Lab2CodeKey

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Prerequisite

```
# Good practice to remove all objects from the workspace
rm(list = ls())

# Use library() for packages you need, or source() for other R files.
library(tidyverse)

# Setting the seed ensures that we get the same random draw over and over again.
set.seed(20201009)

rnorm(5) # Check
```

```
## [1]  0.8315079 -0.9818884  1.1522644 -0.4687453 -0.8344489
```

0. Calculate the following operations by hand (... meaning by R)

a)

$$\sum_{i=1}^{5} i =$$

b)

$$\prod_{i=1}^{5} i =$$

c)

$$5! \times 10^{3!} \times e^4 =$$

```
# a)
sum(1:5)
```

```
## [1] 15
```

```
# b)

prod(1:5)
```

```
## [1] 120
```

```
#Check
1*2*3*4*5
```

```
## [1] 120
```

```r
# c)

factorial(5)
```

```
## [1] 120
```

```r
5*4*3*2*1
```

```
## [1] 120
```

```r
factorial(5) * 10^factorial(3) * exp(4)
```

```
## [1] 6551778004
```

1. Build a Bernoulli distribution using the sample() function, where the probability of "success" is 0.7. Run "?sample" if you are unsure how the function works.

```r
# Create an imaginary person to flip the coin once for you
sample(x = c(0, 1),
       size = 1,
       prob = c(0.3, 0.7)
       )
```

```
## [1] 1
```

2. How do you know if it is working properly? Conduct simulation to check if the assigned probabilities are matached with the empirics

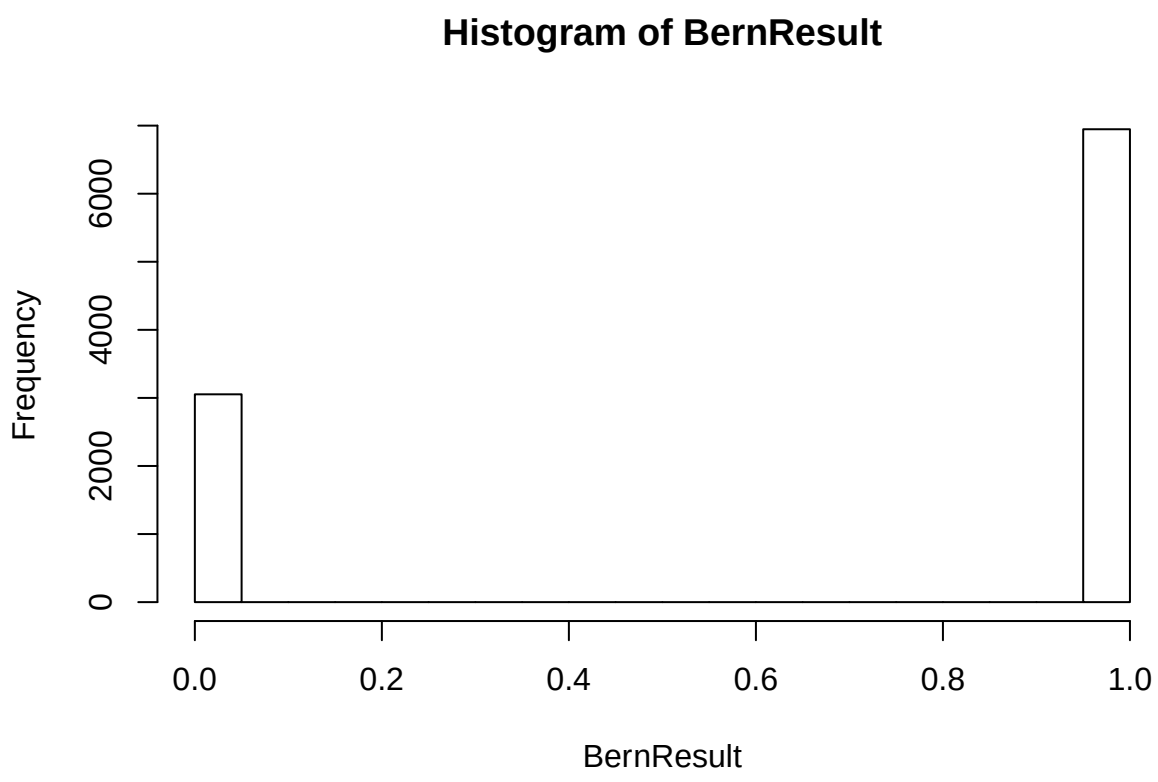
```r
# Specify the number of simulations
sims <- 10000

# Specify the probability
ProbSuccess <- 0.7

# Create an empty vector as "container"
BernResult <- vector(mode = "numeric", length = sims)

# For loop
for (i in 1:sims) {
  BernResult[i] <- sample(c(0, 1),
                          size = 1,
                          prob = c(1- ProbSuccess,
                                   ProbSuccess)
                          )
}

mean(BernResult)
```

```
## [1] 0.6947
```

```
## Faster way w/o loop...but we want to build the intuition
 sample(c(0, 1),
        size = sims,
        replace = TRUE,
        prob = c(0.3, 0.7)
        )
## Or use rbinom (rmb: bernoulli is just a special case of binomial when N = 1)
 rbinom(sims,
        size = 1,
        prob = 0.7)
```

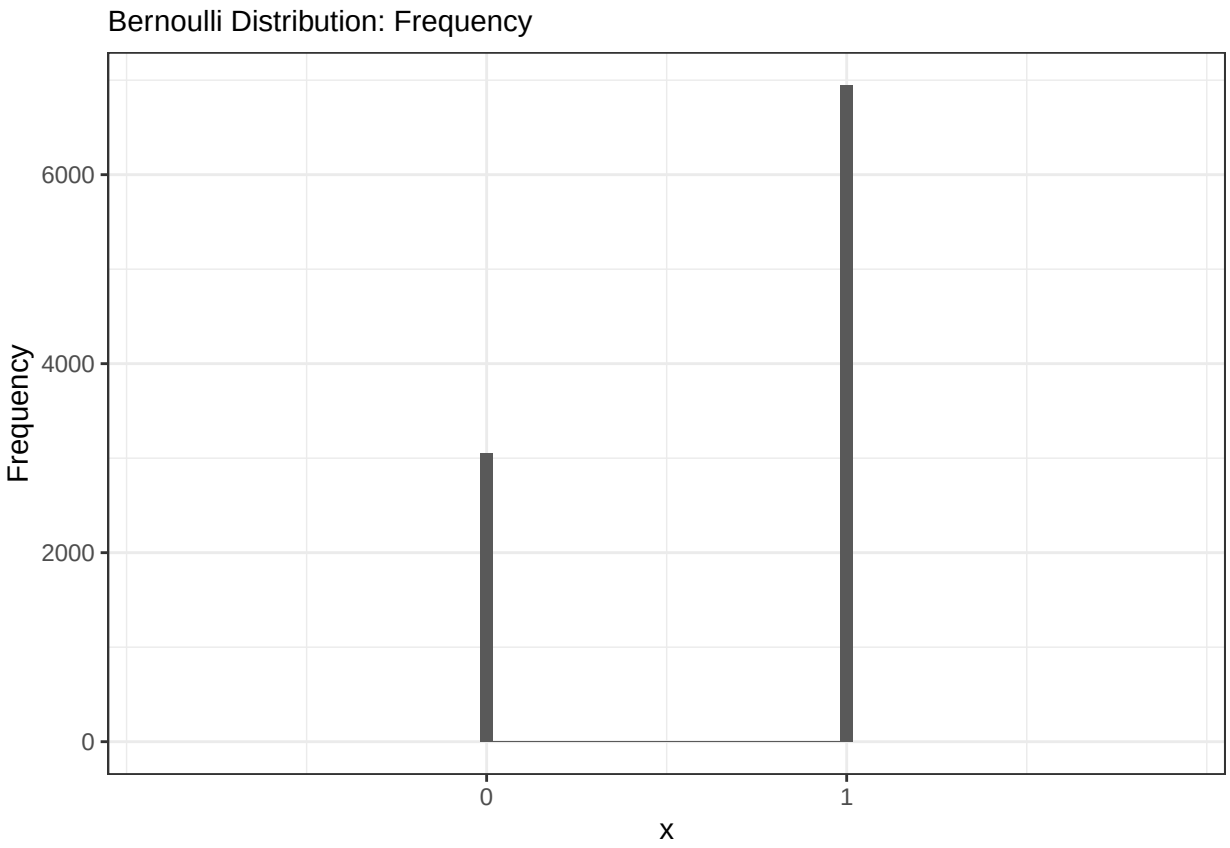
3. Plot the above Bernoulli distribution

```
# Base graphics
hist(BernResult)
```

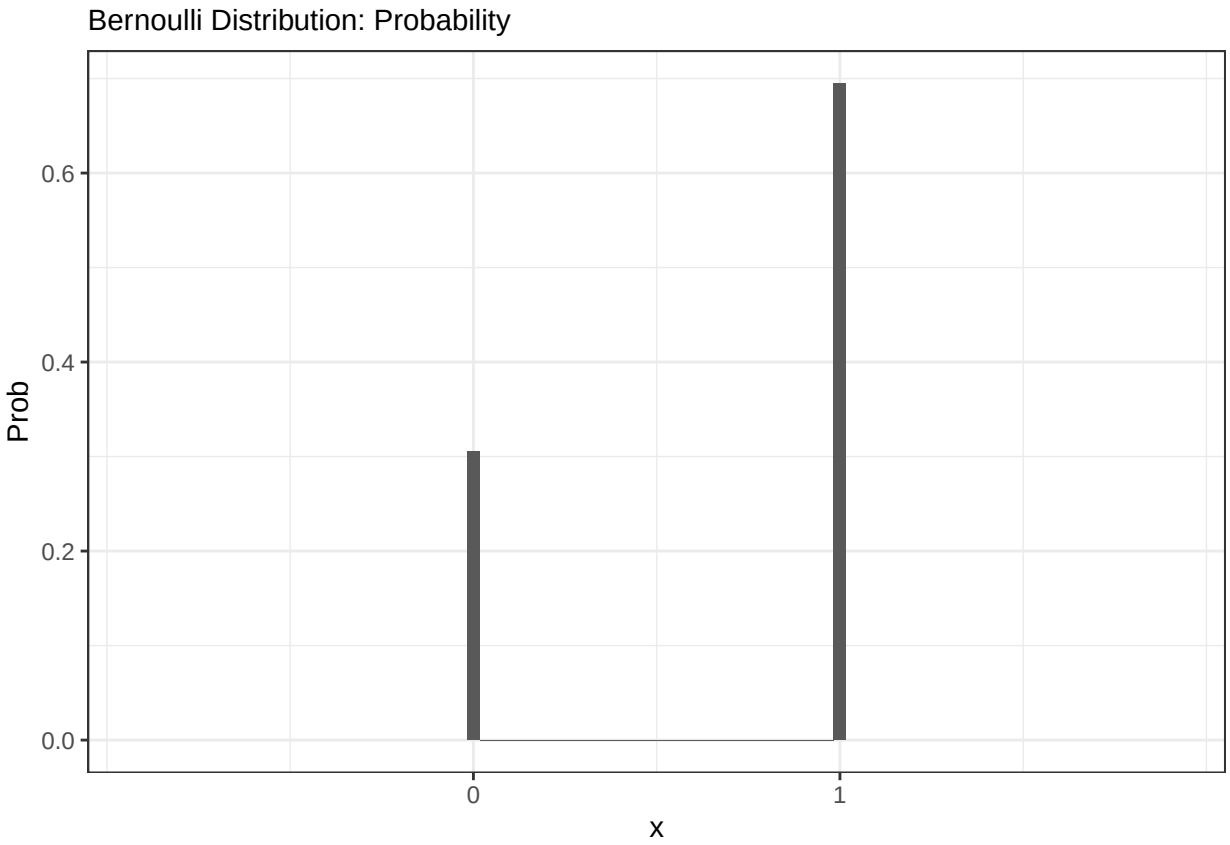



```
# ggplot2
BernDF <- tibble(Outcome = BernResult)


ggplot(BernDF, aes(x = Outcome)) +
```

```
  geom_histogram() +
  scale_x_continuous(breaks = c(0, 1), expand = c(1, 0)) +
  labs(y = "Frequency", x = "x",
       subtitle = "Bernoulli Distribution: Frequency")+
  theme_bw()
```




```
# Adding: aes(y = stat(count / sum(count))) in geom_hist ; What does it do?
ggplot(BernDF, aes(x = Outcome)) +
  geom_histogram(aes(y = stat(count/sum(count)))) +
  scale_x_continuous(breaks = c(0, 1), expand = c(1, 0)) +
  labs(y = "Prob", x = "x",
       subtitle = "Bernoulli Distribution: Probability")+
  theme_bw()
```




```
# y = stat() means...
BernResult %>%
  as_tibble %>%
  count(value) %>%
  mutate(TotalNum = sum(n),
         Prob = n/TotalNum)
```

```
## # A tibble: 2 x 4
##   value     n TotalNum  Prob
## * <dbl> <int>    <int> <dbl>
## 1     0  3053    10000 0.305
## 2     1  6947    10000 0.695
```

4. Based on the above, generate a binomial distribution, with number of trials equal to 10, without using rbinom()

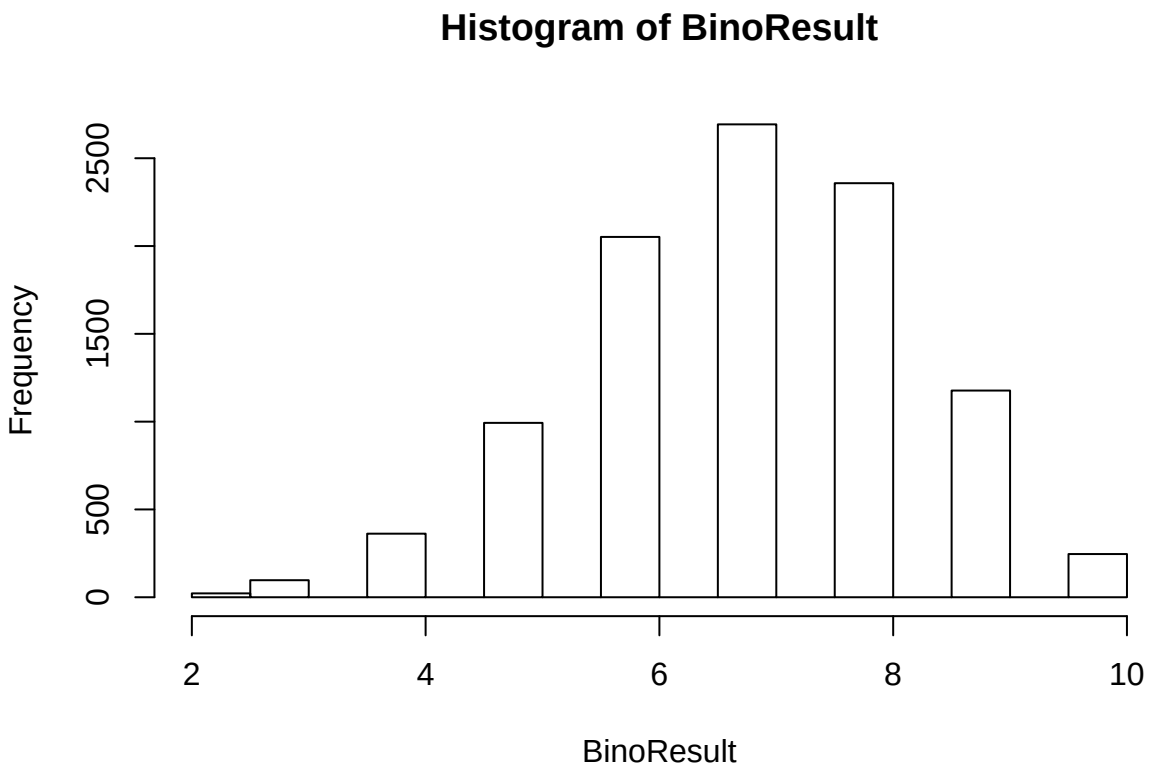
```
# Create an imaginary person to flip the coin ten times for you
# Let's test it outside of the loop:
sample(c(0, 1),
       size = 10,
       replace = TRUE,
       prob = c(1- ProbSuccess,
                ProbSuccess)
       )
```

```
##  [1] 1 0 1 0 1 1 1 1 1 1
```

```r
# Create number of simulations and an empty vector as container
BinoResult <- vector(mode = "numeric", length = sims)

for (i in 1:sims) {

  # Create an imaginary person to flip the coin ten times for you
  flips <- sample(c(0, 1),
                  size = 10,
                  replace = TRUE,
                  prob = c(1- ProbSuccess, ProbSuccess)
                  )

  # Sum up the number of "success" for that person
  count <- sum(flips)

  # Store it into the container; repeat 10,000
  BinoResult[i] <- count

}

# Faster way w/o loop and sample()...but we want to build the intuition
# rbinom(n = sims,
#        size = 10,
#        prob = ProbSuccess)
```

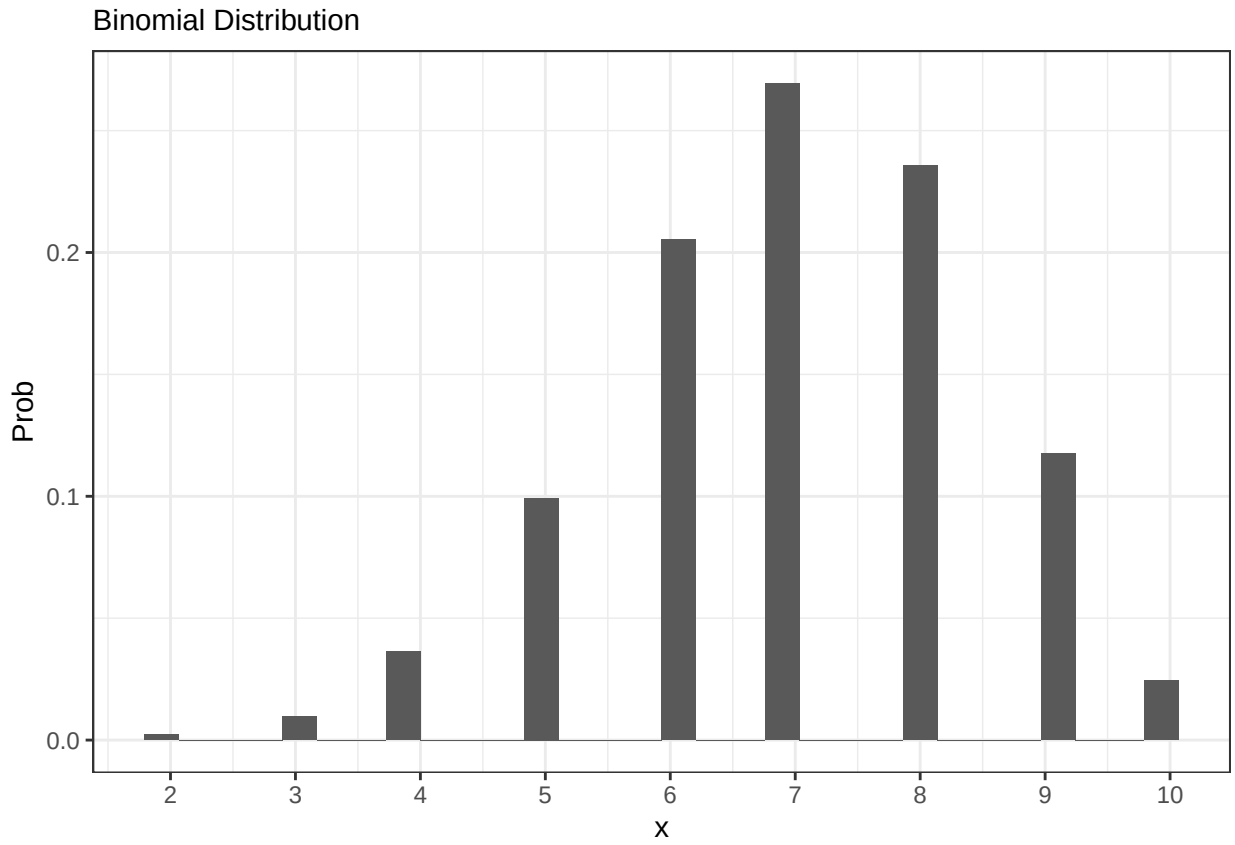
5. Plot the above binomial distribution

```r
# Base graphics
hist(BinoResult)
```




```
# ggplot2
BinoResult %>%
  as_tibble %>%  # Convert to data frame

  ggplot(aes(x = value)) +
  geom_histogram(aes(y = stat(count/sum(count)))) +
  scale_x_continuous(breaks = 1:10) +
  labs(y = "Prob", x = "x",
       subtitle = "Binomial Distribution")+
  theme_bw()
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



6. Explore the rbinom, dbinom, pbinom functions. What do they do? Answer the following questions:

a) The probability of a coin landing on head is 0.7. If you were to flip the coin 10 times, what is the probability of getting exactly 7 heads?
b) What is the probability of getting 7 heads or less?
c) How do you know (b) is true?

```
# a) Pr(exactly 7 heads) -> PDF
dbinom(x = 7, size = 10, prob = 0.7)
```

```
## [1] 0.2668279
```

```
# b) Pr(7 heads or less) -> CDF
pbinom(q = 7, size = 10, prob = 0.7)
```

```
## [1] 0.6172172
```

```
pbinom(q = 7, size = 10, prob = 0.7, lower.tail = FALSE)
```

```
## [1] 0.3827828
```

```r
1- pbinom(q = 7, size = 10, prob = 0.7)
```

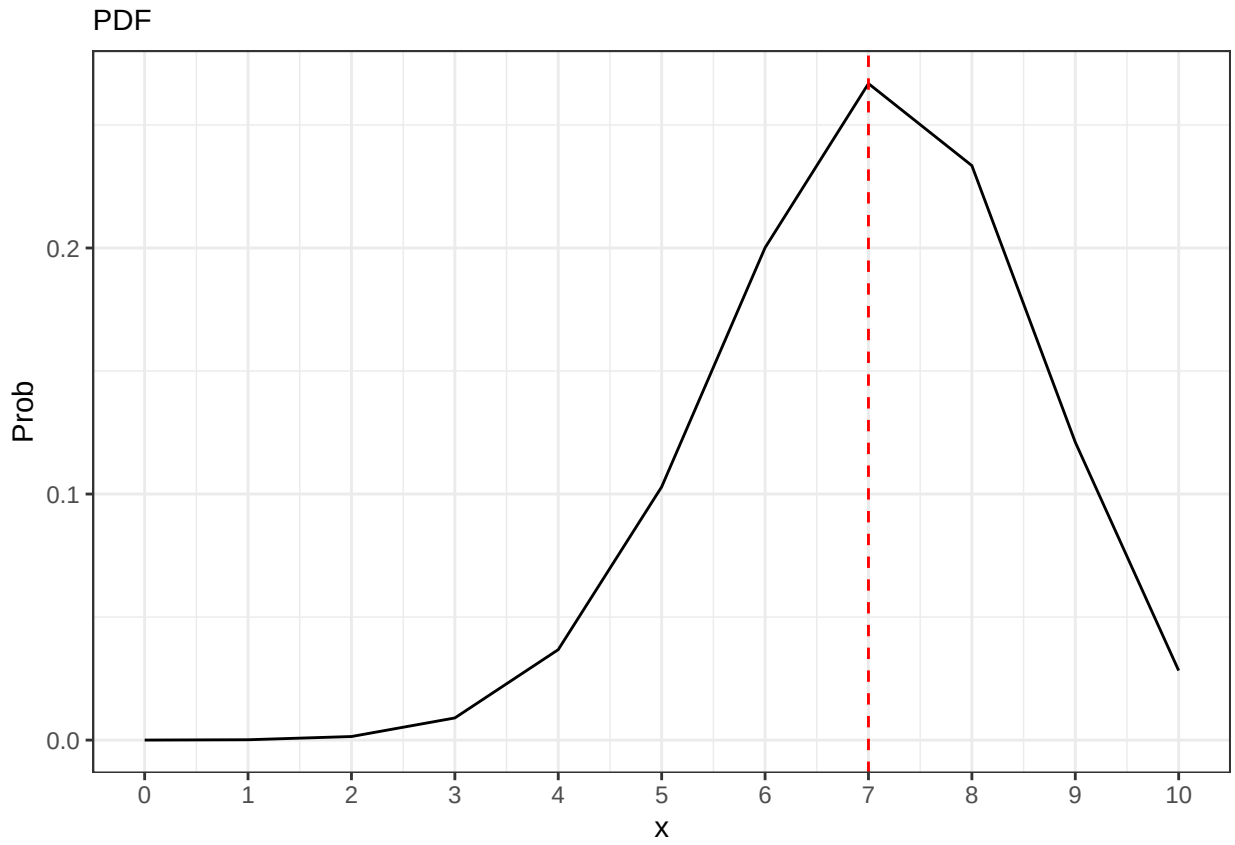
```
## [1] 0.3827828
```

```r
# c) Double check
dbinom(x = c(0:7), size = 10, prob = 0.7) %>%
  sum()
```

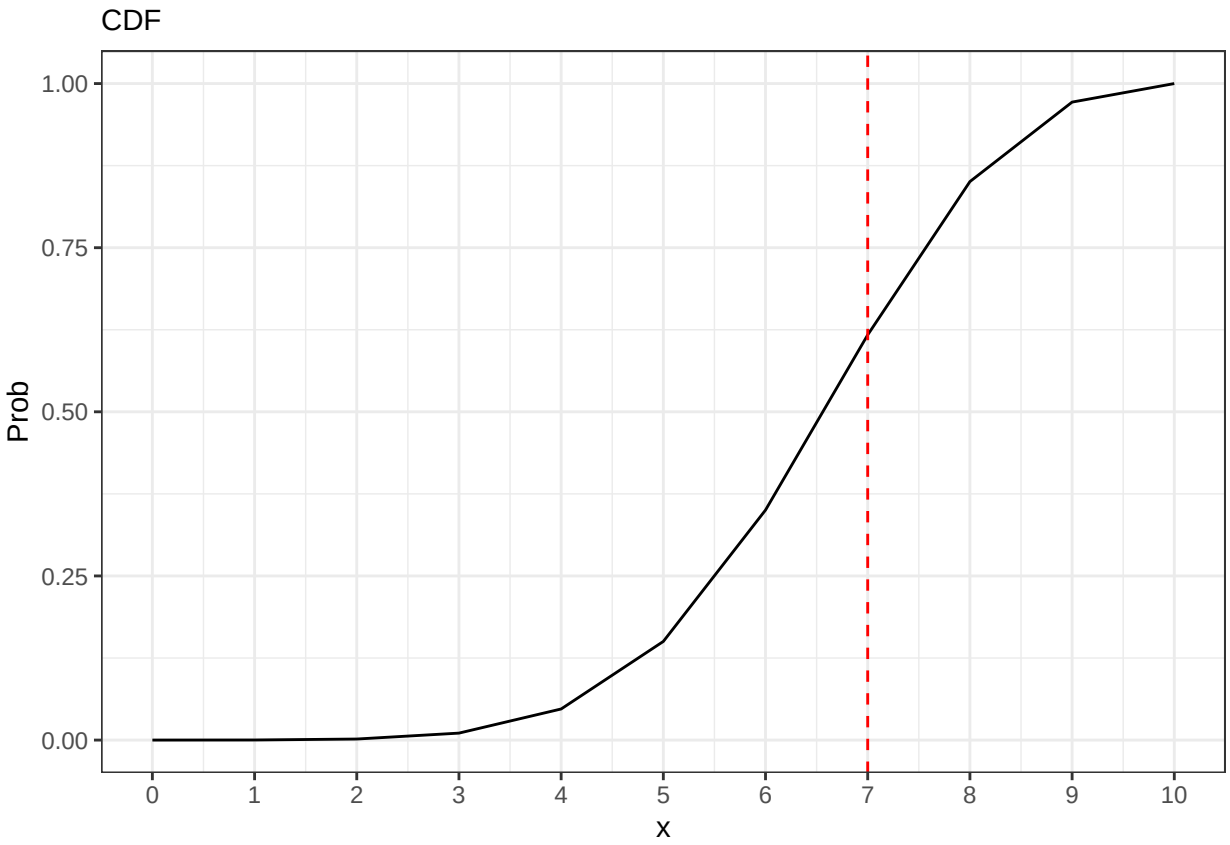
```
## [1] 0.6172172
```

How to plot?

```r
# PDF
# Create x axis in data.frame
tibble(x = seq(from = 0, to = 10, by =1)) %>%

# Create y axis
  mutate(y = dbinom(x = x, size = 10, prob = 0.7)) %>%

# Plot, map data in aesthetic
  ggplot(aes(x=x,y=y))+

# Specify the type of plot
  geom_line()+

# Specify x axis breaks
  #scale_x_continuous(breaks = 0:10)+
  scale_x_continuous(breaks = 0:10)+
# Add vertical line at x = 0.7
  geom_vline(xintercept = 7, color ="red", linetype = "dashed")+

# Change label on y axis
  labs(y="Prob", subtitle = "PDF")+

# (Optional: specify theme )
  theme_bw()
```




```
# CDF
# Create x axis in data.frame
tibble(x = seq(from = 0, to = 10, by =1)) %>%

# Create y axis
  mutate(y = pbinom(q = x, size =10, prob=.7)) %>%

# Plot, map data in aesthetic
  ggplot(aes(x=x,y=y))+

# Specify the type of plot
  geom_line()+

# Specify x axis breaks
  scale_x_continuous(breaks = 0:10)+

# Add vertical line at x = 0.7
  geom_vline(xintercept = 7, color ="red", linetype = "dashed")+

# Change label on y axis
  labs(y="Prob", subtitle = "CDF")+

# (Optional: specify theme )
  theme_bw()
```


CDF
Prob
1.00
0.75
0.50
0.25
0.00
0
1
2
3
4
5
6
7
8
9
10
x