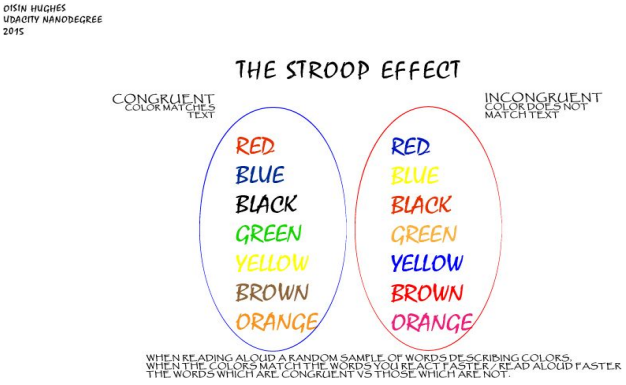
Stroop Effect Udacity Project

We are interested to study the Stroop effect - it is a psychological phenomenon, discovered by John Ridley Stroop in 1930's. It says: when the name of a color is printed in a color that is not denoted by the name (e.g., "BLUE" or "RED"), naming the color of the word takes longer and is more prone to errors than when the color of the ink matches the name of the color (e.g., "BLUE" or "RED"). Stroop test is created on this effect.



Researchers selected 24 people to pass Stroop test. Test contained 2 parts: congruent (ink color matches color name - "RED") and incongruent (ink color does not match color name - "RED"). Time, needed to complete each part of the test, was measured.
We hypothesized that it takes more time to read the words, written in another color, than the words in the correct color.

Type of test: Dependent-samples t-test (within-subject design), two conditions.
This test is used to compare the means of the dependent variable between two related groups. The data must meet some criteria: it's distribution is approximately normal (it is correct for our data), small sample sizes are used to inference about population (our test is for 24 participants), dependent variable must be continuous (we measure time), independent variable must consist of two categorical related groups (we have the same people passing two parts of the test).

Dependent variable: time to name the color of the ink for all the words in the test.

Independent variable: matching between the color of the ink and the word.

Null hypothesis: The population mean time to name the color of the ink for all the words in the congruent test will not differ from that population mean time in the incongruent test.

Alternative hypothesis: The population mean time to name the color of the ink for all the words in the congruent test will be smaller than that population mean time in the incongruent test.

Definition: The measurements of the congruent test (ink color matches color name - "RED") will be marked as X and the measurements of the incongruent test (ink color does not match color name - "RED") will be marked as Y, difference between these values (Y-X) will be marked as D.

So, these are our **hypothesis**:

$$H_0 : \mu_x >= \mu_y \text{ or } \mu_D <= 0$$
$$H_A : \mu_x < \mu_y \text{ or } \mu_D > 0$$

Kind of test: We will perform one-tailed test in positive direction.
Our hypothesis is that the mean time will increase in the second (Y) test, so we are interested only in the positive direction of the effect. If we we interested generally if there will be difference, we would use two-tailed test. But Stroop effect is well-known, so we can make directional hypothesis.

Descriptive Statistics

For X and Y in our dataset we calculated the **means** and the difference between them:

$\overline{x} = 14.051$
$\overline{y} = 22.016$
$\overline{y} - \overline{x} = 7.965$

Also we calculated the **medians**:

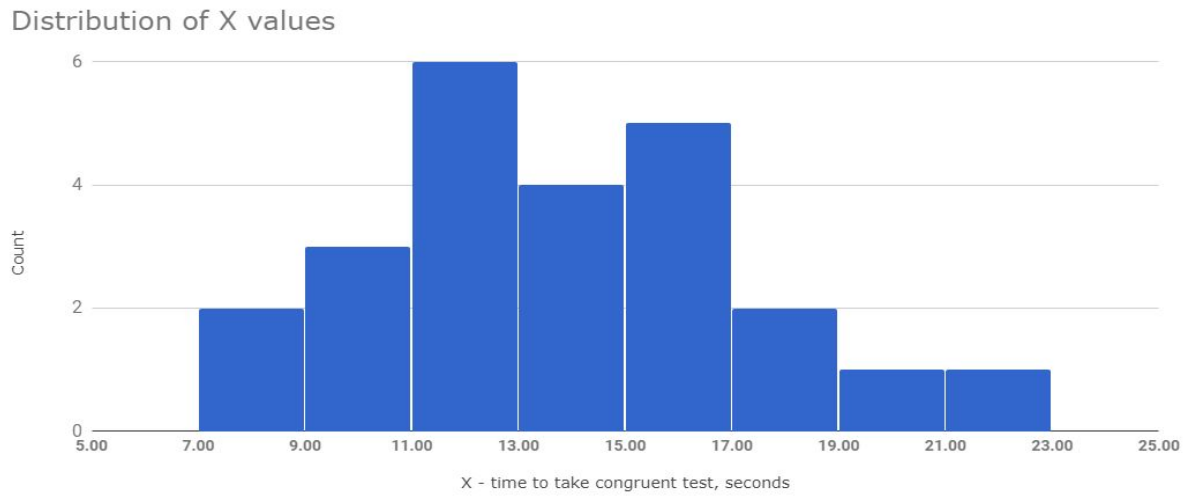
median(x) = 14.357
median(y) = 21.018

And the **standard deviations**:

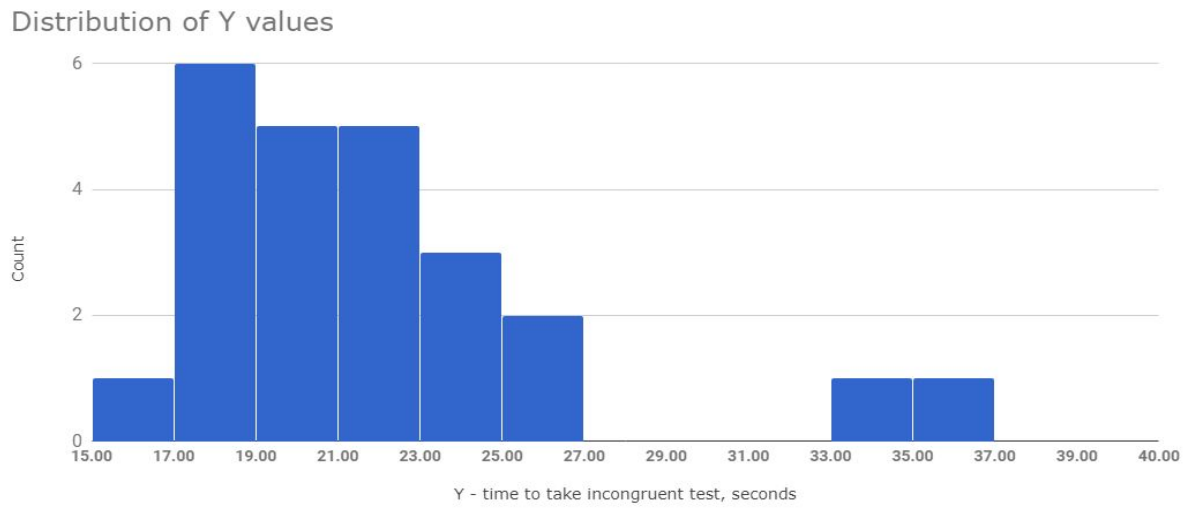
$S_x = 3.559$
$S_y = 4.797$

We can see that the mean and median for X are close to 14, and for Y they are about 21-22. The mean difference is 7.965, so we can expect our hypothesis to come true.

We also created the histograms to see the **distribution of data** in our dataset.



The distribution of X values is close to normal. It is approximately in range 7 to 23 with mean and median to fall in the bucket 13 to 15.



The distribution of Y values is slightly skewed. Values are in the range approximately 15 to 37, mean and median fall in the bucket 21 to 23.

Inferential Statistics.

We found **t-critical** for the one-tailed test in positive direction, having degrees of freedom df = 23 and α=0.05:

t-critical = 1.714

Having standard deviation of the differences = 4.865 and standard error of the mean = 0.993, we calculated **t-statistic:**

t-statistic = 8.021

Based on t-critical and t-statistic, we can make a **decision**:
Our results are statistically significant and we can reject the null, because $p<0.05$.

We calculated the exact **p-value**:

p-value < 0.001

This difference is considered to be extremely statistically significant.

Result:

t(23) = 8.021, $p<0.001$, one-tailed test.

Confidence interval on the mean difference (μ_D = 7.965):

95% CI = (6.263 to 9.667)

Correlation measure:

r^2 = 0.74

74% of the difference is explained by the ink color that does not match the word meaning.

Conclusions:

Making a study on Stroop effect we hypothesized that it takes more time to read the words, written in another color, than the words written in the correct color.
Making analysis on the dataset of 24 people we received extremely significant results in the one-tailed test and rejected the null because p-value is less than 0.001.
74% of variation in the time results in our dataset can be explained by the ink color of the words.

There are several explanations for Stroop effect.
Our brain reads really fast. It takes him much more time to recognize color and to find the name of this color, than just to read the word. Also, reading is a very common process so it is happening automatically. Also process of reading requires less attention, so again it happens more quickly.
But if the words are written in another language, someone who does not understand it, will not be slowed down by their meaning.
This effect was used during cold war by American officials to catch Russian spies who claimed they don't know Russian, but it took them much longer to name the colors of russian words.

One alternative task on Stroop effect is Animal Stroop task. It has the pictures of various animals and the words naming animals. Participants have to name the animal on the picture and not the word written on it.