Module 5 :
Hypothesis Testing

Hypothesis Testing

- Defining Hypothesis
- Type I and Type II Error
- One Sample Z-Test
- One Sample T-Test
- Single Sample Test for Population Proportion
- Testing Equality of Variances
- Testing the Difference Between Two Population Means

Defining Hypothesis

In the world we often need to make decisions based on population parameters. Hypothesis Testing helps us make these decisions.

- Does a drug reduce blood pressure?
- Does reduced class size increase test scores?
- Is a person innocent or guilty of a crime?
- Does more money spent on education in low-income areas improve student performance?

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Defining Hypothesis (2)

- Null and Alternative Hypotheses
  - Overview of Hypotheses Testing
  - Null and Alternative Hypotheses
  - Hypothesis Testing and Null and Alternative Hypotheses
- Upper One-Sided Alternative
  - One and Two Tailed Tests
  - Upper One-Sided Alternative
- Lower One-Sided Alternative

Defining Hypothesis (3)

- Two-Tailed Alternative
- One-Tailed or Two-Tailed Test

  Choosing between One-Tailed or Two-Tailed Test

  One-Tailed or Two-Tailed Test

Hypothesis Testing

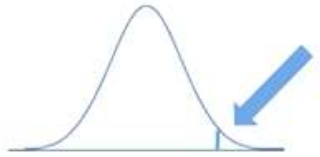
1. Defining Null (H_o)and Alternative Hypotheses (H_a or H_1)
2. Formulate Analysis Plan: level of significance (90%, 95%, 99%) & test statistics (t-test, z-test, f-test, etc.)
3. Conduct study & gather the data
4. Analyze the data
5. Interpret the result

One Tailed Test

- A test of a statistical hypothesis where the region of rejection is on only one side of the sampling distribution
- Example: Upper One Sided

H_0: the mean is <= 500 (left side)

H_a: the mean is >500 (right side)



- Example: Lower One Sided

H_0: the mean is ≥ 500 (right side)

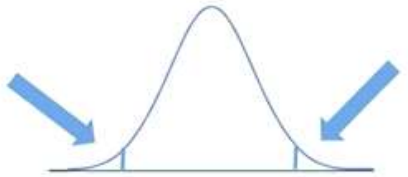
H_a: the mean is < 500 (left side)

Two Tailed Test

- A test of a statistical hypothesis where the region of rejection is on both side of the sampling distribution (left & right)
- Example:

H_0: the mean is = 500 (single line)

H_a: the mean is ≠ 500 (left & right side)



One Tailed Or Two Tailed Test ?

- Two-tailed test:

  A priori, use it if you have no idea of the direction in which deviations from the null hypothesis will occur.

- If a deviation from the null hypothesis is of interest in only one direction, then a one-tailed alternative hypothesis should be used

Type I and Type II Error

- Type I and Type II Error

  Type I Error: Rejects a null hypothesis (H_0) when it is TRUE

  Type II Error: Fail to reject a null hypothesis (H_0) when is it FALSE

		Test Conclusion	
		Do not reject H_0	Reject H_0
Truth	H_0 true	Correct	Type I error
	H_0 false	Type II error	correct

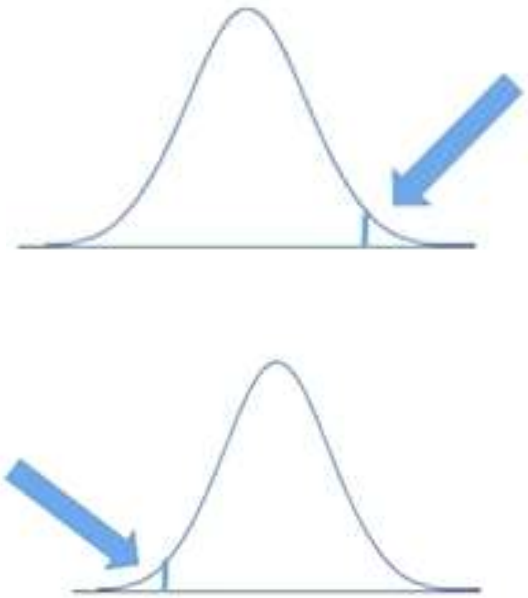
		Test Conclusion	
		Do not reject H_0	Reject H_0
Truth	No difference in quality	We can manufacture anywhere	Although there is no difference in quality, we only manufacture in county A
	Quality is better in country A	Quality is actually better in country A but we manufacture somewhere else	We manufacture in country A

Type I and Type II Error

- α (alpha): the probability of making type I Error
  or also known as Confidence Level
  Reject H_0, given it is TRUE
- β (Beta) : the probability of making Type II Error
  Fail to Reject H_0, given it is FALSE

Critical Region

- critical region is the range of values for a sample statistic that results in rejection of the null hypothesis
- Used to minimize the probability of making Type II error



Z-Test vs t-Test

- z-test is used for:
  - testing the mean of a population versus a standard
  - comparing the means of two populations
  - whether you know the population standard deviation or not
  - also used for testing the proportion of some characteristic versus a standard proportion,

    or comparing the proportions of two populations.

*needs large ($n \geq 30$) samples

Z-Test vs T-Test

- t-test is used for:

  - testing the mean of one population against a standard or

  - comparing the means of two populations if you do not know the populations' standard deviation

    if you know the populations' std. dev, you may use a z-test.

  Example:

  Measuring the average diameter of shafts from a certain machine when you have a small sample.

*can work with a limited sample (n < 30)

F-Test

- F-test is used for:

  - comparing statistical models that have been fitted to a data set, in order to identify the model that best fits the population from which the data were sampled (comparing the variances)

T-Test vs F-Test

- t-test is used for:

  - testing the mean of one population against a standard or

  - comparing the means of two populations if you do not know the populations' standard deviation

    if you know the populations' std. dev, you may use a z-test.

- F-test is used for:

  finding out whether there is any variance within the samples or comparing variances of two samples/populations

One Sample Z-Test

- When to use a One Sample Z-Test

  One Sample Z-Test
- Critical Region

  Critical Region of the One Sample Z-Test

  One Sample Z Test Example
- P-Values

p-Values

- p-Values (probability values):

  the smallest value of alpha (α) for which the data indicates rejection of H_0
- Critical Region, P-Values, and T.INVERSE Function
- One Sample T-Test
  - One Sample T-Test : One Tailed
  - One Sample T-Test : Two Tailed
  - One Sample T-Test in Excel

One Sample T-Test

- T Random Variable
  - T Random Variable
  - T Random Variable in Excel
- Critical Region, P-Values, and T.INVERSE Function
- One Sample T-Test
  - One Sample T-Test : One Tailed
  - One Sample T-Test : Two Tailed
  - One Sample T-Test in Excel

Single Sample Test for Population Proportion

- Single Sample Test for Population Proportion
  - Single Sample Test for Population Proportion
  - Single Sample Test for Population Proportion in Excel
  - Single Sample Test for Population Proportion Example
- Sample Size for Estimating a Population Proportion
  - Sample size for Estimating a Population Proportion

Homework & Quiz