RESEARCH METHODS IN HUMAN-COMPUTER INTERACTION

Second Edition

MORGAN KAUFMANN

Jonathan Lazar | Jinjuan Heidi Feng | Harry Hochheiser

"This is *the* research methods book that I recommend to my students and colleagues. And it's a time-saver: my students make fewer methodological mistakes and we can now engage in deeper and more insightful discussions about specific challenges of their research work. Every HCI student, researcher, and practitioner must read it!"—**Simone Barbosa**, Professor, PUC-Rio, Brazil, and co-Editor-in-Chief of *ACM Interactions*

"This is the book for you! Written in an accessible, engaging style and illustrated with examples and case studies from Google, Yahoo and the authors' own extensive experiences, this book should be on the desk of everyone doing HCI and UX design, development and research."—**Matt Jones**, Author of *There's Not an App for that: Mobile UX Design for Life*, and Professor of Computer Science, Future Interaction Technology Lab, Swansea University, UK

"This is the book that every researcher will want to read. Comprehensive and at the same time 'hand-holding', this book guides researchers through designing and running their own studies using both qualitative and quantitative methods. There's something in the book for everyone."—**Jenny Preece**, Professor, iSchool and Human-Computer Interaction Lab, University of Maryland, co-author of *Interaction Design* (4th edition)

"Aspiring accessibility researchers will find the final chapter packed with invaluable tips for avoiding common pitfalls when working with populations with disabilities. The authors' passion and deep experience shine through."—**Shari Trewin**, IBM Research, Chair of ACM Special Interest Group on Accessible Computing

"As a fan of the first edition who used it extensively in my research methods courses, I am thrilled to see the second edition expanded in exciting ways, especially around quantitative and qualitative data analysis. Also, the industrial case studies add real-world relevance to an already essential book."—**Jacob O. Wobbrock**, Professor at the Information School, University of Washington, Winner of the 2017 ACM SIGCHI Social Impact Award

Revised second edition of the leading textbook on quantitative and qualitative methods for conducting Human-Computer Interaction research

Research Methods in Human-Computer Interaction, Second Edition is a comprehensive guide to performing research and is essential reading for both quantitative and qualitative methods. Since the first edition was published in 2009, the book has been adopted for use at leading universities around the world, including Harvard University, Carnegie-Mellon University, the University of Washington, the University of Toronto, HiOA (Norway), KTH (Sweden), Tel Aviv University (Israel), and many others. Chapters cover a broad range of topics relevant to the collection and analysis of HCI data, going beyond experimental design and surveys, to cover ethnography, diaries, physiological measurements, case studies, crowdsourcing, and other essential elements in the well-informed HCI researcher's toolkit.

Key Features:

- Comprehensive and updated guide to the latest research methodologies and approaches
- Expanded discussions of online datasets, crowdsourcing, statistical tests, coding qualitative data, laws and regulations relating to the use of human participants, and data collection via mobile devices and sensors
- New material on performing research with children, older adults, and people with cognitive impairments, two new case studies from Google and Yahoo!, and techniques for expanding the influence of your research to reach non-researcher audiences, including software developers and policymakers

Authors:

Jonathan Lazar, Professor, Computer and Information Sciences, Towson University, and Shutzer Fellow, Radcliffe Institute for Advanced Study, Harvard University

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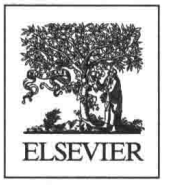

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Research Methods in Human-Computer Interaction

Critical Acclaim for *Research Methods in Human Computer Interaction,* Second Edition

"This book is an outstanding contribution to HCI's pedagogical and reference literature, reviewing and explaining the numerous research methods in common use. It motivates with numerous examples the methods in terms of posing questions and designing research to answer those questions. It covers well both quantitative and qualitative methods. The treatment is accessible and lively. The book should be considered for adoption by all HCI instructors."

—**Ron Baecker,** Member of the CHI Academy, Founder and Co-Director, Technologies for Aging Gracefully lab (TAGlab), and Professor Emeritus of Computer Science, University of Toronto

"This is *the* research methods book I recommend to my students and colleagues. And it's a time-saver: my students make fewer methodological mistakes and we can now engage in deeper and more insightful discussions about specific challenges of their research work. With this improved and updated edition, the bar is even higher! With increasing traces of our lives online and availability of Big Data in many research projects, the new chapter on online and ubiquitous HCI research was a welcome addition to the already comprehensive, multi-method research book. Every HCI student, researcher, and practitioner must read it!"

—**Simone Barbosa,** Professor, PUC-Rio, Brazil, and co-Editor-in-Chief of *ACM Interactions*

"Research Methods in HCI is an excellent resource for newcomers and seasoned HCI professionals alike. Covering all the basic methods for conducting research in HCI, concepts are explained clearly and brought alive through case studies and examples. In addition to offering how-to details, the text offers detailed rationale for why and when to use different methods. Some historical context and controversial viewpoints are also offered. Clear discussions around how to select participants and work with different populations are offered, as are ethical issues in conducting research. The attention to these kinds of details makes this a truly engaging, readable text. The extensive list of references offers plenty of scope for follow-up for those wishing to deepen their knowledge even further. The 2nd edition offers new and refreshed content, updated examples and case studies, and new references and resources."

—**Elizabeth Churchill,** Member of the CHI Academy, Secretary/Treasurer of ACM, currently Director of User Experience at Google, formerly Director of Human Computer Interaction at eBay

"This book by Lazar, Feng, and Hochheiser is a must read for anyone in the field of Human-Computer Interaction. Their multi-discipline approach, housed in the reality of the technological world today, makes for a practical and informative guide for user interface designers, software and hardware engineers and anyone doing user research."

—**Mary Czerwinski,** Principal Research Manager, Microsoft Research, Recipient of the ACM SIGCHI Lifetime Service Award, Member of the CHI Academy, and ACM Fellow

"This is a superb book for all researchers, practitioners, and students interested in the investigation of anything related to HCI. This new edition has much needed information on research methods in HCI that have become prevalent, including crowdsourcing as well as new creative ways to collect and analyze qualitative data, two examples of essential skills for today's HCI students! Highly recommended!"

—**Vanessa Evers,** Full Professor and Chair of Human Media Interaction, Scientific Director of the DesignLab, University of Twente, the Netherlands

"I recommend this book to all my PhD students. It provides excellent coverage of a range of HCI research methods, and importantly, the context for researchers to know how the methods relate to each other and how to choose a method that is appropriate for their own research question. The book is a very nice read. It is an excellent reference for HCI researchers, not only for those just starting out, but also for experienced researchers who would like to firm up their knowledge of HCI methods."

—**Faustina Hwang,** Associate Professor of Digital Health, Biomedical Engineering, University of Reading, UK

"This is the book for you! Whether you are a seasoned practitioner, a student starting out, an established professor, or someone just curious about how HCI finds answers to research questions. Clear, coherent and comprehensive, it covers the classical - like surveys and ethnography - and the highly contemporary, including online and automated methods. Written in an accessible, engaging style and illustrated with examples and case studies from Google, Yahoo and the authors' own extensive experiences, this book should be on the desk of everyone doing HCI and UX design, development and research".

—**Matt Jones,** Author of *Mobile Interaction Design* (Wiley) & *There's Not an App for that: Mobile UX Design for Life* (Morgan Kaufmann). Professor of Computer Science, Future Interaction Technology Lab, Swansea University, UK

"This book is a must-read for those who seek a broad view and in-depth understanding of HCI research methodologies. I have had the privilege of using the earlier version of this book for my HCI research method classes for both academic and professional programs -- it was extraordinarily useful for students and researchers in the HCI field. Now, this 2nd edition becomes even more valuable as it not only includes more content regarding quantitative methods, such as statistical analysis, but also totally revamped qualitative data analysis. This updated version will be an indispensable reference for both students and practitioners who want to enhance their research skills in HCI."

—**Jinwoo Kim,** Professor of HCI at Yonsei University, Korea, Founder and CEO at HAII

"As an educator and a researcher who frequently makes use of methods for gathering data from users, I was excited to see the variety and range of techniques for working with people presented in this book. It is also refreshing to see the book's emphasis on issues such as bias and ethics in research. The chapter that explicitly discusses best practices for working with participants with disabilities truly makes this book stand out. First, there is no equivalent resource that I know of on this topic. Second, I believe the lessons presented in this chapter can help to illustrate the importance of understanding and working with any population that is significantly different from the average undergraduate research participant featured in so many studies! Since HCI is expanding its domain more and more, this is a very timely lesson."

—**Jen Mankoff,** Professor, Human Computer Interaction Institute, Carnegie Mellon University, Chair of the SIGCHI Accessibility Community

"If you care about HCI research, then this book is a must-read. The book contains a broad coverage of methods and techniques for HCI research. This edition contains major additions to the previous version that are extremely timely, dealing with evolutions of interactive technologies and evolutions of knowledge in the area of HCI research. It is clear that the authors have applied the methods described in the book to understand their audience, building a book that is very pedagogic, blending a lot of knowledge in the field of HCI but still remaining easy to read, to understand and to apply for practitioners, students and lecturers in HCI."

—**Philippe Palanque,** Professor of Computer Science at Université Toulouse III, France, Chair of the CHI Conference Steering Committee, member of the CHI Academy, and co-editor of *The Handbook of Formal Methods in Human-Computer Interaction*

"This is the book that every researcher will want to read. Comprehensive and at the same time 'hand-holding', this book guides researchers through designing and

running their own studies using both qualitative and quantitative methods. Even seasoned researchers will want to dip in to check out details, while students will find this book particularly inspiring. There's something in the book for everyone."

—**Jenny Preece,** Professor, iSchool and Human-Computer Interaction Lab, University of Maryland, Member of the CHI Academy, co-author of *Interaction Design* (4th edition)

"Over the last 20 years research and practice in Human-Computer-Interaction have matured. An in-depth understanding of methods in this field is essential and is the key to success in research as well as in industry. The big question is how we teach and learn about these methods. Is a book in the digital age, in times when people are excited about MOOCs, and when video tutorials are everywhere, still an appropriate medium? Absolutely! This book is at the same time an accessible text book as well as a comprehensive reference. The topics are well selected and are highly relevant for students, researchers, and practitioners. Each chapter has a focus, communicates the basics, and teaches how to practically apply it. The new edition includes all the basics I would teach, and additionally provides a profound introduction to new topics, including Human-Computer Interaction in the context of online systems and ubiquitous computing."

—**Albrecht Schmidt,** Professor of Computer Science, Human Computer Interaction Group - VIS, University of Stuttgart, Germany

"Aspiring accessibility researchers will find the final chapter packed with invaluable tips for avoiding common pitfalls when working with populations with disabilities. The authors' passion and deep experience shine through."

—**Shari Trewin,** IBM Research, Chair of the ACM Special Interest Group on Accessible Computing (SIGACCESS)

"As a fan of the first edition who used it extensively in my research methods courses, I am thrilled to see the second edition expanded in exciting ways, especially around quantitative and qualitative data analysis. Also, the industrial case studies add real-world relevance to an already essential book. I highly recommend this new edition, whether you are conducting academic HCI research, or user research in a startup or large company. It is an invaluable resource."

—**Jacob O. Wobbrock,** Professor at the Information School, University of Washington, Recipient of the 2017 ACM SIGCHI Social Impact Award

About the Authors

Jonathan Lazar is a professor in the Department of Computer and Information Sciences at Towson University and has served as director of the Undergraduate Program in Information Systems since 2003. He also founded the Universal Usability Laboratory at Towson University and served as director from 2003 to 2014. In the area of human-computer interaction, Lazar is involved in teaching and research on web accessibility for people with disabilities, user-centered design methods, assistive technology, and law and public policy related to HCI. He has previously authored or edited 10 books, including *Ensuring Digital Accessibility Through Process and Policy* (coauthored with Dan Goldstein and Anne Taylor), *Disability, Human Rights, and Information Technology Accessibility* (coedited with Michael Stein), *Universal Usability: Designing Computer Interfaces for Diverse User Populations*, and *Web Usability: A User-Centered Design Approach*. He has published over 140 refereed articles in journals, conference proceedings, and edited books, and has been granted two US patents for his work on accessible web-based security features for blind users. He frequently serves as an adviser to government agencies and regularly provides testimony at federal and state levels, and multiple US federal regulations cite his research publications. His research has been funded by the National Science Foundation; National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR); American Library Association; and TEDCO. He currently serves on the executive board of the Friends of the Maryland Library for the Blind and Physically Handicapped and the State of Maryland Work Group on Increasing the Teaching of IT Accessibility Concepts in State Universities. He has served in multiple roles in the Association for Computing Machinery Special Interest Group on Computer-Human Interaction (ACM SIGCHI), most recently, adjunct chair of public policy (2010–15) and Digital Accessibility Chair (CHI 2014). Lazar has been honored with the 2017 University System of Maryland Board of Regents Award for Excellence in Research, the 2016 SIGCHI Social Impact Award, given annually to an individual who has promoted the application of human-computer interaction research to pressing societal needs, the 2015 AccessComputing Capacity Building Award (sponsored by the University of Washington and the National Science Foundation) for advocacy on behalf of people with disabilities in computing fields, the 2011 University System of Maryland Board of Regents Award for Excellence in Public Service, and the 2010 Dr. Jacob Bolotin Award from the National Federation of the Blind, for working towards achieving the full integration of the blind into society on a basis of equality. In 2012, Lazar was selected to be the Shutzer Fellow at the Radcliffe Institute for Advanced Study at Harvard University, where he investigates the relationship between human-computer interaction for people with disabilities and US disability rights law.

Jinjuan Heidi Feng is a professor in the Department of Computer and Information Sciences at Towson University. She conducts research in the areas of human-computer interaction, universal accessibility, health informatics, and usable and

accessible security. She works closely with national and local communities to improve the quality of life for people with disabilities through information technology. Her current research projects focus on assistive technologies for people with cognitive disabilities in educational and professional settings, mobile applications for health related activities, and accessible security techniques for individuals with visual or cognitive disabilities. Her research has been funded by various national and state agencies such as the National Science Foundation (NSF), the National Institute on Disability, Independent Living, and Rehabilitation Research (NIDILRR), and TEDCO. Her work has been published in various top-notch journals and presented at conferences such as Human-Computer Interaction, ACM Transactions on Computer-Human Interaction, and ACM Transactions on Accessible Computing. She has received the Maryland Daily Record's "Innovator of The Year Award" twice, in 2009 and 2016. Dr. Feng was appointed as the director for the School of Emerging Technologies in Fall 2015 and is leading the effort to promote interdisciplinary collaboration across the Towson University campus. She currently serves on the editorial board of ACM Transactions on Accessible Computing. She also served as the general conference chair for the 18th ACM SIGACCESS International Conference on Computers and Accessibility (ASSETS 2016).

Harry Hochheiser is currently a faculty member in the Department of Biomedical Informatics and the Intelligent Systems Program at the University of Pittsburgh, where he is actively involved in the Biomedical Informatics Training Program. Previously, Hochheiser served as an assistant professor at Towson University, and worked at Massachusetts General Hospital, Tufts University School of Medicine, AT & T Bell Labs, IBM T.J. Watson Labs, and the National Institutes on Aging. Working at the intersection of human-computer interaction and healthcare informatics, his research has covered a range of topics, including human-computer interaction, information visualization, bioinformatics, clinical informatics, universal usability, security, privacy, and public policy implications of computing systems. His research has been funded by the National Cancer Institute, National Library of Medicine, the Centers for Disease Control and Prevention, and the Baobab Health Trust, among others. Hochheiser has taught and developed several courses at both undergraduate and graduate levels, including introductory computer science, introduction to algorithms, information visualization, advanced web development, and human-computer interaction. He is a member of the US Public Policy Committee of the Association of Computing Machinery, and of the American Medical Informatics Association (AMIA) public policy committee. Hochheiser is co-recipient of the 2009 Maryland Daily Record's "Innovator of the Year Award" with Lazar and Feng, for the development of improved web-based security features for blind users.

Foreword

Many disciplines are hyphenated combinations, such as bio-informatics or physical-chemistry, but human-computer interaction (HCI) spans a broader range of topics than most. As a result, HCI researchers often draw on multiple diverse research methods, even in a single paper. It is just possible that HCI's remarkable successes in academic publishing and in widely used technologies stem from its diverse research methods.

While the traditional scientific method was a solid foundation for HCI, controlled laboratory studies with tests for statistically significant differences were never quite enough to deal with the ambitions of HCI researchers. We also embraced interviews, surveys, and focus groups, sometimes in fresh ways, to capture impressions of distinctive users and elicit suggestions, reactions, frustrations, and fears. Ethnographic observation and anthropological methods were also applied to study computer users "in the wild," which meant going to the place where people worked, lived, or played to see what actual use was like. As researchers shifted from studying the immediate out-of-the-box experience to understanding the evolution of user experiences over weeks and months, long-term case studies and time diaries became more common.

A larger step for HCI researchers was to incorporate iterative engineering processes and design thinking. They had to overcome resistance from traditional researchers who believed that controlled experiments were the best way forward. Over the years still newer methods tuned to the needs of businesses were developed, such as usability testing and expert reviews, to accelerate the development process, rather than refine theories. A major step forward was the development of A/B testing which contrasted two slightly different user interfaces in actual use over a period of days or weeks with thousands of actual users. Web designers were able to make rapid progress in determining which features led to greater commercial success.

Another novel approach has been to crowdsource research, by putting up online experiments available to many users or to use services like Amazon Turk to hire hundreds of participants for experimental studies. In recent years still newer methods based on big data analyses of millions of tweets or social media posts changed the game dramatically. The online availability of so much data about human performance led theoreticians and practitioners to study whole communities at scale in realistic settings.

I am pleased that the authors have used the distinction between micro-HCI and macro-HCI to organize thinking about when to apply one research method or another. Short-term perceptual, motor, or cognitive tasks can be studied by micro-HCI methods such as controlled experiments, but long-term trust, community development, or satisfaction are better studied by macro-HCI methods. I am also pleased that the authors encourage readers to reach out to other research communities to learn of their methods, to partner with them in policy initiatives, and to convey the opportunities that HCI presents for bold new directions and powerful impact.

The continuing discussions about which methods to use make this book a vital resource for new students, active researchers, and serious practitioners. It provides a comprehensive introduction with ample references for those who want more information and for those who are ready to invent still newer research methods, tailored to the issues they are studying.

This book also testifies to the vitality and ambition of HCI researchers, who have moved from narrow studies about pointing times for different target sizes to broader goals such as promoting information and communication technology for development (ICT4D), ensuring universal usability, countering cyberbullying, and reducing fake news. In a world where technology plays an increasing role, HCI is maturing into a larger field that is becoming a necessary component of new ideas in business, education, healthcare, community safety, energy sustainability, and environmental protection. There is an astonishing history of success in enabling 8 billion people to use novel technologies. This book celebrates that history and points to future directions that will yield new theories and still further benefits. There is also a great deal of work to be done by the next generation of creative researchers.

Ben Shneiderman
University of Maryland

Preface

Many textbooks arise from a perceived need—in our case, the lack of a research methods book specifically focusing on Human-Computer Interaction (HCI). When we first began writing the first edition of this book in 2007, we remembered our own experiences as doctoral students, primarily using research methods books in other fields, trying to determine how to properly apply the methods in HCI. As doctoral students, we took courses on research methods—from education, sociology, or psychology departments—or asked mentors. As professors, we found ourselves repeatedly returning to sources from outside our field to learn about unfamiliar research techniques. This gap in the literature led us to believe that the time was ripe for a research methods book specifically on HCI.

In the 10 years since we initially began writing the first edition of the book, academic offerings in HCI have grown immensely. Many universities now offer degrees with the name "Human-Computer Interaction" or "Human-Centered Computing." We are thrilled with this increased focus, and are honored to have played a role, however small, in that growth. We have also witnessed an evolution in the scope of HCI research. Although basic challenges—which research questions to ask, how to go about designing studies that would lead to answers, and how to interpret the results of those studies—remain the same, the range of available methods and techniques has grown. Crowdsourcing, social media, ubiquitous computing, and big data approaches have led to new uses of computing and new opportunities for research. Social networking sites offer billions of pieces of text and multimedia, suitable for analyzing patterns and describing conversations and information flows between users. Ubiquitous devices enable tracking of literally "every step we take," allowing detailed understanding of physical activity. Increased use of information tools in vital areas such as healthcare provides new challenges in understanding computing use in context, as doctors and patients routinely include electronic health records as key elements in medical care. Eye-tracking tools have dropped in price, allowing more researchers to afford them and integrate these tools into their research. More research now takes place outside of the laboratory to better understand usage of portable technology such as tablet computers and smart phones.

We have tried to present the various research methods in this text from the perspective of their use in HCI. Thus our description of experimental design (Chapter 4) discusses experiments with as few as 16 participants—a sample size much smaller than those often found in psychology experiments. Similarly, Chapter 5 (on surveys) discusses how nonrandom sample surveys are acceptable in HCI research—a sharp contrast with the strict sampling methodologies often found in social sciences.

We hope that you use this textbook on a daily basis, as you are faced with the challenges involved in doing data collection. We hope that this book helps inspire you, the reader, to do groundbreaking research, to change the way we all think about HCI, to do something different, something noteworthy, and something important.

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Jinjuan Heidi Feng
Harry Hochheiser