PSTAT 126

Lab 1

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Spring 2021

R Review

Have 2 options on how to use Rstudio

1) Use the "RStudio on Cloud link" on the home page of Gauchospace.
2) Use Rstudio on your own local computer.

First Download R, then Rstudio.

- **R for Mac**: https://cran.r-project.org/bin/macosx/
- **R for windows**: https://cran.r-project.org/bin/windows/base/
- **RStudio** download: https://www.rstudio.com/products/rstudio/download/

How to install packages

```
install.packages("alr4")
install.packages(pkgs =  c("faraway", "tidyverse"))
```

- OR go to the *packages* pane click on *install* then type in package name(s) and click install.

How to load packages

```
library(alr4)
library(faraway)
```

- OR go to the *packages* pane click on the white box next to the package you are trying to load.

help

```
?seq # fast way to go the help page for a function
help(seq) # another way to go to help page for function
```

Vectors

```r
x <- c(1,2,3,4,5)
(x <- 1:5) # can assign and print out object by putting() around code.
```

```
## [1] 1 2 3 4 5
```

```r
seq(from = 1, to = 5, by = 1) # sequence of numbers starting from 1 until 5 by 1
```

```
## [1] 1 2 3 4 5
```

```r
seq(from = 2, to = 10 , by = 2) # sequence of numbers starting from 2 until 10 by 2
```

```
## [1]  2  4  6  8 10
```

```r
seq(1,5,1)
```

```
## [1] 1 2 3 4 5
```

A few other useful functions

```r
rep(3,times=5) # repeats 3 five times
```

```
## [1] 3 3 3 3 3
```

```r
rev(x) # reverse the order of your vector
```

```
## [1] 5 4 3 2 1
```

```r
abs(-8) # absolute value
```

```
## [1] 8
```

```r
log(3) # natural log
```

```
## [1] 1.098612
```

```r
exp(1) # e^()
```

```
## [1] 2.718282
```

```r
summary(x) # prints out 5 number summary along with mean
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##       1       2       3       3       4       5
```

```r
sample(x, 1) # takes a random sample of size 1
```

```
## [1] 3
```

Strings:

```r
y <- "PSTAT 126" # use "" for strings
y
```

```
## [1] "PSTAT 126"
```

```r
class(y) # strings are referred to as characters in R
```

```
## [1] "character"
```

```r
paste("Hello", "World") # a way to put 2 strings together
```

```
## [1] "Hello World"
```

Working with vectors

```
x <- 8:18
x
```

```
##  [1]  8  9 10 11 12 13 14 15 16 17 18
```

```
x[2] # print out second element
```

```
## [1] 9
```

```
x[2] <- 19 # reassign second element
x[2] # print out second element
```

```
## [1] 19
```

```
x[2:5] # print out second to the fifth element
```

```
## [1] 19 10 11 12
```

```
x[c(2,5)] # print out the 2nd and 5th elements
```

```
## [1] 19 12
```

```
length(x) # length of vector
```

```
## [1] 11
```

```
x <- c(2,5,7,9)
x+1 # add 1 to every element in the vector
```

```
## [1]  3  6  8 10
```

```
x/2 # divide every element by 2
```

```
## [1] 1.0 2.5 3.5 4.5
```

```
x*2 # multiply every element by 2
```

```
## [1]  4 10 14 18
```

```
x^2 # square every element
```

```
## [1]  4 25 49 81
```

```
x**2 # another way to square every element
```

```
## [1]  4 25 49 81
```

```
sum(x) # Sum all vector elements
```

```
## [1] 23
```

```
x[4] <- NA # assign the 4th element in the vector as a missing value
sum(x) # does not work with missing values
```

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

```
sum(x, na.rm = TRUE) # use argument na.rm to remove missing values
```

```
## [1] 14
```

```
x <- 2:4
prod(x) # Multiply all vector elements
```

```
## [1] 24
```

```
x <- 5:9
sqrt(x) # square root each element
```

```
## [1] 2.236068 2.449490 2.645751 2.828427 3.000000
```

And some more useful functions

```
mean(x) # mean
```

```
## [1] 7
```

```
sd(x) # standard deviation
```

```
## [1] 1.581139
```

```
var(x) # variance
```

```
## [1] 2.5
```

```
sort(x) # sort the vector in ascending order
```

```
## [1] 5 6 7 8 9
```

```
sort(x, decreasing = TRUE) # sort the vector in descending order
```

```
## [1] 9 8 7 6 5
```

```
min(x) # minimum value for the vector
```

```
## [1] 5
```

```
max(x) # maximum value for the vector
```

```
## [1] 9
```

```
range(x) # range (min max)
```

```
## [1] 5 9
```

```
x <- sqrt(x)
x
```

```
## [1] 2.236068 2.449490 2.645751 2.828427 3.000000
```

```
round(x, 2) # how to round values
```

```
## [1] 2.24 2.45 2.65 2.83 3.00
```

Matrices

```
(mat <- matrix(c(3,2,5,3,1,4,7,4,9), nrow = 3))
```

```
##      [,1] [,2] [,3]
## [1,]    3    3    7
## [2,]    2    1    4
## [3,]    5    4    9
```

```
mat[2,2]
```

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

```r
mat[2,2]<-100
sqrt(mat) # square root of each element in matrix
```

```
##          [,1]      [,2]     [,3]
## [1,] 1.732051  1.732051 2.645751
## [2,] 1.414214 10.000000 2.000000
## [3,] 2.236068  2.000000 3.000000
```

```r
mat^2 # square of each entry in matrix
```

```
##      [,1]  [,2] [,3]
## [1,]    9     9   49
## [2,]    4 10000   16
## [3,]   25    16   81
```

```r
mat%*%mat # matrix multiplication
```

```
##      [,1]  [,2] [,3]
## [1,]   50   337   96
## [2,]  226 10022  450
## [3,]   68   451  132
```

```r
solve(mat) # Matrix inversion for non-singular matrices
```

```
##              [,1]         [,2]         [,3]
## [1,] -1.124681934 -0.001272265  0.875318066
## [2,] -0.002544529  0.010178117 -0.002544529
## [3,]  0.625954198 -0.003816794 -0.374045802
```

```r
diag(mat) # extract the diagonal elements of the matrix
```

```
## [1]   3 100   9
```

```r
mat
```

```
##      [,1] [,2] [,3]
## [1,]    3    3    7
## [2,]    2  100    4
## [3,]    5    4    9
```

```r
t(mat) # transpose of matrix
```

```
##      [,1] [,2] [,3]
## [1,]    3    2    5
## [2,]    3  100    4
## [3,]    7    4    9
```

```r
sum(mat) # sum of all entries in matrix
```

```
## [1] 137
```

```r
mat[2,] # extract second row of matrix
```

```
## [1]   2 100   4
```

```r
sum(mat[2,]) # sum up all the element of the second row of the matrix
```

```
## [1] 106
```

```r
mat[2,] <- c(2,5,10)
mat
```

```
##      [,1] [,2] [,3]
## [1,]    3    3    7
## [2,]    2    5   10
## [3,]    5    4    9
```

Working with data sets

```
data('faithful')
?faithful # information on the dataset
nrow(faithful) # number of rows in the dataset
```

```
## [1] 272
```

```
ncol(faithful) # number of columns in the dataset
```

```
## [1] 2
```

```
dim(faithful) # dimension of dataset
```

```
## [1] 272   2
```

```
head(faithful) # first 6 rows (observations) of the dataset
```

```
##   eruptions waiting
## 1     3.600      79
## 2     1.800      54
## 3     3.333      74
## 4     2.283      62
## 5     4.533      85
## 6     2.883      55
```

```
tail(faithful) # last 6 rows (observations) of the dataset
```

```
##     eruptions waiting
## 267     4.750      75
## 268     4.117      81
## 269     2.150      46
## 270     4.417      90
## 271     1.817      46
## 272     4.467      74
```

```
names(faithful) # name of columns
```

```
## [1] "eruptions" "waiting"
```

```
faithful[1:5,2] # extract the first 5 rows and 2nd column of data set
```

```
## [1] 79 54 74 62 85
```

```
faithful$waiting[1:5] # extract the first 5 rows and `waiting` column of data set
```

```
## [1] 79 54 74 62 85
```

```
apply(faithful, 2 , mean) # obtain the mean of each column in a dataset
```

```
## eruptions   waiting
##  3.487783 70.897059
```

```
x <- 1:5
y <- 2:6
cbind(x,y) # create a matrix by combining vectors column-wise
```

```
##      x y
## [1,] 1 2
## [2,] 2 3
## [3,] 3 4
## [4,] 4 5
## [5,] 5 6
```

```
rbind(x,y) # create a matrix by combining vectors row-wise
```

```
##   [,1] [,2] [,3] [,4] [,5]
## x    1    2    3    4    5
## y    2    3    4    5    6
```

Categorical variables

```
x <- c(1,2,3,2,3,4,3,2,1,2,3,4,4)
class(x)
```

```
## [1] "numeric"
```

```
x <- factor(x) # how to convert a numerical vector into a categorical one
class(x)
```

```
## [1] "factor"
```

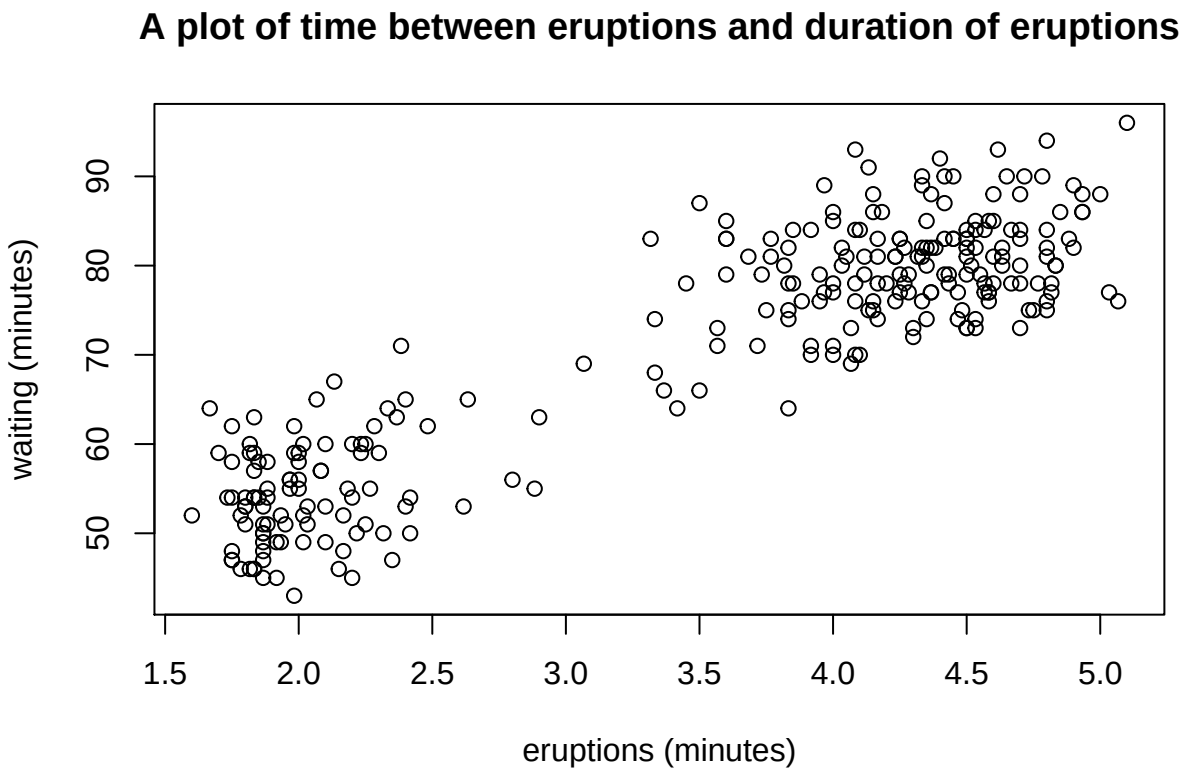
```
levels(x) # prints out the levels of the categories
```

```
## [1] "1" "2" "3" "4"
```

```
nlevels(x) # prints out the number of levels
```

```
## [1] 4
```

Base R plotting



Brief Tidyverse intro

```
library(tidyverse)
faithful %>%
  filter(eruptions > 3) %>% # filter eruptions above 3
  slice(1:5) # print out only first 5 rows
```

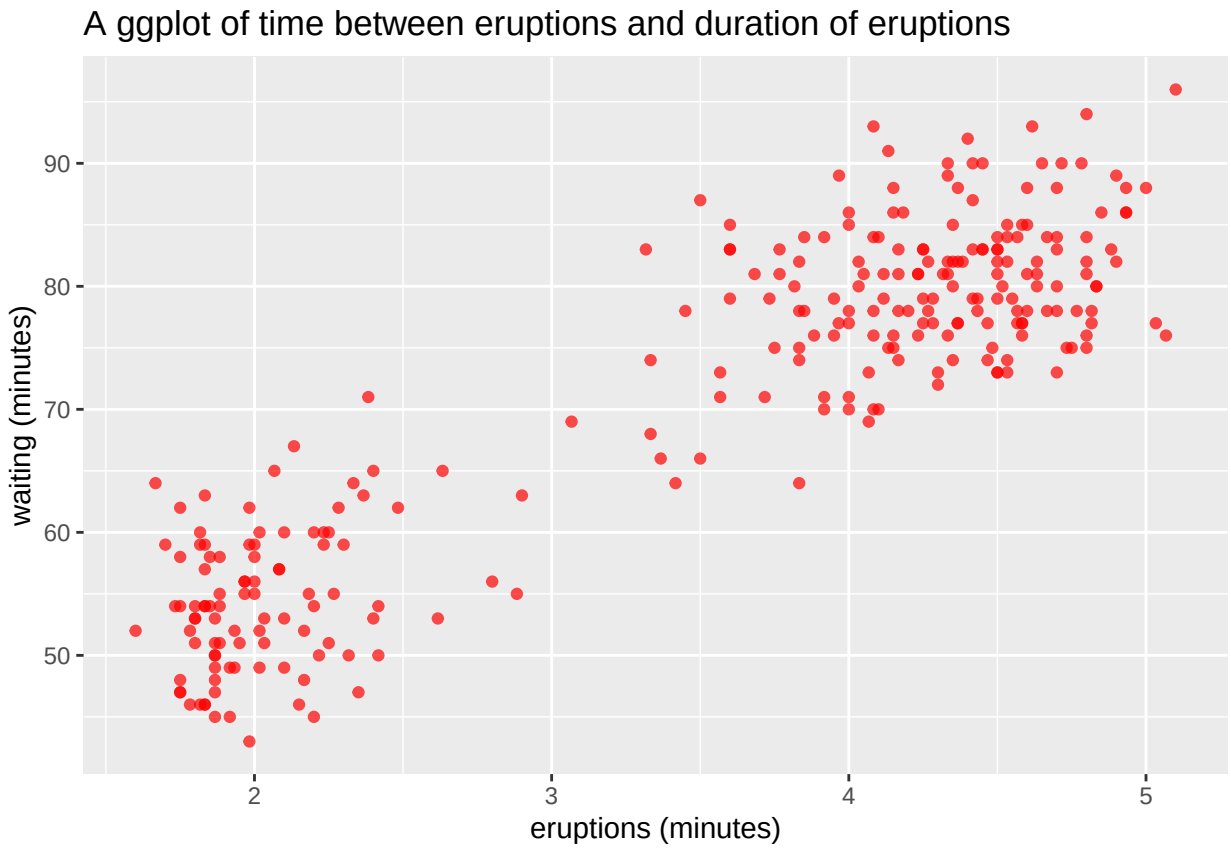
```
##   eruptions waiting
## 1     3.600      79
## 2     3.333      74
## 3     4.533      85
## 4     4.700      88
## 5     3.600      85
```

```
faithful %>%
  select(eruptions) %>%  # select eruptions column
  filter(eruptions <= 2) %>%  # filter eruptions equal to or below 2
  slice(1:5)  # filter eruptions above 3
```

```
##   eruptions
## 1     1.800
## 2     1.950
## 3     1.833
## 4     1.750
## 5     1.750
```

```
# scatterplot with eruptions on x axis and waiting on y
ggplot(data = faithful,
       aes(x = eruptions, y = waiting)) +
```

```
  # red color data points. alpha changes the transparency of the points
  geom_point(color = "red", alpha = 0.7) +
  labs(x = "eruptions (minutes)",
       y = "waiting (minutes)",
       title = "A ggplot of time between eruptions and duration of eruptions")
```



Other useful functions in the tidyverse are `group_by()`,`arrange()`,`mutate()` , and `summarise()`
For more info on tidyverse function go to https://r4ds.had.co.nz/transform.html/
Can use `glimpse()`(from tidyverse package) or `str()` to get a quick look at dataset.

```
str(faithful)
```

```
## 'data.frame':    272 obs. of  2 variables:
##  $ eruptions: num  3.6 1.8 3.33 2.28 4.53 ...
##  $ waiting  : num  79 54 74 62 85 55 88 85 51 85 ...
```

```
glimpse(faithful)
```

```
## Rows: 272
## Columns: 2
## $ eruptions <dbl> 3.600, 1.800, 3.333, 2.283, 4.533, 2.883, 4.700, 3.600, 1.95~
## $ waiting   <dbl> 79, 54, 74, 62, 85, 55, 88, 85, 51, 85, 54, 84, 78, 47, 83, ~
```

Distributions

Can obtain random sample from a specific distribution:

Type in `?distribution` in console to see all the different distributions in R.

- p for "probability", the cumulative distribution function (c. d. f.)

- q for “quantile”, the inverse c. d. f.
- d for “density”, the density function (p. f. or p. d. f.)
- r for “random”, a random variable having the specified distribution

```
rnorm(10, mean = 0, sd = 1)
```

```
##  [1]  1.39704484  0.78018205  0.05917926  0.45881617  1.58207309 -0.18829937
##  [7] -2.38601281 -0.54203906 -0.85189589 -0.66999714
```

- random sample from a normal distribution with mean = 0, standard deviation = 1

```
runif(10, min = 0, max = 1)
```

```
##  [1] 0.02658032 0.75273533 0.18176805 0.48268490 0.93666646 0.09827982
##  [7] 0.56551044 0.55485779 0.48486193 0.72386338
```

- random sample from a uniform distribution with minimum value = 0, maximum value = 1

```
rpois(10, lambda = 7)
```

```
##  [1]  8  6  6 11  4 10  5  5 12  8
```

- random sample from a poisson distribution with lambda parameter = 7

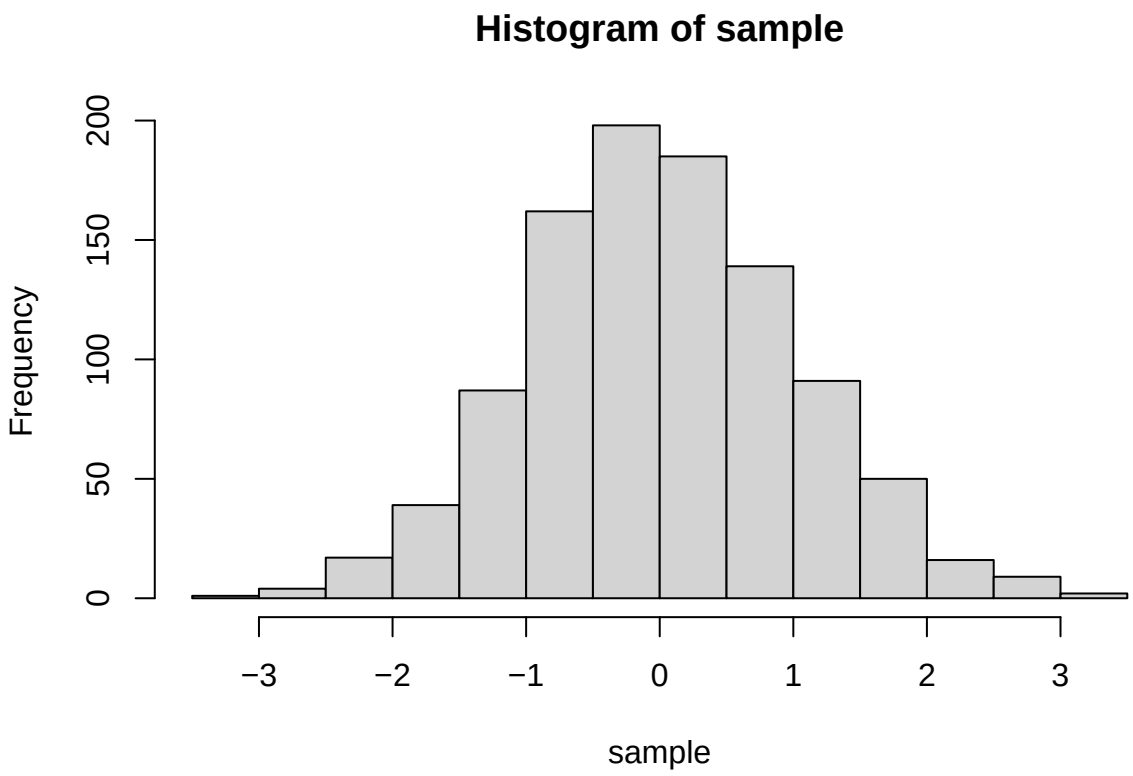
```
sample <- rnorm(1000,mean = 0, sd = 1)
mean(sample) # mean of sample
```

```
## [1] 0.00831154
```

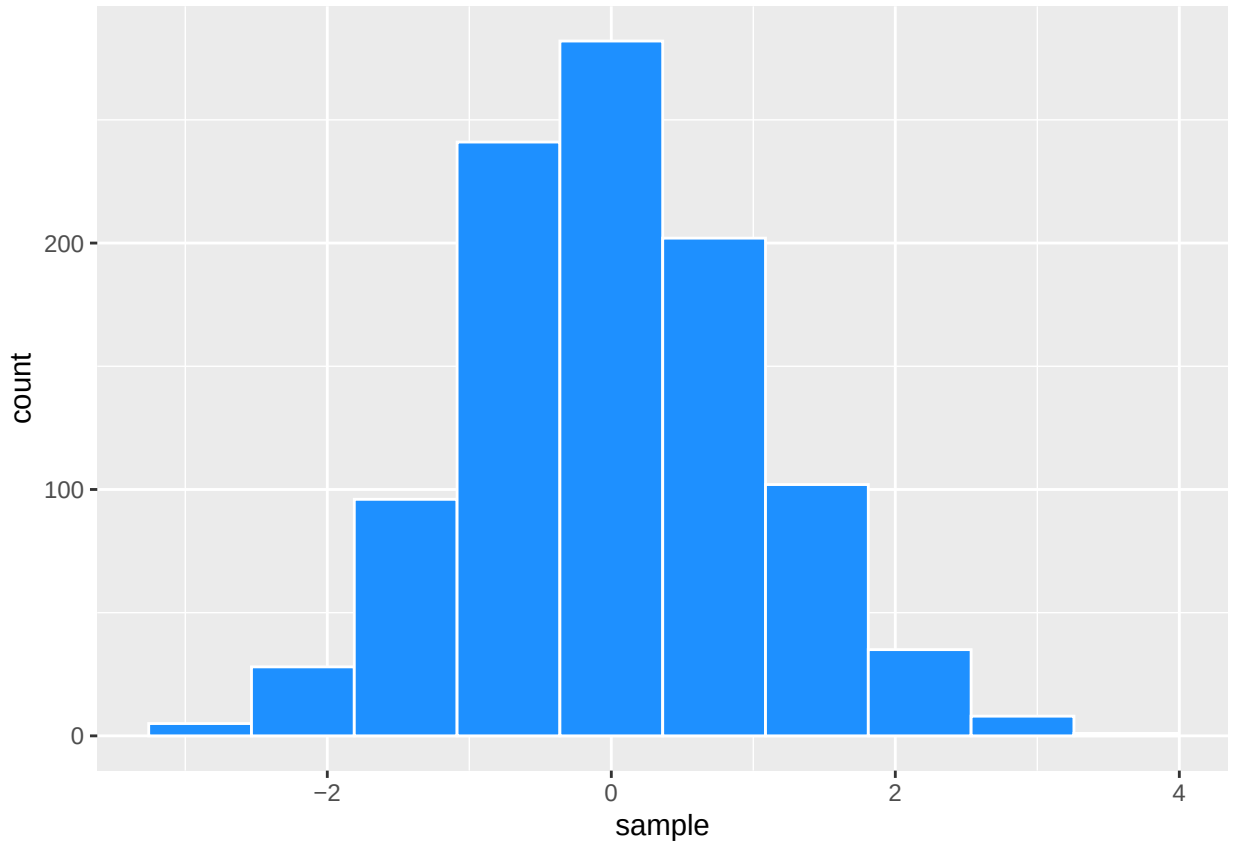
```
sd(sample) # standard deviation of sample
```

```
## [1] 1.010357
```

```
hist(sample) # make a simple histogram from base r plotting
```




```
ggplot() +
  geom_histogram(aes(x = sample), # using ggplot to make histograms
                 bins = 10, color = "white", # control the number of bins
                 fill = "dodgerblue")
```


count
200
100
0
−2
0
2
4
sample

Rmarkdown

In the menu bar of RStudio, click on File, then New File, and choose R Markdown. Select the default option (Document), and click Ok.

Rmd files are a special type of file, referred to as a dynamic document, that allows to combine narrative (text) with R code.

For more info go to https://rmarkdown.rstudio.com/ Also see "RMarkdown Reference Guide"

- Don't name 2 chunks the same!
- Can write in LaTeX in Rmarkdown like this: $\bar{x} = \mu$ or:

$$\sum_{x=1}^{5} x^2 = 55$$

Useful Rstudio shortcuts

- alt(option) + - = assignment operator (<-)
- Ctrl(Cmd) + alt(option) + I = new code chunk in Rmarkdown
- Ctrl(Cmd) + shift + C = Comment or uncomment lines highlighted
- Ctrl(Cmd) + shift + A = Reformat code in a neat way (most of the time)
- Ctrl(Cmd) + shift + M = pipe operator (%>%)
- alt(option) + shift + K = see all of the other fun shortcuts!

Some other useful tips

- In order to keep your files organized (on your local computer) try using R projects. https://teachdatascience.com/projects/
- https://rstudio.com/resources/cheatsheets/ for cheatsheets