

PSC 253 Minimal Manual

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Preface

This book is a supplement to the book, *Quantitative Social Science: An Introduction*, by Kosuke Imai. It also relies heavily on the work of Jeffrey Arnold, who translated the Imai code into tidyverse code.

I aspire for this text to act as a minimal manual for the course PSC 253 Scope and Methods in Political Science taught at Morehouse College. It is intended to cover all of the main analytical tasks that the course requires.

Chapter 1

R Basics

At its most basic functionality, R is a calculator.

1.1 Use R as a Calculator

1.1.1 Problem

You want to add, subtract, multiply, divide, use exponents, and take square roots

1.1.2 Solution

Use + for addition, - for subtraction, * for multiplication and / for division.

```
# addition  
43 + 5
```

```
## [1] 48
```

```
# subtraction  
43 - 5
```

```
## [1] 38
```

```
# multiplication  
43 * 5
```

```
## [1] 215
```

```
# division  
43/5
```

```
## [1] 8.6
```

For exponents, we raise X to the power of y by using \wedge . That is X^y .

```
# raise 43 to the power of 5  
43 ^ 5
```

```
## [1] 147008443
```

Take the square root of some number x by using the function `sqrt()`. That is `sqrt(x)`.

```
# take the square root of 43  
sqrt(43)
```

```
## [1] 6.557439
```

1.1.3 Troubleshooting

- Keep in mind that R follows the order of operations, $2 + 2 * 2$ is equal to 6 and not 8.

```
# correct  
2 + 2 * 2
```

```
## [1] 6
```

```
# incorrect  
(2 + 2) * 2
```

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

1.2 Creating an Object

1.2.1 Problem

You want to create an object to hold a number

1.2.2 Solution

To create an object:

1. type in a name for the object, like `newobject` then
2. use the assignment operator `<-`,
3. input a number, mathematical expression, dataset, or text on the right side of `<-` that you want assigned to the `newobject`

```
# assigning the number 4 to a new object named "myobject"
myobject <- 4

# assigning the text "hallelujah hollaback" to a new object named "second_object"
second_object <- "hallelujah hollaback"
```

Type the name of an object in order to see what it contains.

```
myobject
```

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

```
second_object
```

```
## [1] "hallelujah hollaback"
```

1.2.3 Troubleshooting

- There cannot be any spaces in the name of an object. Instead you could use dots, dashes, underscores, or capitalization to distinguish between words: `small.data`, `big-data`, `bigger_data`, `mediumData`.
- Text needs to be in quotation marks in order to be assigned to an object.
- Object names are case sensitive `Myobject` is not the same as `myobject`

1.3 Creating a Vector

A vector is a list of numbers or characters. We will create vectors for a variety of reasons in this course.

1.3.1 Problem

You want to create a vector.

1.3.2 Solution

Use the function `c()` to create a list by separating the entries with a comma.

```
# create a vector called 'prime'  
prime <- c(1, 3, 5, 7)
```

```
prime
```

```
## [1] 1 3 5 7
```

```
# create a vector called "first_name"  
first_name <- c("Matthew", "Mosi", "Manu", "Ekundayo", "Kwasi")
```

```
first_name
```

```
## [1] "Matthew" "Mosi"      "Manu"      "Ekundayo" "Kwasi"
```

1.3.3 Troubleshooting

- As the name of a function, `c()` is case sensitive. Use the lowercase `c`.
- Make sure that all elements are separated by a comma.
- Vectors are typically assigned to some object.

1.4 Indexing

We can use indexing to pull out specific sets of observations from a vector or dataset.

1.4.1 Problem

You want to select a specific one observation based on its position within a vector or matrix.

1.4.2 Solution

We index by using the brackets `[x, y]` after an object where `x` is the row and `y` is the column.

```
# we have a vector
prime <- c(1, 3, 5, 7)

# we want the number 3, which is the second observation in the vector
prime[2]
```

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

```
# we have a matrix
yup <- matrix(c(prime, 2, 6, 10, 14), nrow = 2, ncol = 4, byrow = T)
yup
```

```
##      [,1] [,2] [,3] [,4]
## [1,]    1    3    5    7
## [2,]    2    6   10   14
```

```
# We want the observation in the first row and fourth column
yup[1, 4]
```

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

1.4.3 Problem

You want to select an entire row or column.

1.4.4 Solution

You can select an entire row by leaving the column index position blank `yup[2,]`. You can select an entire column by leaving the row index position blank `yup[, 2]`.

```
# We have our matrix
yup
```

```
##      [,1] [,2] [,3] [,4]
## [1,]    1    3    5    7
## [2,]    2    6   10   14
```

```
# We want the second row
yup[2, ]
```

```
## [1] 1 3 5 7
```

```
# We want the third column  
yup[ , 3]
```

```
## [1] 5 10
```

1.5 Creating a Project

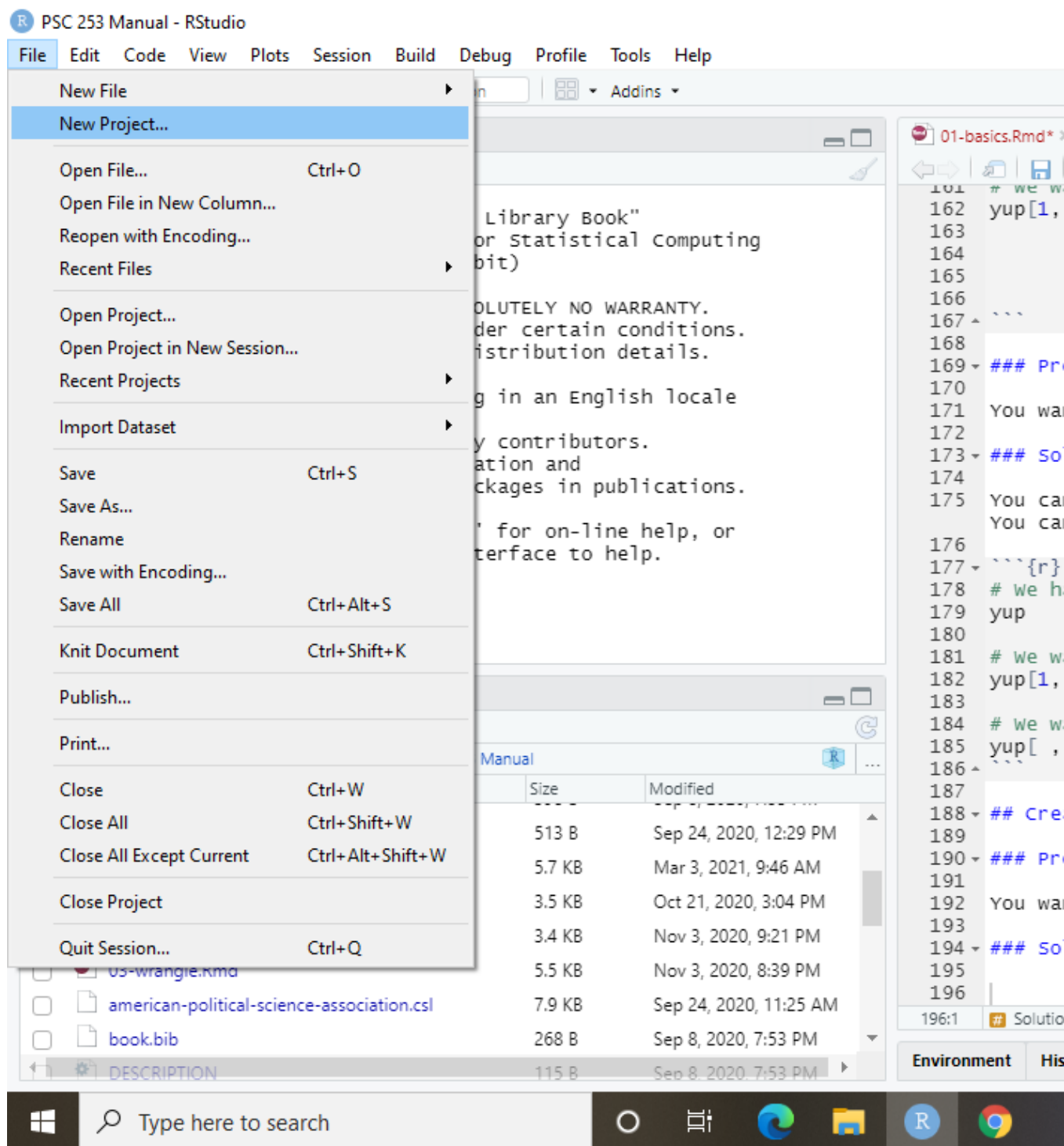
Creating a project creates a folder on your computer that Rstudio and R will treat as the default directory for your code. That is, whenever you tell R to look for something on your computer, it will begin by looking in the project folder.

1.5.1 Problem

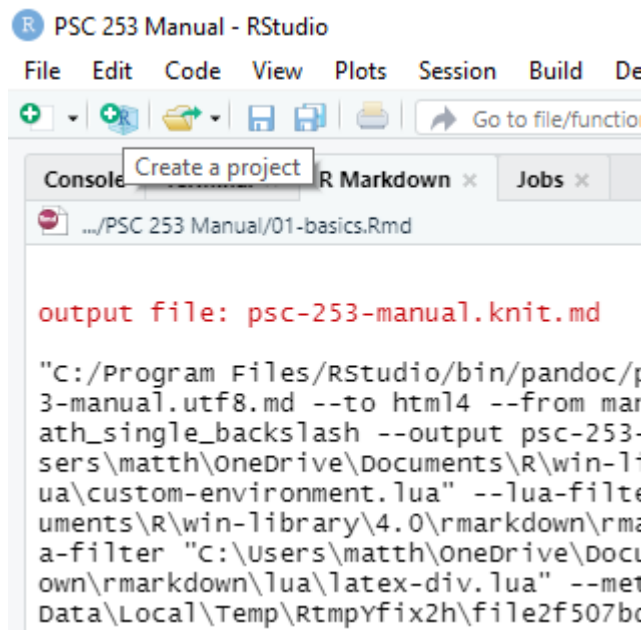
You want to create a new project.

1.5.2 Solution

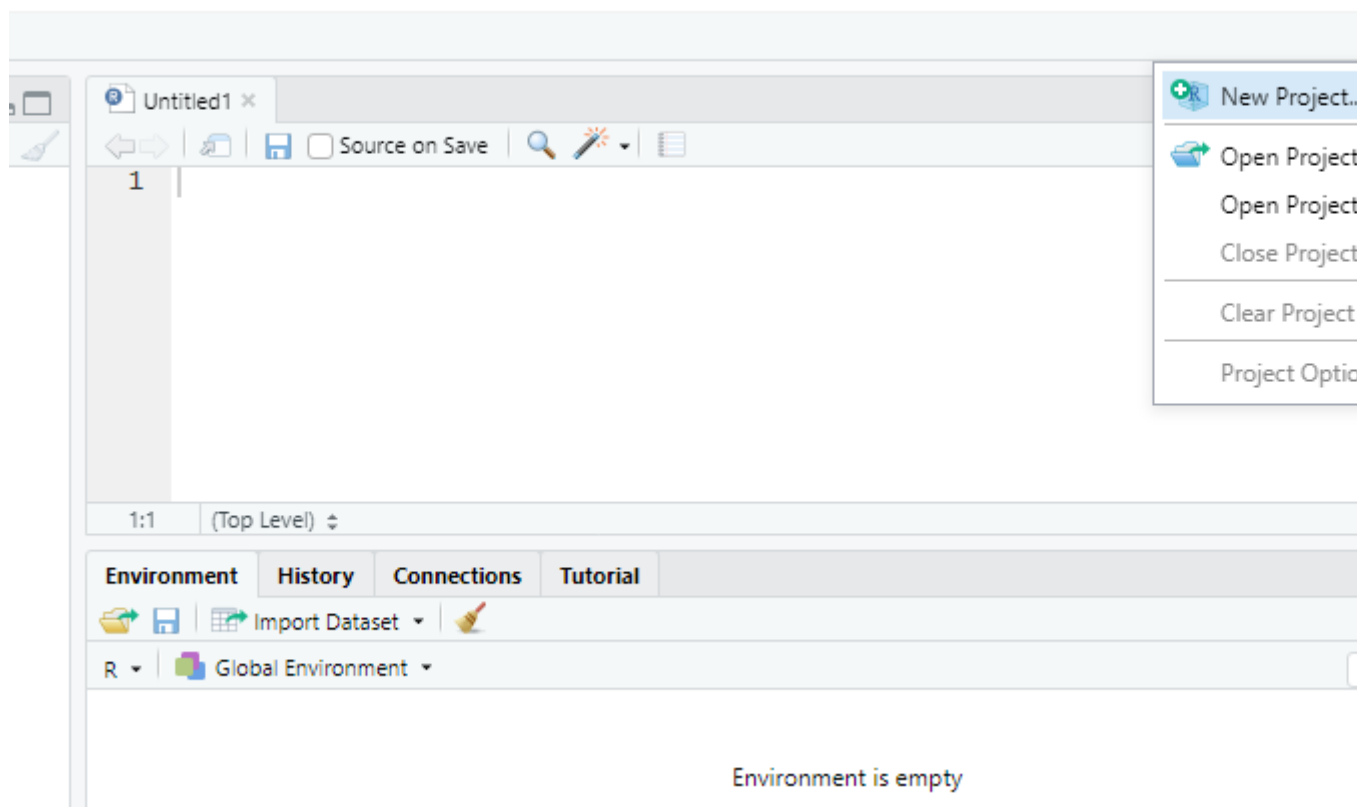
There are multiple ways to create a new project. You can go to the menu bar and select “File”, then “New Project”:



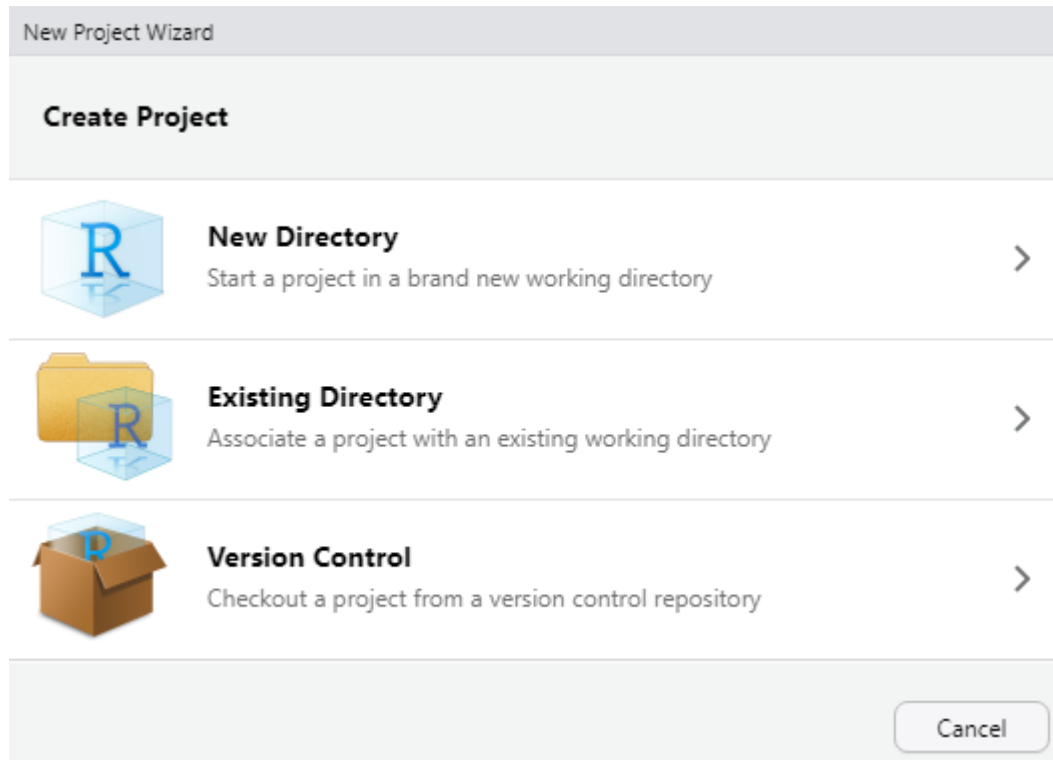
You can click the “create project” icon on the toolbar:



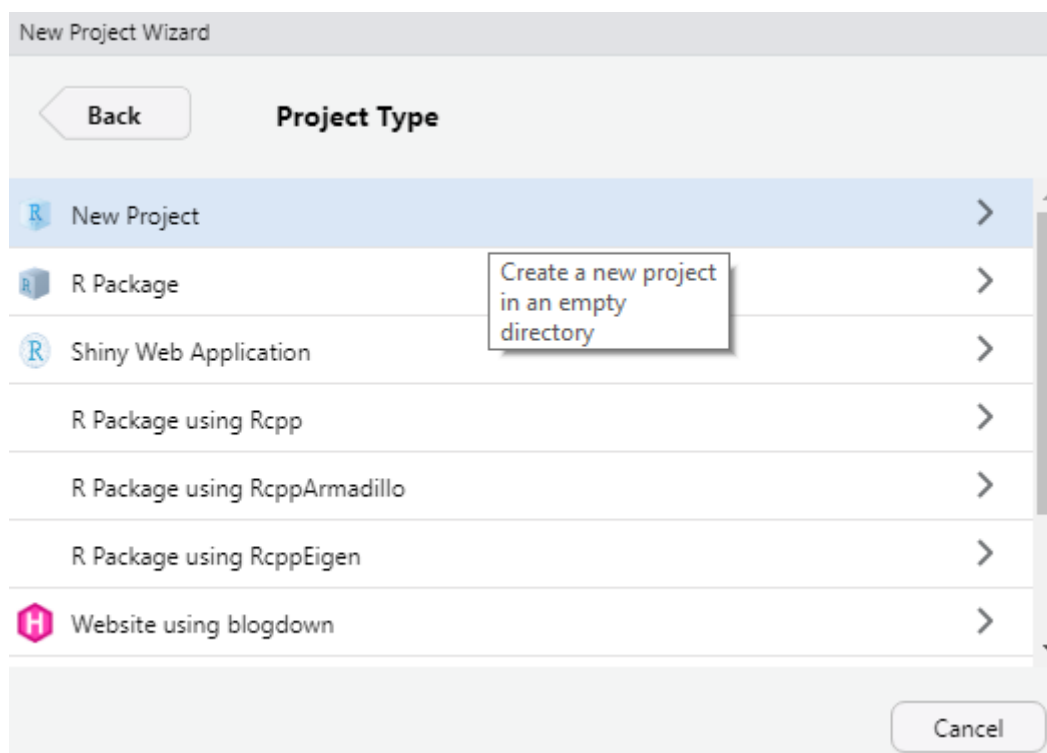
Or you can select “New Project” from the project menu at the top left of Rstudio:



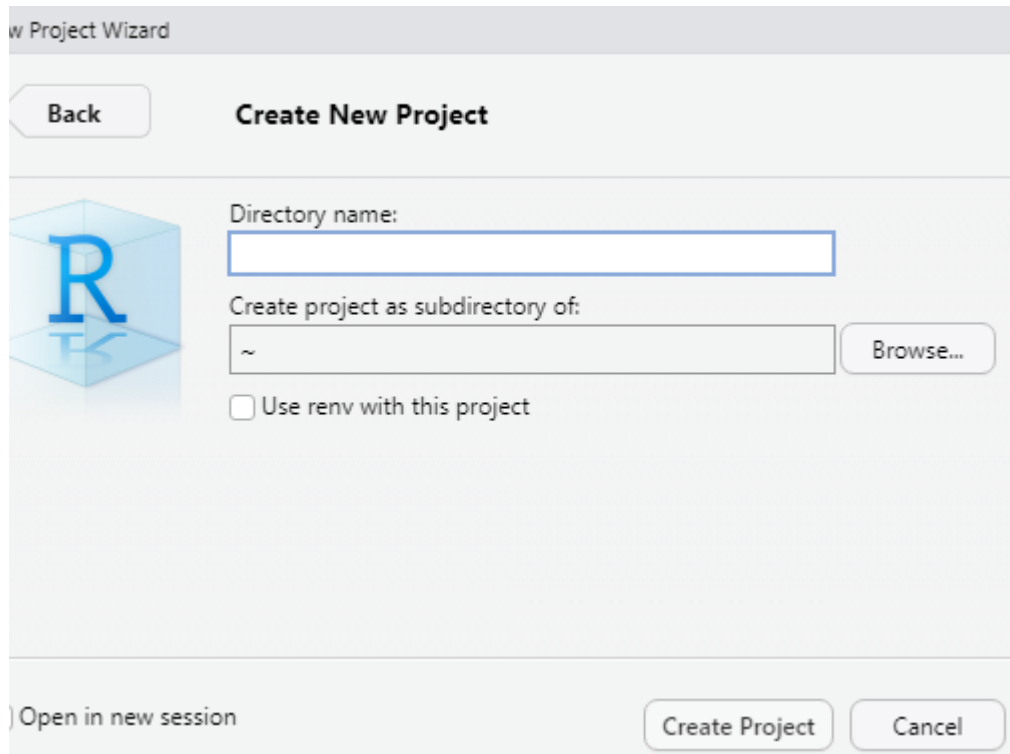
When you select “New Project”, the below dialogue box appears. Select “New Directory”:



Then select “New project”,



enter a name for the project, and browse to where you want the directory located on your computer.



Complete the process by clicking “Create Project.”

1.5.3 Troubleshooting

- You need to know where your project folders are on your computer. I recommend that you create a master folder called “PSC 253”, and then have all of your project folders inside of that master folder.
- We will use separate projects for each lab assignment and for the Data Project assignment.
- Avoid having multiple project folders for the same assignment. It will cause confusion when you are trying to submit the correct project folder for your assignment.

1.6 Installing a Package

A *package* is a specialized collection of R elements – datasets, functions, objects, etc. We will use various packages to help in our data analysis. Packages have to be installed and loaded before their elements can be accessed, so this section will teach you how to install a package.

1.6.1 Problem

You want to install a package.

1.6.2 Solution

1. You can type in the command `install.packages("packagename")`.
Thus, to install the package named “here” we would type `install.packages("here")`.

```
# installing the poliscidata package  
install.packages("poliscidata")
```

Alternatively, you can use the menu bar:

1. Click on “Tools” in the menu bar.
2. select “Install Packages”
3. A dialogue box will appear.
4. Type in the name of the package you want.
5. Click “Install”.

1.6.3 Troubleshooting

- Some packages depend on the installation of other packages first. R will install these dependencies automatically, so it may take a while for your package to install. You know the installation is done when the console shows its arrow and blinking cursor.
- If you get a message asking you to install Rtools, then you can do so [here][<https://cran.r-project.org/bin/windows/Rtools/>].
- If you get a message that says “exited with non-zero status”, then the package did not fully install. This could be due to one of the dependency packages not installing properly. Try to install that dependency package manually – `install.packages("dependencyname")`. Once the dependent package is installed, you can try to install the main package again.
- You will know that the package has been successfully installed if you are able to load the package.
- In rare occasions, a package may require a later edition of R than you have installed on your computer. The message will say something like “This package requires R 4.1.0 and you have R 3.1.0”. In that case, you will need to download and install the latest version of R before you can install the package.
- Remember to use quotation marks around the package name in `install.packages()`.

1.7 Loading a Package

It is not enough to just install a package. Installed packages must be loaded in order for you to access their elements.

1.7.1 Problem

You want to load a package that you have installed.

1.7.2 Solution

The function we use to load packages is `library()`. Its main argument is the name of the package – `library(packagename)`.

```
# load the poliscidata package  
library(poliscidata)
```

1.7.3 Troubleshooting

- Packages must be fully and properly installed before they can be loaded.
- If you get an error saying that a package does not exist then 1) you have not installed the package or 2) you have spelled the name of the package incorrectly.
- Remember that we do not put the name of the package in quotation marks when we are loading it.

1.8 Using relative file paths

Whenever we load data or save data we will need to specify a file path – where the file is located on the computer. Obviously, the file path on your computer will not be the same as the path on someone else’s computer. We want our code to be able to run on any computer, so we create *relative* file paths. That is, we specify where the file is located relative to the project folder.

1.8.1 Problem

You want to create a file path relative to the project folder.

1.8.2 Solution

1. You need to already have a project folder. See Section 1.5.
2. Load the “here” package
3. The function `here()` automatically sets the relative point of the file path as the location of your `.Rproj` file.
4. You can then provide the file path as the argument to `here()`.

```
# Creating a path to the "images" folder in this project.
```

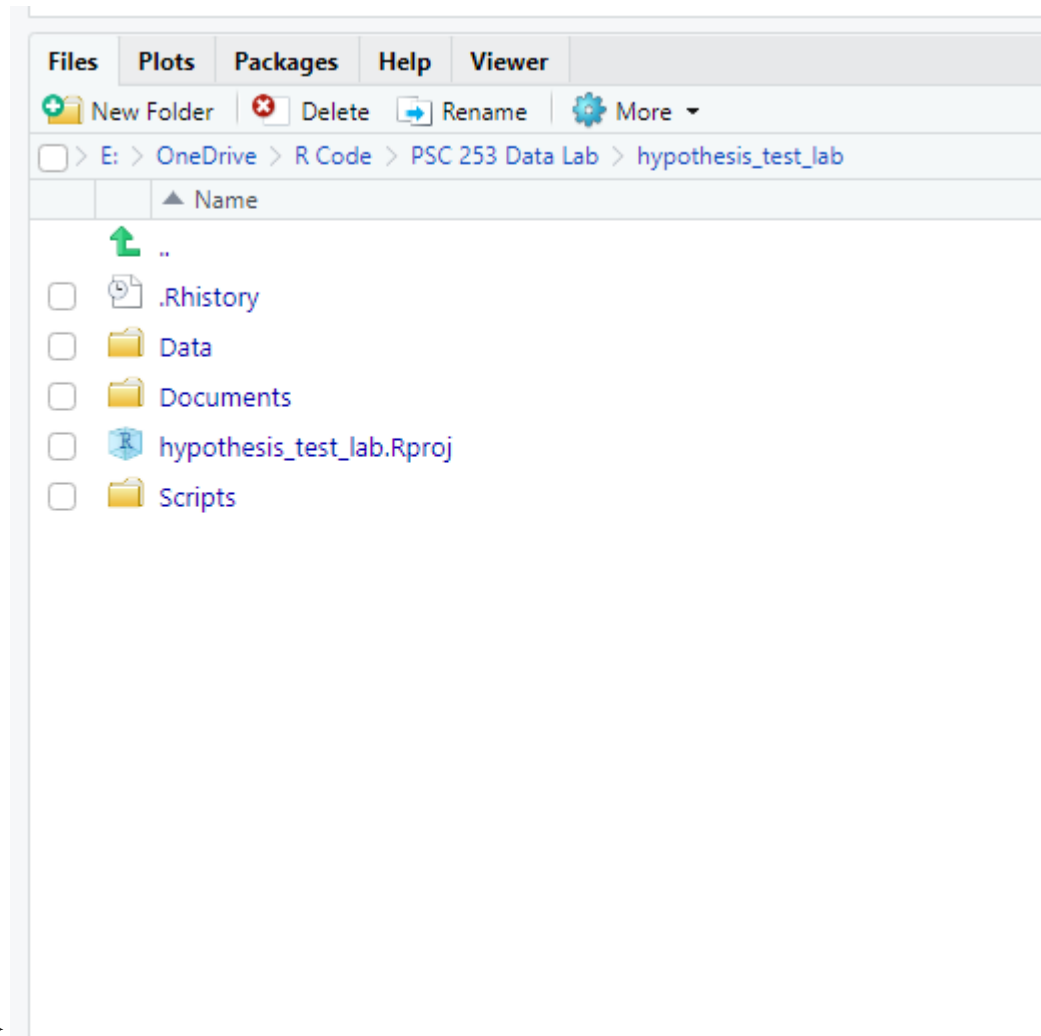
```
library(here)
```

```
## here() starts at E:/OneDrive/R Code/PSC 253 Manual
```

```
here("images")
```

```
## [1] "E:/OneDrive/R Code/PSC 253 Manual/images"
```

For example, we have a project folder named “hypothesis_test_lab”. Figure 1.8.2 shows the inside of that project folder. There are three subfolders: Data, Documents, and Scripts. Inside the “Data” folder there are two more folders called `Analysis_Data` and `Original_Data`.



```
\begin{figure}  
\caption{A screen shot of the hypothesis_test_lab project folder.}  
\end{figure}
```

We will use the `here()` function to load a data file that is found within the `Analysis_Data` folder.

```
# loading "analysis1.RData" file  
load(here("Data/Analysis_Data/analysis1.RData"))
```

1.8.3 Troubleshooting

- Remember to use forward slashes / and quotation marks when writing the relative path for `here()`.
- The use of `here()` is a new function introduced in Fall 2021. Code from prior versions of the course that used relative paths may need to be revised if you want to use the `here()` function.
- Your first code chunk should load the `here` package – `library(here)`.

1.9 Loading .csv Data

There are some packages that come with datasets attached to them. However, we will mostly need to import datasets into R. This section deals with how to specify the file path for the data and the various functions that correspond to the different types of data files you may encounter.

1.9.1 Problem

You want to load a datafile that takes the form `data_name.csv`.

1.9.2 Solution

1. You already have a project folder. (Section 1.5)
2. You already know how to create relative paths. (Section 1.8)
3. In this course, `.csv` files should always be located in the `Original_Data` subfolder, which is found inside the “Data” folder.
4. Create an object to hold the data that you will import. This object will be assigned the imported data.
5. Use the function `read.csv()` or `read_csv()` to import the data into R. Its argument is the file path.

Generically, the code takes the form:

```
your_object <- read.csv(here("Data/Original_Data/your_data.csv"))
```

If I were loading a csv file named “congbills.csv” and assigning it to an object called “bills”, then the code would be:

```
# Loading the csv file "congbills.csv" into R as an object called "bills"
bills <- read.csv(here("Data/Original_Data/congbills.csv"))
```

1.9.3 Troubleshooting

- The most common error is that the file path to the data has not been specified properly. Check the spelling in your file path.
- Make sure that you use `here()` for the file path. Start from the project folder, and then write the path until you get to your file.
- Using `read_csv()` requires the `tidyverse` package.

1.10 Loading .dta Data

Stata is another popular software program for data analysis. It is often used in economics. The types of files that are used in Stata have the suffix `.dta`.

1.10.1 Problem

You want to load a datafile that takes the form `data_name.dta`.

1.10.2 Solution

1. You already have a project folder. (Section 1.5)
2. You already know how to create relative paths. (Section 1.8)
3. In this course, `.dta` files should always be located in the `Original_Data` subfolder, which is found inside the “Data” folder.
4. Create an object to hold the data that you will import. This object will be assigned the imported data.
5. Load the package `haven` – `library(haven)`
6. Use the function `read_dta()` to import the data into R. Its argument is the file path.

Generically, the code takes the form:

```
# load the package 'haven'
library(haven)

# import the data
your_object <- read_data(here("Data/Original_Data/your_data.dta"))
```

If I were loading a `dta` file named “congbills.dta” and assigning it to an object called “bills”, then the code would be:


```
# Loading the csv file "congbills.csv" into R as an object called "bills"  
bills <- read_dta(here("Data/Original_Data/congbills.dta"))
```

1.10.3 Troubleshooting

- The most common error is that the file path to the data has not been specified properly. Check the spelling in your file path.
- Make sure that you use `here()` for the file path. Start from the project folder, and then write the path until you get to your file.
- Using `read_dta()` requires the `haven` package.

Chapter 2

Bivariate Comparisons

2.1 Crosstab

2.1.1 Problem

You want to make a crosstab.

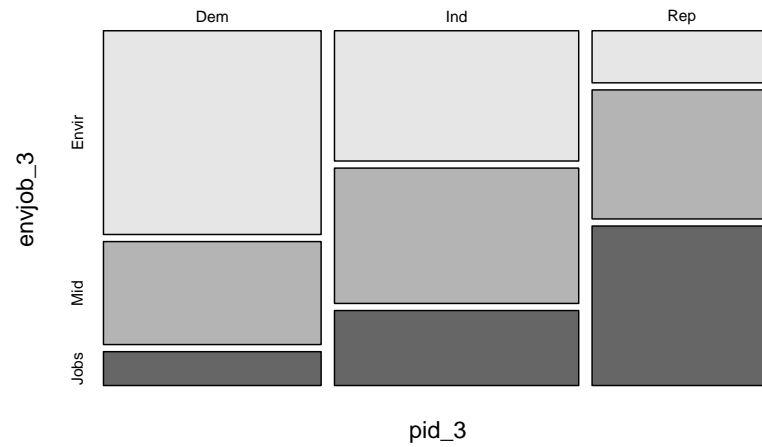
2.1.2 Solution

1. Load the `poliscidata` package.
2. In order to create a crosstab in R, we use the function called `xtp()`.
3. The function follows the following template:

```
xtp(data = your data, y = dependent variable, x = independent variable, w = weights)
```

1. Specify the dataset, the dependent variable, the independent variable, and the weights (if applicable)

```
# Create a crosstab where the dependent variable is "envjob_3", the independent variable is "pid_3"  
# The dataset is "nes", which is found in the "poliscidata" package.  
xtp(data = nes, y = envjob_3, x = pid_3, w = wt)
```



```
##      Cell Contents
## |-----|
## |                Count |
## |      Column Percent |
## |-----|
##
## =====
##                pid_3
## envjob_3      Dem      Ind      Rep      Total
## -----
## Envir          1005        721        212      1938
##                59.82%    38.25%    15.30%
## -----
## Mid              508        749        525      1782
##                30.24%    39.73%    37.88%
## -----
## Jobs              167        415        649      1231
##                9.94%    22.02%    46.83%
## -----
## Total           1680        1885        1386      4951
##                33.93%    38.07%    27.99%
## =====
```

2.1.3 Troubleshooting

- Make sure that the `poliscidata` package is loaded. Use `library(poliscidata)` to load.
- The arguments for the independent and dependent variables are just the variable names. They do not follow the template of `data$variable`.
- Crosstabs are used when both the independent and dependent variables are categorical. Avoid making a crosstab with numeric data.

2.2 Comparison of Means

2.2.1 Problem

You want to make a comparison of means table.

2.2.2 Solution

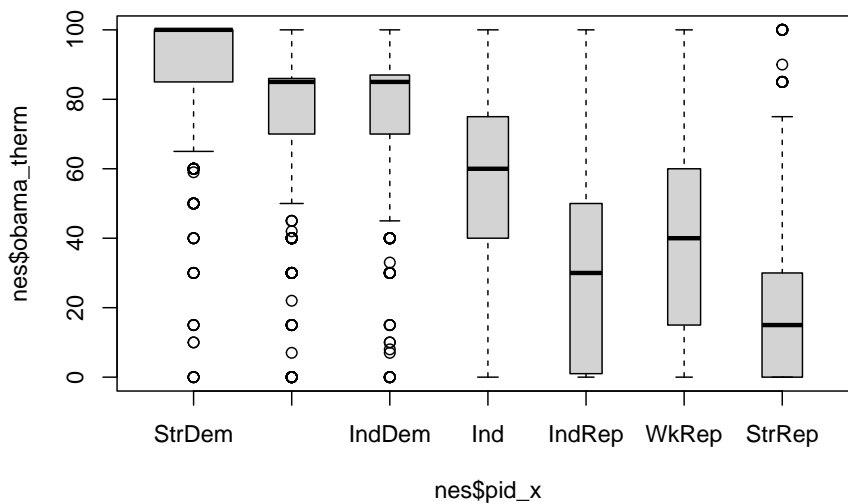
1. Load the `poliscidata` package.
2. In order to create a comparison of means table in R, we use the function called `compmeans()`.
3. The function follows the following template:

```
compmeans(x = data$dependent, f = data$independent)
```

Here is a comparison of means table for feelings towards Obama `obama_therm` by party identification `pid_x`.

```
# create the comparison of means table
compmeans(x = nes$obama_therm, f = nes$pid_x,
           weights = nes$wt)
```

```
## Warning in descr::compmeans(...): 442 rows with missing values dropped
```



```
## Mean value of "nes$obama_therm" according to "nes$pid_x"
##           Mean      N Std. Dev.
## StrDem  91.12934 1384  14.19526
## WkDem   75.39237  813  22.08436
## IndDem  76.11223  695  20.22679
## Ind     54.56354  724  29.85396
## IndRep  32.15929  565  27.71165
## WkRep   36.67241  580  27.85999
## StrRep  18.44039  713  22.65842
## Total   60.72470 5474  34.64432
```

2.2.3 Troubleshooting

- Make sure `poliscidata` is loaded.
- Keep in mind that the variables follow the pattern of `data$variable`.
- You only need to specify the `weights` argument if you have survey data with survey weights.

2.3 Make a Bar Chart

2.3.1 Problem

Make a barchart that plots the mean of a dependent variable (Y) by an independent variable (X).

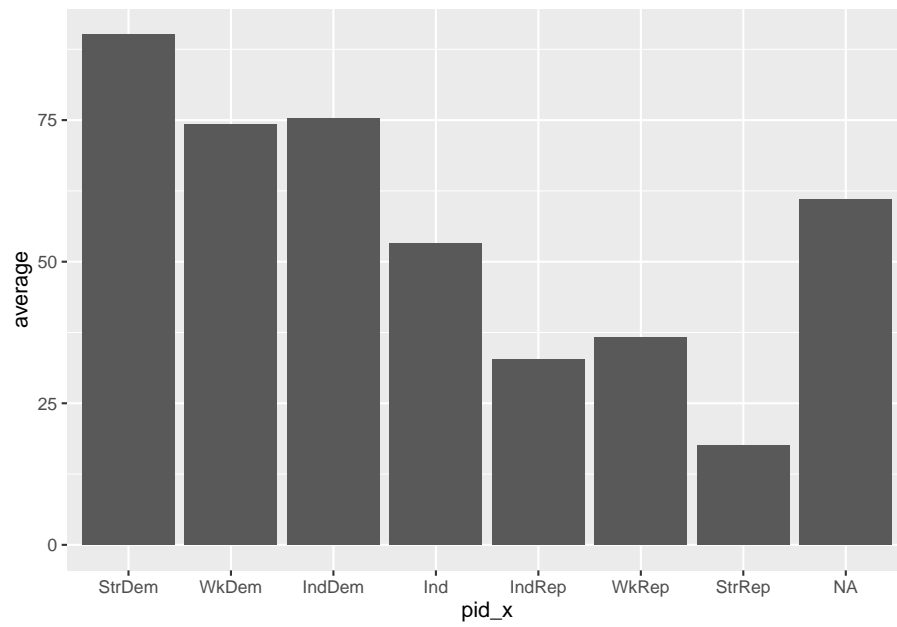
2.3.2 Solution

1. Create a summary dataset to plot (see 3.4).
2. Use `ggplot()` for the data and the mapping.
3. The data is the summary dataset, `data = sum_data`
4. The mapping is `mapping = aes(x = independent, y = dependent)`
5. If you want to color the bars, add `fill = independent` to the mapping.
6. Use a `+` at the end of the line of code.
7. Use `geom_col()` to make the bar shapes.

```
p1 <- ggplot(data = sum_data,  
             mapping = aes(x = independent, y = dependent)) +  
  geom_col()
```

Plot the mean feelings towards Obama `obama_therm` by party identification `pid_x`.

```
# create the summary dataset  
partymeans <- nes %>%  
  group_by(pid_x) %>%  
  summarise(average = wtd.mean(obama_therm, na.rm = T,  
                              weights = wt))  
  
# specify the data and mapping  
p1 <- ggplot(data = partymeans,  
             mapping = aes(x = pid_x, y = average)) +  
  
  # add the bar shape  
  geom_col()  
  
# print the plot  
p1
```



2.3.3 Troubleshooting

- Make sure that you use the summary dataset instead of the larger dataset.
- If there are errors in making the summary dataset, then there will be problems in the plot.
- You need to load the `tidyverse` package.

Chapter 3

Data Wrangling

3.1 Create a Factor Variable

3.1.1 Problem

You want to transform a variable into a factor.

3.1.2 Solution

1. Decide on what to name the factor variable.
2. Use `as.factor()` to assign the old variable values to the new variable.
3. Use `levels()` to assign labels to the values of the variable.
4. The levels should be provided as a list in `c()` with the names of the levels in quotation marks.
5. It would follow the general template below.

```
# define the variable as a factor

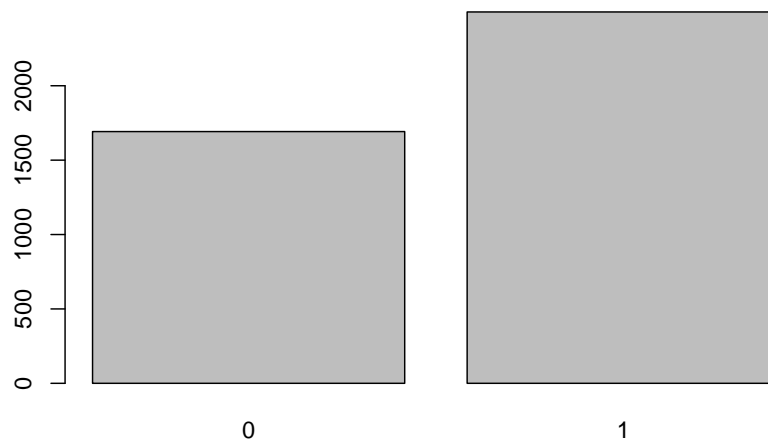
data$newvariable <- as.factor(data$oldvariable)

# add the levels

levels(data$newvariable) <- c("label1", "label2", "labelk")
```

Transform `obama_vote` in the `nes` from a numeric dummy variable into a factor.

```
# the frequency table for the old variable
freq(nes$obama_vote)
```

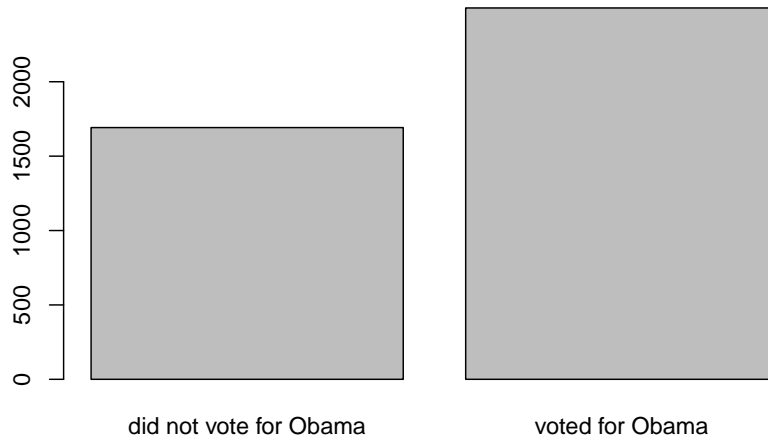


```
## nes$obama_vote
##      Frequency Percent Valid Percent
## 0          1692   28.60          40.4
## 1          2496   42.19          59.6
## NA's          1728   29.21
## Total          5916  100.00         100.0
```

```
# call the new variable `obamafct`
nes$obamafct <- as.factor(nes$obama_vote)

# assign the levels
levels(nes$obamafct) <- c("did not vote for Obama", "voted for Obama")

# the frequency table for the new variable
freq(nes$obamafct)
```



```
## nes$obamafct
##
## did not vote for Obama    Frequency Percent Valid Percent
## voted for Obama          2496    42.19      59.6
## NA's                     1728    29.21
## Total                    5916   100.00      100.0
```

3.1.3 Troubleshooting

- There has to be a level provided for each value of the variable. That is why this process should occur after a variable has been cleaned.
- The level names do not have to be unique. That means this could be used as a (somewhat clunky) method of recoding a variable by collapsing its categories.

3.2 Create a Numeric Variable

3.2.1 Problem

You want to transform an existing variable into a numeric variable.

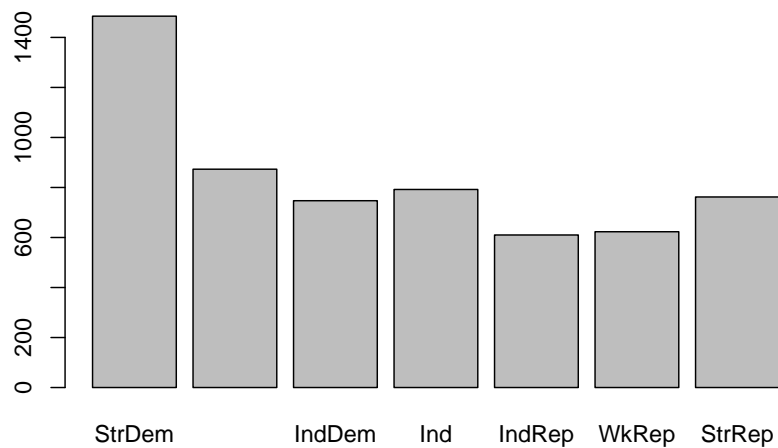
3.2.2 Solution

1. Decide on what to name the numeric variable. It could be the same name as the old variable.
2. Use `as.numeric()` to assign the old variable values to the new variable.
3. It would follow the general template below.

```
data$newvariable <- as.numeric(data$oldvariable)
```

Here is an example that converts the seven-point party identification scale into a numeric variable.

```
# frequency table of the original variable `pid_x`
freq(nes$pid_x)
```

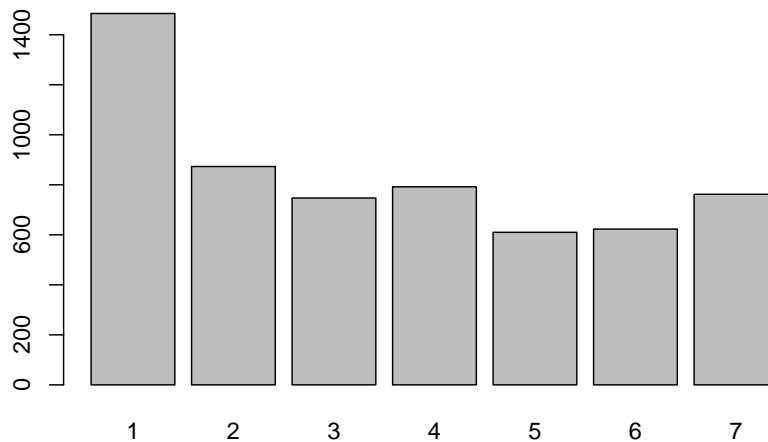


```
## nes$pid_x
##           Frequency  Percent Valid Percent
## StrDem           1485    25.1014         25.20
## WkDem              873    14.7566         14.82
## IndDem             747    12.6268         12.68
## Ind               792    13.3874         13.44
## IndRep            610    10.3110         10.35
## WkRep             623    10.5308         10.57
## StrRep            762    12.8803         12.93
```

```
## NA's          24    0.4057
## Total        5916 100.0000      100.00
```

```
# make `pid_x` numeric
nes$pid7 <- as.numeric(nes$pid_x)

# frequency table of the new variable `pid7`
freq(nes$pid7)
```



```
## nes$pid7
##      Frequency  Percent Valid Percent
## 1          1485   25.1014         25.20
## 2           873   14.7566         14.82
## 3           747   12.6268         12.68
## 4           792   13.3874         13.44
## 5           610   10.3110         10.35
## 6           623   10.5308         10.57
## 7           762   12.8803         12.93
## NA's          24    0.4057
## Total        5916 100.0000      100.00
```

3.2.3 Troubleshooting

- Have not come across any problems yet.

3.3 Create a Subset of Data

3.3.1 Problem

You want to create a subset of your data based on some criteria.

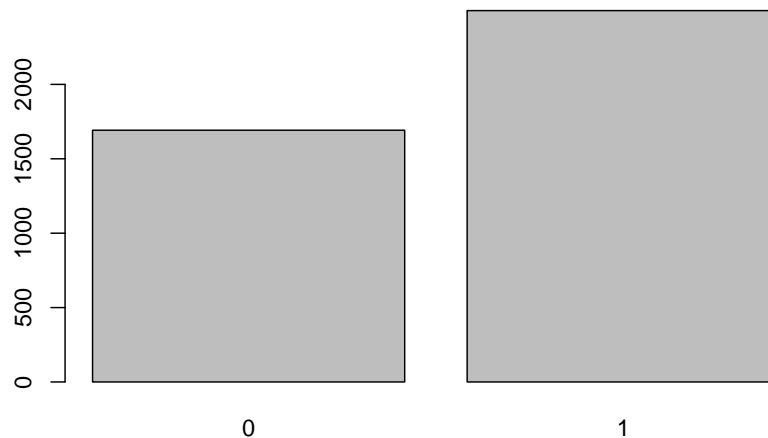
3.3.2 Solution - Basic

1. Provide a name for the subset of data you are creating.
2. Use `subset()`. The main arguments are the data object that is being subsetted, the criteria for determining which observations to include in the subset, and the selection of columns for inclusion in the new data object.
3. The criteria use relational logic such as `==`, `>`, `!=`, etc.
4. Follow the template below.

```
newdata <- subset(old_data, criteria, select = c(list of columns))
```

Here we create a subset that only includes people who voted for Obama.

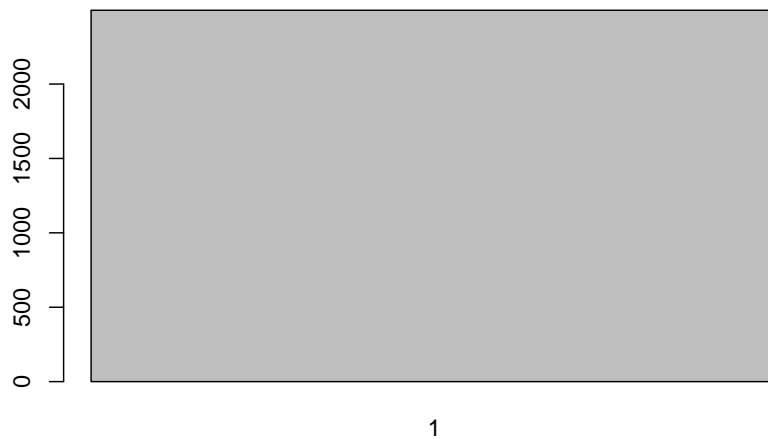
```
# frequency of `obama_vote` in full dataset  
freq(nes$obama_vote)
```



```
## nes$obama_vote
##      Frequency Percent Valid Percent
## 0          1692    28.60          40.4
## 1          2496    42.19          59.6
## NA's          1728    29.21
## Total          5916   100.00         100.0
```

```
# create a subset of `nes` data that only includes Obama voters
ovoters <- subset(nes, obama_vote == 1)

# frequency of a `obama_vote` in subset
freq(ovoters$obama_vote)
```



```
## ovoters$obama_vote
##      Frequency Percent
## 1          2496     100
## Total          2496     100
```

3.3.3 Solution - Tidyverse

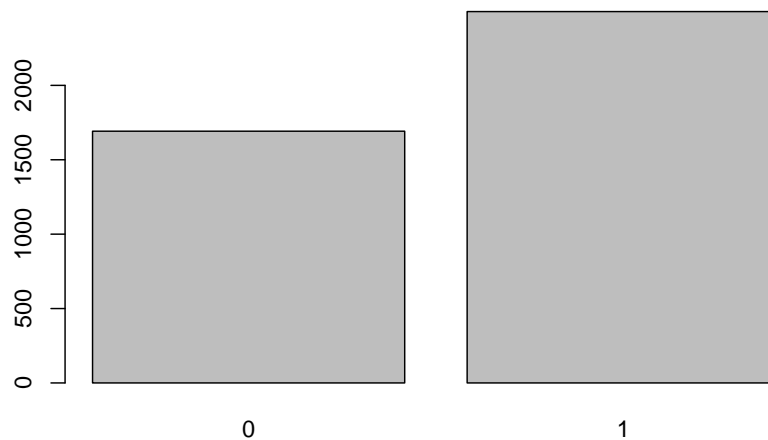
1. Provide a name for the subset of data you are creating.
2. Assign the existing dataset to the new data object.
3. Use the pipe %>%.

4. Use `filter()`. The pipe inherits the dataset from the prior step, so the only argument is the criteria for the subset.
5. The criteria use relational logic such as `==`, `>`, `!=`, etc.
6. Follow the template below.

```
newdata <- old_data %>%
  filter(criteria)
```

Here we create a subset that only includes people who voted for Obama.

```
# frequency of `obama_vote` in full dataset
freq(nes$obama_vote)
```

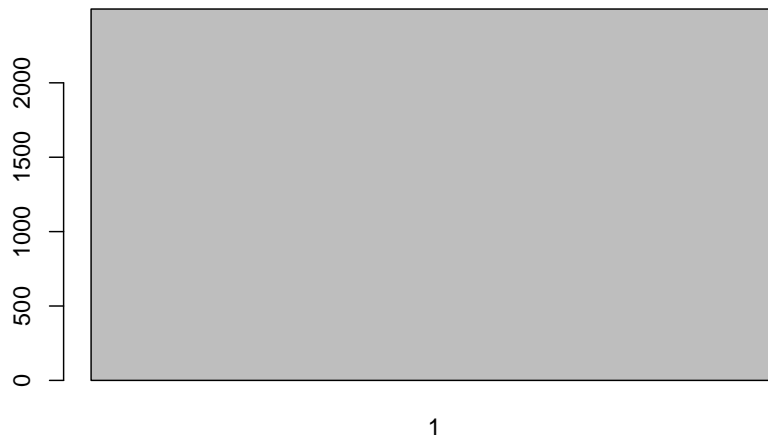


```
## nes$obama_vote
##      Frequency Percent Valid Percent
## 0          1692   28.60          40.4
## 1          2496   42.19          59.6
## NA's        1728   29.21
## Total          5916 100.00          100.0
```

```
# create a subset of `nes` data that only includes Obama voters
obamites <- nes %>%
  filter(obama_vote == 1)
```



```
# frequency of a `obama_vote` in subset  
freq(obamites$obama_vote)
```



```
## obamites$obama_vote  
##      Frequency Percent  
## 1          2496      100  
## Total          2496      100
```

3.3.4 Troubleshooting

- Make sure that your subset is assigned to something.
- The criteria is written as variable, logical operator, and value of the variable.
- The values of categorical variables must be in quotation marks.

3.4 Summarize Data Using Means

3.4.1 Problem

You want to make a summary dataset that shows the mean of one variable for each value of some other variable.

3.4.2 Solution

1. Assign the old data to a new data object.
2. Use the pipe `%>%` at the end of the line of code.
3. Use `group_by()`. The argument is the variable that you want to use to find the means of some other variable.
4. Use the pipe `%>%` at the end of the line of code.
5. Use `summarise()`.
6. Create a name for the summary variable.
7. Set the summary variable as being equal to the mean of the variable that you want to take the mean of.

```
newdata <- old_data %>%
  group_by(group_variable) %>%
  summarise(summary_variable = mean(mean_variable))
```

Here we calculate the mean feelings towards Obama, `obama_therm`, by party identification, `pid_x`.

```
# assign old data to a new data object
partymeans <- nes %>%

  # use group_by() to group the data by pid_x
  group_by(pid_x) %>%

  # calculate the means of obama_therm
  summarise(average = wtd.mean(obama_therm, na.rm = T,
                               weights = wt))

# show the summary dataset
partymeans
```

```
## # A tibble: 8 x 2
##   pid_x average
##   <fct>    <dbl>
## 1 StrDem    90.1
## 2 WkDem     74.2
## 3 IndDem    75.2
## 4 Ind      53.3
## 5 IndRep    32.8
## 6 WkRep     36.7
## 7 StrRep    17.6
## 8 <NA>     61.0
```

3.4.3 Troubleshooting

- For survey data use `wtd.mean()`. Use `mean()` for non-survey data.

3.5 Label Missing Observations in a Dataset

Sometimes we will work with survey data that has observations with numeric codes that are not aligned with a response of interest. For example, the numeric code -9 might signify that a person did not actually answer the survey question. We want to label this particular observation as “missing”.

3.5.1 Problem

You want to label missing observations.

3.5.2 Solution