# Problem Session 1

## Part 1: Quarto

Quarto documents allow one to create reproducible analyses that include both written explanations as well as R code. We will use Quarto documents for all the class code and for the homework. For more information on Quarto see https://quarto.org/

### 1.1 Rendering Quarto documents

We can render a Quarto document to a pdf document by pressing the **Render button** which is located at the top of the Quarto file in RStudio (the button has an arrow symbol). This will generate a pdf that includes both content as well as the output of any embedded R code chunks within the document.

**Note**: When working on the homework, please be sure to render the Quarto document often so that you can tell right away when you make a mistake. Otherwise, it will be very difficulty to debug your code at the end when you try to submit the homework.

### 1.2 LaTeX symbols

We can include LaTeX symbols in our Quarto documents. For example, we can write the Greek letter alpha using the code $\alpha$.

We can also write subscripts using underscores. For example, $x_{original}$.

Sometimes we will want to put marks above characters such as a hat above a letter. For example, we can write $\hat{y}$ to get a hat above the letter y. We can also write $\bar{y}$ to get a bar above it.

**Exercises**: Try writing the following:

- x-bar subscript 20
- y-bar subscript 12

- $\beta$-hat subscript 0

**Answers:**

- $\bar{x}_{20}$
- $\bar{y}_{12}$
- $\widehat{\beta}_0$

# Part 2: Introduction to R

Let's now discuss some of the basics of R!

## 2.1 Running R code

We can run R code on the console or inside of R chunks. If we press the green "play" button at the top of the R chunk, this is the same as running the code in the console.

```
1000 + 9999 # Addition
```

```
[1] 10999
```

```
10 * 4 # Multiplying 2 numbers
```

```
[1] 40
```

```
7 * 7 * 20 # Multiplying 3 numbers
```

```
[1] 980
```

```
3^4 # Exponents (i.e., 3 to the fourth power)
```

```
[1] 81
```

```
132 / 11 # Division
```

```
[1] 12
```

**Exercises**: Compute the area of the following shapes:

- Square with side length 4
- Circle with radius 3 (you can use 3.14 for $\pi$)
- Triangle with base 5 and height 6

**Answers:**

- `4 * 4 (16)`
- `3.14 * 3^2 (28.26)`
- `0.5 * 5 * 6 (15)`

### 2.2 Assigning values to objects

We can assign values to objects using the assignment operator `<-`.

Note, there cannot be any spaces in between the `<` and `-` symbols.

Any object that is placed on a line by itself will print the value stored in that object. This is how you will "show your work" on the homework; i.e., show that you have the correct answer.

```
a <- 45
b <- 55

z <- a + b

z
```

```
[1] 100
```

```
fruit <- "apple"
vegetable <- "carrot"
```

**Exercises**: Assign the areas that you computed above to corresponding variables. You can name the variables based on the shape (e.g., square <- ...).

**Answers:**

- square = 4 * 4
- circle = 3.14 * 3^2
- triangle = 0.5 * 5 * 6

### 2.3 Functions

Functions are used to perform specific tasks. Usually they take input values and return an output value.

Function use syntax that ends with parenthesis: functionName(x)

Any ideas what the functions below do?

1. round(49.209, 2)
2. toupper("panama!")

To get information about a function, use the ? before the function name.

For example: ?round

**Exercises**: Find the help page for the `toupper` function.

**Answers:**

- ?toupper

### 2.4 Vectors

Vectors are used to store multiple values in a single object. We can create vectors using the c() function.

We can access values in a vector using square brackets [].

```
v <- c(1, 3, 5, 7, 9) # defining a vector called v

v
```

```
[1] 1 3 5 7 9
```

```
states <- c("Alabama", "Alaska", "Arizona", "Arkansas")

states[4] # indexing or selecting the fourth element in the vector
```

```
[1] "Arkansas"
```

```
w = 1:10 # Sequence of numbers from 1 through 10

w
```

```
 [1]  1  2  3  4  5  6  7  8  9 10
```

**Exercises**: Answer the following using the vector `v` that we defined above.

- Find the sum of `v` above using the `sum` function. Save the result to a vector called `v_sum`
- Take the square root of `v` using the `sqrt` function. Save the result to a vector called `v_sqrt`
- Subtract `v_sqrt` from `v_sum`, and round it to 2 decimal places

**Answers:**

- v_sum = sum(v)
- v_sqrt = sqrt(v)
- round(v_sum - v_sqrt, 2)

# Part 2: Quick review of categorical data analysis in R

Let's quickly review how to analyze categorical data in R using a fictional dataset of voters' opinions of president Trump.

### 2.1 Getting a simulated sample of voters

We can use the SDS1000 function `get_approval_sample()` to get a vector of random sprinkle colors.

```
# Load the SDS1000 package
library(SDS1000)

# Setting the seed so that we all get the same "random sample"
set.seed(1000)



# Get a random sample of 1000 fictional voter's opinion of president Trump
approval_sample <- get_approval_sample(1000)


# Show the first 10 voters in the sample
approval_sample [1:10]
```

```
 [1] approve    disapprove approve    disapprove approve    approve
 [7] disapprove approve    approve    approve
Levels: disapprove < approve
```

### 2.2 Get the proportion of voters that appropove of trump

We can use the `table()` and `prop.table()` functions to create a frequency and relative frequency table of approval ratings.

We can also use the SDS1000 `get_proprortion()` function to get the proportion of voters that approve of president Trump.

```
# Create a table of the approval ratings
approval_table <- table(approval_sample)


# Create a relative frequency table of the approval ratings
approval_proportions <- prop.table(approval_table)


# Get the proportion that approves
get_proportion(approval_sample, "approve")
```

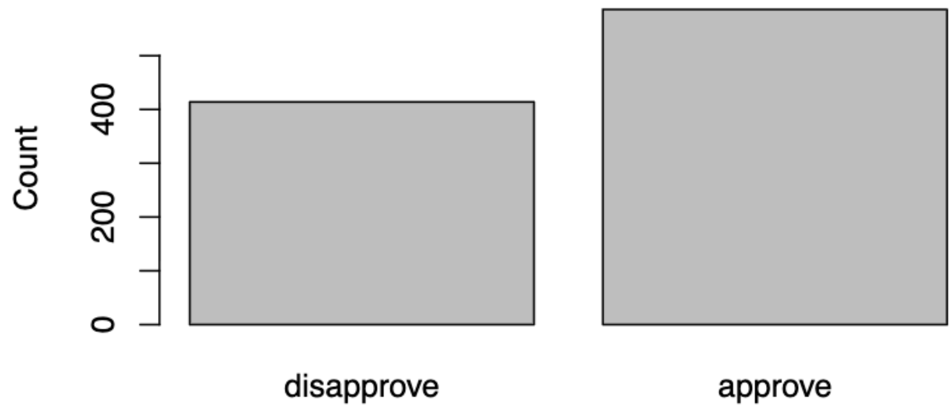
```
approve
  0.586
```

### 2.3 Bar plots and pie charts

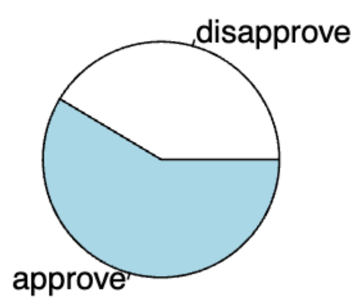
We can use the `barplot()` and `pie()` functions to visualize the data.

Note: Both functions take a frequency table as input, and **not** the original vector of data.

```
# Create a bar plot of the sprinkle colors
barplot(approval_table, ylab = "Count")
```




```r
# Create a pie chart of the sprinkle colors
pie(approval_table)
```




Can you figure out how to change the color of the segments in the pie chart?

### 2.4 Two-Way Tables

We can also make tables for two variables, instead of just one.

```r
age = sample(c("< 30", ">= 30"), size = 1000, replace = TRUE, prob = c(0.5, 0.5))
table(age, approval_sample)
```

```
       approval_sample
age     disapprove approve
  < 30         213     279
  >= 30        201     307
```