Activity 4

Name here

Q1.

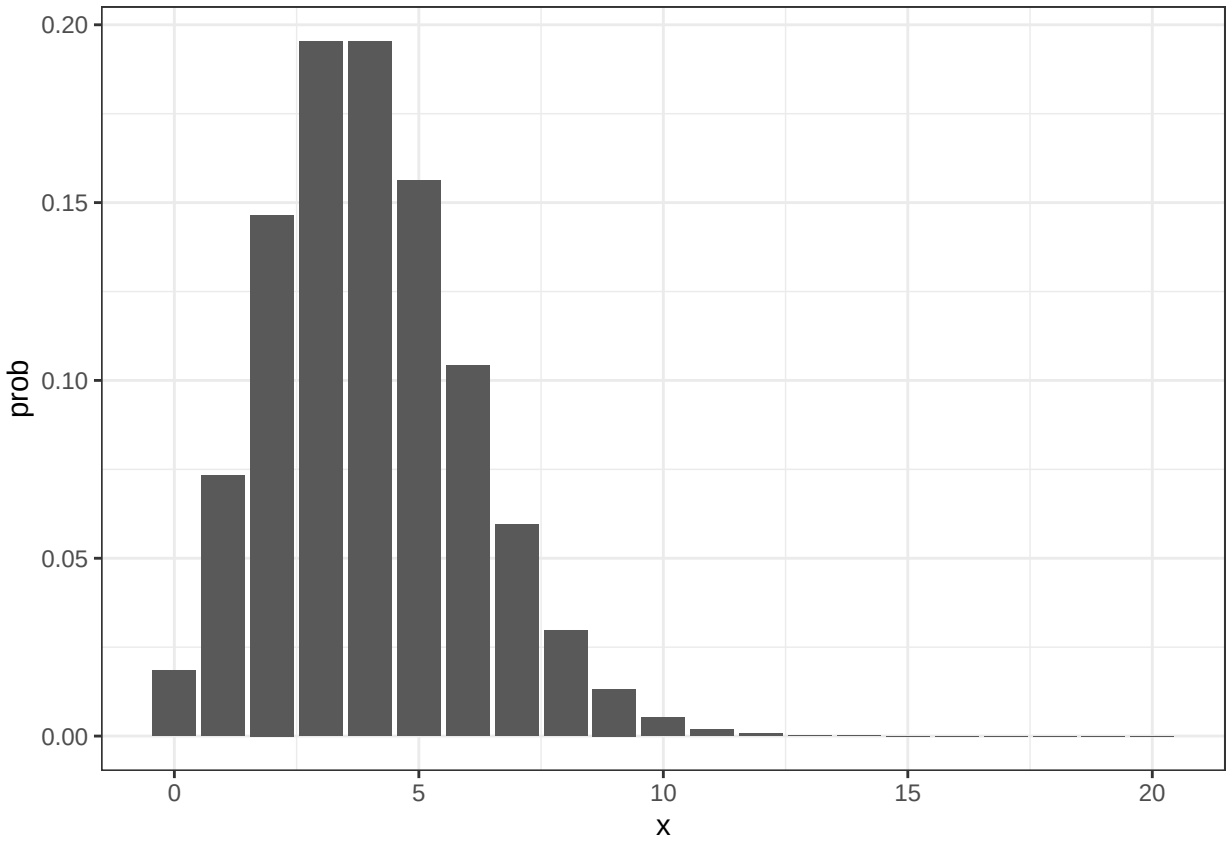
Describe the differences between probability density functions and probability mass functions.

Q2.

The highest density interval (HDI) corresponds to the shortest possible interval, for a specified probability level. What would be the 95% HDI for the following discrete distributions?

a. Poisson(4)

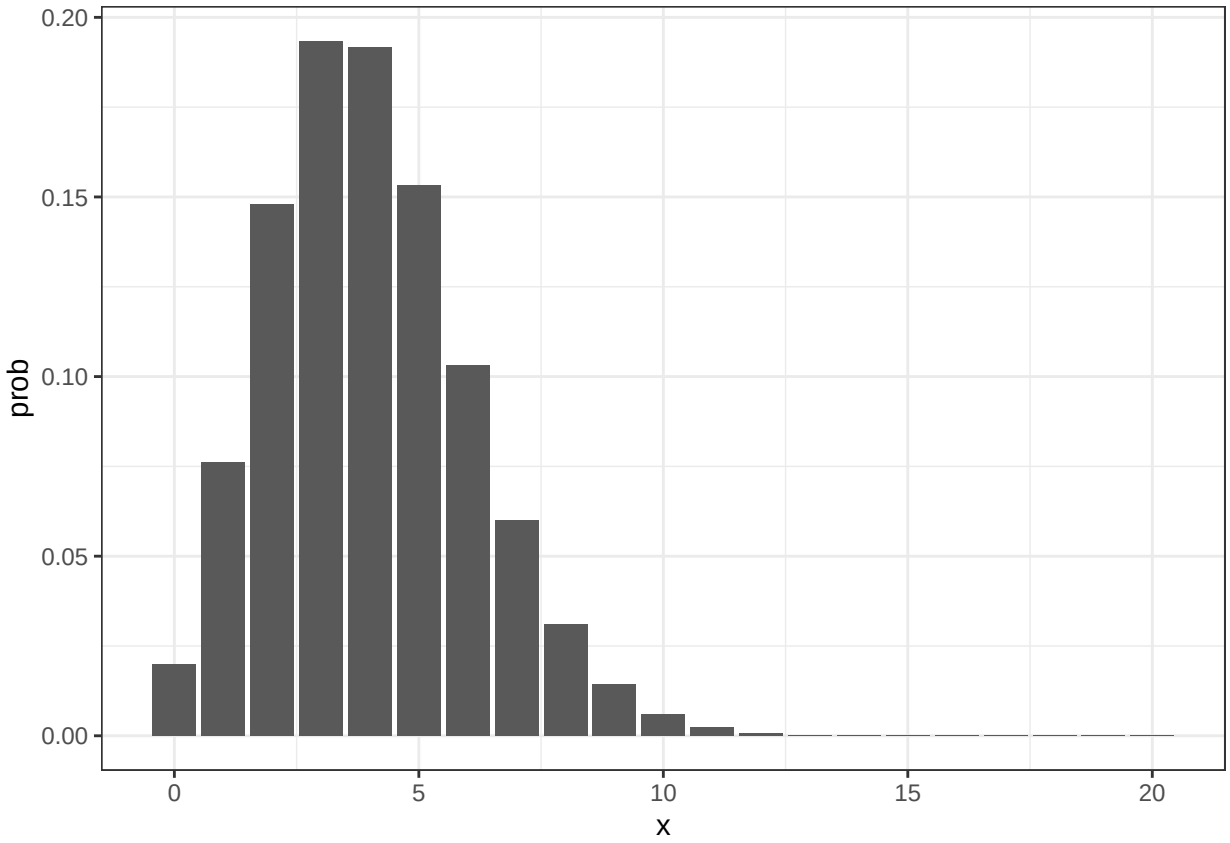
```
library(tidyverse)
x_seq <- 0:20
tibble(x = x_seq, prob = dpois(x_seq,4)) %>%
  ggplot(aes(x=x,y=prob)) + geom_col() + theme_bw()
```



This would be approximately (0, 7) (`ppois(7,4)`)

b. NB(4, 100)

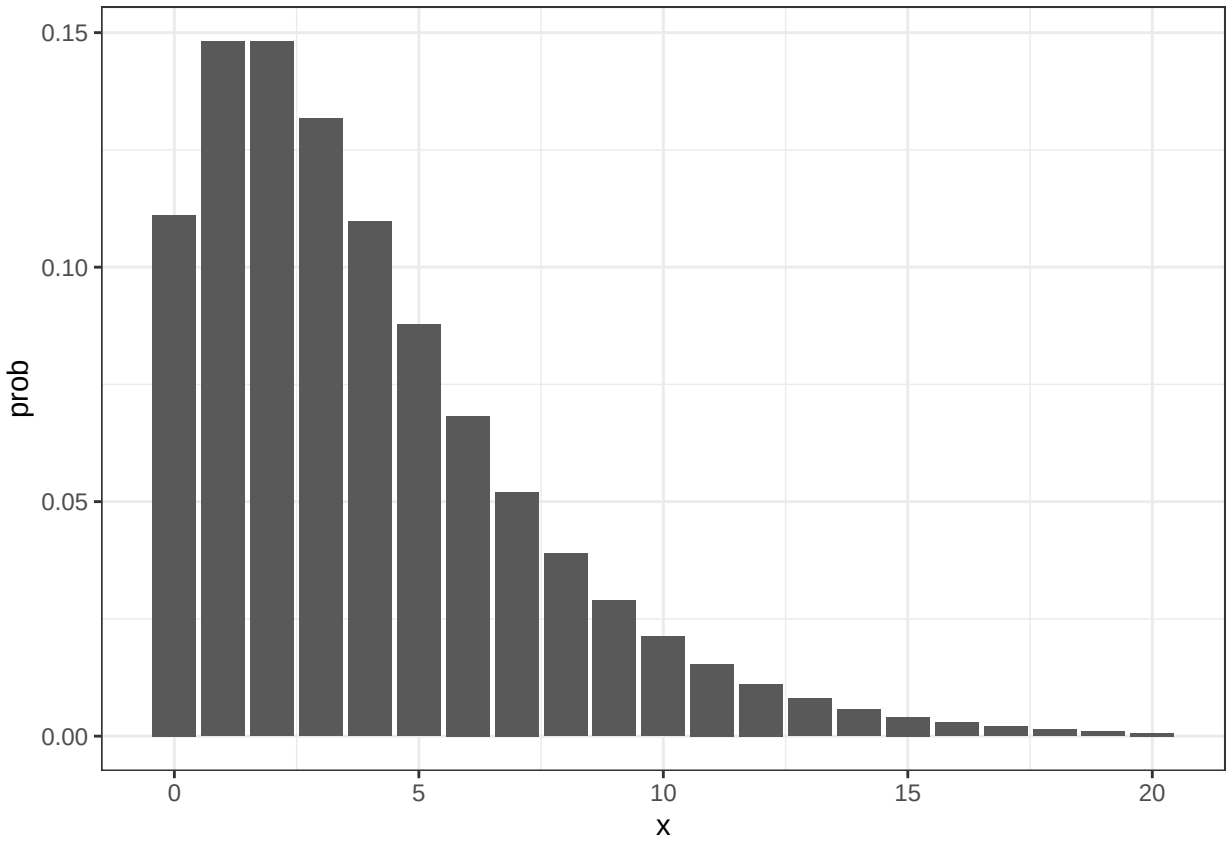
```
x_seq <- 0:20
tibble(x = x_seq, prob = dnbinom(x_seq,mu =4, size = 100)) %>%
  ggplot(aes(x=x,y=prob)) + geom_col() + theme_bw()
```



This would be approximately (0, 7) (`pnbinom(7,mu =4, size = 100)`)

c. NB(4, 1)

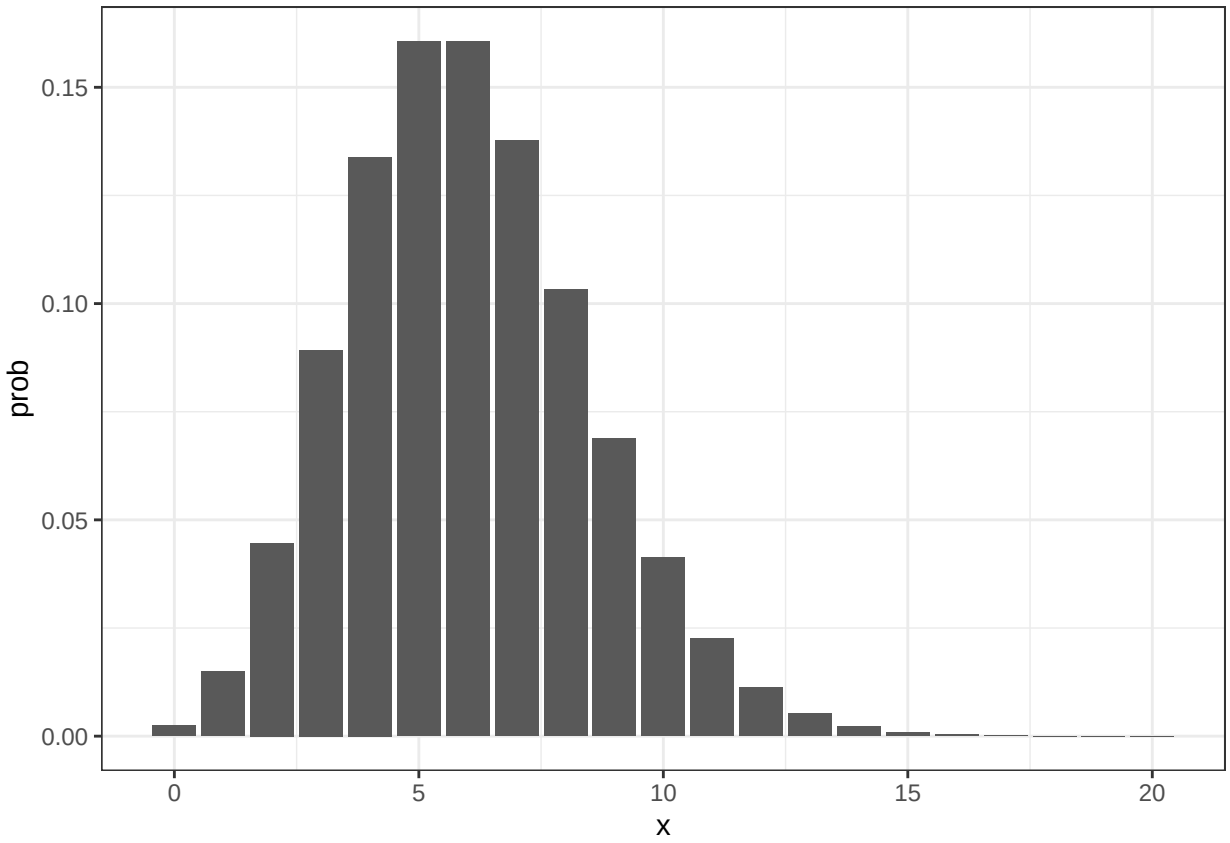
```
x_seq <- 0:20
tibble(x = x_seq, prob = dnbinom(x_seq,mu =4, size = 2)) %>%
  ggplot(aes(x=x,y=prob)) + geom_col() + theme_bw()
```



This would be approximately (0, 10) (`pnbinom(10,mu =4, size = 100)`)

2. Pois(6)

```
tibble(x = x_seq, prob = dpois(x_seq,6)) %>%
  ggplot(aes(x=x,y=prob)) + geom_col() + theme_bw()
```



This would be approximately (2, 11) (`sum(dpois(2:11,6))`)

Q3.

Use a dataset containing homes in the Seattle, WA area http://www.math.montana.edu/ahoegh/teaching/stat408/datasets/SeattleHousing.csv for this question.

```
seattle <- read_csv('http://www.math.montana.edu/ahoegh/teaching/stat408/datasets/SeattleHousing.csv') %
  mutate(bath_category = case_when(
    bathrooms <= 2 ~ '0 - 2',
    bathrooms > 2 & bathrooms <=4 ~ '2 - 4',
    bathrooms > 4 ~ 'more than 4'),
    bed_category = case_when(
    bedrooms == 0 ~ '0',
    bedrooms > 0 & bedrooms <= 2 ~ '1-2',
    bedrooms > 2 & bedrooms <= 4 ~ '3-4',
    bedrooms > 4 ~ 'more than 5'
   )
  )
```

```
## Rows: 869 Columns: 14
## -- Column specification --------------------------------------------------------
## Delimiter: ","
## dbl (14): price, bedrooms, bathrooms, sqft_living, sqft_lot, floors, waterfr...
##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

Use the two-by-two table containing bathrooms (grouped as: 0 - 2, more than 2 - 4, more than 4) and bedrooms (0, 1-2, 3-4, 5 or more).

```
table(seattle$bath_category, seattle$bed_category)
```

```
##
##                 0 1-2 3-4 more than 5
##   0 - 2         3 129 332          13
##   2 - 4         0  22 314          32
##   more than 4   0   0  10          14
```

```
round(table(seattle$bath_category, seattle$bed_category) / nrow(seattle),3)
```

```
##
##                   0   1-2   3-4 more than 5
##   0 - 2       0.003 0.148 0.382       0.015
##   2 - 4       0.000 0.025 0.361       0.037
##   more than 4 0.000 0.000 0.012       0.016
```

a. Compute marginal probability of having 0 - 2 bathrooms

The probability is 0.548

b. Compute joint probability of having 0 - 2 bathroom and 3-4 bedrooms

The probability is .382

c. Compute conditional probability of having 3-4 bedrooms given that it has 0 - 2 bathrooms

The probability is 0.697

d. Are bathrooms and bedrooms independent? Why or why not.

No the probability of the number of bedrooms depends on the number of bathrooms. In particular there are different values for parts a and c.

Q4. (DBDA 4.5B)

Use a normal curve to describe the following belief. Suppose you believe that women's heights follow a bell-shaped distribution, centered at 162 cm with about 2/3rds of all women having heights between 147 and 177. What should be the μ and σ values?

- $\mu = 162$
- $\sigma = 15$ (as about 2/3rd of observations fall within 1 sd of the mean)

Q5.

Assume your roommate has taken, and tested positive, for an at home antigen Covid test. Let's assume the test was from Cochrane (data)[https://www.cochrane.org/CD013705/INFECTN_how-accurate-are-rapid-antigen-tests-diagnosing-covid-19] with the following properties:

- P[Test = + | Disease = +] = .82
- PP[Test = - | Disease = -] = .995

a. If the overall population prevalence was 5%, what is the probability that your roommate has COVID-19?

```r
p.t.plus <- .82
p.t.minus <- 1 - .995
p.theta <- .05
p.theta.true <- p.t.plus * p.theta / (p.t.plus * p.theta + p.t.minus * (1 - p.theta))
```

The probability would be about 0.896.

b. Now assume that your other roommate took a test (with the same characteristics) and that test was negative. What is the probability the other roommate has COVID-19?

```r
p.t.plus <- .82
p.t.minus <- 1 - .995
p.theta <- .05
p.theta.neg <- (1 - p.t.plus) * (p.theta) / ((1 - p.t.minus) * (1- p.theta) + (1 - p.t.plus) * (p.theta
```

The probability would be about 0.009