
Interaction Design & Prototyping for Immersive Analytics

Benjamin Bach

University of Edinburgh
Edinburgh, Scotland
bbach@inf.ed.ac.uk

Maxime Cordeil

Monash University
Melbourne, VIC, Australia
max.cordeil@monash.edu

Ulrich Engelke

CSIRO Data61
Perth, WA, Australia
ulrich.engelke@data61.csiro.au

Barrett Ens

Monash University
Melbourne, VIC, Australia
barrett.ens@monash.edu

Marcos Serrano

IRIT - University of Toulouse
Toulouse, France
marcos.serrano@irit.fr

Wesley Willett

University of Calgary
Calgary, AB, Canada
wesley.willett@ucalgary.ca

ABSTRACT

Immersive Analytics is concerned with the design and evaluation of interactive next-generation interfaces that support human understanding, data analysis, and decision making. New immersive technologies present many opportunities for enhancing humans' experiences with data interaction, but also present many challenges, a subset of which are specific to the analytics domain. This workshop is centered around a set of group prototyping sessions, aimed at identifying new approaches to existing design challenges. In addition to giving perspective on opportunities and difficulties faced by future

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designers, these exercises will also explore new prototyping methods and tools for the design of interactive data-centric interfaces. This part-day workshop aims to build new ties between the existing immersive analytics community with researchers across many disciplines of the CHI community.

CCS CONCEPTS

• **Human-centered computing** → **Interaction techniques; Interface design prototyping; Visualization systems and tools;**

KEYWORDS

Immersive Analytics; Situated Analytics; Spatial Interactions; Augmented Reality; Virtual Reality; Data Visualization

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INTRODUCTION AND BACKGROUND

Immersive Analytics [4] is a developing field concerned with supporting human-in-the-loop data exploration, understanding, and analytic reasoning using immersive and spatially-oriented technologies including virtual-, augmented-, and mixed-reality (VR/AR/MR) devices. There are many instances where interactive exploration is an essential component of the analytic pipeline [10]. However, researchers have only recently begun to design and evaluate interactive data analysis tools for these new immersive platforms. One key barrier to immersive interface design is the scarcity and limited refinement of prototyping tools to help accelerate the design process. Nonetheless, these technologies open new possibilities previously unforeseen with traditional desktop and multitouch platforms, and the recent commercialization of AR and VR technologies provides an opportune time to investigate the benefits of their application to analytic reasoning problems.

This **part-day workshop** will continue efforts from previous workshops that focused on immersive analytics in general, including at ACM ITS 2016 [2] and IEEE VIS 2017 [1], as well as a Dagstuhl seminar (2016) and a NII Shonan seminar (2015). These workshops have successfully brought together a diverse community with a range of technical and analytic expertise. These researchers have taken various approaches to building and evaluating systems, including theoretical frameworks [3, 13] (Figure 1), tools for scientific visualization [5] (Figure 2), in-situ interface design [6, 8], toolkits for visualization design [12] (Figure 3), and exploration of various input modalities [7, 11] (Figure 4).

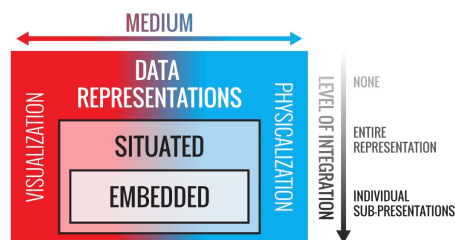


Figure 1: A framework for data representations in immersive analytics [13].

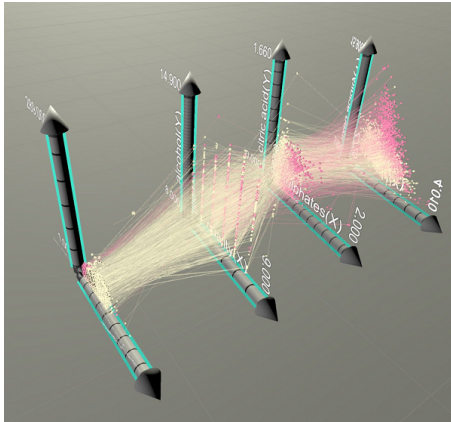


Figure 2: A parallel coordinates scatterplot created with ImAxes [5].

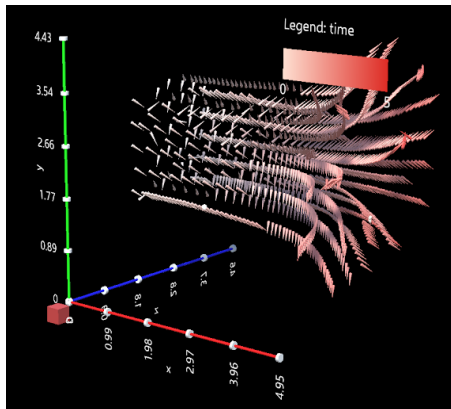


Figure 3: An example of a streamline visualization, created with the DXR toolkit [12].

Unlike the previous gatherings, this workshop will **focus on design and interaction challenges for immersive analytics** that are relevant to the CHI community. Immersive analytic systems involve new environments and technologies for which standard interaction methods and prototyping strategies have not yet evolved. For instance, analytic support for in-situ applications involves new design considerations such as social acceptability, privacy, cognitive load, and worker safety which emerge when placing visualizations into unpredictable real-world environments. Moreover, the support of interactive analytic tools raises issues not commonly addressed in prior work on immersive or 3D interaction design, for instance the need for precision required to isolate and select a tiny point or an irregular subset of points in a 3D scatterplot, to limit fatigue over long and complex sequences of actions, or to explore real-time data in the physical context of its real-world referent. Meanwhile tools and methods for creating storyboards and low-fidelity prototypes, which are commonly employed when designing for other platforms, are virtually non-existent for immersive systems. CHI is the optimal venue to explore these challenges as we aim to bring together researchers from a wide cross-section of areas, including design methods, data visualization, interaction techniques, user experience, human factors, and ubiquitous computing.

This workshop aims to further grow the community and address the above challenges by actively engaging participants in prototyping exercises that explore new interaction possibilities for immersive analytics systems. These sessions will give participants a chance to explore a range of design and prototyping methods together. Moreover, these prototyping exercises will facilitate productive discussions regarding interaction challenges for immersive analytics as well as new prototyping methods for immersive systems.

Workshop Goals and Topics

In this workshop, we will explore new approaches for designing interactions for data-driven mixed reality applications (including both AR and VR) and improving their accessibility and usability. To that end, the workshop follows four main goals: (i) community building, (ii) gaining design insights, (iii) forging new perspectives, and (iv) creating a research agenda.

Community building: Building effective systems for interactive immersive analysis requires expertise from a variety of fields, including interaction design and prototyping, data visualization, tangible interfaces, and data physicalization, on-body, wearables, etc. Moreover, the spatial nature of most immersive systems suggests fruitful intersections with research in ubiquitous and pervasive computing. We believe that immersive interface technology poses exciting and novel challenges for each of these areas as well as their intersections. Consequently, this workshop will serve as a platform to exchange knowledge and design methodologies, tighten existing connections between the different communities at CHI as well as create new ties. To foster such collaboration, workshop participants will form into interdisciplinary groups and work together to brainstorm and prototype

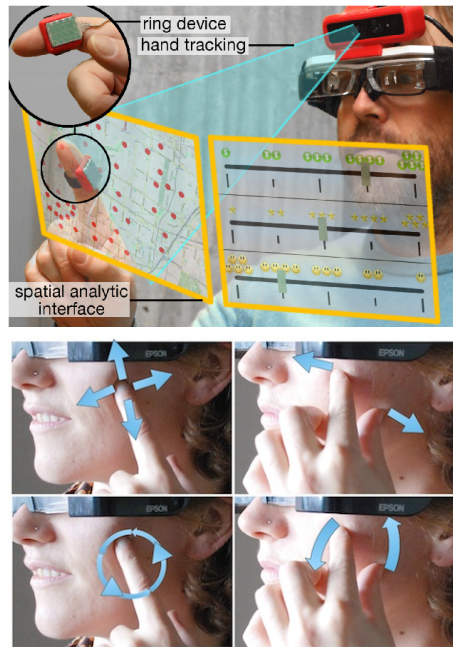


Figure 4: Interaction for immersive analytics includes strategies such as using a ring device to reduce fatigue [7] or using hand-to-face input to improve social acceptance [11].

new immersive tools and interactions. These sessions will (i) create opportunities for collaboration and cross-pollination between participants from different communities including data visualization and interaction design, and (ii) encourage grounded ideation that may lead to better prototyping approaches and tools for designing new immersive interaction techniques.

Gaining Design Insights: A primary goal of this workshop is to shed light on new ways to tackle the specific challenges of data-centric immersive interaction and interface design. We aim to achieve this through a prototyping exercise, which will help to elicit new approaches and build a library of design and prototyping tools for this specific class of systems. Potential challenges that will be addressed include designing for AR environments [3], interaction with holograms, providing multimodal experiences [9, 11], supporting collaboration, etc. The specific challenges to address will be identified in a group discussion prior to the prototyping session.

To help encourage rapid iteration during the workshop, we will provide materials for and encourage a variety of low-fidelity prototyping methods including storyboarding and sketching, bodystorming, video prototyping, physical prototyping, and Wizard-of-Oz. We will also encourage some groups to explore prototyping using general-purpose digital tools, including VR sketching applications like Google Tilt Brush, Leap Motion Scaffolding, or mobile AR drawing tools like World Brush. In addition, we will organize a pre-workshop discussion to identify additional tools that may be used in the prototyping session, including those contributed by workshop participants.

Forging new Perspectives: Through actively solving challenges and designing (novel) interactive visualization methods, we aim to discover new insights on design approaches for immersive analytics and on the design process itself. We will gather such insights through reflection sessions and discussion near the end of the workshop. These will bring together knowledge and observations from members of different communities and provide an opportunity to surface new ideas and opportunities that emerged during the prototyping sessions.

Creating a Research Agenda From the insights and perspectives gained during these sessions, we will compile an agenda for future research. With the new relationships built during the workshop, we envision that these takeaways will ultimately lead to one or more follow-up publications on methods for designing and prototyping in immersive environments. As a concrete first step, we will record and document all of the activities and steps during the workshop, allowing us to prepare an extended documentation and follow-up publication. This will be supplemented by notes from our closing session, which will include a cross-disciplinary discussion to produce a list of the items not yet addressed by the workshop activities, and identify the key challenges that lay ahead.

ORGANIZERS

Our workshop organizing team brings expertise in data visualization, immersive analytics, interaction design, and interface prototyping. Several members of the organizing team (Bach, Cordeil, Willett)

have previously organized workshops on related topics, including immersive analytics workshops at IEEE VIS and ISS. All members of the organizing team are active members of the visualization and HCI research communities with considerable experience reviewing for conferences and workshops.

Benjamin Bach is an Assistant Professor at the University of Edinburgh within the Design Informatics group. He was a co-organizer of the ACM ISS and IEEE VIS Workshops and a participant at the Dagstuhl seminar on Immersive Analytics. His research interests include interactive visualizations for 2D and 3D data, visual storytelling, and immersive analytics.

Maxime Cordeil is a Research Fellow at Monash University (Australia) working in the Immersive Analytics group. Maxime was a co-organizer of the IEEE VIS 17 Workshop on Immersive Analytics. His research addresses and explores information visualization and visual analytics in virtual and augmented reality.

Ulrich Engelke is a Senior Scientist in Decision Sciences at the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Perth, Australia. He is co-founder and steering committee member of the International Symposium on Big Data Visual and Immersive Analytics (BDVA). His research is concerned with human factors in visual and immersive analytics of complex data.

Barrett Ens is a Lecturer at Monash University in Melbourne in the Immersive Analytics research group, and was a participant of the Dagstuhl seminar on Immersive Analytics. His research overlaps HCI with next-generation technologies, such as augmented reality, the internet of things and wearable computing, to support data exploration and understanding. Interests include novel interaction methods for augmented reality, and in-situ data visualization for nomadic workers.

Marcos Serrano is an Assistant Professor within the ELIPSE group, at the IRIT Lab, University of Toulouse, France. His research is dedicated to designing novel interaction techniques in the field of mobile and ubiquitous computing. His most recent projects cover interaction with head-mounted displays, wearable devices and freeform interfaces.

Wesley Willett is an assistant professor of Computer Science at the University of Calgary where he holds a Canada Research Chair in Visual Analytics. His interests span information visualization, social computing, new media, and human-computer interaction, and his research focuses on pairing data and interactivity to support collaboration, learning, and discovery.

PRE-WORKSHOP PLANS

An international program committee including both organizers and external experts, already involved in previous workshops (<http://immersiveanalytics.net>), will review and select submissions based on their quality, originality, and fit for the workshop. The program committee will endeavor to build a diverse pool of participants, matching expertise in data visualization and immersive analytics with experience in interaction design and VR/AR development.

2:30-2:45	Opening and host introductions	15 min
2:45-3:30	Participant lightning talks	45 min
3:30-4:00	Challenge discussion	30 min
4:00-4:45	Group prototyping session begins	45 min
4:45-5:05	Break	20 min
5:05-6:45	Prototyping session continues	100 min
6:45-7:10	In-group reflection	25 min
7:10-7:30	Break	20 min
7:30-8:10	Group presentations	40 min
8:10-8:30	Discussion, Closing, & Wrap-up	20 min

Table 1: Workshop schedule.

Before the workshop we will cultivate an initial set of core challenges for designing interactive immersive visualizations, drawing from the accepted workshop submissions. We will also use a shared forum on our workshop website (<http://immersiveanalytics.net>) to solicit additional challenges from participants and assess participants' enthusiasm for and experience with a variety of possible prototyping methods. Based on this feedback the organizers will prepare hardware, materials, instructions to support a several different physical and virtual prototyping methods. These may include materials to support video prototyping, physical prototypes, and bodystorming, as well as VR and AR tools for rapid virtual design. Where the time and technical constraints of the workshop format permit, we also hope to encourage experimentation with new experimental prototyping tools developed by participants and by members of the organizing team.

Our workshop website (<http://immersiveanalytics.net>) will provide information about the call-for-papers, the organizers, schedule, and PC members. The call for papers will be distributed through mailing lists such as CHI, InfoVis, local mailing lists, twitter, etc.

WORKSHOP STRUCTURE

Because participants may come with a variety of different backgrounds and interests, we plan to start the workshop with a series of 2-3 minute lightning talks (Table 1). Participants will briefly outline their related research and highlight one or more opportunities they wish to explore during the workshop. The talks will be followed by a discussion of the design challenges for interaction in immersive analytics. This challenge discussion will be supplemented by pre-workshop discussions, with the aim of identifying specific goals to address in the prototyping session. Participants will then break into 4-5 small groups.

The core of the workshop will consist of small group prototyping exercises (3-4 participants) in which participants will work together to prototype a set of immersive analytics interactions using common HCI prototyping methods. Following this session, groups will be asked to reflect on their designs to identify what unexpected challenges they encountered and new opportunities they found for extending their design.

After the second break, groups will present the results of their prototyping efforts and their group's reflections on the benefits and challenges of their approach. These presentations should focus on outlining further opportunities and challenges for future interaction design and prototyping tools for immersive analytics applications. Afterwards, participants will join a final discussion to synthesize observations from the workshop and identify opportunities for future collaborations.

POST-WORKSHOP PLANS

Following the workshop, we plan to summarize post workshop outcomes online alongside the set of accepted submissions. We also plan to organize a follow-up publication in an HCI journal or a

magazine article (e.g., ACM Interactions) to synthesize results from workshop. This publication will draw in particular on observations from the interactive prototyping sessions conducted during the workshop, as well as the end-of-workshop discussion. We envision this publication as a research agenda for interaction in immersive analytics, which will help outline opportunities and challenges for the prototyping, development, and evaluation of new immersive data-driven interfaces. We will engage interested workshop attendees in continued discussion and collaboration via the workshop website and, where possible, through contributions to the follow-up publications.

CALL FOR PARTICIPATION

Recent commercialisation of immersive mixed reality technologies present new possibilities to support interactive analytic reasoning, beyond the limitations of traditional desktop, mobile and touchscreen devices. However, these platforms bring challenges for designing effective interactive experiences in immersive environments.

This workshop will engage the CHI community in an effort to improve interaction design for data-centric, immersive systems. Through an engaging prototyping session, we aim to gain new insights on approaches to immersive analytics-specific design challenges and prototyping methods, to forge new perspectives on the design process and identify future challenges. We invite participants to submit 2-4 page position papers on the following topics:

- Applications or approaches for collaboration for immersive analytics
- Interaction techniques, devices and modalities for immersive analytics
- Prototyping tools and techniques for AR/VR
- In-situ interface design and situated analytics
- Best practices for spatial interaction and prototyping
- Evaluation methods for immersive systems
- Social acceptability of interaction with immersive platforms
- Human factors including awareness, distraction and cognitive load
- Theories and frameworks

Papers should be formatted in the CHI extended abstracts format and submitted via the workshop website. Accepted papers will be chosen by single-blind peer review by a program committee based on relevance to the workshop and the potential for contributing to discussions. Accepted papers will be distributed to workshop participants and a summary presented at the workshop. At least one author of each accepted position paper must attend the workshop and all participants must register for both the workshop and for at least one day of the conference. For more information see our full Call for Participation on the workshop website: <http://immersivanalytics.net>

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