CS4249 Phenomena and Theories of HCI

Assignment 1: Experimental Design and Analysis

Due dates:

- Part 1 (section 1 and 2, which include the design of the experiment and the implementation of the experimental environment) is due Sept. 6th, 2014, 23:59 (Saturday of week 4)
- Part 2: (section 3, which includes the actual running of the experiment, the analysis report) is due Sept. 29th, 2014, 23:59 (Monday of week 7).

Note: although the analysis is due later, we will encourage you to think about it while working on the first part of the experiment design as they are tightly related. For example, if you didn’t work out the design carefully, it might be difficult for you to justify your design decision in the report. While writing the final report, if you find certain design decisions made earlier do not make sense, you are welcome to make adjustments and include a discussion of it in your final report.

Grading:

- Report (20%), program and code (5%)

Description:

Assignment 1 is an individual assignment. The purpose of assignment 1 is to apply the lessons you have learned about experimental design & analysis to design, conduct, analyze, and report the results of an experiment. You will be working with a software package written in HTML and JavaScript to compare a new copy-paste technique called AutoComPaste with existing copy paste techniques. The tasks you need to complete include:

1) Design the experiment: in addition to the default independent variables, introduce and justify one more independent variable in the experiment.

2) Customize the provided experiment environment to suit your design
   a. Create an interface for the experiment
   b. Implement the condition arrangement
   c. Log the dependent variables (experimental data) to a file
3) Conduct the experiment with participants
4) Analyze the data using statistical software and report the result and analysis

The deliverables for assignment 1 are divided into three sections:

- Section 1 – Report on your experimental design (5%)
- Section 2 – Program and code you written and used in conducting the experiment (5%)
- Section 3 – Report your experimental results and analysis by writing up the study description, results, and discussions sections according to the SIGCHI guidelines (15%)
Section 1 – Complete the Experiment Design for AutoComPaste (5%)

You are an HCI researcher who invented a new copy-and-paste technique called AutoComPaste that allows users to copy-and-paste sentences and even paragraphs in a different manner from the traditional copy-paste techniques (such as ctrl c, ctrl v). You want to evaluate the performance of this technique against the traditional copy-paste technique (via keyboard shortcuts and mouse clicks).

Referring to the five-step approach to experimental design in lecture 2 and 3, try to fill out (the highlighted part) the following experiment design template (5%).

1. Define the research question

<table>
<thead>
<tr>
<th>1.1: Start with a general question</th>
<th>How does AutoComPaste compare with traditional copy-paste technique (control-C + control-V) in terms of performance?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2: Define the target population</td>
<td>Please fill in this part</td>
</tr>
<tr>
<td>1.3: Define task(s)</td>
<td>Copy-paste text with different granularities (e.g., phrase, sentence, paragraph)</td>
</tr>
<tr>
<td>1.4: Define measure(s)</td>
<td>e.g., Speed, Accuracy</td>
</tr>
<tr>
<td>1.5: Define other factor(s)</td>
<td>Please fill in this part</td>
</tr>
</tbody>
</table>

2. Determine variables

<table>
<thead>
<tr>
<th>2.1: Techniques, Task Types, &amp; Other Factors → Independent variables</th>
<th>Independent variables: (e.g.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Technique (2 levels: AutoComPaste vs. control-c vs. control-v)</td>
<td>• Text granularity (3 levels: phrase, sentence, paragraph)</td>
</tr>
<tr>
<td>• Come up with one more independent variables with at least 2 levels that is likely to help to differentiate the primary independent variable. By differentiate we mean that there will be statistical significance when analyzing the dependent variables based on this independent variable. <strong>Hint:</strong> this can come from both task types, or other factors. In the slides from the class, a few factors have been mentioned, you can use one of the factors mentioned there. <strong>Note that we don’t recommend between-subject factors such as gender or age group since it does not require any coding.</strong> <strong>Extra credit:</strong> if you can identify</td>
<td></td>
</tr>
<tr>
<td>Please choose a within-subject factor.</td>
<td>Please choose a within-subject factor.</td>
</tr>
<tr>
<td>Extra credit: if you can identify</td>
<td>Extra credit: if you can identify</td>
</tr>
</tbody>
</table>
another factor that's not mentioned in the lecture slides which can also help to differentiate the techniques.

2.2: Measures → Dependent variables

<table>
<thead>
<tr>
<th>Dependent variables (e.g.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completion time (seconds)</td>
</tr>
<tr>
<td>Error rate (%)</td>
</tr>
<tr>
<td>Please add one more dependent variable here.</td>
</tr>
</tbody>
</table>

2.3: Everything else → Control/Random Variables

<table>
<thead>
<tr>
<th>Control variables (e.g.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of day, device, same instruction, etc.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Random variables (e.g.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants’ age, gender, occupation, etc.</td>
</tr>
</tbody>
</table>

3. Arrange conditions

3.1: List all independent variables and their levels

<table>
<thead>
<tr>
<th>Technique (2 levels: AutoComPaste vs. control-c, control-v) → Fully counter balanced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text granularity (3 levels: phrase, sentence, paragraph) → Which strategy will you use? Fill it in.</td>
</tr>
<tr>
<td>Define the third independent variable and its counter-balance strategy.</td>
</tr>
</tbody>
</table>

3.2: Decide counter-balancing strategy for each variable

3.3: Determine the minimum No. of participants

3.4: Arrange the overall design

3.5: Determine detailed arrangement for each participant

4. Decide blocks and trials

4.1: Estimate time for each trial (typically >= 3 trials per condition)

| Please fill in this part (4.1, 4.2, 4.3, 4.4). It is recommended that the each block of the experiment will be finished within 10 minutes, excluding the pre and post questionnaires. This is because this allows you to quickly test with more participants since each participant only need to spend less than 15 minutes for your experiment. However, if you have good reasons to extend the experiment beyond 10 minutes, it’s also fine with us. |

4.2: Estimate the time for each block

4.3: Balance the trials and blocks so that the main experiment is within 45 minutes

4.4: Combine with the condition arrangement

5. Set instruction and procedures

5.1: Recruit participants (determine target users and randomize)

| Recruit the minimum number of participants (however, make sure it is equal to or more than 6 participants) |

5.2: Consent form and pre-experiment questionnaire

| e.g.: Name: ____, Age: ____, Occupation: ____, etc. Please come up with a basic questionnaire to help you to gather participant information. The purpose of this questionnaire is to report the participant information. |

<p>| Please fill in this part |</p>
<table>
<thead>
<tr>
<th>5.3: Instructions</th>
<th>Provide clear and consistent instructions to participants. Please fill in this part in a separate document.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.4: Practice trials</td>
<td>Make sure people start with each technique with roughly the same experience. You may decide to include or not include any practice trials for one or more of your testing conditions. We will leave this part for you to decide.</td>
</tr>
<tr>
<td>5.5: Main experiment with breaks</td>
<td>Ask participants to take breaks</td>
</tr>
<tr>
<td>5.6: Post-experiment questionnaire and interview</td>
<td>e.g.: Which technique you like better? Rate the ease of use of Technique A in a 5 point Likert scale. Rate the ease of use of Technique B in a 5 point Likert scale. After the experiment, you want to collect more qualitative and quantitative feedback about the tested techniques. Some of the typical questions include, personal preferences, any difficulties participants experienced in the experiment, and areas of improvement. Please design a basic post-experimental questionnaire (no more than 10 questions in a separate document) to help you to provide more in-depth information about the trade-offs between the tested techniques.</td>
</tr>
<tr>
<td>5.7: Debriefing</td>
<td>Answer any questions, thank the participants, etc.</td>
</tr>
</tbody>
</table>

The deliverable for section 1 is:

1) Copy the paste the five tables above into a new Word document. Fill in the parts highlighted with underlined text descriptions. If you need more space, feel free to fill in the details in separate documents and refer them back to the cells.
Section 2 – Creating the Program for Running the Experiment (5%)

AutoComPaste online experimental environment can be downloaded via this link: https://github.com/tjmonsi/AutoComPasteHTML/. Read the documentation provided in the package for instructions on installing and using the AutoComPaste experimental environment.

We have provided the basic code for the two techniques for copy and paste you want to test: AutoComPaste and Control-C, Contro-V. In section 2, your task is to customize the implementation to match your design. In particular, you need to finish implement the following three components.

1) **The startup interface of the experiment:** the startup interface provides the basic instructions to your participants, and also collect input from the participant/experimenter the participant ID so that you can generate the correct data log for a particular experiment session.

2) **The instruction, stimuli, and feedback to each individual experimental condition, and experimental trial.** For example, the instruction for one trial may look like the following. Providing instructions to participants allows them to know where exactly they are in the experiment. It also helps the experimenter to know which condition the participant is currently in at a given moment.

   Copy-paste Experiment
   Condition: AutoComPaste, Phrase, <<Independent Variable 3>>
   Trial No: 3/24
   Instruction Please copy-paste the highlighted phrase from one of the opened document window

3) **Log.** You need to log the data you collected (dependent variables), such as the time taken for each trial and the accuracy data into a log file so that you can perform statistical analysis later. You can log the data in any way you want, but for the convenience of data processing, the following format is recommended.

   Participant id, primary independent variable, secondary independent variable 1, secondary independent variable 2, …, trial no, stimuli, user response, trial start time, trial end time, trial time, accuracy.
For example, a line of data may look like this.

... 
1, AutoComPaste, Phrase, XXX, 3, Hello world, Hello, 12000, 15500, 3500, 0 
1, AutoComPaste, Phrase, XXX, 4, Hello earth, Hello earth, 11200, 16500, 4300, 1 
...

The above lines indicate that the participant 1 was tested under the AutoComPaste, Phrase, and XXX condition for his/her third trial and fourth trial. In the third trial, the stimuli are asking him/her to copy-paste the “Hello world” phrase, but he/she copied “Hello” phrase instead. The trial starting time is 12000 mili-second, and the finishing time is 15500 mili-second, so he/she spend 3.5 second to complete this task, and the stimuli does not match the response, which means the accuracy is incorrect (0), instead of correct (1). In the fourth trial, the stimuli are asking him/her to copy-paste the “Hello earth” phrase, he/she actually copied “Hello earth” phrase. The trial starting time is 11200 mili-second, and the finishing time is 16500 mili-second, so he/she spend 4.3 second to complete this task, and the stimuli match the response, which means the accuracy is correct (1).

4) The internal arrangement for the trials and conditions. You also need to come up with the stimuli for each trial and condition and make sure they are correctly arranged for each participant. One way to make this flexible is to provide all information of the condition and trials in a text file, and your program will read from the text file to determine the sequence of condition and trials.

The deliverable for section 2 are:
1. The code and any other files you used to setup the experimental environment as well as a readme file to guide the teaching assistant to understand what you have done to the experimental environment..

**Note:** While you are free to discuss some technical issues as well as knowledge points with your classmates, you must finish the implementation independently. Plagiarism software will be used to test whether or not you have copied the code from other students. You will receive 0 for the assignment if plagiarism is detected.

**Section 3 – Report and Discuss the Results (15%)**

In section 3, you will run the experiment with actual participants (minimum 6) and collect the data to perform statistical analysis. For statistical analysis in this experiment, you will use R, an open source and free statistical software.

Besides, your supervisor and you have decided to submit a research paper on AutoComPaste to the SIGCHI (Conference on Human Factors in Computing Systems) conference, and you were being told to only write-up the study description, results, and discussion section. High level guidelines for reporting them in a CHI paper are provided in a separate document (guidelines-CHIpaper.pdf) in the assignment folder in IVLE. Besides, a brief how-to guide on writing those three sections is provided below.

The deliverables for section 3 are:

1. Your write-up of the study description, results, and discussion sections according to the CHI guidelines. Use a separate Word document (from the report in section 1) for this write-up.
2. The raw data files and the statistical analysis files.

**A How-to Guide in Writing Study Description, Results, and Discussions**

**STUDY DESCRIPTION**

Goals: State the goal of the experiment. Why it is necessary to carry out an experiment? What do you hope to discover through the experiment?
Participants
To convince the readers that you have selected the appropriate target users and the results can be reasonably generalized, you need to provide the details of the participants you selected for the experiment. Below is a possible template to describe the participants.

XX participants, X women and X men ranging in age from XX to XX years (M=XX, SD=XX), recruited from <<describe where are they recruited>>, volunteered for the experiment. <<describe the background of the participants and their prior experience with the tested techniques>>

Apparatus
You need to describe the hardware and software used to conduct the experiment. What type of machine, how large is the monitor, in what resolution, what input devices are used? … Since each experiment is conducted in a specific experimental environment, it is necessary to provide the details of the experimental setup so that other researchers to replicate your experiment.

Task and Stimuli
Describe the task you ask the participant to do, and what stimuli are used in the experiment. Provide justification for the selection of tasks and stimuli.

Design
Describe the design of the experiment. This include whether the experiment is a within-participant design or a between-participant design. How each independent variable is counter-balanced? How are the trials selected and arranged? How many blocks are incorporated?

Provide the design in a summary format
For example, the design for an experiment is following:

12 participants x
2 techniques (compound and simple) x
3 sizes (large, medium, small) per technique x
(16+16+32+64) items for the four menu layouts
= 9216 menu selections in total.

RESULTS
In the result section, you typically report the findings for each dependent variable separately followed by a summary of the overall result. For each dependent variable, you need to provide the statistical significance you find. If there is a statistical significance, you need to tell the readers how are the different levels different from each other. You also want to report any interaction effects between the different independent variables for a particular dependent variable. For example, below is an example of how the accuracy and selection time result for comparing two different menu techniques is reported.

Accuracy

<<How the accuracy is measured>> Accuracy is measured as the percentage of menu selections made that matched the given stimulus.

<<Significant effect one>> Analysis of variance showed a significant main effect for technique ($F_{1,11} = 131.38$, $p < .0001$), with the simple mark technique having an accuracy of 93%, while the compound mark technique was 80%. Figure 5 illustrates the various effects discussed in this section.

<<Significant effect two>> There was also a significant main effect for input size ($F_{2,22} = 30.79$, $p < .0001$). ....

<<Interaction effect one>> There was also a significant size $\times$ technique interaction ($F_{2,22} = 21.02$, $p < .0001$), indicating that changes in input size affected the two techniques differently. Pairwise means comparisons (t Tests with 5% alpha-level) indicate that size had no significant effect on accuracy ($p > .05$) for the simple mark technique. For the compound mark technique, the medium and large sizes did not significantly differ in their effect on accuracy ($p > .05$), however, the small size resulted in significantly less accuracy than both medium and large sizes ($p < .01$).

Note: when you report the data, it’s useful to insert charts and graphs so that it is easier to see the differences and trends of the data.

DISCUSSION
In the discussion section, please provide a high level summary of the result and explain the reasons behind the observations. Based on the experimental result, what kind of recommendation can you provide to designers and users about the techniques tested? Any lessons you have learned through this process that are worth sharing? Please list them here.

**Submitting Assignment 1**
All deliverables in section 1, 2, and 3 should be archived into a .zip file with the following naming convention:

YOURNAME_MATRICNUMBER_Assignment1_part1.zip

and

YOURNAME_MATRICNUMBER_Assignment1_part2.zip

submitted to the IVLE Assignment 1 workbin before September 6th 2014, 23:59 (Part1) and September 29th 2014 23:59 (Part2), respectively.

In the part1.zip, you will include

YOURNAME_MATRICNUMBER_A2_Experiment_Design.docx

Program (folder)

readme.txt

(other files)

In the part2.zip, you will include

YOURNAME_MATRICNUMBER_A2_Result_and_Analysis.docx

Experiment (folder)

All pre- and post- questionnaires,

All data log file

All statistical analysis files