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Human-Computer Interaction – INTERACT 2023

19th IFIP TC13 International Conference
York, UK, August 28 – September 1, 2023
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Foreword

INTERACT 2023 is the 19th International Conference of Technical Committee 13 (Human-Computer Interaction) of IFIP (International Federation for Information Processing). IFIP was created in 1960 under the auspices of UNESCO. The IFIP Technical Committee 13 (TC13) aims at developing the science and technology of human-computer interaction (HCI). TC13 started the series of INTERACT conferences in 1984. These conferences have been an important showcase for researchers and practitioners in the field of HCI. Situated under the open, inclusive umbrella of IFIP, INTERACT has been truly international in its spirit and has attracted researchers from several countries and cultures. The venues of the INTERACT conferences over the years bear testimony to this inclusiveness.

INTERACT 2023 was held from August 28th to September 1st 2023 at the University of York, York, United Kingdom. The INTERACT Conference is held every two years, and is one of the longest-running conferences on Human-Computer Interaction. The INTERACT 2023 Conference was held both in-person and online. It was collocated with the British Computer Society HCI 2023 Conference.

The theme of the 19th conference was "Design for Equality and Justice". Increasingly computer science as a discipline is becoming concerned about issues of justice and equality – from fake news to rights for robots, from the ethics of driverless vehicles to the Gamergate controversy. The HCI community is surely well placed to be at the leading edge of such discussions within the wider computer science community and in the dialogue between computer science and the broader society. Justice and equality are particularly important concepts both for the City of York and for the University of York. The City of York has a long history of working for justice and equality, from the Quakers and their philanthropic chocolate companies, to current initiatives. The City of York is the UK's first Human Rights City, encouraging organizations and citizens to "increasingly think about human rights, talk about human rights issues and stand up for rights whether that's at work, school or home". The City of York has also launched "One Planet York", a network of organizations working towards a more sustainable, resilient and collaborative "one planet" future. York is now working to become the first "Zero emissions" city centre, with much of the medieval centre already car free.

Finally, great research is the heart of a good conference. Like its predecessors, INTERACT 2023 aimed to bring together high-quality research. As a multidisciplinary field, HCI requires interaction and discussion among diverse people with different interests and background. We thank all the authors who chose INTERACT 2023 as the venue to publish their research.

We received a total of 375 submissions distributed in 2 peer-reviewed tracks, 4 curated tracks, and 3 juried tracks. Of these, the following contributions were accepted:

- 71 Full Papers (peer reviewed)
- 58 Short Papers (peer reviewed)
- 6 Courses (curated)

- 2 Industrial Experience papers (curated)
- 10 Interactive Demonstrations (curated)
- 44 Interactive Posters (juried)
- 2 Panels (curated)
- 16 Workshops (juried)
- 15 Doctoral Consortium (juried)

The acceptance rate for contributions received in the peer-reviewed tracks was 32% for full papers and 31% for short papers. In addition to full papers and short papers, the present proceedings feature contributions accepted in the form of industrial experiences, courses, interactive demonstrations, interactive posters, panels, invited keynote papers, and descriptions of accepted workshops. The contributions submitted to workshops were published as an independent post-proceedings volume.

The reviewing process was primary carried out by a panel of international experts organized in subcommittees. Each subcommittee had a chair and a set of associated chairs, who were in charge of coordinating a double-blind reviewing process. Each paper received at least 2 reviews of associated chairs and two reviews from external experts in the HCI field. Hereafter we list the twelve subcommittees of INTERACT 2023:

- Accessibility and assistive technologies
- Design for business and safety/critical interactive systems
- Design of interactive entertainment systems
- HCI Education and Curriculum
- HCI for Justice and Equality
- Human-AI interaction
- Information visualization
- Interaction design for culture and development
- Interactive systems technologies and engineering
- Methodologies for HCI
- Social and ubiquitous Interaction
- Understanding users and human behaviour

The final decision on acceptance or rejection of full papers was taken in a Programme Committee meeting held in London, United Kingdom in March 2023. The full papers chairs, the subcommittee chairs, and the associate chairs participated in this meeting. The meeting discussed a consistent set of criteria to deal with inevitable differences among the large number of reviewers. The final decisions on other tracks were made by the corresponding track chairs and reviewers, often after electronic meetings and discussions.

INTERACT 2023 was made possible by the persistent efforts across several months by 12 subcommittee chairs, 86 associated chairs, 28 track chairs, and 407 reviewers. We thank them all.

September 2023

José Abdelnour Nocera
Helen Petrie
Marco Winckler

IFIP TC13 – http://ifip-tc13.org/

Established in 1989, the International Federation for Information Processing Technical Committee on Human–Computer Interaction (IFIP TC13) is an international committee of 37 IFIP Member national societies and 10 Working Groups, representing specialists of the various disciplines contributing to the field of human-computer interaction (HCI). This field includes, among others, human factors, ergonomics, cognitive science, computer science and design. INTERACT is the flagship conference of IFIP TC13, staged biennially in different countries in the world. The first INTERACT conference was held in 1984, at first running triennially and becoming a biennial event in 1993.

IFIP TC13 aims to develop the science, technology and societal aspects of HCI by encouraging empirical research promoting the use of knowledge and methods from the human sciences in design and evaluation of computing technology systems; promoting better understanding of the relation between formal design methods and system usability and acceptability; developing guidelines, models and methods by which designers may provide better human-oriented computing technology systems; and, cooperating with other groups, inside and outside IFIP, to promote user-orientation and humanization in system design. Thus, TC13 seeks to improve interactions between people and computing technology, to encourage the growth of HCI research and its practice in industry and to disseminate these benefits worldwide.

The main orientation is to place the users at the centre of the development process. Areas of study include: the problems people face when interacting with computing technology; the impact of technology deployment on people in individual and organisational contexts; the determinants of utility, usability, acceptability and user experience; the appropriate allocation of tasks between computing technology and users, especially in the case of autonomous and closed-loop systems; modelling the user, their tasks and the interactive system to aid better system design; and harmonizing the computing technology to user characteristics and needs.

While the scope is thus set wide, with a tendency toward general principles rather than particular systems, it is recognised that progress will only be achieved through both general studies to advance theoretical understanding and specific studies on practical issues (e.g., interface design standards, software system resilience, documentation, training material, appropriateness of alternative interaction technologies, guidelines, the problems of integrating multimedia systems to match system needs and organisational practices, etc.).

IFIP TC13 also stimulates working events and activities through its Working Groups (WGs). The WGs consist of HCI experts from around the world, who seek to expand knowledge and find solutions to HCI issues and concerns within their domains. The list of current TC13 WGs and their area of interest is given below:

- WG 13.1 (Education in HCI and HCI Curricula) aims to improve HCI education at all levels of higher education, coordinate and unite efforts to develop HCI curricula and promote HCI teaching.

- WG 13.2 (Methodology for User-Centred System Design) aims to foster research, dissemination of information and good practice in the methodical application of HCI to software engineering.
- WG 13.3 (Human Computer Interaction, Disability and Aging) aims to make HCI designers aware of the needs of people with disabilities and older people and encourage development of information systems and tools permitting adaptation of interfaces to specific users.
- WG 13.4/WG2.7 (User Interface Engineering) investigates the nature, concepts and construction of user interfaces for software systems, using a framework for reasoning about interactive systems and an engineering model for developing user interfaces.
- WG 13.5 (Resilience, Reliability, Safety and Human Error in System Development) seeks a framework for studying human factors relating to systems failure, develops leading-edge techniques in hazard analysis and safety engineering of computer-based systems, and guides international accreditation activities for safety-critical systems.
- WG 13.6 (Human-Work Interaction Design) aims at establishing relationships between extensive empirical work-domain studies and HCI design. It will promote the use of knowledge, concepts, methods and techniques that enable user studies to procure a better apprehension of the complex interplay between individual, social and organisational contexts and thereby a better understanding of how and why people work in the ways that they do.
- WG 13.7 (Human–Computer Interaction and Visualization) aims to establish a study and research program that will combine both scientific work and practical applications in the fields of Human–Computer Interaction and Visualization. It will integrate several additional aspects of further research areas, such as scientific visualization, data mining, information design, computer graphics, cognition sciences, perception theory, or psychology into this approach.
- WG 13.8 (Interaction Design and International Development) aims to support and develop the research, practice and education capabilities of HCI in institutions and organisations based around the world taking into account their diverse local needs and cultural perspectives.
- WG 13.9 (Interaction Design and Children) aims to support practitioners, regulators and researchers to develop the study of interaction design and children across international contexts.
- WG 13.10 (Human-Centred Technology for Sustainability) aims to promote research, design, development, evaluation, and deployment of human-centred technology to encourage sustainable use of resources in various domains.

IFIP TC13 recognises contributions to HCI through both its Pioneer in HCI Award and various paper awards associated with each INTERACT conference. Since the processes to decide the various awards take place after papers are sent to the publisher for publication, the recipients of the awards are not identified in the proceedings.

The IFIP TC13 Pioneer in Human-Computer Interaction Award recognises the contributions and achievements of pioneers in HCI. An IFIP TC13 Pioneer is one who, through active participation in IFIP Technical Committees or related IFIP groups, has made outstanding contributions to the educational, theoretical, technical, commercial, or professional aspects of analysis, design, construction, evaluation, and use of interactive

systems. The IFIP TC13 Pioneer Awards are presented during an awards ceremony at each INTERACT conference.

In 1999, TC13 initiated a special IFIP Award, the Brian Shackel Award, for the most outstanding contribution in the form of a refereed paper submitted to and delivered at each INTERACT Conference, which draws attention to the need for a comprehensive human-centred approach in the design and use of information technology in which the human and social implications have been considered. The IFIP TC13 Accessibility Award, launched in 2007 by IFIP WG 13.3, recognises the most outstanding contribution with international impact in the field of ageing, disability, and inclusive design in the form of a refereed paper submitted to and delivered at the INTERACT Conference. The IFIP TC13 Interaction Design for International Development Award, launched in 2013 by IFIP WG 13.8, recognises the most outstanding contribution to the application of interactive systems for social and economic development of people around the world taking into account their diverse local needs and cultural perspectives. The IFIP TC13 Pioneers' Award for Best Doctoral Student Paper at INTERACT, first awarded in 2019, is selected by the past recipients of the IFIP TC13 Pioneer title. The award is made to the best research paper accepted to the INTERACT Conference which is based on the doctoral research of the student and authored and presented by the student.

In 2015, TC13 approved the creation of a steering committee for the INTERACT conference. The Steering Committee (SC) is currently chaired by Marco Winckler and is responsible for:

- Promoting and maintaining the INTERACT conference as the premiere venue for researchers and practitioners interested in the topics of the conference (this requires a refinement of the topics above).
- Ensuring the highest quality for the contents of the event.
- Setting up the bidding process to handle future INTERACT conferences. Decision is made up at TC13 level.
- Providing advice to the current and future chairs and organizers of the INTERACT conference.
- Providing data, tools, and documents about previous conferences to future conference organizers.
- Selecting the reviewing system to be used throughout the conference (as this impacts the entire set of reviewers).
- Resolving general issues involved with the INTERACT conference.
- Capitalizing on history (good and bad practices).

Further information is available at the IFIP TC13 website: http://ifip-tc13.org/.

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Invited Talks

Disability, Design and Innovation for a Fairer World

Catherine Holloway, Ben Hardman, Ben Oldfrey, Daniel Hajas, Jamie Danemayer, Maryam Bandukda, and Tigmanshu Bhatnagar

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Abstract. People with disabilities still face many barriers that prevent them from full participation. Some of these barriers can be overcome by innovation. This course aims to introduce the Disability Interaction framework and explore its application at different stages of the innovation process. Participants will learn how to acknowledge the complexities of Disability. In addition, they will get to design new solutions that overcome the barriers faced by people with disabilities in a practical, impactful and creative way.

Keywords: Disability · Design and Innovation

1 Introduction

Many barriers still prevent people with disabilities from fully participating in society. These barriers can be in the form of social issues such as stigma, physical barriers such as inaccessibility and technological barriers causing a lack of appropriate assistive technology (AT). Such barriers prevent people from accessing basic life requirements such as education, employment, and social participation. The situation is particularly severe in the Global South, where most people with disabilities live [1].

Disability innovation breaks down these barriers by developing new technologies, products and services that reach people. In addition, disability innovation can help promote inclusion and diversity in society by ensuring everyone has equitable access to opportunities and resources. However, Disability is complex because it is influenced by many factors that range from individual variability [2] and social interdependence [3] to attitudes [4] and systemic barriers [5]. Addressing disability requires a holistic approach that considers these multiple and multifaceted factors and acknowledges the diversity of experiences of people with disabilities.

This course will introduce practical strategies based on the Disability Interaction framework [2]. Through real case studies, the course will introduce ways to consider and manage the diverse and different needs of the stakeholders on innovation while addressing the multiple confounding factors contributing to a disability, such as social

attitudes and environmental barriers. The course will also introduce ways to think and create implementable disability innovations practically. In this hands-on course, we will chart various innovation journeys and discuss the key challenges that HCI can address and pathways to impact that HCI can facilitate.

2 Disability Interactions Framework

The Disability Interactions (DiX) approach combines theories from HCI, disability studies, assistive technology and social development to design disruptive technologies to address the unmet needs of people with disabilities [2]. The central theme of the approach is to acknowledge and include the complexity of Disability in the design process. It motivates the use of participatory design to co-create solutions specific to their use's context. The framework also encourages utilising technological advancements in new ways to make lives with disabilities more accessible and increase the value and usefulness of products. It also positions itself to motivate open innovation that shares ideas, knowledge and resources with external partners to deliver user value. It utilises applied and basic research [6] to address the granular technical and broader societal and attitudinal challenges through design. The course will facilitate the application of Disability Interactions to inclusion, accessibility and technological barriers at different stages of the innovation process.

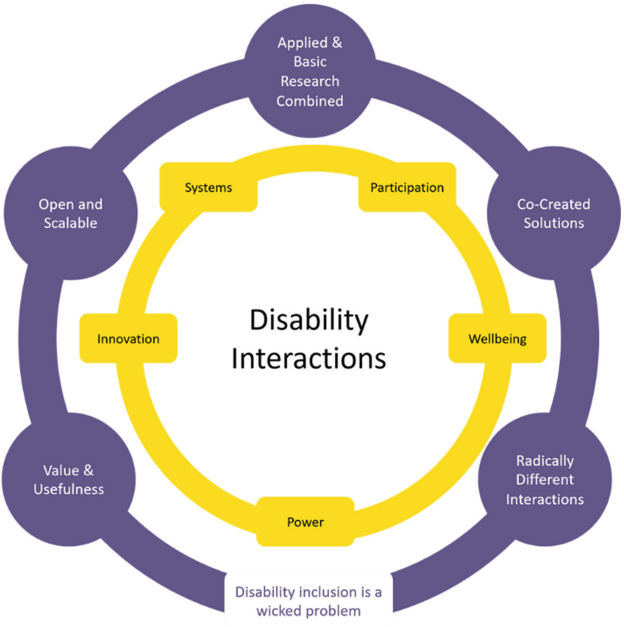

Fig. 1. The Disability Interaction framework [2]

3 Learning Objectives

This short course aims to introduce the framework of Disability Interactions through the process of innovation, from the exploration of a problem to the construction and validation of its solution to its dissemination and impact. After this learning experience, the participants will be able to understand the ways to work with people with disabilities and to think creatively of solutions to problems that have the potential to create an impact. The learning outcome from this course will be:

1. An understanding of the complex interdependent aspects related to disability in different global contexts.
2. The use of the Disability Interactions framework to design new and meaningful interactions that have the potential to create impact.

By the end of this course, learners will be able to analyse real-world disability issues, understand and identify key challenges, design conceptual solutions to address the solutions and develop a strategic and creative way to create impact.

4 Course Format and Intended Audience

At the core of this course is an effort to implement Disability Interactions so that designer and developers of any new technology can think about accessibility and inclusion in a practical and effective way. The instructional approach will be driven through actionable activities, discussion and problem solving. It will include both individual and group work on specific challenges inspired by real life case studies. We will explore how to innovate in the complex and wicked domain of Disability, while acknowledging the many factors that influence disability innovation at different levels of development towards impact. We will apply the theory of Disability Interactions through different tools and instruments for creative exploration at each stage of the course.

We hope to accommodate up to 20 people. Anyone who is interested in developing disruptive assistive technologies or interested in sustaining and scaling existing technologies to new markets or to make existing systems more efficient is welcome to the course. There is no required submission to participate in the course. The course will run for three hours with a 10-min break in between.

We hope that through the discussions and reflections, we will be able to collect valuable insights and information that will make the theory and tools better and more useful. In addition, participants will be able to use the framework for future projects and allow their students to use them as well.

Table 1 Overview of the course program

Agenda	Time
Overview and Presentation	20 min
Lecture + Group activity 1: Co-creation	40 min
Lecture + Group activity 2: Designing new interactions	30 min
Break	10 min
Lecture + Group activity 3: Nurture open and scalable	30 min
Lecture + Group activity 4: Ensuring sustainable value and use	30 min
Final debriefs and discussion	20 min

5 Reading List

1. Disability Interactions: Creating Inclusive Innovations. Link: https://link.springer.com/book/10.1007/978-3-031-03759-7
2. Global Report on Assistive Technology. Link: https://www.who.int/publications/i/item/9789240049451
3. Ability-Based Design: Concept, Principles and Examples. Link: https://doi.org/10.1145/1952383.1952384
4. What Do We Mean by "Accessibility Research"? Link: https://doi.org/10.1145/3411764.3445412
5. The New ABCs of Research: Achieving Breakthrough Collaborations. Link: https://doi.org/10.1093/acprof:oso/9780198758839.001.0001
6. Interdependence as a Frame for Assistive Technology Research and Design. Link: https://doi.org/10.1145/3234695.3236348

References

1. World Health Organization, Fund (UNICEF) UNC. Global report on assistive technology [Internet]. World Health Organization [cited 2022 Dec 15]. xv, 123 p. (2022). https://apps.who.int/iris/handle/10665/354357
2. Disability Interactions [Internet] [cited 2022 Jul 5]. https://link.springer.com/book/10.1007/978-3-031-03759-7
3. Bennett, C.L., Brady, E., Branham, S.M.: Interdependence as a frame for assistive technology research and design. In: Proceedings of the 20th International ACM SIGACCESS Conference on Computers and Accessibility [Internet] [cited 2020 Sep 17], pp. 161–73. ACM, Galway Ireland (2018). https://dl.acm.org/doi/10.1145/3234695.3236348
4. Shinohara, K., Wobbrock, J.O.: In the shadow of misperception: assistive technology use and social interactions. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems [Internet] (CHI 2011) [cited 2020 Jun 24], pp. 705–14.

Association for Computing Machinery, Vancouver (2011). https://doi.org/10.1145/1978942.1979044
5. Wobbrock, J.O., Kane, S.K., Gajos, K.Z., Harada, S., Froehlich, J.: Ability-based design: concept, principles and examples. ACM Trans Access Comput. **3**(3), 9:1–9:27 (2011)
6. Shneiderman, B.: The New ABCs of Research: Achieving Breakthrough Collaborations, 1st edn. Oxford University Press, Inc. (2016)

How to Assess Human Reliance on Artificial Intelligence in Hybrid Decision-Making

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Keywords: Decision Support Systems · Human-AI Interaction · AI Assessment · Hybrid Decision-Making.

1 Learning Objectives

The adoption of AI systems for decision support in sensitive domains has become increasingly normalized and of interest. However, it often relies on the unstated presumption that the accuracy of the AI system is the only relevant element to be considered to ensure a positive impact of AI on human decision-making [2, 6].

This assumption is appealing due to its simplifying consequences, as it allows for the evaluation of an AI system's performance in isolation or by comparing it with the average performance of human decision-makers in the same task. However, this approach has limited applicability in real-world scenarios. It is only reasonable in cases where humans willingly adopt a fully automated decision-making setting and completely delegate decision-making to machines, which is still relatively rare [9]. Instead, in most cases, the automation of classifying tasks is partial and intended as support for human decision-making, for which the human is solely responsible.

In this course, we will emphasize the relevance of taking into consideration the complex socio-technical context [10] in which the system will be embedded after deployment and the emergent phenomena arising from the continuous adjustment and fit between humans, machines, and tasks. The primary learning objective of this course is to enable participants to evaluate AI systems by factoring in both cognitive and socio-psychological determinants and effects, aiming at understanding the role of Decision Support Systems in letting people either avoid or commit incorrect decisions. We will do so by presenting the concepts of *technology dominance* [1], *reliance patterns* [3] and *white-box paradox* [5] and introducing metrics and tools to assess them.

2 Content

In this course, we will focus on the fit between human decision makers and AI support in classification tasks, in order to assess the extent humans *rely* on machines, and the effects of this relationship in the short term of decision efficacy and confidence (purposely neglecting any long-term effect, such as complacency [7] and deskilling [8]). In particular, we will introduce and illustrate a general methodological framework that we recently proposed in [4] to gauge "technology dominance" [1]: the dominating influence that technology may have over the user, which allows the user to take a more subservient position—in essence, the user deferring to the technology in the decision-making process.

To this aim we will present, and discuss the rationales behind, the framework of the reliance patterns (see Table 1, and Fig. 2), that allows to distinguish between positive and negative dominance, and the related biases, such as automation bias, algorithm appreciation, and a phenomenon that deserves more attention: what we defined as the white box paradox (shortly put, whenever automation bias is influenced by the provision of explanations [5]). We will then illustrate a set of methods for the quali-quantitative assessment of technology dominance, which encompass both metrics and data visualizations (see Figs. 1 and 2): we will also distinguish between a standard statistical approach and a causal analysis-based approach that can be applied when additional information is available about the context of interest.

Finally, we apply these methods in case studies from a variety of settings, by also providing open source software and tools that we developed to this purpose to be adopted by the community of interested scholars and researchers.[1] A final roundtable and wrap-up discussion among the participants and organizers will conclude the work of the tutorial about what it means to have a quali-quantitative assessment of human reliance on AI and future research within the INTERACT community.

3 Duration and Intended Audience

Duration. One session (1 h 30 m).
Intended audience. Both scholars and practitioners at all levels of expertise can benefit from this course.

[1] Available at: https://dss-quality-assessment.vercel.app.

Table 1 Definition of all possible decision- and reliance-patterns between human decision makers and their AI system (0: incorrect decision, 1: correct decision). We associate the attitude towards the AI in each possible decision pattern which leads to either accepting or discarding the AI advice, to the main related cognitive biases.

Human judgment (H)	AI support (AI)	Final decision (D)	Reliance pattern	Biases and effects
0	0	0	detrimental reliance (dr)	automation complacency
0	0	1	beneficial under-reliance (bur)	extreme algorithmic aversion
0	1	0	detrimental self-reliance (dsr)	conservatism bias
0	1	1	beneficial over-reliance (bor)	algorithm appreciation
1	0	0	detrimental over-reliance (dor)	automation bias
1	0	1	beneficial self-reliance (bsr)	algorithmic aversion
1	1	0	detrimental under-reliance (dur)	extreme algorithmic aversion
1	1	1	beneficial reliance (br)	confirmation bias (in later cases)

4 Reading List

Cabitza, F., Campagner, A., et al. (2023). Rams, hounds and white boxes: Investigating human–AI collaboration protocols in medical diagnosis. Artificial Intelligence in Medicine, 138, 102506.

Cabitza, F., Campagner, A., Natali, C., et al. (2023). Painting the black box white: experimental findings from applying XAI to an ECG reading setting. Machine Learning and Knowledge Extraction, 5(1), 269–286.

Cabitza, F., Campagner, A., Angius, R., et al. (2023). AI Shall Have No Dominion: on How to Measure Technology Dominance in AI-supported Human decision-making. In CHI'23 Proceedings, April 23–28, 2023, Hamburg, Germany.

Cabitza, F., & Natali, C. (2022). Open, multiple, adjunct. Decision support at the time of relational AI. In HHAI2022: Augmenting Human Intellect (pp. 243–245). IOS Press.

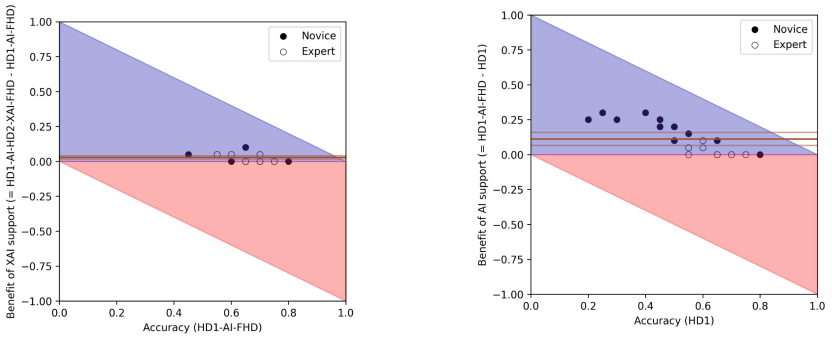

Fig. 1. Example of Benefit Diagrams to visually evaluate the benefit coming from relying on AI (a) and XAI support (b), respectively.

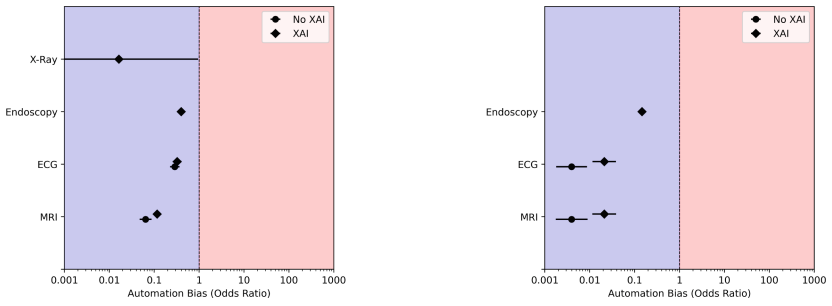

Fig. 2. An example of Automation Bias odds ratios, for the 4 considered case studies: on the left, (a) the frequentist metric; on the right, (b), the causal metric.

References

1. Arnold, V., Sutton, S.G.: The theory of technology dominance: understanding the impact of intelligent decision aids on decision maker's judgments. Adv. Acco. Behav. Res. **1**(3), 175–194 (1998)
2. Birhane, A., Kalluri, P., Card, D., Agnew, W., Dotan, R., Bao, M.: The values encoded in machine learning research. In: Proceedings of the 2022 ACM Conference on Fairness, Accountability, and Transparency, pp. 173–184 (2022)
3. Cabitza, F., Campagner, A., Angius, R., Natali, C., Reverberi, C.: AI shall have no dominion: on how to measure technology dominance in AI-supported human decision-making. In: Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems, pp. 1–20 (2023)
4. Cabitza, F., Campagner, A., Angius, R., Natali, C., Reverberi, C.: AI shall have no dominion: on how to measure technology dominance in AI-supported human

decision-making. In: CHI 2023: The Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems (2023, to be published)
5. Cabitza, F., et al.: Painting the black box white: experimental findings from applying XAI to an ECG reading setting. Mach. Learn. Knowl. Extr. **5**(1), 269–286 (2023)
6. Dignum, V.: Relational artificial intelligence. arXiv preprint arXiv:2202.07446 (2022)
7. Parasuraman, R., Manzey, D.H.: Complacency and bias in human use of automation: an attentional integration. Hum. Factors **52**(3), 381–410 (2010)
8. Rafner, J., et al.: Deskilling, upskilling, and reskilling: a case for hybrid intelligence. Morals Mach. **1**(2), 24–39 (2022)
9. Shrestha, Y.R., Ben-Menahem, S.M., Von Krogh, G.: Organizational decision-making structures in the age of artificial intelligence. Calif. Manage. Rev. **61**(4), 66–83 (2019)
10. Trist, E.L., et al.: On Socio-Technical Systems. Sociotechnical Systems: A Source-book, pp. 43–57 (1978)

Introduction to Information Visualisation

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Abstract. This course will give participants will an understanding of the principles and methods of information visualisation. The course will start with some basic concepts and a look at human visual perception. Then, it will survey various methods and techniques from information visualisation according to data type. The course will conclude with an overview of tools and toolkits which can be used to produce one's own visualisations.

Keywords: Information visualisation · Introduction · Course

1 Introduction

Information visualisation (InfoVis) is the visual presentation of abstract information spaces and structures together with accompanying interactions, so as to facilitate their rapid assimilation and understanding. In essence, information visualisation techniques harness the visual processing capabilities of the human visual system to amplify cognition.

Interactive data visualisations are used for two main purposes:

1. *Analysis*: Exploratory visualisations help researchers to explore and analyse unfamiliar datasets.
2. *Presentation*: Explanatory visualisations present results and insights to a wider audience.

The visual representation is only half the story. Interaction facilities for navigation and manipulation are equally as important.

The course proposer teaches a graduate-level course on information visualisation at Graz University of Technology every summer semester [1], and has taught short courses on information visualisation at a number of conferences. A short introduction to the field is given in an online slide deck [2]. A full set of course notes (146 pages, PDF) is also available [3]. The course proposer gave a talk about information visualisation at TEDxGraz 2015 [4].

The course will introduce participants to the concepts which underpin information visualisation, guide them through some of the various techniques, and show them some of the more common tools used to produce visualisations.

2 Information Visualisation

Information visualisation (InfoVis) deals with abstract information spaces. Geographic visualisation (GeoVis) deals with spatial, map-based data. Together, these two fields are often called data visualisation (DataVis). The related field of scientific visualisation (SciVis) typically involves concrete (3d) objects and simulations, often depicting flows, volumes, and surfaces in (3d) space.

Different techniques have evolved for visualising different types of data, such as hierarchies, networks, multidimensional (tabular) data, and feature spaces, among others. Figure 1 shows a collage of some of the main techniques for visualising hierarchies. Figure 2 shows a collage of some of the main techniques for visualising multidimensional data.

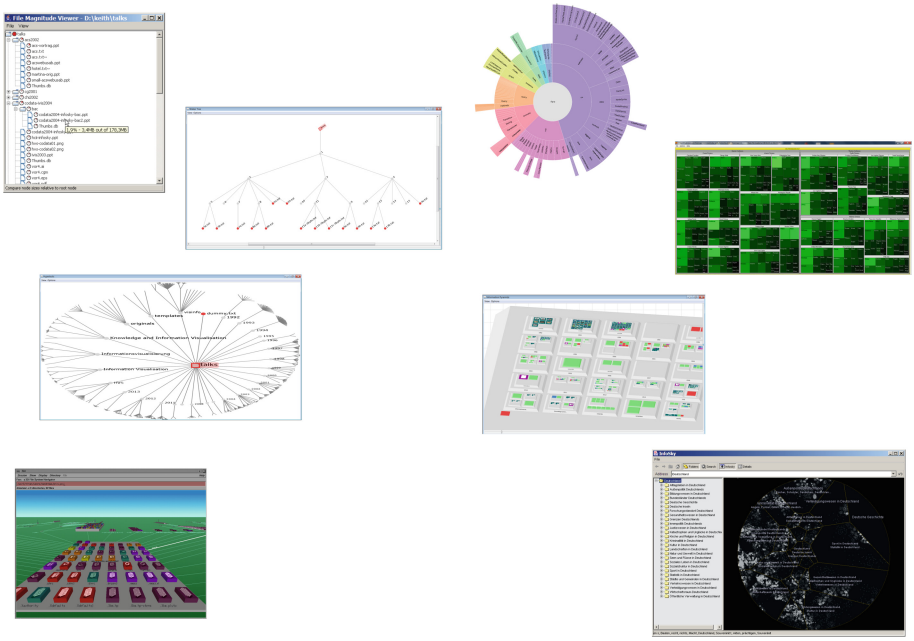

Fig. 1. Techniques for visualising hierarchies.

3 Description of the Course

The course is planned for 3 h and will cover the following topics:

1. Introduction
2. Visual Perception
3. Visualising Hierarchies

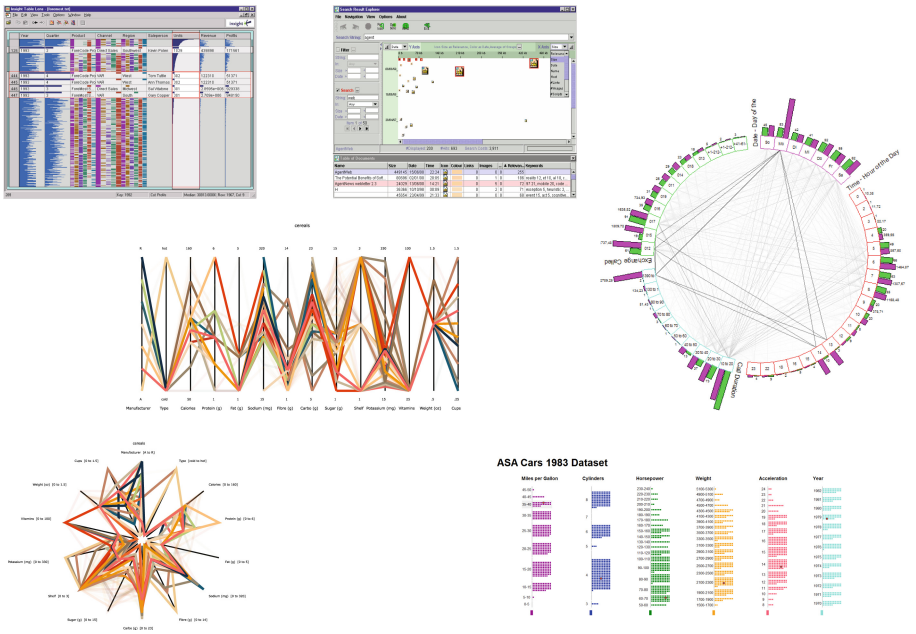

Fig. 2. Techniques for visualising multidimensional data.

4. Visualising Networks and Graphs
5. Visualising Multidimensional Metadata
6. Visualising Text and Object Collections (Feature Spaces)
7. Tools and Toolkits

The topics will be liberally illustrated with live demos and video clips. One or two breaks will be scheduled in accordance with the conference schedule.

4 Intended Audience

The intended audience are lecturers, researchers, professionals, and students attending INTERACT 2023, who have heard about information and data visualisation, and who want to receive a broad introduction to the field.

5 Reading List

The following additional resources are recommended for further reading and viewing:

– Tamara Munzner; *Visualization Analysis and Design*; CRC Press, 2014 [5]. https://cs.ubc.ca/~tmm/vadbook/

- Ward, Grinstein, and Keim; *Interactive Data Visualization: Foundations, Techniques, and Applications*; 2nd Edition, CRC Press, 2015 [6].
- Colin Ware; *Visual Thinking for Design*; 2nd Edition, Morgan Kaufmann, 2021 [7].
- Stephen Few; *Show Me the Numbers*; 2nd Edition, Analytics Press, 2012 [8].
- Hans Rosling; *Stats That Reshape Your World View*; 20-min video [9].

References

1. Andrews, K.: Information Visualisation. Graz University of Technology. https://courses.isds.tugraz.at/ivis/. Accessed 25 Apr 2023
2. Andrews, K.: Introduction to Information Visualisation. Slide deck. https://keithandrews.com/talks/2023/2023-03-15-infovis/. Accessed 15 Mar 2023
3. Andrews, K.: Information Visualisation: Course Notes. https://courses.isds.tugraz.at/ivis/ivis.pdf. Accessed 10 Mar 2023
4. Andrews, K.: Illuminating Data Through Visualisation, TEDxGraz 2015 Talk (2015). https://youtu.be/fnyKj8r0CN4
5. Munzner, T.: Visualization Analysis and Design. CRC Press (2014)
6. Ward, M., Grinstein, G., Keim, D.: Interactive Data Visualization: Foundations, Techniques, and Applications. CRC Press (2015)
7. Ware, C.: Visual Thinking for Design. Morgan Kaufmann (2021)
8. Few, S.: Show Me the Numbers: Designing Tables and Graphs to Enlighten. Analytics Press (2012)
9. Rosling, H.: The Best Stats You've Ever Seen, TED 2006 Talk (2006). https://ted.com/talks/hans_rosling_the_best_stats_you_ve_ever_seen

Contents – Part IV

Virtual Reality

Virtual Reality and Training

Courses

Industrial Experiences

Interactive Demonstrations