Hypothesis Testing

Let's look at the topics we are going to discuss in this article

- What is a hypothesis?
- Types of hypothesis
- Hypothesis testing
    - Level of significance
    - Types of errors
    - p value
    - One & two tail tests
    - Degree of freedom
    - Data analysis

What is a hypothesis?

- An educated guess
- A tentative point of view
- A proposition not yet tested
- A preliminary explanation
- A preliminary Postulate
- A hypothesis is a claim (assumption) about a population parameter.

According to Various authors,

- "A hypothesis is a conjectural statement of the relation between two or more variables". (Kerlinger, 1956)
- "Hypotheses are single tentative guesses, good hunches – assumed for use in devising theory or planning experiments intended to be given a direct experimental test when possible". (Eric Rogers, 1966)
- "Hypothesis is a formal statement that presents the expected relationship between an independent and dependent variable."(Creswell, 1994)
- A hypothesis is a logical supposition, a reasonable guess, an educated conjecture. It provides a tentative explanation for a phenomenon under investigation." (Leedy and Ormrod, 2001).

A Hypothesis :

- must make a prediction
- must identify at least two variables
- should have an elucidating power
- should strive to furnish an acceptable explanation or accounting of a fact
- must be falsifiable meaning hypotheses must be capable of being refuted based on the results of the study
- must be formulated in simple, understandable terms
- should correspond with existing knowledge
- In general, a hypothesis needs to be unambiguous, specific, quantifiable, testable and generalizable.

Types of hypothesis

It can be categorized in different ways.Based on their formulation it is categorised into the following,

- Null Hypotheses and
- Alternate Hypotheses

The Null Hypothesis, H_0

- States the claim or assertion to be tested
- Is always about a population parameter, not about a sample statistic
- Begin with the assumption that the null hypothesis is true
  – Similar to the notion of innocent until proven guilty
- Refers to the status quo
- Always contains “=” , “≤” or “≥” sign
- May or may not be rejected
- It states that independent variables have no effect and there will be no difference b/w the two groups.

The Alternative Hypothesis, H_1

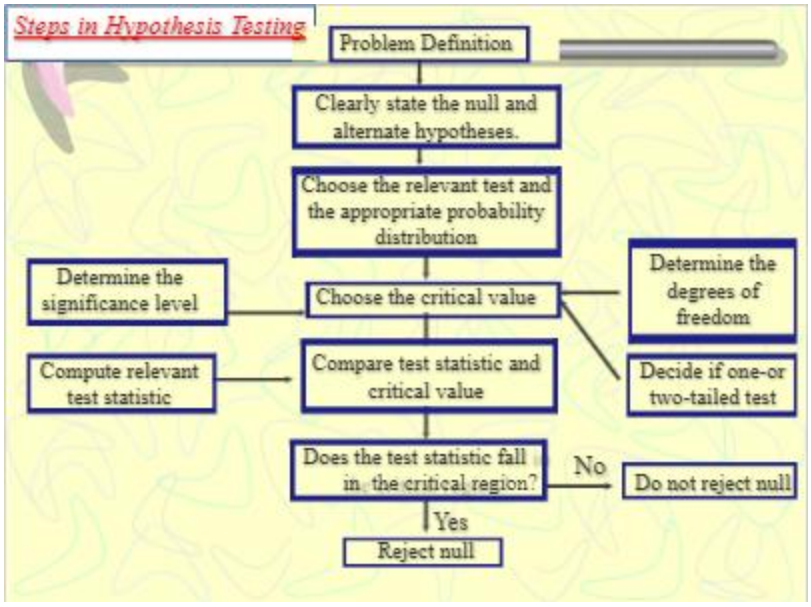
- Is the opposite of the null hypothesis
- Challenges the status quo
- Never contains the “=” , “≤” or “≥” sign
- May or may not be proven
- Is generally the hypothesis that the researcher is trying to prove

- It states that independent variable has an effect and there will be a difference b/w the two groups.

Hypothesis testing

6 Steps in Hypothesis Testing:

1. State the null hypothesis, H_0 and the alternative hypothesis, H_1
2. Choose the level of significance, α, and the sample size, n
3. Determine the appropriate test statistic (two-tail, one-tail, and Z or t distribution) and sampling distribution
4. Determine the critical values(mainly three criteria, (i) significance level,(ii) degree of freedom,(iii) One or two tailed test,that divide the rejection and non rejection regions
5. Collect data and compute the value of the test statistic
6. Make the statistical decision and state the managerial conclusion. If the test statistic falls into the non rejection region, do not reject the null hypothesis H_0. If the test statistic falls into the rejection region, reject the null hypothesis.Express the managerial conclusion in the context of the problem.



Terms used in hypothesis testing and their significance:

Level of Significance, α

- Defines the unlikely values of the sample statistic if the null hypothesis is true
- Indicates the percentage of sample means that is outside the cut-off limits (critical value)
- It is the max. value of probability of rejecting null hypothesis when it is true.
  - Defines rejection region of the sampling distribution
- Is designated by α , (level of significance)
  - Typical values are 0.01, 0.05, or 0.10
- Is selected by the researcher at the beginning
- Provides the critical value(s) of the test

Level of Significance and the Rejection Region

Level of significance = α

Two-tail test

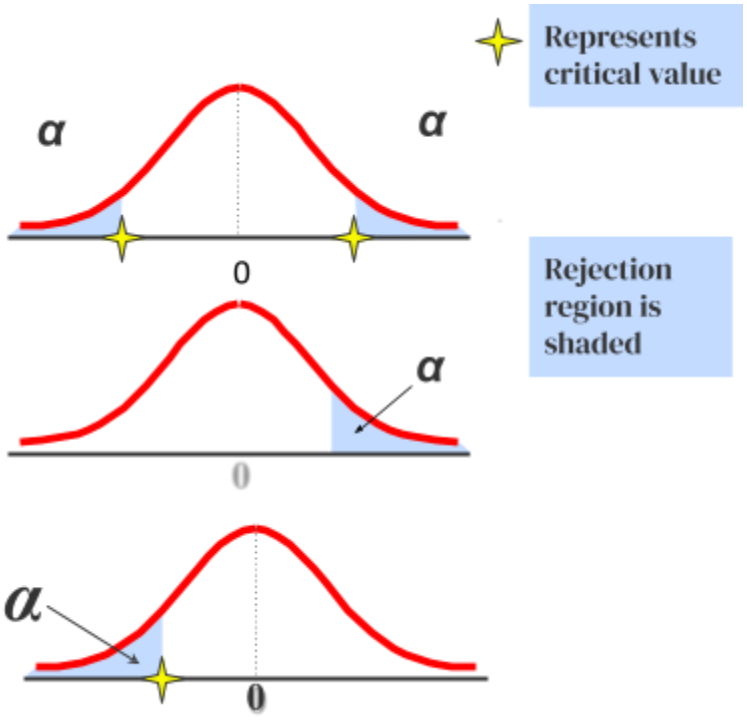
H_0: μ = 3
H1:μ ≠ 3

Upper-tail test

H_0: μ ≤ 3
H1: μ > 3

Lower-tail test

H_0: μ ≥ 3
H_1: μ < 3



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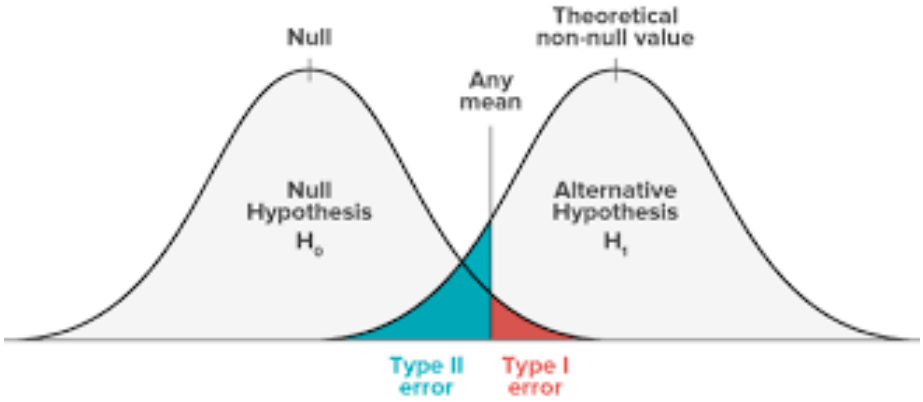
Errors in Making Decision



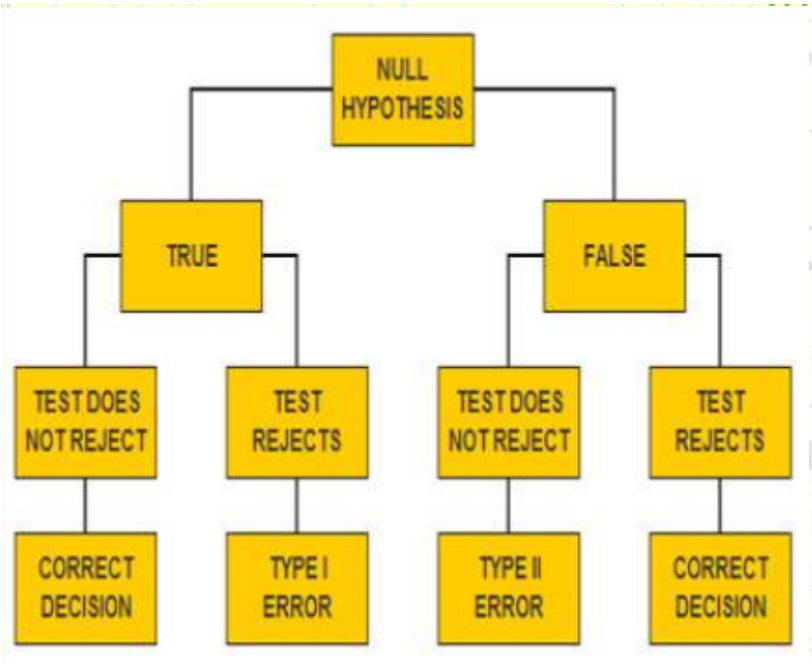
Type I Error

- Reject a true null hypothesis
- Considered a serious type of error
- The probability of Type I Error is α
- Called level of significance of the test
- Set by the researcher in advance

Type II Error

- Fail to reject a false null hypothesis
- The probability of Type II Error

No study is perfect, there is always the chance for error



Null Hypothesis	Decision: Accept	Decision: Reject
True	Correct Decision Probability is 1-α, called confidence level	TYPE I ERROR probability of making error is α (always known) minimize by decreasing α (the significance level)
False	TYPE II ERROR probability of making error is β (rarely known) minimize β by increasing difference of alternative hypothesis, increasing sample size, increasing α, or by choosing a different test	Correct Decision probability is 1-β, called power of test power is determined by signficance level, alternative hypothesis, sample size, and nature of test

α - level of significance

1-β - power of the test

There is only 5 chance in 100 that the result termed "significant" could occur by chance alone
α =0.0

The probability of making a Type I (α) can be decreased by altering the level of significance.

↓

It will be more difficult to find a significant result

↓

The power of the test will be decreased the risk of a Type II error will be increased.

Type I & II Error Relationship

- Type I and Type II errors cannot happen at the same time
  - Type I error can only occur if H_0 is true
  - Type II error can only occur if H_0 is false
- If Type I error probability (**α**) ⇧ , then
  Type II error probability (β) ⇩

Factors affecting type II error

All else equal:

- β ⇧ when the difference between hypothesized parameter and its true value ⇩
- β ⇧ when ⇩ α
- β ⇧ when ⇧ σ
- β ⇧ when ⇩ n

The probability of making a Type II (β) can be decreased by increasing the level of significance.

↓

it will increase the chance of a Type I error

To which type of error you are willing to risk ?

Degree of Freedom

- The number or bits of "free" or unconstrained data used in calculating a sample statistic or test statistic
- It refers to the scores in a distribution that are free to change without changing the mean of distribution.
- A sample mean (X) has `n' degree of freedom
- A sample variance (s^2) has (n-1) degrees of freedom
- This no. is used to determine power ,because the more subjects the greater the power

One-Tail Test

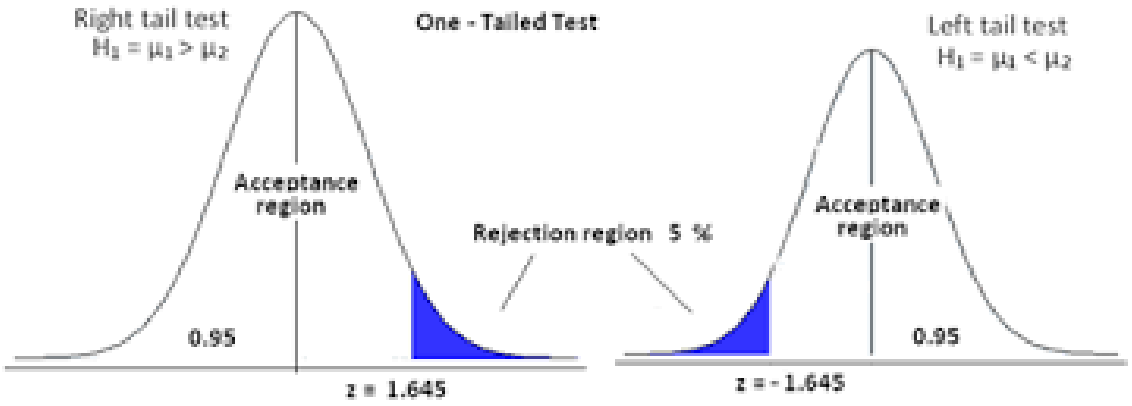
- In many cases, the alternative hypothesis focuses on a particular direction
- Determines whether a particular population parameter is larger or smaller than some predefined value
- Uses one critical value of test statistic

H_0: $\mu \geq 3$
H_1: $\mu < 3$

This is a lower-tail test since the alternative hypothesis is focused on the lower tail below the mean of 3

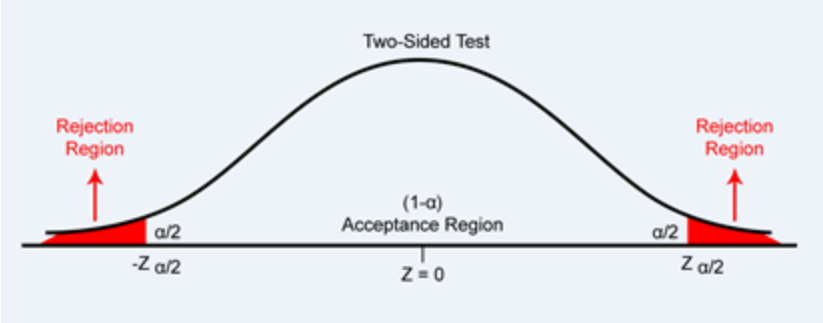
H_0: $\mu \leq 3$
H_1: $\mu > 3$

This is an upper-tail test since the alternative hypothesis is focused on the upper tail above the mean of 3



Two tailed test

- Two-tailed Test
  - Determines the likelihood that a population parameter is within certain upper and lower bounds
- May use one or two critical values



Confidence interval and significance test

Null hypothesis is accepted

A value for null hypothesis within the 95% CI ⟺ p-value > 0.05

Null hypothesis is rejected

A value for null hypothesis outside of 95% CI ⟺ p-value < 0.05

The Chi-Square Test for Independence

- The second chi-square test, the chi-square test for independence,can be used and interpreted in two different ways:
    1. Testing hypotheses about the relationship between two variables in a population, or
    2. Testing hypotheses about differences between proportions for two or more populations.