

stroop_effect

April 16, 2016

1 Stroop Effect Analysis

1.0.1 Question 1: What are the independent and dependent variables ?

Answer: The dependent variable is the **time taken to complete the naming of the colors**. The independent variable is whether the **colors shown are congruent or not**. Congruence in this context means that color correspond to their name printed on the screen.

```
In [1]: import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
%matplotlib inline

In [3]: stroop_data = pd.read_csv('stroopdata.csv');
print "Stroop data read successfully !"
```

Stroop data read successfully !

```
In [4]: print stroop_data
```

	Congruent	Incongruent
0	12.079	19.278
1	16.791	18.741
2	9.564	21.214
3	8.630	15.687
4	14.669	22.803
5	12.238	20.878
6	14.692	24.572
7	8.987	17.394
8	9.401	20.762
9	14.480	26.282
10	22.328	24.524
11	15.298	18.644
12	15.073	17.510
13	16.929	20.330
14	18.200	35.255
15	12.130	22.158
16	18.495	25.139
17	10.639	20.429
18	11.344	17.425
19	12.369	34.288
20	12.944	23.894
21	14.233	17.960
22	19.710	22.058
23	16.004	21.157

1.0.2 Question 2: What is an appropriate set of hypotheses for this task? What kind of statistical test do you expect to perform? Justify your choices.

Answer: The data is for a sample from a population and we are trying to infer about the population. This is why we use t-tests (when the population parameters are not known). Let us name **population parameter for mean of congruent reading times to be μ_C** and **population parameter for mean of incongruent reading times to be μ_I** and further for this data set, null hypotheses should be that, there is no change in mean reading times in both cases. Alternative hypotheses should be that, there is an increase in mean reading times when the colors are incongruent.

H₀ (null hypotheses): No change in reading times. ($\mu_I - \mu_C = 0$)

H_A (alternative hypotheses): Reading time in Incongruent case increases. ($\mu_I - \mu_C \geq 0$)

Since this appears like a case, where reading tests are performed on the same set of people for two different conditions. We should perform a dependent t-test for paired samples.

Assumptions made for a dependent t-test for paired samples are: 1. The sample of differences should be roughly normal. 2. Samples should be dependent and it should be possible to pair them. 3. The obvious requirement that both samples should be of equal size.

1.0.3 Question 3: Report some descriptive statistics regarding this dataset. Include at least one measure of central tendency and at least one measure of variability.

Answer:

```
In [16]: stroop_data_summary = stroop_data.describe()
        mean_congruent = stroop_data_summary['Congruent'].loc['mean']
        mean_incongruent = stroop_data_summary['Incongruent'].loc['mean']
        std_congruent = stroop_data_summary['Congruent'].loc['std']
        std_incongreunt = stroop_data_summary['Incongruent'].loc['std']

        print "Mean Congruent reading times: {:.2f} s".format(mean_congruent)
        print "Mean Incongruent reading times: {:.2f} s".format(mean_incongruent)
        print "Standard deviation of Congruent reading times: {:.2f} s".format(std_congruent)
        print "Standard deviation of Incongruent reading times: {:.2f} s".format(std_incongreunt)
```

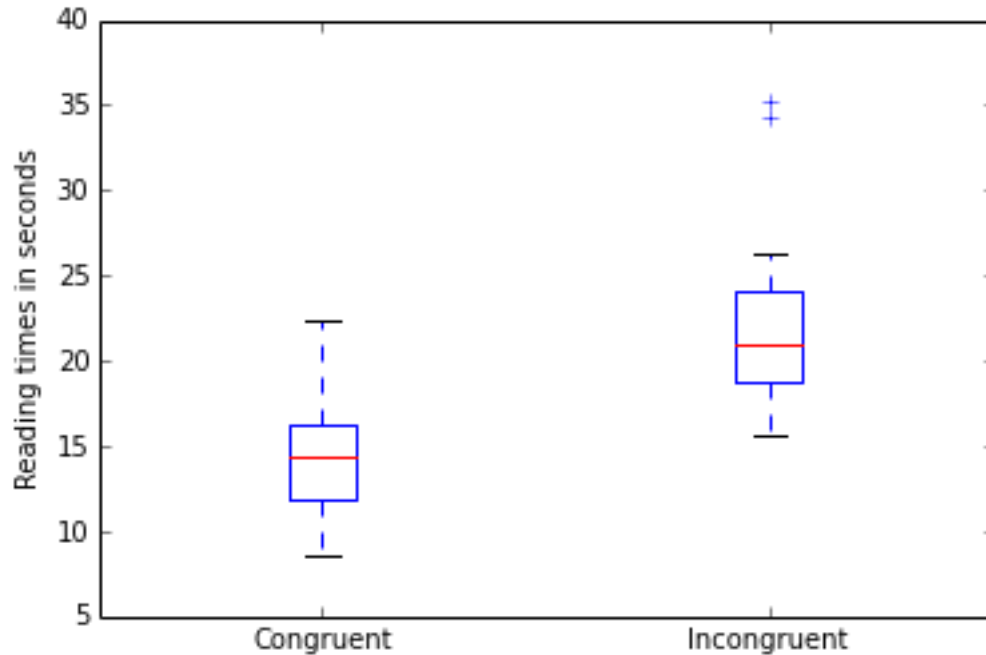
```
Mean Congruent reading times: 14.05 s
Mean Incongruent reading times: 22.02 s
Standard deviation of Congruent reading times: 3.56 s
Standard deviation of Incongruent reading times: 4.80 s
```

1.0.4 Question 4: Provide one or two visualizations that show the distribution of the sample data. Write one or two sentences noting what you observe about the plot or plots.

Answer:

```
In [18]: stroop_data.plot.box()
        pl.ylabel('Reading times in seconds')

        pl.show()
```



As we can see from the plots itself that, congruent reading times overall are lesser than that of incongruent reading times. Congruent reading times lower quartile and upper quartile range from roughly 12 to 16 while incongruent reading times range from 18 to 24. Further more as the calculated standard deviations shows, we can see that standard deviation of incongruent reading times is higher, as there are outliers. (which only increase the variability of data)

1.0.5 Question 5. Now, perform the statistical test and report your results. What is your confidence level and your critical statistic value? Do you reject the null hypothesis or fail to reject it? Come to a conclusion in terms of the experiment task. Did the results match up with your expectations?

Answer: Since our alternative hypotheses is that the reading times have increased, we will perform a one-tailed t-test. Taking an α level of 0.05, we get the t-statistic for a degree of freedom of 23, equal to 1.714. Now we can quickly do a t-test to determine whether the change is statistically significant or not. Before that we need to prepare the data.

```
In [13]: difference = stroop_data['Incongruent'] - stroop_data['Congruent']
         difference_summary = difference.describe()
         mean_difference = difference_summary.loc['mean']
         std_difference = difference_summary.loc['std']

         print "Mean of the difference is {:.4f} s".format(mean_difference)
         print "Standard deviation of the difference is {:.4f} s".format(std_difference)
```

```
Mean of the difference is 7.9648 s
Standard deviation of the difference is 4.8648 s
```

Now we have all the ingredients to do the data t-test. First we will calculate the t-statistic which is given by $(\text{mean} - 0) / (\text{sigma} / \sqrt{n})$

```
In [15]: t_statistic = mean_difference / (std_difference / np.sqrt(24))
         print "t-statistic for the test is {:.4f}".format(t_statistic)
```

t-statistic for the test is 8.0207

We can clearly see that this is much larger than the critical value of 1.714 and its p-value is less than 0.0001 and hence it is statically significant. Therefore we can reject the null, which means we can 'accept' our alternative hypotheses that the reading times in case of incongruent colors are statistically higher and different.

1.0.6 Question 6. Optional: What do you think is responsible for the effects observed? Can you think of an alternative or similar task that would result in a similar effect? Some research about the problem will be helpful for thinking about these two questions!

Answer : There have been various theories on explaining the stroop effect. Citing from the wikipedia, I think that it is because our brain processes words much faster than colors and we need more attention in figuring out the color compared to the word.

An alternative task (which has already been performed) and is an extension to the classic stroop test is the emotional stroop test. In emotional stroop test, the task is to name the colors of depressing words compared to normal words. In another type of stroop test, people suffering from a phobia are shown words related to phobia vs words not related to phobia and it has been found that they can name the colors of non-phobic words faster.