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?**

Based on studies of interference in serial verbal reactions from J.Ridley Stroop 1935, the independent variable would be **test color set with no interference (red color will be written red etc) / congruent task** and **test color set with interference (red color will be written yellow etc) /incongruent task**

and the dependent variable would be **time spent** to finish the test.

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

H_o: μC = μI
Null Hypothesis states that time spent to finish congruent task mean is equal with time spent to finish incongruent task mean

Hi : μC < μI
The Alternative Hypothesis would be mean time spent to finish congruent task is smaller than time spent to finish incongruent task.

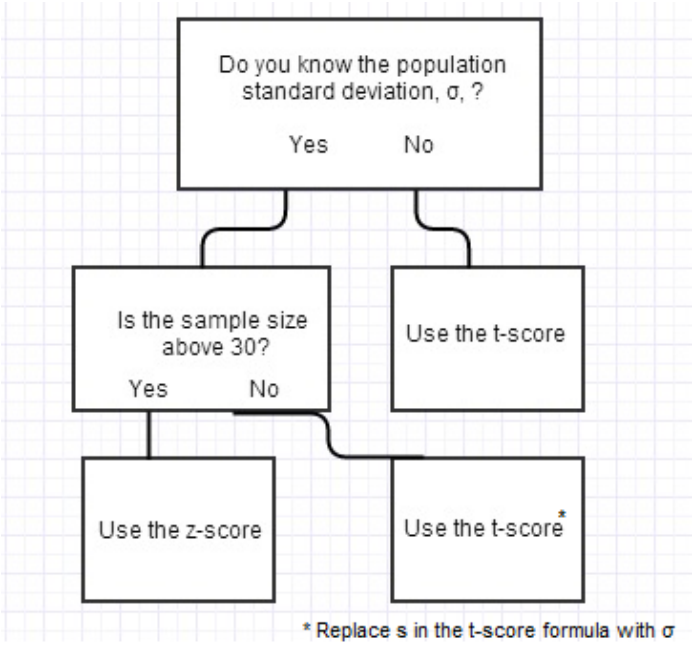
There are many types of statistical sets according to their uses

Type of Test	Use
Correlational	These tests look for an association between variables
Pearson correlation	Tests for the strength of the association between two continuous variables
Spearman correlation	Tests for the strength of the association between two ordinal variables (does not rely on the assumption of normally distributed data)
Chi-square	Tests for the strength of the association between two categorical variables
Comparison of Means: look for the difference between the means of variables	
Paired T-test	Tests for the difference between two related variables
Independent T-test	Tests for the difference between two independent variables
ANOVA	Tests the difference between group means **after** any other variance in the outcome variable is accounted for
Regression: assess if change in one variable predicts change in another variable	
Simple regression	Tests how change in the predictor variable predicts the level of change in the outcome variable
Multiple regression	Tests how change in the combination of two or more predictor variables predict the level of change in the outcome variable
Non-parametric: used when the data does not meet assumptions required for parametric tests	
Wilcoxon rank-sum test	Tests for the difference between two independent variables—takes into account magnitude and direction of difference
Wilcoxon sign-rank test	Tests for the difference between two related variables—takes into account the magnitude and direction of difference
Sign test	Tests if two related variables are different—ignores the magnitude of change, only takes into account direction

Since we need to test the difference of mean of time spent, the most appropriate is using independent T-test. But, For hypothesis testing we should also consider whether to use t-test or Z-test. A **z-score** and a **t score** are both used in hypothesis testing. Few topics in elementary statistics cause more confusion to students than deciding when to use the z-score and when to use the t score. Generally, in elementary stats and AP stats, we use a z-score in testing more often than a t score. The general rule of thumb for *when* to use a t score is when your sample:

- Has a sample size below 30,
- Has an unknown population standard deviation

We **must** know the standard deviation of the **population** *and* our sample size **should** be above 30 in order for you to be able to use the z-score. Otherwise, use the t-score.



in this case we need to do t-testing because the sample **size is less than 30.**

We need to do **t-test dependent means** to compare the differences of means between congruent & incongruent, specifically **lower-tailed test testing the hypothesis**

The basis of t–test dependent means, is because *t*-Test for Dependent Means Samples or sets of data used to produce the difference scores are linked in the population through **repeated measurement**, natural association, or matching In this case the population sample did the repeated measurement with different treatment, once with congruent set test, the other one was with incongruent set test.

Hypothesis testing to determine whether a population mean, μ, is equal to some target value μ_0 include the following:

- H_o: $\mu = \mu_0$
- H_1: $\mu < \mu_0$ -> test using lower-tailed test
- H_1: $\mu > \mu_0$ -> test using upper-tailed test
- H_1: $\mu \neq \mu_0$ -> test using two-tailed test

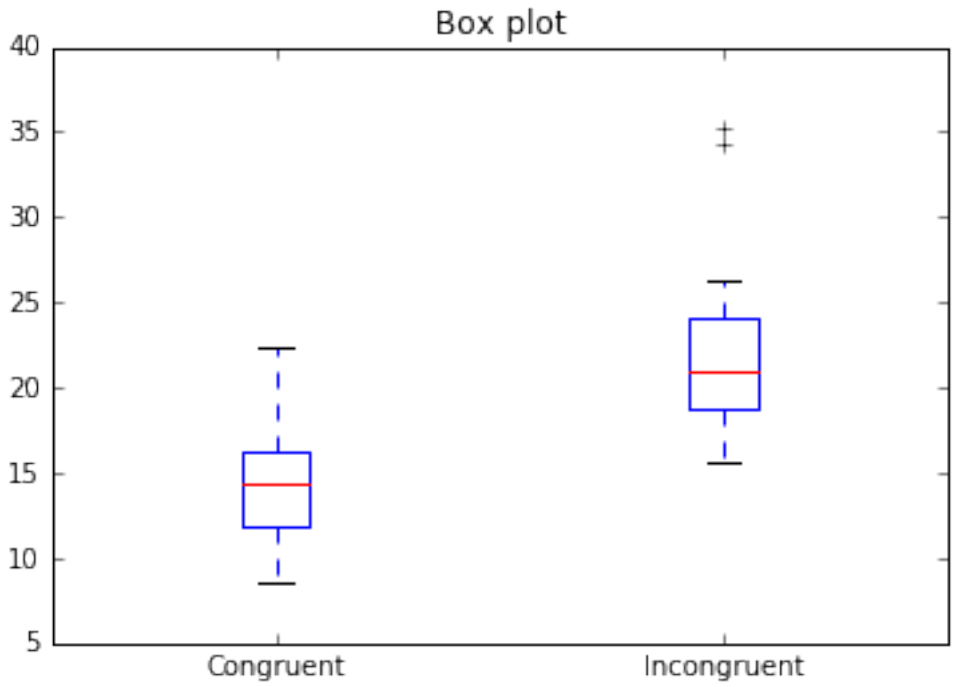
In Stroop effect study case, we will use lower-tailed test to test the hypothesis, because we assume that mean time spent to finish congruent test ***might be less*** than time spent to finish incongruent test

http://support.minitab.com/en-us/minitab/17/topic-library/basic-statistics-and-graphs/hypothesis-tests/basics/null-and-alternative-hypotheses.

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

	Congruent	***Incongruent***
Mean	14.051125	22.01591667
Standard Error	0.726550901	0.979195185
Median	14.3565	21.0175
Mode	#N/A	#N/A
Standard Deviation	3.559357958	4.797057122
Sample Variance	12.66902907	23.01175704
Kurtosis	-0.205224823	2.688900198
Skewness	0.416899874	1.547590026
Range	13.698	19.568
Minimum	8.63	15.687
Maximum	22.328	35.255
Sum	337.227	528.382
Count	24	24
Confidence Level(95.0%)	1.50298505	2.025619571

3. **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.**



It always takes more time to finish incongruent task than to finish congruent task for all subjects.

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?**

Level of confidence = 95%

t-Test: Paired Two Sample for Means

	Congruent	*Incongruent*
Mean	14.051125	22.01591667
Variance	12.66902907	23.01175704
Observations	24	24
Pearson Correlation	0.351819527	
Hypothesized Mean Difference	0	
df	23	
	-	
t Stat	8.020706944	
P(T<=t) one-tail	2.0515E-08	
t Critical one-tail	1.713871528	
P(T<=t) two-tail	4.103E-08	
t Critical two-tail	2.06865761	

Pearson correlation showing P one-tail test result was 2.0515E-08 which is less than p <= 0.5, which is which means that the difference between congruent and incongruent test was significant. So, reject null hypothesis.

The result was expected because from the graph we can totally see the differences.

This means null hypothesis H_o: μC = μI is rejected.

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!

What do you think is responsible for the effects observed?

interferences which arise in naming colors are due not so much to an equal readiness of the color names as to an equal readiness of the color recognition processes. Another factor present in interference is very probably **the present strength of the associations between colors and their names, already determined by past use**." Peterson (1918 and 1925) has attributed the difference to the fact that, "One particular response habit has become associated with each word while in the case of colors themselves a variety of response tendencies have developed

alternative or similar task that would result in a similar effect?

According to Kualif and Vaile (2008), there are alternatives to Stroop Color-Word Test (SCWT), which is denominated **the Colored Numbers Test (CNT**), to evaluate the selective attention of illiterate individuals. Volunteers had to name the color of the rectangles in the CNT neutral condition, and in the critical condition they had to either name the color of the numbers or, when the numbers were black, read the numbers.

References

Cyfar.org. (2017). *Types of Statistical Tests | CYFAR*. [online] Available at: https://cyfar.org/types-statistical-tests [Accessed 28 Jul. 2017].

Kulaif, T. and Valle, L. (2008). Alternative to the Stroop Color-Word Test for Illiterate Individuals. *The Clinical Neuropsychologist*, 22(1), pp.73-83.

Statistics How To. (2017). *T-Score vs. Z-Score: What's the Difference?*. [online] Available at: http://www.statisticshowto.com/when-to-use-a-t-score-vs-z-score/ [Accessed 28 Jul. 2017].

Stroop, J. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, 18(6), pp.643-662.