Statistics: The Science of Decisions Project Instructions

Background Information

In a Stroop task, participants are presented with a list of words, with each word displayed in a color of ink. The participant's task is to say out loud the *color of the ink* in which the word is printed. The task has two conditions: a congruent words condition, and an incongruent words condition. In the *congruent words* condition, the words being displayed are color words whose names match the colors in which they are printed: for example RED, BLUE. In the *incongruent words* condition, the words displayed are color words whose names do not match the colors in which they are printed: for example PURPLE, ORANGE. In each case, we measure the time it takes to name the ink colors in equally-sized lists. Each participant will go through and record a time from each condition.

Questions For Investigation

As a general note, be sure to keep a record of any resources that you use or refer to in the creation of your project. You will need to report your sources as part of the project submission.

1. What is our independent variable? What is our dependent variable?

> *The dependent variable is the time each person took to read the text. The independent variable is the condition of text: congruent or incongruent.*

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

> *The null hypotheses for this test could be: there is no difference in the average response time between the congruent and the incongruent set. The alternative would be: there is a difference in the average response time between the congruent and incongruent set.*
>
> *Writing this mathematically, we have:*
>
> $H_0 : \mu_c = \mu_i$

$H_1 : \mu_c \neq \mu_i$

Please note that for this exercise, the index letter "c" will be used to denote the "congruent set", and the index letter "i" will be used to denote the "incongruent set", as used for the average above.

We do not have data regarding the whole population average response time for the Stroop test, for this reason a t-Student approximation for the distribution function will be used on the samples.

Considering how the experiment was designed, it is clearly a paired sample since each individual is submitted to both tests one just after the other. For this reason, we will work with the differences of both tests:

$H_0 : \mu_c - \mu_i = 0$
$H_1 : \mu_c - \mu_i \neq 0$

Now it's your chance to try out the Stroop task for yourself. Go to this link, which has a Java-based applet for performing the Stroop task. Record the times that you received on the task (you do not need to submit your times to the site.) Now, download this dataset which contains results from a number of participants in the task. Each row of the dataset contains the performance for one participant, with the first number their results on the congruent task and the second number their performance on the incongruent task.

I got around 14 seconds for the congruent condition and around 28 seconds for the incongruent. The difference is huge. Based on this results, I am inclined to believe the statistical analysis will show there is evidence to support a difference in both samples.

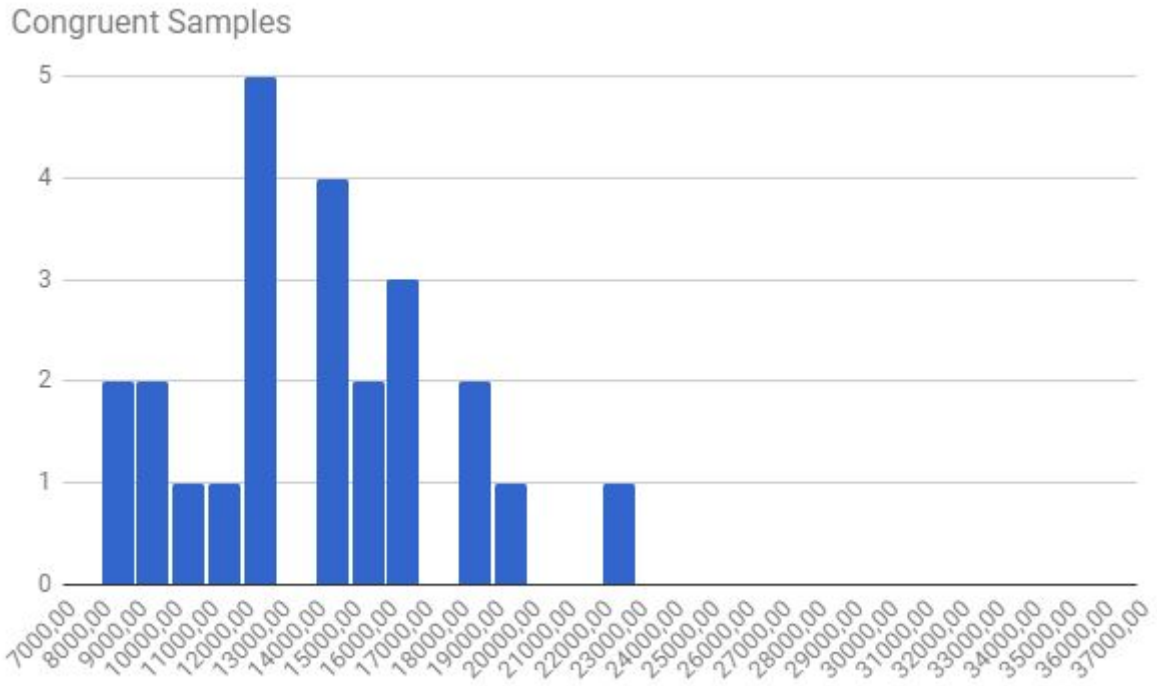
3. Report some descriptive statistics regarding this dataset. Include at least one measure of central tendency and at least one measure of variability.

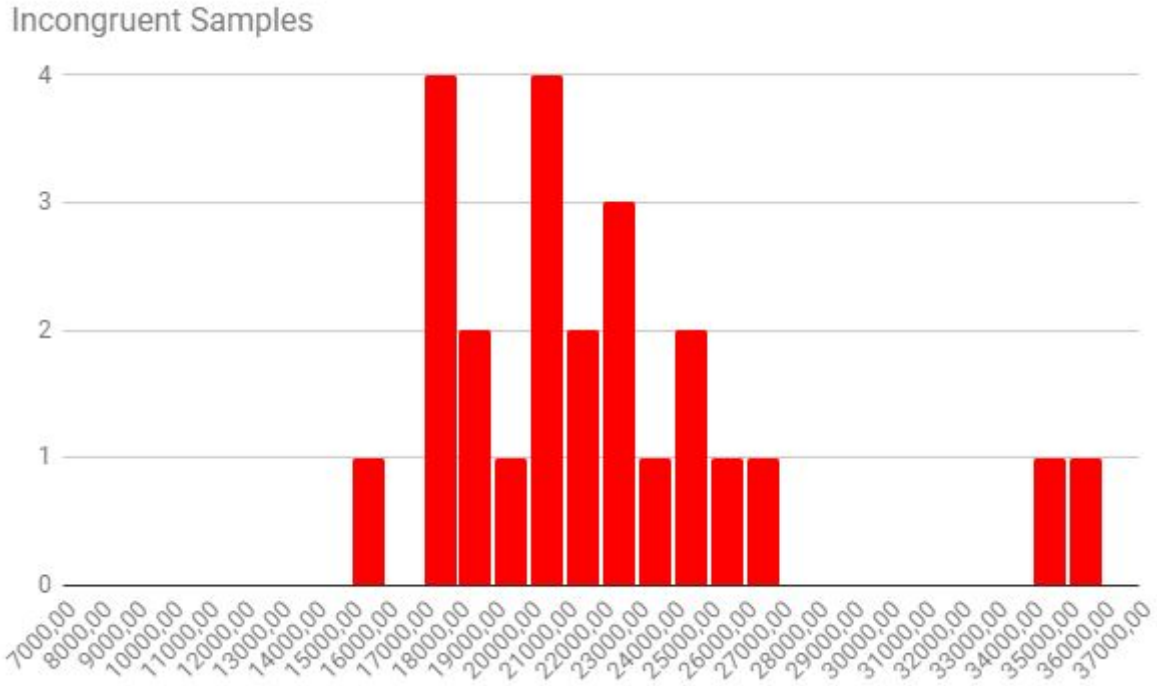
First of all, please notice all data used is in milliseconds. For the given dataset, we have the following statistical values for ***the difference between samples****:*

Average $\mu_d = 7964.79$ *, Sample Standard Deviation* $s_d = 4864.83$ *, Degrees of Freedom* $DF_d = 23$

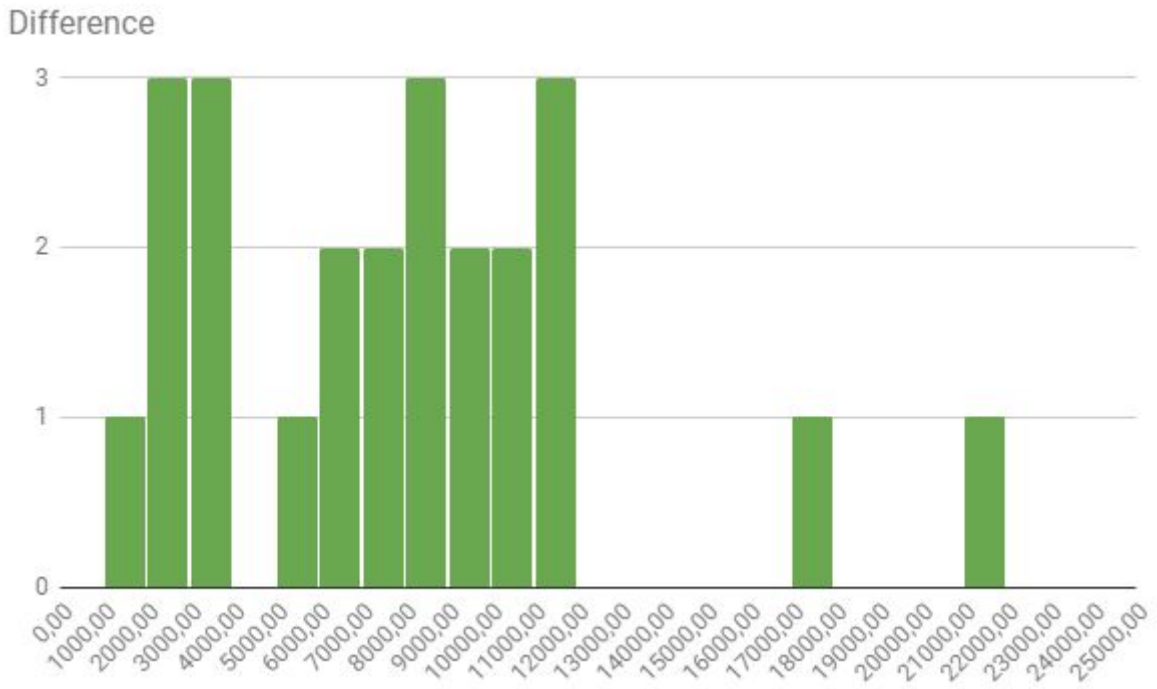
4. Provide one or two visualizations that show the distribution of the sample data. Write one or two sentences noting what you observe about the plot or plots.

For all graphs below, the histogram window size was set to 1000 miliseconds.





Above it is possible to see the histogram for congruent samples in blue and another for incongruent samples in red. They are in the same horizontal axis scale so the observation of their relation is easier.



On the graph above it is possible to see the difference between measurements.

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?

We can calculate the t-student statistic using the formula:

$$\frac{\mu_c - \mu_i}{\frac{s_d}{\sqrt{n}}} = \frac{-7964,79}{\frac{4.864,83}{\sqrt{24}}} = -8.02$$

This results in t= -8.02

Then we can calculate t-critic for $\alpha = 0.05$ *(which means we will reject the null hypothesis only if it falls on the 5% furthest results from the mean value) and DF=23, which results in -2.07<x<2.07.*

We can also calculate the p value using the website https://www.graphpad.com, which gives us a p smaller than 0.0001.

Based on this results, we must reject H_0 *and conclude the difference between the sets must not be due to chance. I was supposing this would be the case because of the huge difference between test results when I took the test.*

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!

> *One possibility is that our brain try to use many different clues to perform interpretation of information faster, in this particular case the color name. If this is the case, maybe using only two different colours, like blue and red for an example, and switching between them randomly as the different colour names are displayed, should produce similar results.*

References