Activity Report 2014

Project-Team AVIZ

Analysis and Visualization

RESEARCH CENTER
Saclay - Île-de-France

THEME
Interaction and visualization

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Project-Team AVIZ

Keywords: Visualization, Data Analysis, Interaction, Collaborative Work, Perception, Evolutionary Algorithms

Creation of the Team: 2007 February 08*, updated into Project-Team:* 2008 January 01.

1. Members

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2. Overall Objectives

2.1. Objectives

All human activities are being transformed by our rapidly increasing abilities to collect, manage and understand vast amounts of data. A 2003 study estimated that the amount of data produced in the world was increasing by 50% each year [1]. According to SearchEngineWatch [2], the amount of information made available through Internet search engines has grown exponentially for the last decade, and major Web search engines currently index more than 2 billion documents. However, since our brains and sensory capacities have not evolved in the meantime, gaining competitive advantage from all this data depends increasingly on the effectiveness with which we support human abilities to perceive, understand, and act on the data.

With this increase of data, the traditional scientific method of applying model-based analysis to understand the data is no longer sufficient. We have access to data that we have never encountered before and have little or no idea of applicable models. Therefore, we need to explore them first to gain insights and eventually find models. This process has already been promoted by John Tukey in his 1977 book on *Exploratory Data Analysis* [3] which has become a branch of the domain of statistics. Whereas EDA is ultimately interested in finding models, data exploration can also reveal relevant facts that are, in themselves interesting and important.

Aviz (Analysis and VIsualiZation) is a multidisciplinary project that seeks to improve visual exploration and analysis of large, complex datasets by tightly integrating analysis methods with interactive visualization. It focuses on five research themes:

- *Methods to visualize and smoothly navigate through large datasets;*
- *Efficient analysis methods to reduce huge datasets to visualizable size;*
- *Visualization interaction using novel capabilities and modalities;*
- *Evaluation methods to assess the effectiveness of visualization and analysis methods and their usability;*
- *Engineering tools for building visual analytics systems that can access, search, visualize and analyze large datasets with smooth, interactive response.*

2.2. Research Themes

Aviz's research on Visual Analytics is organized around five main Research Themes:

Methods to visualize and smoothly navigate through large data sets: Large data sets challenge current visualization and analysis methods. Understanding the structure of a graph with one million vertices is not just a matter of displaying the vertices on a screen and connecting them with lines. Current screens only have around two million pixels. Understanding a large graph requires both data reduction to visualize the whole and navigation techniques coupled with suitable representations to see the details. These representations, aggregation functions, navigation and interaction techniques must be chosen as a coordinated whole to be effective and fit the user's mental map.

Aviz designs new visualization representations and interactions to efficiently navigate and manipulate large data sets.

Efficient analysis methods to reduce huge data sets to visualizable size: Designing analysis components with interaction in mind has strong implications for both the algorithms and the processes they use. Some data reduction algorithms are suited to the principle of sampling, then extrapolating, assessing the quality and incrementally enhancing the computation: for example, all the linear reductions such as PCA, Factorial Analysis, and SVM, as well as general MDS and Self Organizing Maps. Aviz investigates the possible analysis processes according to the analyzed data types.

[1] Peter Lyman and Hal R. Varian. How much information. Retrieved from http://www2.sims.berkeley.edu/research/projects/how-much-info-2003/, 2003.

[2] http://www.searchenginewatch.com

[3] John W. Tukey. *Exploratory Data Analysis*. Addison-Wesley, 1977.

Visualization interaction using novel capabilities and modalities: The importance of interaction to Information Visualization and, in particular, to the interplay between interactivity and cognition is widely recognized. However, information visualization interactions have yet to take full advantage of these new possibilities in interaction technologies, as they largely still employ the traditional desktop, mouse, and keyboard setup of WIMP (Windows, Icons, Menus, and a Pointer) interfaces. At Aviz we investigate in particular interaction through tangible and touch-based interfaces to data.

Evaluation methods to assess their effectiveness and usability: For several reasons appropriate evaluation of visual analytics solutions is not trivial. First, visual analytics tools are often designed to be applicable to a variety of disciplines, for various different data sources, and data characteristics, and because of this variety it is hard to make general statements. Second, in visual analytics the specificity of humans, their work environment, and the data analysis tasks, form a multi-faceted evaluation context which is difficult to control and generalize. This means that recommendations for visual analytics solutions are never absolute, but depend on their context.

In our work we systematically connect evaluation approaches to visual analytics research—we strive to develop and use both novel as well as establish mixed-methods evaluation approaches to derive recommendations on the use of visual analytics tools and techniques. Aviz regularly published user studies of visual analytics and interaction techniques and takes part in dedicated workshops on evaluation.

Engineering tools: for building visual analytics systems that can access, search, visualize and analyze large data sets with smooth, interactive response.

Currently, databases, data analysis and visualization all use the concept of data tables made of tuples and linked by relations. However, databases are storage-oriented and do not describe the data types precisely. Analytical systems describe the data types precisely, but their data storage and computation model are not suited to interactive visualization. Visualization systems use in-memory data tables tailored for fast display and filtering, but their interactions with external analysis programs and databases are often slow.

Aviz seeks to merge three fields: databases, data analysis and visualization. Part of this merging involves using common abstractions and interoperable components. This is a long-term challenge, but it is a necessity because generic, loosely-coupled combinations will not achieve interactive performance.

Aviz's approach is holistic: these five themes are facets of building an analysis process optimized for discovery. All the systems and techniques Aviz designs support the process of understanding data and forming insights while minimizing disruptions during navigation and interaction.

3. Research Program

3.1. Scientific Foundations

The scientific foundations of Visual Analytics lie primarily in the domains of Information Visualization and Data Mining. Indirectly, it inherits from other established domains such as graphic design, Exploratory Data Analysis (EDA), statistics, Artificial Intelligence (AI), Human-Computer Interaction (HCI), and Psychology.

The use of graphic representation to understand abstract data is a goal Visual Analytics shares with Tukey's Exploratory Data Analysis (EDA) [60], graphic designers such as Bertin [45] and Tufte [59], and HCI researchers in the field of Information Visualization [44].

EDA is complementary to classical statistical analysis. Classical statistics starts from a *problem*, gathers *data*, designs a *model* and performs an *analysis* to reach a *conclusion* about whether the data follows the model. While EDA also starts with a problem and data, it is most useful *before* we have a model; rather, we perform visual analysis to discover what kind of model might apply to it. However, statistical validation is not always required with EDA; since often the results of visual analysis are sufficiently clear-cut that statistics are unnecessary.

Visual Analytics relies on a process similar to EDA, but expands its scope to include more sophisticated graphics and areas where considerable automated analysis is required before the visual analysis takes place. This richer data analysis has its roots in the domain of Data Mining, while the advanced graphics and interactive exploration techniques come from the scientific fields of Data Visualization and HCI, as well as the expertise of professions such as cartography and graphic designers who have long worked to create effective methods for graphically conveying information.

The books of the cartographer Bertin and the graphic designer Tufte are full of rules drawn from their experience about how the meaning of data can be best conveyed visually. Their purpose is to find effective visual representation that describe a data set but also (mainly for Bertin) to discover structure in the data by using the right mappings from abstract dimensions in the data to visual ones.

For the last 25 years, the field of Human-Computer Interaction (HCI) has also shown that interacting with visual representations of data in a tight perception-action loop improves the time and level of understanding of data sets. Information Visualization is the branch of HCI that has studied visual representations suitable to understanding and interaction methods suitable to navigating and drilling down on data. The scientific foundations of Information Visualization come from theories about perception, action and interaction.

Several theories of perception are related to information visualization such as the "Gestalt" principles, Gibson's theory of visual perception [51] and Triesman's "preattentive processing" theory [58]. We use them extensively but they only have a limited accuracy for predicting the effectiveness of novel visual representations in interactive settings.

Information Visualization emerged from HCI when researchers realized that interaction greatly enhanced the perception of visual representations.

To be effective, interaction should take place in an interactive loop faster than 100ms. For small data sets, it is not difficult to guarantee that analysis, visualization and interaction steps occur in this time, permitting smooth data analysis and navigation. For larger data sets, more computation should be performed to reduce the data size to a size that may be visualized effectively.

In 2002, we showed that the practical limit of InfoVis was on the order of 1 million items displayed on a screen [48]. Although screen technologies have improved rapidly since then, eventually we will be limited by the physiology of our vision system: about 20 millions receptor cells (rods and cones) on the retina. Another problem will be the limits of human visual attention, as suggested by our 2006 study on change blindness in large and multiple displays [46]. Therefore, visualization alone cannot let us understand very large data sets. Other techniques such as aggregation or sampling must be used to reduce the visual complexity of the data to the scale of human perception.

Abstracting data to reduce its size to what humans can understand is the goal of Data Mining research. It uses data analysis and machine learning techniques. The scientific foundations of these techniques revolve around the idea of finding a good model for the data. Unfortunately, the more sophisticated techniques for finding models are complex, and the algorithms can take a long time to run, making them unsuitable for an interactive environment. Furthermore, some models are too complex for humans to understand; so the results of data mining can be difficult or impossible to understand directly.

Unlike pure Data Mining systems, a Visual Analytics system provides analysis algorithms and processes compatible with human perception and understandable to human cognition. The analysis should provide understandable results quickly, even if they are not ideal. Instead of running to a predefined threshold, algorithms and programs should be designed to allow trading speed for quality and show the tradeoffs interactively. This is not a temporary requirement: it will be with us even when computers are much faster, because good quality algorithms are at least quadratic in time (e.g. hierarchical clustering methods). Visual Analytics systems need different algorithms for different phases of the work that can trade speed for quality in an understandable way.

Designing novel interaction and visualization techniques to explore huge data sets is an important goal and requires solving hard problems, but how can we assess whether or not our techniques and systems provide real improvements? Without this answer, we cannot know if we are heading in the right direction. This is why we have been actively involved in the design of evaluation methods for information visualization [57], [56], [52], [53], [49]. For more complex systems, other methods are required. For these we want to focus on longitudinal evaluation methods while still trying to improve controlled experiments.

3.2. Innovation

We design novel visualization and interaction techniques. Many of these techniques are also evaluated throughout the course of their respective research projects. We cover application domains such as sports analysis, digital humanities, fluid simulations, and biology. A focus of Aviz' work is the improvement of graph visualization and interaction with graphs. We further develop individual techniques for the design of tabular visualizations and different types of data charts. Another focus is the use of animation as a transition aid between different views of the data. We are also interested in applying techniques from illustrative visualization to visual representations and applications in information visualization as well as scientific visualization.

3.3. Evaluation Methods

Evaluation methods are required to assess the effectiveness and usability of visualization and analysis methods. Aviz typically uses traditional HCI evaluation methods, either quantitative (measuring speed and errors) or qualitative (understanding users tasks and activities). Moreover, Aviz is also contributing to the improvement of evaluation methods by reporting on the best practices in the field, by co-organizing workshops (BELIV 2010, 2012, 2014) to exchange on novel evaluation methods, by improving our ways of reporting, interpreting and communicating statistical results, and by applying novel methodologies, for example to assess visualization literacy.

3.4. Software Infrastructures

We want to understand the requirements that software and hardware architectures should provide to support exploratory analysis of large amounts of data. So far, "big data" has been focusing on issues related to storage management and predictive analysis: applying a well-known set of operations on large amounts of data. Visual Analytics is about exploration of data, with sometimes little knowledge of its structure or properties. Therefore, interactive exploration and analysis is needed to build knowledge and apply appropriate analyses; this knowledge and appropriateness is supported by visualizations. However, applying analytical operations on large data implies long-lasting computations, incompatible with interactions, and generates large amounts of results, impossible to visualize directly without aggregation or sampling. Visual Analytics has started to tackle these problems for specific applications but not in a general manner, leading to fragmentation of results and difficulties to reuse techniques from one application to the other. We are interested in abstracting-out the issues and finding general architectural models, patterns, and frameworks to address the Visual Analytics challenge in more generic ways.

3.5. Emerging Technologies

We want to empower humans to make use of data using different types of display media and to enhance how they can understand and visually and interactively explore information. This includes novel display equipment and accompanying input techniques. The Aviz team specifically focuses on the exploration of the use of large displays in visualization contexts as well as emerging physical and tangible visualizations. In terms of interaction modalities our work focuses on using touch and tangible interaction. Aviz participates to the Digiscope project that funds 11 wall-size displays at multiple places in the Paris area (see http://www.digiscope.fr), connected by telepresence equipment and a Fablab for creating devices. Aviz is in charge of creating and managing the Fablab, uses it to create physical visualizations, and is also using the local wall-size display (called WILD) to explore visualization on large screens. The team also investigates the perceptual, motor and cognitive implications of using such technologies for visualization.

3.6. Psychology

More cross-fertilization is needed between psychology and information visualization. The only key difference lies in their ultimate objective: understanding the human mind vs. helping to develop better tools. We focus on understanding and using findings from psychology to inform new tools for information visualization. In many cases, our work also extends previous work in psychology. Our approach to the psychology of information visualization is largely holistic and helps bridge gaps between perception, action and cognition in the context of information visualization. Our focus includes the perception of charts in general, perception in large display environments, collaboration, perception of animations, how action can support perception and cognition, and judgment under uncertainty.

4. Application Domains

4.1. Panorama

Research in visual analytics can profit from the challenges and requirements of real-world datasets. Aviz develops active collaboration with users from a range of application domains, making sure it can support their specific needs. By studying similar problems in different domains, we can begin to generalize our results and have confidence that our solutions will work for a variety of applications.

We apply our techniques to important medical applications domains such as bioinformatics and brain studies. In particular, we are interested in helping neuroscientists make sense of evolving functional networks, in the form of weighted and/or dynamic graphs.

Other application domains include:

- *Digital Humanities* in general, and in particular with the Cendari European project with historians from most European countries, and the joint project with Microsoft Research and Inria on Graph Visualization;
- *Genealogy*, in cooperation with North Carolina State University;
- *Digital Libraries*, in cooperation with the French National Archives and the Wikipedia community.

5. New Software and Platforms

5.1. MakerVis

Participants: Sai Ganesh Swaminathan, Shi Conglei, Yvonne Jansen, Pierre Dragicevic [correspondant], Lora Oehlberg, Jean-Daniel Fekete.

An increasing variety of physical visualizations are being built, for purposes ranging from art and entertainment to business analytics and scientific research. However, crafting them remains a laborious process and demands expertise in both data visualization and digital fabrication. We created the MakerVis prototype [34], the first tool that integrates the whole workflow, from data filtering to physical fabrication. The design of MakerVis tries to overcome the limitations of current workflows, that we initially analyzed through three real case studies. Design sessions with three end users shows that tools such as MakerVis can dramatically lower the barriers behind producing physical visualizations. Observations and interviews also revealed important directions for future research. These include rich support for customization, and extensive software support for materials that accounts for their unique physical properties as well as their limited supply.

More details on the Web page: www.aviz.fr/makervis

5.2. Bertifier

Participants: Charles Perin, Pierre Dragicevic, Jean-Daniel Fekete.

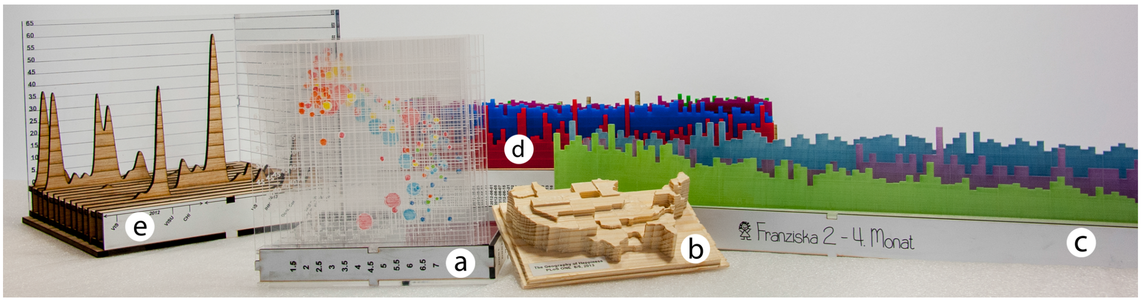

Figure 1. Physical visualizations created with our fabrication tool MakerVis: a) a scatterplot created after Hans Rosling's TED talk, b) a prism map showing happiness across the US computed from Twitter sentiments, c),d),e) visualizations created by users during design sessions.

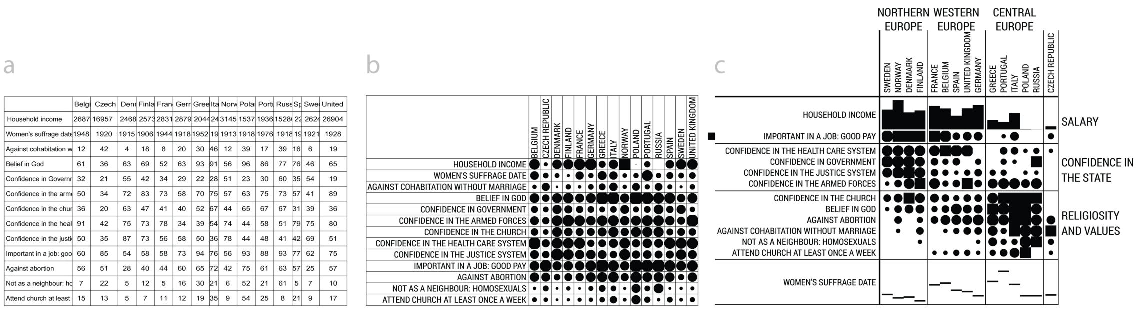

Figure 2. A spreadsheet formatted and reordered with BERTIFIER: a) the original numerical table; b) the corresponding tabular visualization; c) the final result, reordered, formatted and annotated. The final result is ready to be exported and inserted as a figure.

Bertifier [20] is a web application (available at www.bertifier.com) for rapidly creating tabular visualizations from spreadsheets. Bertifier draws from Jacques Bertin's matrix analysis method, whose goal was to "simplify without destroying" by encoding cell values visually and grouping similar rows and columns. Although there were several attempts to bring this method to computers, no implementation exists today that is both exhaustive and accessible to a large audience. Bertifier remains faithful to Bertin's method while leveraging the power of today's interactive computers. Tables are formatted and manipulated through *crossets* [36], a new interaction technique for rapidly applying operations on rows and columns. Vertifier also introduces *visual reordering*, a semi-interactive reordering approach that lets users apply and tune automatic reordering algorithms in a WYSIWYG manner. We showed in an evaluation that Bertifier has the potential to bring Bertin's method to a wider audience of both technical and non-technical users, and empower them with data analysis and communication tools that were so far only accessible to a handful of specialists.

More details about the software are available at www.aviz.fr/bertifier

5.3. Sparklificator

Participants: Pascal Goffin, Wesley Willett, Jean-Daniel Fekete, Petra Isenberg.

Figure 3. Four examples of the integration of word-scale visualizations into HTML documents

Sparklificator [17] is a general open-source jQuery library that eases the process of integrating word-scale visualizations into HTML documents. It provides a range of options for adjusting the position (on top, to the right, as an overlay), size, and spacing of visualizations within the text. The library includes default visualizations, including small line and bar charts, and can also be used to integrate custom word-scale visualizations created using web-based visualization toolkits such as D3.

More on the project Web page: www.aviz.fr/sparklificator

5.4. GraphDiaries

Participants: Benjamin Bach [correspondant], Emmanuel Pietriga, Jean-Daniel Fekete.

Identifying, tracking and understanding changes in networks that change over time, such as social networks, brain connectivy or migration flows, are complex and cognitively demanding tasks. To better understand the tasks related to the exploration of these networks, we introduced a task taxonomy which informed the design of GraphDiaries, [13], a new visual interface (Figure 4) designed to improve support for these tasks. GraphDiaries relies on animated transitions that highlight changes in the network between time steps, thus helping users

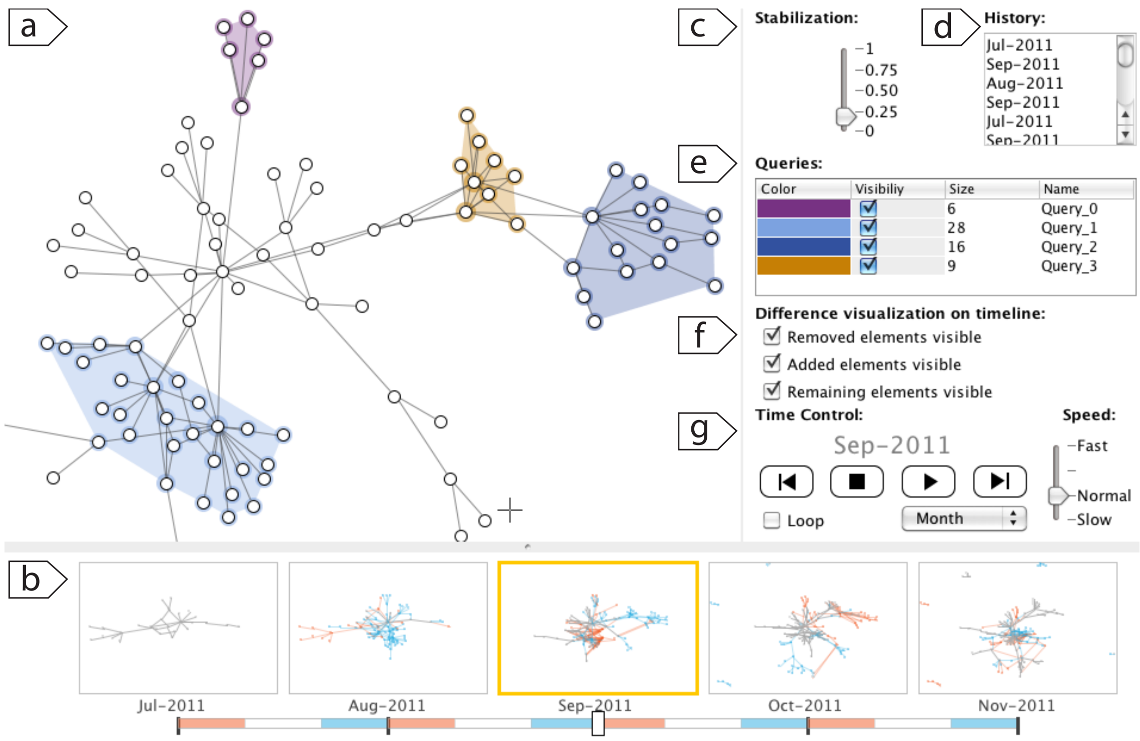

Figure 4. GraphDiaries interface: a) Network view, b) Time- line, c) Layout stabilization slider, d) Navigation history, e) Node queries, f) Panel to change visibility of red, blue or gray elements in the Timeline, g) Animation playback panel.

identify and understand changes. GraphDiaries features interaction techniques to quickly navigate between individual time steps of the network. We conducted on a user study, based on representative tasks identified through the taxonomy, that compares GraphDiaries to existing techniques for temporal navigation in dynamic networks, showing that it outperforms them both in terms of task time and errors for several of these tasks.

5.5. Cubix

Participants: Benjamin Bach [correspondant], Emmanuel Pietriga, Jean-Daniel Fekete.

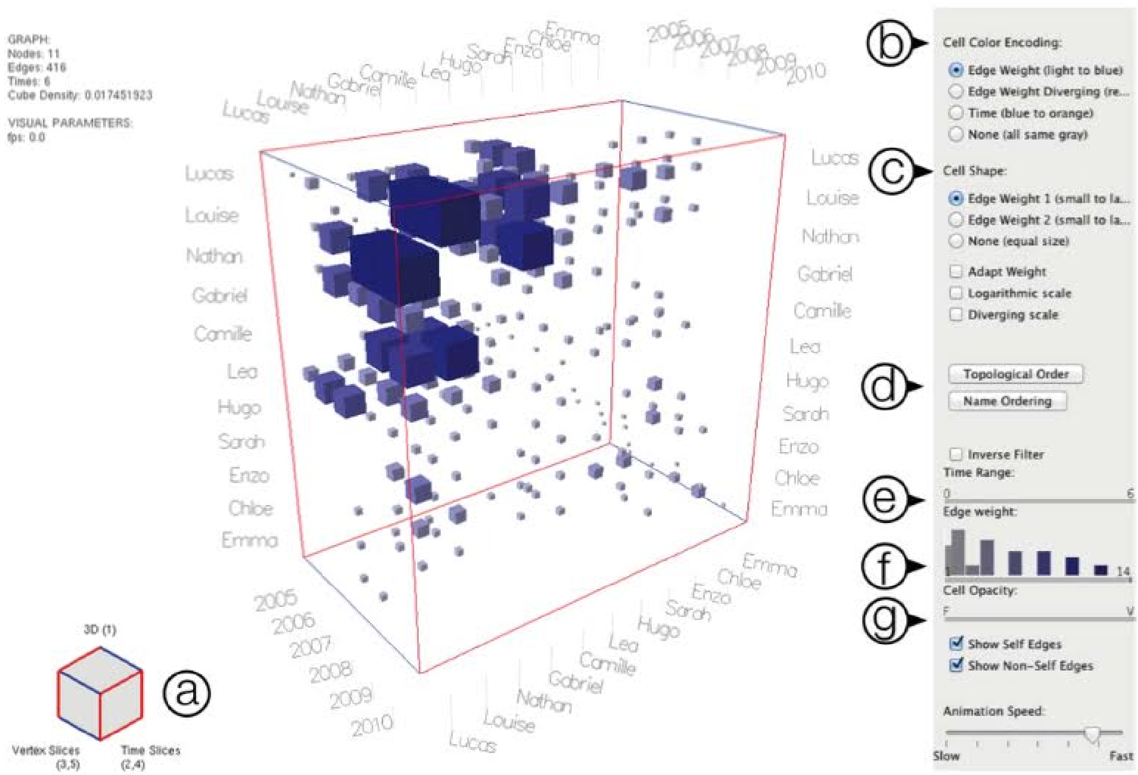

Figure 5. Cubix UI screenshot. a) Cubelet Widget, b) Cell color encod ing, c) Cell shape encoding, d) Vertex ordering, e) Time range slider, f) Cell weight filter with histogram indicating edge weight distribution, g) Cell opacity.

Designing visualizations of dynamic networks is challenging, both because the data sets tend to be complex and because the tasks associated with them are often cognitively demanding. Different tasks may require different visualizations and visual mappings, but combined in a simple interface. We developed Cubix [23] (Figure 5), a software featuring a novel visual representation and navigation model for dynamic networks, inspired by the way people comprehend and manipulate physical cubes. Users can change their perspective on the data by rotating or decomposing the 3D cube. These manipulations can produce a range of different 2D visualizations that emphasize specific aspects of the dynamic network suited to particular analysis tasks. A range of interactions can be performed on dynamic networks using the Cubix system. We showed how two domain experts, an astronomer and a neurologist, successfully used Cubix to explore and report on their own network data.

More on the project Web page: www.aviz.fr/cubix

5.6. EditorsNotes

Participants: Jean-Daniel Fekete [correspondant], Nadia Boukhelifa, Evanthia Dimara.

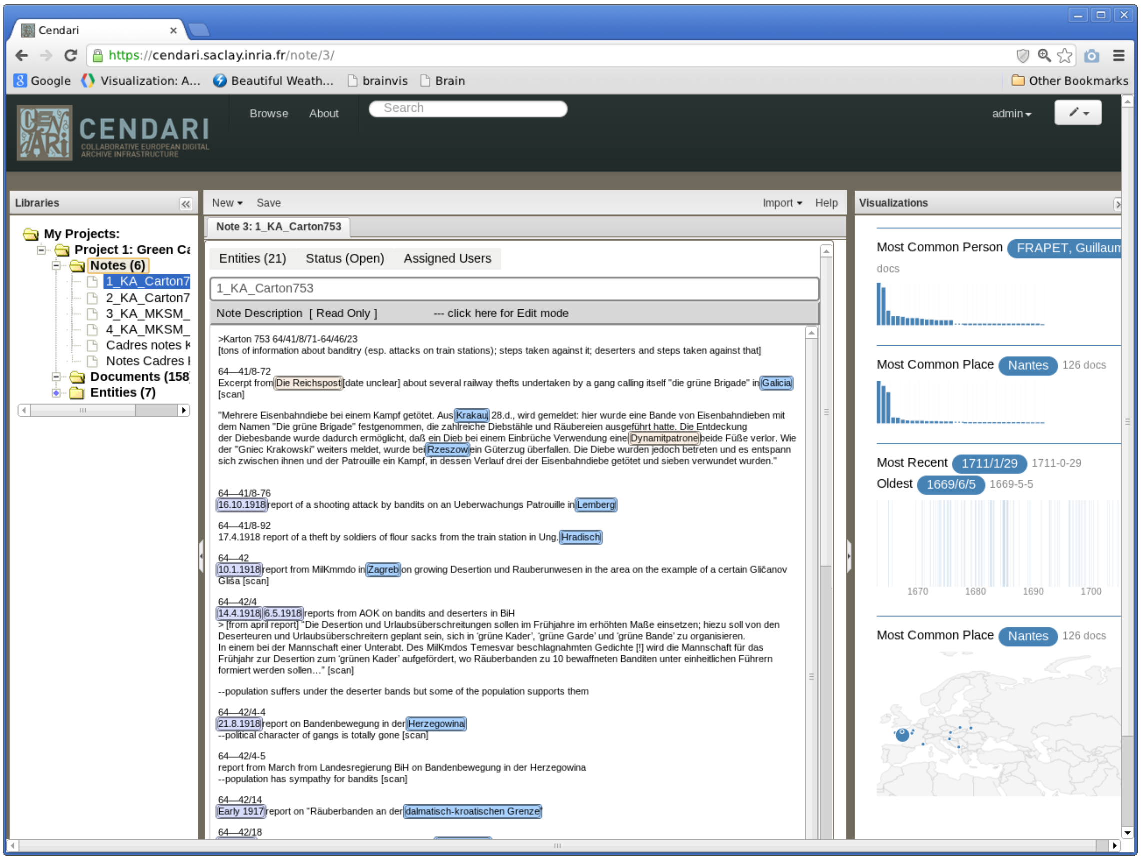

Figure 6. EditorsNotes environment with its three main panes: on the left, the list of projects, in the middle the editor and related documents, on the right the visualizations showing entities appearing in the current project.

CENDARI Is a European Infrastructure project funded by the EU for 4 years: 2012-2016. Aviz is in charge of the Human-Computer Interface for the project, and develops a tool to allow historians and archivists to take notes, enter them online, manage their images in relations with the notes and documents, and visualize the entities they find in the documents and notes. This system is an extension of the original EditorsNotes project, integrating several innovative components asked by the historians: visualizations, relations with the Semantic Web, and a management of access rights respecting the researchers' desire of privacy for their notes, as well as desire of sharing entities and relations gathered throught the notes and documents.

More on the project Web page: www.aviz.fr/Research/CENDARI

6. New Results

6.1. Highlights of the Year

We had a number of highlights this year:

- Jean-Daniel Fekete was General Chair of the IEEE VIS 2014 conference, organized for the first time ever outside of the USA, in Paris, with a record attendance.
- Aviz presented 7 articles at the IEEE VIS 2014 conference, and co-organized 3 workshops.
- Five PhD students defended this year.
- Benjamin Bach was awarded the second price in the IEEE VGTC Doctoral Dissertation Competition for his thesis "Connections, Changes, Cubes: Unfolding Dynamic Networks for Visual Exploration" [10].
- Yvonne Jansen was awarded the second price for the Gilles Kahn dissertation award for her thesis "Physical and Tangible Information Visualization" [11].
- Samuel Huron received the best paper honorable mention award at DIS 2014 for the paper “Constructive Visualization” [28].

6.2. Effectiveness of Staggered Animations

Participants: Fanny Chevalier, Pierre Dragicevic [correspondant], Steven Franconeri.

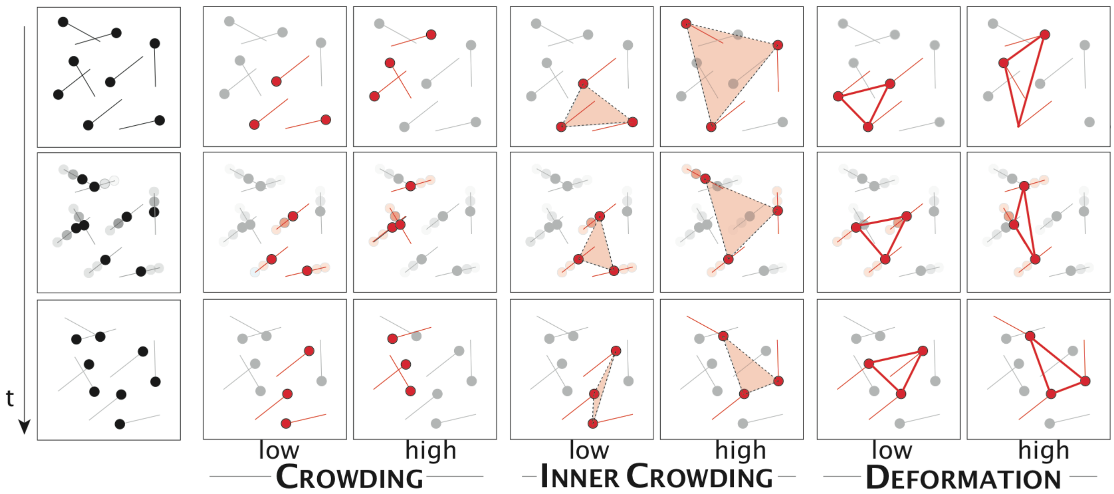

Figure 7. Illustration of the complexity metrics used in the study.

Interactive visual applications often rely on animation to transition from one display state to another. There are multiple animation techniques to choose from, and it is not always clear which should produce the best visual correspondences between display elements. One major factor is whether the animation relies on staggering—an incremental delay in start times across the moving elements. It has been suggested that staggering may reduce occlusion, while also reducing display complexity and producing less overwhelming animations, though no empirical evidence has demonstrated these advantages. Work in perceptual psychology does show that reducing occlusion, and reducing inter-object proximity (crowding) more generally, improves performance in multiple object tracking.

We empirically investigated the effectiveness of staggering [15]. We ran simulations confirming that staggering can in some cases reduce crowding in animated transitions involving dot clouds (as found in, e.g., animated 2D scatterplots). We empirically evaluated the effect of two staggering techniques on tracking tasks, focusing on cases that should most favour staggering. We found that introducing staggering has a negligible, or even negative, impact on multiple object tracking performance. The potential benefits of staggering may be outweighed by strong costs: a loss of common-motion grouping information about which objects travel in similar paths, and less predictability about when any specific object would begin to move. Staggering may be beneficial in some conditions, but they have yet to be demonstrated. Our results are a significant step toward a better understanding of animation pacing, and provide direction for further research.

More on the project Web page: fannychevalier.net/animations

6.3. Tablet-Based Interaction for Immersive 3D Data Exploration

Participants: David López, Lora Oehlberg, Candemir Doger, Tobias Isenberg [correspondant].

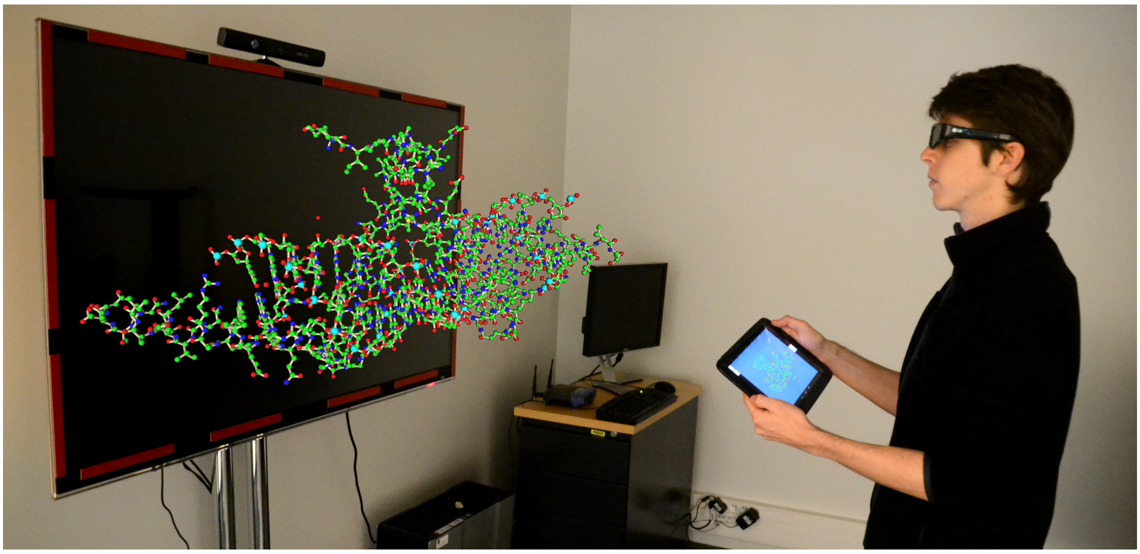

Figure 8. Illustration of the interaction setup for a combined touch-based navigation and stereoscipic viewing of 3D data.

We examined touch-based navigation of 3D visualizations in a combined monoscopic and stereoscopic viewing environment [32] (see Figure 8). We identified a set of interaction modes, and a workflow that helps users transition between these modes to improve their interaction experience. For this purpose we analyzed, in particular, the control-display space mapping between the different reference frames of the stereoscopic and monoscopic displays. We showed how this mapping supports interactive data exploration, but may also lead to conflicts between the stereoscopic and monoscopic views due to users' movement in space; we resolved these problems through synchronization. To support our discussion, we conducted an exploratory observational evaluation with domain experts in fluid mechanics and structural biology. These experts explored domain-specific datasets using variations of a system that embodies the interaction modes and workflows; we could report on their interactions and qualitative feedback on the system and its workflow.

6.4. Understanding the Perception of Star Glyphs

Participants: Johannes Fuchs, Petra Isenberg [correspondant], Anastasia Bezerianos, Fabian Fischer, Enrico Bertini.

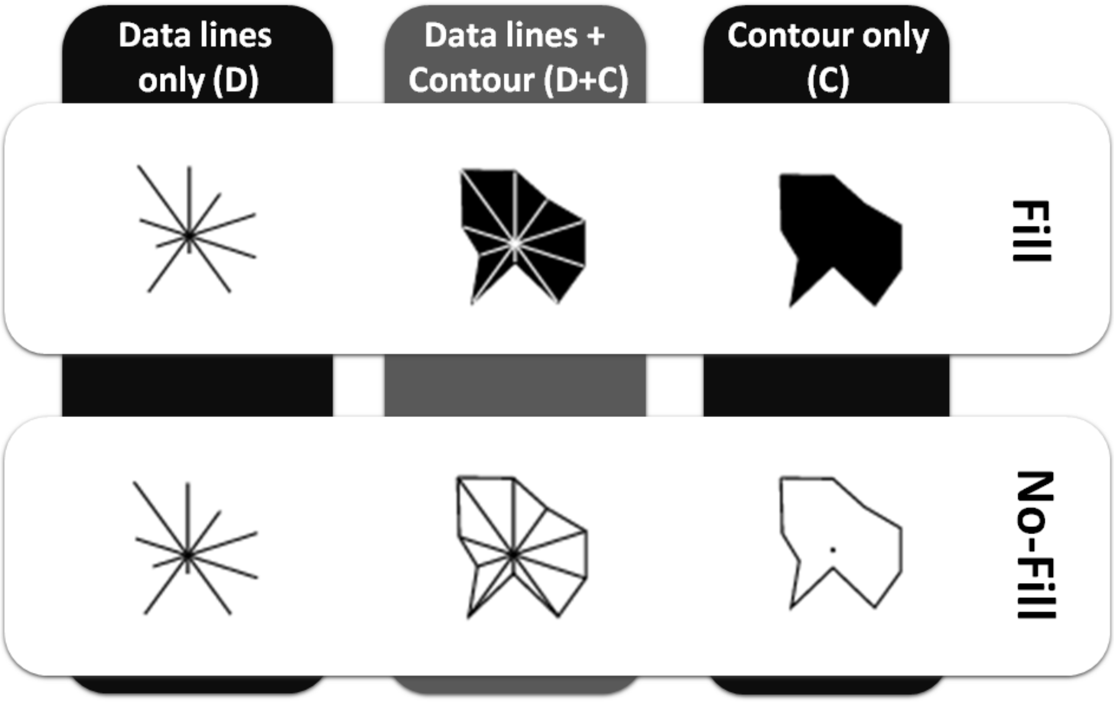

Figure 9. Illustration of the design space of the perception study.

We conducted three experiments to investigate the effects of contours on the detection of data similarity with star glyph variations [16]. A star glyph is a small, compact, data graphic that represents a multi-dimensional data point. Star glyphs are often used in small-multiple settings, to represent data points in tables, on maps, or as overlays on other types of data graphics. In these settings, an important task is the visual comparison of the data points encoded in the star glyph, for example to find other similar data points or outliers. We hypothesized that for data comparisons, the overall shape of a star glyph—enhanced through contour lines—would aid the viewer in making accurate similarity judgments. To test this hypothesis, we conducted three experiments. In our first experiment, we explored how the use of contours influenced how visualization experts and trained novices chose glyphs with similar data values. Our results showed that glyphs without contours make the detection of data similarity easier. Given these results, we conducted a second study to understand intuitive notions of similarity. Star glyphs without contours most intuitively supported the detection of data similarity. In a third experiment, we tested the effect of star glyph reference structures (i.e., tickmarks and gridlines) on the detection of similarity. Surprisingly, our results show that adding reference structures does improve the correctness of similarity judgments for star glyphs with contours, but not for the standard star glyph. As a result of these experiments, we conclude that the simple star glyph without contours performs best under several criteria, reinforcing its practice and popularity in the literature. Contours seem to enhance the detection of other types of similarity, e.g., shape similarity and are distracting when data similarity has to be judged. Based on these findings we provide design considerations regarding the use of contours and reference structures on star glyphs.

6.5. Constructive Visualization

Participants: Samuel Huron [correspondant], Yvonne Jansen, Sheelagh Carpendale.

Figure 10. Constructing a visualization with tokens: right hand positions tokens, left hand points to the corresponding data.

The accessibility of infovis authoring tools to a wide audience has been identified as one of the major research challenges. A key task of the authoring process is the development of visual mappings. While the infovis community has long been deeply interested in finding effective visual mappings, comparatively little attention has been placed on how people construct visual mappings. We conducted a study designed to shed light on how people spontaneously transform data into visual representations [18]. We asked people to create, update and explain their own information visualizations using simple materials such as tangible building blocks. We learned that all participants, most of whom had no experience in visualization, were readily able to create and talk about their own visualizations. On the basis of our observations, we discussed the actions of our participants in the context of the development of their visual representations and their analytic activities. From this we suggested implications for tool design that can enable broader support for infovis authoring.

More on the project Web page: constructive.gforge.inria.fr

6.6. Multi-touch Gestures for Data Graphics

Participants: Wesley Willett, Qi Lan, Petra Isenberg.

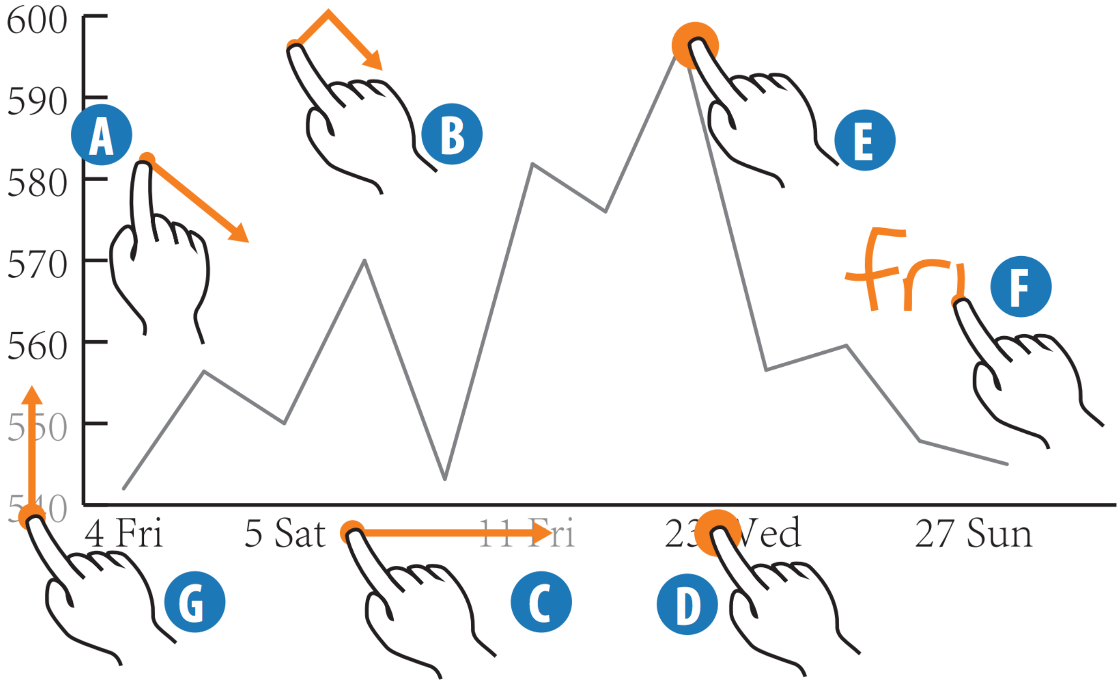

Figure 11. The most common gestures used for selecting (a) downward trends, (b) peaks, (c) ordinal ranges, (d) non-contiguous items, (e) highest points, (f) repeating dates, and (g) the lowest three points in a time series chart.

Selecting data items is a common and extremely important form of interaction with data graphics, and serves as the basis for many other data interaction techniques. However, interactive charting tools for multi-touch displays typically only provide dedicated multi-touch gestures for single-point selection or zooming. We conducted a study in which we used gesture elicitation to explore a wider range of possible selection interactions for multi-touch data graphics [35]. The results show a strong preference for simple, one-handed selection gestures. They also show that users tend to interact with chart axes and make figurative selection gestures outside the chart, rather than interact with the visual marks themselves. Finally, we found strong consensus around several unique selection gestures related to visual chart features.

6.7. Exploring Word-Scale Visualizations

Participants: Pascal Goffin, Wesley Willett, Jean-Daniel Fekete, Petra Isenberg.

We presented an exploration and a design space that characterize the usage and placement of word-scale visualizations within text documents [17]. Word-scale visualizations are a more general version of sparklines—small, word-sized data graphics that allow meta-information to be visually presented in-line with document text. In accordance with Edward Tufte's definition, sparklines are traditionally placed directly before or after words in the text. We described alternative placements that permit a wider range of word-scale

Figure 12. Four examples of the integration of word-scale visualizations into HTML documents

graphics and more flexible integration with text layouts. These alternative placements include positioning visualizations between lines, within additional vertical and horizontal space in the document, and as interactive overlays on top of the text. Each strategy changes the dimensions of the space available to display the visualizations, as well as the degree to which the text must be adjusted or reflowed to accommodate them. We provided an illustrated design space of placement options for word-scale visualizations and identify six important variables that control the placement of the graphics and the level of disruption of the source text. We also contributed a quantitative analysis that highlights the effect of different placements on readability and text disruption. Finally, we used this analysis to propose guidelines to support the design and placement of word-scale visualizations.

More on the project Web page: www.aviz.fr/sparklificator

6.8. Assessing Visualization Literacy

Participants: Jeremy Boy, Ronald A. Rensink, Enrico Bertini, Jean-Daniel Fekete.

We described a method for assessing the visualization literacy (VL) of a user [14]. Assessing how well people understand visualizations has great value for research (e.g., to avoid confounds), for design (e.g., to best determine the capabilities of an audience), for teaching (e. g., to assess the level of new students), and for recruiting (e. g., to assess the level of interviewees). In this project we proposed a method for assessing VL based on Item Response Theory. We described the design and evaluation of two VL tests for line graphs, and presents the extension of the method to bar charts and scatterplots. Finally, we discussed the reimplementation of these tests for fast, effective, and scalable web-based use.

More on the project Web page: peopleviz/vLiteracy/home.

7. Bilateral Contracts and Grants with Industry

7.1. Google Research Award

Participants: Jean-Daniel Fekete [correspondant], Petra Isenberg, Jeremy Boy, Heidi Lam.

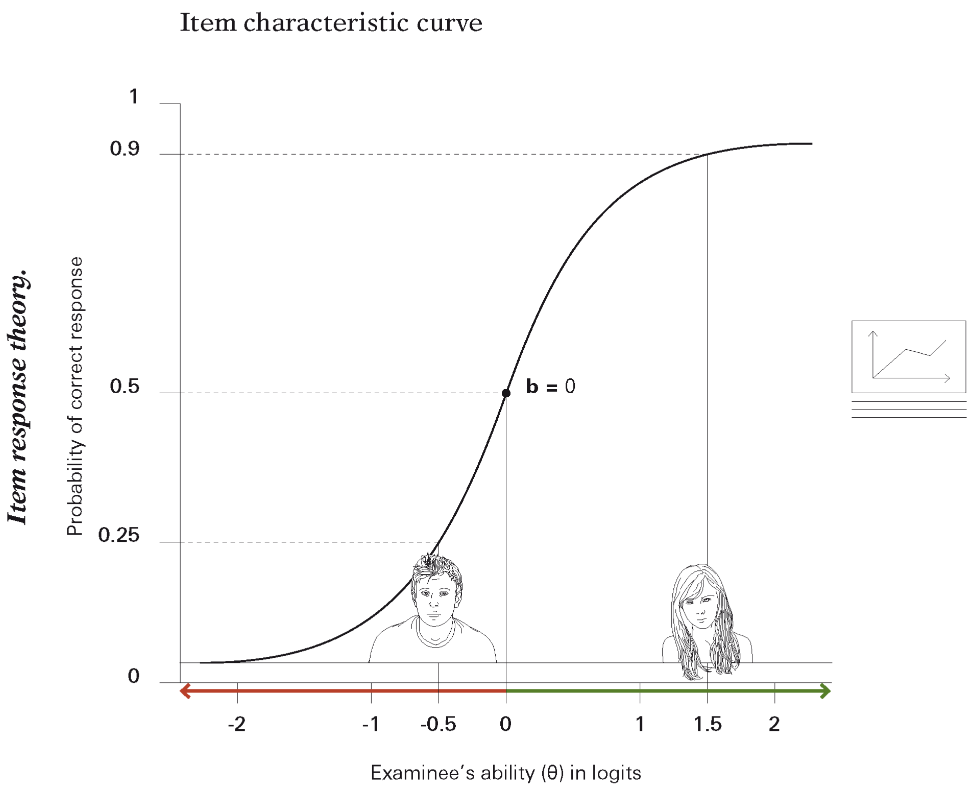

Figure 13. Example of an Item Characteristic Curve, and how people's abilities are plotted against a test-item's difficulty to determine probability of success.

Offering data access to the public is a strong trend of the recent years. Several free data providers or repositories are now online (e.g. http://data.gov.uk, http://stats.oecd.org, http://publicdata.eu, http://opendata.paris.fr, http://www.google.com/publicdata, http://www.data-publica.com), offering a rich set of data to allow citizens to build their own understanding of complex political and economic information by exploring information in its original form. However, these initiatives have had little impact directly on the public since working with this open data is often cumbersome, requires additional data wrangling, and the spreadsheets themselves take a long time to understand before useful further work can be done with them. This proposal focuses on public data visualization to offer more engaging environments for exploration of public data and to enable stronger democratic discourse about the data contents.

The goal of this proposed research project is to bridge the gap between generic visualization sites for public data and engaging content-specific visualization of this data which can be used and individually adapted to tell a story about public data. Through the design and deployment of rich and engaging interactive visualizations from public data sources we want to truly reach the goal of the public data movement: empowering the citizens and social actors by allowing them to better understand the world they are living in, to make informed decisions on complex issues such as the impact of a medical treatment on a dangerous illness or the tradeoffs offered of power plant technologies based on facts instead of assumptions.

For more information, see http://peopleviz.gforge.inria.fr/www.

8. Partnerships and Cooperations

8.1. National Initiatives

8.1.1. ANR FITOC: From Individual To Collaborative Visual Analytics

Participants: Petra Isenberg [correspondant], Jean-Daniel Fekete, Pierre Dragicevic, Wesley Willett.

The project addresses fundamental problems of technological infrastructure and the design of data representation and interaction to build a bridge between individual and team work for visual data analysis. In collaboration with the University of Magdeburg we have begun to tackle this challenge through the design of tangible widgets that help to bridge the gap between individual and collaborative information seeking.

8.1.2. ANR EASEA-Cloud

Participants: Evelyne Lutton [correspondant], Waldo Cancino, Hugo Gilbert, Pierre Collet.

The aim of the EASEA-CLOUD project is to exploit the massively parallel resources that are offered by clusters or a grid of modern GPU-equipped machines in order to find solutions to inverse problems whose evaluation function can be intrinsically sequential. Massive parallelization of generic sequential problems can be achieved by evolutionary computation, that can efficiently exploit the parallel evaluation of thousands of potential solutions (a population) for optimization or machine-learning purposes. The project consists in turning the existing EASEA (EAsy Specification of Evolutionary Algorithms, http://easea.unistra.fr/) research platform into an industrial-grade platform that could be exploited by running in “cloud” mode, on a large grid of computers (ISC-PIF/CREA is the current manager of the French National Grid). The necessary steps are to develop:

- a professional-grade API, development environment and human-computer interface for the existing academic EASEA platform,
- cloud-management tools (in order to launch an experiment on a grid of computers, monitor the experiment and bill the laboratories or companies that will be using EASEA-CLOUD for intensive computation,
- novel visualisation tools, in order to monitor an evolutionary run, potentially launched on several hundred heterogeneous GPU machines.

The consortium is made of thee partners: LSIIT/UDS (which is developing the EASEA platform), ISCPIR/CREA (for its experience in grid and cloud computing), AVIZ/Inria (for its experience in visualization tools for evolutionary computation) and two subcontractors: LogXLabs (a software development company in order to create industrial-grade code and interfaces) an BIOEMERGENCE-IMAGIF, the "valorisation" department of CNRS Gif s/Yvette. Valorisation will take place in strong collaboration with UNISTRA VALO, the valorisation structure of Université de Strasbourg. The project started on October 1st, 2012, for 2 years. AVIZ is in charge of developing new visualisation tools adapted to the monitoring of the optimization process.

8.2. European Initiatives

8.2.1. FP7 & H2020 Projects

8.2.1.1. CENDARI

Program: Infrastructures

Project acronym: **CENDARI**

Project title: Collaborative EuropeaN Digital/Archival Infrastructure

Duration: 01/2012 - 12/2015

Coordinator: Trinity College, Dublin (IE),

Other partners: Freie Universitaet Berlin (DE), Matematicki Institut Sanu u Beogradu (Serbia), University of Birmingham (UK), King's College London (UK), Georg-August-Universitaet Goettingen Stiftung Oeffentlichen Rechts (DE), Narodni Knihovna Ceske Republiky (Czech Republic), Societa Internazionale per lo Studio del Medioevo Latino-S.I.S.M.E.L. Associazione (IT), Fondazione Ezio Franceschini Onlus (IT), Ministerium fur Wissenschaft, Forschung und Kunst Baden-Wurttemberg (DE), Consortium of European Research Libraries (UK), Koninklijke Bibliotheek (NL), UNIVERSITA DEGLI STUDI DI CASSINO (IT).

Abstract:

The Collaborative EuropeaN Digital Archive Infrastructure (CENDARI) will provide and facilitate access to existing archives and resources in Europe for the study of medieval and modern European history through the development of an 'enquiry environment'. This environment will increase access to records of historic importance across the European Research Area, creating a powerful new platform for accessing and investigating historical data in a transnational fashion overcoming the national and institutional data silos that now exist. It will leverage the power of the European infrastructure for Digital Humanities (DARIAH) bringing these technical experts together with leading historians and existing research infrastructures (archives, libraries and individual digital projects) within a programme of technical research informed by cutting edge reflection on the impact of the digital age on scholarly practice.

The enquiry environment that is at the heart of this proposal will create new ways to discover meaning, a methodology not just of scale but of kind. It will create tools and workspaces that allow researchers to engage with large data sets via federated multilingual searches across heterogeneous resources while defining workflows enabling the creation of personalized research environments, shared research and teaching spaces, and annotation trails, amongst other features. This will be facilitated by multilingual authority lists of named entities (people, places, events) that will harness user involvement to add intelligence to the system. Moreover, it will develop new visual paradigms for the exploration of patterns generated by the system, from knowledge transfer and dissemination, to language usage and shifts, to the advancement and diffusion of ideas.

See more at http://cendari.eu/ and http://www.aviz.fr/Research/CENDARI.

8.2.2. Collaborations with Major European Organizations

Fraunhofer Institute, IGD (DE)

We are collaborating on visual analytics, setting up European projects and coordinating European initiatives on the subject.

University of Dresden, (DE)

We have been collaborating with Raimund Dachselt on stackable tangible devices for faceted browsing [55], [54].

8.3. International Initiatives

8.3.1. Inria International Partners

8.3.1.1. Declared Inria International Partners

AVIZ researchers collaborate with a number of international partners, including:

- Google, Mountain View, USA
- Microsoft Research, Redmond, USA
- New York University, USA
- University of Toronto, Canada
- University of Calgary, Canada
- University of British Columbia, Canada
- University of Kent, UK
- University of Konstanz, Germany
- University of Magdeburg, Germany

8.3.1.2. Informal International Partners

- Arizona State University, USA
- University of Vienna, Austria
- University of Groningen, the Netherlands
- University of Granada, Spain

8.3.2. Inria International Labs

- *Massive Data team*, Inria Chile.

8.3.3. Collaboration with Google

AVIZ collaborates with Google on several projects, related to the Google Research Grant and to evaluation methodology in information visualization.

8.3.4. Collaboration with Microsoft Research

AVIZ collaborates with several researchers from Microsoft Research Redmond, in particular on the topic of new interactions for information visualization and brain connectivity visualization.

8.3.5. Collaboration with New-York University

Jean-Daniel Fekete collaborates with Claudio Silva and Juliana Freire from NYU-Poly on the VisTrails workflow system for visual analytics (http://www.vistrails.org). Rémi Rampin, intern from the Univ. Paris-Sud Master in HCI, has spent one month at Orsay and 5 months at NYU-Poly to allow VisTrails to run Java-based applications and Toolkits. Rémi successfully connected the traditional Python-C implementation of VisTrails to the Java virtual machine using the JPype package. Jean-Daniel Fekete is now porting the Obvious Toolkit [47] in this environment to integrate all its components [50].

8.4. International Research Visitors

8.4.1. Visits to International Teams

8.4.1.1. Sabbatical programme

Jean-Daniel Fekete

Date: Jan 2015 - Dec 2015

Institution: University of New-York (USA)

9. Dissemination

9.1. Promoting Scientific Activities

AVIZ members are active worldwide in the domains of Visualization, Visual Analytics, HCI, and computer graphics.

9.1.1. Keynotes and Invited Talks

- Jean-Daniel Fekete: "Visualisation de réseaux par matrices d'adjacence", Horizon Maths 2014, Dec. 16, 2014.
- Jean-Daniel Fekete: "Matrix-Based Visualization of Graphs", keynote speaker for the Graph Drawing 2014 Symposium, , Würzburg, Germany, Sep. 25th, 2014.
- Jean-Daniel Fekete: "Visualizing Dynamic Interactions", Summer School in Cognitive Sciences 2014, Web Science and the Mind, Universite du Québec à Montréal, Jul 10th, 2014.
- Jean-Daniel Fekete: "La visualisation d'information pour comprendre et interagir avec les données" seminar at IRT SystemX, Saclay, Jul. 1st, 2014.
- Jean-Daniel Fekete: "Dataviz & BigData : Mythes & réalités", Panel at Microsoft Techdays, Paris, Feb. 11th, 2014.
- Tobias Isenberg: "*Touching* the Third Dimension—Exploration of Scientific Data on Surfaces". Microsoft eScience Workshop, Guarujá, Brazil, Oct. 22, 2014.
- Tobias Isenberg: "Direct-Touch Interaction for Scientific Visualization". Center for Data Science Kick-Off Meeting, Orsay, France, June 30, 2014.
- Tobias Isenberg: "Direct-touch Interaction for Scientific Visualization". Forum on Tactile and Gestural Interaction, Tourcoing, France, May 13, 2014.
- Tobias Isenberg: "Interaction with 3D Scientific Data on Touch-Sensitive Surfaces". University of Granada, Spain, May 7, 2014.
- Tobias Isenberg: "Interaction with 3D Scientific Data on Touch-Sensitive Surfaces". University of Rostock, Germany, Apr. 16, 2014.
- Petra Isenberg: "How Important is Display Technology for Visualization and Visual Analytics?" Capstone at the 2014 European Workshop on Visual Analytics (EuroVA), Swansea, UK.
- Pierre Dragicevic: "Wrong Stats are Miscommunicated Stats". Yves Guiard's Emeritus Ceremony, Telecom ParisTech, 9 July 2014.
- Pierre Dragicevic: "Bad Stats are Miscommunicated Stats". Keynote at VIS'14 BELIV workshop, 10 Nov 2014.
- Samuel Huron: "La sédimentation visuelle". Invited speaker at Sud Web 2014, Toulouse
- Wesley Willett: "Tools and Strategies for Social Data Analysis". SIGCHI Paris, 27 January 2014.
- Benjamin Bach: "Visualizing functional brain connectivity". Invited talk at The 10th IEEE International Conference on e-Science, Guaruja, Brazil, Oct. 2014.

9.1.2. Scientific Associations

- Jean-Daniel Fekete is a member of the Steering Committee of EuroVis (Eurographics WG on Data Visualization).
- Jean-Daniel Fekete is a member of the Steering Committee of the IEEE Information Visualization Conference.
- Jean-Daniel Fekete is a member of the IEEE VIS Executive Committee.
- Tobias Isenberg is a member of the Steering Committee of the Expressive conference.
- Tobias Isenberg is a member of the Executive Committee of the Visualization and Computer Graphics Technical Committee of the IEEE Computer Society (VGTC), serving as publications chair.

9.1.3. Conference Organization

- Jean-Daniel Fekete was the President of the IEEE Conference on Visualization VIS'2014 in Paris.
- Petra Isenberg and Tobias Isenberg co-organized the IEEE VisWeek Workshop on Beyond Time and Errors—Novel Evaluation Methods for Visualization (BELIV 2014) at IEEE VIS 2014.
- Tobias Isenberg was Workshops co-chair at IEEE VIS 2014.
- Tobias Isenberg was Publicity co-chair at IEEE SUI 2014.
- Petra Isenberg was poster co-chair at ITS 2014.
- Petra Isenberg was exhibits co-chair at ITS 2014.
- Charles Perin, Pierre Dragicevic and Jean-Daniel Fekete organized the Bertin Exhibition at IEEE VIS'2014.
- Charles Perin was Student Volunteers co-chair at IEEE VIS'2014.
- Jeremy Boy designed the sponsors brochure for collecting funds for the IEEE VIS'14 Conference.
- Jeremy Boy designed the interface for displays showing the conference program at the IEEE VIS'14 Conference venue.
- Jeremy Boy redesigned all the Fast-Forward material for the IEEE VIS'14 Conference.
- Jeremy Boy and Heidi Lam designed the Vis in other venues posters for the IEEE VIS'14 Conference.
- Jeremy Boy, Sung Hee Kim, Sukwon Lee, Ji Soo Yi, and Niklas Elmqvist organized the workshop on visualization literacy at the IEEE VIS'14 Conference.
- Benjamin Bach co-chaired the celebration of the 25th anniversary of the IEEE VIS conference.

9.1.4. Conference Program Committees

- Jean-Daniel Fekete was a member of the program committee of IEEE VAST.
- Tobias Isenberg was a member of the program committee for ACM ITS Posters.
- Tobias Isenberg was a member of the program committee for ACM SUI.
- Tobias Isenberg was a member of the program committee for IEEE VISAP.
- Tobias Isenberg was a member of the program committee for IEEE InfoVis.
- Tobias Isenberg was a member of the program committee for IEEE SciVis.
- Tobias Isenberg was a member of the program committee for ACM/Eurographics Expressive.
- Tobias Isenberg was a member of the program committee for EuroVis full papers.
- Tobias Isenberg was a member of the program committee for EuroVis short papers.
- Tobias Isenberg was a member of the program committee for IEEE 3DUI.
- Petra Isenberg was a member of the program committee for AVI 2014.
- Petra Isenberg was a member of the program committee for CHI 2014.

- Petra Isenberg was a member of the program committee for InfoVis 2014.
- Petra Isenberg was a member of the program committee for ITS 2014.
- Petra Isenberg was a member of the program committee for SUI 2014.
- Petra Isenberg was a member of the program committee for PerDis 2014.
- Pierre Dragicevic was a member of the program committee for VIS 2014.
- Pierre Dragicevic was a member of the best poster committee for VIS 2014.
- Pierre Dragicevic was a member of the workshop committee for CHI 2015.
- Wesley Willett was a member of the works-in-progress program committee for CHI 2014.
- Wesley Willett was a member of the program committee for the iConference 2015.
- Wesley Willett was a member of the program committee for GI 2015.

9.1.5. Journal Editorial Board

- Jean-Daniel Fekete is associate editor of IEEE Transactions on Visualization and Computer Graphics.
- Tobias Isenberg is associate editor of Elsevier Computers & Graphics.

9.1.6. Conference Reviewing

3DUI IEEE Symposium on 3D User Interfaces: Tobias Isenberg

3DVis IEEE VIS International Workshop on 3DVis: Tobias Isenberg

alt.chi Alt.chi Forum: Pierre Dragicevic

AVI International Working Conference on Advanced Visual Interfaces: Pierre Dragicevic, Petra Isenberg

BioVis IEEE Symposium on Biological Data Visualization: Tobias Isenberg

CAe International Symposium on Computational Aesthetics in Graphics, Visualization, and Imaging: Tobias Isenberg

CHI ACM Conference on Human Factors in Computing System: Pierre Dragicevic, Tobias Isenberg, Samuel Huron, Charles Perin, Wesley Willett, Jeremy Boy, Benjamin Bach

CSCW ACM Conference on Computer Supported Cooperative Work: Wesley Willett

DIS ACM conference on Designing Interactive Systems: Pierre Dragicevic, Petra Isenberg

EuroVA EuroVis Workshop on Visual Analytics: Pierre Dragicevic, Petra Isenberg

EuroVis Eurographics/IEEE Conference on Visualization: Tobias Isenberg, Petra Isenberg, Samuel Huron, Charles Perin, Wesley Willett, Benjamin Bach

GD International Symposium on Graph Drawing: Samuel Huron

IHM Conférence Francophone sur l'Interaction Homme-Machine: Charles Perin

iConference iSchools conference on critical information issues in contemporary society: Wesley Willett

InfoVis IEEE Information Visualization Conference: Tobias Isenberg, Petra Isenberg, Charles Perin

ITS ACM Conference on Interactive Tabletops and Surfaces: Pierre Dragicevic, Tobias Isenberg, Petra Isenberg, Wesley Willeett

IUI ACM International Conference on Intelligent User Interfaces: Tobias Isenberg

MobileHCI International Conference on Human-Computer Interaction with Mobile Devices and Services: Petra Isenberg

NPAR ACM Symposium on Non-Photorealistic Animation and Rendering: Tobias Isenberg

PacificVis IEEE Pacific Visualization Symposium: Wesley Willett, Benjamin Bach

PG Pacific Conference on Computer Graphics and Applications: Tobias Isenberg

PerDis International Symposium on Pervasive Displays: Petra Isenberg

SciVis IEEE Scientific Visualization Conference: Tobias Isenberg

SIGGRAPH ACM Conference on Computer Graphics and Interactive Techniques: Tobias Isenberg

SUI ACM Symposium on Spatial User Interaction: Tobias Isenberg, Petra Isenberg

UIST ACM Symposium on User Interface Software and Technology: Pierre Dragicevic, Tobias Isenberg, Charles Perin, Wesley Willett

VAST IEEE Conference on Visual Analytics Science and Technology: Petra Isenberg, Charles Perin

9.1.7. Journal Reviewing

C&G Elsevier Computers and Graphics: Tobias Isenberg

CG&A IEEE Computer Graphics and Applications: Tobias Isenberg, Samuel Huron, Wesley Willett

CGF Computer Graphics Forum: Tobias Isenberg

COSU Computer Supported Cooperative Work: Petra Isenberg

IJHCS International Journal of Human-Computer Studies: Tobias Isenberg

TOG ACM Transactions on Graphics: Pierre Dragicevic

TVCG IEEE Transactions on Visualization and Computer Graphics: Pierre Dragicevic, Tobias Isenberg, Petra Isenberg, Wesley Willett, Benjamin Bach

9.2. Teaching - Supervision - Juries

9.2.1. Teaching

- “Interactive Information Visualization” (M2 module), taught by Jean-Daniel Fekete, Pierre Dragicevic, Benjamin Bach, Nadia Boukhelifa, Lonni Besançon at Univ. Paris-Sud
- “Visual Analytics” (M2 module) taught by Wesley Willett, Petra Isenberg, Pierre Dragicevic, Jean-Daniel Fekete, Nadia Boukhelifa at Ecole Centrale, Paris
- “Innovative Interactive Systems for Medical Visualization” taught by Tobias Isenberg at the ‘SUMMER’ FP7 Marie Curie Research Training Network summer-school, TU Delft, the Netherlands
- “Non-Photorealistic Rendering” taught by Tobias Isenberg at the University of Granada, Spain
- “Non-Photorealistic Rendering” taught by Tobias Isenberg at Polytech Paris-Sud, France

9.2.2. Supervision

- PhD: Yvonne Jansen, Physical and Tangible Information Visualization, Université Paris-Sud, 10 March 2014, Pierre Dragicevic and Jean-Daniel Fekete.
- PhD: Benjamin Bach, Connections, Changes, and Cubes: Unfolding Dynamic Networks for Visual Exploration, Université Paris-Sud, 9 May 2014, Emmanuel Pietriga and Jean-Daniel Fekete.
- PhD: Nicolas Heulot, Étude des projections de données comme support interactif de l’analyse visuelle de la structure de données de grande dimension, Université Paris-Sud, 4 Jul 2014, Jean-Daniel Fekete.
- PhD: Charles Perin, Direct Manipulation for Information Visualization, Université Paris-Sud, 17 Nov 2014, Jean-Daniel Fekete
- PhD: Samuel Huron, Constructive Visualization: A token-based paradigm allowing to assemble dynamic visual representation for non-experts, Université Paris-Sud, 29 Sep 2014, Jean-Daniel Fekete.
- PhD in progress: Jeremy Boy, Visualization for the People, Telecom ParisTech, Jean-Daniel Fekete and Françoise Detienne.
- PhD in progress: Pascal Goffin, From Individual to Collaborative Work, Université Paris-Sud, 2013, Petra Isenberg and Jean-Daniel Fekete

- PhD in progress: Mathieu Le Goc, Dynamic and Interactive Physical Visualization, Université Paris-Sud, 2013, Pierre Dragicevic and Jean-Daniel Fekete
- PhD in progress: Evanthia Dimara, Information Visualization for Decision Making, Université Paris-Sud, 2014, Pierre Dragicevic, Anastasia Bezerianos and Jean-Daniel Fekete
- PhD in progress: Lonni Besançon, Interactive visualization using touch input and tangibles, Université Paris-Sud, 2014, Tobias Isenberg and Mehdi Ammi.

9.2.3. Juries

- Pierre Dragicevic: CR hiring committe at Inria Lille
- Pierre Dragicevic: Member of the "Commission Scientifique" (CS) at Inria Saclay
- Pierre Dragicevic: Member of the "Commission Consultative de Spécialistes de l'Université (CCSU) " at Université Paris-Sud
- Tobias Isenberg: PhD committee of Dr. Martin Luboschik, Illustrative Informationsvisualisierung [Illustrative Information Visualization], University of Rostock, Germany, Apr. 16, 2014.

9.3. Popularization

- Pierre Dragicevic and Yvonne Jansen are curating an online List of Physical Visualizations and Related Artefacts with now 180+ entries.
- Benjamin Bach is curating an online List of Temporal Visualizations based on Space-Time cube visualizations.
- Benjamin Bach is maintaining a Webpage describing the efforts of the Microsoft Research-Inria Joint Research Center on visualizing functional brain connectivity.
- Jeremy Boy and Jean-Daniel Fekete developed a Series of Visualizations for the People.
- Jeremy Boy: CO2: La carte de la pollution mondial, Mediapart data-journalism article.
- Jeremy Boy: Les diplômes, est-ce que ça paye?, Mediapart data-journalism article.
- Jeremy Boy: Le poids du nucléaire dans le monde, Mediapart data-journalism article.
- Jeremy Boy, Samuel Huron, and Jean-Daniel Fekete organized a workshop on Data Visualization at Futur En Seine 2104, Paris, France.

10. Bibliography

Major publications by the team in recent years

[1] A. BEZERIANOS, F. CHEVALIER, P. DRAGICEVIC, N. ELMQVIST, J.-D. FEKETE. *GraphDice: A System for Exploring Multivariate Social Networks*, in "Computer Graphics Forum - Eurographics/IEEE-VGTC Symposium on Visualization 2010 (EuroVis 2010)", June 2010, vol. 10, n^{o} 3, pp. 863-872 [*DOI :* 10.1111/J.1467-8659.2009.01687.X], http://hal.inria.fr/inria-00521661

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