Experiment 14:

Illustrate the different types of t-tests using R

- Aim: To analyze data using One-Sample t-test and Two-Sample t-test in R

Exp. 14: t-tests using R

- It is called Student's t-test
- One of the most common tests in statistics is the t-test, used to determine whether the means of two groups are equal to each other
- Performs one and two sample t-tests on vectors of data.
- t.test() can be used to perform t-tests in R

Exp. 14: t-tests using R

t-statistic is calculated as:

Test statistic

$$t = (\bar{x} - \mu_0) / (s / \sqrt{n})$$

where:

- $\bar{x}$ = the sample mean
- μ_0 = the hypothesized population mean
- s = the sample standard deviation
- n = the sample size

Exp. 14: t-tests using R

- The assumption for the test is that both groups are sampled from normal distributions with equal variances
- The null hypothesis is that the two means are equal, and the alternative is that they are not.

Exp. 14: t-tests using R

Syntax:

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

- **x** is a numeric vector of data values
- **y** is an optional numeric vector of data values
- If y is excluded, the function performs a one-sample t-test on the data contained in x, if it is included it performs a two-sample t-tests using both x and y.

Exp. 14: t-tests using R

Syntax:

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

- **mu** provides a number indicating the true value of the mean (or difference in means if performing a two sample test) under the null hypothesis
- **alternative** is a character string specifying the alternative hypothesis:
  - "two.sided" (which is the default)
  - "greater" or "less" depending on whether the alternative hypothesis is that the mean is different than, greater than or less than mu, respectively

Exp. 14: t-tests using R

Syntax:

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

- **paired** - a logical value indicating whether a paired t-test is to be done
- **var.equal** - a logical variable indicating whether to treat the two variances as being equal.
- **conf.level** - confidence level of the interval

Exp. 14: t-tests using R

One-Sample t-test:

```
>data(CO2)
>t1= t.test(CO2$uptake)                    #Null Hypothesis, mean=0
or
> t1=t.test(CO2$uptake, alternative="t")   #two.sided=TRUE, mean=0
> print(t1)
> t2=t.test(CO2$uptake,alternative="g", mu=10)   # mean <= 10
>print(t2)
> t3=t.test(CO2$uptake,alternative="l", mu=10)   # mean >= 10
>print(t3)
```

Exp. 14: t-tests using R

One-Sample t-test:

```
> x=c(10,35,25,50,90,75,45,60)        #Tips received by hotel server
> t.test(x)
> t.test(x, mu=50)                        #mean(Tips) =50
> t.test(x, alternative="g", mu=50)       #mean(Tips) <=50
> t.test(x, alternative="l", mu=80)       #mean(Tips) >=80
```

Exp. 14: t-tests using R

Two-Sample t-test:

```
>data(CO2)

>t4=t.test(CO2$uptake,CO2$conc)        # Welch Two Sample t-test,True mean =0

>t5=t.test(CO2$uptake,CO2$conc,alternative="l", mu=12)        #True mean >= 12

>t6=t.test(CO2$uptake,CO2$conc,alternative="g", mu=12)        #True mean <= 12

>t7=t.test(CO2$uptake,CO2$conc,alternative="g", mu=12, var.equal=TRUE)
        #Two Sample t-test , assuming variance is equal
```

Note: *true mean =mean(x) –mean(y)*

Exp. 14: t-tests using R

Two-Sample t-test:

```
> x=c(10,35,25,50)        # Tips received by Women servers in a hotel
> y=c(90,75,45,60)        # Tips received by Men servers in a hotel
> t.test(x, y)                                  #Assuming tips are same
> t.test(x, y, alternative="g")                 #women tips are <= men tips
```

Exp. 14: t-tests using R

Paired t-tests

- For testing paired data (for example, measurement on twins, before and after treatment effects, father and son comparison), we cannot use two-sample t-tests since the independence assumption is not valid
- Instead we need to use a paired t-test. This can be done using the option paired =TRUE.

Exp. 14: t-tests using R

Paired t-test:

```
>fheight=c(165,144,178,189,123)
>sheight=c(167,141,191,200,120)
>ht=t.test(fheight,sheight,paired=TRUE)     # True Mean=0
>print(ht)

>ht1=t.test(fheight, sheight, alternative="g", paired=TRUE)     # True Mean<=0
>print(ht1)
```

Experiment 15:

Illustrate the ANOVA test using R

- Aim: To analyze data using ANOVA test in R

Exp. 15: ANOVA test using R

- **ANOVA** (**AN**alysis **O**f **VA**riance) test
- An **ANOVA** test is a way to find out if survey or experiment results are significant
- It is used for testing of various groups to see if there is a difference between them

Exp. 15: ANOVA test using R

Examples:

- A group of psychiatric patients are trying three different therapies: counseling, medication and biofeedback. You want to see if one therapy is better than the others.
- A manufacturer has two different processes to make light bulbs. They want to know if one process is better than the other.
- Students from different colleges take the same exam. You want to see if one college outperforms the other.

Exp. 15: ANOVA test using R

- In R, ANOVA test is done using aov().

Syntax:

aov(formula, data = NULL, ...)

- formula- formula specifying the model.
- data - data frame in which the variables specified in the formula will be found

Exp. 15: ANOVA test using R

```
> require(reshape2)
> data("tips", package="reshape2")
> tipANOVA=aov(tip ~ day-1, tips)                    #-1 to exclude intercept
> print(tipANOVA)
> print(tipANOVA$coefficients)
```

Alternative way : To use regression

```
> tiplm=lm(tip ~ day-1, tips)                        #No intercept term
> print(tiplm)
```

TEXT BOOKS:

1. R for Everyone, Jared P Lander, Pearson
2. R in Action, Rob I Kabacoff, Manning (http://www.cs.uni.edu/~jacobson/4772/week11/R_in_Action.pdf)

REFERENCE BOOK:

The Art of R Programming, Norman Matloff, No Starch Press (https://diytranscriptomics.com/Reading/files/The%20Art%20of%20R%20Programming.pdf)