Experiments

Data Science Immersive

FLATIRON SCHOOL

Outline

1. Components of Experiments
2. 1 Sample T-Tests
3. 2 Sample T-Tests
4. Effect Size

Steps to an Experiment

1. **Establish a null hypothesis**
2. Specify significance level
3. Find critical value
4. Calculate test statistic
5. Make a conclusion about the Hypothesis

1. Establish a Null Hypothesis

A null hypothesis (H_0) is an **assumption** about your data

An alternative hypothesis (H_1) is a **claim** about your data

Null Hypotheses contain….	Alternative Hypothesis contain ….
= , ≥, ≤	≠ , > , <

Example: You smell something burning in the air

H_0 : Fire = 0

H_1 : Fire ≠ 0

1. Establish a Null Hypothesis

The high school athletic director is asked if football players are doing as well academically as the other student athletes. We know from a previous study that the average GPA for all students is 3.10. We want to test if football players have higher grades.

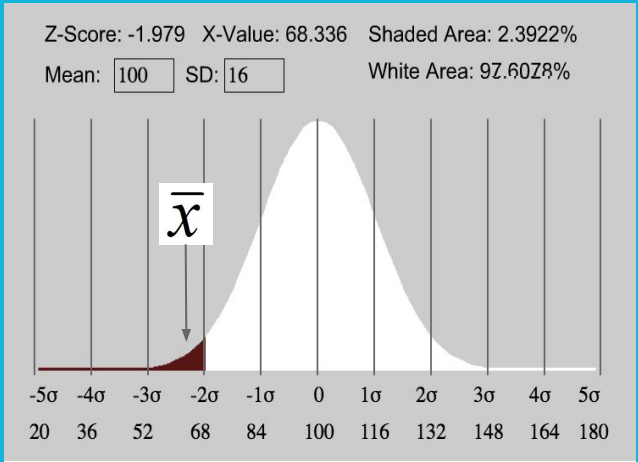
Do football players have different grades than the student population?

Steps to an Experiment

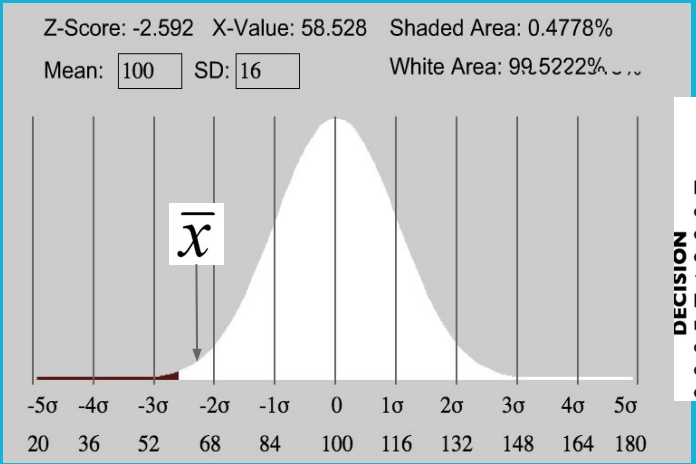
1. Establish a null hypothesis
2. **Specify significance level**
3. Find critical value
4. Calculate test statistic
5. Make a conclusion about the Hypothesis

2. Specify Significance Level

Rejected



Not Rejected



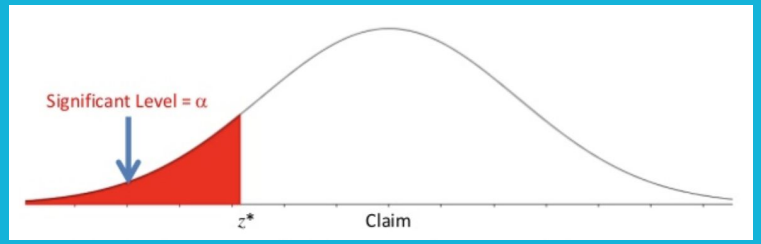
		REALITY	
		Drug is effective	Drug is not effective
DECISION	Reject H_0; decide drug is effective	Correct Decision	Type I Error
	Fail to reject H_0; decide drug isn't effective	Type II Error	Correct Decision

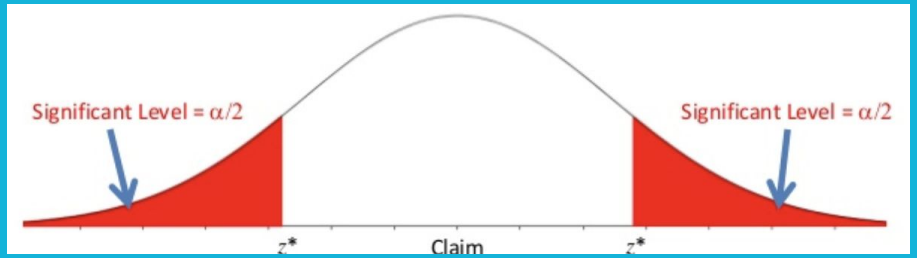
https://measuringu.com/normal_curve/

2. Specify Significance Level

One Tailed v. Two Tailed Test

Determined by your H_0





Steps to an Experiment

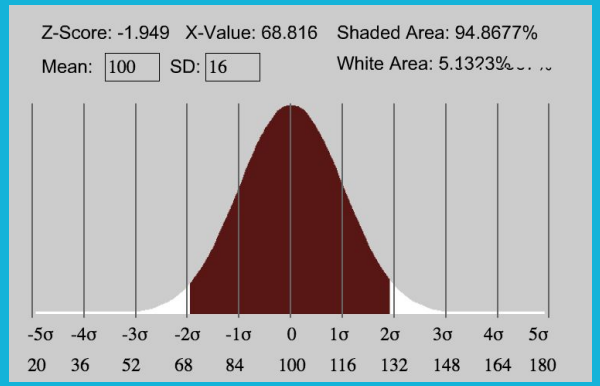
1. Establish a null hypothesis
2. Specify significance level
3. **Find critical value**
4. Calculate test statistic
5. Make a conclusion about the Hypothesis

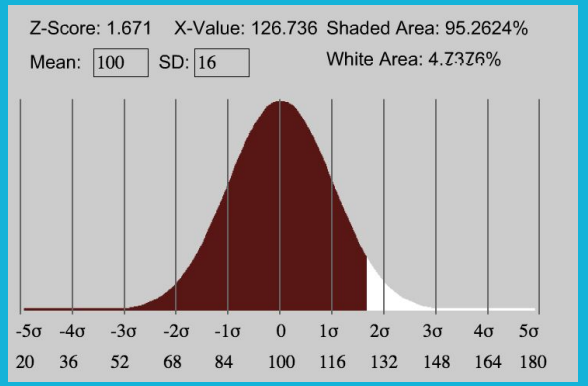
3. Find Critical Value

One Tailed v. Two Tailed Test

Determined by your H_0

α : significance level





Steps to an Experiment

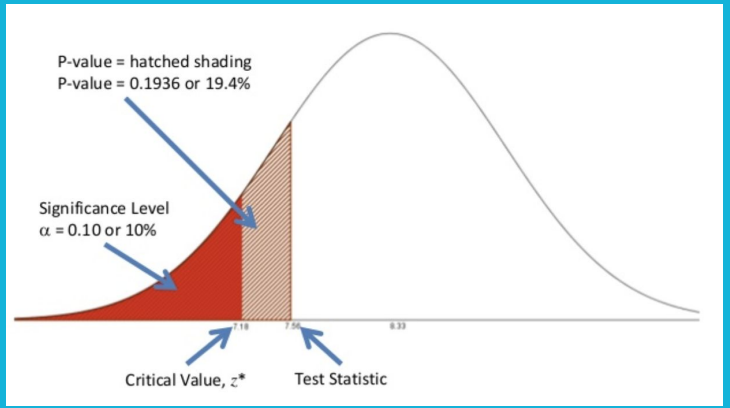
1. Establish a null hypothesis
2. Specify significance level
3. Find critical value
4. **Calculate test statistic**
5. Make a conclusion about the Hypothesis

4. Calculate Test Statistic/P-value

Remember:
The test statistic is in units of standard error

$$t = \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}}$$

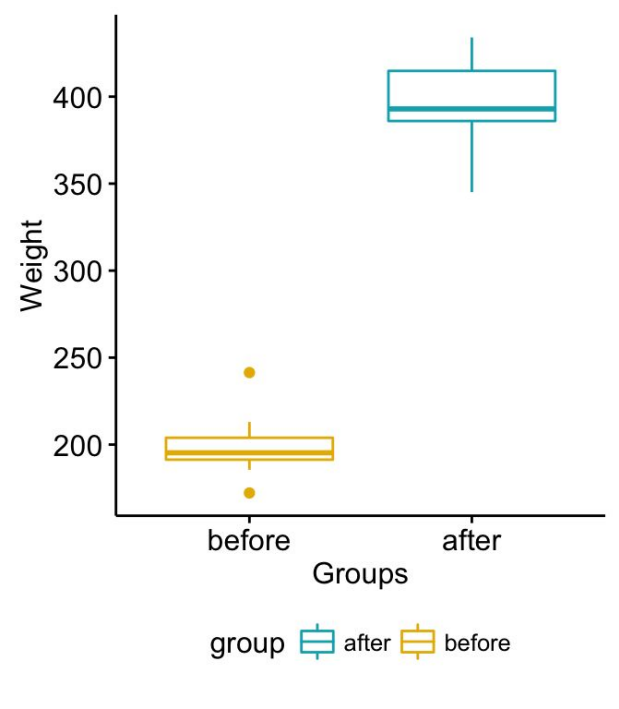
$$s = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2}$$



Steps to an Experiment

1. Establish a null hypothesis
2. Determine appropriate statistical test
3. Specify significance level
4. Find critical value
5. **Make a conclusion about the Hypothesis**

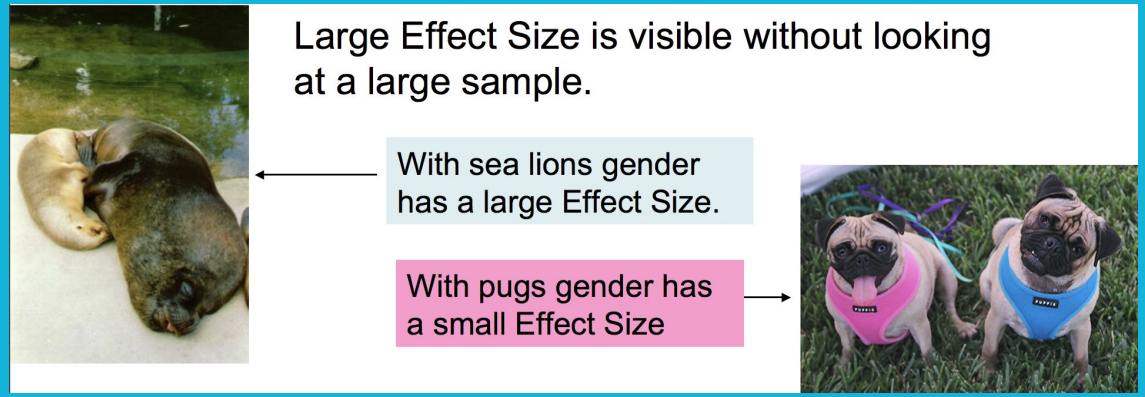
Paired T-tests



Paired t: Tests whether the mean of the differences between dependent or paired observations is equal to a target value

Effect Size

An alternative approach. Takes into account the difference between two different distributions



"Statistical significance is not equivalent to scientific, human, or economic significance. Smaller p-values do not necessarily imply the presence of larger or more important effects, and larger p-values do not imply a lack of importance or even lack of effect. Any effect, no matter how tiny, can produce a small p-value if the sample size or measurement precision is high enough, and large effects may produce unimpressive p-values if the sample size is small or measurements are imprecise. Similarly, identical estimated effects will have different p-values if the precision of the estimates differs."

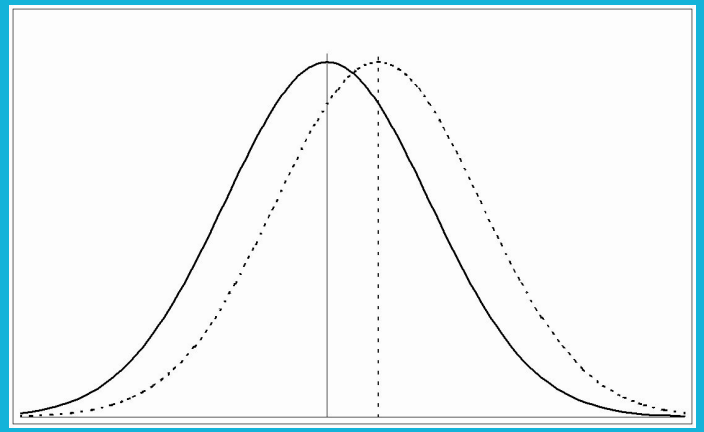
-American Statistical Association

Effect Size

- A measure of the difference between two distributions
- Typically used with meta-analysis

$$d = \frac{M_1 - M_2}{SD_{pooled}}$$

$$SD_{pooled} = \sqrt{\frac{\sum (X_1 - \bar{X}_1)^2 + \sum (X_2 - \bar{X}_2)^2}{n_1 + n_2 - 2}}$$



Effect size	*d*
Very small	0.01
Small	0.20
Medium	0.50
Large	0.80
Very large	1.20
Huge	2.0

$$SD_{pooled} = \sqrt{\frac{SD_1^2 + SD_2^2}{2}}$$