



Hypothesis Testing and Statistical Tests

Data Boot Camp
Lesson 7.3



Class Objectives

By the end of today's class you will be able to:



Understand the difference between Hypothesis and Null Hypothesis.



Apply one-sample t-test to identify significant difference between sample and population data.



Apply two sample t-test to identify significant differences between two groups.



Apply ANOVA to compare the means of three or more groups.



Perform Chi Square Test to compare distribution of categorical data.



Instructor Demonstration

Intro to Hypothesis Testing



Hypothesis testing can be confusing at times, mostly because you **must create** your **null** and **alternative hypothesis** before performing any analysis.

What is Hypothesis? Intro to Hypothesis Testing

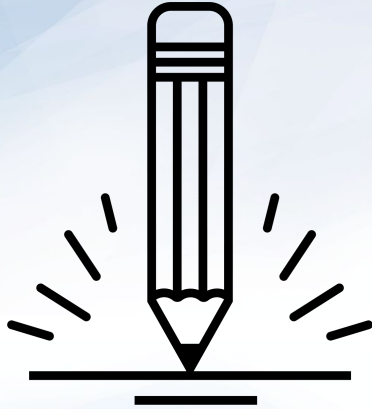
- Hypothesis is an **educated guess** about something.
- **Hypothesis Statement:**
 - The Hypothesis is often expressed as an **If/Then** statement.
- **Hypothesis Testing:**
 - Hypothesis testing in statistics is a way for you to test the results of a survey or experiment to see if you have meaningful results.
 - We test against for two mutually exclusive outcomes - **null** and **alternative** hypothesis

Intro to Hypothesis Testing

- **Null Hypothesis (H_0):**
 - Null hypothesis is the hypothesis that we are trying to disprove due to no statistical significance between the two variables.
 - In short, you null hypothesis assumes that your results **happened by chance**.
- **Alternative Hypothesis (H_a):**
 - Alternative hypothesis is the opposite of the null hypothesis, it assumes there is some factor influencing the results. The hypothesis assumes your results **did not happen by chance**.

Steps for Hypothesis Testing: Intro to Hypothesis Testing

1. Determine the Hypothesis and Null Hypothesis.
2. Identify the appropriate statistical test.
3. Determine the acceptable significance value.
4. Compute the P-value.
5. Determine if the P-value rejects the Null Hypothesis by comparing it to the significance value (Typically < 0.05)



Activity: Forming a Null Hypothesis

In this activity, you and your partner will take two given questions into an Hypothesis and Null Hypothesis.

Suggested Time:
10 Minutes

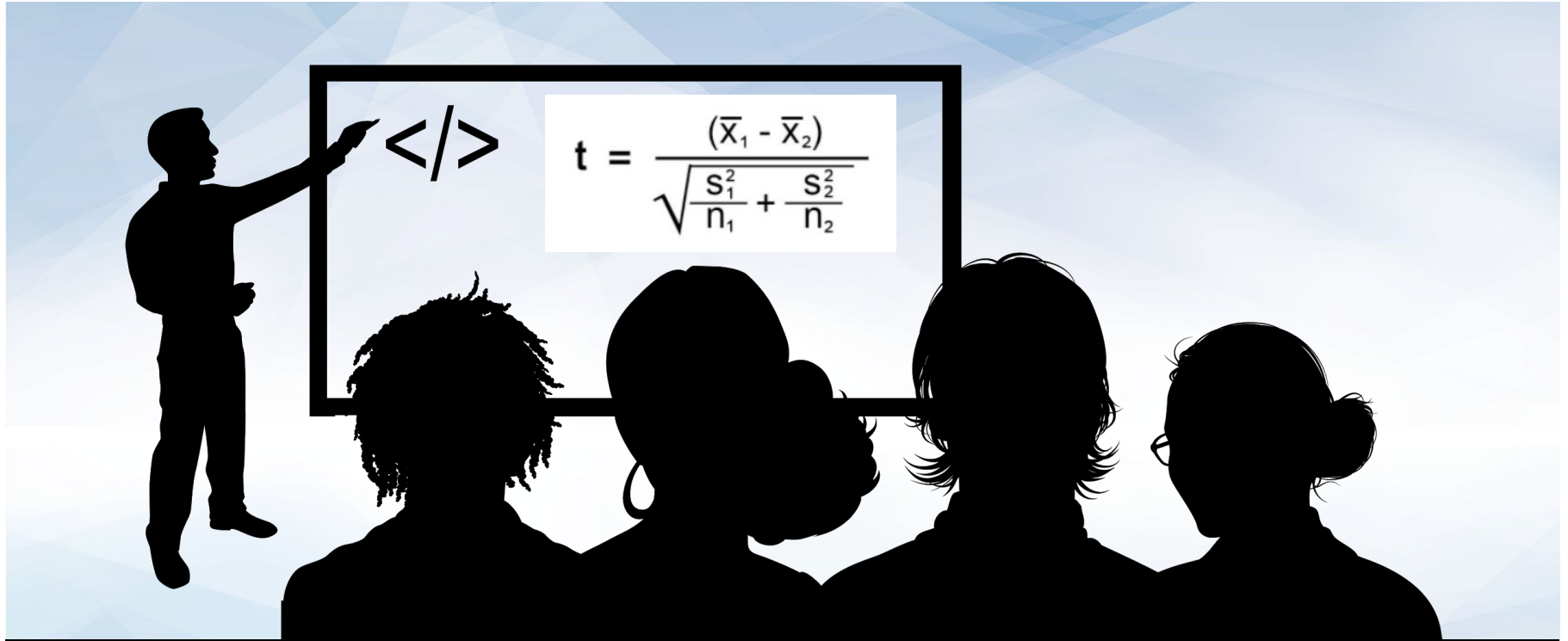


Instructions: Activity: Forming a Null Hypothesis

- Convert the following Questions into an Hypothesis and Null Hypothesis.
 - Does Dark Chocolate affect arterial function in healthy individuals?
 - Does Coffee have anti-aging properties?



Time's Up! Let's Review.



Instructor Demonstration

T-Test

T-Test

Calculating T-Test

$$t = \frac{(\bar{X}_1 - \bar{X}_2)}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}$$

- **\bar{X}_1** = mean of the first data set.
- **\bar{X}_2** = mean of the second data set.
- **S_1^2** = standard deviation of the first data set.
- **S_2^2** = standard deviation of the second data set.
- **N_1** = number of elements in the first data set.
- **N_2** = number of elements in the second data set.



What is T-Test?

T-Test

- T-Test tells you how significant the differences between groups are.
- It lets you know if the differences, measured in means/average, could have happened by chance.
- **One Sample T-Test:**
 - Determines whether the sample mean statistically differ from a known or hypothesized population mean.
- **Independent T-Test:**
 - Also known as **two sample t-test** , determines whether there is a statistically significant difference between the means in **two unrelated** groups.

What type of T-Test Should I use?

T-Test

- There are couple of things to consider before performing T-Test:
 - Whether the compared groups comes from a single population or two distinct population.
 - Whether you want to est the difference in a specific direction.



- **One Sample T-Test**

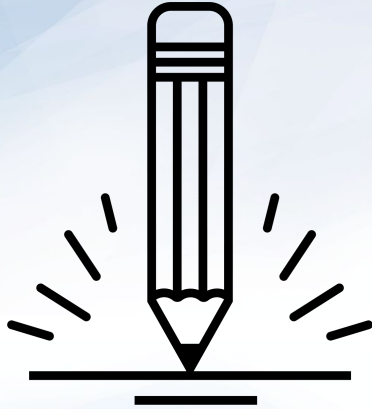
- One group being compared against a standard value.
- e.g. comparing gasoline octane level to a octane level.

- **Independent T-Test**

- Groups coming from two distinct populations.
- e.g. different countries, different species.

<Time to Code>





Activity: T-Test

In this activity, you will use a T-Test to compare the difference in Adult Sardine Vertebrae counts from two different locations.

Suggested Time:
15 Minutes



Instructions: Activity: T-Test

- Calculate the mean for each population.
- Use a T-Test to determine if there is a statistically significant difference in the number of vertebrae of Adult Sardines in Alaska vs. San Diego.
- It is up to you to determine if you should use a One Sample independent T-Test.



Time's Up! Let's Review.



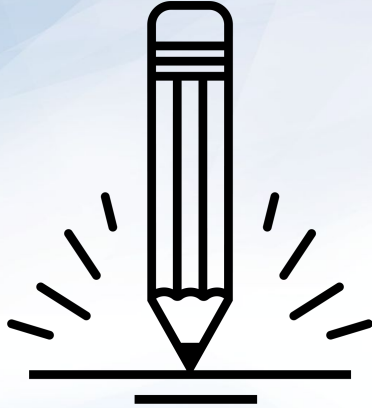
Instructor Demonstration

ANOVA

What's ANOVA?

ANOVA

- In short, **ANOVA** is an extension of a T-Test. As we previously covered, with T-Test you can test two **groups** to see if it is difference in means.
- An **ANOVA** test is a way to find out if survey or experiment results are significant.
- They help you to figure out if you need to **reject** the **null hypothesis** or **accept** the **alternate hypothesis**.



Activity: ANOVA

In this activity, you will use ANOVA to compare the differences in Pain Threshold for people with different hair colors.

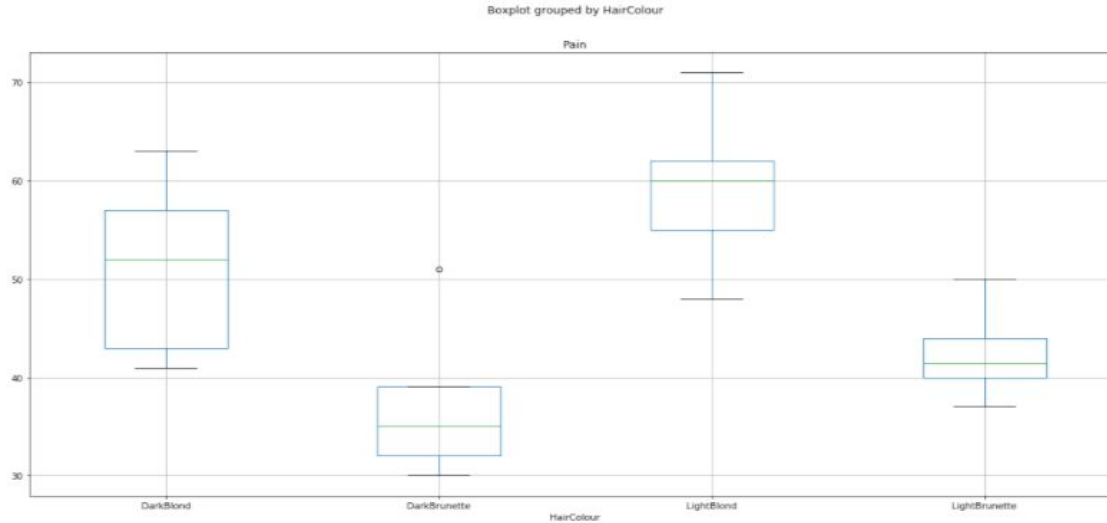
Suggested Time:
10 Minutes



Instructions: Activity: ANOVA

- Perform a one-way ANOVA test to determine if there are any significant differences in Hair Color vs. Pain Threshold.
- Create a Boxplot to show the distribution of pain tolerances for each hair color.

Out[4]: <matplotlib.axes._subplots.AxesSubplot at 0x112628978>





Time's Up! Let's Review.



Instructor Demonstration

Chi Square

The Chi-Square Test

What's used for?



To answer the question: Is the distribution of frequencies in the dataset meaningful?



In other words, does the data match our expectations?



In still other words, do we accept or reject the null hypothesis?

The Chi-Square Test

Example: Out of 300 dinosaurs,



220 eat
everything



55 eat
only meat



25 eat
only plants

Null hypothesis:

No statistical significance exists in the distribution of omnivores, carnivores, and herbivores. That is, this data can be explained by random distribution.



The chi-square test can help us accept or reject the null hypothesis.

The Chi-Square Python Function

How is the chi-square test used:

01

Determine chi-square value.

02

Determine degree of freedom.

03

Choose a p-value.

04

Determine critical value.

05

Make a decision.

Degree of Freedom

To determine the degree of freedom (df), take the number of rows and subtract 1:

Omnivores: 220
Carnivores: 55
Herbivores: 25

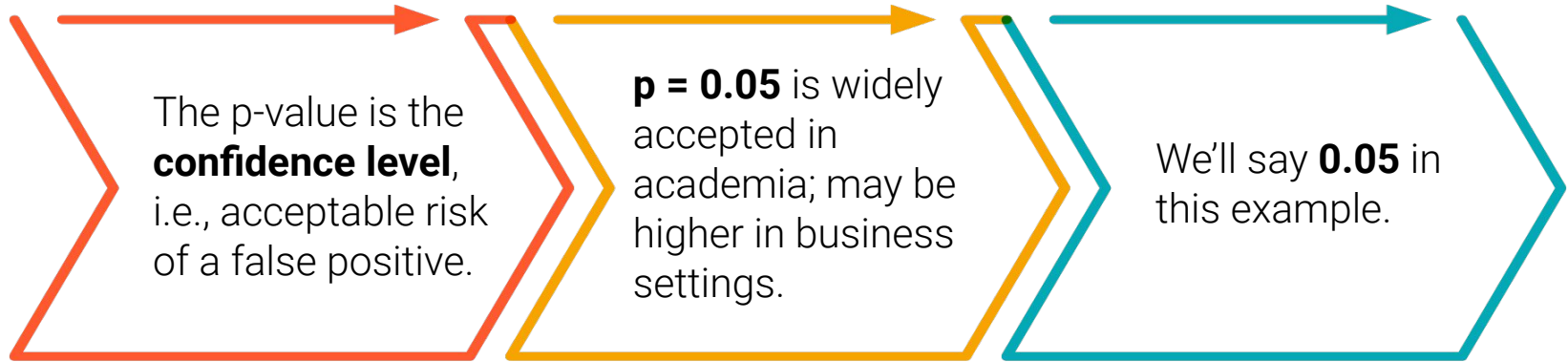
There are three rows, so the degree of freedom is

$$3 - 1 = 2$$

The degree of freedom is the number of figures required to fill out the table (like Sudoku).

If we have two of the numbers, we can figure out the value of the third.

P-value



Importance of Findings	Significance Level	Probability of Being Wrong
Low	0.1	1 in 10
Normal	0.05	5 in 100
High	0.01	1 in 100
Very high	0.001	1 in 1,000
Extreme	0.0001	1 in 10,000

The Chi-Square Test Formula

A few more considerations:



The chi-squared test is used to test categorical variables; it can't be used on continuous data.



The categories must be mutually exclusive.



We have covered using the chi-square test formula to test goodness of fit.



It can also be used to test independence. (Feel free to explore this on your own.)

Using the Chi-Squared Test In Python

01

Import the **scipy.stats** module.

```
# The statistical module used to run chi square test  
import scipy.stats as stats
```

02

Determine the **critical value**.

```
# The degree of freedom is 3-1 = 2  
# With a p-value of 0.05, the confidence level is 1.00-0.05 = 0.95.  
critical_value = stats.chi2.ppf(q = 0.95, df = 2)
```

```
# The critical value  
critical_value
```

```
5.99146454710798
```

03

Run the **chi-squared test**.

```
# Run the chi square test with stats.chisquare()  
stats.chisquare(df['observed'], df['expected'])
```

```
Power_divergenceResult(statistic=220.5, pvalue=1.3153258948574585e-48)
```



Activity: Chi-Square

In this activity, you will perform the Chi-Square test:
First in Python, then by hand.

Suggested Time:
10 Minutes



Instructions: Activity: Chi-Square

- You are the owner of four cafés in a town of avid coffee drinkers.
- Using a Chi-square goodness-of-fit test, determine whether the results suggest that customers are more likely to frequent one cafe over another.
- Perform the necessary calculations by using Python.
- Then perform the calculations by hand to verify your findings.
- Use a p-value of 0.05.
- Consult a Chi-square table to find your critical value:
<https://www.medcalc.org/manual/chi-square-table.php>
- On your student repository, open: [Stu-Cafes.ipynb](#)



Time's Up! Let's Review.



Countdown timer

40:00

(with alarm)



TRADING PLATFORM

ETC ETH USD LTC

190.34 +3.44
199.31 +0.31 +0.05% 19:55 Jun 01.06



SELL

BUY

Last Trade: 19:01 (+\$144.41) -0.44% Last Trade: 19:01 (+\$144.41) -0.44%
Market Cap 34.00 (+4.12%) Higt 4.801.21 (+4.12%) Market Cap 34.00 (+4.12%) Higt 4.801.21 (+4.12%)
Mined Coins 34.00 (+4.12%) Low \$1.421.33 (-1.41%) Mined Coins 34.00 (+4.12%) Low \$1.421.33 (-1.41%)



*The
End*