CS 522: Human Computer Interaction
Home Work 3
Solution

Lakshmi Manaswi Karra
UIN: 657276611

[REFER TO README for instructions
On how to RUN the experiment]

Project : https://github.com/lkarra2/FittsLaw

Contents

1. Over view of Fitt's Law
2. Experimental Set-up
3. Results
4. Conclusion

1. Fitt's Law:

For a given target acquisition, Fitt's Law describes how the **distance from the start to target** and **width of target** influence the **Index of Difficulty**.

The mathematical notation of the same, is as follows:

$$\mathbf{ID = \log_2(A/W + 1)}$$

Where,
ID is the Index of Difficulty,
A is the Amplitude or Distance from start to target point and
W is the Width of the target.
We can infer that the task becomes harder, or the Index of Difficulty increases when,

1. The Amplitude increases (A increases)
2. The Width of target reduces (W decreases)

Fitt's Law can be seen to have applications in terms of HCI. The first, is to predict the time required by a user to complete a certain GUI action. This is the direct implementation of the Law. The other application is the use of this Law to evaluate pointing devices and their effectiveness. This second method, turns Fitt's Law inside out. (Soukoreff, R. W., & MacKenzie, I. S. (2004)) By calculating different movement times, for different conditions, the coefficients within Fitt's Law equation are analyzed and compressed into a single statistic, the throughput, which combines both speed and accuracy.
In this assignment, I have attempted to undertake an experiment, that imitates this implementation of Fitt's Law, as per the given instructions.

An over view of the data collection and calculations required:
The following data shall be set, for the basis of this experiment:
Amplitude (A): x, y, z units of length
Width, (W): a, b units of length

Data to be collected from the experiment:

1. For each set of values of startWidth, targetWidth and Amplitude:
   A. Time taken
   B. Point at which user clicked (inside the target)

<u>Using the above data, we will now calculate the Regression Coefficients and Throughput by completing the following steps:</u>

1. Determine the ***end-point-scatter-data***
2. Calculate the ***standard deviation(SD)*** from these values
3. Calc ***effective target Width(We) = 4.133*SD***
4. Determine ***mean distance from start to end point (De)***
5. ***IDe = $\log_2$(De/We+1)***
6. Now, using the MT and corresponding Side values, we build a regression model (using R)

7. This graph will yield the ***regression coefficients***, a and b where ***a is the y-intercept*** and the ***slope of the line is b***
8. We calculate ***Throughput*** as follows:

$$TP = \frac{1}{y}\sum_{i=1}^{y}\left(\frac{1}{x}\sum_{j=1}^{x}\frac{IDe_j}{MT_{ij}}\right),$$

9. Plot a ***graph MT vs IDe***
10. Plot a ***graph TP vs IDe***

2. Experimental Setup

For the purpose of this experiment, we have made the following considerations:

- De has been taken as D
- We, similarly, is taken as W

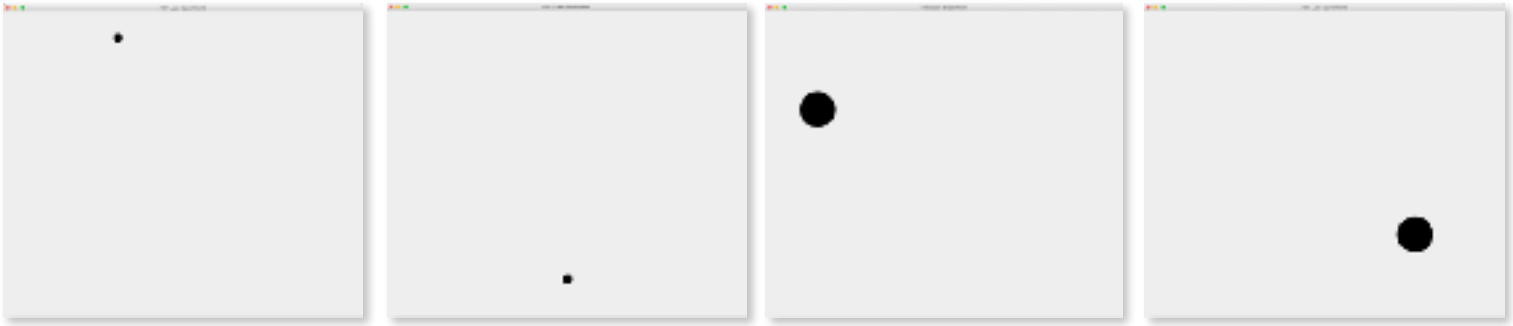
Number of Distances considered: 3
D = [50, 350, 100]
Number of Target Widths considered: 2
W = [25, 100]

Total cases: D*W = 6 cases [(50,25),(50,100),(350,25),(350,100),(100,25),(100,100)]

Test Conditions:

- On starting the experiment, pairs of circles with same D and W begin to appear as the user keeps clicking
- The cases are completely randomized. Which means that, after (50,25) —> (D*,W*) ANY case can appear next. This is to make sure that the User doesn't get affected by the experimenter effect
- The iterations continue till each case has appeared twice

User Interface Appearance:



3. Test Results and Data Analysis

Data Captured from the two users:

User 1:

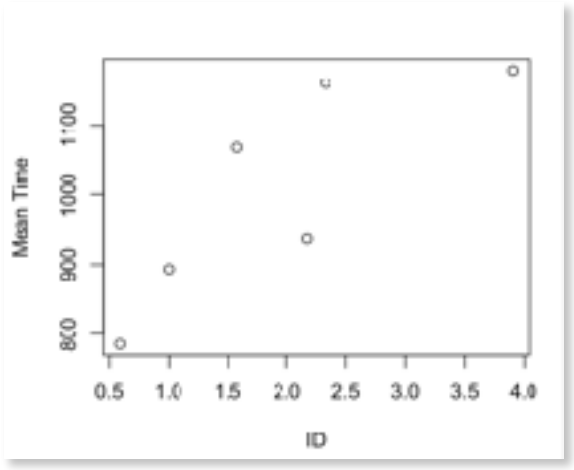
Time	D	W
1135	350	25
881	350	100
1006	50	25
1264	350	25
851	350	100
971	350	100
1047	100	25
980	350	100
1079	50	25
720	50	100
1070	100	25
1137	350	25

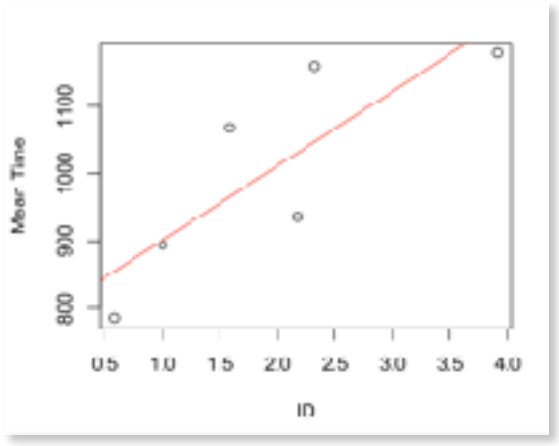
User 2:

1167	50	25
724	100	100
851	50	100
1072	100	100
1018	50	25
908	350	100
989	100	100
987	100	25
1544	100	25
800	100	100
1022	350	100
1044	50	25

Each user was given randomly generated Pairs. The first column, **Time** is the Time elapsed from first click to second click on the circle for each pair.
The units of the Time are in **Milliseconds.**

The Data Analysis was done using R.





1. **ID is calculated as ID = log2(D/W + 1)**

```
> ID
[1] 1.5849625 2.3219281 3.9068906 0.5849625 1.0000000 2.1699250
```

2. **Scatter plot of MT vs ID**

The regression coefficients, a and b are calculated and the Regression

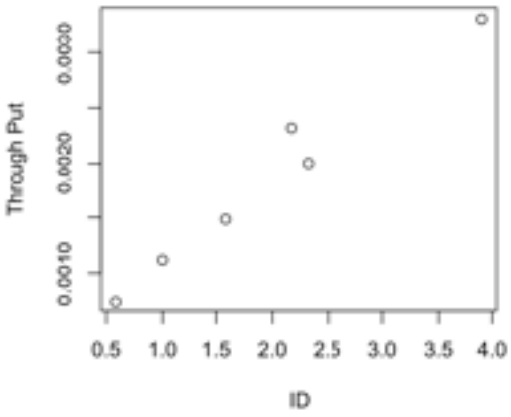
```
Coefficients:
(Intercept)          ID
      790.2       110.6
```

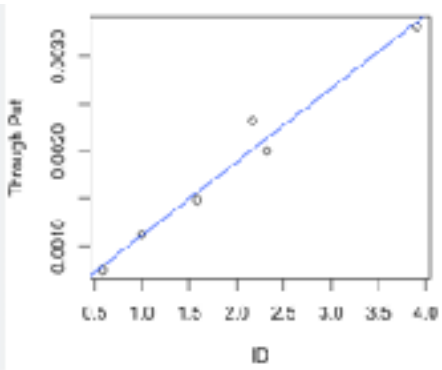
Model is drawn, where **MT = a + b(ID)**

3. **Throughput is Calculated as ThPut = ID/MT**

```
> ThPut
[1] 0.0014846033 0.0020025253 0.0033146696 0.0007447008 0.0011188811
[6] 0.0023191218
```

4. **Scatter plot of Throughput vs ID**






```
Coefficients:
(Intercept)          ID
  0.0003356    0.0007755
```

TP is a complete measure encompassing both the speed and accuracy of the movement performance.

Conclusion:

From the study, we can infer the following:

- As the Distance between Targets increases and the Target size reduces, the Index of Difficulty increases.
- From MT vs ID graph, we can conclude that increase in Index of Difficulty increases the time required to move from one target to another
- Surprisingly, we observe from this experiment that the Throughput also increases as the Index of Difficulty increases.