Lab 1 Probability Distributions

Rachakonda Hrithik Sagar

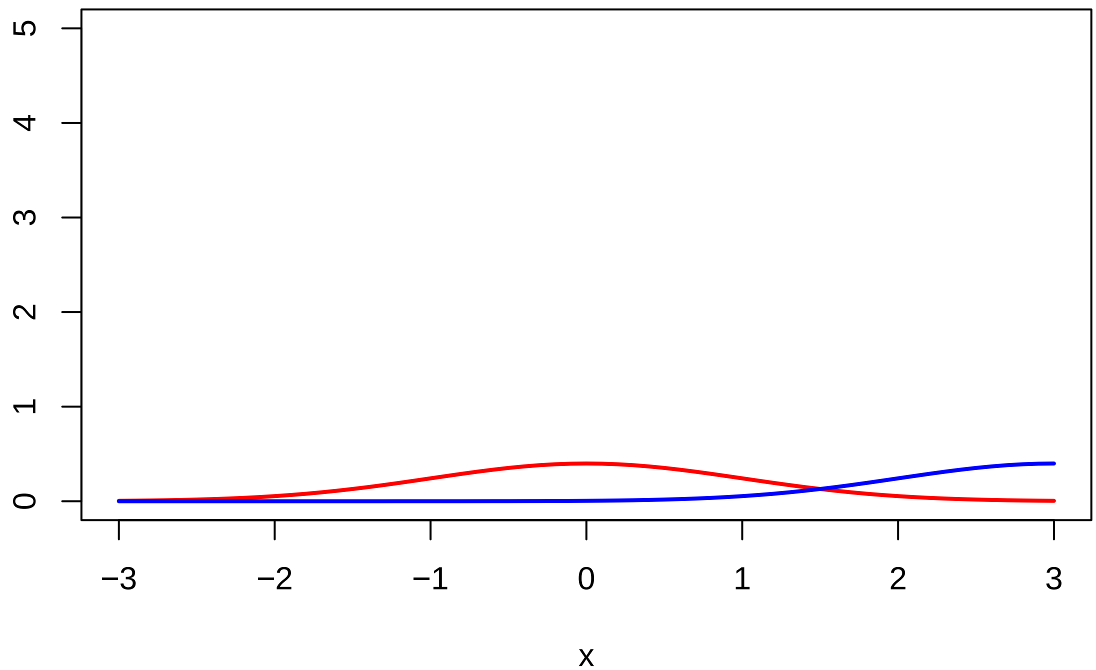
19/1/2026

Contents

Lab 1 Lab Manual Exercise

copy and paste your work by following each example from the lab manual for this exercise

```r
rm(list = setdiff(ls(), lsf.str()))

# Plot Normal Distributions with
#-----------------------------------------
# Same standard deviation, different mean
#-----------------------------------------
# Mean 1, sd 1
# Grid of X-axis values
x <- seq(-3, 3, 0.1)

plot(x, dnorm(x, mean = 0, sd = 1), type = "l",
     ylim = c(0, 5), ylab = "", lwd = 2, col = "red")
# Mean 3, sd 1
lines(x, dnorm(x, mean = 3, sd = 1), col = "blue", lty = 1, lwd = 2)
```




```r
# # Function Syntax
#
# function_name <- function(arg_1, arg_2, ...) {
#    Function body
# }
```

```r
# Calculate the 60th %ile of the standard normal.
qnorm(0.6,0,1)
```

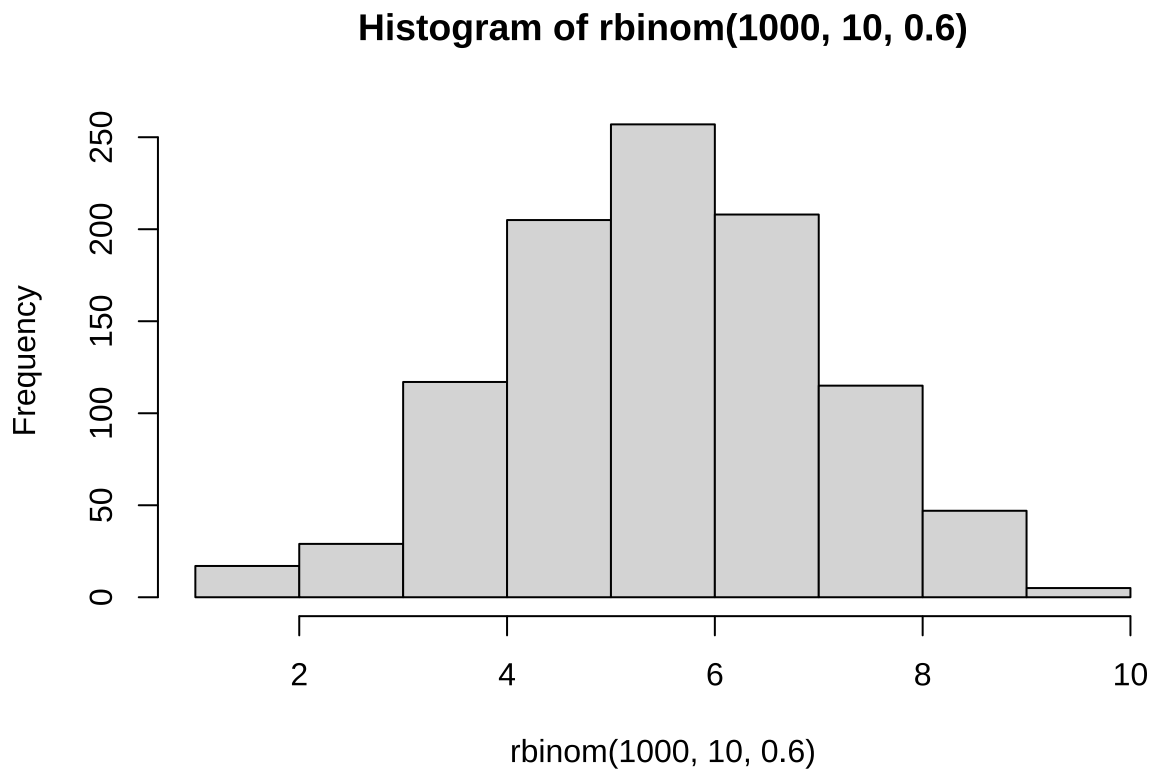
```
## [1] 0.2533471
```

```r
# Calculate the probability that a value lies below 0.8 in the standard normal distribution
pnorm(0.8,0,1)
```

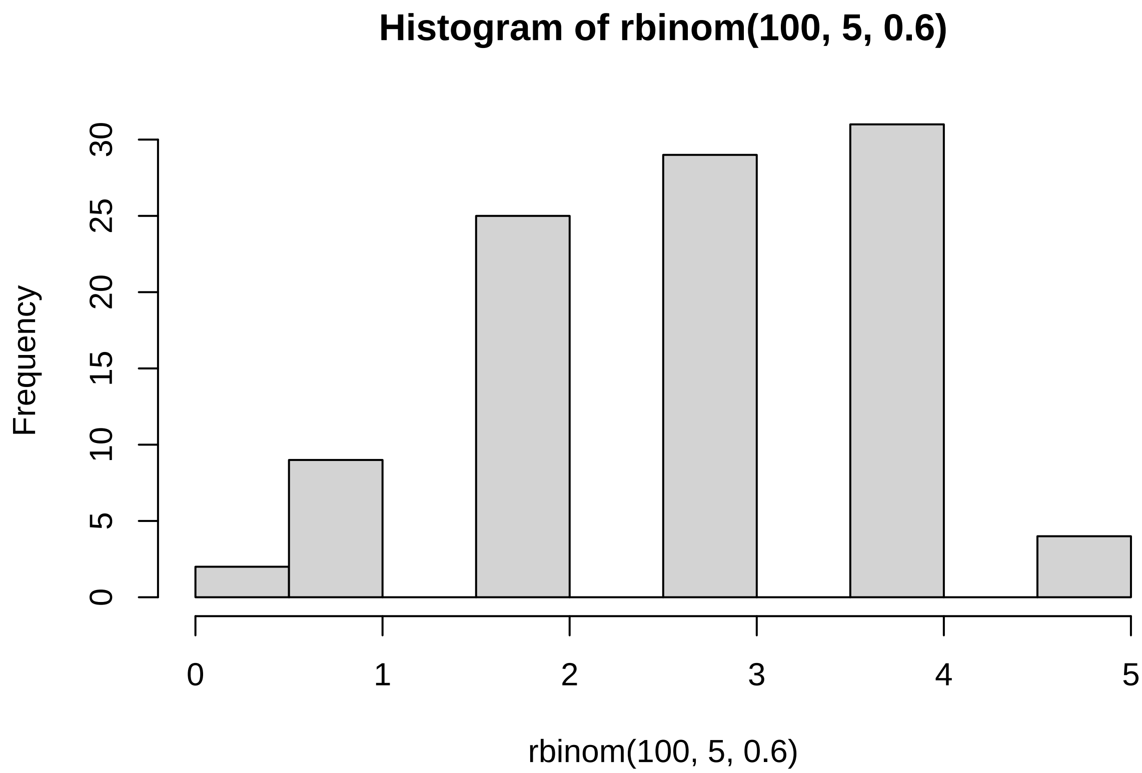
```
## [1] 0.7881446
```

```r
# Draw 1000 samples of 30 coin tosses with p(heads) = 0.6 # and plot the distribution
# Syntax: rbinom (# observations, # trials per observation, probability of success )
hist(rbinom(1000,30,0.6))
```

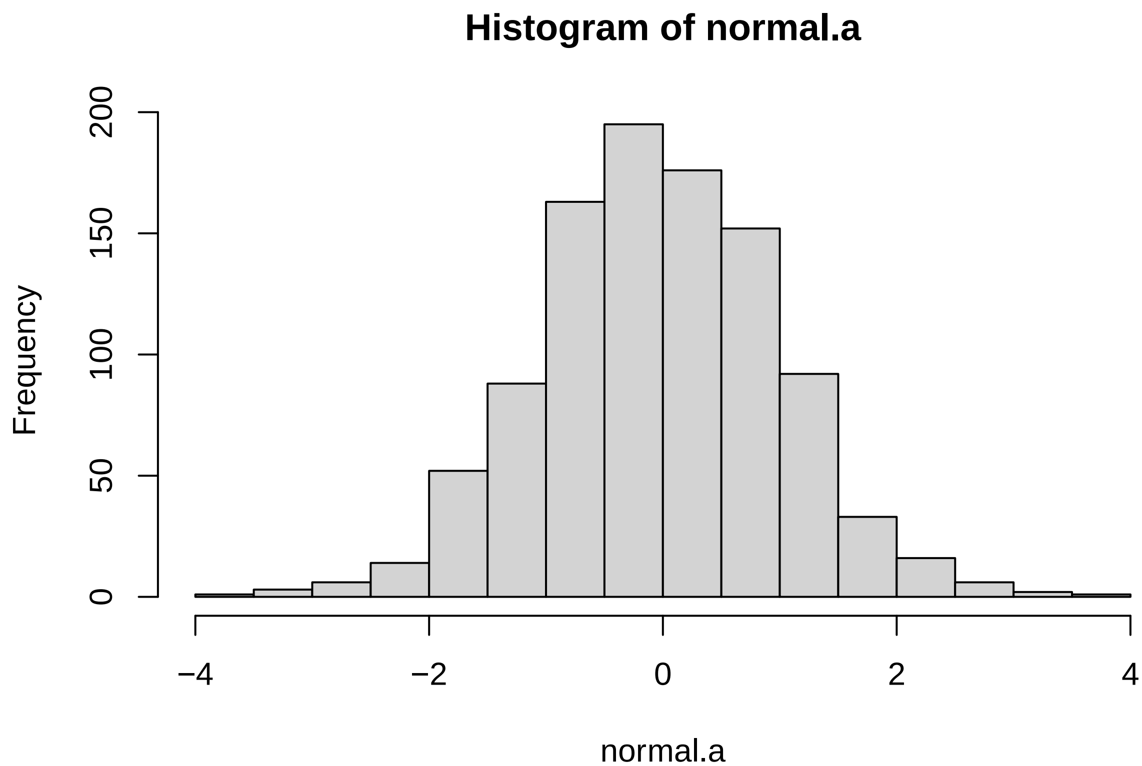

```r
# Do the above with only 10 trials per observation
hist(rbinom(1000,10,0.6))
```



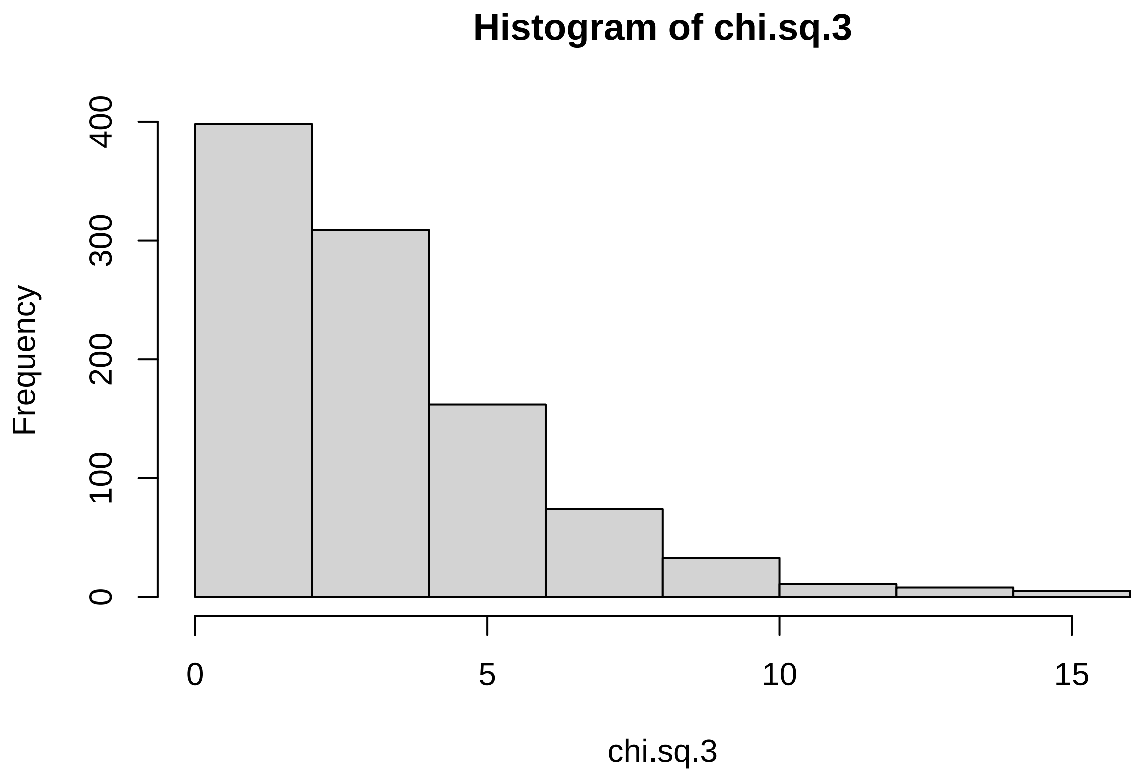

```r
# Do the above with 100 observations and 5 trials per observation
hist(rbinom(100,5,0.6))
```



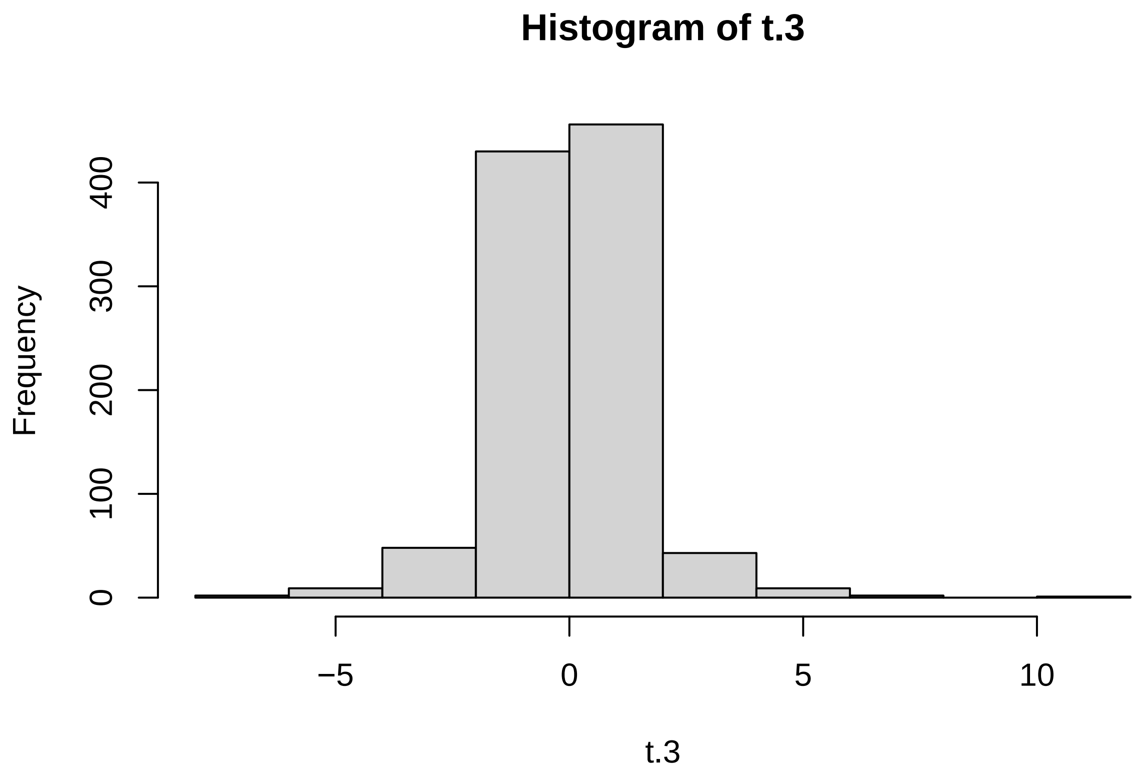

```r
# Transformations between probability distributions

# generate 1000 trials from a normal distribution
normal.a <- rnorm( n=1000, mean=0, sd=1 )
hist( normal.a )
```



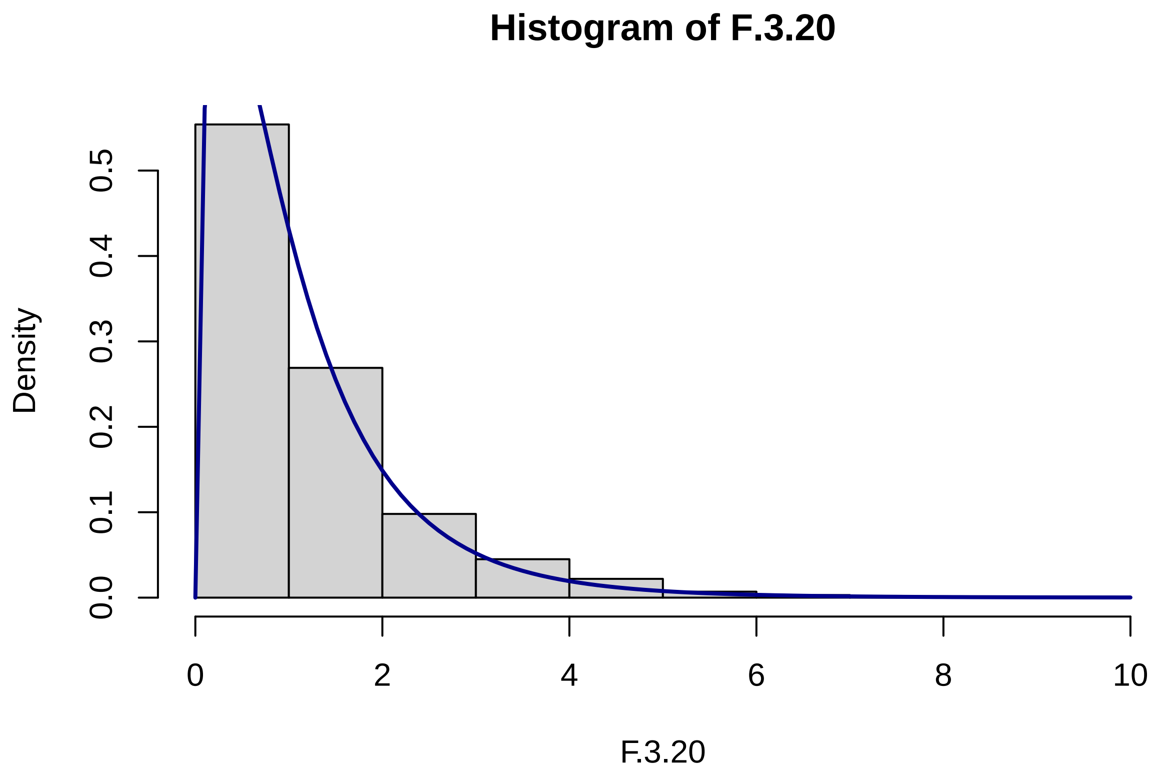

```
#next, we generate a chi-square distribution with 3 #degrees of freedom:

normal.b <- rnorm( n=1000 )  # another set of normally distributed data
normal.c <- rnorm( n=1000 )  # and another!

# Take the SUM of SQUARES of the above 3 normally distributed variables a, b, and c
chi.sq.3 <- (normal.a)^2 + (normal.b)^2 + (normal.c)^2

# and the resulting chi.sq.3 variable should contain 1000 observations that follow a chi-square distrib

hist(chi.sq.3)
```




```
## Now how do we get to a t-distribution from Normal and chi-sq distributions?
# First, take a scaled chi-sq by dividing it by the degrees of freedom
scaled.chi.sq.3 <- chi.sq.3 / 3
# Then take a normally distributed variable and divide them by the square root of the scaled chi-sq var

normal.d <- rnorm( n=1000 )                 # yet another #set of normally distributed data
t.3 <- normal.d / sqrt( scaled.chi.sq.3 )  # divide by #square root of scaled chi-square to get t
hist (t.3)
```




```r
## To get to an F distribution, take the ratio between two scaled chi-sq distributions.
# F distribution with 3 and 20 degrees of freedom:
# first take two chi-sq variables, with 3 dof and 20 dof respectively, and take the ratio:

chi.sq.20 <- rchisq( 1000, 20)                   # generate chi square data with df = 20...
scaled.chi.sq.20 <- chi.sq.20 / 20               # scale #the chi square variable...
F.3.20 <-  scaled.chi.sq.3  / scaled.chi.sq.20 # take the ratio of the two chi squares...
hist( F.3.20, freq = FALSE)                                # ... and draw a picture
curve(df(x, 3, 20),
      col="darkblue", lwd=2, add=TRUE, yaxt="n")
```




```
## The curve above confirms this looks similar if you use the R built-in function df (just like dnorm, 
```

Lab 1 Generalization exercises

use the code from above to attempt to solve the extra things we ask you do for this assignment

```
# Q1 Plot a normal distribution with mean = 2, s.d. = 0.4

# Q2 Calculate the 85th %ile of the above distribution.

# Q3 Calculate the probability that a value lies in between 1 and 2 given the above distribution
```

Lab 1 Written answer question

Write your answer here.

Answers (@RachakondaHrithikSagar)

Q1 Plot a normal distribution with mean = 2, s.d. = 0.4

```r
png("q1_normal_mean2_sd0.4.png", width = 800, height = 600, res = 120)
x <- seq(2 - 4*0.4, 2 + 4*0.4, by = 0.01)
# Plot
plot(x, dnorm(x, mean = 2, sd = 0.4),
     type = "l", lwd = 2,
     main = "Normal Distribution (mean=2, sd=0.4)",
     xlab = "x", ylab = "Density")
x
```

```
##   [1] 0.40 0.41 0.42 0.43 0.44 0.45 0.46 0.47 0.48 0.49 0.50 0.51 0.52 0.53 0.54
##  [16] 0.55 0.56 0.57 0.58 0.59 0.60 0.61 0.62 0.63 0.64 0.65 0.66 0.67 0.68 0.69
##  [31] 0.70 0.71 0.72 0.73 0.74 0.75 0.76 0.77 0.78 0.79 0.80 0.81 0.82 0.83 0.84
##  [46] 0.85 0.86 0.87 0.88 0.89 0.90 0.91 0.92 0.93 0.94 0.95 0.96 0.97 0.98 0.99
##  [61] 1.00 1.01 1.02 1.03 1.04 1.05 1.06 1.07 1.08 1.09 1.10 1.11 1.12 1.13 1.14
##  [76] 1.15 1.16 1.17 1.18 1.19 1.20 1.21 1.22 1.23 1.24 1.25 1.26 1.27 1.28 1.29
##  [91] 1.30 1.31 1.32 1.33 1.34 1.35 1.36 1.37 1.38 1.39 1.40 1.41 1.42 1.43 1.44
## [106] 1.45 1.46 1.47 1.48 1.49 1.50 1.51 1.52 1.53 1.54 1.55 1.56 1.57 1.58 1.59
## [121] 1.60 1.61 1.62 1.63 1.64 1.65 1.66 1.67 1.68 1.69 1.70 1.71 1.72 1.73 1.74
## [136] 1.75 1.76 1.77 1.78 1.79 1.80 1.81 1.82 1.83 1.84 1.85 1.86 1.87 1.88 1.89
## [151] 1.90 1.91 1.92 1.93 1.94 1.95 1.96 1.97 1.98 1.99 2.00 2.01 2.02 2.03 2.04
## [166] 2.05 2.06 2.07 2.08 2.09 2.10 2.11 2.12 2.13 2.14 2.15 2.16 2.17 2.18 2.19
## [181] 2.20 2.21 2.22 2.23 2.24 2.25 2.26 2.27 2.28 2.29 2.30 2.31 2.32 2.33 2.34
## [196] 2.35 2.36 2.37 2.38 2.39 2.40 2.41 2.42 2.43 2.44 2.45 2.46 2.47 2.48 2.49
## [211] 2.50 2.51 2.52 2.53 2.54 2.55 2.56 2.57 2.58 2.59 2.60 2.61 2.62 2.63 2.64
## [226] 2.65 2.66 2.67 2.68 2.69 2.70 2.71 2.72 2.73 2.74 2.75 2.76 2.77 2.78 2.79
## [241] 2.80 2.81 2.82 2.83 2.84 2.85 2.86 2.87 2.88 2.89 2.90 2.91 2.92 2.93 2.94
## [256] 2.95 2.96 2.97 2.98 2.99 3.00 3.01 3.02 3.03 3.04 3.05 3.06 3.07 3.08 3.09
## [271] 3.10 3.11 3.12 3.13 3.14 3.15 3.16 3.17 3.18 3.19 3.20 3.21 3.22 3.23 3.24
## [286] 3.25 3.26 3.27 3.28 3.29 3.30 3.31 3.32 3.33 3.34 3.35 3.36 3.37 3.38 3.39
## [301] 3.40 3.41 3.42 3.43 3.44 3.45 3.46 3.47 3.48 3.49 3.50 3.51 3.52 3.53 3.54
## [316] 3.55 3.56 3.57 3.58 3.59 3.60
```

```r
dev.off()
```

```
## pdf
##   2
```

Q2 Calculate the 85th %ile of the above distribution.

```r
q85 <- qnorm(0.85, mean = 2, sd = 0.4)
q85
```

```
## [1] 2.414573
```

Q2 ANS) 2.414573

Q3 Calculate the probability that a value lies in between 1 and 2 given the above distribution

```r
p_between_1_and_2 <- pnorm(2, mean = 2, sd = 0.4) - pnorm(1, mean = 2, sd = 0.4)
p_between_1_and_2
```

```
## [1] 0.4937903
```

Q3 ANS) 0.4937903

Q4 Plot a simulated t-distribution with 5 degrees of freedom.

```r
png("q4_t_distribution_df5.png", width = 800, height = 600, res = 120)
t_sim <- rt(10000, df = 5)
hist(t_sim, breaks = 50, freq = FALSE,
     main = "Simulated t-distribution (df = 5)",
     xlab = "t values", col = "lightgray", border = "white")

curve(dt(x, df = 5), add = TRUE, lwd = 2, col = "darkblue")
dev.off()
```

```
## pdf
##   2
```