Empirical Research Methods for Human-Computer Interaction

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ABSTRACT

In this two-session course, attendees learn how to conduct empirical research in human-computer interaction (HCI). This course delivers an A-to-Z tutorial on designing a user study and demonstrates how to write a successful CHI paper. It would benefit anyone interested in conducting a user study or writing a CHI paper. Only general HCI knowledge is required.

CCS CONCEPTS

• **Human-centered computing** → Empirical studies in HCI
• **Human-centered computing** → HCI design and evaluation methods

KEYWORDS

Empirical research; experiment design; user study; quantitative methods; writing a CHI paper

SESSION ONE SCHEDULE:

- What is empirical research and what is the scientific method?

- Discovering and refining topics suitable for research in HCI

- Formulating "testable" research questions

- How to design an experiment (broadly speaking) to answer research questions

- Parts of an experiment (independent variables, dependent variables, counterbalancing, etc.)

- Group participation in a real experiment

BENEFITS

Most CHI attendees would agree that an experiment (i.e., user study) is the hallmark of good research in human-computer interaction. But what constitutes an experiment? And how does one go from an experiment to a CHI paper?

This course teaches how to pose testable research questions, how to make and measure observations, and how to design an experiment. Specifically, attendees participate in a real experiment (detailed in Practical Work below) to gain experience as both an investigator and as a participant. The second session covers how to analyze data, and how to how to write a CHI paper based on experiment results. Upon course completion, attendees are able to:

- Discover and narrow in on topics suitable for research in HCI
- Identify the four scales of measurement and describe characteristics of each
- Formulate "testable" research questions for empirical study
- Design and conduct an experiment (aka user study) to answer research questions
- Collect and analyze empirical data from an experiment
- Write a CHI-styled research paper based on an experiment

INTENDED AUDIENCE

This course caters to attendees who are motivated to learn about and use empirical research methods in HCI research. Specifically, it is for those in academia or industry who evaluate interaction techniques using quantitative methods (e.g., user experience design), or those who make decisions based on usability tests.

PREREQUISITES

No specific background is required other than a general knowledge of HCI as conveyed, for example, through an undergraduate HCI course or attendance at CHI conferences. Knowledge of advanced statistics, such as ANOVA (analysis of variance), is *not* required.

CONTENT

The course begins by guiding attendees on discovering research topics in HCI and formulating research questions that can be answered with a user study. The instructors highlight experiment design questions, and explain experiment terminology.

In addition, attendees participate in an experiment evaluating two keyboard layouts (see Practical Work below). Because of the time required to run the experiment, analyze the data, and present the results, this course requires two sessions. The instructors and student volunteers (SVs) transcribe and analyze the experiment data during the break, and present the results during the second session.

SESSION TWO SCHEDULE:

- Results and discussion of the experiment from Session One (this affords a strong opportunity to revisit and expand on the elements of empirical research)

- Experiment design issues ("within subjects" vs. "between subjects" factors, internal validity, external validity, counterbalancing test conditions, etc.)

- Data analyses (main effects and interaction effects, requirements to establish cause and effect relationships, etc.)

- How to organize and write a successful CHI paper (including suggestions for style and approach, as per CHI conference submissions)

In the second session, the instructors present and discuss the results from the experiment of the first session. The data is illustrated using charts, and summarized using tables of means and standard deviations, ANOVA tests, and linear regression. The instructors provide examples of publication-ready plots of data showing error bars, and describe accompanying statistics, such as linear regression equations. All materials are made available to registrants via handouts and web links. The last portion of the course presents guidelines for writing a CHI paper. This includes how to best organize and present experiment results, tips for writing style, and pitfalls to avoid.

PRACTICAL WORK

Attendees participate in a real experiment (lasting about 30 minutes). Working in pairs and using handouts prepared by the instructors, attendees take turns acting both as participant (i.e., perform tasks while data are collected) and as investigator (i.e., instruct the participant, administer the tasks, collect and record data). The experiment has all the components of a real experiment: independent variables, dependent variables, counterbalancing, etc.

This particular experiment compares two different soft keyboard layouts. The primary dependent variable is *task completion time*, which is measured using a stopwatch. There are two independent variables: *interface type* (i.e., layout), and *learning* (i.e., trial number). The levels of interface type are administered using counterbalancing, with participants organized in groups.

INSTRUCTOR BACKGROUND

Scott MacKenzie's research is in HCI with an emphasis on human performance measurement and modeling, experimental methods and evaluation, interaction devices and techniques, alphanumeric entry, language modeling, and mobile computing. He has more than 180 HCI publications (including 44 from the SIGCHI conference and 2 HCI books) and has given numerous invited talks over the past 20 years. Since 1999, he has been Associate Professor of Electrical Engineering and Computer Science at York University, Canada.

Steven Castellucci has served as an Assistant Professor of Electrical Engineering and Computer Science at York University, Canada. He now works at Amazon in Toronto. His research interests include mobile text entry, and remote pointing techniques. In addition to having SIGCHI publications, he has taught first-year Computer Science and Engineering courses, and senior and graduate-level HCI university courses.

RESOURCES

Scott's website:
http://www.yorku.ca/mack/
http://www.yorku.ca/mack/HCIbook/

Steven's website:
http://www.eecs.yorku.ca/~stevenc/
http://www.eecs.yorku.ca/~stevenc/chi2019/