



Due: Thursday 19 January 2012, 18:00
Group Size: same as your project group
Contribution to the course score: 3/100
Estimated workload: 3 hours/person

Description

In this project, you will quantitatively compare three different formulations of Fitts' Law to determine which model best fits empirical data.

The goals of this project are to gain experience in designing and performing user studies and develop an in-depth understanding of Fitts' Law.

Background

Fitts' Law is a model of human motor behavior derived from Shannon's communications theory. Fitts' model was a breakthrough because it modeled the human nervous system as a communication channels. Through these channels, information (measured in bits) is transmitted by carrying out a movement task. Fitts' model is one of the most robust, highly cited, and widely adopted models to come out of experimental psychology.

The generic formulation of Fitts' Law for this assignment in the form of a linear regression is as follows:

$$MT = a + b * ID$$

where MT is the movement time, and ID is the index of difficulty of the movement task. Note that this formula is consistent with the simplified version that was presented in class (set $a = 0$ and $b = 100ms$, a and b were not given in Fitts' original formulation). These a and b parameters vary by input technique and input device (i.e., pen vs. mouse vs. finger). You will need this more generic formulation for this exercise.

The ID term is a factor that varies across the different formulations of Fitts' Law. The definitions for ID are as follows:

1. Fitts' original formulation:

$$ID = \log_2\left(\frac{2D}{W}\right)$$

2. Welford's formulation:

$$ID = \log_2\left(\frac{D}{W} + \frac{1}{2}\right)$$

3. Shannon's formulation:

$$ID = \log_2\left(\frac{D}{W} + 1\right)$$

Where D is the distance to the center of the target region, and W is the size of the target in the direction of movement.

However, as users execute the tapping tests for a particular ID , they will perform the tests at a variety of different speeds and accuracies. In order to get good linear results, we need to compensate for these differences by computing the effective size (W_e) of the target region:

$$W_e = 4.133\sigma_x$$

where σ_x is the standard deviation of the distance of the user selections to the center of the target region. This calculation adjusts the target width so that 4 percent of the user selections are outside the target assuming that the distribution is normal. The effective size can be used to calculate the effective index of difficulty (ID_e) using the same formulations above. If you want to know more about the reason behind effective width, check reference 1.

Procedure

1. *Experiment*: You will perform a multi-directional tapping test as defined by ISO 9241-9 (see appendix B of ISO 9241-9). After completing the experiments, use the three different formulations of the models to calculate ID_e . For each formulation you will create a scatter plot of the movement times (averaged over all group members), and then perform a linear regression to determine the quality of the fit of the model to empirical data.

We have provided a java program to help you run your experiments. You will find a zip file containing all of the software needed directly in the L2P (together with this document). Use the `readme.txt` for information on how to use the program.

For each member of your team, take measurements of target selection times for $ID = 1, 2, 3, 4, 5, 6, 7$. Use the Shannon formulation of Fitts' Law to determine the distances and

sizes appropriate for each ID . Use the output of the java program from these experiments to calculate the W_e , average MT , and ID_e for each trial. Be sure you use the same experimental setup (same computer, same input device) to minimize experimental error. Also, you should alternate the order of ID 's between users to minimize learning effects.

HINT: Make sure that you read and understand Appendix B of ISO 9241-9. Think of the purpose of the experiment and try to identify independent and dependent variables. Ask yourselves: what is the experimental design that is indicated? Students in past years used incorrect experimental designs leads to incorrect analysis.

2. *Model Construction:* You will fit a linear regression (see Appendix) to your data. Identify the model that fits the data best. Relate your linear regression result of the best fitting model to the generic Fitts' law equation above.

3. *Prediction and Verification:* Using the best fitting model, predict how long it would take to select a target of size 75 from distance 525.

Next, use the simplified version of Fitts' law that was introduced in class to predict the movement time for these parameters. Verify the accuracy of your predictions experimentally.

Deliverables

You can find submission template in `A06SubmissionExample.zip`. Empirical result will be verified by a computer, so we need the data in the correct form. Therefore, points will be deducted if you did not format the data according to the template.

1. Format your raw data as shown in `raw.csv`. Note the the example in the file contain the result of two users ('CW' and 'SV'). Each line represent one click in the program. You will obtain time and distance from the Java program at the end of each trial.
2. Summarize your result in one page `summary.pdf`. Use the template provided in: `summary-template.xlsx`. Note that you have to create the graph by yourself. (If you do not have Excel, you may use other program to compose text and graph in the same format. An example is provided in `summary.pdf`).
3. Write a short report (1–2 pages) to discuss the results: `report.pdf`. Under what circumstances is it better to use the simplified version of Fitts' Law, and when is it better to use the empirically measured version? You may refer to graph in `summary.pdf` in your report. Include your names and matriculation numbers on each page.
4. Upload three files (`raw.csv`, `summary.pdf`, `report.pdf`) to your submission entry in L2P.

Appendix: Computing linear regression directly on graph in Excel

These instructions are for Microsoft Excel X for Mac, other versions of Excel may require slight variations of this procedure.

1. Create an XY scatter plot of the ID_e vs. MT for one of the formulations of Fitts' Law.
2. Select one of the data points directly on the graph.
3. Right click on the data point, and select "Add Trendline..."
4. Leave "Type" as linear regression.
5. Go to the "Options" tab.
6. Select the "Display equation on chart" option.
7. Select the "Display R-squared value on chart" option.
8. Leave "Set intercept" unchecked.
9. Select finish and voila!

References

1. Murata, Atsuo(1999) 'Extending Effective Target Width in Fitts' Law to a Two-Dimensional Pointing Task', International Journal of Human-Computer Interaction, 11: 2, 137 152