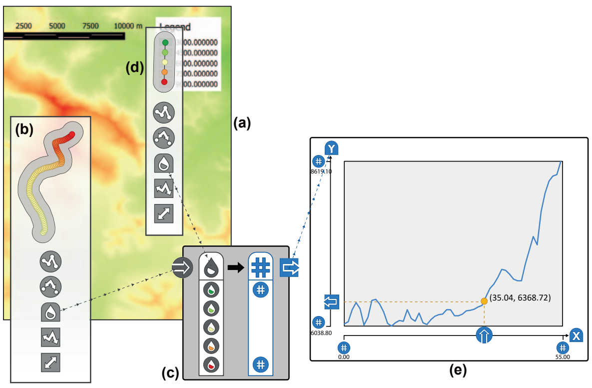

Fig. 2. Color data is extracted from a raster image of an elevation map to generate the altitude profile of a user defined path.

iVoLVER can also be used on mobile devices. Fig. 3 shows the interface while running on a tablet. Using the camera of the device, the user photographs a map (a) on top of which adds several color-based iVoLVER extractors (b). Finally, two colleagues discuss while manipulating and visualizing the extracted data (c).

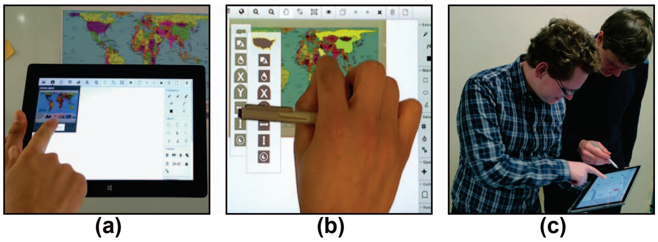

Fig. 3. iVoLVER used on collaborationa tablet

IV. Discussion and Future Work

Our current ongoing work has made it obvious that interaction is a major element for the success of OpportuVis tools. Our initial experimental evaluations suggest scalability as one of the biggest challenges. It is also clear that novel strategies are need to overcome the inherent trade-off between power and simplicity of visual programming approaches. Because of the user-centered design of our prototype, learnability and error correction strategies, together with the automation of user-defined tasks, seem to be of paramount importance as well. Future work will focus on further evaluation of iVoLVER from two different perspectives: (1) its analytical support and (2) its interaction design. This will allow us to validate and refine the overall design of the tool.
The still underexplored challenges imposed by OpportuVis look exciting and promising. Further work on this InfoVis subdomain opens up opportunities to investigate new design considerations that can ultimately lead to the use of visualization in more and more situations.

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