**-: Part 5 :-**

**Hypothesis Testing**

**Hypothesis** :- A premise or claim that we want to test.

The test on the sample out of a data or the data is tested against an ideal condition.

**Null Hypothesis** :- Currently accepted value of a parameter. Denoted by H0.

It can also be defined as, A hypothesis associated with a contradiction to a theory one would like to prove.

**Alternate Hypothesis** :- It involves the claim to be tested. Denoted by Ha. It is

Also called **Research Hypothesis**. It can also be defined as, A hypothesis (often composite) associated with a theory one would like to prove.

H0 is always practically **opposite** to Ha.

For Example, An employee claims the after maintanence of the machine, the machine is not able to produc 5gms chocolate bar as before. Please infer the null and alternate values.

Here, Ideal value is 5 gms, so :-

H0 = 5 gms, and

Ha != 5 gms.

Possible Outcomes of this test:-

1. Reject Null Hypothesis.
2. Fail to reject Null Hypothesis.

**Test Statistic**:- Calculated from the sample data and it is used to decide.

Like, we will take a sample, say 50 bars and calculate their average. Here, avg is the test statistic.

Statistically significant:- Where do we draw a line to make a decision.

Like, 5.12,5.72,7.23. For the first two values we can say the null hypothesis is true, but for the third value we can say that null hypothesis is false.

We can say, hypothesis testing is like a acquitted person is considered innocent until proved guilty. In this case the laws are the ideal scenario and if we don’t obey it we are proved guilty.

**Level of confidence**:- Denoted by C. it is how confident are we on our decision.

**Level of significance**:- Denoted by α. It measures the significance of the decision.

**α = 1-C**

**Test Steps**:-

1. There is an initial research hypothesis of which the truth is unknown.
2. The first step is to state the relevant **null** and **alternative hypotheses**. This is important, as mis-stating the hypotheses will muddy the rest of the process.
3. The second step is to consider the [**statistical assumptions**](https://en.wikipedia.org/wiki/Statistical_assumption) being made about the sample in doing the test; for example, assumptions about the [**statistical independence**](https://en.wikipedia.org/wiki/Statistical_independence) or about the form of the distributions of the observations. This is equally important as invalid assumptions will mean that the results of the test are invalid.
4. Decide which test is appropriate, and state the relevant [test statistic](https://en.wikipedia.org/wiki/Test_statistic) *T*.
5. Derive the distribution of the test statistic under the null hypothesis from the assumptions. In standard cases this will be a well-known result. For example, the test statistic might follow a [**Student's t distribution**](https://en.wikipedia.org/wiki/Student%27s_t_distribution)or a[**normal distribution**](https://en.wikipedia.org/wiki/Normal_distribution)**.**
6. Select a significance level (***α***), a probability threshold below which the null hypothesis will be rejected. Common values are 5% and 1%.
7. The distribution of the test statistic under the null hypothesis partitions the possible values of *T* into those for which the null hypothesis is rejected—the so-called ***critical region***—and those for which it is not. The probability of the critical region is *α*.
8. Compute from the observations the observed value ***t*obs** of the test statistic *T*.
9. Decide to either reject the null hypothesis in favour of the alternative or not reject it. The decision rule is to reject the null hypothesis *H*0 if the observed value *t*obs is in the critical region, and to accept or "fail to reject" the hypothesis otherwise.

**Type 1 and Type 2 error**:-

|  |  |  |
| --- | --- | --- |
| Desicion | Null Hpy is true | Null hyp is false |
| Null Hyp is accepted | Correct Acceptance  **P = 1-α** | Type 1 Error  **P = β** |
| Null Hyp is rejected | Type 2 Error  **P = α** | Correct rejection  **P = 1-β** |

**P-Value:-**

The p-value is the probability that a given result (or a more significant result) would occur under the null hypothesis.

1. If the **p-value is less** than the chosen significance threshold (equivalently, if the observed test statistic is in the critical region), then we say the null hypothesis is rejected at the chosen level of significance. Rejection of the null hypothesis is a conclusion. This is like a "**guilty**" verdict in a **criminal trial**: the evidence is sufficient to reject innocence, thus proving guilt. We might accept the alternative hypothesis (and the research hypothesis).

2. If the **p-value is not less** than the chosen significance threshold (equivalently, if the observed test statistic is outside the critical region), then the evidence is insufficient to support a conclusion. This is similar to a "**not guilty" verdict**. The researcher typically gives extra consideration to those cases where the p-value is close to the significance level.