

TUTORIAL 03

ENVX1002

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R Commands for Binomial and Poisson

$X \sim \text{Bin}(np)$ and $X \sim \text{Po}(\lambda)$

| Function | Binomial | Poisson |
|--------------------------|--------------------------|----------------------------|
| PDF $P(X = x)$ | $\text{dbinom}(x, n, p)$ | $\text{dpois}(x, \lambda)$ |
| CDF $F(x) = P(X \leq x)$ | $\text{pbinom}(x, n, p)$ | $\text{ppois}(x, \lambda)$ |

Binomial distribution

1. Let's think about a situation that could be modelled by $X \sim \text{Bin}(n = 8, p = 0.7)$?
2. Use R to find the following **Binomial** probabilities for hybrid tomatoes:

The new Dixie Red hybrid tomato is claimed to have larger fruit, better disease package and higher yield potential compared to the current industry leader Florida 47 R hybrid tomato.

<https://www.growingproduce.com/vegetables/seminis-introduces-dixie-red-fresh-tomato-variety/>

Suppose we plant 8 seeds of Dixie Red and that each seed has a 70% success rate of germination.

- Let X = The number of Dixie Red seeds that germinate. What is the distribution of X ?
- Use R to find the exact probability distribution function and add in the table.

| Number seeds x | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|------------------------|---|---|---|---|---|---|---|---|---|
| Probability $P(X = x)$ | | | | | | | | | |

```
x <- c(0,1,2,3,4,5,6,7,8) # creates x values. You can also use x <- 0:8
p <- dbinom(x,8,0.7) #calculated the probabilities at each x.
rbind(x,round(p,3)) # view the probabilities with x in top row and rounded p in bottom row
```

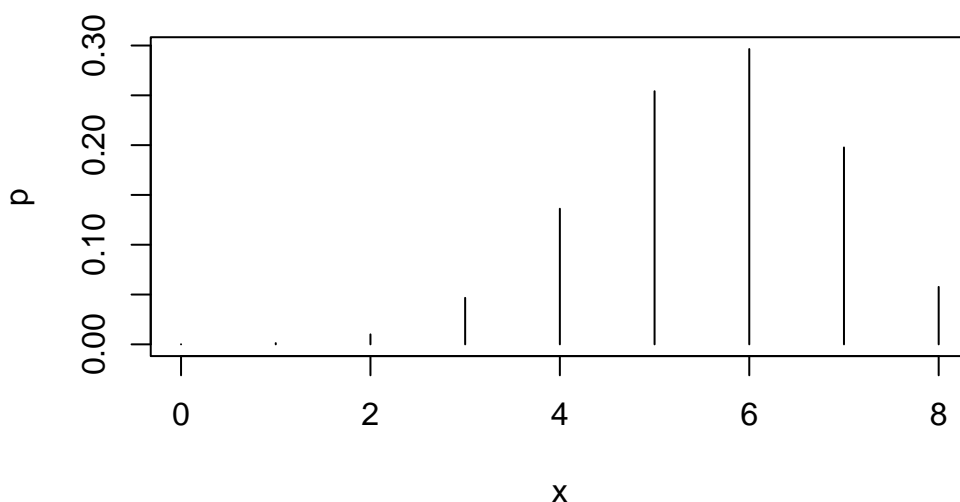
```
[,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9]
x    0 1.000 2.00 3.000 4.000 5.000 6.000 7.000 8.000
    0 0.001 0.01 0.047 0.136 0.254 0.296 0.198 0.058
```

```
sum(p) # Notice that all the probabilities sum to 1
```

[1] 1

- Use R to construct a histogram of the pdf. You can hit the code button to reveal the code to use.

```
plot(x,p,type="h") # type "h" draws lines to the points
```



Notice the Shape: The pdf is **left skewed**. This is because there is a high success rate ($p = 0.7$) so we expect more germination than no germination.

- What is the probability that 7 or more Dixie Red seeds germinate?

$$P(X \geq 7) = P(X = 7) + P(X = 8) = 1 - P(X < 7) = 1 - P(X \leq 6)$$

$$P(X \geq 7) = \frac{8!}{7!(8-7)!}0.7^7(1-0.7)^{8-7} + \frac{8!}{8!(8-8)!}0.7^8(1-0.7)^{8-8}$$

```
dbinom(7,8,0.7)+dbinom(8,8,0.7)
```

```
[1] 0.2552983
```

```
## or
```

```
1-pbinom(6,8,0.7)
```

```
[1] 0.2552983
```

Poisson distribution

On a certain joy flight path, the number of dolphin pod sightings is 2.2 per hour. Using a Poisson model, calculate the probabilities of viewing 0 to 8 dolphin pods in the table below

- Use R to find the exact probability distribution function and all in the table.

| Number dolphin pods x | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|-------------------------|---|---|---|---|---|---|---|---|---|
| Probability $P(X = x)$ | | | | | | | | | |

```
x <- c(0,1,2,3,4,5,6,7,8) # creates x values. You can also use x <- 0:8
p <- dpois(x,2.2) #calculated the probabilities at each x and round to 3 d.p.
rbind(x,round(p,3)) # view the probabilities with x in top row and p in bottom row
```

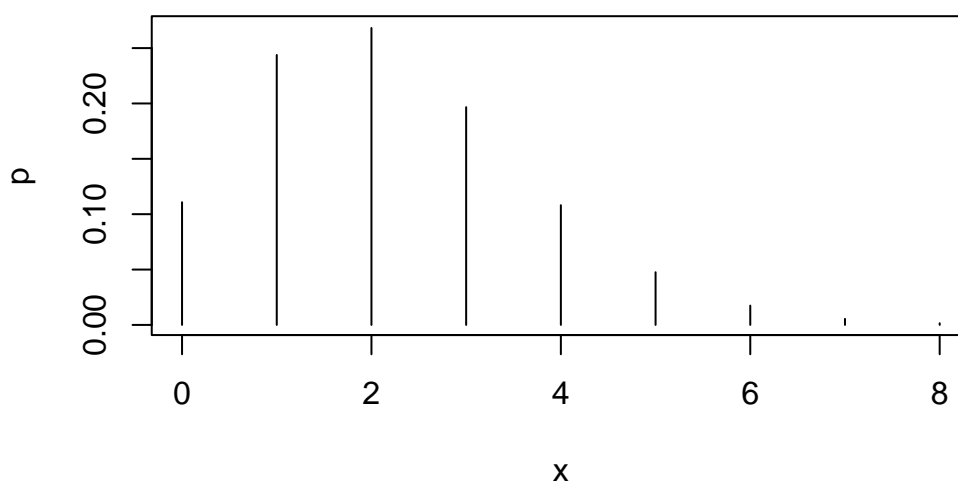
```
  [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9]
x 0.000 1.000 2.000 3.000 4.000 5.000 6.000 7.000 8.000
  0.111 0.244 0.268 0.197 0.108 0.048 0.017 0.005 0.002
```

```
sum(p) ## notice that all the probabilities don't sum to 1
```

```
[1] 0.9995305
```

- do a barplot of the probabilities

```
plot(x,p,type="h") # type "h" draws lines to the points
```



- What is the probability of seeing no dolphin pods.

$$P(X = 0) = \frac{2.2^0 e^{-2.2}}{0!} = 0.1108$$

so about 11% of the flights i.e. 1 in 10 flights you will see no dolphins

```
dpois(0,2.2)
```

```
[1] 0.1108032
```

- What is the probability of seeing more than 3 dolphin pods?

$$P(X \geq 3) = 1 - P(X = 0) - P(X = 1) - P(X = 2) - P(X = 3)$$

$$P(X \geq 3) = 1 - \frac{2.2^0 e^{-2.2}}{0!} - \frac{2.2^1 e^{-2.2}}{1!} - \frac{2.2^2 e^{-2.2}}{2!} - \frac{2.2^3 e^{-2.2}}{3!} = 0.1806476$$



```
1-dpois(0,2.2)-dpois(1,2.2)-dpois(2,2.2)-dpois(3,2.2)
```

```
[1] 0.1806476
```

```
1-ppois(3,2.2)
```

```
[1] 0.1806476
```