Practical 1 :

Title : Random Variable

Q1] Find the mean and variance for the following :

a]

X	−1	0	1	2
P(X)	0.1	0.2	0.3	0.4

Solution :

X	P(X)	X·P(X)	$E(X)^2$	$[E(X)]^2$
−1	0.1	−0.1	0.1	0.01
0	0.2	0	0	0
1	0.3	0.3	0.3	0.09
2	0.4	0.8	1.6	0.64
TOTAL	$\Sigma = 1$	$\Sigma = 1$	$\Sigma E(X)^2 = 2.0$	$\Sigma [E(X)]^2 = 0.74$

$\therefore$ Mean $= E(X) = \Sigma xi \cdot p(X) = 1$

$\therefore$ Variance $= V(X) = \Sigma E(X)^2 - \Sigma [E(X)]^2$

$= 2 - 0.74$

$= 1.24$

$\therefore$ Mean $E(X) = 1$ & variance $V(X) = 1.24$

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b]

X	-1	0	1	2
P(X)	1/8	1/8	1/4	1/2

solution:

X	P(X)	X P(X)	$E(X)^2$	$[E(X)]^2$
-1	1/8	-1/8	1/8	1/64
0	1/8	0	0	0
1	1/4	1/4	1/4	1/16
2	1/2	1	2	1
TOTAL	$\Sigma = 1$	$\Sigma = 9/8$	$\Sigma = 19/8$	$\Sigma = 69/64$

$\therefore$ Mean $= E(X) = \sum X.P(X) = 9/8$

$\therefore$ Variance $= V(X) = \sum E(X)^2 - \sum [E(X)]^2$

$$= \frac{19}{8} - \frac{69}{64}$$

$$= \frac{152-69}{64}$$

$$= \frac{83}{64}$$

$\therefore$ Mean $E(X) = 9/8$ & variance $V(X) = 83/64$

c]

X	−3	10	15
P(X)	0.4	0.35	0.25

Solution:

X	P(X)	X·P(X)	$E(X)^2$	$[E(X)]^2$
−3	0.4	−1.2	3.6	1.44
10	0.35	3.5	35	12.25
15	0.25	3.75	56.25	14.0625
TOTAL	$\Sigma = 1$	$\Sigma = 6.05$	$\Sigma = 94.85$	$\Sigma = 27.7525$

$\therefore$ Mean $= E(X) = \sum X \cdot P(X) = 6.05$

$\therefore$ Variance $= V(X) = \sum E(X)^2 - \sum [E(X)]^2$

$= 94.85 - 27.7525$

$= 67.0975$

$\therefore$ Mean $E(X) = 6.05$ & Variance $V(X) = 67.0975$

Q2] If P(X) is pmf of a random variable X

2nd If P(X) represents pmf for random variable X. Find value of k. Then evaluate mean & variance.

Solution: As P(Xi) is a pmf it should satisfy the properties of pmf which are

a] $P(X_i) > 0$ for all sample space

b] $\sum P(X_i) = 1$

X	-1	~~K~~ 0	1	2
P(X)	K+1/13	K/13	1/13	K-4/13

$$\therefore \sum P(X_i) = 1 = \frac{K+1}{13} + \frac{K}{13} + \frac{1}{13} + \frac{K-4}{13}$$

$$1 = \frac{K+1+K+1+K-4}{13}$$

$$13 = 3K - 2$$

$$15 = 3K$$

$$\boxed{K = 5}$$

X	P(X)	X·P(X)	E(X)²	[E(X)]²
-1	6/13	-6/13	6/13	36/169
0	5/13	0	0	0
1	1/13	1/13	1/13	1/169
2	1/13	2/13	4/13	4/169
TOTAL	Σ = 1	Σ = -3/13	Σ = 11/13	Σ = 41/169

$$\therefore \text{Mean} = E(X) = \sum X \cdot P(X) = -\frac{3}{13}$$

$$\therefore \text{Variance} = V(X) = \sum E(X)^2 - \sum [E(X)]^2$$

$$= \frac{11}{13} - \frac{41}{169}$$

$$= \frac{143-41}{169}$$

$$= \frac{102}{169}$$

$\therefore$ Mean $= -3/13$ & variance $= 102/169$

Q.3] The pmf of random variable X is given by

X	-3	-1	0	1	2	3	5	8
P(X)	0.1	0.2	0.15	0.2	0.1	0.15	0.05	0.0[illegible]

Obtain cdf. Find ① $P(-1 \le x \le 2)$
② $P(1 \le x \le 5)$ ③ $P(X \le 2)$ ④ $P(X \ge 0)$

Solution:

X	-3	-1	0	1	2	3	5	8
P(X)	0.1	0.2	0.15	0.2	0.1	0.15	0.05	0.05
F(X)	0.1	0.3	0.45	0.65	0.75	0.90	0.95	1.0

① $P(-1 \le x \le 2) = P(X \le 2) - P(X \le -1) + P(X = -1)$
$= F(X_b) - F(X_a) + P(a)$
$= F(2) - F(-1) + P(-1)$
$= 0.75 - 0.3 + 0.2$
$= 0.25$

② $P(1 \le x \le 5) = F(X_b) - F(X_a) + P(a)$
$= F(5) - F(1) + P(1)$
$= 0.95 - 0.65 + 0.2$
$= 0.15$

③ $P(X \le 2) = P(X=-3) + P(X=-1) + P(X=0) + P(X=1) + P(X=2)$
$= 0.1 + 0.2 + 0.15 + 0.2 + 0.1$
$= 0.75$

④ $P(X \ge 0) = 1 - F(0) + P(0)$
$= 1 - 0.45 + 0.15$
$= 0.40$

Q.4] Let f be continuous random variable with pdf

$$\therefore f(x) = \frac{x+1}{2} \quad -1 < x < 1$$

$$= 0 \quad \text{otherwise}$$

Obtain cdf of x. Find mean & variance

Solution: By definition of cdf we have

$$F(X) = \int_{0-1}^{x+1} t\,dt$$

$$= \int_{-1}^{1} \frac{x+1}{2}\,dx$$

$$= \frac{1}{2}\left(\frac{1}{2}x^2 + x\right) \text{ for } -1 \leq x \leq 1$$

Hence the cdf is

$$F(x) = 0 \quad \text{for } x \leq 0 -1$$

$$= \frac{1}{4}x^2 + \frac{1}{2}x \quad \text{for } -1 \leq x \leq 1$$

$$= 0 \quad \text{for } x \geq 1$$

Q.5] Let f be continuous random variable with pdf

$$\because \quad f(x) = \frac{x+2}{18} \qquad -2 \leq x \leq 4$$

$$= 0 \qquad \text{otherwise}$$

calculate cdf

solution: By definition of cdf we have

$$F(X) = \int_{-2}^{4} t \, dt$$

$$= \int_{2}^{4} \frac{x+2}{18} \, dx$$

$$= \frac{1}{18}\left(\frac{1}{2}x^2 + 2x\right)$$

for $-2 \leq x \leq 4$

Hence cdf is

$$F(X) = 0 \quad \text{for } x < -2$$

$$= \frac{1}{18}\left(\frac{1}{2}x^2 + 2x\right)$$

for $-2 < x < 4$

$$= 0 \quad \text{for } x \geq 4$$

Practical 2

Title: Binomial Distribution

Q.1] An unbiased coin is tossed 4 times calculate the probability of obtaining no head, atleast one head & more than one tail

NO HEAD:

```
> dbinom(0,4,0.5)
[1] 0.0625
```

ATLEAST ONE HEAD

```
> 1 - dbinom(0,4,0.5)
[1] 0.9375
```

MORE THAN ONE TAIL:

```
> pbinom(1,4,0.5, lower.tail=F)
[1] 0.9375
```

Q.2] The probability that student is accepted to a prestigious college is 0.3 If 5 students apply, what's the probability of atmost 2 are accepted

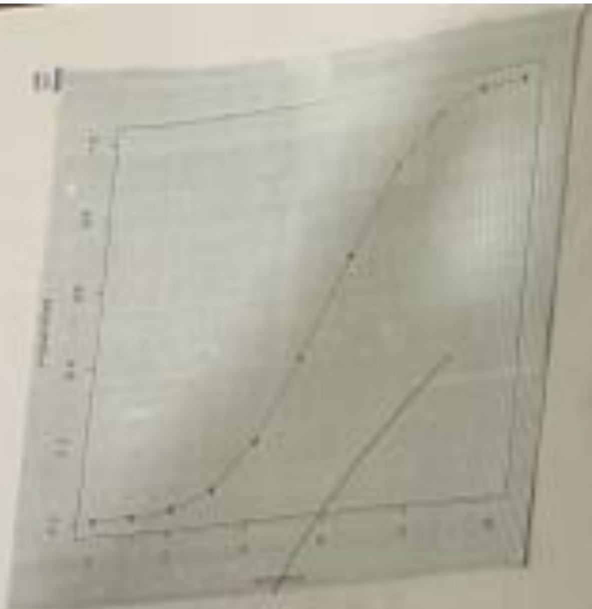
```
> pbinom(2,5,0.3)
[1] 0.83692
```

Q.3] An unbiased coin is tossed 6 times the probability of head at any toss = 0.3. Let x be no of heads that comes up. Calculate $P(X=2)$, $P(X=3)$, $P(1<x<5)$

```
> dbinom(2,6,0.3)
[1] 0.324135
> dbinom(3,6,0.3)
[1] 0.18522
> dbinom(2,6,0.3) + dbinom(3,6,0.3)+
      dbinom(4,6,0.3)
[1] 0.74373
```

Q.4] For $n=10$, $p=0.6$, evaluate binomial probabilities and plot the graphs of pmf & cdf

```
> x = seq(0,10)
> y = dbinom(x,10,0.6)
> y
[1] 0.0001048576 0.0015728640 0.0106168320
    0.0424673280 0.1114767360 0.2006581248
    0.2508226560 0.2149908480 0.1209323520
    0.0403107840 0.0060466176
> plot(x,y,xlab="sequence", ylab=
"probabilities", "o", pch=16)
```


```
> x = seq(0,10)
> y = pbinom(x,10,0.6)
> plot(x,y, xlab = "sequence", ylab =
  "probabilities", "o", pch = 16)
```

Q4) Generate a random sample of size 10 for a B.D → B(8,0.3). Find the mean & the variance of the sample.

```
>x = rbinom(8,10,0.3)
[1] 2 2 3 4 3 4 2 3
> mean(rbinom(8,10,0.3)) summary(x)
[1] 2.375
> var(rbinom(8,10,0.3))
[1] 1.696469 3.125
```

Q5) The probability of man hitting the target is 1/4 if he shoots 10 times what is the probability that he hits the target exactly 3 times. probability that he hits target atleast one time.

```
> dbinom(3,10,0.25)
[1] 0.2502823
> 1-dbinom(1,10,0.25)
[1] 0.8122883
```

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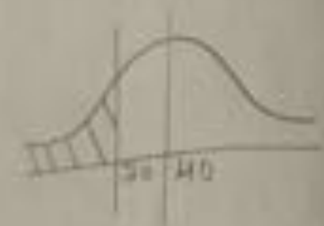
Q.1] Bits are sent for communication channel in packet of 12. If the probability of bit being corrupted is 0.1. What is the probability of no more than 2 bits are corrupted in a packet?

```
> pbinom(2,12,0.1, lower.tail = F) +
          dbinom(2,12,0.1)
[1] 0.3409977
```

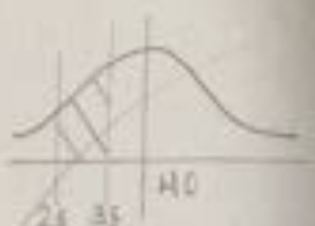
Q1

a]

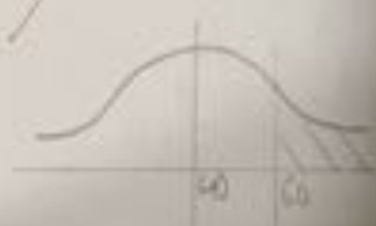


b]

c]



d]



Practical 3 :

Title : Normal Distribution

A normal distribution of 100 students with mean = 40 , SD = 15
Find no of students whose marks are ① P(X<30) ② P(40<X<70) ③ P(25<X<35) ④ P(X>60)

```
> pnorm(30,40,15)
[1] 0.2524925

> pnorm(70,40,15) - pnorm(40,40,15)
[1] 0.4772499

> pnorm(35,40,15) - pnorm(25,40,15)
[1] 0.2107861

> 1 - pnorm(60,40,15)
[1] 0.09121122
```

Q.1] If the random variable x follows the normal distribution with mean = 50, $v = 100$. Find ① $P(X \leq 70)$ ② $P(X > 65)$ ③ $P(X \leq 92)$ ④ $P(35 < x < 60)$ ⑤ $P(20 < x < 30)$

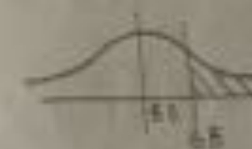
```
> pnorm(70,50,10)
[1] 0.9772499

> 1-pnorm(65,50,10)
[1] 0.0668072

> pnorm(92,50,10)
[1] 0.99993032

> pnorm(60,50,10) - pnorm(35,50,10)
[1] 0.7745375

> pnorm(30,50,10) - pnorm(20,50,10)
[1] 0.02140023
```

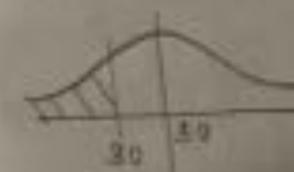
Q.3] Let $X \sim N(160, 400)$ find k_1 & k_2 such that $P(X < k_1) = 0.6$ & $P(X > k_2) = 0.8$

```
> qnorm(0.6,160,20)
[1] 165.0669
> qnorm 1-qnorm(0.8,160,20)
[1] 176.8324
```

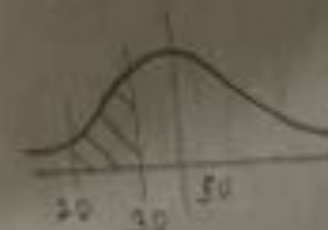
Q.2

a] 

b] 

c] 

d] 

e] 

Q.4] A random variable x follows normal distribution with $\mu = 10$, $\sigma = 2$. Generate 100 observations and evaluate its mean, median & variance

```
> x=rnorm(100,10,2)
> summary(x)
[1] Min    1st Q   Median  Mean   3rd Q   Max
    5.713  8.444   9.723   9.914  11.325  14.238
> var(x)
[1] 3.648924
```

Q.5] Write a command to generate 10 random numbers for normally distribution with $\mu = 50$, $\sigma = 4$. Find the sample mean & median

```
> x = rnorm(10,50,4)
> summary(x)
  Min    1st Q   Median  Mean   3rd Q   Max
  44.73  50.46   52.01   52.35  54.39   58.8
```

Kew

Practical 4

Title: Testing of Hypothesis

Q] Sample mean & deviation given single population

1] Suppose the food level on the cookie states that it has atmost 2g of saturated fats in a single cookie. In a sample of 35 cookies, it was found that mean amt of saturated fat per cookies 2.1g. Assume that the sample sd is 0.3 at 5% level of conf can be refuted the claim on food label

H0 = $\mu < 2$
H1 = $\mu > 2$

```
> z = (2.1-2)/(0.3/sqrt(35))
[1] 1.972027
> 1-pnorm(z)
> [1] 0.0243
```

∴ Reject the null Hypothesis
∴ Accept H1

2] A sample of 100 customers was randomly selected & it was found that average spending was 275/-. The SD = 30. Using 0.05 level of significance would you conclude that amount spent by customer is more than 250/-

Ho : $\mu < 250$

H1 : $\mu > 250$

> z = (275-~~30~~ 250)/(30/sqrt(100))

> z

[1] 8.333

> 1-pnorm(z,99)

[1] 2.305736e-13

~~∴ Reject the null Hypothesis~~

∴ Accept H0

∴ Reject null Hypothesis

3] A quality control of engineer finds that sample of 100 light have average life of 470 hours. Assuming population SD = 25 test whether the population mean is 480 hours. LOS → 0.05

Ho = $\mu < 480$

H1 = $\mu > 480$

> z = (470-480)/(25/sqrt(100))

> z

[1] -4

> pt(z,99, lowertail = T)

[1] 6.112576e-05

∴ Reject null Hypothesis

∴ Accept H1

Q.4] A principle at school claims that the IQ is 100 of the students. A random sample of 30 students whose IQ was found to 118. The SD of population = 15. test the claim of principal

H0 = μ = 100

H1 = μ > 100

```
> z = (112-100)/(15/sqrt(30))
> z
[1] 4.38178
> pt(z,99, lower.tail=F)
[1] 5.8856e-06
```

∴ Reject null Hypothesis

Q Single Population proportion

1] It is believed that coin is fair. The coin is tossed 40 times; 28 times head occurs. Indicate whether the coin is fair or not at 95% LOC

$p_0 = 0.5$ $q_0 = 1 - p_0 = 0.5$ $p = 28/40 = 0.7$

$n = 40$ $H_0 = \mu = 0.5$ $H_1 = \mu \neq 0.5$

```
> z = (0.7-0.5)/sqrt((0.5*0.5)/40)
> z
> pnorm 2*(1-pnorm(abs(z)))
[1] 0.01141204
```

Reject null Hypothesis

Accept the ~~Alt~~ H1

2] In a hospital 400 females & 520 males are born in a week. Do this confirm male & female are born equal in number

H0 = u = 0.5

H1 = u ≠ 0.5

> z=(0.52 - 0.5)/(sqrt((0.5*0.5)/1000))

> z

[1] 1.2645

> 2*(1-pnorm(abs(z)))

[1] 0.2060506

Reject H0

Accept H1

3] In a big city, 325 men out of 600 men were found to be self employed. conclusion is that maximum men in city are self employed

H0 = u = 0.5

H1 = u ≠ 0.5

> z=(0.5-0.325)/sqrt((0.5*0.5)/600)

> 2*1-pnorm(abs(z))

[1] 0.04165239

Reject H0

Accept H1

Q.4] Experience shows that 20% of manufactur products are of top quality. In 1 day production of 400 articles only 50 are top quality. Test hypothesis that experience of 20% of manufactured is wrong

$H_0 = \mu = 0.2$

$H_1 = \mu \neq 0.2$

> z = (0.125 - 0.20)/sqrt((0.2 * 0.8)/400)

> 2 * 1-pnorm(abs(z))

[1] 0.0001768346

Reject H_0, Accept = H_1

Q Equality of 2 population proportion

1] In an early election campaign a telephone phone of 800 registered voters shows favor 460. In second pole opinion 520 of 1000 registered voters favoured the candidate at 5% level of confidence is there sufficient evidence that popularity has decreased

$H_0 = P_1 = P_2$

$H_1 = P_1 \neq P_2$

> ~~z =~~ P = (P1*P...

> P = (460 * 800 + 520 * 1000)/(520 + 1000)

> P

> 0.544

> 1 - 0.544

> 0.456

> z = sqrt (0.544 * 0.456 * (1/520 + 1/1000))

> 2 * (1 - pnorm(abs(z)))

[1] 0.5444

Accept H_0

Q) From a consinment 200 articles are drawn & 44 was found defective. from consinment B, 200 samples are drawn out of which 30 was found defective. test whether the proportion of defective items in 2 consinment are significantly defferement

$H_0 = \cancel{P_1 \neq P_1}$ $P_1 = P_2$

$H_1 = P_1 \neq P_2$

> (0.22 * 200 + 0.15 * 200/(1/200 + 1/200))

> 0.185

> 1 - 0.185

> 0.815 sqrt

> z = (0.185 * 0.815 * (1/200 + 1/200))

> 2 * (1 - pnorm(abs(z)))

[1] 0.9969018

Accept H_0

12 Practical 5

Title: chi square Test

Q1] Use the following data to test whether the attribute conditions of home & child are independent

		Condition of Homes	
		clean	dirty
condition of child	clean	70	50
	f. clean	80	20
	dirty	35	45

Ho = Both are independent, H1 = Both are dependent

```
> x = c(70,80,35)
> y = c(50,20,45)
> z = data.frame(x,y)
> z
[1]   x   y
  1  70  50
  2  80  20
  3  35  45
> chisq.test(z)

        Pearson's chi squared test
data : z
X-squared = 25.646, df = 2, p-value = 2.698e-06
```

∴ Reject the null hypothesis

∴ Both are dependent

A dice is tossed 120 times & following results are obtained

No of terms	frequency
1	30
2	25
3	18
4	10
5	22
6	15

Ho: Test the hypothesis that dice is unbaised

∴ Ho = dice is unbaised
∴ H1 = dice is baised

```
> obs = c(30, 25, 18, 10, 22, 15)
> exp = sum(obs)/length(obs)
> exp
[1] 20
> z = sum((obs-exp)^2/exp)
> pchisq(z, df=length(obs)-1)
[1] 0.956659
```

∴ Accept the null hypothesis
∴ dice is unbaised.

Q.3] An IQ test was conducted & the students were observed before & after training the result are following.

before	after
110	120
120	118
123	125
132	136
125	121

Test whether there is change in the IQ after the training.

∴ H0 = no change in IQ
∴ H0 = IQ increased after training

```
> a=c(120,118,125,136,121)
> b=c(110,120,123,132,125)
> z=sum((b-a)^2)/a)
> pchisq(z,df=length(b)-1)
[1] 0.1135959
```

Accept the null hypothesis
∴ There is ~~no~~ change in IQ after training.

Q.4]

	graduate	undergraduate
online	20	25
face to face	40	5

Is there any association between student's preference for type of education & method

∴ H_0 : Independent
H_1 : Dependent

```
> x = c(20, 40, 25, 5)
> z = matrix(x, nrow = 2)
> chisq.test(z)
        Pearson's chi squared test with
            Yates' continuity correction
  data: z
  X-squared = 18.05, df = 1, p-value = 2.157e-05
```

∴ Reject null Hypothesis
∴ Both are dependent

Q.5] A dice is tossed 180 times

No of terms	frequency
1	20
2	30
3	35
4	40
5	12
6	43

Test the hypothesis that dice is unbaised

H0: dice is un baised

H1: dice is ~~un~~baised

```
> x=c(20,30,35,40,12,43)
> chisq.test(x)
   Chi squared test for given probabilities
data:z
X-squared = 23.933 , df = 5, p-value = 0.0002236
```

∴ Reject null hypothesis

∴ dice is unbaised.

Practical 6
Titled: t test

Q.1] let x = 3366, 3337, 3361, 3410, 3316, 3357, 3348, 3356, 3376, 3382, 3377, 3355, 3408, 3401, 3398, 3424, 3383, 3374, 3384, 3374
Write the R command for following to test hypothesis
① Ho: μ = 3400 , H1: μ ≠ 3400
② Ho: μ = 3400 , H1: μ > 3400
③ Ho: μ = 3400 , H1: μ < 3400
at 95% level of confidence. Also check at 97% level of confidence

→ ① Ho: μ = 3400
H1: μ ≠ 3400
> x = c(3366, 3337, 3361, 3410, 3316, 3357, 3348, 3356, 3376, 3382, 3377, 3355, 3408, 3401, 3398, 3424, 3383, 3374, 3384, 3374)
> t.test (x, mu = 3400, alter = "two.sided", conf.level = 0.95)
One sample t-test
data: x
t = -4.4865, df = 19, p value = 0.0002528
alternative hypothesis: true mean is not equal to 3400
95 percent confidence level:
3361.797 3386.103

sample estimates:
mean of x:
3373.95
> t.test(x, mu = 3400,
∴ Reject H0
∴ Accept H1
> t.test (x, mu = 3400, alter = "two sided", conf.level = 0.97)
One sample t-test
data: x
t = -4.4865, df = 19, p-value = 0.00025
alternative hypothesis: true mean is not equal to 3400
3360.33 3387.57
sample estimates:
mean of x:
3373.95
∴ Reject H0
∴ Accept H1

(2) $H_0 = \mu = 3400$
$H_1 = \mu > 3400$
> t.test (x, mu = 3400, alter = "greater", conf.level = 0.95)
One sample t-test
data: x
t = -4.4865, df = 19, pvalue = 0.9999
alternative hypothesis: true mean is greater than 3400
3363.41 Inf

sample estimates:
mean of x:
3373.95 ∴ Accept H_0

> t.test(x, mu=3400, alter="greater", conf.level = 0.97)

One sided t-test

data: x

t= -4.4865 , df = 19, pvalue = 0.9999

alternative hypothesis: true mean is greater than 3400

3367.337 Inf

sample estimates:
mean of x:
3373.95

∴ Accept H_0

③ $H_0 = \mu = 3400$

$H_1 = \mu < 3400$

> t.test(x, mu=3400, alter="less", conf.level= 0.95)

One sided t-test

data: x

t= -4.4865 , df = 19, pvalue = 0.0001264

alternative hypothesis: true mean is less than 3400

95 percent level of confidence

-Inf 3383.99

sample estimates:
mean of x:
3373.95

∴ Reject H0
∴ Accept H1
> t.test(x, mu = 3400, alter = "less"
conf.level = 0.97)
One sample t test
data: x
t = -4.4865, df = 19, pvalue = 0.000124
alternative hypothesis : true mean
is less than 3400
97 percent level of confidence
-Inf 3385.563
sample estimates:
mean of x
3373.95
∴ Reject H0
∴ Accept H1

Q.2] Below are the data of gain in weights on 2 different diets A & B

Diet A: 25, 32, 30, 43, 24, 14, 32, 24, 31, 31, 35, 25
Diet B: 44, 34, 22, 10, 47, 31, 40, 30, 32, 35, 18, 21

→ ∴ H0 = a - b = 0
∴ H1 = a - b ≠ 0
> a = c(25, 32, 30, 43, 24, 14, 32, 24, 31, 31, 18, 21)

> b=c(44, 34, 22, 10, 47, 31, 40, 30, 32, 35, 18, 21)

t.test(a, b, paired = T, alter = "two sided", conf.level = 0.95)

Paired t-test

data: a and b

t = -0.62787 , df = 11 , p-value = 0.5429

alternative hypothesis: true difference in means is not equal to 0

95 percent confidence interval:

-14.267330 7.933997

sample estimates:

mean of the differences

-3.166667

∴ Accept H_0

∴ There is no difference in weights.

[3] 11 students gave the test after 1 month they again gave the test after the tuitions do the marks gives evidence that students have benifited by coaching.

E1: 23, 20, 19, 21, 18, 20, 18, 17, 23, 16, 19

E2: 24, 19, 22, 18, 20, 22, 20, 20, 23, 20, 17

Test at 99 level of confidence

13

→ >e1: 23, 20, 19, 21, 18, 20, 18, 17, 23, 16, 19
>e2: 24, 19, 22, 18, 20, 22, 20, 20, 23, 20, 17
∴ Ho: e1 = e2
∴ H1: e1 < e2
> t.test(e1, e2, paired = T, alter = "less",
conf.level = 0.99)

Paired t test
data: e1 and e2
t = -1.4832, df = 10, p-value = 0.0844
alternative hypothesis: true difference in means is less than 0.
99 percent confidence interval:
-Inf 0.863333
sample estimates:
mean of the differences:
-1

∴ Accept Ho

Q.4] Two drugs for BP was given & data was collected
D1: 0.7, -1.6, -0.2, -1.2, -0.1, 3.4, 3.7, 0.8, 0, 2
D2: 1.9, 0.8, 1.1, 0.1, -0.1, 4.4, 5.5, 1.6, 4.6, 3.4
The two drugs have same effect, check whether two drugs have "same effect" on patient or not.

Ho: d1 = d2
H1: d1 ≠ d2
> d1 = c(0.7, -1.6, -0.2, -1.2, -0.1, 3.4, 3.7, 0.8,
0, 2)
> d2 = c(1.9, 0.8, 1.1, 0.1, -0.1, 4.4, 5.5, 1.6, 4.6,
3.4)
> t.test(d1, d2, alter = "two.sided",
paired = T, conf.level = 0.95)

paired t test

data: d1 and d2
t = -4.0621, df = 9, p-value = 0.002833
alternative hypothesis: true difference
in means is not equal to 0
95 percent confidence interval:
mean of the differences:
-1.58

∴ Reject Ho
∴ Accept H1

5) If there is difference in salaries for
the same job in 2 different
countries
CA: 53000, 49958, 41974, 44366, 40470, 36963
CB: 62490, 58850, 49495, 52263, 47674, 43552

62

→ ∴ Ho : 61 = 62

∴ H1 : 61 ≠ 62

```
> CA=C(53000,49958,41974,44366,
       40470,36963)
> CB=C(62490,58850,49495,52263,
       47674,43552)
>t.test(ca,cb, paired=T, alter="
       two.sided", conf.level=0.95)

Paired t test
data: ca and cb
t = -4.4569 , df = 5, p-value = 0.0066
alternative hypothesis: true differe
nce in means is not equal to 0
95 percent confidence interval:
   -10404.821   -2792.846
sample estimates:
mean of the differences:
                  -6598.833
```

∴ Reject Ho

∴ Accept H1

Practical 7

Title: f test

Q.1] Life expentancy in 10 region of India in 1990 & 2000 are given below test. Whether the variance at the 2 times are same

1990: 37, 39, 36, 42, 45, 44, 46, 49, 50, 51

2000: 44, 45, 47, 43, 42, 49, 50, 41, 48, 52, 42, 59

∴ $H_0 : \sigma_1^2 = \sigma_2^2$

$H_1 : \sigma_1^2 \neq \sigma_2^2$

```
> x = c(37, 39, 36, 42, 45, 44, 46, 49, 50, 51)
> y = c(44, 45, 47, 43, 42, 49, 50, 41, 48, 52,
        42, 59)
> var.test(x, y)
```

F test to compare two variance

data: p-value = 0.9176

∴ Accept H_0

∴ variance at 2 times are same

Q.2] I: 25, 28, 26, 22, 22, 29, 31, 31, 26, 31

II: 30, 25, 31, 32, 23, 25, 31, 32, 32, 27, 31, 35, 24

at 95% of confidence level, check the ratio of population variation

$\therefore H_0 = \sigma_1^2 = \sigma_2^2$

$\therefore H_1 = \sigma_1^2 \neq \sigma_2^2$

```
> x = c(25, 28, 26, 22, 22, 29, 31, 31, 2
> y = c(30, 25, 31, 32, 23, 25, 36, 25, 31, 3
     32, 27, 31, 38, 24)
> var.test(x, y)
```

F test to compare two variance

p-value = 0.4535

$\therefore$ Accept H_0

$\therefore$ variance of I & II are same

Q.3] For the following data test the hypothesis for

① equality of 2 population mean

② equality of proportion variance

I : 175, 168, 145, 190, 181, 185, 175, 200

II : 180, 170, 153, 180, 179, 183, 187, 205

① : $H_0 : \mu_1 = \mu_2$

$H_1 : \mu_1 \neq \mu_2$

```
> x = c(175, 168, 145, 190, 181, 185, 175, 200)
> y = c(180, 170, 153, 180, 179, 183, 187, 205)
> t.test(x, y, alter = "two sided",
         conf.level = 0.95)
```

welch two sample test

p value = 0.7771

Accept H_0

$\therefore$ ~~equality~~ of 2 population mean are same.

> var.test (x, y)

F test to compare two variance

p-values = 0.4759

∴ Accept Ho

∴ The ~~equality~~ of proportion variance of 2 data are same.

Q.4] The following are the prices of commodity in sample of shops selected at random from different city.

CA: 74.10, 77.10, 75.35, 74, 73.80, 79.30, 75.80, 79.30, 75.80, 76.80, 77.10, 76.40

CB: 70.80, 74.90, 76.20, 72.80, 78.10, 74.80, ~~74.90, 76.20, 72.80, 7~~ 69.80, 81.20

∴ $H_0: \sigma_1^2 = \sigma_2^2$

∴ $H_1: \sigma_1^2 \neq \sigma_2^2$

> x=c(74.10, 77.10, 75.35, 74, 73.80, 79.30, 75.80, 79.30, 75.80, 76.80, 77.10, 76.40)

> y=c(70.80, 74.90, 76.20, 72.80, 78.10, 74.80, 69.80, 81.20)

> var.test (x, y)

F test to compare 2 variances

pvalue : 0.02756

Reject Ho

∴ variances of 2 population are not same.

53

Q.5] Prepare CSV file in excel, import the file in R & apply the test to check the equality

$\therefore H_0 : \mu_1 = \mu_2$
$\therefore H_1 : \mu_1 \neq \mu_2$

```
> t.test(x, y, var.equal=F,
         paired=F)
```

p value : 0.3244
∴ Accept H_0
∴ mean of two population is same.

Q5] Prepare CSV file in excel. Import the file in R & apply the test to check the equality of variance 2 data

Ob1 : 10, 15, 17, 11, 16, 20
Ob2 : 15, 14, 16, 11, 12, 19

$\therefore H_0 : \sigma_1^2 = \sigma_2^2$
$\therefore H_1 : \sigma_1^2 \neq \sigma_2^2$

save the above observations in excel file in CSV (MS-DOS) format

```
> data = read.csv(file.choose(),
                  header = T)
> data
```

	Ob1	Ob2
1	10	15
2	15	14
3	17	16
4	11	11
5	16	12
6	20	19

> attach (data)
> var.test (Ob1, Ob2)

p-value : 0.5717

Accept H_0

$\therefore$ the variance of 2 data are same

$\therefore$

Neha

Practical 8

Title: Non parametric test

Q.1] The times of failures in hrs of 10 randomly selected 9 volt batteries of a certain company is as follows
28.9, 15.2, 28.7, 72.5, 48.6, 52.4, 37.6, 49.5, 62.1, 54.5

Test the hypothesis that the population median is 63 against alternative is than 63 at 5% of level of significance

∴ H_0: median = 63

∴ H_1: median < 63

```
> x = c(28.9, 15.2, 28.7, 72.5, 48.6, 52.4,
    37.6, 49.5, 62.1, 54.5)
> sp = length(which(x>63))
> sn = length(which(x<63))
> sp
4
> sn
1
> n = sp + sn
> qbinom(0.05, n, 0.5)
2
```

∵ qbinom < sn

∴ Accept H_0

∴ median = 63

Q) The following data gives the weight of 40 students in random sample
46, 49, 57, 64, 46, 67, 54, 48, 69, 61, 57, 54, 50, 48, 65, 61, 66, 54, 50, 48, 49, 62, 47, 49, 47, 55, 59, 63, 53, 56, 67, 49, 60, 64, 53, 50, 48, 51, 52, 54 Use the sign test to test whether the median rate of population is 50 kg against alternative it is >50 kg

∴ H0: median = 50
∴ H1: median > 50

```
x = c(46, 49, 57, 64, 46, 67, 54, 48, 69, 61, 57,
54, 50, 48, 65, 61, 66, 54, 50, 48, 49, 62, 47,
49, 47, 55, 59, 63, 53, 56, 67, 49, 60, 64,
53, 50, 48, 51, 52, 54)
> sp = length(which(x > 50))
> sp
25
> sn = length(which(x < 50))
> sn
12
> n = sp + sn
> qbinom(0.05, n, 0.5)
14
```

∵ qbinom > sn
∴ Reject H0

Q3 The median age of tourists visiting a certain place is claim to be 41 yrs. A random sample of 17 tourists have the age 25, 29, 52, 48, 57, 39, 45, 36, 30, 49, 28, 39, 44, 63, 32, 65, 42. Use the sign test to check the claim

∴ H0 : median = 41
∴ H1 : median ≠ 41

```
> x = c(25, 29, 52, 48, 57, 39, 45, 36, 30, 49, 28, 39, 44, 63, 32, 65, 42)
> sp = length(which(x > 41))
> sp
9
> sn = length(which(x < 41))
> sn
8
> n = sp + sn
> qbinom(0.05, n, 0.5)
5
```

∵ qbinom < sn
∴ Accept H0
∴ median = 41

Q.4] The times in min that patient has to wait for consultation
15, 17, 24, 25, 20, 21, 32, 28, 12, 25, 24, 26. Use wilcoxon sign test to check whether the median waiting time is more than 20 at 5% l.o.s

∴ H0: median > 20
∴ H1: median < 20
x = c(15, 17, 24, 25, 20, 21, 32, 28, 12, 25,
24, 26)
>wilcox.test(x, alternative = "greater")
p value : 0.001253
∴ Reject H0
∴ median < 20

Q.5] The weight in kgs of a person before & after they stop smoking are as follows

before : 65, 75, 75, 62, 72
after : 72, 82, 72, 63, 73
Use the wilcoxon test to check whether the weight of person increases after stop smoking at 5% of l.o.s

∴ H0: weight increases after stopping
∴ H1: weight not increases

55

```
>x=c(65,75,75,62,72)
>y=c(72,82,72,66,73)
>z=x-y
>wilcox.test(z, mu=0)
pvalue= 0.1756
Accept Ho?
```

Practical 9

Title: ANOVA

Q1] The following data gives the effect of 3 treatments

T1: 2, 3, 7, 2, 6
T2: 10, 8, 7, 5, 10
T3: 10, 13, 14, 13, 15

Test the hypothesis that all treatments are equally effective.

∴ Ho: t1 = t2 = t3
∴ H1: t1 ≠ t2 ≠ t3

```
> t1=c(2,3,7,2,6)
> t2=c(10,8,7,5,10)
> t3 = c(10,13,14,13,15)
> data= data.frame(t1,t2,t3)
> e=stack(data)
> oneway.test(values~ind, data=e)
```

[1] p-value = 0.0006232

∴ Reject Ho

∴ All treatments are not equally effective.

25

Q.2] The following gives life of tyres of 4 brands

a: 20, 23, 18, 17, 22, 24

b: 19, 15, 17, 20, 16, 17

c: 21, 19, 22, 17, 20

d: 15, 14, 16, 18, 14, 16

Test hypothesis whether the average life of all brands are same

H0: a = b = c = d

H1: a ≠ b ≠ c ≠ d

```
> a = c(20, 23, 18, 17, 22, 24)
> b = c(19, 15, 17, 20, 16, 17)
> c = c(21, 19, 22, 17, 20)
> d = c(15, 14, 16, 18, 14, 16)
> e = list(a1 = a, b1 = b, c1 = c, d1 = d)
> f = stack(e)
> oneway.test(values ~ ind, data = f)
[1] p-value: 0.004673
```

∴ Reject H0

∴ The average life of tyres of all brands are not same

Q3] 3 types of wax is applied for the protection of cars and no of days of protection were noted. Test whether these are equally effective

a: 44, 45, 46, 47, 48, 49
b: 40, 42, 51, 52, 55
c: 50, 53, 58, 59

∴ $H_0: a = b = c$
∴ $H_1: a \neq b \neq c$

```
>a=c(44,45,46,47,48,49)
>b=c(40,42,51,52,55)
>c=c(50,53,58,59)
>d=list(a11=a, a12=b, a13=c)
>e=stack(e)
>oneway.test(values~ind, data=e)
```

O] p-value = 0.03822
∴ Reject H_0
∴ Protection of 3 types of wax used for cars are not equally effective

15.

Q.4] An experiment was conducted on 8 ~~pop~~ person and observations were noted. There are 3 types of groups

Non Exercise : 23, 26, 51, 48, 58, 37, 29, 44
20min Exercise : 22, 27, 29, 39, 46, 48, 49, 65
60min Exercise : 59, 66, 38, 49, 56, 60, 56, 62
Test whether the hypothesis that all groups have equal results on their health

∴ H0 : Ne = e1 = e2
∴ H1 : Ne ≠ e2 ≠ e1

```
> Ne = c(23, 26, 51, 48, 58, 37, 29, 44)
> e1 = c(22, 27, 29, 39, 46, 48, 49, 65)
> e2 = c(59, 66, 38, 49, 56, 60, 56, 62)
> data = data.frame(Ne, e1, e2)
> e = stack(data)
> oneway.test(values ~ ind, data=e)
```

[] p value = 0.01633
∴ Reject H0
∴ All groups don't have equal res[ults] on their health.