Practical :- 1

Title :- Random variable.

Q.1) Find the mean and variance for the following

a)

x	-1	0	1	2
$p(x)$	0.1	0.2	0.3	0.4

Sol^n :-

x	$p(x)$	$x \cdot p(x)$	$E(x)^2$	$[E(x)]^2$
-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	0.16	0.64
Total	$\Sigma = 1$	$\Sigma = 1$	$\Sigma E(x)^2 = 0.20$	$[\Sigma(x)]^2 = 0.74$

$\therefore$ Mean $= E(x) = \Sigma x_i \cdot p(x) = 1$.

$\therefore$ variance $= V(x) = \Sigma E(x)^2 - \Sigma[E(x)]^2$

$= 2 - 0.74$

$= 1.24$

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

b)

x	-1	0	1	2
$p(x)$	$1/8$	$1/8$	$1/4$	$1/2$

Sol^n :-

X	$P(x)$	$xP(x)$	$E(x)^2$	$[E(x)]^2$
-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 $= E(x) = \Sigma x P(x) = 9/8$

$\therefore$ variance $= v(x) = \Sigma E(x)^2 - \Sigma [E(x)]^2$

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

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

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

$\therefore$ Mean $E(x) = 9/8$ & variance $v(x) = 83/64$

c)

X	−3	10	15
P(X)	0.4	0.35	0.25

Solⁿ:-

X	P(X)	XP(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 $= E(x) = \Sigma x \cdot P(x) = 6.05$

variance $= V(X) = \Sigma E(x)^2 - \Sigma [E(x)]^2$

$= 94.85 - 27.7525$

$= 67.0975$

$\therefore$ Mean $E(x) = 6.05$ & variance $V(x) = 67.0975$

2] If P(x) is pmf of a random variable X if P(x) represent pmf for random variable X. Find the value of K. Then evaluate mean ~~&~~ & variable.

Solⁿ:- 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) $\Sigma P(x_i) = 1$

x	-1	0	1	2
$P(x)$	$k+1/13$	$k/13$	$1/13$	$k-4/13$

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

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

$$13 = 3k-2$$

$$15 = 3k$$

$$\therefore k = 5$$

x	$P(x)$	$x \cdot P(x)$	$E(x)^2$	$[E(x)]^2$
-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	$\Sigma = 1$	$\Sigma = -3/13$	$\Sigma = 11/13$	$\Sigma = 41/169$

$\therefore$ Mean $= E(x) = \sum x \cdot P(x) = -3/13$

$\therefore$ 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 $= 102/169$

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	0.05

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

Solⁿ:-

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) $P(X \ge 0) = 1 - F(0) + P(0)$

$= 1 - 0.45 + 0.15$

$= 0.40$

4) Let f be continuous random variable with pdf

$$\because f(x) = \frac{x+1}{2} \qquad -1 < x < 1$$
$$= 0 \qquad \text{otherwise}$$

obtain cdf of x. Find mean & variance

Solⁿ:-

By definition of cdf, we have

$$F(x) = \int_{0-1}^{x+1} t\,dt$$
$$= \int_{-1}^{1} \frac{x+1}{2}\,dx$$
$$= \frac{1}{2}\left(\frac{1}{2}x^2 + x\right) \text{ for } -1 \le x \le 1$$

Hence the cdf is

$$F(x) = 0 \quad \text{for} \quad x \le 0-1$$
$$= \frac{1}{4}x^2 + \frac{1}{2}x \quad \text{for} \quad -1 \le x \le 1$$
$$= 0 \quad \text{for} \quad x \ge 1$$

5) Let X be continuous random variable with pdf

$\therefore f(x) = \frac{x+2}{18}$ $\quad -2 \le x \le 4$.

$= 0$ $\quad$ otherwise.

Calculate cdf.

Solⁿ:—

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 $-2 \le x \le 4$

Hence cdf is

$F(x) = 0$ $\quad$ for $x < -2$

$= \frac{1}{8} \left(\frac{1}{2} x^2 + 2x \right)$

for $-2 < x < 4$

$= 0$ $\quad$ for $x \ge 4$

Nil

Practical :- 2

Title :- Binomial Distribution.

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

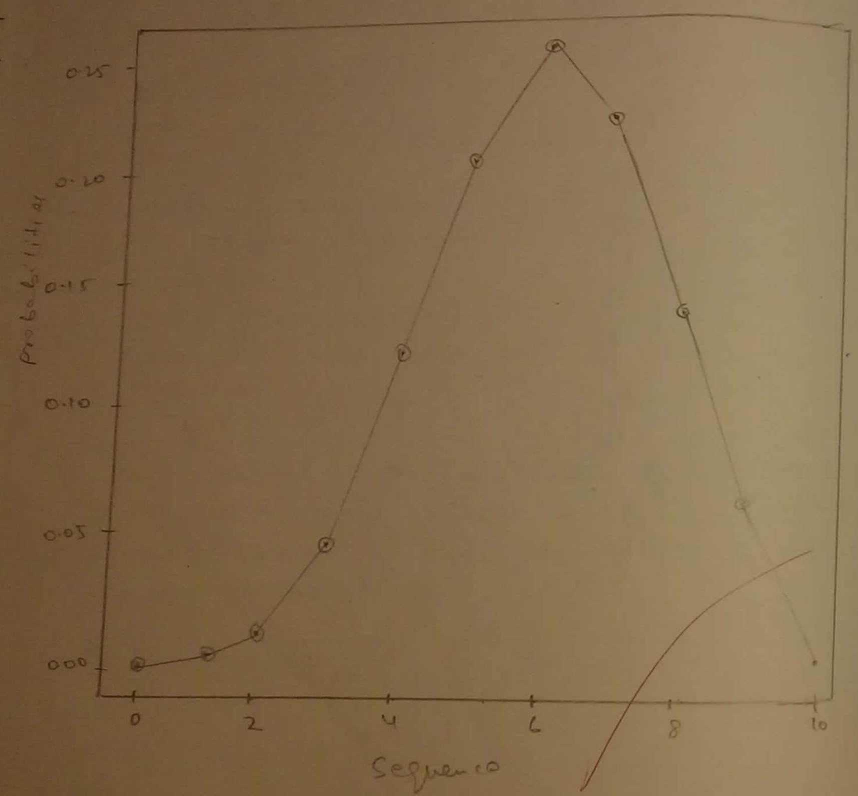
```
> 1- dbinom (0,4,0.5)
[1] 0.9375
```

MORE THAN ONE TAIL :

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

2) The probability that student is accepted to a prestigious college is 0.3 if 5 student supply, what's the probability of almost 2 are accepted.

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



3) An unbiased coin is tossed 6 times. the probability of head at any toss = 0.3. det 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
```

4) For $n=10$, $p=0.6$ evaluate binomial probabilities and plot the graph of pmf & cdf

```
>x = seq (0,10)
>y = dbinom (x, 10, 0.6)
[1] 0.0001048576    0.0015728640    0.0106168835
    0.0424673280    0.1114767360    0.2006581124
    0.2508226560    0.2149908480    0.120932352
    0.0403107840    0.0060466176
> plot (x,y, xlab = " sequence", ylab = "probabilities", "D",
                                                  pch=16)
> x = seq (0,10)
> y = pbinom (x, 10, 0.6)
```

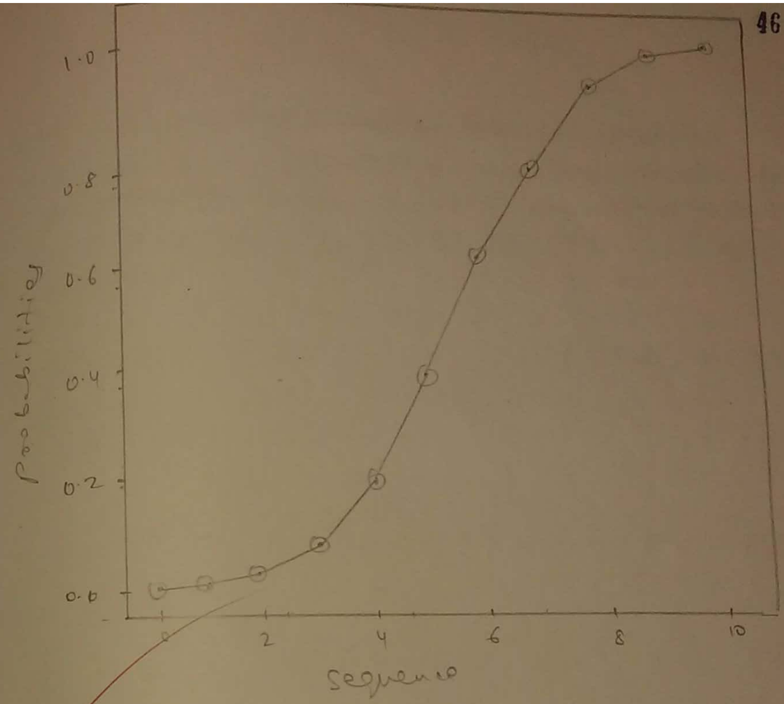
```
> plot (x, y, xlab = "sequence", ylab = "probabilities",
      "o", pch = 16)
```

5) 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
> ~~rbinom (8,10,~~ summary (x)
[1] 2.375
> var (x)
[1] 3.125
```

6) 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
```

7) Bits are sent for communication channel in packet of 12. If the probability of bit being corresponing is 0.1. What is the probability of no more then 2 bits are corresponing in a packet?

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

Jleen

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Practical :- 3

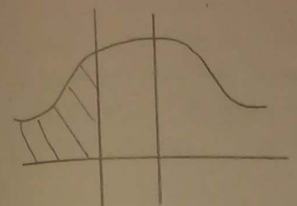
Title :- Normal distribution.

1) A normal distribution of 100 student with mean = 40 ~~sb~~ sd = 15
find no of student whose marks are
1) $p(x<30)$ 2) $p(40<x<70)$ 3) $p(25<x<35)$
4) $p(x>60)$

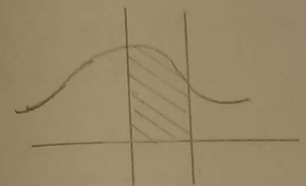
```
> pnorm(30,40,15)
[1] 0.2524925

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

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

> 1-pnorm(60,40,15)
[1] 0.0912112
```

Q1

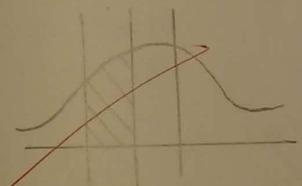
a)



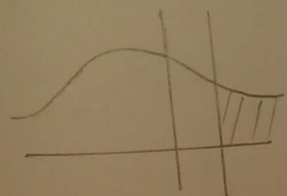
b)



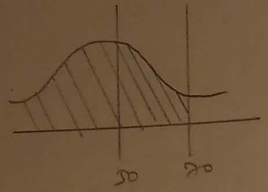
c)



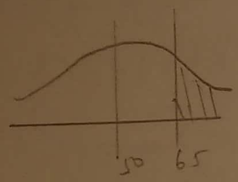
d)



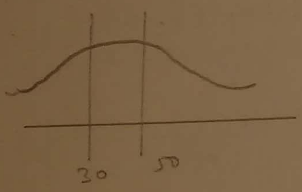
a)



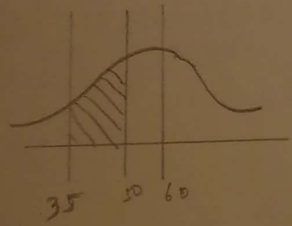
b)



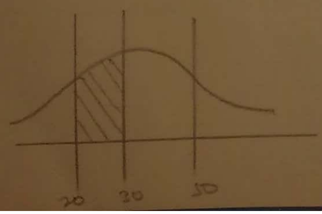
c)



d)



e)



1) If the random variable x follows normal distribution with mean = 50, V = 100 find
1) p(x ≤ 70) 2) p(x > 65) 3) p(x ≤ 32)
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(60,50,10) - pnorm(35,50,10)
[1] 0.7745375

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

2) let x ~ N(160, 400) find k_1 and k_2 such that
p(x < k_1) = 0.6 and p(x > k_2) = 0.6

> qnorm(0.6,160,20)
[1] 165.0669

> qnorm(0.8,160,20)
[1] 176.8320

4) A random variable x follows normal distribution with $\mu=10$, $\sigma=2$ operate 100 observation and evaluate its mean, median and variance

```
> x = rnorm(100,10,2)
> summary(x)
[1] min    1st    median  mean   3rd     max
    5.713  8.444  9.723   9.914  11.325  14.298

> var(x)
[1] 3.648924
```

5] write a R command to generate 10 random number for normally distribution with $\mu=50$, $\sigma=4$. find the sample mean and median

```
> x = rnorm(10,50,4)
> summary(x)
min    1Q     median  mean   3rd Q  Max
44.73  50.46  52.01   52.35  54.39  58.85
```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Practical :- 4

* sample mean & std deviation given single population.

Q1) Suppose the food based on the cookie bags stats that it has atmost 2 grams of saturated fat in a single cookie. In a sample of 55 cookies it was found that mean and of saturated fat per cookies is 2.1 grams. Assume that the sample std deviation is 0.3 at 15 % level of significance can be rejected the law of food.

→ To check whether reject on accept will hypothesis at 95% level of confidence or 5% level of significance.

$\sigma = 0.3$ $\bar{x} = 2.1$

$n = 35$ $\mu = 2$

H_0 (null Hypothesis) = $\mu < 2$

H_1 (null' Hypothesis = $\mu > 2$

$$Z = \frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}} = \frac{2.1 - 2}{\frac{0.3}{\sqrt{35}}} = 1.972021$$

Pvalue = 1 - pnorm(z)

= 0.0243

∴ Reject the null hypothesis ∵ Pvalue < 0.5

∴ Accepted alternate hypothesis

51

Q2) A sample of 100 customers was randomly & it was found that avg spending was 275/- . The S.D = 30 using 0.05 level of significance. you conclude that the amount spent by the customer is more than 250/- whereas the restaurant ~~claims~~ claises that it is not 250/-

→ $\bar{x} = 275$ $\mu = 250$ $\sigma = 30$, $n = 100$

$H_0 = \mu < 250$

$H_1 = \mu > 250$

$\because Z = \dfrac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}} = \dfrac{275 - 250}{\frac{30}{\sqrt{100}}} = 8.333$

~~p value~~ pt(z, 99, lower.tail = F)

∴ pvalue = 2.305786e-13

∴ Reject the null hypothesis

∴ Pvalue < 0.05

∴ Accept the alternate hypothesis ∴ $(\mu > 2)$

Q3) A quality control engineer finds that sample of 100 bulbs have avg life of 470 hours. Assuming population test whether the population mean is 480 hours vs population mean < 480 at 0.05 → 0.05.

→ $n = 100$, $\bar{x} = 470$, $\mu < 480$ $\sigma = 26$, $\mu = 480$

$Z = \dfrac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}} = \dfrac{470 - 480}{\frac{25}{\sqrt{100}}} = -4$

∴ pt(z, 99, lower.tail = T) = 6.115776e-05

∴ Reject the null hypothesis

∴ $p < 0.05$

∴ Accept the alternate hypothesis

$(\mu_1 < 480)$

Q4) A principal at school claims that the IQ is 100 of the students. A random sample of 30 students where IQ was found to be 112. The S.D of population is 15. Test the claim of principal.

→ Method-1 :

$H_0 = \mu = 100$

$H_1 = \mu = 100$

$\bar{x} = 112$, $SD = 15$, $\mu = 100$, $n = 30$.

$Z = \dfrac{p - p_0}{\sqrt{\frac{p_0 q_0}{n}}}$

$p_0 = 0.5$, $q_0 = 1 - p_0 = 0.5$

$p = \frac{28}{40} = 0.7$, $n = 40$

$\therefore Z = \dfrac{0.7 - 0.5}{\sqrt{\frac{0.5 \times 0.5}{40}}}$

$H_0 = 0.5$

$H_1 \neq 0.5$

∴ Pvalue = 2(1 - pnorm(abs(z)))

= 0.01141209

∴ Reject the null hypothesis

∵ $p < 0.05$

∴ Accept the alternate hypothesis.

* Single population proportions.

Q1) It is believed that coin is fair. The coin is tossed 40 times, 25 times head. Indicate whether the coin is fair or not at 95% loc.

$\rightarrow Z = \frac{p - p_0}{\sqrt{\frac{p_0 q_0}{n}}}$

$p_0 = 0.5$, $q_0 = 1 - p_0 = 0.5$

$p = \frac{28}{40} = 0.7$, $n = 40$

$\therefore Z = \frac{0.7 - 0.5}{\sqrt{\frac{0.5 \times 0.5}{40}}}$

$\because H_0 = \mu = 0.5$

$H_1 = \mu \neq 0.5$

$\therefore$ Pvalue $= 2(1 - pnorm(abs(z)))$
$= 0.01141209$

$\therefore$ Reject the null hypothesis
$\because p < 0.05$

$\therefore$ Accept the alternate hypothesis.

Q1) In an hospital 480 ~~[illegible]~~ female & 520 males are born in a week to confirm male & female are equal in is.

$Z = \frac{p - p_0}{\sqrt{\frac{p_0 q_0}{n}}}$ $p = \frac{520}{1000} = 0.52$ $p_0 = 0.5$

$q_0 = 0.5$, $n = 1000$

$h_0 = [p = p_0]$
$h_1 = [p \neq p_0]$
$Z = (p - p_0)$ (sqrt($p_0 q_0$(n)))
$Z = 1.2645$

Pvalue $= 2 \times (1 - pnorm(abs(z)))$
$\therefore$ pvalue $= 0.2060506$

$\therefore$ Reject the null hypothesis < 0.5
$\therefore$ Accept the alternate hypothesis
i.e $p \neq 100$

Q2) For a big city 325 mens out of 600 men are found to be self employed. conclusion is that maximum men in city are self employed.

$Z = \frac{p - p_0}{\sqrt{\frac{p_0 q_0}{n}}}$ $p \rightarrow \frac{325}{600} = 0.541307$ $p_0 = 0.5$

$q_0 = 0.5$ $n = 600$

$h_0 = [p_0 = p]$
$h_1 = [p_0 \neq p]$

$Z = [0.5416 - 0.5] / (sqrt(0.5 \times 0.5 / 600))$

$Z = 2.03975$

pvalue $= 2 \times (1 - pnorm(abs(z)))$
pvalue $= 0.04155239$

$\therefore$ Reject the null hypothesis
$\therefore$ Pvalue < 0.5
$\therefore$ Accept the alternate hypothesis i.e $p \neq p_0$

Q3) experience shows that 20% of manufactured products are of top quality. In 1 day production of 400 articles only 50 are top quality. Let hypothesis that experience of 10% of manufactured products if wrong.

→ $Z = \frac{p - p_0}{\sqrt{\frac{p_0 q_0}{n}}}$ $p = 0.125\ (50/400)$
$p_0 = 0.2 \quad q_0 = 0.8$
$n = 400.$

$h_0 = [p = 0.2]$
$h_1 = [p \neq 0.2]$

z = [(0.125 - 0.2)/sqrt (0.2 * 0.8/400)]
$z = -3.75$

pvalue = 2x(1- pnorm(abs(z))
∴ pvalue = 0.0001768346
∴ Reject the null hypothesis ∴ Pvalue < 0.2

∴ Accept the alternate hypothesis i.e: $p \neq 0.2$

* Formula :-
$Z = \sqrt{pq\left(\frac{1}{n} + \frac{1}{m}\right)}$ where $p = \frac{p_1 n + p_2 m}{n+m}$

Q1) In an election campaign a telephone phone of 800 registered where ~~above~~ shows pvalue 460. Second pole opinion 520 of 1000 registered voters found the candidate at 0.5%. LOC (Level of confidence) is there sufficient evidence that popularity has decreased.

→ $n = 800$, $p_1 = 460/800 = 0.575$
$m = 1000$, $p_2 = 520/1000 = 0.52$

p = (0.575 * 800 + 0.52x1000)/(1800)
$p = 0.5444$
z = sqrt (0.54 x 0.46) + 1/8
$z = 0.01121894$

$H_0 = p = 0.544$
$H_1 = p < 0.544$

∴ pvalue = 2x(1- pnorm(abs(z))
pvalue = 0.9991053

∴ Accept the null hypothesis
∴ Pvalue > 0.5
∴ Accept $p = 0.5444$

Q.2) From a consignment A 100 articles are drawn & 44 was found ~~defination~~ defective from consignment 200. Samples are drawn out of which 30 are defective. Test whether the proportion of defective items in 2 consignment are significantly different.

→ $H_0 = p_1 = p_2$
$H_1 = p_1 \neq p_2$
$p_1 = 44/200 = 0.22$
$n = 200 = m$
$p_2 = 30/200 = 0.15$
$p = \frac{(p_1 n + p_2 m)}{n+m}$

$p = (0.22 \times 200 + 0.15 \times 200)/400$
$p = 0.125$

z = (sqrt(0.185 x 0.815) x (21200))

z = 0.00388976

pvalue = 2 x (1-pnorm(abs(z)))

∴ pvalue = 0.9969018

∴ pvalue > p.

∴ Accept the null hypothesis

i.e $p_1 = p_2$

Practical No:-5

Chisquare Test

a) Use the following data to test whether the attribute conditions of home & child are independent

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

H_0 = Both are independent ; H_1 = 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 , pvalue = 2.678e-06

∴ Reject the null hypothesis

∴ Both are dependent

55

Q2) A dice is tossed 120 times & following results are obtained

→ No of terms | frequency

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

Test the hypothesis that dice is unbiased.

H_0 = dice is unbiased
H_1 = dice is biased

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

∴ Accept the null hypothesis
∴ dice is unbiased.

Q3) An IQ test was conducted & the Student's were observed before & after training the results 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

∴ H_1 = no change in IQ
H_0 = 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 change in IQ after training.

Q4)

	~~Candidate~~ Graduate	undergraduate.
Online	20	25
face to face	40	5

Is there any association between Students preference for type of educational 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 = 12.05, df = 1, p-value = 2.157e-05
```

∴ Reject null hypothesis

∴ Both are dependent

Q5) A dice is tossed 180 times.

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

Test the hypothesis that dice is unbiased

H_0 = dice is baised

H_1 = dice is unbaised.

```
> 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.

Title: t test

Q1) 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 H0 : 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, Pvalue = 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
∴ Reject H0
∴ Accept H1
> t.test (x, mu = 3400, alter = "two sided", conf.level = 0.97)

One sample test.

data: x
t = -4.4865, df = 19, p-value = 0.0002528
alternative hypothesis: true mean is not equal to 3400

3360.33 3387.57
Sample estimates: ~~mean of x~~
mean of x : 3373.95
∴ Reject H0
∴ Accept H1

→ ② H0 = μ = 3400
H1 = μ > 3400
> t.test (x, mu = 3400, alter = "greater", conf.level = 0.95)

One sample t test.

data: x
t = -4.4865, df = 19, p.value = 0.9999
alternative hypothesis: true mean is greater than 3400

3363.91 inf
Sample estimates:
mean of x : 3373.95
∴ Accept H0

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

One sided t.test

data: x
t = -4.4865, df = 19, p.value = 0.9999
alternative hypothesis: true mean is greater than 3400

3367.37 inf
Sample estimates:
mean of x : 3373.95
∴ Accept H0
→ ③ H0 = μ = 3400
H1 = μ < 3400
> t.test (x, mu = 3400, alter = "less", conf.level = 0.95)

One sided t.test

data: x
~~t.test ()~~
t = -4.4865, df = 19, P.value = 0.0001264
alternative hypothesis: true mean is less than 3400
95 percent level of confidence
-Inf 3383.98
Sample estimates:
mean of x : 3373.95
∴ Reject H0
∴ Accept H1
> t.test (x, mu = 3400, alter = "less" conf.level = 0.97)

One sided t.test

data: x
t = -4.4865, df = 19, Pvalue = 0.0001264

alternative hypothesis : true mean is less than 3400

97 percent level of confidence
-Inf 3385.563

Sample estimates ;
mean of x : 3373.95

∴ Reject Ho
∴ 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

→ ∴ Ho = 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 Ho
∴ There is no difference in weights.

Q.3) 11 Students gave the test after 1 month. they again gave the test after the tutions, do the marks give evidence that students have ~~to~~ benefited by coaching.
E1 : 23, 19, 21, 18, 20, 18, 17, 23, 16, 19, 20
E2 : 24, 19, 22, 18, 20, 22, 20, 20, 23, 20, 17
test at 99 level of confidence

→ >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 = 0.08441
alternative hypothesis : true difference in means is less than 0 .
99 percent confidence interval :
-inf 0.868333

Sample estimates :
mean of the differences : -1

∴ Accept Ho .

Q4) Two drugs for BP was given & data was collected.
D1: 0.7, -1.6, -0.2, -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 effects, check whether two drugs have same effect on patients or not.

→ H0 : 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 H0
∴ Accept H1

Q5) 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

→ ∴ H0 = S1 = S2
∴ H1 = S1 ≠ S2

```
>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 = 0.00666
alternative hypothesis: true difference in means is not equal to 0.
95 percent confidence interval:
-10404.821 -2792.846
Sample estimates:
mean of the differences:
-6598.833

∴ Reject H0
∴ Accept H1

Practical :- 7

Title :- F. Test

Q1) Life exceptancy in 10 region of India in 1990 and 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, 57

→ 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, 57)
var.test(x,y)

F. test to compare two variances

data: x and y
F = 1.0548 , num df = 9, denom df = 11, P-value = 0.9176
Alternative hypothesis : true ratio of variance is not equal to 98 percent confidence interval :
0.2939977 4.1265887
Sample estimates:
ratio of variance
1.054834

∴ Accept Ho.
∴ variance at 2 times are same

Q2) I 25, 28, 26, 27, 27, 29, 31, 31, 26, 31
II 30, 25, 31, 32, 23, 25, 36, 28, 31, 32, 32, 27, 31, 38, 24.

at 95% of confidence level check the ratio of the population variance:

→ ∴ $H_0 = \sigma_1^2 = \sigma_2^2$
$H_1 = \sigma_1^2 \neq \sigma_2^2$

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

F. Test to compare two variance
p-value = 0.4535
∴ Accept the H_0
∴ variance of I and II are same

Q.3. For the following data test the hypothesis for
① equality of 2 population mean → t.test
② equality of proportion variance → f.test.

Sample1: 175, 168, 145, 190, 181, 185, 175, 200
sample2: 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 t.test
p-value = 0.7771

∴ Accept H_0
∴ equality of 2 population mean are same

② equality of proportion variance.

```
>var.test(x,y)
```

f.test to compare two variances
p-value = 0.7759

∴ Accept H_0
∴ equality of proportion variance are same.

Q4) The following are the price of comodity in the sample of shops selected in random from different city.

City A: 74.10, 77.70, 75.35, 74, 73.80, 79.30, 75.80, 76.80, 77.10, 76.40

City B: 70.80, 74.90, 76.20, 72.80, 78.10, 74.70, 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, 77.70, 75.35, 74, 73.80, 79.30, 75.80, 76.80, 77.10, 76.40)

> Y = c(70.80, 74.90, 76.20, 72.80, 78.10, 74.70, 69.80, 81.20]

> var.test (x,y)

F test to compare two variance.

p-value = 0.02756

∴ Reject Ho

∴ equality of 2 population mean are not same.

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

welch Two sample t-test

p-value = 0.3244

∴ Accept Ho

∴ mean of two population is same

Q.5) prepare a csv file in excel import the file in R and apply the test to check the equality of variance of 2 data.

observed 1: 10 15 17 11 16 20

observed 2: 15 14 16 11 12 19

→ ∴ $H_0 : \sigma_1^2 = \sigma_2^2$

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

Save the above observation in excel file in csv (ms-dos) format.

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

> data.

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

> attach (data)

> var.test (obs1, obs2)

F test to compare two variance.

p-value = 0.5717

∴ Accept Ho

∴ The variance of 2 data are same.

Neat

Practical No:8

Non Paramatic test.

Q.1) The times of failure in hours 10 random select a-volt batteries is given. test the population test that the population median is 63 against the population median is than 63.

Solⁿ:- H_0 = median = 63
H_1 = median = 63

x = c (28.9, 15.2, 28.9, 72.5, 48.5, 52.4, 37.6, 49.5, 62.1, 54.2)
sp = len (which (x<63))
sp = len (which (x=63))
n = Sn + Sp
qbinom (0.05, n, 0.5)
n
Sn
q

Pbinom (Sn, n, 0.5)
0.9990204

H_0 is accepted.

Q.2) Data of give a weight of 40 students in random sample 'test' hypothesis that the median of the hypothesis that the median is 50 against it is greater than 50.

Solⁿ:- H_0 = median = 50
H_1 = median > 50

\> x = c (46, 49, 57, 64, 67, 54, 48, 46, 69, 61, 57, 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)

\> Sn = length (x [x<50])
\> sp = length (x [x<250])
\> n = sp + Sn
\> qbinom (0.05, n, 0.5)
14

\> Sn
13

So, SA is Rejected Ho
Ho is rejected.

Q.3) The median age of tourist visiting a certain place to claired to be 41 yrs. A random sample of 17 tourist is given. Use the sign test to check the claim.

Solⁿ:- H_0 = median = 41
H_1 = median ≠ 41

```
> x=c(25,29,52,48,57,39,45,36,30,49,28,39,
      44,63,32,65,42)
> pn = len(which(x>41))
> Sn = len(which(x<41))
  qbinom(0.05,n,0.5)
> n
> Sn
  r
```

qbinom < Sn, Ho is accepted

median=41 is accepted.

Q.4) The time in minutes that has patient has to wait for consultation is recorded as followed.
Use wilcox sign test to test whether the median waiting time is more than 20 min at 5% of significant

Solⁿ:- H_0 = median > 20
H_1 = median < 20

```
> x = c(15,17,20,24,25,20,21,32,28,12,25,24,26)
> wilcox.test(x,alternative='less')
```


0.999

Accept Ho.

Q.5) The weight in kg of a person before and after the smoking is given. Use wilcoxn test to check whether the weight of person increases after stopping smoking. Use 5% level of significance.

Solⁿ: H_0 = median = after you stop smoking
H_1 = weight dont change.

```
a = c(65,75,75,62,72)
b = c(72,82,72,66,73)
> x=b-a
> x
-7,-7,3,-4,-1
> wilcox.test(x,mu=0)
  pvalue = 0.1756
```

pair, pvalue > 0.05

Accept Ho

Practical:- 9

Anova test

Q.1) The following data gives the effect of 3 treatment.

Treatment 1 : 2, 3, 7, 2, 6

Treatment 2 : 10, 8, 7, 5, 10

Treatment 3 : 10, 13, 14, 13, 15

Test the hypothesis, all treatment are equally effective.

Solution:-

```
>   t1 = c(2,3,7,2,6)
>   t2 = c(10,8,7,5,10)
>   t3 = c(10,13,14,13,15)
> ~~x = matrix~~
> x = data.frame(t1, t2, t3)
> x
```

x	t1	t2	t3
1	2	10	10
2	3	8	13
3	7	7	14
4	2	5	13
5	6	10	15

y = stack(x)


```
> y
```

	value	ind
1	2	t1
2	3	t1
3	7	t1
4	2	t1
5	6	t1
6	10	t2
7	8	t2
8	7	t2
9	5	t2
10	10	t2
11	10	t3
12	13	t3
13	14	t3
14	13	t3
15	15	t3

```
> aov(values ~ ind, data = y)
> oneway.test(values ~ ind, data = y)
```

∴ p-value = 0.0006232

∴ p-value < 0.05

∴ Reject the null hypothesis.

Q.2) The following gives the life of ~~typ~~ types of 4 brands A, B, C, D.

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 the hypothesis that the average life of all type is same.

→ Sol^n:- H_0

```
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)

> x = list(a1=a, b1=b, c1=c, d1=d)
> x
$a1  20 22 23 24 14 18
$b1  19 15 17 20 16 17
$c1  21 19 22 17 20
$d1  15 14 16 18 14 16

> y = stack(x)
> oneway.test(values~ind, data=y)
```

∵ P-value = 0.006291
i.e p-value < 0.05
∴ Reject the null hypothesis.

Q3) 3 types of wax is applied for the protection of cars & number of days of protection were noted. Test whether these are equally effected.

A = 44, 45, 46, 47, 48, 49
B = 40, 42, 51, 52, 55
C = 50, 53, 58, 59

→ Sol^n:- H_0

```
a = c(44, 45, 46, 47, 48, 49)
b = c(40, 42, 51, 52, 55)
c = c(50, 53, 58, 59)

> x = list(a1=a, b1=b, c1=c)
> x
$ a1 = 44 45 46 47 48 49
$ b1 = 40 42 51 52 55
$ c1 = 50 53 58 59

> y = stack(x)
> y
> oneway.test(values~ind, data=y)
```

∴ P-value = 0.03822
i.e p-value < 0.05

∴ Reject the null hypothesis.

Q.4) An experiment was conducted on 8?. person & observation were noted.

No 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 the hypothesis that all groups have equal results on their health.

Soln:- No = 8

a=c(23, 26, 51, 48, 58, 37, 29, 44)

b=c(22, 27, 29, 39, 46, 48, 49, 65)

c=c(59, 66, 38, 49, 56, 60, 56, 62)

```
> x = list(a1=a, b1=b, c1=c)
> x
$a1 = (23  26  51  48  58  37  29  44
$b1 =  22  27  29  39  46  48  49  65
$c1 =  59  66  38  49  56  60  56  62

> y = stack(x)
> y
> oneway.test(values ~ ind, data=y)
```

∴ P-value = 0.01633

i.e P-value < 0.05

∴ Reject the null hypothesis.