Testing of hypothesis (Small Samples)

t-test

```
t.test(x, y = NULL,
       alternative = c("two.sided", "less", "greater"),
       mu = 0, paired = FALSE, var.equal = FALSE,
       conf.level = 0.95, …)
```

Example

```
x=c(578,572,570,568,572,570,570,572,596,584)
t.test(x,y=NULL,alternative = "two.sided",mu=577,paired =
FALSE,var.equal=FALSE, conf.level = 0.95)
```

Example

```
x=c(12,15,17,11,21,17,19)
y=c(18,13,16,23,14,15,11)
t.test(x,y,alternative = "two.sided",paired = TRUE,var.equal=FALSE,
conf.level = 0.95)
```

Chi square test for independence

```
chisq.test(mtcars)
```

```
> chisq.test(data_frame$treatment, data_frame$improvement,
correct=FALSE)
```

Exercise

1. The annual rainfall at a certain place is normally distributed with mean 30. If the rainfall during the past 8 years are 31.1, 30.7, 24.3, 28.1, 27.9, 32.2, 25.4 and 29.1, can we conclude that average rainfall during the past 8 years is less than the normal rainfall?

Write R program for above problem.

2. Two random samples gave the following data:

Sample	Size	Mean	Variance
1	16	440	40
2	25	460	42

Can we conclude that the means of the two samples differ significantly?

Write R program for above problem.

3. The following data relate to the marks obtained by 11 students in 2 tests, one held at the beginning of a year and the other at the end of the year after intensive coaching.

Test 1:55 60 65 75 49 25 18 30 35 54 61 72

Test 2:63 70 70 81 54 29 21 38 32 50 70 80

Do the data indicate that the students have benefited by coaching?

Write R program for above problem.

4. In a test given to two groups of students the marks obtained were as follows.

First Group

18 20 36 50 49 36 34 49 41

Second Group

29 28 26 35 30 44 46

Examine the significant difference between the means of marks secured by students of the above two groups.

Write R program for above problem.

Application/Case Study

1. To Check the Manufacturing Processes

Hypothesis testing finds its application in the manufacturing processes such as in determining whether the implication of the new technique or process in the manufacturing plant caused the anomalies in the quality of the product or not. Let us suppose, that manufacturing plant X decides to verify that the particular method results in an increase in the defective products per quarter, say this number to be 200. Now, to verify this the researcher needs to calculate the mean of the number of defective products produced before the start and the end of the quarter.

Case study: A battery manufacturing company claims that the average life of its two-wheeler batteries is 2.1 years. The quality inspector surveyed ten customers to know the lasting period of their batteries. The following data was collected:

Customer No.	**Battery Life (in years)**
1	1.9

2	2.3
3	2.1
4	2.2
5	1.9
6	2.4
7	2.1
8	2.3
9	2.2
10	2.0

If the standard deviation is 0.17 and the significance level is 0.05, conduct a hypothesis testing to prove the company's claim.

Reading material:

https://www.taylorfrancis.com/chapters/mono/10.1201/b16371-8/hypothesis-testing-quality-control-manufacturing-company-kishore-pochampally

2. Process capability Analysis

Every manufacturing process has variation associated with it. Since process variation can never be totally eliminated, the variability in a process should be minimized to improve product quality. Process capability analysis deals with the techniques used to understand the variability of a process and its effect on the product performance. Process capability analysis is an important engineering decision-making tool and has found application in a number of areas: as a criterion for vendor selection, reducing variability in a manufacturing process, specifying process requirements for new equipment, predicting how well the process will hold tolerances, assisting product designers in selecting or modifying a process and formulating quality improvement programs. Process capability analysis techniques have helped manufacturers control the quality of goods produced.

Reading material:

https://onlinelibrary.wiley.com/doi/abs/10.1002/qre.2290

https://onlinelibrary.wiley.com/doi/abs/10.1002/qre.1713