

Lecture Notes in Artificial Intelligence

11580

Subseries of Lecture Notes in Computer Science

Series Editors

Randy Goebel

University of Alberta, Edmonton, Canada

Yuzuru Tanaka

Hokkaido University, Sapporo, Japan

Wolfgang Wahlster

DFKI and Saarland University, Saarbrücken, Germany

Founding Editor

Jörg Siekmann

DFKI and Saarland University, Saarbrücken, Germany

More information about this series at <http://www.springer.com/series/1244>

Dylan D. Schmorrow · Cali M. Fidopiastis (Eds.)

Augmented Cognition

13th International Conference, AC 2019

Held as Part of the 21st HCI International Conference, HCII 2019

Orlando, FL, USA, July 26–31, 2019

Proceedings

Editors

Dylan D. Schmorrow
Soar Technology Inc.
Orlando, FL, USA

Cali M. Fidopiastis
Design Interactive, Inc.
Orlando, FL, USA

ISSN 0302-9743 ISSN 1611-3349 (electronic)

Lecture Notes in Artificial Intelligence

ISBN 978-3-030-22418-9 ISBN 978-3-030-22419-6 (eBook)

<https://doi.org/10.1007/978-3-030-22419-6>

LNCS Sublibrary: SL7 – Artificial Intelligence

© Springer Nature Switzerland AG 2019

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

The 21st International Conference on Human-Computer Interaction, HCI International 2019, was held in Orlando, FL, USA, during July 26–31, 2019. The event incorporated the 18 thematic areas and affiliated conferences listed on the following page.

A total of 5,029 individuals from academia, research institutes, industry, and governmental agencies from 73 countries submitted contributions, and 1,274 papers and 209 posters were included in the pre-conference proceedings. These contributions address the latest research and development efforts and highlight the human aspects of design and use of computing systems. The contributions thoroughly cover the entire field of human-computer interaction, addressing major advances in knowledge and effective use of computers in a variety of application areas. The volumes constituting the full set of the pre-conference proceedings are listed in the following pages.

This year the HCI International (HCII) conference introduced the new option of “late-breaking work.” This applies both for papers and posters and the corresponding volume(s) of the proceedings will be published just after the conference. Full papers will be included in the *HCII 2019 Late-Breaking Work Papers Proceedings* volume of the proceedings to be published in the Springer LNCS series, while poster extended abstracts will be included as short papers in the *HCII 2019 Late-Breaking Work Poster Extended Abstracts* volume to be published in the Springer CCIS series.

I would like to thank the program board chairs and the members of the program boards of all thematic areas and affiliated conferences for their contribution to the highest scientific quality and the overall success of the HCI International 2019 conference.

This conference would not have been possible without the continuous and unwavering support and advice of the founder, Conference General Chair Emeritus and Conference Scientific Advisor Prof. Gavriel Salvendy. For his outstanding efforts, I would like to express my appreciation to the communications chair and editor of *HCI International News*, Dr. Abbas Moallem.

July 2019

Constantine Stephanidis

HCI International 2019 Thematic Areas and Affiliated Conferences

Thematic areas:

- HCI 2019: Human-Computer Interaction
- HIMI 2019: Human Interface and the Management of Information

Affiliated conferences:

- EPCE 2019: 16th International Conference on Engineering Psychology and Cognitive Ergonomics
- UAHCI 2019: 13th International Conference on Universal Access in Human-Computer Interaction
- VAMR 2019: 11th International Conference on Virtual, Augmented and Mixed Reality
- CCD 2019: 11th International Conference on Cross-Cultural Design
- SCSM 2019: 11th International Conference on Social Computing and Social Media
- AC 2019: 13th International Conference on Augmented Cognition
- DHM 2019: 10th International Conference on Digital Human Modeling and Applications in Health, Safety, Ergonomics and Risk Management
- DUXU 2019: 8th International Conference on Design, User Experience, and Usability
- DAPI 2019: 7th International Conference on Distributed, Ambient and Pervasive Interactions
- HCIBGO 2019: 6th International Conference on HCI in Business, Government and Organizations
- LCT 2019: 6th International Conference on Learning and Collaboration Technologies
- ITAP 2019: 5th International Conference on Human Aspects of IT for the Aged Population
- HCI-CPT 2019: First International Conference on HCI for Cybersecurity, Privacy and Trust
- HCI-Games 2019: First International Conference on HCI in Games
- MobiTAS 2019: First International Conference on HCI in Mobility, Transport, and Automotive Systems
- AIS 2019: First International Conference on Adaptive Instructional Systems

Pre-conference Proceedings Volumes Full List

1. LNCS 11566, Human-Computer Interaction: Perspectives on Design (Part I), edited by Masaaki Kurosu
2. LNCS 11567, Human-Computer Interaction: Recognition and Interaction Technologies (Part II), edited by Masaaki Kurosu
3. LNCS 11568, Human-Computer Interaction: Design Practice in Contemporary Societies (Part III), edited by Masaaki Kurosu
4. LNCS 11569, Human Interface and the Management of Information: Visual Information and Knowledge Management (Part I), edited by Sakae Yamamoto and Hirohiko Mori
5. LNCS 11570, Human Interface and the Management of Information: Information in Intelligent Systems (Part II), edited by Sakae Yamamoto and Hirohiko Mori
6. LNAI 11571, Engineering Psychology and Cognitive Ergonomics, edited by Don Harris
7. LNCS 11572, Universal Access in Human-Computer Interaction: Theory, Methods and Tools (Part I), edited by Margherita Antona and Constantine Stephanidis
8. LNCS 11573, Universal Access in Human-Computer Interaction: Multimodality and Assistive Environments (Part II), edited by Margherita Antona and Constantine Stephanidis
9. LNCS 11574, Virtual, Augmented and Mixed Reality: Multimodal Interaction (Part I), edited by Jessie Y. C. Chen and Gino Fragomeni
10. LNCS 11575, Virtual, Augmented and Mixed Reality: Applications and Case Studies (Part II), edited by Jessie Y. C. Chen and Gino Fragomeni
11. LNCS 11576, Cross-Cultural Design: Methods, Tools and User Experience (Part I), edited by P. L. Patrick Rau
12. LNCS 11577, Cross-Cultural Design: Culture and Society (Part II), edited by P. L. Patrick Rau
13. LNCS 11578, Social Computing and Social Media: Design, Human Behavior and Analytics (Part I), edited by Gabriele Meiselwitz
14. LNCS 11579, Social Computing and Social Media: Communication and Social Communities (Part II), edited by Gabriele Meiselwitz
15. LNAI 11580, Augmented Cognition, edited by Dylan D. Schmorow and Cali M. Fidopiastis
16. LNCS 11581, Digital Human Modeling and Applications in Health, Safety, Ergonomics and Risk Management: Human Body and Motion (Part I), edited by Vincent G. Duffy

17. LNCS 11582, Digital Human Modeling and Applications in Health, Safety, Ergonomics and Risk Management: Healthcare Applications (Part II), edited by Vincent G. Duffy
18. LNCS 11583, Design, User Experience, and Usability: Design Philosophy and Theory (Part I), edited by Aaron Marcus and Wentao Wang
19. LNCS 11584, Design, User Experience, and Usability: User Experience in Advanced Technological Environments (Part II), edited by Aaron Marcus and Wentao Wang
20. LNCS 11585, Design, User Experience, and Usability: Application Domains (Part III), edited by Aaron Marcus and Wentao Wang
21. LNCS 11586, Design, User Experience, and Usability: Practice and Case Studies (Part IV), edited by Aaron Marcus and Wentao Wang
22. LNCS 11587, Distributed, Ambient and Pervasive Interactions, edited by Norbert Streitz and Shin'ichi Konomi
23. LNCS 11588, HCI in Business, Government and Organizations: eCommerce and Consumer Behavior (Part I), edited by Fiona Fui-Hoon Nah and Keng Siau
24. LNCS 11589, HCI in Business, Government and Organizations: Information Systems and Analytics (Part II), edited by Fiona Fui-Hoon Nah and Keng Siau
25. LNCS 11590, Learning and Collaboration Technologies: Designing Learning Experiences (Part I), edited by Panayiotis Zaphiris and Andri Ioannou
26. LNCS 11591, Learning and Collaboration Technologies: Ubiquitous and Virtual Environments for Learning and Collaboration (Part II), edited by Panayiotis Zaphiris and Andri Ioannou
27. LNCS 11592, Human Aspects of IT for the Aged Population: Design for the Elderly and Technology Acceptance (Part I), edited by Jia Zhou and Gavriel Salvendy
28. LNCS 11593, Human Aspects of IT for the Aged Population: Social Media, Games and Assistive Environments (Part II), edited by Jia Zhou and Gavriel Salvendy
29. LNCS 11594, HCI for Cybersecurity, Privacy and Trust, edited by Abbas Moallem
30. LNCS 11595, HCI in Games, edited by Xiaowen Fang
31. LNCS 11596, HCI in Mobility, Transport, and Automotive Systems, edited by Heidi Krömker
32. LNCS 11597, Adaptive Instructional Systems, edited by Robert Sottilare and Jessica Schwarz
33. CCIS 1032, HCI International 2019 - Posters (Part I), edited by Constantine Stephanidis

34. CCIS 1033, HCI International 2019 - Posters (Part II), edited by Constantine Stephanidis
35. CCIS 1034, HCI International 2019 - Posters (Part III), edited by Constantine Stephanidis

<http://2019.hci.international/proceedings>



13th International Conference on Augmented Cognition (AC 2019)

**Program Board Chair(s): Dylan D. Schmorrow
and Cali M. Fidopiastis, USA**

- Brendan Allison, USA
- Amy Bolton, USA
- Micah Clark, USA
- Martha Crosby, USA
- Fausto De Carvalho, Portugal
- Daniel Dolgin, USA
- Sven Fuchs, Germany
- Rodolphe Gentili, USA
- Scott S. Grigsby, USA
- Katy Hancock, USA
- Monte Hancock, USA
- Frank Hannigan, USA
- Robert Hubal, USA
- Kurtulus Izzetoglu, USA
- Øyvind Jøsok, Norway
- Ion Juvina, USA
- Benjamin Knott, USA
- Benjamin Knox, Norway
- Julie Marble, USA
- Chang S. Nam, USA
- Banu Onaral, USA
- Sarah Ostadabbas, USA
- Lesley Perg, USA
- Robinson Pino, USA
- Mannes Poele, The Netherlands
- Lauren Reinerman-Jones, USA
- Stefan Sütterlin, Norway
- Suraj Sood, USA
- Ayoung Suh, Hong Kong, SAR China
- Georgios Triantafyllidis, Denmark
- Christian Wagner, Hong Kong, SAR China
- Melissa Walwanis, USA
- Quan Wang, USA
- Martin Westhoven, Germany

The full list with the Program Board Chairs and the members of the Program Boards of all thematic areas and affiliated conferences is available online at:

<http://www.hci.international/board-members-2019.php>



HCI International 2020

The 22nd International Conference on Human-Computer Interaction, HCI International 2020, will be held jointly with the affiliated conferences in Copenhagen, Denmark, at the Bella Center Copenhagen, July 19–24, 2020. It will cover a broad spectrum of themes related to HCI, including theoretical issues, methods, tools, processes, and case studies in HCI design, as well as novel interaction techniques, interfaces, and applications. The proceedings will be published by Springer. More information will be available on the conference website: <http://2020.hci.international/>

General Chair

Prof. Constantine Stephanidis

University of Crete and ICS-FORTH

Heraklion, Crete, Greece

E-mail: general_chair@hcii2020.org

<http://2020.hci.international/>



Contents

Cognitive Modeling, Perception, Emotion and Interaction

Creating Affording Situations with Animate Objects	3
<i>Chris Baber, Sara Al-Tunaib, and Ahmed Khattab</i>	
FUNii: The Physio-Behavioural Adaptive Video Game	14
<i>Alexis Fortin-Côté, Nicolas Beaudoin-Gagnon, Cindy Chamberland, Frédéric Desbiens, Ludovic Lefebvre, Jérémy Bergeron, Alexandre Campeau-Lecours, Sébastien Tremblay, and Philip L. Jackson</i>	
Deriving Features for Designing Ambient Media.	29
<i>Kota Gushima, Shuma Toyama, Yukiko Kinoshita, and Tatsuo Nakajima</i>	
Cognitive Dissonance in a Multi-mind Automated Decision System	41
<i>Monte Hancock, Antoinette Hadgis, Katy Hancock, Benjamin Bowles, Payton Brown, and Tyler Higgins</i>	
A Hierarchical Characterization of Knowledge for Cognition	58
<i>Monte Hancock, Jared Stiers, Tyler Higgins, Fiona Swarr, Michael Shrider, and Suraj Sood</i>	
A Study on the Development of the Psychological Assessment a Using Eye-Tracking: Focused on Eye Gaze Processing of Literacy Text	74
<i>Joon Hyun Jeon, Gyoung Kim, and Jeong Ae Kim</i>	
Impedances of Memorable Passphrase Design on Augmented Cognition	84
<i>Lila A. Loos, Michael-Brian Ogawa, and Martha E. Crosby</i>	
Tokens of Interaction: Psychophysiological Signals, a Potential Source of Evidence of Digital Incidents	93
<i>Nancy Mogire, Randall K. Minas, and Martha E. Crosby</i>	
The Artificial Facilitator: Guiding Participants in Developing Causal Maps Using Voice-Activated Technologies.	111
<i>Thrishma Reddy, Philippe J. Giabbanelli, and Vijay K. Mago</i>	

Human Cognition and Behavior in Complex Tasks and Environments

Augmented Cognition for Socio-Technical Systems.	133
<i>Scott David and Barbara Endicott-Popovsky</i>	

Using Eye Tracking to Assess the Navigation Efficacy of a Medical Proxy Decision Tool	143
<i>Soussan Djamasbi, Bengisu Tulu, Javad Norouzi Nia, Andrew Aberdale, Christopher Lee, and Susanne Muehlschlegel</i>	
Considerations for Human-Machine Teaming in Cybersecurity	153
<i>Steven R. Gomez, Vincent Mancuso, and Diane Staheli</i>	
Do We Need “Teaming” to Team with a Machine?	169
<i>Craig Haimson, Celeste Lyn Paul, Sarah Joseph, Randall Rohrer, and Bohdan Nebesh</i>	
Automating Crime Informatics to Inform Public Policy	179
<i>Katy Hancock and Monte Hancock</i>	
Visualizing Parameter Spaces of Deep-Learning Machines	192
<i>Monte Hancock, Antoinette Hadgis, Benjamin Bowles, Payton Brown, Alexis Wahlid Ahmed, Tyler Higgins, and Nikki Bernobic</i>	
Geometrically Intuitive Rendering of High-Dimensional Data	211
<i>Monte Hancock, Kristy Sproul, Jared Stiers, Benjamin Bowles, Fiona Swarr, Jason Privette, Michael Shrider, and Antoinette Hadgis</i>	
Enacting Virtual Reality: The Philosophy and Cognitive Science of Optimal Virtual Experience	225
<i>Garri Hovhannisyan, Anna Henson, and Suraj Sood</i>	
The Impact of Game Peripherals on the Gamer Experience and Performance	256
<i>Xiaobo Ke and Christian Wagner</i>	
Biomimicry and Machine Learning in the Context of Healthcare Digitization.	273
<i>Corinne Lee, Suraj Sood, Monte Hancock, Tyler Higgins, Kristy Sproul, Antoinette Hadgis, and Stefan Joe-Yen</i>	
Facilitating Cluster Counting in Multi-dimensional Feature Space by Intermediate Information Grouping	284
<i>Chloe Chun-wing Lo, Jishnu Chowdhury, Markus Hollander, Alexis-Walid Ahmed, Suraj Sood, Kristy Sproul, and Antoinette Hadgis</i>	
Training to Instill a Cyber-Aware Mindset	299
<i>Kelly Neville, Larry Flint, Lauren Massey, Alex Nickels, Jose Medina, and Amy Bolton</i>	

Demonstrably Safe Self-replicating Manufacturing Systems: Banishing the Halting Problem—Organizational and Finite State Machine Control Paradigms.	312
<i>Eli M. Rabani and Lesley A. Perg</i>	
Usability Inspection of a Mobile Clinical Decision Support App and a Short Form Heuristic Evaluation Checklist.	331
<i>Blaine Reeder, Cynthia Drake, Mustafa Ozkaynak, Wallace Jones, David Mack, Alexandria David, Raven Starr, Barbara Trautner, and Heidi L. Wald</i>	
Holarchic Psychoinformatics: A Mathematical Ontology for General and Psychological Realities	345
<i>Suraj Sood, Corinne Lee, Garri Hovhannisyan, Shannon Lee, Garrett Rozier, Antoinette Hadgis, Kristy Sproul, Tyler Higgins, Anna Henson, Michael Shrider, and Monte Hancock</i>	
Computing with Words — A Framework for Human-Computer Interaction . . .	356
<i>Dan Tamir, Shai Neumann, Naphtali Rishé, Abe Kandel, and Lotfi Zadeh</i>	
Brain-Computer Interfaces and Electroencephalography	
Assessing Correlation Between Virtual Reality Based Serious Gaming Performance and Cognitive Workload Changes via Functional Near Infrared Spectroscopy	375
<i>Emin Aksoy, Kurtulus Izzetoglu, Banu Onaral, Dilek Kitapcioglu, Mehmet Erhan Sayali, and Feray Guven</i>	
Construction of Air Traffic Controller’s Decision Network Using Error-Related Potential.	384
<i>Sim Kuan Goh, Ngoc Phu Tran, Duc-Thinh Pham, Sameer Alam, Kurtulus Izzetoglu, and Vu Duong</i>	
UAS Operator Workload Assessment During Search and Surveillance Tasks Through Simulated Fluctuations in Environmental Visibility	394
<i>Jaime Kerr, Pratusha Reddy, Shahar Kosti, and Kurtulus Izzetoglu</i>	
Processing Racial Stereotypes in Virtual Reality: An Exploratory Study Using Functional Near-Infrared Spectroscopy (fNIRS)	407
<i>Gyoung Kim, Noah Buntain, Leanne Hirshfield, Mark R. Costa, and T. Makana Chock</i>	
An Enactive Perspective on Emotion: A Case Study on Monitoring Brainwaves	418
<i>Vanessa Regina Margareth Lima Maike and M. Cecilia C. Baranauskas</i>	

An Immersive Brain Painting: The Effects of Brain Painting in a Virtual Reality Environment.	436
<i>Willie McClinton, Sarah Garcia, and Marvin Andujar</i>	
Predicting Java Computer Programming Task Difficulty Levels Using EEG for Educational Environments.	446
<i>Ramaswamy Palaniappan, Aruna Duraisingam, Nithyakalyani Chinnaiiah, and Murugappan Murugappan</i>	
Towards Hybrid Multimodal Brain Computer Interface for Robotic Arm Command.	461
<i>Cristian-Cezar Postelnicu, Florin Girbacia, Gheorghe-Daniel Voinea, and Razvan Boboc</i>	
Interpolation, a Model for Sound Representation Based on BCI	471
<i>Hector Fabio Torres-Cardona, Catalina Aguirre-Grisales, Victor Hugo Castro-Londoño, and Jose Luis Rodriguez-Sotelo</i>	
Wavelet Packet Entropy Analysis of Resting State Electroencephalogram in Sleep Deprived Mental Fatigue State	484
<i>Yanjing Wang, Zhongqi Liu, Qianxiang Zhou, and Xuewei Chen</i>	
Augmented Learning	
Holographic and Related Technologies for Medical Simulation	497
<i>Christine Allen, Sasha Willis, Claudia Hernandez, Andrew Wismer, Brian Goldiez, Grace Teo, Lauren Reinerman-Jones, Mark Mazzeo, and Matthew Hackett</i>	
Nature Inspired Scenes for Guided Mindfulness Training: Presence, Perceived Restorativeness and Meditation Depth.	517
<i>Mark R. Costa, Dessa Bergen-Cico, Trevor Grant, Rocio Herrero, Jessica Navarro, Rachel Razza, and Qiu Wang</i>	
Calculating Cognitive Augmentation – A Case Study	533
<i>Ron Fulbright</i>	
Designing an Interactive Device to Slow Progression of Alzheimer’s Disease	546
<i>Ting-Ya Huang, Hsi-Jen Chen, and Fong-Gong Wu</i>	
Cognitive Profiles and Education of Female Cyber Defence Operators.	563
<i>Ricardo G. Lugo, Andrea Firth-Clark, Benjamin J. Knox, Øyvind Jøsok, Kirsi Helkala, and Stefan Sütterlin</i>	

Self-control Strategies: Interpreting and Enhancing Augmented Cognition from a Self-regulatory Perspective	573
<i>Mina Milosevic, Nicholas A. Moon, Michael W. McFerran, Sherif al-Qallawi, Lida P. Ponce, Chris Juszczuk, and Patrick D. Converse</i>	
Guided Mindfulness: New Frontier to Augmented Learning	586
<i>Nisha Quraishi, Nicholas A. Moon, Katherine Rau, Lida P. Ponce, Mina Milosevic, Katrina Merlini, and Richard L. Griffith</i>	
Reading Behavior and Comprehension of C++ Source Code - A Classroom Study	597
<i>Jonathan A. Saddler, Cole S. Peterson, Patrick Peachock, and Bonita Sharif</i>	
Self-regulated Learning and Expertise: Dual Cognitive Processes	617
<i>Webb Stacy, Jeffrey M. Beaubien, and Tara Brown</i>	
Clarifying Cognitive Flexibility from a Self-regulatory Perspective	631
<i>Melissa M. Walwanis and Shelby-Jo Ponto</i>	
Enhancing Simulated Students with Models of Self-regulated Learning	644
<i>Robert E. Wray</i>	
Author Index	655