Name : Bhalsod Aditya M **Enrollment** : 175690693001
Subject : Statistical Methods (SM) **Subject Code** : 4649302

PRACTICAL 3

1) Suppose there are twelve multiple choice questions in an English class quiz. Each question has five possible answers, and only one of them is correct. Find the probability of having four or less correct answers if a student attempts to answer every question at random.

Solution: Since only one out of five possible answers is correct, the probability of answering a question correctly by random is 1/5=0.2. We can find the probability of having exactly 4 correct answers by random attempts as follows.

Dbinom():

```
dbinom(4, size=12, prob=0.2)
[1] 0.1328756
```

To find the probability of having four or less correct answers by random attempts, we apply the function dbinom with $x = 0,\ldots,4$.

```
 dbinom(0, size=12, prob=0.2)+
+ dbinom(1, size=12, prob=0.2)+
+ dbinom(2, size=12, prob=0.2)+
+ dbinom(3, size=12, prob=0.2)+
+ dbinom(4, size=12, prob=0.2)
[1] 0.9274445
```

Answer: The probability of four or less questions answered correctly by random in a twelve question multiple choice quiz is 92.7%.

pbinom():

Solution: Since only one out of five possible answers is correct, the probability of answer ring a question correctly by random is 1/5=0.2. We can find the probability of having exactly 4 correct answers by random attempts as follows.

```
pbinom(4, size=12, prob=0.2)
[1] 0.9274445
```

Answer: The probability of four or less questions answered correctly by random in a twelve question multiple choice quiz is **92.7%.**

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2) In the past few years, outsourcing overseas has become more frequently used than ever before by U.S. companies. However, outsourcing is not without problems. A recent survey by Purchasing indicates that 20% of the companies that outsource overseas use a consultant. Suppose 15 companies that outsource overseas are randomly selected.

a. What is the probability that exactly 5 companies that outsource overseas use a consultant?

```
dbinom(x=5, size=15, p=0.20)
[1] 0.1031823
```

b. What is the probability that none of the companies that outsource overseas use a consultant?

```
dbinom(x=0, size=15, p=0.20)
[1] 0.03518437
```

c. What is the probability that less than 10 companies that outsource overseas use a consultant?

```
pbinom(9, size=15, p=0.20)
[1] 0.9998868
```

d. What is the probability that 10 or fewer(at most 10) of the companies that outsource overseas use a consultant?

```
pbinom(10, size=15, p=0.20)
[1] 0.9999875
```

e. What is the probability that more than 6 companies that outsource overseas use a consultant?

```
pbinom(7, size=15, p=0.20, lower.tail = FALSE)
[1] 0.00423975
```

f. What is the probability that 6 or more (at least 6) companies that outsource overseas use a consultant?

```
pbinom(6, size=15, p=0.20, lower.tail = FALSE)
[1] 0.01805881
```

g. What is the probability that between 4 and 7 (not inclusive) companies that outsource overseas use a consultant?

```
sum(dbinom(5:6, size=15, p=0.20))
[1] 0.1461749
```

h. What is the probability that between 4 and 7 (inclusive) companies that outsource overseas use a consultant?

```
sum(dbinom(4:7, size=15, p=0.20))
[1] 0.3475981
```

i. How many companies that outsource overseas are randomly selected if it has a probability of 0.25(25th percentile) of total no. of 15 companies.

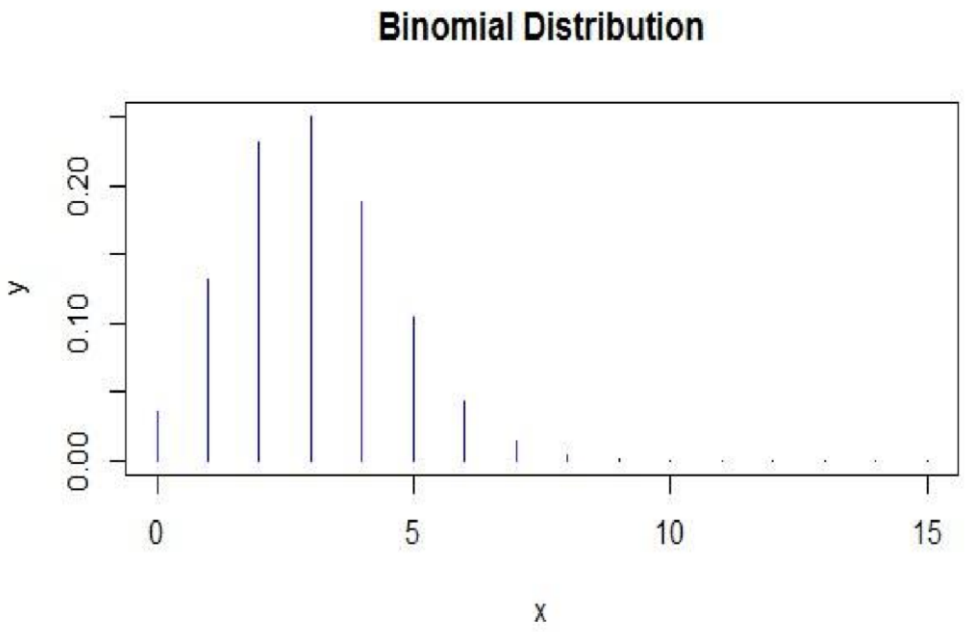
```
qbinom(0.25, size = 15, p=0.20)
[1] 2
```

j. Find 8 random values from a sample of 15 with probability of 0.20

```
rbinom(8, size=15, p=0.20)
[1] 3 4 3 3 4 4 2 2
```

k. Construct a graph for this binomial distribution.

```
x = seq(0, 15, by=1)
> y = dbinom(x, size=15, p=0.20)
> plot(x, y, main ="Binomial Distribution", col="blue", type="h")
```



3) If there are twelve cars crossing a bridge per minute on average, find the probability of having seventeen or more cars crossing the bridge in a particular minute?

Solution: Hence the probability of having seventeen or more cars crossing the bridge in a minute is in the *upper tail* of the probability density function.

```
ppois(16, lambda=12, lower=FALSE)  [1]
0.101291
```

Answer: If there are twelve cars crossing a bridge per minute on average, the probability of having seventeen or more cars crossing the bridge in a particular minute is **10.1%.**

4) The average number of annual trips per family to amusement parks in the United States is Poisson distributed, with a mean of 0.6 trips per year. What is the probability of randomly selecting an American family and finding the following?

a. The family did not make a trip to an amusement park last year.

```
dpois(x=0, lambda=0.6)
[1] 0.5488116
```

b. The family took exactly 1 trip to an amusement park last year.

```
dpois(x=1, lambda=0.6)
[1] 0.329287
```

c. The family took less than 3 trips to amusement parks last year.

```
ppois(2, lambda=0.6)
[1] 0.9768847
```

d. The family took 3 or fewer (at most 3) trips to amusement parks last year.

```
ppois(3, lambda=0.6)  [1]
0.9966419
```

e. The family took more than 2 trips to amusement parks last year.

```
ppois(3, lambda=0.6, lower.tail = FALSE)
[1] 0.003358069
```

f. The family took 2 or more (at least 2) trips to amusement parks last year.

```
ppois(2, lambda=0.6, lower.tail = FALSE)
[1] 0.02311529
```

g. The family took between 1 and 5 (not inclusive) trips to amusement parks last year.

```
sum(dpois(2:4, lambda=0.6))
[1] 0.1215069
```

h. The family took between 1 and 5 (inclusive) trips to amusement parks last year.

```
sum(dpois(1:5, lambda=0.6))
[1] 0.4511495
```

i. How many number of annual trips per family to amusement parks in the United States are organized if it has a probability of 0.65(65th percentile)?

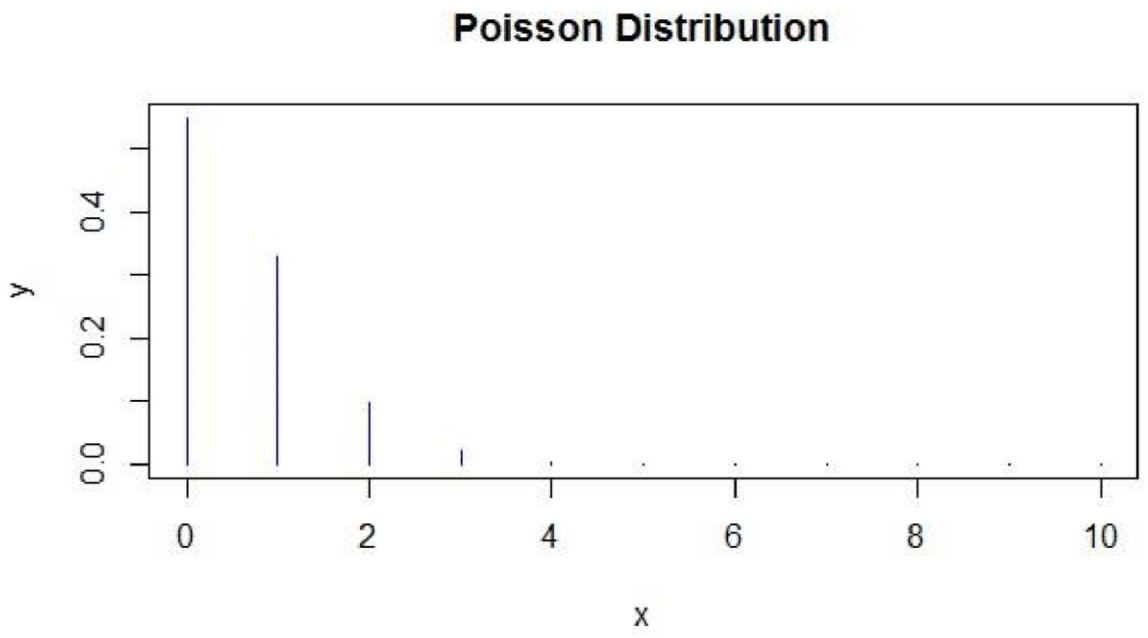
```
qpois(0.65, lambda=0.6)
[1] 1
```

j. Find 6 random values for this given poisson distribution.

```
rpois(6, lambda=0.6)
[1] 0 0 0 0 1 0
```

k. Construct a graph for this poisson distribution.

```
x = seq(0, 10, by=1)  > y =
dpois(x, lambda=0.6)
> plot(x, y, main ="Poisson Distribution", col="blue", type="h")
```



5) Suppose the mean checkout time of a supermarket cashier is three minutes. Find the probability of a customer checkout being completed by the cashier in less than two minutes.

Solution: The checkout processing rate is equals to one divided by the mean checkout completion time. Hence the processing rate is 1/3 checkouts per minute. We then apply the function pexp of the exponential distribution with rate=1/3.

```
> pexp(2, rate=1/3)
[1] 0.4865829
```

Answer: The probability of finishing a checkout in under two minutes by the cashier is 48.7%

6)The time between arrivals of vehicles at a particular intersection follows an exponential probability distribution with a mean of 12 seconds.

a. What is the probability that the arrival time is exactly 10 seconds?

```
dexp(x=10, rate = 1/12)   [1]
0.03621652
```

b.What is the probability that the arrival time between vehicles is less than 12 (12 or fewer, at most 12) seconds?

```
pexp(12, rate = 1/12)  [1]
0.6321206
```

c.What is the probability that the arrival time between vehicles is greater than 15(15 or more, at least 15) seconds?

```
pexp(15, rate = 1/12, lower.tail=FALSE)   [1]
0.2865048
```

d. What is the probability of between 10 and 15 seconds between vehicle arrivals?

```
sum(dexp(10:15, rate = 1/12))
[1] 0.1782251
```

e. How many arrivals of vehicles at a particular intersection if it has a probability of 0.65(65th **percentile)**?

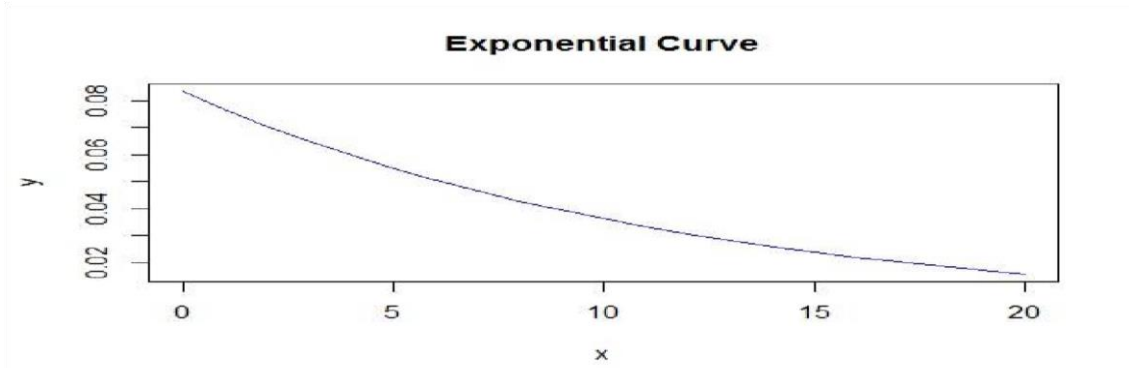
```
qexp(0.65, rate = 1/12)
[1] 12.59787
```

f. Find 5 random values for this given exponential distribution. `rexp(5, rate = 1/12)`

```
[1] 19.827687 15.295788 19.819357  1.423271  6.817861
```

g.Construct a graph for this exponential distribution.

```
x = seq(0, 20, by=1)     y = dexp(x, rate = 1/12)     plot(x, y, main ="Exponential Curve", col="blue", type = "l")
```



7) Assume that the test scores of a college entrance exam fits a normal distribution. Furthermore, the mean test score is 72, and the standard deviation is 15.2. What is the percentage of students scoring 84 or more in the exam?

Solution: We apply the function pnorm of the normal distribution with mean 72 and standard deviation 15.2. Since we are looking for the percentage of students scoring higher than 84, we are interested in the *upper tail* of the normal distribution.

```
pnorm(84, mean=72, sd=15.2, lower.tail=FALSE)   [1]
0.2149176
```

Answer: The percentage of students scoring 84 or more in the college entrance exam is 21.5%.

Name : Padiya Kashyap R Enrollment : 175690693025
Subject : Statistical Methods (SM) Subject Code : 4649302

8) Tompkins Associates reports that the mean clear height for a Class A warehouse in the United States is 22 feet. Suppose clear heights are normally distributed and that the standard deviation is 4 feet. A Class A warehouse in the United States is randomly selected.

a. What is the probability that the clear height is exactly 14 feet?

```
dnorm(x=14, mean=22, sd=4)
[1] 0.01349774
```

b. What is the probability that the clear height is less than 18(18 or fewer, at most 18) feet?

```
pnorm(18, mean=22, sd=4)
[1] 0.1586553
```

c. What is the probability that the clear height is greater than 26(26 or more, at least 26) feet?

```
pnorm(26, mean=22, sd=4, lower.tail=FALSE)
[1] 0.1586553
```

d. What is the probability that the clear height is between 14 and 30 feet?

```
sum(dnorm(14:30, mean=22, sd=4))
[1] 0.9668739
```

e. How many number of Class A warehouse in the United States are reported if it has a probability of 0.45(45th percentile)?

```
qnorm(0.45, mean=22, sd=4)
[1] 21.49735
```

f. Find 4 random values for this given normal distribution.

```
rnorm(4, mean=22, sd=4)
[1] 21.04551 22.06509 20.92758 13.99557
```

g. Construct a graph for this normal distribution.

```
x = seq(4, 40, by=0.1)  > y =
dnorm(x, mean=22, sd=4)
> plot(x, y, main ="Normal curve", col="blue", type = "l")
```