Activity Report 2015

Team ILDA

Interacting with Large Data

Inria teams are typically groups of researchers working on the definition of a common project, and objectives, with the goal to arrive at the creation of a project-team. Such project-teams may include other partners (universities or research institutions).

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Creation of the Team: 2015 January 01

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Hugo Romat [Inria, from Dec 2015]

2. Overall Objectives

2.1. Overall Objectives

In an increasing number of domains, computer users are faced with large datasets, that are often interlinked and organized according to elaborate structures thanks to new data models such as those that are arising with the development of, e.g., the Web of Data. Rather than seeing the inherent complexity of those data models as a hindrance, we aim at leveraging it to design new interactive systems that can better assist users in their data understanding and processing tasks.

These "Data-centric Interactive Systems" aim at providing users with the right information at the right time, presenting it in the most meaningful manner, and letting users efficiently manipulate, edit and share these data with others. This entails minimizing the effort required to retrieve and relate data from relevant sources; displaying data using visual presentation techniques that match the data's characteristics and the users' tasks; and providing users with means of interacting with the data that effectively support their train of thought.

Our approach is based on the idea of bringing the fields of Web data management [23] and Human-computer interaction [46], [66] closer together, based on the strong belief that they have the potential to cross-fertilize one another. User interface design is essential to the management and understanding of large, interlinked datasets. Interlinked datasets enriched with even a small amount of semantics have the potential to help create interfaces that let users analyze and manipulate data in a more efficient manner by providing them with, e.g, more relevant query results and giving them efficient means to navigate and relate those results. Our ultimate, long-term goal is to design interactive systems that make it as straightforward to manipulate large webs of data as spreadsheets do for tabular data.

3. Research Program

3.1. Introduction

Our ability to acquire or generate, store, process, interlink and query data has increased spectacularly over the last few years. The corresponding advances are commonly grouped under the umbrella of so called *Big Data*. Even if the latter has become a buzzword, these advances are real, and they are having a profound impact in domains as varied as scientific research, commerce, social media, industrial processes or e-government. Yet, looking ahead, emerging technologies related to what we now call the *Web of Data* (a.k.a the Semantic Web) have the potential to create an even larger revolution in data-driven activities, by making information accessible to machines as semistructured data [22] that eventually becomes actionable knowledge. Indeed, novel Web data models considerably ease the interlinking of semi-structured data originating from multiple independent sources. They make it possible to associate machine-processable semantics with the data. This in turn means that heterogeneous systems can exchange data, infer new data using reasoning engines, and that software agents can cross data sources, resolving ambiguities and conflicts between them [64]. Datasets are becoming very rich and very large. They are gradually being made even larger and more heterogeneous, but also much more useful, by interlinking them, as exemplified by the Linked Data initiative [41].

These advances raise research questions and technological challenges that span numerous fields of computer science research: databases, communication networks, security and trust, data mining, as well as human-computer interaction. Our research is based on the conviction that interactive systems play a central role in many data-driven activity domains. Indeed, no matter how elaborate the data acquisition, processing and storage pipelines are, data eventually get processed or consumed one way or another by users. The latter are faced with large, increasingly interlinked heterogeneous datasets (see, e.g., Figure 1) that are organized according to complex structures, resulting in overwhelming amounts of both raw data and structured information. Users thus require effective tools to make sense of their data and manipulate them.
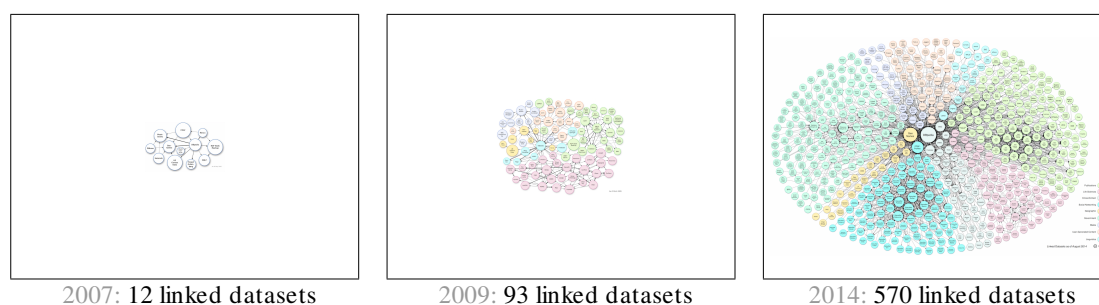
2007: 12 linked datasets   2009: 93 linked datasets   2014: 570 linked datasets

Figure 1. Linking Open Data cloud diagram from 2007 to 2014 – http://lod-cloud.net

We approach this problem from the perspective of the Human-Computer Interaction (HCI) field of research, whose goal is to study how humans interact with computers and inspire novel hardware and software designs aimed at optimizing properties such as efficiency, ease of use and learnability, in single-user or cooperative work contexts. More formally, HCI is about designing systems that lower the barrier between users' cognitive model of what they want to accomplish, and computers' understanding of this model. HCI is about the design, implementation and evaluation of computing systems that humans interact with [46], [66]. It is a highly multidisciplinary field, with experts from computer science, cognitive psychology, design, engineering, ethnography, human factors and sociology.

In this broad context, ILDA aims at designing interactive systems that display [31], [53], [73] the data and let users interact with them, aiming to help users better *navigate* and *comprehend* large webs of data represented visually, as well as *relate* and *manipulate* them.

Our research agenda consists of the three complementary axes detailed in the following subsections. Designing systems that consider interaction in close conjunction with data semantics is pivotal to all three axes. Those semantics will help drive navigation in, and manipulation of, the data, so as to optimize the communication bandwidth between users and data.

3.2. Semantics-driven Data Manipulation

Participants: Emmanuel Pietriga, Caroline Appert, Hande Ozaygen, Mengying Du, Hugo Romat.

The Web of Data has been maturing for the last fifteen years and is starting to gain adoption across numerous application domains (Figure 1). Now that most foundational building blocks are in place, from knowledge representation, inference mechanisms and query languages [42], all the way up to the expression of data presentation knowledge [60] and to mechanisms like look-up services [72] or spreading activation [37], we need to pay significant attention to how human beings are going to interact with this new Web, if it is to *"reach its full potential"* [38].

Most efforts in terms of user interface design and development for the Web of data have essentially focused on tools for software developers or subject-matter experts who create ontologies and populate them [48], [36]. Tools more oriented towards end-users are starting to appear [28], [30], [43], [44], [47], [55], including the so-called *linked data browsers* [41]. However, those browsers are in most cases based on quite conventional point-and-click hypertext interfaces that present data to users in a very page-centric, web-of-documents manner that is ill-suited to navigating in, and manipulating, webs of data.

To be successful, interaction paradigms that let users navigate and manipulate data on the Web have to be tailored to the radically different way of browsing information enabled by it, where users directly interact with the data rather than with monolithic documents. The general research question addressed in this part

of our research program is how to design novel interaction techniques that help users manipulate their data more efficiently. By data manipulation, we mean all low-level tasks related to manually creating new content, modifying and cleaning existing content, merging data from different sources, establishing connections between datasets, categorizing data, and eventually sharing the end results with other users; tasks that are currently considered quite tedious because of the sheer complexity of the concepts, data models and syntax, and the interplay between all of them.

Our approach is based on the conviction that there is a strong potential for cross-fertilization, as mentioned earlier: on the one hand, user interface design is essential to the management and understanding of webs of data; on the other hand, interlinked datasets enriched with even a small amount of semantics can help create more powerful user interfaces, that provide users with the right information at the right time.

We envision systems that focus on the data themselves, exploiting the underlying *semantics and structure* in the background rather than exposing them – which is what current user interfaces for the Web of Data often do. We envision interactive systems in which the semantics and structure are not exposed directly to users, but serve as input to the system to generate interactive representations that convey information relevant to the task at hand and best afford the possible manipulation actions.

3.3. Generalized Multi-scale Navigation

Participants: Olivier Chapuis, Emmanuel Pietriga, Caroline Appert, Anastasia Bezerianos, Olivier Gladin, María-Jesús Lobo, Arnaud Prouzeau.

The foundational question addressed here is what to display when, where and how, so as to provide effective support to users in their data understanding and manipulation tasks. ILDA targets contexts in which workers have to interact with complementary views on the same data, or with views on different-but-related datasets, possibly at different levels of abstraction. Being able to combine or switch between representations of the data at different levels of detail and merge data from multiple sources in a single representation is central to many scenarios. This is especially true in both of the application domains we consider: mission-critical systems (e.g., natural disaster crisis management) and the exploratory analysis of scientific data (e.g., correlate theories and heterogeneous observational data for an analysis of a given celestial body in Astrophysics).

A significant part of our research over the last ten years has focused on multi-scale interfaces. We designed and evaluated novel interaction techniques, but also worked actively on the development of open-source UI toolkits for multi-scale interfaces (see Section 6.2). These interfaces let users navigate large but relatively homogeneous datasets at different levels of detail, on both workstations [8], [25], [59], [58], [57], [26], [62], [24], [63] and wall-sized displays [5], [49], [61], [54], [27], [33], [32]. This part of the ILDA research program is about extending multi-scale navigation in two directions: 1. Enabling the representation of multiple, spatially-registered but widely varying, multi-scale data layers in Geographical Information Systems (GIS); 2. Generalizing the multi-scale navigation paradigm to interconnected, heterogeneous datasets as found on the Web of Data.

The first research problem is mainly investigated in collaboration with IGN in the context of ANR project MapMuxing (Section 8.2.1), which stands for *multi-dimensional map multiplexing*. Project MapMuxing aims at going beyond the traditional pan & zoom and overview+detail interface schemes, and at designing and evaluating novel cartographic visualizations that rely on high-quality generalization, *i.e.*, the simplification of geographic data to make it legible at a given map scale [69], [70], and symbol specification. Beyond project MapMuxing, we are also investigating multi-scale multiplexing techniques for geo-localized data in the specific context of ultra-high-resolution wall-sized displays, where the combination of a very high pixel density and large physical surface (Figure 2) enable us to explore designs that involve collaborative interaction and physical navigation in front of the workspace. This is work done in cooperation with team Massive Data at Inria Chile.

The second research problem is about the extension of multi-scale navigation to interconnected, heterogeneous datasets. Generalization has a rather straightforward definition in the specific domain of geographical information systems, where data items are geographical entities that naturally aggregate as scale increases. But it

is unclear how generalization could work for representations of the more heterogeneous webs of data that we consider in the first axis of our research program. Those data form complex networks of resources with multiple and quite varied relationships between them, that cannot rely on a single, unified type of representation (a role played by maps in GIS applications).

Addressing the limits of current generalization processes is a longer-term, more exploratory endeavor. Here again, the machine-processable semantics and structure of the data give us an opportunity to rethink how users navigate interconnected heterogeneous datasets. Using these additional data, we investigate ways to generalize the multi-scale navigation paradigm to datasets whose layout and spatial relationships can be much richer and much more diverse than what can be encoded with static linear hierarchies as typically found today in interfaces for browsing maps or large imagery. Our goal is thus to design and develop highly dynamic and versatile multi-scale information spaces for heterogeneous data whose structure and semantics are not known in advance, but discovered incrementally.

3.4. Novel Forms of Input for Groups and Individuals

Participants: Caroline Appert, Anastasia Bezerianos, Olivier Chapuis, Emmanuel Pietriga, André Spritzer, Can Liu, Rafael Morales Gonzalez, Bruno Fruchard, Hae Jin Song.

Analyzing and manipulating large datasets can involve multiple users working together in a coordinated manner in multi-display environments: workstations, handheld devices, wall-sized displays [27]. Those users work towards a common goal, navigating and manipulating data displayed on various hardware surfaces in a coordinated manner. Group awareness [40], [21] is central in these situations, as users, who may or may not be co-located in the same room, can have an optimal individual behavior only if they have a clear picture of what their collaborators have done and are currently doing in the global context. We work on the design and implementation of interactive systems that improve group awareness in co-located situations [50], making individual users able to figure out what other users are doing without breaking the flow of their own actions.

In addition, users need a rich interaction vocabulary to handle large, structured datasets in a flexible and powerful way, regardless of the context of work. Input devices such as mice and trackpads provide a limited number of input actions, thus requiring users to switch between modes to perform different types of data manipulation and navigation actions. The action semantics of these input devices are also often too much dependent on the display output. For instance, a mouse movement and click can only be interpreted according to the graphical controller (widget) above which it is moved. We focus on designing powerful input techniques based upon technologies such as tactile surfaces (supported by UI toolkits developed in-house), 3D motion tracking systems, or custom-built controllers [52] *to complement (rather than replace) traditional input devices* such as keyboards, that remain the best method so far for text entry, and indirect input devices such as mice or trackpads for pixel-precise pointing actions.

The input vocabularies we investigate enable users to navigate and manipulate large and structured datasets in environments that involve multiple users and displays that vary in their size, position and orientation [27], [39], each having their own characteristics and affordances: wall displays [5], [74], workstations, tabletops [56], [35], tablets [7], [71], smartphones [10], [34], [67], [68], and combinations thereof [3], [9], [54], [27].

We aim at designing rich interaction vocabularies that go far beyond what current touch interfaces offer, which rarely exceeds five gestures such as simple slides and pinches. Designing larger gesture vocabularies requires identifying discriminating dimensions (e.g., the presence or absence of anchor points and the distinction between internal and external frames of reference [7]) in order to structure a space of gestures that interface designers can use as a dictionary for choosing a coherent set of controls. These dimensions should be few and simple, so as to provide users with gestures that are easy to memorize and execute. Beyond gesture complexity, the scalability of vocabularies also depends on our ability to design robust gesture recognizers that will allow users to fluidly chain simple gestures that make it possible to interlace navigation and manipulation actions.

We also plan to study how to further extend input vocabularies by combining touch [10], [7], [56] and mid-air gestures [5] with physical objects [45], [65], [52] and classical input devices such as keyboards to enable users to input commands to the system or to involve other users in their workflow (request for help, delegation,

communication of personal findings, etc.) [29], [51]. Gestures and objects encode a lot of information in their shape, dynamics and direction, that can be directly interpreted in relation with the user, independently from the display output. Physical objects can also greatly improve coordination among actors for, e.g., handling priorities or assigning specific roles.

4. Application Domains

4.1. Mission-critical systems

Mission-critical contexts of use include emergency response & management, and critical infrastructure operations, such as public transportation systems, communications and power distribution networks, or the operations of large scientific instruments such as particle accelerators and astronomical observatories. Central to these contexts of work is the notion of situation awareness [21], i.e., how workers perceive and understand elements of the environment with respect to time and space, such as maps and geolocated data feeds from the field, and how they form mental models that help them predict future states of those elements. One of the main challenges is how to best assist subject-matter experts in constructing correct mental models and making informed decisions, often under time pressure. This can be achieved by providing them with, or helping them efficiently identify and correlate, relevant and timely information extracted from large amounts of raw data, taking into account the often cooperative nature of their work and the need for task coordination. With this application area, our goal is to investigate novel ways of interacting with computing systems that improve collaborative data analysis capabilities and decision support assistance in a mission-critical, often time-constrained, work context.

4.2. Exploratory analysis of scientific data

Many scientific disciplines are increasingly data-driven, including astronomy, molecular biology, particle physics, or neuroanatomy. While making the right decision under time pressure is often less of critical issue when analyzing scientific data, at least not on the same temporal scale as truly time-critical systems, scientists are still faced with large-to-huge amounts of data. No matter their origin (experiments, remote observations, large-scale simulations), these data are difficult to understand and analyze in depth because of their sheer size and complexity. Challenges include how to help scientists freely-yet-efficiently explore their data, keep a trace of the multiple data processing paths they considered to verify their hypotheses and make it easy to backtrack, and how to relate observations made on different parts of the data and insights gained at different moments during the exploration process. With this application area, our goal is to investigate how data-centric interactive systems can improve collaborative scientific data exploration, where users' goals are more open-ended, and where roles, collaboration and coordination patterns [40] differ from those observed in mission-critical contexts of work.

5. Highlights of the Year

5.1. Highlights of the Year

5.1.1. Awards

- ACM CHI Honorable mention for **An Evaluation of Interactive Map Comparison Techniques** [4], awarded to the top 5% of all 2150 paper submissions.
- ACM CHI Honorable mention for **SketchSliders: Sketching Widgets for Visual Exploration on Wall Displays** [9], awarded to the top 5% of all 2150 paper submissions.

6. New Software and Platforms

6.1. Smarties

FUNCTIONAL DESCRIPTION

The Smarties system provides an easy way to add mobile interactive support to collaborative applications for wall displays.

It consists of (i) a mobile interface that runs on mobile devices for input, (ii) a communication protocol between the mobiles and the wall application, and (iii) libraries that implement the protocol and handle synchronization, locking and input conflicts. The library presents the input as an event loop with callback functions and handles all communication between mobiles and wall application. Developers can customize the mobile interface from the wall application without modifying the mobile interface code.

On each mobile we find a set of cursor controllers associated with keyboards, widgets and clipboards. These controllers (pucks) can be shared by multiple collaborating users. They can control simple cursors on the wall application, or specific content (objects or groups of them). The developper can decide the types of widgets associated to pucks from the wall application side.

- Contact: Olivier Chapuis
- URL: http://smarties.lri.fr/

6.2. ZVTM

Zoomable Visual Transformation Machine
KEYWORDS: Information visualization - Data visualization - Geovisualization - Visualization - Big data - Graph visualization
FUNCTIONAL DESCRIPTION

ZVTM is a toolkit enabling the implementation of multi-scale interfaces for interactively navigating in large datasets displayed as 2D graphics.

ZVTM is used for browsing large databases in multiple domains: geographical information systems, control rooms of complex facilities, astronomy, power distribution systems.

The toolkit also enables the development of applications running on ultra-high-resolution wall-sized displays.

- Participants: Caroline Appert, Olivier Chapuis, Bruno Fruchard, Maria Jesus Lobo Gunther, Arnaud Prouzeau, Hande Ozaygen and Can Liu
- Contact: Emmanuel Pietriga
- URL: http://zvtm.sf.net

6.3. Platforms

6.3.1. Platform: WILDER

Ultra-high-resolution wall-sized displays [27] feature a very high pixel density over a large physical surface. Such platforms have properties that make them well-suited to the visualization of very large datasets. They can represent the data with a high level of detail while at the same time retaining context: users can transition from an overview of the data to a detailed view simply by physically moving in front of the wall display. Wall displays also offer good support for collaborative work, enabling multiple users to simultaneously visualize and interact with the displayed data. To make them interactive, wall-sized displays are increasingly coupled with input devices such as touch frames, motion-tracking systems and wireless multitouch devices, in order to enable multi-device and multi-user interaction with the displayed data. Application areas for such visualization platforms range from the monitoring of complex infrastructures and crisis management situations to tools for the exploratory visualization of scientific data.

WILDER is the latest ultra-high-resolution wall-sized display set up at Inria Saclay, and is one of the nodes of the Digiscope EquipEx. We use this platform for multiple projects, both fundamental HCI research, and research and development activities for specific application areas such as geographical informations systems (Figure 2) and astronomy (see Figure 3).

6.3.2. Platform: ANDES

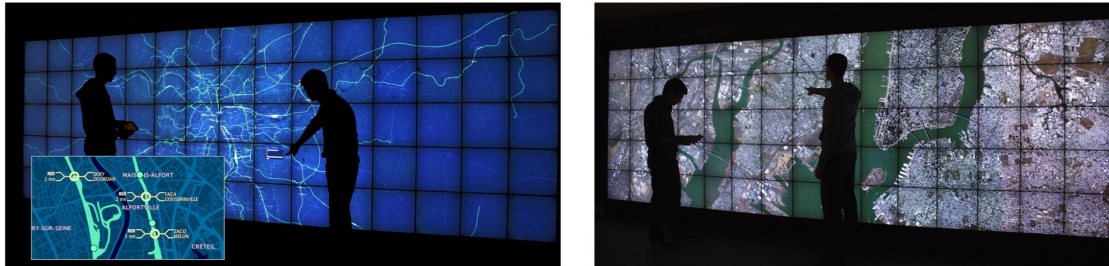*Figure 2. Geovisualization applications running on the WILDER platform. Real-time monitoring of railroad trafic in France (left), large-scale high-resolution orthoimagery visualization (right).*
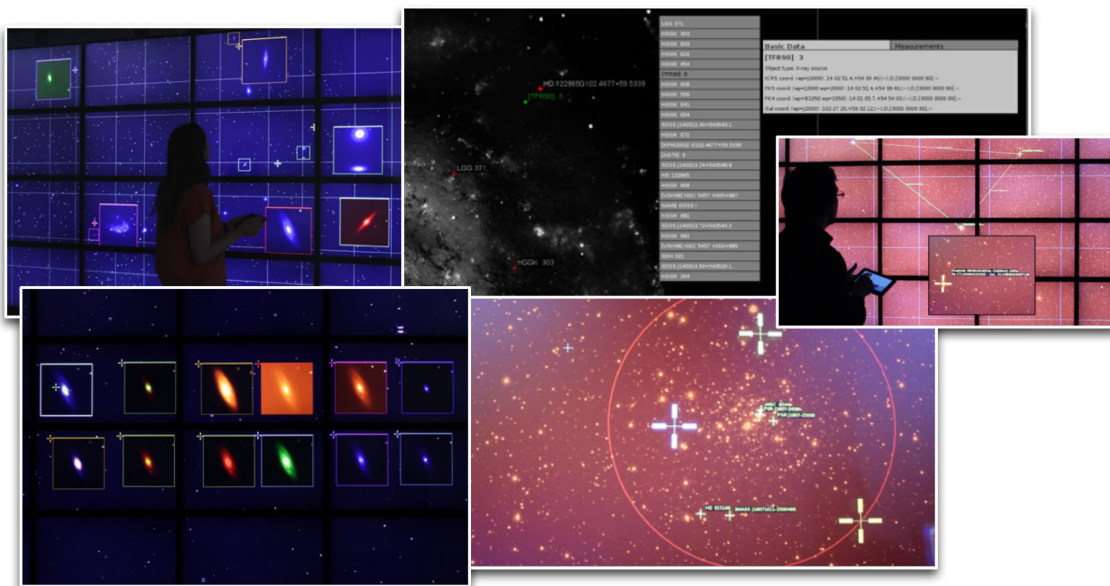

Figure 3. Visualization of high-dynamic-range FITS images and associated data catalogs in the domain of Astronomy on ANDES (collaboration with Inria Chile, Millenium Institute of Astrophysics, and Institut d'Astrophysique Spatiale).

ANDES is a platform similar to WILDER, set up at Inria in Santiago de Chile, that we use both as a research platform and as a showroom of our research and development activities. ANDES is the main platform used for our collaborative research project with the Millenium Institute of Astrophysics on the visualization of large FITS images (see Figure 3).

7. New Results

7.1. An Evaluation of Interactive Map Comparison Techniques

Figure 4. Empirical evaluation of multiplexing strategies using juxtaposition or overlaying for spatially-registered map comparison tasks [4]. Research conducted in the context of ANR project MapMuxing with IGN (Institut National de l'Information Géographique et Forestière).

Geovisualization applications typically organize data into layers. These layers hold different types of geographical features, describe different characteristics of the same features, or represent those features at different points in time. Layers can be composited in various ways, most often employing a juxtaposition or superimposition strategy, to produce maps that users can explore interactively. From an HCI perspective, one of the main challenges is to design interactive compositions that optimize the legibility of the resulting map and that ease layer comparison. We characterized five representative techniques, and empirically evaluated them using a set of real-world maps in which we purposefully introduced six types of differences amenable to inter-layer visual comparison. We discussed the merits of these techniques in terms of visual interference, user attention and scanning strategy. Those results can help inform the design of map-based visualizations for supporting geo-analysis tasks in many application areas.

This work was published at ACM CHI 2015 [4], and received an honorable mention (top 5% of all submissions).

7.2. Reciprocal Drag and Drop

Drag-and-drop has become ubiquitous, both on desktop computers and touch-sensitive surfaces. It is used to move and edit the geometry of elements in graphics editors, to adjust parameters using controllers such as sliders, or to manage views (e.g., moving and resizing windows, panning maps). Reverting changes made via a drag-and-drop usually entails performing the reciprocal drag-and-drop action. This can be costly as users have to remember the previous position of the object and put it back precisely. We introduced the DnD^{-1} model that handles all past locations of graphical objects. We redesigned the Dwell-and-Spring widget to interact with this history. Applications can implement DnD^{-1} to enable users to perform reciprocal drag-and-drop to any past location for both individual objects and groups of objects. We performed two user studies, whose results show that users understand DnD^{-1}, and that Dwell-and-Spring enables them to interact with this model effectively.

This work was published in ACM ToCHI [1].

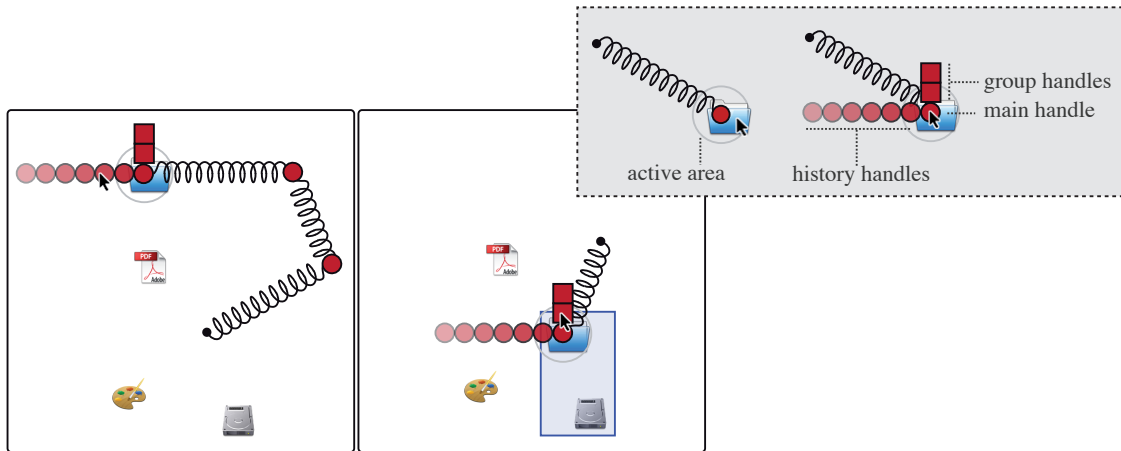*Figure 5. Navigating a graphical object's direct manipulation history as captured by the DnD^{-1} model, using the Dwell-and-Spring widget.*
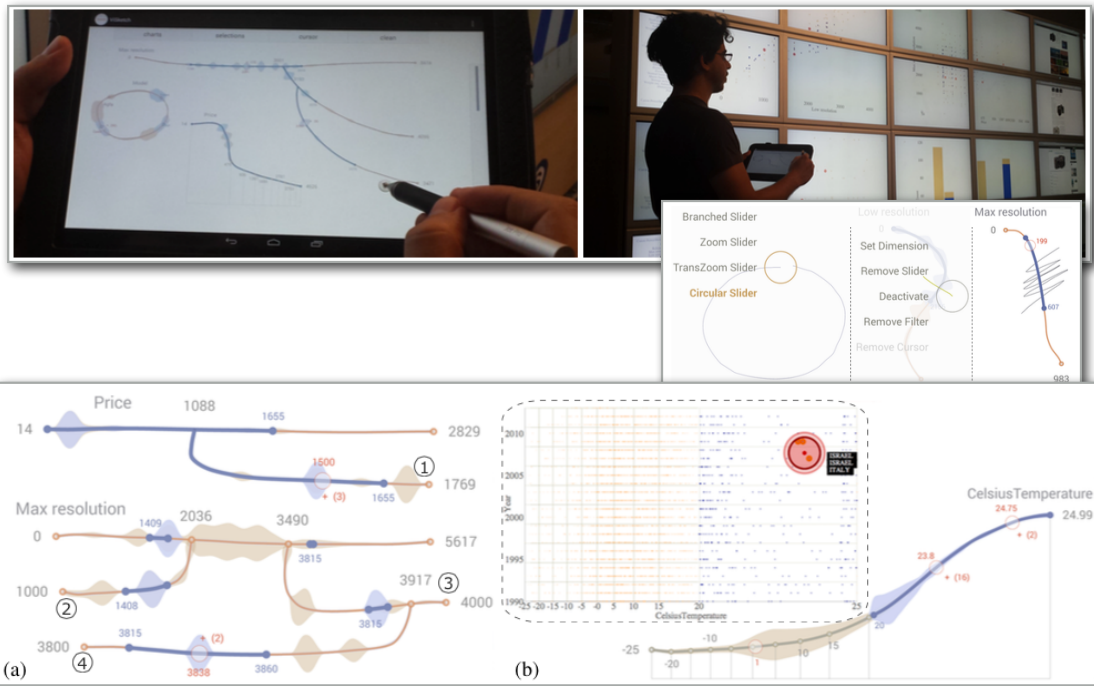

Figure 6. (top) The user sketching their sliders on the fly (left), to interact with their data on the wall display (right). Menus and simple gestures (middle) are enough to create complex sliders (bottom) that can help explore data at different granularities.

7.3. SketchSliders: Sketching Widgets for Visual Exploration on Wall Displays

Given our interest in how to effectively interact with wall displays, we have started investigating ways to empower end users, by allowing them to easily create themselves their interfaces. We introduced a sketching interface that runs on mobile devices, and allows users to explore multi-dimensional datasets on wall displays by sketching on the fly the interactive controllers they require. We demonstrated this concept with *SketchSliders*, range sliders that users can freely sketch on the mobile surface to customize their exploration. A small combination of sketches and gestures allows the creation of complex interactive sliders, such as circular sliders for periodic data, slider branches for detailed interaction, and fisheye transformation sliders. We augmented sliders with a suite of tools, such as markers, slider cursors, and approximate views of data distributions. These designs were inspired by a design study with three visualization experts, and validated through a user study with six experts using our system.

This work was published at ACM CHI 2015 [9], and received an honorable mention (top 5% of all submissions).

7.4. Ultra-high-resolution Wall-sized Displays

We have worked on the following other projects, also related to the interactive visualization of large datasets on ultra-high-resolution wall displays:

- Mid-air Pointing on Ultra-Walls [5]. The size and resolution of ultra-high resolution wall-sized displays ("ultra-walls") make traditional pointing techniques inadequate for precision pointing. We studied mid-air pointing techniques that can be combined with other, domain-specific interactions. We explored the limits of existing single-mode remote pointing techniques and demonstrated theoretically that they do not support high-precision pointing on ultra-walls. We then explored solutions to improve mid-air pointing efficiency: a tunable acceleration function and a framework for dual-precision (DP) techniques, both with precise tuning guidelines.

- WallTweet: A Knowledge Ecosystem for Supporting Situation Awareness [20]. Tweets are an important source of information during large-scale events, like tornados or terrorist attacks. Yet, tweets are hard to visualize and put in a geographical context: large quantities of tweets get sent in a short period, that vary greatly in content and relevance with respect to the crisis at hand. WallTweet is a tweet visualization designed for wall displays and aimed at improving the situation awareness of users monitoring a crisis event utilizing tweets.

- The monitoring of road trafic data on wall-sized displays [15]. Road traffic is a complex system that can be very unstable. A little perturbation can lead to a traffic-crippling congestion. To avoid such situations, researchers attempt to model traffic in order to prevent congestions and optimize traffic flow. Traffic is also continually monitored by operators in traffic control rooms. We designed an interactive system to monitor traffic on a wall display, that is coupled to traffic modeling algorithms. The system enables users to interactively adjust traffic parameter settings and visualize the impact of these adjustments at both a local and global scale.

8. Partnerships and Cooperations

8.1. Regional Initiatives

ScaleGest. Surface Gestures for Advanced Graphical Interfaces: Which Gesture for What. (2014-2017) Funded by Digiteo. In collaboration with Telecom ParisTech: **109Keuros**. Participants: Caroline Appert (PI), Rafael Morales Gonzalez, Emmanuel Pietriga.

The project aims at designing gesture-based interaction for expert users who navigate and manipulate large datasets. In the context of advanced graphical applications, the number of gestures should be large-enough to cover the set of controls (*i.e.*, commands and parameter settings) but remain simple-enough to avoid exceeding human abilities. Making gesture-based interaction scale with graphical applications' growing complexity can be achieved only by understanding the foundational aspects of this input modality. This project is about characterizing and structuring both the space of application controls and the space of surface gestures in order to establish guidelines for appropriate control-gesture mappings. It is also about the definition of a sound and systematic evaluation methodology that will serve as a reference benchmark for evaluating these mappings. The resulting control-gesture mappings are demonstrated in the specific application domains of cartography and astronomy.

8.2. National Initiatives

8.2.1. ANR

MapMuxing - Multi-dimensional Map Multiplexing. (2014-2018) Funded by the French National Research Agency (ANR). In collaboration with IGN (Institut National de l'Information Géographique et Forestière): **208Keuros**/499Keuros. Participants: Emmanuel Pietriga (PI), Caroline Appert, Olivier Chapuis, María-Jesús Lobo. http://mapmuxing.ign.fr

The project explores novel ways of combining different maps and data layers into a single cartographic representation, and investigates novel interaction techniques for navigating in it. The project aims at going beyond the traditional pan & zoom and overview+detail interface schemes, and at designing and evaluating novel cartographic visualizations that rely on high-quality generalization, *i.e.*, the simplification of geographic data to make it legible at a given map scale, and symbol specification.

8.2.2. Collaborations with other French Research Organizations

CorTextViz. (2015-2016) Funded by INRA (Institut National de la Recherche Agronomique). In collaboration with project-team Aviz at Inria Saclay (Jean-Daniel Fekete) and INRA (Jean-Philippe Cointet, Guy Riba). Interactive visualization of medium-scale multi-level networks, supporting data storytelling on wall displays. Participants: Emmanuel Pietriga (PI), André Spritzer.

8.3. European Initiatives

8.3.1. Collaborations with Major European Organizations

European Southern Obseervatory (ESO)

ALMA Operations Monitoring and Control - design and implementation of state-of-the-art interactive visualization components for the operations monitoring and control software that runs the ALMA radio-observatory in Chile.

Deutsches Elektronen-Synchrotron (DESY)

Scientific consulting on the design and implementation of user interfaces for array operations monitoring and control for the Cherenkov Telescope Array (CTA) project, to be built in the Canary Islands (Spain) and in the Atacama desert (Chile).

8.4. International Initiatives

8.4.1. Inria International Labs

Inria Chile / CIRIC. Since 2012, Emmanuel Pietriga is the scientific leader of the Massive Data team at Inria Chile, working on projects in collaboration with the ALMA radio-telescope and the Millenium Institute of Astrophysics.

8.4.2. Inria International Partners

8.4.2.1. Informal International Partners

Japan Advanced Institute of Science and Technology (JAIST): René Vestergaard on the interactive visualization of complex networks in molecular biology.

Microsoft Research: Nathalie Henry Riche and Bongshin Lee on defining the value of interaction on complex visualization systems. Participants: Anastasia Bezerianos.

Northwestern University: Steven Franconeri and Steve Haroz on understanding the impact of animations on interactive visual exploration. Participants: Anastasia Bezerianos.

University of Konstanz: Daniel Keim and Johannes Fuchs on mapping out the design space for visualization glyphs. Participants: Anastasia Bezerianos.

Universidad Carlos III de Madrid: Teresa Onorati and Paloma Diaz on the visualization of tweet feeds related to crisis events using a wall display, so as to help crisis monitoring and management. Participants: Anastasia Bezerianos, Emmanuel Pietriga.

8.4.3. Participation In other International Programs

Program MIT-France, Hae-Jin Song, summer 2015 (3-month senior student internship).

8.5. International Research Visitors

Steve Feiner, Professor of Computer Science, head of the Computer Graphics and User Interfaces Lab at Columbia University (March 2015).

Deb Agarwal and David Brown, LBNL Computational Research Division, University of California at Berkeley (June 2015).

9. Dissemination

9.1. Promoting Scientific Activities

9.1.1. Scientific events selection

9.1.1.1. Chair of conference program committees

- CHI 2015, 33rd ACM SIGCHI Conference on Human Factors in Computing Systems: Caroline Appert (SC - subcommittee chair)

9.1.1.2. Member of the conference program committees

- CHI 2015, 33rd ACM SIGCHI Conference on Human Factors in Computing Systems: Anastasia Bezerianos, Emmanuel Pietriga (AC - associate chairs)
- VL/HCC 2015, 32nd IEEE Symposium on Visual Languages and Human-Centric Computing: Emmanuel Pietriga
- InfoVis 2015, IEEE Information Visualization Conference: Anastasia Bezerianos (AC - associate chair)
- Mobile HCI 2015, 17th ACM SIGCHI International Conference on Human-Computer Interaction with Mobile Devices and Services: Caroline Appert (AC - associate chair)
- DocEng 2015, 15th ACM SIGWEB International Symposium on Document Engineering: Emmanuel Pietriga
- MobiSys 2015 – Future Mobile User Interfaces workshop, 13th ACM SIGCHI International Conference on Mobile Systems, Applications, and Services: Caroline Appert
- VOILA @ ISWC 2015, Visualizations and User Interfaces for Ontologies and Linked Data, workshop co-located with ISWC 2015: Emmanuel Pietriga

- IHM 2015 – Conference of the Association Francophone d'Interaction Homme-Machine: Olivier Chapuis (AC - associate chair)

9.1.1.3. Reviewer

- ACM CHI, Conference on Human Factors in Computing Systems: Olivier Chapuis
- ACM UIST, Symposium on User Interface Software and Technology: Caroline Appert, Anastasia Bezerianos, Olivier Chapuis, Emmanuel Pietriga
- ACM ITS, International Conference on Interactive Tabletops and Surfaces: Caroline Appert, Anastasia Bezerianos, Olivier Chapuis
- ACM Mobile HCI, International Conference on Human-Computer Interaction with Mobile Devices and Services: Anastasia Bezerianos
- ACM UbiComp, International Joint Conference on Pervasive and Ubiquitous Computing: Anastasia Bezerianos
- IEEE InfoVis, Information Visualization Conference: Emmanuel Pietriga
- IEEE Virtual Reality: Olivier Chapuis
- GI, International conference on Graphics, Visualization and Human-Computer Interaction: Anastasia Bezerianos
- IHM, Conférence Francophone sur l'interaction Homme-Machine: Caroline Appert

9.1.2. Journal

9.1.2.1. Member of the editorial boards

- Semantic Web Journal: Emmanuel Pietriga (guest editor, special issue on Visual Exploration and Analysis of Linked Data)

9.1.2.2. Reviewer - Reviewing activities

- ACM ToCHI, Transactions on Computer-Human Interaction: Caroline Appert, Olivier Chapuis, Emmanuel Pietriga
- IEEE TVCG, Transactions on Visualization and Computer Graphics: Anastasia Bezerianos, Emmanuel Pietriga
- IWC, Interacting with Computers: Emmanuel Pietriga
- IJHCS International Journal of Human-Computer Studies: Olivier Chapuis
- IEEE CG&A, Computer Graphics and Applications: Anastasia Bezerianos

9.1.3. Invited talks

- Emmanuel Pietriga, Advances in Human-Computer Interaction for Operations Monitoring and Control and Exploratory Data Analysis, III Taller Astroingeniería, November 2015, Santiago de Chile
- Emmanuel Pietriga, Interactive, collaborative visualization of large datasets on ultra-high-resolution wall-sized displays, March 2015, Viseo, Grenoble, France

9.1.4. Scientific expertise

- Evaluator for European Commission's H2020 Programme Future and Emerging Technologies Open Scheme RIA: Emmanuel Pietriga
- Evaluation Committee member for the appel générique, ANR (French National Research Agency), CES Contenus, connaissances, interactions: Caroline Appert
- Referee for the appel générique, ANR (French National Research Agency): Emmanuel Pietriga

9.1.5. Research administration

Hiring committees

- Univ. Paris-Sud hiring committee, Commission Consultative des Spécialistes de l'Université 27ème section (computer science), members: Caroline Appert.
- Univ. Paris-Sud hiring committee, Comités de Sélection 27ème section (computer science), members: Caroline Appert, Anastasia Bezerianos.

9.2. Teaching - Supervision - Juries

9.2.1. Teaching

Master: Caroline Appert, Design Project in HCI, 25h TD, M1 HCID, Univ. Paris-Sud

Master: Caroline Appert, Evaluation of Interactive Systems, 48h CM, M1 HCID, Univ. Paris-Sud

Master: Caroline Appert, Evaluation of Interactive Systems – Intro, 21h CM, M1 HCID + M2R Interaction, Univ. Paris-Sud

Master: Caroline Appert, Programming Interactive Systems, 3h CM, M1 HCID + M2R Interaction, Univ. Paris-Sud

Master: Anastasia Bezerianos, Mixed Reality and Tangible Interaction, 11h CM, M2R Interaction + M1 HCID + M2 HCID, Univ. Paris-Sud.

Master: María-Jesús Lobo, Programming Project, 11h, M1 HCID, Univ. Paris-Sud.

Master: Emmanuel Pietriga, Data Visualization, 24h CM, M2 Informatique Décisionelle, Univ. Paris-Dauphine.

Licence: Bruno Fruchard, Initiation à la Programmation Orientée Objet (Java) - 13h - Télécom Paristech.

Licence: Bruno Fruchard, Paradigmes de programmation - 3h - Télécom Paristech.

Licence: María-Jesús Lobo, Informatique Graphique, 28h, L3 Univ. Paris-Sud

Licence: María-Jesús Lobo, Programmation d'Interfaces Interactives avancées, 29h, L3 Univ. Paris-Sud

Licence: Arnaud Prouzeau, Interaction Homme-Machine - 12h - Polytech Paris-Sud.

Licence: Arnaud Prouzeau, Projet de Programmation Concurrentielle et Interfaces Interactives - 25h - L3 Université Paris-Sud.

Licence: Olivier Chapuis, Interaction Homme-Machine - 12h - Polytech Paris-Sud.

9.2.2. Supervision

PhD : Can Liu, Embodied Interaction for Data Manipulation Tasks on a Wall-Sized Display, Université Paris-Sud, Dec 17th, 2015: Advisors: Olivier Chapuis, Michel Beaudouin-Lafon, Eric Lecolinet

PhD in progress : María-Jesús Lobo, Interaction Techniques for Map Multiplexing, since October 2014, Advisors: Caroline Appert, Emmanuel Pietriga

PhD in progress : Rafael Morales Gonzalez, Surface Gestures for Advanced Graphical Interfaces: Which Gesture for What, November 2014, Advisors: Caroline Appert, Gilles Bailly, Emmanuel Pietriga

PhD in progress : Arnaud Prouzeau, Collaboration around Wall-Displays in Time Critical and Command and Control Contexts, since October 2014, Advisors: Anastasia Bezerianos, Olivier Chapuis

PhD in progress : Evanthia Dimara, Merging Interactive Visualization and Automated Analysis for Group Decision-Making Involving Large Datasets, October 2014, Advisors: Pierre Dragicevic, Anastasia Bezerianos

PhD in progress : Bruno Fruchard, Techniques d'interaction exploitant la mémoire spatiale pour faciliter l'accès rapide aux commandes et aux données, October 2015, Advisors: Eric Lecolinet, Olivier Chapuis

9.3. Popularization

- Publication in Bits de Ciencia about our research and development actitivites on wall-sized displays [18].

- *Antenna Dance at ALMA* movie, in collaboration with Denis Barkats (ALMA). http://almaobservatory.org/en/press-room/announcements-events/790-antenna-dance-at-alma

10. Bibliography

Major publications by the team in recent years

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[2] A. BEZERIANOS, P. ISENBERG. *Perception of Visual Variables on Tiled Wall-Sized Displays for Information Visualization Applications*, in "IEEE Transactions on Visualization and Computer Graphics", 2012, vol. 18, n° 12, pp. 2516-2525, https://hal.inria.fr/hal-00719203

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[5] M. NANCEL, E. PIETRIGA, O. CHAPUIS, M. BEAUDOUIN-LAFON. *Mid-air Pointing on Ultra-Walls*, in "ACM Transactions on Computer-Human Interaction", August 2015, vol. 22, n° 5, pp. 21:1–21:62 [*DOI : 10.1145/2766448*], https://hal.inria.fr/hal-01184544

[6] M. NANCEL, J. WAGNER, E. PIETRIGA, O. CHAPUIS, W. MACKAY. *Mid-air Pan-and-Zoom on Wall-sized Displays*, in "CHI '11: Proceedings of the SIGCHI Conference on Human Factors and Computing Systems", Vancouver, Canada, May 2011, pp. 177–186 [*DOI : 10.1145/1978942.1978969*], https://hal.archives-ouvertes.fr/hal-00559171

[7] H. OLAFSDOTTIR, C. APPERT. *Multi-Touch Gestures for Discrete and Continuous Control*, in "International Working Conference on Advanced Visual Interfaces (AVI)", Como, Italy, May 2014, 8 p. [*DOI : 10.1145/2598153.2598169*], https://hal.archives-ouvertes.fr/hal-00998971

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Publications of the year

Articles in International Peer-Reviewed Journals

[11] C. APPERT, O. CHAPUIS, E. PIETRIGA, M. LOBO. *Reciprocal Drag-and-Drop*, in "ACM Transactions on Computer-Human Interaction", September 2015, vol. 22, n[o] 6, pp. 29:1–29:36 [*DOI :* 10.1145/2785670], https://hal.archives-ouvertes.fr/hal-01185805

[12] N. BOUKHELIFA, A. BEZERIANOS, W. CANCINO, E. LUTTON. *Evolutionary Visual Exploration: Evaluation of an IEC Framework for Guided Visual Search*, in "Evolutionary Computation", 2016, forthcoming [*DOI :* 10.1162/EVCO_a_00161], https://hal.inria.fr/hal-01218959

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International Conferences with Proceedings

[14] M.-J. LOBO, E. PIETRIGA, C. APPERT. *An Evaluation of Interactive Map Comparison Techniques*, in "CHI '15 Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems", Seoul, South Korea, ACM, April 2015, pp. 3573-3582 [*DOI :* 10.1145/2702123.2702130], https://hal.inria.fr/hal-01144163

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[17] N. BOUKHELIFA, A. BEZERIANOS, E. LUTTON. *A Mixed Approach for the Evaluation of a Guided Exploratory Visualization System*, in "EuroVis Workshop on Reproducibility, Verification and Validation in Visualization (EuroRV[3])", Cagliari, Italy, May 2015, https://hal.inria.fr/hal-01153887

Scientific Popularization

[18] M. LOBO, E. PIETRIGA, C. PUECH. *Visualización de Big Data en Alta Resolución a Disposición de la Comunidad Científica y la Industria Chilena*, January 2015, 6 p. , Big data, https://hal.inria.fr/hal-01134134

Other Publications

[19] P. GOFFIN, W. WILLETT, A. BEZERIANOS, P. ISENBERG. *Exploring the Effect of Word-Scale Visualizations on Reading Behavior*, ACM, 2015, Extended Abstracts of the Conference on Human Factors in Computing Systems (CHI), Poster [*DOI :* 10.1145/2702613.2732778], https://hal.inria.fr/hal-01127995

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