

Binomial Distribution

The binomial distribution model deals with finding the probability of success of an event which has only two possible outcomes in a series of experiments. For example, tossing of a coin always gives a head or a tail. The probability of finding exactly 3 heads in tossing a coin repeatedly for 10 times is estimated during the binomial distribution.

R has four in-built functions to generate binomial distribution. They are described below.

```
dbinom(x, size, prob)
pbinom(x, size, prob)
qbinom(p, size, prob)
rbinom(n, size, prob)
```

Following is the description of the parameters used –

- **x** is a vector of numbers.
- **p** is a vector of probabilities.
- **n** is number of observations.
- **size** is the number of trials.
- **prob** is the probability of success of each trial.

dbinom()

Create a sample of 50 numbers which are incremented by 1.

```
x <- seq(0,50,by = 1)
```

Create the binomial distribution.

```
y <- dbinom(x,50,0.5)
```

Plot the graph for this sample.

```
plot(x,y)
```

pbinom()

This function gives the cumulative probability of an event. It is a single value representing the probability.

Probability of getting 26 or less heads from a 51 tosses of a coin.

```
x <- pbinom(26,51,0.5)
```

```
print(x)
```

qbinom()

This function takes the probability value and gives a number whose cumulative value matches the probability value.

```
# How many heads will have a probability of 0.25 will come out when a coin  
# is tossed 51 times.  
x <- qbinom(0.25,51,1/2)
```

```
print(x)
```

rbinom()

This function generates required number of random values of given probability from a given sample.

```
# Find 8 random values from a sample of 150 with probability of 0.4.  
x <- rbinom(8,150,.4)  
  
print(x)
```

P1) 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. 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(4, size=12, prob=0.2)

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

**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)**

Alternatively, we can use the cumulative probability function for binomial distribution pbinom.

pbinom(4, size=12, prob=0.2)

P2) Suppose you have a biased coin that has a probability of 0.8 of coming up heads. The probability of getting 5 heads in 16 tosses of this coin is

**`dbinom(5,16,.8)` or
`choose(16,5)*.8^5*.2^11`**

The probability of getting at most 5 heads in 16 tosses is

**`pbinom(5,16,.8)`
`qbinom(.25,16,.8)`**

`rbinom()`

This function generates required number of random values of given probability from a given sample.

`rbinom(8,150,.4)`

P3) A coin is flipped 10 times. Calculate the probability of getting 5 heads using a Binomial distribution formula.

Answer: $P(x=5) = 0.2461$

P4) In a study, it is found that 70% of people who purchase pet insurance are mostly women. If we randomly select 9 pet insurance owners. What is the probability, out of them 7 will be women?

Answer: $P(x=7) = 0.2668$

P5) Last year in the survey of Autocar India, it was found that 70% of buyers of sports cars are men. If 10 sports car owners are randomly selected. What is the probability, out of them 6 will be men?

Answer: $P(x=5) = 0.2001$

P6) Hospital database displays that the patients suffering from cancer, 65% die of it. What will be the probability that of 5 randomly chosen patients out of which 3 will recover?

Answer: $P(x=3) = 0.336415$

P7) consider a scenario, let's assume a probability of a student lending a book from a library is 0.7. There are 6 students in the library, what is the probability of 3 of them lending a book?

P8) Dravid scores a wicket on 20% of his attempts when he bowls. If he bowls 5 times, what would be the probability that he scores 4 or lesser wicket?

Answer: $P(x \leq 4) = 0.99968$

P9) 4% of Americans are Black. Find the probability of 2 black students when randomly selecting 6 students from a class of 100 without replacement.

Answer: $P(x=2) = 0.99999$

P10) How many tails will have a probability of 0.2 when a coin is tossed 61 times.

Hint: `qbinom()`

Answer: 27