EXPERIMENT: 6
(2K17/SE/79 PARV GUPTA)

AIM: Statistical Hypothesis Testing in R- Statisticians use hypothesis testing to formally check whether the hypothesis is accepted or rejected. Consider an example or data of your choice and identify the following:

- a) State the Hypotheses
- b) Formulate an Analysis Plan
- c) Analyze Sample Data
- d) Interpret Results
- e) Estimate type-I and type-II error

THEORY:

Introduction to Statistical Hypothesis Testing in R:

A statistical hypothesis is an assumption made by the researcher about the data of the population collected for any experiment. It is not mandatory for this assumption to be true every time. Hypothesis testing, in a way, is a formal process of validating the hypothesis made by the researcher.

In order to validate a hypothesis, it will consider the entire population into account. However, this is not possible practically. Thus, to validate a hypothesis, it will use random samples from a population. On the basis of the result from testing over the sample data, it either selects or rejects the hypothesis.

Statistical Hypothesis Testing can be categorized into two types as below:

- **Null Hypothesis** – Hypothesis testing is carried out in order to test the validity of a claim or assumption that is made about the larger population. This claim that involves attributes to the trial is known as the Null Hypothesis. The null hypothesis testing is denoted by *H0*.
- **Alternative Hypothesis** – An alternative hypothesis would be considered valid if the null hypothesis is fallacious. The evidence that is present in the trial is basically the data and the statistical computations that accompany it. The alternative hypothesis testing is denoted by H_1 or H_a.

Let's take an example of the coin. We want to conclude that a coin is unbiased or not. Since null hypothesis refers to the natural state of an event, thus, according to the null hypothesis, there would an equal number of occurrences of heads and tails, if a coin is tossed several times. On the other hand, the alternative hypothesis negates the null hypothesis and refers that the occurrences of heads and tails would have significant differences in number.

Hypothesis Testing in R

Statisticians use hypothesis testing to formally check whether the hypothesis is accepted or rejected. Hypothesis testing is conducted in the following manner:

1. **State the Hypotheses** – Stating the null and alternative hypotheses.
2. **Formulate an Analysis Plan** – The formulation of an analysis plan is a crucial step in this stage.
3. **Analyze Sample Data** – Calculation and interpretation of the test statistic, as described in the analysis plan.

4. **Interpret Results** – Application of the decision rule described in the analysis plan.

Hypothesis testing ultimately uses a p-value to weigh the strength of the evidence or in other words what the data are about the population. The p-value ranges between 0 and 1. It can be interpreted in the following way:

- A small p-value (typically ≤ 0.05) indicates strong evidence against the null hypothesis, so you reject it.
- A large p-value (> 0.05) indicates weak evidence against the null hypothesis, so you fail to reject it.

A p-value very close to the cutoff (0.05) is considered to be marginal and could go either way.

Decision Errors in R

The two types of error that can occur from the hypothesis testing:

- **Type I Error** – Type I error occurs when the researcher rejects a null hypothesis when it is true. The term significance level is used to express the probability of Type I error while testing the hypothesis. The significance level is represented by the symbol α *(alpha)*.
- **Type II Error** – Accepting a false null hypothesis H_0 is referred to as the Type II error. The term power of the test is used to express the probability of Type II error while testing hypothesis. The power of the test is represented by the symbol β *(beta)*.

RESULTS:

- While performing Hypothesis-Testing, Hypotheses can't be proved or disproved since we have evidence from sample (s) only. At most, Hypotheses may be rejected or retained.

- Use of the term "accept H_0" in place of "do not reject" should be avoided even if the test statistic falls in the Acceptance Region or p-value ≥ α. This simply means that the sample does not provide sufficient statistical evidence to reject the H_0. Since we have tried to nullify (reject) H_0 but we haven't found sufficient support to do so, we may retain it but it won't be accepted.
- Confidence Interval (Interval Estimation) can also be used for testing of hypotheses. If the hypothesis parameter falls within the confidence interval, we do not reject H_0. Otherwise, if the hypothesized parameter falls outside the confidence interval i.e. confidence interval does not contain the hypothesized parameter, we reject H_0.

CONCLUSION:

In this experiment we learn how to validate that the proposed hypothesis is correct or not using statistical hypothesis using R hypothesis testing. And learned various terminologies used during testing of the hypothesis.