Visual interfaces that aim to ease the exploration of large datasets are becoming pervasive in digital media. Not only do we find a wealth of visual metaphors such as network graphs, timelines, maps and so forth for presenting the data in an effective way, we also are at an era where progress in physical technologies makes it possible to use various technologies such as small touch devices, tablets, interactive wall displays, motion capture and so forth for the display and manipulation of such interactive systems. My research vision is to help users of interactive visual interfaces effectively explore data and communicate information. I do so by providing appropriate visual data representations coupled with natural and rich interaction. Through the combination of visual metaphors and powerful interactive capabilities, my goal is to empower users to communicate their insights and make sense of new information they are looking at. My research lies at the intersection of Human-Computer Interaction (HCI), Information Visualization and Design. I specifically focus on interfaces for data exploration and knowledge discovery.

Information visualization exploits the bandwidth of human vision and makes it possible to relieve cognitive resources through the use of external graphical space as a support for thinking. Research in this area is increasingly bridging with HCI to allow rapid manipulation and rearrangement of data in highly interactive visualizations. In particular, when the user has only vague or no hypotheses about the data, **visual exploration**—the process of *interactively* browsing through different portions of the data to gain a better understanding of it—becomes essential for knowledge discovery.

Much of my postdoctoral research has involved the design of interactive visualization interfaces with an implicit aim to encourage and facilitate visual exploration in a direct and engaging way. My work has explored visual interfaces that rely on direct manipulation principles [19] - the use of interactions that are analogous to interaction with tangible objects to make it easier for users to learn and manipulate the interface while keeping the focus on the data. More specifically, I focus on: 1) the use of smooth animated transitions to help keep track of changes when they occur within the visualization and 2) the exploration of new tangible interactions for manipulating graphical user interfaces.

Here, I summarize a subset of my projects that best illustrate my research approach. As a logical follow up of my PhD work focusing on the comparison of network graphs [2,3,5], I developed visualization and interaction techniques to facilitate the exploration of large networks such as co-authorship, or air traffic networks. Bring'n Go and Link Sliding [11] are interaction techniques that we designed to help users navigate such large network graphs. Our techniques exploit topology information of the networks to ease the navigation. All the interaction is performed directly on the visualization so that one can easily explore the neighborhood of actors in the network without disrupting the flow of the exploration. In the same vein, GraphDice [1] is a system for visualizing multivariate social networks that we developed for historians and sociologists who are not experts in information visualization. I have also been interested in the manipulation of temporal data. Kronominer [13] and ChronoLenses [14] are powerful interactive visual interfaces that we implemented for the exploration of time-series data in a fluid and generic manner. The popular blog Information Aesthetics [21] mentioned ChronoLenses as being one of the most interesting papers presented at the IEEE InfoVis conference.

An important goal of my design work has been to create interfaces that are both powerful, supporting complex user tasks, and fluid, promoting opportunistic exploration. All the applications that I presented above embed novel interaction techniques for quick manipulation that do not depend on the use of dialogs and menus, which often disrupt the flow of data exploration. Yet, empowering a user interface with natural and consistent mappings between actions on visual objects and their effects does not always ensure a constant visual flow of information. To address this problem, a large body of my work has focused on how smooth animations can help users better assess the impact of their actions on the visualization, and keep track of changes within the view. More specifically, we designed and evaluated animation techniques for document visualization with Diffamation [6], a tool that relies on smooth text animation to help the user navigate through document histories. We found that smooth text animation allows users to track changes in the evolution of textual documents more effectively than flipping pages. Gliimpse [8] is another technique that provides smooth, continuous



GraphDice [1] is an interactive interface for exploring multivariate social networks.



Kronominer [13] is a generic interface for the visual exploration of time-series data.



Diffamation [6] uses text animated transitions to navigate in document histories

Research Statement



The force-feedback double sliders [17] is a novel physical input device for multimodal data exploration



Bi-brush [16] is a technique allowing users to sketch on interactive displays using a small touch device as a reconfigurable paintbrush



iChase [12] is an interactive visualization tool we designed with Wikipedia administrators for activity monitoring on Wikipedia



Described as a combination of Tetris, Yoga and Twitter,Tweetris [9,18] is a two-player game based on whole body interaction.

transitions from the source code of a document in a markup language, such as HTML and LaTeX, to the rendered PDF document. Here again, we found that smooth animated transitions can effectively convey changes within the view without distracting users from their primary task.

While the above work has focused on graphical interfaces, my recent work has moved to the examination of tangible user interfaces, with the force-feedback double slider [17], Bi-brush [16] and Tweetris [9,18]. The force-feedback double slider [17] is a novel physical input device for data-visualization applications. We have augmented sliders with a haptic channel for the manipulation and sensing of visualized data. Our goal is to assess the capabilities of this device as an alternative to the mouse to explore data analysis interactions and applications. With Bi-brush [16], I explored how small touch devices such as mobile phones can be repurposed for art composition: the small touch device is turned into a reconfigurable digital brush that can be used to paint on interactive surfaces. Bi-brush enables a rich painting process with dynamic brush parameters controlled both by the built-in sensors and the touch display of the tangible device. This work, designed with and tested by digital painting experts from OCAD University, targets an audience of artists. Yet, the research methodology that we followed for this project falls into a human-centric scientific approach commonly used in HCI. For example, we conducted brainstorm and participatory-design sessions with end-users to better understand their needs and constraints.

In order to design digital interfaces and new technologies that best support the needs of specific target user groups, it is imperative to identify the requirements, expectations and constraints of these potential users upfront. It is also important to maintain regular contact with the users during the design and implementation process. Through regular consultations, prototypes can be developed and refined during the lifecycle of a design project. Therefore, I strive to involve end-users at the early stages of a project through a series of participatory design sessions and design-focused ethnographic inquiries. Throughout this iterative design process, I collect feedback from users, derive task taxonomies and design rationales that serve as guidelines for the implementation of prototypes. During the design sessions, I give users a chance to try out our current prototypes and collect their feedback on the strengths and flaws of the proposed solution at different stages of the development. By following this process I can ensure the continuous improvement of our interactive interfaces and tangible devices, and also observe and understand users' experiences, behaviours, and expectations. iChase [12] and WikipediaViz [7] are typical examples of interactive tools that we designed in close collaboration with Wikipedia users. Such user-centered approaches can highly benefit art and design practices in the development and evaluation of new interactive interfaces that effectively satisfy the needs of users.

Although I highly value domain experts' feedback to inform the design of user interfaces, I pay close attention not to fall into the pitfalls of user-driven design in that I do not blindly rely on methods, guestions and metaphors that simply recapitulate existing knowledge [21]. Since my arrival at OCAD University. I have enjoyed a close collaboration with artists and designers, I have been able to extend my research methodologies and began to exploit artistic projects as a means to explore tangible interfaces in a more ecological and creative way. Indeed, I took active part in the design and implementation of Tweetris [9,18]. Described as a combination of Tetris, yoga and Twitter, Tweetris is a Kinect-based two player game based on whole-body interaction. Tweetris is an art project resulting from a common effort of researchers at DFI, computer scientists at the University of Toronto (UofT) and an independent artist. We exhibited the game at several venues including the last Nuit Blanche event in Toronto and the Art Exploration exhibit at the Tangible Embedded and Embodied Interaction conference (TEI). We took the opportunity to collect quantitative data while attendees were playing. As an art installation, the setting of Tweetris differed from a traditional laboratory experimental study, encouraging everyone to play and behave freely without introducing the potential bias of participating to a research study. In this way, we ensured the ethnographical validity of the quantitative data collected during the game. The analysis of these data will provide design guidelines for wholebody interfaces [18]. I am convinced that the examination of users' behaviour while they interact with artistic installations will be of a great value for both the HCI and designers communities. Therefore, I see my collaboration with artists and designers to be highly beneficial for opening up new questions and introducing new mixed methods to research in these fields.

Research Statement



Money Tree [10] uses the metaphor of growing trees to compare positive, welldiscussed banks (big lively green trees) to negative, least discussed banks (small dark trees) and vice versa.



Cell chamber [15] is an exploratory sketch for the navigation of news media, that builds upon Foucault's *Discursive Formations*.

Besides its strong influence on my research methodology, working with designers and artists has also been highly informative and productive during the creative process of designing new interaction and visualization techniques. Focusing on usability, researchers in Information Visualization and HCI often rely on well-known rules to inform the design of visual interfaces and give less attention to artistic qualities of a design product, such as imagination, inspiration from social trends, and aesthetics. My collaboration with graphic designers and professional artists has helped me deepen my creativity with metaphors of a more artistic, more aesthetic point of view that aims to engage user affect. My experience has shown that if we combine the traditional approach of incremental research with methodologies, models and modeling practices from art and design, we can often produce novel research hypotheses that lead to new ideas and innovation. Several examples of my previous work have taken this direction. For example, I have studied how work practices of computer scientists, artists and designers relate in the context of HCI and Information Visualization [4,15]. I have also worked on a new methodology for designing interactive interfaces to visualize sentiments in business-customer relations using artistic metaphors [10].

One of the main goals of my work is to increase the role of interactive systems in the professional and day-to-day life of people by encouraging and facilitating user engagement. I try to design interfaces and input devices that are easy to learn and pleasant to use, improving the data exploration process and facilitating the communication of insights. I will continue exploring how direct manipulation through digital and tangible controls, smooth animated transition, graphic design and metaphors could best improve user experience when users interact with digital media.

I will especially concentrate on the following directions:

Tangible techniques and devices for navigation to provide insights and eventually guidelines for eye-free and whole-body interaction. Such guidelines will instruct the design of effective forms of user interaction based on tangible input.

Graphic Design to improve visual communication and presentation capabilities of interfaces, making them (i) more compelling, and thereby more pleasant to use, and (ii) more effective for communicating insights to others.

Interaction techniques for quick manipulation that replace traditional dialogs and menus with two main goals: (i) to support the tasks of users without disturbing the flow of their explorations; and (ii) to reduce the learning process by reinforcing natural and consistent mappings between input actions and their associated effects on the graphical representation of objects.

Smooth animations while transitioning between different view states to ensure a constant visual flow of information that does not distract users from their primary task and helps them keep track of the changes.

Finally, I plan to further my theoretical research within the Centre of Innovation for Information Visualization and Data-Driven Design. I plan to leverage the expertise of design researchers to adapt and reinvent participatory-design strategies in Human-Computer Interaction and Information Visualization. In this project, I am particularly interested in exploring alternative ways of incorporating design techniques including the *charrette*, personas, design sketching and scenario modeling, as well as dramaturgical creative techniques in my methodology.

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