

# Lecture Notes in Computer Science

14145

Founding Editors


Gerhard Goos


Juris Hartmanis

## Editorial Board Members

Elisa Bertino, *Purdue University, West Lafayette, IN, USA*

Wen Gao, *Peking University, Beijing, China*

Bernhard Steffen , *TU Dortmund University, Dortmund, Germany*

Moti Yung , *Columbia University, New York, NY, USA*

The series Lecture Notes in Computer Science (LNCS), including its subseries Lecture Notes in Artificial Intelligence (LNAI) and Lecture Notes in Bioinformatics (LNBI), has established itself as a medium for the publication of new developments in computer science and information technology research, teaching, and education.

LNCS enjoys close cooperation with the computer science R & D community, the series counts many renowned academics among its volume editors and paper authors, and collaborates with prestigious societies. Its mission is to serve this international community by providing an invaluable service, mainly focused on the publication of conference and workshop proceedings and postproceedings. LNCS commenced publication in 1973.

José Abdelnour Nocera ·  
Marta Kristín Lárusdóttir · Helen Petrie ·  
Antonio Piccinno · Marco Winckler  
Editors

# Human-Computer Interaction – INTERACT 2023

19th IFIP TC13 International Conference  
York, UK, August 28 – September 1, 2023  
Proceedings, Part IV

### *Editors*

José Abdelnour Nocera   
University of West London  
London, UK

Marta Kristín Lárusdóttir   
Reykjavik University  
Reykjavik, Iceland

Helen Petrie   
University of York  
York, UK

Antonio Piccinno   
University of Bari Aldo Moro  
Bari, Italy

Marco Winckler   
Université Côte d'Azur  
Sophia Antipolis Cedex, France

ISSN 0302-9743

ISSN 1611-3349 (electronic)

Lecture Notes in Computer Science

ISBN 978-3-031-42292-8

ISBN 978-3-031-42293-5 (eBook)

<https://doi.org/10.1007/978-3-031-42293-5>

© The Editor(s) (if applicable) and The Author(s), under exclusive license  
to Springer Nature Switzerland AG 2023

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors, and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG  
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

# 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 primarily 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/>.

# IFIP TC13 Members

## Officers

### Chair

Paula Kotzé, South Africa

### Vice-chair for Conferences

Marco Winckler, France

### Vice-chair for Equity and Development

José Abdelnour-Nocera, UK

### Vice-chair for Media and Communications

Helen Petrie, UK

### Vice-chair for Membership and Collaboration

Philippe Palanque, France

### Vice-chair for Working Groups

Simone D. J. Barbosa, Brazil

### Vice-chair for Finance (Treasurer)

Regina Bernhaupt, The Netherlands

### Secretary

Janet Wesson, South Africa

### INTERACT Steering Committee Chair

Marco Winckler, France

## Country Representatives

### Australia

Henry B. L. Duh  
Australian Computer Society

### Austria

Christopher Frauenberger  
Austrian Computer Society

### Belgium

Bruno Dumas  
IMEC – Interuniversity  
Micro-Electronics Center

### Brazil

André Freire  
Simone D. J. Barbosa (section b)  
Sociedade Brasileira de Computação  
(SBC)

### Bulgaria

Petia Koprinkova-Hristova  
Bulgarian Academy of Sciences

**Croatia**

Andrina Granić  
Croatian Information Technology  
Association (CITA)

**Cyprus**

Panayiotis Zaphiris  
Cyprus Computer Society

**Czech Republic**

Zdeněk Míkovec  
Czech Society for Cybernetics and  
Informatics

**Denmark**

Jan Stage  
Danish Federation for Information  
Processing (DANFIP)

**Finland**

Virpi Roto  
Finnish Information Processing  
Association

**France**

Philippe Palanque  
Marco Winckler (section b)  
Société informatique de France (SIF)

**Germany**

Tom Gross  
Gesellschaft für Informatik e.V.

**Ireland**

Liam J. Bannon  
Irish Computer Society

**Italy**

Fabio Paternò  
Associazione Italiana per l' Informatica ed  
il Calcolo Automatico (AICA)

**Japan**

Yoshifumi Kitamura  
Information Processing Society of Japan

**Netherlands**

Regina Bernhaupt  
Koninklijke Nederlandse Vereniging  
van Informatieprofessionals (KNVI)

**New Zealand**

Mark Apperley  
Institute of IT Professionals New Zealand

**Norway**

Frode Eika Sandnes  
Norwegian Computer Society

**Poland**

Marcin Sikorski  
Polish Academy of Sciences (PAS)

**Portugal**

Pedro Filipe Pereira Campos  
Associação Portuguesa para o  
Desenvolvimento da Sociedade da  
Informação (APDSI)

**Serbia**

Aleksandar Jevremovic  
Informatics Association of Serbia (IAS)

**Singapore**

Shengdong Zhao  
Singapore Computer Society

**Slovakia**

Wanda Benešová  
Slovak Society for Computer Science

**Slovenia**

Matjaž Kljun  
Slovenian Computer Society  
INFORMATIKA

**South Africa**

Janet L. Wesson  
Paula Kotzé (section b)  
Institute of Information Technology  
Professionals South Africa (IITPSA)

**Sri Lanka**

Thilina Halloluwa  
Computer Society of Sri Lanka (CSSL)

**Sweden**

Jan Gulliksen  
Swedish Interdisciplinary Society for  
Human-Computer Interaction  
Dataföreningen i Sverige

**Switzerland**

Denis Lalanne  
Schweizer Informatik Gesellschaft (SI)

**United Kingdom**

José Luis Abdelnour Nocera  
Helen Petrie (section b)  
British Computer Society (BCS),  
Chartered Institute for IT

**International Members at Large Representatives****ACM**

Gerrit van der Veer  
Association for Computing  
Machinery

**CLEI**

César Collazos  
Centro Latinoamericano de Estudios en  
Informatica

**Expert Members**

Anirudha Joshi, India  
Constantinos Coursaris, Canada  
Carmelo Ardito, Italy  
Daniel Orwa Ochieng, Kenya  
David Lamas, Estonia  
Dorian Gorgan, Romania  
Eunice Sari, Australia/Indonesia  
Fernando Loizides, UK/Cyprus  
Geraldine Fitzpatrick, Austria

Ivan Burmistrov, Russia  
Julio Abascal, Spain  
Kaveh Bazargan, Iran  
Marta Kristin Lárusdóttir, Iceland  
Nikolaos Avouris, Greece  
Peter Forbrig, Germany  
Torkil Clemmensen, Denmark  
Zhengjie Liu, China

## **Working Group Chairpersons**

### **WG 13.1 (Education in HCI and HCI Curricula)**

Konrad Baumann, Austria

### **WG 13.2 (Methodologies for User-Centered System Design)**

Regina Bernhaupt, Netherlands

### **WG 13.3 (HCI, Disability and Aging)**

Helen Petrie, UK

### **WG 13.4/2.7 (User Interface Engineering)**

Davide Spano, Italy

### **WG 13.5 (Human Error, Resilience, Reliability, Safety and System Development)**

Tilo Mentler, Germany

### **WG13.6 (Human-Work Interaction Design)**

Barbara Rita Barricelli, Italy

### **WG13.7 (HCI and Visualization)**

Gerrit van der Veer, Netherlands

### **WG 13.8 (Interaction Design and International Development)**

José Adbelnour Nocera, UK

### **WG 13.9 (Interaction Design and Children)**

Gavin Sim, UK

### **WG 13.10 (Human-Centred Technology for Sustainability)**

Masood Masoodian, Finland

# Organization

## General Chairs

Helen Petrie

University of York, UK

Jose Abdelnour-Nocera

University of West London, UK and ITI/Larsys,  
Portugal

## Technical Program Chair

Marco Winckler

Université Côte d'Azur, France

## Full Papers Chairs

Antonio Piccinno

University of Bari Aldo Moro, Italy

Marta Kristin Lárusdóttir

Reykjavik University, Iceland

## Short Papers Chairs

Marta Rey-Babarro

Zillow, USA

Frode Eika Sandnes

Oslo Metropolitan University, Norway

Grace Eden

University of York, UK

## Poster Chairs

Alena Denisova

University of York, UK

Burak Merdenyan

University of York, UK

## Workshops Chairs

Jan Stage

Aalborg University, Denmark

Anna Bramwell-Dicks

University of York, UK

## **Panels Chairs**

Effie Lai-Chong Law  
Massimo Zancanaro

Durham University, UK  
University of Trento, Italy

## **Student Volunteers Chairs**

Sanjit Samaddar  
Daniel Lock

University of York, UK  
University of York, UK

## **Interactive Demonstrations Chairs**

Barbara Rita Barricelli  
Jainendra Shukla

University of Brescia, Italy  
Indraprastha Institute of Information Technology,  
India

## **Courses Chairs**

Nikos Avouris  
André Freire

University of Patras, Greece  
Federal University of Lavras, Brazil

## **Doctoral Consortium Chairs**

David Lamas  
Geraldine Fitzpatrick  
Tariq Zaman

Tallinn University, Estonia  
TU Wien, Austria  
University of Technology Sarawak, Malaysia

## **Industrial Experiences Chairs**

Helen Petrie  
Jose Abdelnour-Nocera

University of York, UK  
University of West London, UK and ITI/Larsys,  
Portugal

## **Publicity Chairs**

Delvin Varghese  
Lourdes Moreno

Monash University, Australia  
Universidad Carlos III de Madrid, Spain

## Advisors

Marco Winckler	University of the Côte d'Azur, France
Fernando Loizides	Cardiff University, UK
Carmelo Ardito	LUM Giuseppe Degennaro University, Italy

## Web Master

Edmund Wei	University of York, UK
------------	------------------------

## INTERACT Subcommittee Chairs

Anirudha Joshi	Industrial Design Centre, IIT Bombay, India
Célia Martinie	IRIT, Université Toulouse III - Paul Sabatier, France
Fabio Paternò	CNR-ISTI, Pisa, Italy
Frank Steinicke	Universität Hamburg, Germany
Gerhard Weber	TU Dresden, Germany
Helen Petrie	University of York, UK
José Campos	University of Minho, Portugal
Nikolaos Avouris	University of Patras, Greece
Philippe Palanque	IRIT, Université Toulouse III - Paul Sabatier, France
Rosa Lanzilotti	University of Bari, Italy
Rosella Gennari	Free University of Bozen-Bolzano, Switzerland
Simone Barbosa	PUC-Rio, Brazil
Torkil Clemmensen	Copenhagen Business School, Denmark
Yngve Dahl	Norwegian University of Science and Technology, Norway

## INTERACT Steering Committee

Anirudha Joshi	Industrial Design Centre, IIT Bombay, India
Antonio Piccinno	University of Bari, Italy
Carmelo Ardito	University of Bari, Italy
Fernando Loizides	University of Cardiff, UK
Frode Sandnes	Oslo Metropolitan University, Norway
Helen Petrie	University of York, UK
Janet Wesson	Nelson Mandela University, South Africa
Marco Winckler (Chair)	Université Côte d'Azur, France
Marta Lárusdóttir	Reykjavik University, Iceland



Paolo Buono	University of Bari, Italy
Paula Kotzé	University of Pretoria, South Africa
Philippe Palanque	IRIT, Université Toulouse III - Paul Sabatier, France
Raquel Oliveira Prates	Universidade Federal de Minas Gerais, Brazil
Tom Gross	University of Bamberg, Germany

## Program Committee

Alan Chamberlain	University of Nottingham, UK
Alessandra Melonio	Ca' Foscari University of Venice, Italy
Alessandro Pagano	University of Bari, Italy
Andrea Marrella	Sapienza Università di Roma, Italy
Andrés Lucero	Aalto University, Finland
Anna Sigríður Islind	Reykjavik University, Iceland
Antonio Piccinno	University of Bari, Italy
Ashley Colley	University of Lapland, Finland
Aurora Constantin	University of Edinburgh, UK
Barbara Rita Barricelli	Università degli Studi di Brescia, Italy
Bridget Kane	Karlstad University Business School, Sweden
Bruno Dumas	University of Namur, Belgium
Carla Dal Sasso Freitas	Federal University of Rio Grande do Sul, Brazil
Célia Martinie	Université Toulouse III - Paul Sabatier, France
Chi Vi	University of Sussex, UK
Christopher Power	University of Prince Edward Island, Canada
Christopher Clarke	University of Bath, UK
Cristian Bogdan	KTH, EECS, HCT, Sweden
Cristina Gena	Università di Torino, Italy
Dan Fitton	University of Central Lancashire, UK
Daniela Fogli	University of Brescia, Italy
Daniela Trevisan	Universidade Federal Fluminense, Brazil
Denis Lalanne	University of Fribourg, Switzerland
Dipanjan Chakraborty	BITS Pilani, Hyderabad Campus, India
Fabio Buttussi	University of Udine, Italy
Federico Cabitza	University of Milano-Bicocca, Italy
Fernando Loizides	Cardiff University, UK
Frøde Eika Sandnes	Oslo Metropolitan University, Norway
Gerd Bruder	University of Central Florida, USA
Gerhard Weber	TU Dresden, Germany
Giuliana Vitiello	Università di Salerno, Italy
Giuseppe Desolda	University of Bari Aldo Moro, Italy

Helen Petrie	University of York, UK
Jan Van den Bergh	UHasselt - tUL - Flanders Make, Belgium
Jan Gulliksen	KTH Royal Institute of Technology, Sweden
Janet Wesson	Nelson Mandela University, South Africa
Janet Read	University of Central Lancashire, UK
Jens Gerken	Westphalian University of Applied Sciences, Germany
Jo Lumsden	Aston University, UK
Jolanta Mizera-Pietraszko	Military University of Land Forces, Poland
Jonna Häkikä	University of Lapland, Finland
José Abdelnour Nocera	University of West London, UK
Judy Bowen	University of Waikato, New Zealand
Karen Renaud	University of Strathclyde, UK
Kaveh Bazargan	Allameh Tabataba'i University, Islamic Republic of Iran
Kris Luyten	Hasselt University - tUL - Flanders Make, Belgium
Kshitij Sharma	NTNU, Norway
Lara Piccolo	Open University, UK
Lene Nielsen	IT University of Copenhagen, Denmark
Lucio Davide Spano	University of Cagliari, Italy
Luigi De Russis	Politecnico di Torino, Italy
Manjiri Joshi	Swansea University, UK
Marco Winckler	Université Côte d'Azur, France
Maristella Matera	Politecnico di Milano, Italy
Mark Apperley	University of Waikato, New Zealand
Marta Lárusdóttir	Reykjavik University, Iceland
Netta Iivari	University of Oulu, Finland
Oliver Korn	Offenburg University, Germany
Paloma Diaz	University Carlos III of Madrid, Spain
Paolo Bottoni	Sapienza University of Rome, Italy
Paolo Buono	University of Bari Aldo Moro, Italy
Paula Kotzé	University of Pretoria, South Africa
Pedro Campos	ITI/LARSyS, Portugal
Peter Forbrig	University of Rostock, Germany
Raquel O. Prates	Universidade Federal de Minas Gerais, Brazil
Renaud Blanch	Université Grenoble Alpes, France
Sandy Claes	LUCA School of Arts, Belgium
Sayan Sarcar	Birmingham City University, UK
Shaun Macdonald	University of Glasgow, UK
Simone Kriglstein	Masaryk University, Czech Republic
Sophie Dupuy-Chessa	Université Grenoble Alpes, France

Sumita Sharma	University of Oulu, Finland
Sven Mayer	LMU Munich, Germany
Tania Di Mascio	Università dell'Aquila, Italy
Theodoros Georgiou	Heriot-Watt University, UK
Thilina Halloluwa	University of Colombo, Sri Lanka
Tilo Mentler	Trier University of Applied Sciences, Germany
Timothy Merritt	Aalborg University, Denmark
Tom Gross	University of Bamberg, Germany
Valentin Schwind	Frankfurt University of Applied Sciences, Germany
Virpi Roto	Aalto University, Finland
Vita Santa Barletta	University of Bari Aldo Moro, Italy
Vivian Genaro Motti	George Mason University, USA
Wricha Mishra	MIT Institute of Design, India
Zdeněk Míkovec	Czech Technical University Prague, Czech Republic
Zeynep Yildiz	Koç University, Turkey

## Additional Reviewers

Abhishek Shrivastava	Aline Menin
Adalberto Simeone	Alisson Puska
Aditya Prakash Kulkarni	Alma Cantu
Adrien Chaffangeon Caillet	Amy Melniczuk
Adrien Coppens	An Jacobs
Aekaterini Mavri	Ana Serrano
Ahmad Samer Wazan	Anderson Maciel
Aidan Slingsby	André Freire
Aimee Code	Andre Salgado
Aizal Yusrina Idris	Andre Suslik Spritzer
Akihisa Shitara	Andrea Antonio Cantone
Aku Visuri	Andrea Bellucci
Alberto Monge Roffarello	Andrea Esposito
Alessandro Forgiarini	Andreas Fender
Alessio Malizia	Andreas Mallas
Alex Binh Vinh Duc Nguyen	Andreas Sonderegger
Alex Chen	Andres Santos-Torres
Alexander Maedche	Ángel Cuevas
Alexander Meschtscherjakov	Angela Locoro
Alexander Wachtel	Angus Addlesee
Alexandra Voit	Angus Marshall
Alexandre Canny	Anicia Peters
Ali Gheitasy	Anirudh Nagraj

Ankica Barisic  
Anna Spagnolli  
Annika Schulz  
Anthony Perritano  
Antigoni Parmaxi  
Antje Jacobs  
Antonella Varesano  
Antonio Bucchiarone  
Antonio Piccinno  
Anupriya Tuli  
Argenis Ramirez Gomez  
Arminda Lopes  
Arnaud Blouin  
Ashwin Singh  
Ashwin T. S.  
Asim Evren Yantac  
Axel Carayon  
Aykut Coşkun  
Azra Ismail  
Barsha Mitra  
Basmah Almekhled  
Beat Signer  
Beenish Chaudhry  
Behnaz Norouzi  
Benjamin Schnitzer  
Benjamin Tag  
Benjamin Weyers  
Berardina De Carolis  
Bharatwaja Namatherdhala  
Bhumika Walia  
Biju Thankachan  
Bram van Deurzen  
Çağlar Genç  
Canlin Zhang  
Carolyn Holter  
Céline Coutrix  
Chameera De Silva  
Charlotte Magnusson  
Chiara Ceccarini  
Chiara Natali  
Chikodi Chima  
Christian Frisson  
Christophe Kolski  
Christopher Frauenberger  
Christos Katsanos

Christos Sintoris  
Cléber Corrêa  
Cleidson de Souza  
Daisuke Sato  
Damianos Dumi Sigalas  
Damon Horowitz  
Dan Fitton  
Daniel Görlich  
Daniel Zielasko  
Danielle Langlois  
Daphne Chang  
Dario Bertero  
David Gollasch  
David Navarre  
Davide D'Adamo  
Davide Mulfari  
Davide Spallazzo  
Debjani Roy  
Diana Korka  
Diego Morra  
Dilrukshi Gamage  
Diogo Cabral  
Dixie Ching  
Domenico Gigante  
Dominic Potts  
Donald McMillan  
Edwige Pissaloux  
Edy Portmann  
Effie Law  
Eike Schneiders  
Elisa Mekler  
Elise Grevet  
Elizabeth Buie  
Elodie Bouzbib  
Emanuele Pucci  
Enes Yigitbas  
Eric Barboni  
Estela Peralta  
Euan Freeman  
Evangelia Chrysikou  
Evelyn Eika  
Fabiana Verno  
Fabio Cassano  
Fabrizio Balducci  
Fanny Vainionpää

Fausto Medola  
Favour Aladesuru  
Federica Cena  
Federico Botella  
Florian Gnadlinger  
Francesco Cauteruccio  
Francesco Chiossi  
Francesco Ferrise  
Francesco Greco  
Francisco Iniesto  
Francisco Maria Calisto  
Frank Beruscha  
Frank Fischer  
Frank Nack  
Frida Milella  
Funmi Adebesein  
Gavin Sim  
George Adrian Stoica  
George Raptis  
Georgios Papadoulis  
Gianluca Schiavo  
Girish Dalvi  
Grischa Liebel  
Guanhua Zhang  
Guilherme Schardong  
Gustavo Roveló Ruiz  
Hanne Sørum  
Heidi Hartikainen  
Himanshu Verma  
Holger Regenbrecht  
Hsin-Jou Lin  
Hui-Yin Wu  
Ikram Ur Rehman  
Isabela Gasparini  
Ivo Malý  
Jack Jamieson  
James Simpson  
Jan Leusmann  
Jana Jost  
Jannes Peeters  
Jari Kangas  
Jayden Khakurel  
Jean Hallewell Haslwanter  
Jemma König  
Jermaine Marshall

Jeroen Ceyskens  
Jesper Gaardsdal  
Jessica Sehr  
Jiaying Liu  
Job Timmermans  
Joe Cutting  
Jonas Moll  
Jonathan Hook  
Joni Salminen  
Joongi Shin  
Jorge Wagner  
José Campos  
Joseph O'Hagan  
Judith Borghouts  
Julia Hertel  
Julio Reis  
Kajetan Enge  
Kasper Rodil  
Kate Rogers  
Katerina Cerna  
Katherine Seyama  
Kathia Oliveira  
Kathrin Gerling  
Khyati Priya  
Konstantin Biriukov  
Kostantinos Moustakas  
Krishna Venkatasubramanian  
Laden Husamaldin  
Lars Lischke  
Lars Oestreicher  
Laura Helsby  
Leena Ventä-Olkkonen  
Lele Sha  
Leonardo Sandoval  
Lorena Riol-Blanco  
Lorenzo Torrez  
Louise Barkhuus  
Luis Leiva  
Luis Teran  
M. Cristina Vannini  
Maälis Lefebvre  
Magdaléna Kejstová  
Malay Dhamelia  
Manik Gupta  
Manuel J. Fonseca

Marco de Gemmis  
Marco Manca  
Marco Romano  
Margarita Anastassova  
Margault Sacré  
Margherita Andrao  
Mari Karhu  
Maria Fernanda Antunes  
María Óskarsdóttir  
Marianna Di Gregorio  
Marika Jonsson  
Marios Constantinides  
Mark Apperley  
Mark Lochrie  
Marko Tkalcic  
Markus Löchtefeld  
Markus Tatzgern  
Marta Serafini  
Martin Hedlund  
Martin Kocur  
Massimo Zancanaro  
Mateusz Dubiel  
Matthias Baldauf  
Matthias Heintz  
Max Birk  
Maxime Savary-Leblanc  
Maximiliano Jeanneret Medina  
Mehdi Rizvi  
Mengyu Chen  
Michael Burch  
Michael Rohs  
Michalis Xenos  
Mihail Terenti  
Min Zhang  
Mireia Ribera  
Mirko De Vincentiis  
Miroslav Macík  
Mohd Kamal Othman  
Monica Divitini  
Monisha Pattanaik  
Mrim Alnfai  
Murali Balusu  
Nada Attar  
Nadine Flegel  
Nadine Vigouroux

Nadir Weibel  
Nahal Norouzi  
Najla Aldaraani  
Nancy Alajarmeh  
Nicholas Vanderschantz  
Nicoletta Adamo  
Niels van Berkel  
Nikolaos Avouris  
Nils Beese  
Nivan Ferreira  
Nurha Yingta  
Ohoud Alharbi  
Omar Al Hashimi  
Pallabi Bhowmick  
Pallavi Rao Gadahad  
Panayiotis Koutsabasis  
Paolo Massa  
Parisa Saadati  
Pascal Lessel  
Patricia Arias-Cabarcos  
Paula Alexandra Silva  
Pavel Slavik  
Peter Bago  
Philippe Truillet  
Pinar Simsek Caglar  
Po-Ming Law  
Prabodh Sakhardande  
Pranjal Protim Borah  
Quynh Nguyen  
Radovan Madleňák  
Ragad Allwihan  
Rahat Jahangir Rony  
Rajni Sachdeo  
Razan Bamoallem  
Rekha Sugandhi  
Rishi Vanukuru  
Rogério Bordini  
Rohan Gaikwad  
Romane Dubus  
Rosella Gennari  
Rui José  
Sabrina Burtscher  
Sabrina Lakhdhir  
Sahar Mirhadi  
Saif Hadj Sassi

Salvatore Andolina	Thomas Kosch
Salvatore Sorce	Tilman Dingler
Samangi Wadinambi Arachchi	Tom Veuskens
Sanika Doolani	Tomas Alves
Sanjit Samaddar	Tomáš Pagáč
Sara Capecchi	Tomi Heimonen
Sarah Hodge	Tommaso Turchi
Saumya Pareek	Tong Wu
Scott MacKenzie	Tzu-Yang Wang
Scott Trent	Valentino Artizzu
Sebastian Feger	Vanessa Cesário
Sebastian Günther	Vanessa Maike
Sebastian Weiß	Vania Neris
Sébastien Scannella	Vasiliki Mylonopoulou
Shah Rukh Humayoun	Vera Memmesheimer
Shun Yao Wu	Vickie Nguyen
Siddharth Gulati	Victor Adriel de Jesus Oliveira
Siiri Paananen	Vidushani Dhanawansa
Silvia Espada	Vikas Upadhyay
Silvia Gabrielli	Vincent Zakka
Simon Ruffieux	Vincenzo Dentamaro
Simon Voelker	Vincenzo Gattulli
Simone Barbosa	Vinitha Gadiraju
Siti Haris	Vit Rusnak
Sónia Brito-Costa	Vittoria Frau
Sophie Dupuy-Chessa	Vivek Kant
Sophie Lepreux	Way Kiat Bong
Soraia M. Alarcão	Weiqin Chen
Srishti Gupta	Wenchen Guo
Stefan Johansson	William Delamare
Stéphanie Fleck	Xiying Wang
Stine Johansen	Yann Savoye
Subrata Tikadar	Yao Chen
Suzanna Schmeelk	Yaoli Mao
Sybille Caffiau	Yaxiong Lei
Sylvain Malacria	Yilin Liu
Taejun Kim	Ying Ma
Tahani Alahmadi	Yingying Zhao
Tahani Albalawi	Yong-Joon Thoo
Takumi Yamamoto	Yoselyn Walsh
Tariq Zaman	Yosra Rekik
Tathagata Ray	Yuan Chen
Telmo Zarraonandia	Yubo Kou
Teresa Onorati	Zhiyuan Wang
Tero Jokela	Zi Wang
Theodoros Georgiou	

## Sponsors and Partners

### Sponsors



### Partners



International Federation for Information Processing



In-cooperation with ACM



In-cooperation with SIGCHI



## **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

Global Disability Innovation Hub, University College London,  
London, E20 2AF, UK

{c.holloway,ben.hardman,b.oldfrey,d.hajas,  
j.danemayer.21,m.bandukda,t.bhatnagar.18}@ucl.ac.uk

**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.

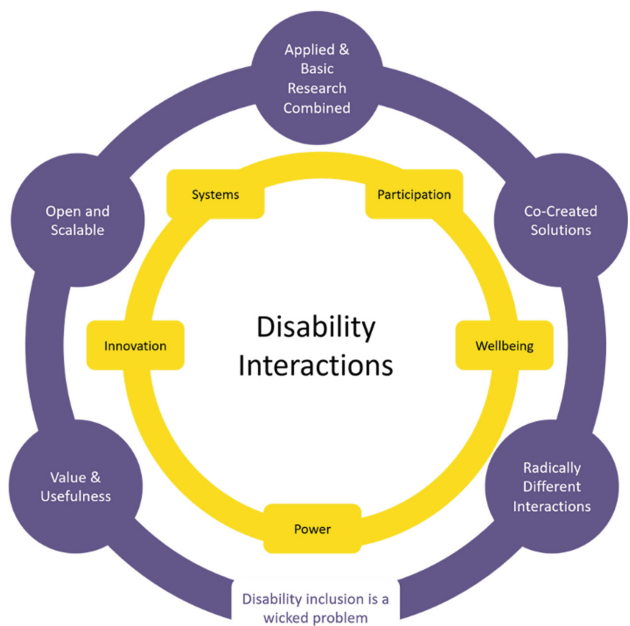


Fig. 1. The Disability Interaction framework [2]

### **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/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

Chiara Natali<sup>1</sup> , Andrea Campagner<sup>2</sup>  and Federico Cabitza<sup>2</sup> 

<sup>1</sup> DISCo, University of Milano-Bicocca, viale Sarca 336, 20126 Milan, Italy  
chiara.natali@unimib.it

<sup>2</sup> IRCCS Orthopedic Institute Galeazzi, via Galeazzi, 4, 20161 Milan, Italy

**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.<sup>1</sup> 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.

---

<sup>1</sup> Available at: <https://dss-quality-assessment.vercel.app>.

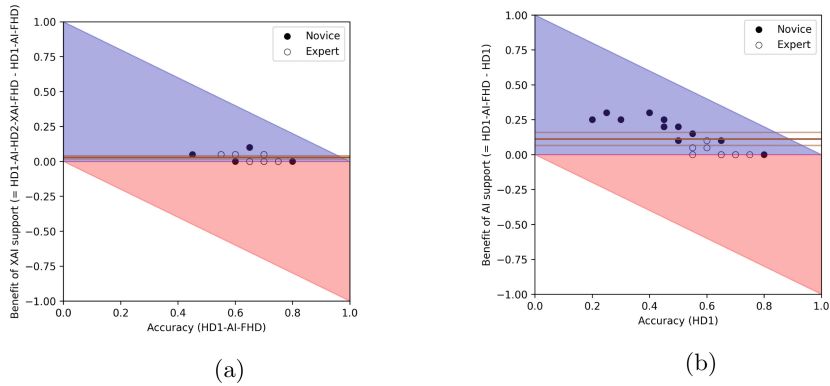


**Table 1** Definition of all possible decision- and reliance-patterns between human decision makers and their AI system (0: incorrect decision, 1: correct decision). We associate the attitude towards the AI in each possible decision pattern which leads to either accepting or discarding the AI advice,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

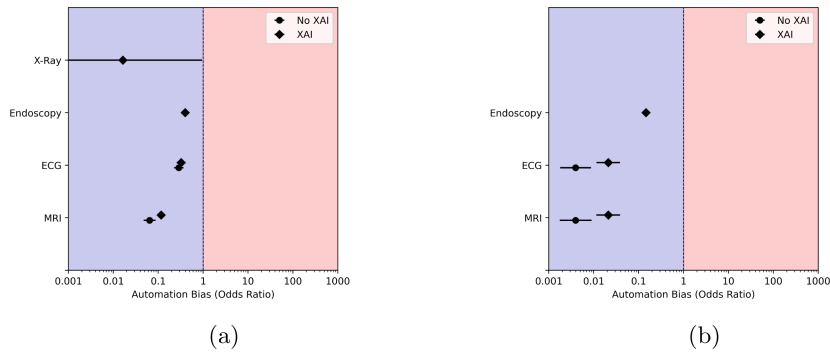
Human judgment (H)	AI support (AI)	Final decision (D)	Reliance pattern	Biases and effects
0	0	0	detrimental reliance (dr)	automation complacency
0	0	1	beneficial under-reliance (bur)	extreme algorithmic aversion
0	1	0	detrimental self-reliance (dsr)	conservatism bias
0	1	1	beneficial over-reliance (bor)	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.: Deskillling, upskilling, and reskillling: 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

Keith Andrews

Graz University of Technology, Austria

[kandrews@tugraz.at](mailto:kandrews@tugraz.at)

<https://isds.tugraz.at/keith>

**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.

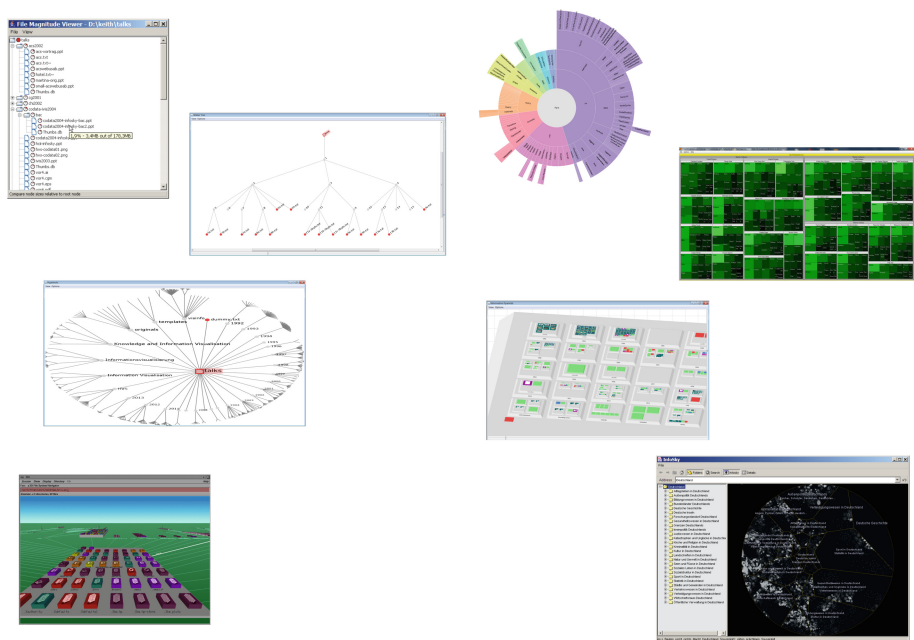
The course proposer teaches a graduate-level course on information visualisation at Graz University of Technology every summer semester [1], and has taught short courses on information visualisation at a number of conferences. A short introduction to the field is given in an online slide deck [2]. A 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.

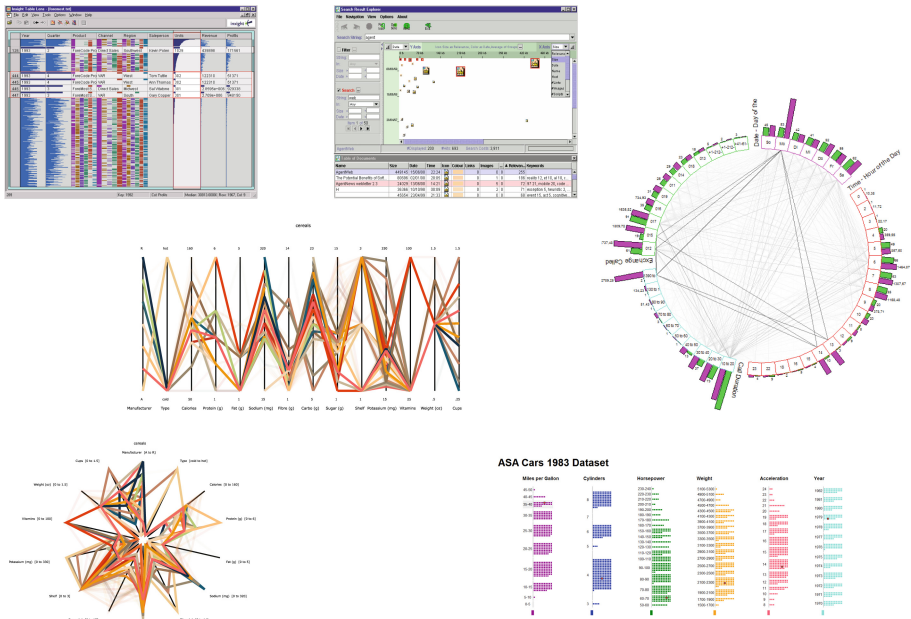


**Fig. 1.** Techniques for visualising hierarchies.

## 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*; 2<sup>nd</sup> Edition, CRC Press, 2015 [6].
- Colin Ware; *Visual Thinking for Design*; 2<sup>nd</sup> Edition, Morgan Kaufmann, 2021 [7].
- Stephen Few; *Show Me the Numbers*; 2<sup>nd</sup> 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](https://ted.com/talks/hans_rosling_the_best_stats_you_ve_ever_seen)

## Contents – Part IV

### User Studies

Comparing Perceived Restorativeness and Stress Reduction in Virtual Reality Environments Using Abstract Fractal Geometries Versus Realistic Natural Landscapes .....	3
<i>Diana C. G. Mendes and Mónica S. Cameirão</i>	
“I Miss Going to that Place”: The Impact of Watching Nature Videos on the Well-Being of Informal Caregivers .....	23
<i>Beatriz Peres, Hildegarde Noronha, Daniel S. Lopes, Joaquim Jorge, and Pedro F. Campos</i>	
Our Nudges, Our Selves: Tailoring Mobile User Engagement Using Personality .....	33
<i>Nima Jamalian, Marios Constantinides, Sagar Joglekar, Xueni Pan, and Daniele Quercia</i>	
Turn & Slide: Designing a Puzzle Game to Elicit the Visualizer-Verbalizer Cognitive Style .....	46
<i>Sotirios Petsas, George E. Raptis, and Christos Katsanos</i>	

### User Studies, Eye-Tracking, and Physiological Data

Electroencephalographic (EEG) Correlates of Visually Induced Motion Sickness (VIMS) in the Virtual Reality (VR) Based Simulations .....	59
<i>Jan K. Argasiński, Natalia Lipp, and Szymon Mazurek</i>	
Exploring Eye Expressions for Enhancing EOG-Based Interaction .....	68
<i>Joshua Newn, Sophia Quesada, Baosheng James Hou, Anam Ahmad Khan, Florian Weidner, and Hans Gellersen</i>	
How Many Participants Do You Need for an Open Card Sort? A Case Study of E-commerce Websites .....	80
<i>Christos Pechlevanoudis, Grigorios Zilidis, and Christos Katsanos</i>	
Quantifying Device Usefulness - How Useful is an Obsolete Device? .....	90
<i>Craig Goodwin, Sandra Woolley, Ed de Quincey, and Tim Collins</i>	



Usability Evaluation of a Brazilian Dam Safety Data Exploration Platform:  
A Consolidation of Results from User Tests and Heuristic Evaluation ..... 100  
*Bruna Santana Capeleti, Caroline Queiroz Santos,  
Jaqueline Isabel de Souza, and André Pimenta Freire*

**Virtual Reality**

Asymmetric Communication in Virtual Reality: Designing for Presence,  
Effectiveness, and Enjoyment ..... 123  
*Markus Kirjonen and Mika P. Nieminen*

Digital Modeling for Everyone: Exploring How Novices Approach  
Voice-Based 3D Modeling ..... 133  
*Giuseppe Desolda, Andrea Esposito, Florian Müller, and Sebastian Feger*

Exploring the Potential of Metaverse Apps for Real-World Applications:  
A Case Study with CALEND\_AR ..... 156  
*Konstantinos Tsomokos, Christos Sintoris, Christos Fidas,  
and Nikolaos Avouris*

PeriFocus - Training Peripheral Color- and Shape Detection in Virtual  
Reality ..... 166  
*Mads Thomsen, Mathias Halilovic, Alexandru Giuran,  
and Markus Löchtefeld*

Supporting Resilience Through Virtual Reality: Design and Preliminary  
Evaluation of a VR Experience Based on Viktor Frankl's Logotherapy ..... 176  
*Quynh Nguyen, Rodrigo Gutierrez, Lukas Kröninger, and Ulrike Kretzer*

**Virtual Reality and Training**

A Case Study Using Virtual Reality to Prime Knowledge for Procedural  
Medical Training ..... 189  
*Paul W. L. Watson, Samuel House, Robert Hart, Jonathan Abbas,  
Sheena Asthana, and Swen E. Gaudl*

Mind the Heart: Designing a Stress Dashboard Based on Physiological  
Data for Training Highly Stressful Situations in Virtual Reality ..... 209  
*Olivia Zechner, Helmut Schrom-Feiertag, Jakob Uhl, Quynh Nguyen,  
Lisanne Kleygrewe, and Manfred Tscheligi*

VR for HR – A Case Study of Human Resource Development Professionals  
Using Virtual Reality for Social Skills Training in the Workplace ..... 231  
*Britta Nordin Forsberg, Anders Lundström, and Jan Gulliksen*

## Courses

Hacking the Brain: The Risks and Challenges of Cognitive Augmentation .....	255
<i>Sarah Clinch and Nigel Davies</i>	
The UCD Sprint: Bringing Users Along to Sprint .....	259
<i>Marta Larusdottir, Virpi Roto, Rosa Lanzilotti, and Ioana Visescu</i>	

## Industrial Experiences

How to Bring Diversity into Industry: Industrial Experiences in Public Transport Repair and Maintenance .....	267
<i>Rafael Vrekar, Markus Steinlechner, Patrick Rupprecht, Aaron Wedral, Marlies Negele, Maciej Palucki, Brigitte Ratzer, and Astrid Weiss</i>	
Whose Responsibility is Accessibility in Games Anyway? Everyone .....	273
<i>Christopher Power, Paul Cairns, Mark Barlet, and Steven Weitz</i>	

## Interactive Demonstrations

A Toolkit for Human-Centred Engineering: An Experience with Pre-teens .....	281
<i>Rosella Gennari, Soufiane Krik, and Alessandra Melonio</i>	
Color Blind: A Figma Plugin to Simulate Colour Blindness .....	286
<i>Kishan Kanakhara, Drishya Bhattarai, and Sayan Sarcar</i>	
Comfort Management Through a Universal Wheelchair Dashboard .....	290
<i>Andreas Polydorides and Yvonne Rogers</i>	
Dataslip: How Far Does Your Personal Data Go? .....	295
<i>Alejandra Gómez Ortega, Vasileios Miliadis, James Scott Broadhead, Carlo van der Valk, and Jacky Bourgeois</i>	
Ingá Telikit: A Virtual Reality Game for Learning Penan's Hunting Techniques .....	300
<i>Tariq Zaman, Bram Kreuger, Vanden Michael, Diana Azlyn William, and Taman Pitah</i>	
StoryCarnival: Inspiring Play with Stories and an Enhanced Puppet .....	305
<i>Flannery Hope Currin and Juan Pablo Hourcade</i>	
Together Porting: Multi-user Locomotion in Social Virtual Reality .....	310
<i>Gavin Wood and Patrick Dickinson</i>	

Towards “Image Reflow” on the Web: Avoiding Excessive Panning  
of Magnified Images by Multiplexing Automatically Cropped Regions  
of Interest ..... 315  
*Frode Eika Sandnes*

Two Domain-Specific Languages for Controlling a Humanoid Robot  
in a Therapeutic Context ..... 320  
*Peter Forbrig, Alexandru Umlauf, Mathias Kühn, and Anke Dittmar*

Using Polymorphic Glyphs to Support the Visual Exploration  
of Hierarchical Spatio-Temporal Data ..... 325  
*Aline Menin, Hadil Ayari, Franck Michel, and Marco Winckler*

**Keynotes**

A Framework for Born-Accessible Development of Software and Digital  
Content ..... 333  
*Jonathan Lazar*

Why We Do What We Do – HCI and Societal Impact ..... 339  
*Jan Gulliksen*

**Panels**

A Multi-perspective Panel on User-Centred Transparency, Explainability,  
and Controllability in Automations ..... 349  
*Philippe Palanque, Fabio Paternò, Virpi Roto, Albrecht Schmidt,  
Simone Stumpf, and Jürgen Ziegler*

Ethical Value Exchange in HCI ..... 354  
*Jose Abdelnour-Nocera, Marta Kristín Lárusdóttir, Jonathan Lazar,  
Helen Petrie, Gavin Sim, and Tariq Zaman*

**Posters**

A Comparative Analysis of Multi-Object Animation with Motion Paths  
in Virtual Reality ..... 363  
*Tobias Krogh Risom, Jonas Rommel Attrup, Rasmus Valentin Jacobsen,  
Stefan Alexander Larsen, and Jesper Gaarsdal*

A Human-Robot Conversation Interface for Children with ASD ..... 368  
*Jena Affleck, Sean Gooravin, Cameron Malcolm, Sarah McHutchison,  
Andrew Shearer, Cameron Watt, and Andrea Alessandrini*

A Literature Review on Positive and Negative Effects of Interruptions and Implications for Design .....	373
<i>Tom Gross and Michael von Kalben</i>	
A New Interactive Paradigm for Speech Therapy .....	380
<i>Vita Barletta, Miriana Calvano, Antonio Curci, and Antonio Piccinno</i>	
A Simple Evaluation Framework for Enhanced Usability and Accessibility of Cultural Heritage Information Systems .....	386
<i>Zainab AlMeraj</i>	
A Study on Prototyping in a Design Course .....	391
<i>Andrea Alessandrini</i>	
A Theoretical Framework for the Development of “Needy” Socially Assistive Robots .....	396
<i>Nathan Jones, Fernando Loizides, and Kathryn Jones</i>	
AllyChat: Developing a VR Conversational AI Agent Using Few-Shot Learning to Support Individuals with Intellectual Disabilities .....	402
<i>Brittany Garcia-Pi, Rohan Chaudhury, Miles Versaw, Jonathan Back, Dongjin Kwon, Caleb Kicklighter, Paul Taele, and Jinsil Hwaryoung Seo</i>	
An Approach to Evaluate User Interfaces in a Scholarly Knowledge Communication Domain .....	408
<i>Denis Obrezkov, Allard Oelen, and Sören Auer</i>	
Are Italian and French Public University Websites Sustainable? .....	413
<i>Barbara Rita Barricelli, Ines Di Loreto, Michele Sciarabba, and Samir Zamouma</i>	
Are You Okay? Development of Electronic Check-In Systems for Isolated Older Adults .....	418
<i>Pallabi Bhowmick and Erik Stolterman</i>	
Availability for Work, Family, and Leisure: An Empirical Study .....	423
<i>Tom Gross</i>	
Better Real-Life Space Utilization in VR Through a Multimodal Guardian Alternative .....	429
<i>Jonas Lind, Kristian Sørensen, Arlonsompoon Lind, Mads Sørensen, Jakob Trærup, and Ivan Nikolov</i>	

Building Teamwork: Mixed Reality Game for Developing Trust and Communication .....	434
<i>Kristian Jespersen, Kristian Julsgaard, Jens Lakmann Madsbøll, Mathias Øgaard Niebuhr, Marcus Høyen Lundbak, Rasmus Odgaard, and Ivan Nikolov</i>	
Coding with Colors: Children’s Errors Committed While Programming Robotito for the First Time .....	439
<i>Ewelina Bakala, Ana C. Pires, Mariana da Luz, María Pascale, Gonzalo Tejera, and Juan Pablo Hourcade</i>	
Design and Development of an Immersive Virtual Reality Application to Reduce Anxiety in Young Adults .....	444
<i>Henar Guillen-Sanz, Ines Miguel-Alonso, Itziar Quevedo Varona, and Bruno Rodriguez-Garcia</i>	
Designing AR Applications for People Living with Dementia .....	449
<i>Teresa Onorati, Paloma Díaz, Álvaro Montero, and Ignacio Aedo</i>	
Designing Interaction to Support Sustained Attention .....	454
<i>Naile Hacioglu, Maria Chiara Leva, and Hyowon Lee</i>	
Digital Educational Games with Storytelling for Students to Learn Algebra ....	459
<i>Kubra Kaymakci Ustuner, Effie Lai-Chong Law, and Frederick W. B. Li</i>	
Distinguishing User Paths for Personas and Stakeholders Through Motives and Decision Making .....	464
<i>Megan Marie Doherty</i>	
Embodied PointCloud: Combining Embodied Avatars with Point Clouds to Represent Users in VR Remote Meetings .....	469
<i>Amal Yassien, Yusuf Badawi, and Slim Abdennadher</i>	
Enhancing Learnability with Micro Teachings .....	475
<i>Katja Pott and Doris Agotai</i>	
Exploring Responsible AI Practices in Dutch Media Organizations .....	481
<i>Tina Mioch, Nathalie Stembert, Cathelijn Timmers, Oumaima Hajri, Pascal Wiggers, and Maaike Harbers</i>	
Exploring Users’ Ability to Choose a Proper Fit in Smart-Rings: A Year-Long “In the Wild” Study .....	486
<i>Peter Neigel, Andrew Vargo, Yusuke Komatsu, Chris Blakely, and Koichi Kise</i>	

Heuristics to Design Trustworthy Technologies: Study Design and Current Progress .....	491
<i>Iuliia Paramonova, Sonia Sousa, and David Lamas</i>	
Influences of Cognitive Styles on EEG-Based Activity: An Empirical Study on Visual Content Comprehension .....	496
<i>Maria Trigka, Georgios Papadoulis, Elias Dritsas, and Christos Fidas</i>	
Interactive 3D Printed Urban Maps for Blind People .....	501
<i>Malgorzata Telesinska and Boleslaw Telesinski</i>	
Interactive Visualization of Sport Climbing Data .....	507
<i>Fangze Qiu and Yue Li</i>	
Interactors, not Users! Towards a Neutral Interaction Design .....	512
<i>Sónia Rafael</i>	
Lessons Learned from Designing and Implementing Interaction Mechanics for Viewer Participation in Game Streaming .....	517
<i>Pavel Mrázek, Pejman Mirza-Babaei, Günter Wallner, and Simone Kriglstein</i>	
Mapping the Digital Injustices of Technology-Facilitated Sex Trafficking .....	523
<i>Linnea Öhlund and Teresa Almeida</i>	
MetaCUX: Social Interaction and Collaboration in the Metaverse .....	528
<i>Paola Barra, Andrea Antonio Cantone, Rita Francese, Marco Giammetti, Raffaele Sais, Otino Pio Santosuosso, Aurelio Sepe, Simone Spera, Genoveffa Tortora, and Giuliana Vitiello</i>	
Multisensory Climbing in the Magic Room .....	533
<i>Matteo Secco, Mattia Gianotti, Alessandro Colombo, and Franca Garzotto</i>	
News Bulletins Supporting Human Memory .....	539
<i>Ian D. Benest</i>	
PECSOnline: A Bespoke Classroom Based Picture Exchange Communication System (PECS) for Children with Autism .....	544
<i>Joseph Liu, Becky Stephens, Chra Abdoulqadir, and Fernando Loizides</i>	
Prediction of Love-Like Scores After Speed Dating Based on Pre-obtainable Personal Characteristic Information .....	551
<i>Ryo Ishii, Fumio Nihei, Yoko Ishii, Atsushi Otsuka, Kazuya Matsuo, Narichika Nomoto, Atsushi Fukayama, and Takao Nakamura</i>	

SamS-Vis: A Tool to Visualize Summary View Using Sampled Data ..... 557  
*Shah Rukh Humayoun, Salman Zaidi, and Ragaad AlTarawneh*

They Need to Know and Learn – Gamified Social Communication  
Framework for Adolescent Reproductive Health and Well Being ..... 563  
*Debjani Roy and Urmi Nanda Biswas*

Towards Cross-Cultural Assessment of Trust in High-Risk AI ..... 569  
*Gabriela Beltrão, Sonia Sousa, and David Lamas*

Towards Enhancing the Media Industry Through AI-Driven Image  
Recommendations ..... 574  
*George E. Raptis, Vasilis Theodorou, and Christina Katsini*

Using Virtual Reality to Investigate the Emergence of Gaze Conventions  
in Interpersonal Coordination ..... 580  
*Gregory Mills and Remko Boschker*

What’s in a Name? How Perceived Music Playlist Personalization  
Influences Content Expectations ..... 585  
*Bruce Ferwerda, Nina Boksjö, Naomi Petricioiu, and Carolin Wollny*

Where Do All Stakeholders Find the Software Product Blueprint? ..... 590  
*Shah Rukh Humayoun, Yael Dubinsky, Kerri Kariti, and Moshe Kariti*

Why Choose You? - Exploring Attitudes Towards Starter Pokémon ..... 595  
*Toby Best and Yu-Jhen Hsu*

**Workshops**

Algorithmic Affordances in Recommender Interfaces ..... 605  
*Aletta Smits, Ester Bartels, Chris Detweiler, and Koen van Turnhout*

Co-designing Immersive Virtual and Extended Reality Systems for Remote  
and Unsupervised Interaction, Intervention, Training and Research ..... 610  
*Wiesław Kopeć, Monika Kornacka, Grzegorz Pochwatko, Cezary Biele,  
Anna Jaskulska, Kinga Skorupska, Steven Barnes, Maciej Grzeszczuk,  
Tommy Nilsson, Wladyslaw Fuchs, Jagoda Lazarek, Krzysztof Pijarski,  
and Gabriel G. de la Torre*

Designing for Map-Based Interfaces and Interactions ..... 616  
*Masood Masoodian and Saturnino Luz*

Designing Technology for Neurodivergent Self-determination: Challenges and Opportunities .....	621
<i>David Gollasch, Meinhardt Branig, Kathrin Gerling, Jan Gulliksen, Oussama Metatla, Katta Spiel, and Gerhard Weber</i>	
HCI for Digital Democracy and Citizen Participation .....	627
<i>Jose Abdelnour Nocera, Juan José Gómez Gutiérrez, María Estela Peralta Álvarez, and Lene Nielsen</i>	
HCI-E <sup>2</sup> -2023: Second IFIP WG 2.7/13.4 Workshop on HCI Engineering Education .....	632
<i>José Creissac Campos, Laurence Nigay, Alan Dix, Anke Dittmar, Simone D. J. Barbosa, and Lucio Davide Spano</i>	
Human-Centered Software Engineering: Rethinking the Interplay of Human–Computer Interaction and Software Engineering in the Age of Digital Transformation .....	638
<i>Carmelo Ardito, Regina Bernhaupt, and Stefan Sauer</i>	
Intelligence Augmentation: Future Directions and Ethical Implications in HCI .....	644
<i>Andrew Vargo, Benjamin Tag, Mathilde Hutin, Victoria Abou-Khalil, Shoya Ishimaru, Olivier Augereau, Tilman Dingler, Motoi Iwata, Koichi Kise, Laurence Devillers, and Andreas Dengel</i>	
Interacting with Assistive Technology (IATech) Workshop .....	650
<i>Paul Whittington, Huseyin Dogan, and Nan Jiang</i>	
On Land, at Sea, and in the Air: Human-Computer Interaction in Safety-Critical Spaces of Control: IFIP WG 13.5 Workshop at INTERACT 2023 .....	657
<i>Tilo Mentler, Philippe Palanque, Kristof Van Laerhoven, Margareta Holtensdotter Lützhöft, and Nadine Flegel</i>	
Playful, Curious, Creative, Equitable: Exploring Opportunities for AI Technologies with Older Adults .....	662
<i>Ewan Soubutts, Aneesha Singh, Bran Knowles, Amid Ayobi, Nervo Verdezeto Dias, Britta Schulte, Julia McDowell, Caroline Swarbrick, Andrew Steptoe, Jasmine Fledderjohann, Helen Petrie, Richard Harper, and Yvonne Rogers</i>	
Re-contextualizing Built Environments: Critical and Inclusive HCI Approaches for Cultural Heritage .....	668
<i>Linda Hirsch, Siiri Paananen, Eva Hornecker, Luke Hespanhol, Tsvi Kuflik, Tatiana Losev, and Jonna Häkkinä</i>	



<b>Sustainable Human-Work Interaction Designs .....</b>	<b>674</b>
<i>Elodie Bouzekri, Barbara Rita Barricelli, Torkil Clemmensen, Morten Hertzum, and Masood Masoodian</i>	
<b>Understanding HCI Approaches for the Metaverse in Education Applications for the Global South .....</b>	<b>680</b>
<i>Anmol Srivastava, Torkil Clemmensen, Pradeep Yammiyavar, and Pankaj Badoni</i>	
<b>VR Accessibility in Distance Adult Education .....</b>	<b>685</b>
<i>Bartosz Muczyński, Kinga Skorupska, Katarzyna Abramczuk, Cezary Biele, Zbigniew Bohdanowicz, Daniel Cnotkowski, Jazmin Collins, Wiesław Kopeć, Jarosław Kowalski, Grzegorz Pochwatko, and Thomas Logan</i>	
<b>Author Index .....</b>	<b>693</b>