Introduction to Hypothesis Testing

* **Research** is designed to answer questions, and statistics are the tools to help us reach answers and make decisions. Most often, research questions are addressed via hypothesis testing.
* **Hypothesis testing** are procedures designed for determining whether a hypothesis is supported by data. To do this, we will use inferential statistics that are used to draw conclusions about populations based on data collected from samples.
* **Inferential statistics** are built upon probabilities, specifically determining the probability that the data represents a particular population.

**Hypothesis Testing Steps**

1. State hypotheses in your own words
2. Design the study
3. Create statistical hypotheses
4. Select the appropriate statistical test
* Imagine that a researcher wants to investigate whether entrepreneurs who exercise daily have higher sales revenue in their company.

**Step 1: State the hypothesis using words**

* Hypotheses are reasoned predictions about the outcomes of a study. It is important that researchers not only consider what they expect or hope to happen, but also all of the possible outcomes of their researcher and data analysis. Therefore, when stating research hypotheses it is useful to state a set of hypotheses that are both mutually exclusive (complete independent, and only one can be true) and exhaustive (no other possibilities exist).
* For our example, there are three possibilities:
1. Those who exercise daily do not have higher a difference in sales revenue in their company
2. Those who exercise daily have lower sales revenue in their in their company
3. Those who exercise daily have higher sales revenue in their company

**Step 2: Design the Study**

* Once all of the possible hypotheses/outcomes have been formalized, a proper research study can be designed to effectively “test” the hypotheses. The topic of research design is not the focus in this course, but I will briefly emphasize the importance of the quality of the statistical analysis, which is greatly dependent upon the quality of the research study from which the data originated. In other words, statistics cannot make up for poorly conducted research.
* Regarding our example, let’s imagine that a researcher designs to obtain a random sample of entrepreneurs who exercise daily to determine if such individuals have higher than average sales revenue. Because it is now known that the average sales revenue for a company is $100,000, evidence supporting the researchers prediction would be if the entrepreneurs who exercised average in revenue greater than $100,000.

**Step 3: Create Statistical Hypotheses**

* Statistical hypotheses are based upon the written hypotheses previously stated in step 1, but describe the population parameters of interest using statistical symbols. More specifically, there are two types of statistical hypotheses: the null and alterative.

**Null hypothesis**

* symbolized as H0
* is the hypothesis that no difference or no difference of interest and thus always includes an equal sign.

**Alternative hypothesis**

* symbolized as HA
* is the hypothesis that corresponds to the researchers prediction (in this sense, the alternative hypothesis is often called the research hypothesis).
* Alternate hypotheses can be either one-tailed or two-tailed.
	+ **One-tail alternative hypotheses** are set forth when the research predictions the direction of the expected difference (up or down).
	+ In **two-tailed alternative hypotheses**, the researcher does not predict the direction of the difference but simply predicts there is a difference.
* For our example, we indicated that the researcher expects entrepreneurs who exercise daily to perform BETTER in sales revenue. Therefore, this situation calls for a one-tail alternative hypothesis.
* The null hypothesis would be that the entrepreneurs who exercise daily do not have higher sales revenue of $100,000 in their company
* The alternative hypothesis would be that the entrepreneurs who exercise daily do have higher sales revenue of $100,000 in their company

**Step 4: Select the appropriate statistical test**

* Once the hypothesis are stated, the study is designed, the statistical hypotheses are stated, and the data are collected it is time to analyze the data to determine whether there is evidence for the null or alternative hypothesis. Such evidence is obtained through use of inferential hypothesis tests. These include z-tests, t-tests, Analysis of Variance, and Regression. You will learn about these later.

**The Logic of Hypothesis Testing**

* It is important to understand that it is impossible to statistically demonstrate or prove that something is “true”, instead we use statistics to determine how likely something is to be true. This is why probability is important in statistics. In order to determine a probability regarding how likely a hypothesis is to be true, we must make an assumption. Specifically, when conducting statistical hypothesis tests, we start by assuming that the NULL is true, and then determine how likely our data is to have occurred given this assumption. Because we assume the null is true, whenever we conduct a test we are testing the null hypothesis.
* The researcher then makes a decision:
* **Reject the null**: if the data are too unlikely to occur when the null is true
* **Fail to reject the null**: if the data are relatively likely to have occurred when the null is true

**Statistical Significance: p <.05**

* You may have heard the phrase “p is less than .05” in the context of statistical analysis.
* P <.05 simply indicates that when the null hypothesis is true, the probability of obtaining the data are less than 5 out of 100. This criterion, p<.05 is the most common one that researchers use to determine when to reject the null hypothesis.
* Therefore, if P <.05, we conclude that it is probably safe to reject the null hypothesis and further conclude that there is a statistically significant evidence in favor of the alternative hypothesis.

**P < .05** – reject the null

**P > .05** – accept the null (or fail to reject)

**Errors and Outcomes**

* As stated above, a researcher can conclude only 1 of 2 things: either to reject the null. However, when we consider the accuracy of these decisions and the possibility for error (making an incorrect decision) there are two errors that can occur.

**Type I Errors**

* occur when the researcher rejects a true null hypothesis.
* Stated differently, this is when a researcher concludes that there is a statistically significant result but the conclusion was made in error because it does not reflect the true nature of the world.

**Type II Errors**

* occur when the researcher fails to reject a false null hypothesis.
* In other words, the researcher should have rejected the null hypothesis because it is not true, but failed to do so.

**References**
Tagler, M. (2009). *Understanding Basic Statistics with Spreadsheets.* Pearson Custom Publishing