Assignment #3 – CS 4065/6065
Performing an Empirical Evaluation of Bubble Cursor

Please read the whole document before you do anything.

In this assignment you will be learning how to run a human-subject experiment by doing one. This document and the provided spreadsheet should provide you with everything you need to know to do it.

Due Date

Monday, February 22nd, 2021 at 11:30pm on D2L

Goal

The goal is to provide you with experience in creating an experimental system for evaluating a new interaction technique, performing a user evaluation, working with experiment participants and analyzing data from an experiment.

Partners

This assignment is to be done in pairs, and you must have a partner that is in your class level (e.g., a 4065 student should not partner with a 6065 student).
You are allowed to choose a partner that you have previously worked with for this assignment.

Register Your Group

As in assignment, you will be paired with other groups to facilitate testing of your systems.

Complete this form ASAP:
https://forms.office.com/Pages/ResponsePage.aspx?id=0m5OJJoz80e5XORTUcGYt5Cv_Yazi1ZOk3ethx-h5lhUQTdYTThUR0gwNTYzTFc3N05YUzhGM0NYVi4u

Overview

In this assignment you will be performing an empirical evaluation of the "bubble cursor" targeting assistance technique. Bubble cursor is a technique that changes the size of your cursor to compensate for targeting errors and make selecting targets fast. With Bubble Cursor, you are always selecting a target, specifically, the closest target. So, even if the mouse cursor is not right on a target (like a button or icon) it can select it, if its close enough.

Background

Watch the following videos to get an idea about how Bubble Cursor works and the motivation:

- Original Bubble Cursor Video: https://www.youtube.com/watch?v=JUBXkD_8ZeQ
- Bubble Cursor for the Real World: https://www.youtube.com/watch?v=46EopD_2K_4
- See the example code provided on Teams to get you started with Bubble Cursor

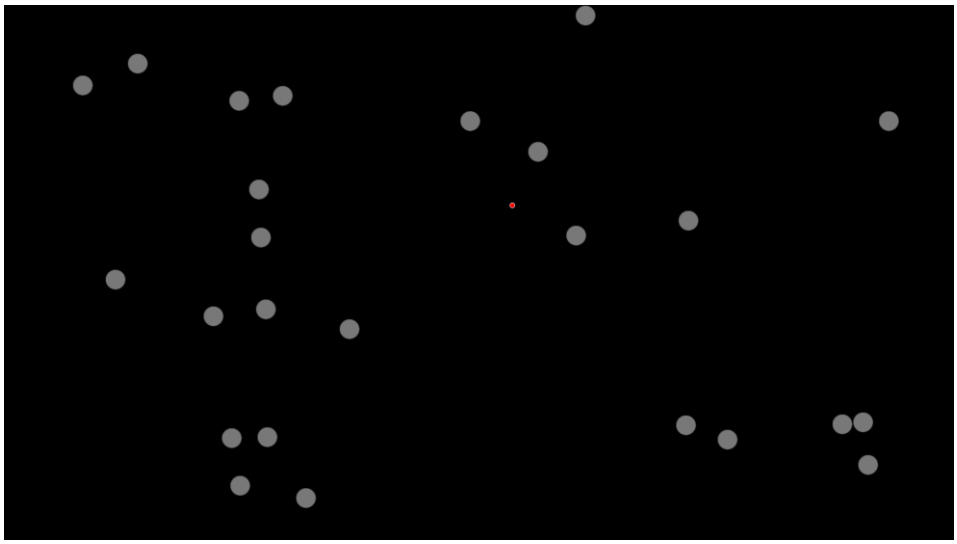
The Experimental System

The system you will create will be similar to the one created in Assignment #1. See the example code provided on Teams to get you started with Bubble Cursor

Requirements Repeated from Assignment 1

While this system has some overlap with Assignment #1 and you may be able to reuse some parts of your system, you must conform to the requirements below.

Build a system that allows you to gather data about people's targeting performance using either a normal pointing or a bubble cursor. The system should cover the full screen, and will present a series of buttons on the screen. Buttons can be visually designed as you like (e.g., simple circles or circular icons, but must follow the rest of the requirements). Your systems will display 25 buttons randomly placed on the screen. Each button should be in a 25 by 25 pixel bounding box, and should be separated from the other buttons by at least 15 pixels (i.e., there is 15 pixels from the closest point on the edge of one button to the next). Like in the image below:



Specific requirements:

- You have been given some sample code that should make the development and meeting the requirements below easier. You should implement your system, so that it behaves as closely as possible to the original bubble cursor system. I.e., can you design your bubble cursor so it works more like the one in the video… and not just like the provided code (there will be some marks for designing a carefully designed bubble cursor).
- The system should display the same cursor in both the normal cursor condition or the bubble cursor condition. Keeping the red dot that has been provided is OK for this.

- When started, the system should cover the full screen.
- The system should ask for a user id (this will be attached to all trial records). Note: if you are using Processing you can use Java GUI components; e.g., JDialog.
- The system should then present a button or way to select either "condition 0" (representing normal cursor) or "condition 1" (which represents area cursor). We do this so participants don't know what version they are using, or even that something other than "normal" is happening. The system will then enter in the correct mode depending on the selection.
- The system should then present the testing system, with a dialog or message that states: "Please select highlighted buttons as quickly and accurately as possible. This is round 1 of 4." along with a button that says “click to begin practice”. Each round should consist of 20 highlighted targets.
- After clicking the button, the first round of practice will begin. (NOTE: no data needs to be collected during the "practice block").
- In each trial, the system presents all of the buttons, and during each trial one of the button is randomly highlighted. The user must move their mouse to the target and click on it as quickly as possible. The system records the time taken from the appearance of the target to the successful click, the number of erroneous clicks before a successful click on the target, and the distance between the center of the previous target and the target that has just been highlighted.
- Note: that the first trial should not be logged in any "round" since there is no previous target to calculate the distance from.
- Only one target is randomly highlighted at a time (it should not be the same button twice in a row); the next target is highlighted as soon as the user has successfully clicked on the previous target.
- After 21 targets (the first target to get started, plus the 20 logged targets for the round), then the practice round is complete
- After the practice is completed, a dialog or message that states: "Please select each target as quickly and accurately as possible. This is round 2 of 4." Along with a button that says, “click to begin evaluation”.
- When running your experiment, the participants can rest before beginning the next evaluation block.
- When the user clicks the button, the system continues to the next block of 21 targets, as described above (recall that data is only recorded after the first button is clicked, i.e., for the last 25 successful clicks/trials).
- After the first two blocks are completed (one practice and one evaluation), the system will start another practice and evaluation round but for the other condition (e.g., the system will start in the normal condition, if the original condition was "bubble"), and update the round feedback accordingly.
- This system needs collect the following data (where condition should be "normal" or "bubble"):
    - user# trial# condition elapsedTime numberOferrors distance

- The system can write out these logs to a file, or to a console window. If you use a tab delimited output, you can easily paste the data into the provided spreadsheet.

Experiment Participants

For the experiment you will need to find and schedule **6 *participants*** to use the experimental system. **The experiment must be completed using a standard external mouse**. Running each participant through the experiment should be quick, less than 10 minutes (and closer to 5) for all aspects of the experiment. You should use other members of the class to be participants in your assignment. Ideally you would recruit participants who know nothing about what you are doing, and who have not yet done the experiment for another group in the class. However, this is not possible in this situation.

Experiment Overview

You are provided with a detailed experiment procedure script that you are to follow during the experiment (see below – last page). Running an evaluation experiment is all about managing the many details. You will recruit and schedule participants to run through the experiment. You will brief, run and debrief all participants according to the experiment script. Afterwards you will perform some descriptive statistical analysis, test for statistical significance, calculate the throughput for the unassisted and area cursor targeting conditions, and write a brief report concerning your experiences and observations in running the experiment. A spreadsheet is provided for the steps described previously to help you through all of this.

NOTE: Importantly, do not lead participants to think that one way of selecting is going to be "better" than the other. Try to let them come to that conclusions themselves.

Providing Control and Setting up the Testing Environment

If you are using Windows, you will want to disable the cursor enhancement (as we discussed in class) this can affect the results you see, and since Microsoft doesn't reveal their exact algorithm, we won't be able to account for it in our results. Here is a video to guide you: https://www.youtube.com/watch?v=SEFHpzbaOZo

Remember to do your best to treat every participant in the same way. You do not need to provide more details (before the experiment) than saying you are evaluating a system that helps people click on targets. You should use the exact same computer (if at all possible) and the same mouse (a standard external mouse) for the experiment. You want to keep the setup and experience as consistent as possible for all of the participants, to avoid introducing unforeseen biases. Stick to the script as best as possible, but allow the participant to ask questions. Make sure there is enough room to move the mouse and that the keyboard is not in the way. Make sure that there are no distractions nearby (e.g. people talking, loud noises, etc.).

Analysis

Analyze your data using Excel or LibreOffice, and the provided spreadsheet. If you collect your data in tab delimited format, you should be able to easily copy and paste data directly into the spreadsheet.

Open and read the provided Excel file. Notice there are two tabs you will use for your analysis, "Movement Time" and "Errors". For our experiment we will be assessing area cursor versus no assistance (normal pointing), using avg. movement time and total errors. Our hypothesis is that area cursor is faster than no assistance, this is based on what we know about Fitts' law (to be covered in our lecture on Laws and Design from Ch. 7). We do not have a strong theoretical basis for a hypothesis on errors though. However, we may want to test it anyway to see if there is statistical difference between the errors committed using area cursor and the errors using no assistance. Fill your data in to the appropriate places in the spreadsheet (after you have run your five participants through the experiment).

Also calculate the throughput (the Index of Performance) based on your experiments. This is done on the Throughput tab of the Excel file. Don't remember what Throughput means? See lecture notes on Fitts' Law and modeling interactions (and your textbook!).

Report

Once you have completed the analysis, write a brief report 12pt, single spaced Times (should be around 2 pages, no more than 3 pages). In the report address all of the following issues/questions and complete the following tasks:

1. Describe in a few lines the point of the experiment and what was trying to be evaluated. What were the questions?
2. Briefly describe how your area cursor works and how you tried to maximize it's performance through how it was implemented.
3. State the experiment hypotheses.
4. Summarize the results of the experiment. E.g. What were the average movement times and total errors? Include the graphs for movement time and errors in the report.
5. How much improvement does the bubble cursor give (if any) – this could be given by difference in average completion times and/or percentage improvement.
6. Were the results of the recorded observations significantly different? What was the probability (the p value) that the results were due to chance? Your results might or might not be significant, either is OK.
    - Note we will discuss this more fully in class, so it is OK, not to know exactly what this means at this point, simply answer these questions based on the information provided in the spreadsheet.
7. If your results are not significantly different, did bubble cursor still perform better? How do you think you might be able to get statistically significant results? (Answer the second

question regardless of your significance results. Hint: the more measurements we have, the more confident we can be, even with very small observed differences.)

8. Why do you think you have the results you do?
9. What were the measured throughputs of the mouse with bubble cursor technique and the normal use of the mouse?
10. How do these compare to the to the previously established mouse throughputs (which was determined to be 3.8)? How did the predicted times compare to the measured times? Why might these be different? (Answer the last question regardless of how close the predicted and measured times were.)
11. Why would we use a measure like throughput to assess the speed of different devices?
12. Report on your informal questioning of the participants about whether they noticed a difference between the first and second block? Did they think one was easier? If they thought one was easier, did their performance actually match their perception? (Note: see the questions and directions in the script).
13. What do the results actually mean? Are bubble cursor better than normal? Don't tell me what you think you want me to hear... what do you think?
14. How do you feel about such a "narrow" evaluation approach? Did you learn anything about the bubble cursor technique at all, in terms of "how good" it is?
15. Do you think bubble cursor could be included in real applications (what type of applications might be well suited)?
16. The last three points should be based on your own opinion, not based on what you heard in class.

Handing In Your Report and Evaluation

Hand in your final system (just Processing project directory, no compiled code needed, in a zip file), your report (in PDF format) and your Excel file (xls) through D2L, by the due date.

You will be evaluated on the quality of your report and answers to the above report, as well as the contents of your excel file. Your excel file will be checked to demonstrate that you have correctly performed the experiment and analysis.

Experimental Procedure (Script)

Bring this page and have it on hand as a checklist when you conduct your experiment.

NOTE: This script is designed for an in-person, controlled study. However, given the restrictions, do your best to adapt this script so that the experiment can be completed as consistently as possible.

Before the Experiment:

Setup the system and ensure that you have a clean, comfortable environment for conducting your experiment. All participants would use the exact same computer and input (ideally). Given the restrictions, please ensure that all participants are using a standard external mouse (no trackpads should be used in completing the experiment).

- If you are on Windows, make sure that you have "Disable Enhanced Pointer Precision" see instructions above.
- Explain the goal of experiment without compromising the experiment. Something like:
    - I am collecting performance metrics of the mouse through experimentation. (Note: This is true, but only part of the story).
    - Tell them you can fully explain the experiment as soon as they are finished if they have more questions. If they are not comfortable they are free not to participate, no harm done and no questions asked.
- Explain that you are assessing the system not the person
- Explain how their data will be used
    - You will be using anonymous system performance data just for your assignment.
- Demonstrate the equipment/system
    - Do a practice run for them so they can see how it works.
    - Ask them to complete two practice rounds of the task.
- Explain procedure
    - This can be done through demonstration.
    - Ask them not to speak during the experiment and just concentrate on the task.
- Explain that you will not provide help once they have started.
- Describe the task
    - The task is: "To click on the highlighted circles as quickly and accurately as possible, without stopping."
- Administer signed consent form (Typically you would do this in a real experiment, but not necessary here)
    - We will not use a consent form, but for an example consent form (just FYI) see: https://www.dropbox.com/s/c46kb7cd6vk8shn/default-consent.doc?dl=0

Run the study:

- You will help them get the system started, by providing them with their user id and telling them which condition they should start with (Condition 0 or Condition 1). Half the participants will start with 0, half will start with 1 (or 3 and 2 in this case).
- Ask them if they are ready, start the system to first screen and let them know they can start whenever they are ready to go and feel comfortable, but ask them not to stop until they have finished the complete task.
- Make sure participant is comfortable at all times.
- Maintain a relaxed atmosphere.
- Never indicate displeasure or anger.

After the study:

- Before you reveal any details about the goal of the experiment it's time to do a little informal interview. This will be included in the report. Record these in your notes.
- Ask them if they noticed any difference between the two evaluation rounds. Stop here if they didn't notice anything, but if they did notice, follow up. Did they have a preference? Was one easier? Remember to mark down which one they thought was easier (if they did at all), you will have to keep track if it was the area cursor condition or normal condition, and which participant number said it.
- Now ask them if they have any questions. And you are free to reveal all details.
- Remember to thank them for helping you out!

Important Questions and Answers

1. *During the experiment, if someone tells me "Hey, uh, I think your mouse is having problems" (in response to the behaviour of the bubble cursor being used), should I just simply respond with something like "It isn't" and let them continue?*

   We don't want to reveal any information about the specifics of what we are testing during this type of experiment. This ensures that the participants expectations don't influence their results. You should remind them to please continue the experiment, do as best they can, and you will answer any questions after the experiment is over. It is always better to be prepared with the right answer, especially in such a tightly controlled experiment, where the differences in timing will be relatively small.