

PhD Qualifying Examination: **Human-Computer Interaction**

University of Wisconsin–Madison, Department of Computer Sciences

Fall 2018 — Monday, September 17, 2018

General Instructions

- * This exam has **7** numbered pages including this page.
- * Answer each question in a separate book.
- * Indicate on the cover of each book **the area** (HCI) of the exam, your **code number**, and the **question number** answered in that book. Do not write your name on any answer book.
- * Return all answer books in the folder provided. Additional answer books are available if needed.

Specific Instructions

- * Answer all **6** questions.

Policy on Misprints and Ambiguities

The Exam Committee tries to proofread the exam as carefully as possible. Nevertheless, the exam sometimes contains misprints and ambiguities. If you are convinced that a problem has been stated incorrectly, mention this to the proctor. If necessary, the proctor can contact a representative of the area to resolve problems during the *first hour* of the exam. In any case, you should indicate your interpretation of the problem in your written answer. Your interpretation should be such that the problem is nontrivial.

Question Topics

1. Interface usability
2. Quantitative data analysis
3. Diary studies
4. Cognitive modeling
5. Qualitative data analysis
6. Study design

Question 1. *Interface Usability*

Consider the OS-level controls and displays provided in smart phones, particularly the “app drawer” in the Android OS or the “notification center” in iOS. Identify violations of three of the *usability evaluation heuristics* proposed by Nielsen,¹ describing each heuristic and how the design of the text editor violates it. Describe the types of usability issues a *cognitive walkthrough*² could identify with these designs and outline the steps you would follow to carry out a cognitive walkthrough.

¹ Nielsen, J. (1993) *Usability Engineering (Chapter 5)*. Morgan Kaufmann, pp. 115–163.

² Wharton, C., Ricman, J., Lewis, C., & Polson, P. (1994). The cognitive walkthrough method: A practitioner's guide. In *Usability inspection methods* (pp. 105-140). John Wiley & Sons, Inc.

Question 2. Quantitative Data Analysis

You are in the process of drafting the proposal for your doctoral dissertation. The proposal will outline a series of laboratory studies in which you will compare the system that you have been building over the last few years to baseline systems that represent the state of the art. In your description of how you plan to analyze the data from your experiment, you would like to include a discussion of how your analysis will control or account for various forms of *biases* and *errors*.

- (a) Briefly explain *parametric* and *nonparametric* statistical tests. List three *assumptions* in the use of parametric statistical tests. Suggest nonparametric alternatives to (1) unpaired t-test, (2) paired t-test, (3) one-factor analysis of variance, and (4) repeated-measures one-factor analysis of variance.
- (b) Describe *post-hoc* and *a priori* tests, discussing their differences. Provide two common methods used for these tests and compare their uses in statistical analysis.
- (c) Define the terms *systematic error*, *random error*, and *Type I*, *Type II*, and *Type III errors* and describe sources for these errors. Recommend methods for reducing or accounting for these errors.

Question 3. *Diary Studies*

You are planning to study how mobile phone notifications affect user attention while driving in order to create specifications for the design of in-car notification schemes for mobile operating systems. Answer the following questions about the design of your study.

- (a) Compare *a diary study*, *an ethnography*, and *a retrospective think aloud* in this context, discussing their *advantages* and *disadvantages*.
- (b) Describe the three types of diary studies you could use in this context, according to Iida et al.³
- (c) How would you approach participant *selection* and *sampling*?
- (d) Discuss how you might approach *data analysis*. What is *multilevel analysis*? And what kinds of questions can it answer?

³ Iida, M., Shrout, P. E., Laurenceau, J. P., & Bolger, N. (2012). Using diary methods in psychological research. In Cooper, H., Camic, P. M., Long, D. L., Panter, A. T., Rindskopf, D., Sher, K. J. (Eds), *APA handbook of research methods in psychology, Vol 1: Foundations, planning, measures, and psychometrics*, (pp. 277-305). Washington, DC, US: American Psychological.

(g) Question 4. Cognitive Modeling

Cognitive modeling approaches (e.g., keystroke-level modeling) have been widely used to model and predict user behavior with computer interfaces. Consider the task of using a *telepresence robot* as a remote operator and apply key concepts from cognitive modeling to this context.

- (a) Briefly define the concept of an *operator*⁴ and identify three operators in the context of using a telepresence robot.
- (b) Provide a short definition of the *unit task*⁵ and its relationship with *working memory*⁵ and identify three unit tasks that remote users of telepresence robots perform.
- (c) Discuss how *critical path analysis*⁵ might inform cognitive modeling in the context of using a telepresence robot.

⁴ Card, S. K., Moran, T. P., & Newell, A. (1980). The keystroke-level model for user performance time with interactive systems. *Communications of the ACM*, 23 (7), 396–410.

⁵ Olson, J. R. & Olson, G. M. (1990). The growth of cognitive modeling in human-computer interaction since GOMS. *Human-Computer Interaction*, 5 (2), 221–265.

Question 5. Qualitative Data Analysis

Your research team has developed a new robotic companion for children and deployed the robot at the homes of 30 families for 30 days each. You have interviewed the children and family members before and after the deployment, audio-recorded the interviews, and transcribed them into text. You would like to next analyze the data to understand children's interactions with and perceptions of the robotic companion. Answer the questions below about analyzing your data.

- (a) List two *qualitative data analysis methods* you could employ and discuss their relative *advantages* and *disadvantages*?
- (b) Choose one of the methods you discussed in (a) and provide a brief step-by-step description of the *process* of applying it to your data.
- (c) Describe the three types of *validity* that are relevant in qualitative analysis according to Lazar et al.,⁶ and briefly discuss how you would improve validity.
- (d) What does *Cohen's Kappa* measure? How is it calculated? And how is it relevant to qualitative data analysis?

⁶ Lazar, J., Feng, J. H., & Hochheiser, H. (2017). *Research methods in human-computer interaction*. Morgan Kaufmann.

Question 6. Study Design

For each research question below, taken directly from human-computer interaction research, propose (1) a research design, (2) a method of measurement, and (3) a data analysis method that offers optimal *generalizability*, *precision*, and *realism*, while maximizing *validity* and *reliability*.⁷

- 1) “How are the personal network (a) duration, (b) multiplexity,⁸ and (c) proximity associated with individuals’ patterns of Facebook use?”⁹
- 2) “What is the most frequent strategy that individuals with eating disorders use online to solicit social support?”¹⁰
- 3) “Will there be differences in individuals’ perceptions of the communication quality (credibility, attraction, communication competence, and intent to interact) of a Twitterbot and a human Twitter agent?”¹¹
- 4) “Is communication between two people on Facebook associated with changes in tie strength beyond the effects of their communication by other channels, such as email, the phone, and in-person conversation?”¹²

⁷ McGrath, J. E. (1995). Methodology Matters: Doing Research in the behavioral and social sciences. In R. M. Baecker, J. Grudin, W. A. S. Buxton, S. Greenberg, (eds.), *Readings in Human-Computer Interaction: Toward the Year 2000*, pp. 152–169.

⁸ “Multiplexity” is the number of separate social connections between any two actors.

⁹ Park, N., Lee, S., & Kim, J. H. (2012). Individuals’ personal network characteristics and patterns of Facebook use: A social network approach. *Computers in Human Behavior*, 28(5), 1700-1707.

¹⁰ Eichhorn, K. C. (2008). Soliciting and providing social support over the Internet: An investigation of online eating disorder support groups. *Journal of Computer-Mediated Communication*, 14(1), 67-78.

¹¹ Edwards, C., Edwards, A., Spence, P. R., & Shelton, A. K. (2014). Is that a bot running the social media feed? Testing the differences in perceptions of communication quality for a human agent and a bot agent on Twitter. *Computers in Human Behavior*, 33, 372-376.

¹² Burke, M., & Kraut, R. E. (2014, April). Growing closer on facebook: changes in tie strength through social network site use. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 4187-4196). ACM.