Hypothesis Testing

One Sample, Two Sample, Chi-Square

Learning Objectives

- What is Hypothesis Testing?
- One Sample Testing
- Two Sample Testing
- Power of Test
- Chi-Square Testing for 1 & 2 Categorical variables

What is a hypothesis?

- It is a claim about a population parameter

- Example: Population mean
- The mean salaries of Data Scientists in India is $50,000

Null Hypothesis

- States the claim to be tested.
- It always talks about population parameter and not sample statistic.
- Can use “=“ , “<=“ or “>=“ conditions only.
- It may or may not be rejected
- It is similar to the notion of innocent until proven guilty as we begin with the assumption that Null Hypothesis is true.

Alternate Hypothesis

- Opposite of the Null Hypothesis
- Challenges the claim made
- Can use “!=“, “<“ or “>” only
- This is generally the statement which we are trying to prove
- May or may not be proved.

Claim to be tested

- Example:
- Null Hyp: The population mean salary in India is INR 1,000
- Alternate Hyp: The mean salary is not equal to INR 1,000
- Steps to follow - Sample the population and obtain sample mean
- Suppose the sample mean salary is = INR 1800

Claim to be tested

- This is significantly higher than the population mean.
- If the null hypothesis were true, then the sample mean would have been closer to the population mean, so we reject the null hypothesis based on some statistical conditions.
- In other words, getting a sample mean of 1800 is so unlikely if population mean is 1000, hence we reject the population mean of 1000 claim.

Test Statistic & Critical Values

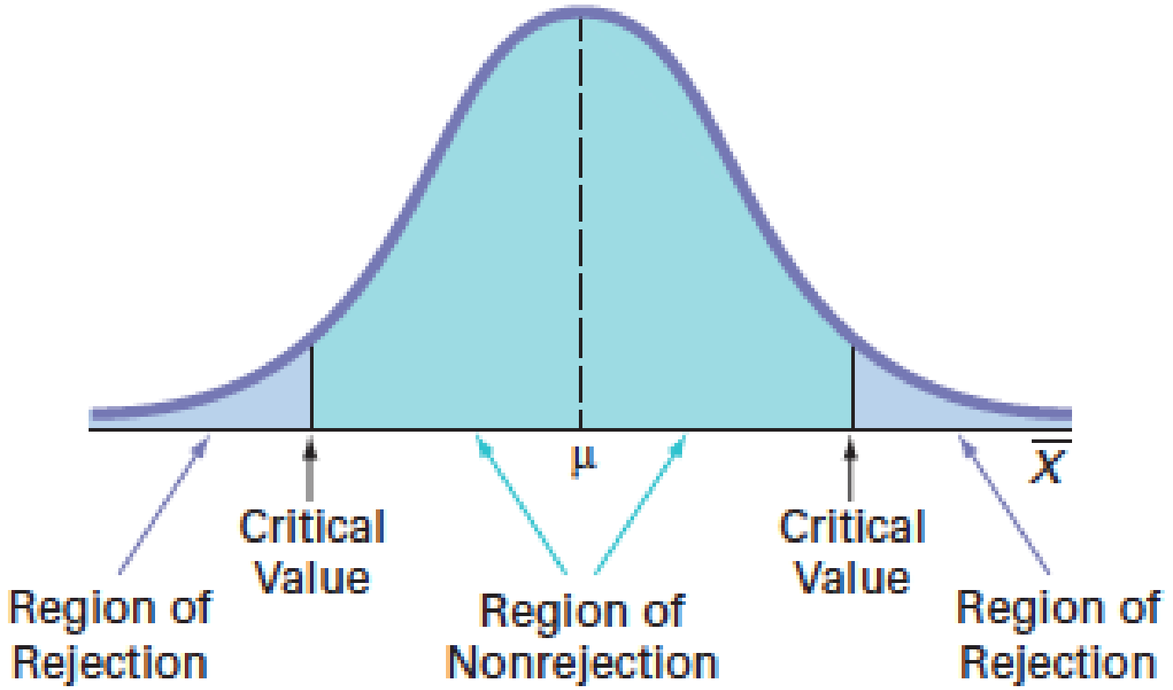


Image Source : https://medium.com/@chitu_rk/statistics-for-every-data-analyst-part-2-2ef555d8e08c

Possible errors in hypothesis testing

		THE TRUTH	
		The null hypothesis (H_0) is true (H_a is false)	**The null hypothesis (H_0) is not true** (H_a is true)
THE DECISION THE ANALYST MAKES	**Reject H_0** (support H_a)	**TYPE I (α) error/ Alpha Risk/ p – value** **Overreacting** **(1 - α) = the Confidence level of the test**	**Correct Decision (1 - β)** **Power of the test**
	Fail to Reject H_0 (do not support Ha)	**Correct Decision**	**TYPE II (β) error/ Beta Risk** **Underreacting**

Image Source - http://www.sixsigmadaily.com/type-i-and-type-ii-errors-in-hypothesis-testing/

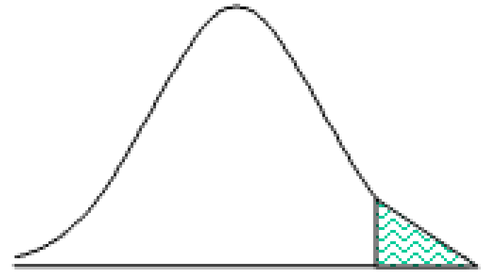
Type 1 and Type 2 error

- They both cannot happen at the same time.
- Type 1 error can occur if Null Hyp is True
- Type 2 error can occur only if Null Hyp is false
- That is, if one increases the other decreases.

Level of significance and rejection region

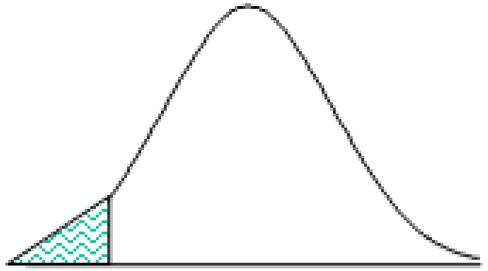
Level of significance - 5%

Confidence Interval - 95%



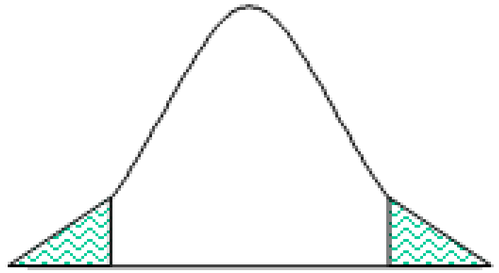
Positive one-tailed test

H0: Pop.mean<=1000
H1: Pop.mean>1000



Negative one-tailed test

H0: Pop.mean>=1000
H1: Pop.mean<1000



Two-tailed test

H0: Pop.mean=1000
H1: Pop.mean!=1000

Image Source - http://www.mathspadilla.com/macsII/Unit11-InferentialStatistics/statistical_hypothesis_test.html

Hypothesis test for mean

- There are two methods to test for the means
- Z-test - is used when population SD is known
- T-test - is used when population SD is unknown

Approach to testing

- Convert the sample statistic or sample mean into the z-statistic or t-statistic
- Determine the critical z or t values for a specified level of significance (alpha) from a table
- Decision rule - If the test statistic falls in the rejection region, then we reject null hypothesis , else we do not reject the null hypothesis

Power of Test

- Type 1 Error
- Type 2 Error
- Power of Test calculation

Two Sample Test

- Paired vs Unpaired Test
- Parametric vs Non-Parametric Tests

Chi-Square Test

- Goodness of fit test
- Can be used to check the proportions for a single categorical variable.
- Also, to check the dependency between 2 categorical variables using the Observed and Expected frequencies.