

# Journal

This page will contain all the assignments you submit for the class.

## Instructions for all assignments

I want you to submit your assignment as a PDF, so I can keep a record of what the code looked like that day. I also want you to include your answers on your personal GitHub website. This will be good practice for editing your website and it will help you produce something you can keep after the class is over.

1. Download the Assignment1.Rmd file from Canvas. You can use this as a template for writing your answers. It's the same as what you can see on my website in the Assignments tab. Once we're done with this I'll edit the text on the website to include the solutions.
2. On RStudio, open a new R script in RStudio (File > New File > R Script). This is where you can test out your R code. You'll write your R commands and draw plots here.
3. Once you have finalized your code, copy and paste your results into this template (Assignment 1.Rmd). For example, if you produced a plot as the solution to one of the problems, you can copy and paste the R code in R markdown by using the ```{r} ``` command. Answer the questions in full sentences and Save.
4. Produce a PDF file with your answers. To do this, knit to PDF (use Knit button at the top of RStudio), locate the PDF file in your docs folder (it's in the same folder as the Rproj), and submit that on on Canvas in Assignment 1.
5. Build Website, go to GitHub desktop, commit and push. Now your solutions should be on your website as well.

## Assignment 1

**Collaborators: Natalie Yang.**

This assignment is due on Canvas on Monday 9/20 before class, at 10:15 am. Include the name of anyone with whom you collaborated at the top of the assignment.

### Problem 1

Install the datasets package on the console below using `install.packages("datasets")`. Now load the library.

```
library(datasets)
```

Load the USArrests dataset and rename it `dat`. Note that this dataset comes with R, in the package datasets, so there's no need to load data from your computer. Why is it useful to rename the dataset?

```
dat <- USArrests
```

It's useful to rename the dataset so you know can keep track of which dataset is which - it can stick in your mind more if you rename it. Also, when you're altering data, it's best to keep track of the different versions are which (ie which datasets are untouched, etc). Lastly, I wouldn't want to alter a Base R package dataset, and then save it to my workspace, and have that alter things in the future.

## Problem 2

Use this command to make the state names into a new variable called State.

```
dat$state <- tolower(rownames(USArrests))
```

This dataset has the state names as row names, so we just want to make them into a new variable. We also make them all lower case, because that will help us draw a map later - the map function requires the states to be lower case.

List the variables contained in the dataset USArrests.

```
colnames(dat)
```

```
## [1] "Murder" "Assault" "UrbanPop" "Rape"
```

The output is: [1] "Murder" "Assault" "UrbanPop" "Rape" "state"

## Problem 3

What type of variable (from the DVB chapter) is Murder?

Answer: A quantitative variable.

What R Type of variable is it?

Answer: Numeric (class(dat\$Murder) returns numeric)

## Problem 4

What information is contained in this dataset, in general? What do the numbers mean?

Answer: This dataset contains information on Murder, Assault, and Rape per 100,000 residents, by state for all 50 states in the United States.

## Problem 5

Draw a histogram of Murder with proper labels and title.

```
hist(dat$Murder,
     main = "Histogram of Murders",
     xlim = c(0, 20),
     ylim = c(0, 13),
     xlab = "Number of Murders",
     ylab = "Frequency")
```

## Histogram of Murders



### Problem 6

Please summarize `Murder` quantitatively. What are its mean and median? What is the difference between mean and median? What is a quartile, and why do you think R gives you the 1st Qu. and 3rd Qu.?

```
mean(dat$Murder)
```

```
## [1] 7.788
```

```
median(dat$Murder)
```

```
## [1] 7.25
```

```
summary(dat$Murder)
```

```
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      0.800   4.075   7.250   7.788  11.250   17.400
```

Mean is the average amount of Murders in all 50 states, while median is the middle state Murder level in the dataset. The 1st quartile shows us that the lowest 25% state Murder rates are under 4.075. The 3rd quartile shows us that for the 50.1-75% of states, which is the block right above the median. We don't need the 2nd quartile because we have the Median to know that the 25.1-50% of states fall between that number and the 1st quartile. We are given the max as well, which is technically the 4th quartile, and that alongside the 3rd quartile amount gives us all the information we need about distribution of Murder rate in the dataset. The mean is also greater than the median, so the dataset is positively skewed.

### Problem 7

Repeat the same steps you followed for `Murder`, for the variables `Assault` and `Rape`. Now plot all three histograms together. You can do this by using the command `par(mfrow=c(3,1))` and then plotting each of the three.

```
par(mfrow=c(3, 1))

hist(dat$Assault,
     main = "Histogram of Assaults",
     xlim = c(0, 355),
     ylim = c(0, 15),
     xlab = "Number of Assaults",
     ylab = "Frequency")

hist(dat$Murder,
     main = "Histogram of Murders",
     xlim = c(0, 20),
     ylim = c(0, 13),
     xlab = "Number of Murders",
     ylab = "Frequency")

hist(dat$Rape,
     main = "Histogram of Rapes",
     xlim = c(0, 52),
     ylim = c(0, 15),
     xlab = "Number of Rapes",
     ylab = "Frequency")
```



What does the command `par` do, in your own words (you can look this up by asking R `?par`)?

Answer: `Par` splits up our screen so we can see more than one figure in one viewing. In the example above, we used `par` to split the screen into three horizontal chunks. By changing the second number in the `par` function, we could also bisect the screen vertically.

What can you learn from plotting the histograms together?

Answer: You can compare frequencies, and you can also see how some crimes (such as Assaults) are committed

more than others (e.g. Murders).

### Problem 8

In the console below (not in text), type `install.packages("maps")` and press Enter, and then type `install.packages("ggplot2")` and press Enter. This will install the packages so you can load the libraries.

Run this code:

```
library('maps')
library('ggplot2')

ggplot(dat, aes(map_id=state, fill=Murder)) +
  geom_map(map=map_data("state")) +
  expand_limits(x=map_data("state")$long, y=map_data("state")$lat)
```

What does this code do? Explain what each line is doing.

Answer: This code shows the murder rates graphically. With the entire contiguous US being shown on a map, the code shades states on a light-dark scale based on how high their Murder rate (per 100,000 residents) are. States with lower murder rates are shaded darker, and vice versa for higher ones. We can see states in the PNW and NE regions have lower Murder rates than states in the SE visually with this map.

## Assignment 2

Instructions: Copy your code, paste it into a Word document, and turn it into Canvas. You can turn in a .docx or .pdf file. Show any EDA (graphical or non-graphical) you have used to come to this conclusion.

**Collaborators: Natalie Yang.**

Instructions: Copy your code, paste it into a Word document, and turn it into Canvas. You can turn in a .docx or .pdf file. Show any EDA (graphical or non-graphical) you have used to come to this conclusion.

**Set your working directory to the folder where you downloaded the data.**

**Read the data**

```
library(readr)
dat <- read_csv("dat.nsduh.small.1.csv")
```

```
## Rows: 171 Columns: 7
```

```
## -- Column specification -----
## Delimiter: ","
## dbl (7): mjage, cigage, iralcage, age2, sexatract, speakengl, irsex

##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

## What are the dimensions of the dataset?

```
dim(dat)
```

```
## [1] 171 7
```

The dimensions are 171 rows by 7 columns

## Problem 2: Variables

Describe the variables in the dataset.

The variables are all numeric. They represent different number ranges, which account for different meanings. For example, the age2 variable represents the respondents age. In some buckets, only the exact age is contain (ie 1 represents the age 12), but in others it represents a range (eg 13 represents ages 26-29).

What is this dataset about? Who collected the data, what kind of sample is it, and what was the purpose of generating the data?

This data set is from the National Survey of Drug Use in 2019. It looks into when respondents first started using drugs/alcohol/nicotine, even if it's before the legal age. The NSDUH collected the data, and it seems to be a random sample from a large range of ages. This data is meant to reflect drug/alcohol/etc use across the whole country.

```
names(dat)
```

```
## [1] "mjage"      "cigage"      "iralcage"    "age2"        "sexatract"   "speakengl"
## [7] "irsex"
```

The variables are: mjage, cigage, iralcage, age2, sexatract, speakengl, and irsex

## Problem 3: Age and gender

What is the age distribution of the sample like? Make sure you read the codebook to know what the variable values mean.

```
hist(dat$age2,
      main = "Histogram of Age",
      xlim = c(0, 20),
      ylim = c(0, 120),
      xlab = "Quantity in Each Age Bucket",
      ylab = "Frequency")
```

## Histogram of Age



The age frequency obviously isn't fully representative of the US population, because it doesn't have respondents below the age of 12.

Is the sample balanced in terms of gender? If not, are there more females or males?

```
sum(dat$irsex[dat$irsex == 2])
```

```
## [1] 160
```

```
sum(dat$irsex)
```

```
## [1] 251
```

160 females, 251 respondents in total

This sample isn't balanced in terms of gender because there are 69 more females than males. This is not representative of the US population, where gender is mostly balanced.

## Problem 4: Substance use

For which of the three substances included in the dataset (marijuana, alcohol, and cigarettes) do individuals tend to use the substance earlier?

```
dat$iralcage[dat$iralcage == 5]
```

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

```
dat$cigage[dat$cigage == 10]
```

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



```
dat$mjage[dat$mjage == 7]
```

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

There is only one user in the earliest bucket for marijuana and cigarette use. There are two for alcohol use. I am deducing that individuals tend to use alcohol earlier.

## Problem 5: Sexual attraction

What does the distribution of sexual attraction look like? Is this what you expected?

```
dat$sex.attract <- dat$sexattract
dat$sex.attract[dat$sex.attract == 85 | dat$sex.attract == 94 | dat$sex.attract == 97 |
               dat$sex.attract == 98 | dat$sex.attract == 99 ] <- NA

hist(dat$sex.attract,
     main = "Histogram of Sexual Attraction",
     xlab = "Quantity in Each Age Bucket",
     ylab = "Frequency")
```



Most people identify as heterosexual, which is what I expected.

What is the distribution of sexual attraction by gender?

```
tab.sexgender <- table(dat$sex.attract, dat$irsex)
barplot(tab.sexgender,
       main = "Stacked barchart",
       xlab = "Gender", ylab = "Frequency",
       legend.text = rownames(tab.sexgender),
       beside = FALSE) # Stacked bars (default)
```

## Stacked barchart



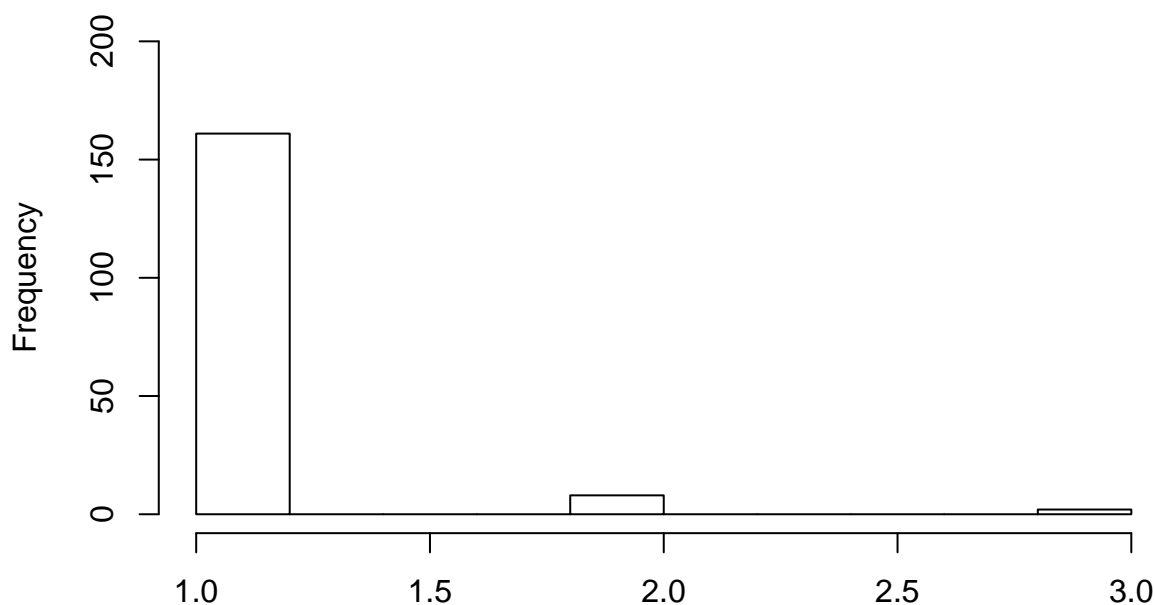
males identify as straight than females.

### Problem 6: English speaking

What does the distribution of English speaking look like in the sample? Is this what you might expect for a random sample of the US population?

```
hist(dat$speakengl,  
      main = "Histogram of English Speaking",  
      xlim = c(1,3),  
      ylim = c(0, 200),  
      xlab = "Quantity in Each Age Bucket",  
      ylab = "Frequency")
```

## Histogram of English Speaking



### Quantity in Each Age Bucket

Mostly

everyone is an English speaker, and speaks very well/well, which is what I expected, as this is a national sample coming from the United States, and the official language is English. It would be interesting to look at how many people are native English speakers in the future.

Are there more English speaker females or males?

(in this, I'm using values 1-3 to count as speaking English)

```
sum(dat$irsex[dat$irsex == 1 & (dat$peakengl == 1 | dat$peakengl == 2 | dat$peakengl == 3)])
```

```
## [1] 91
```

```
sum(dat$irsex[dat$irsex == 2 & (dat$peakengl == 1 | dat$peakengl == 2 | dat$peakengl == 3)])
```

```
## [1] 160
```

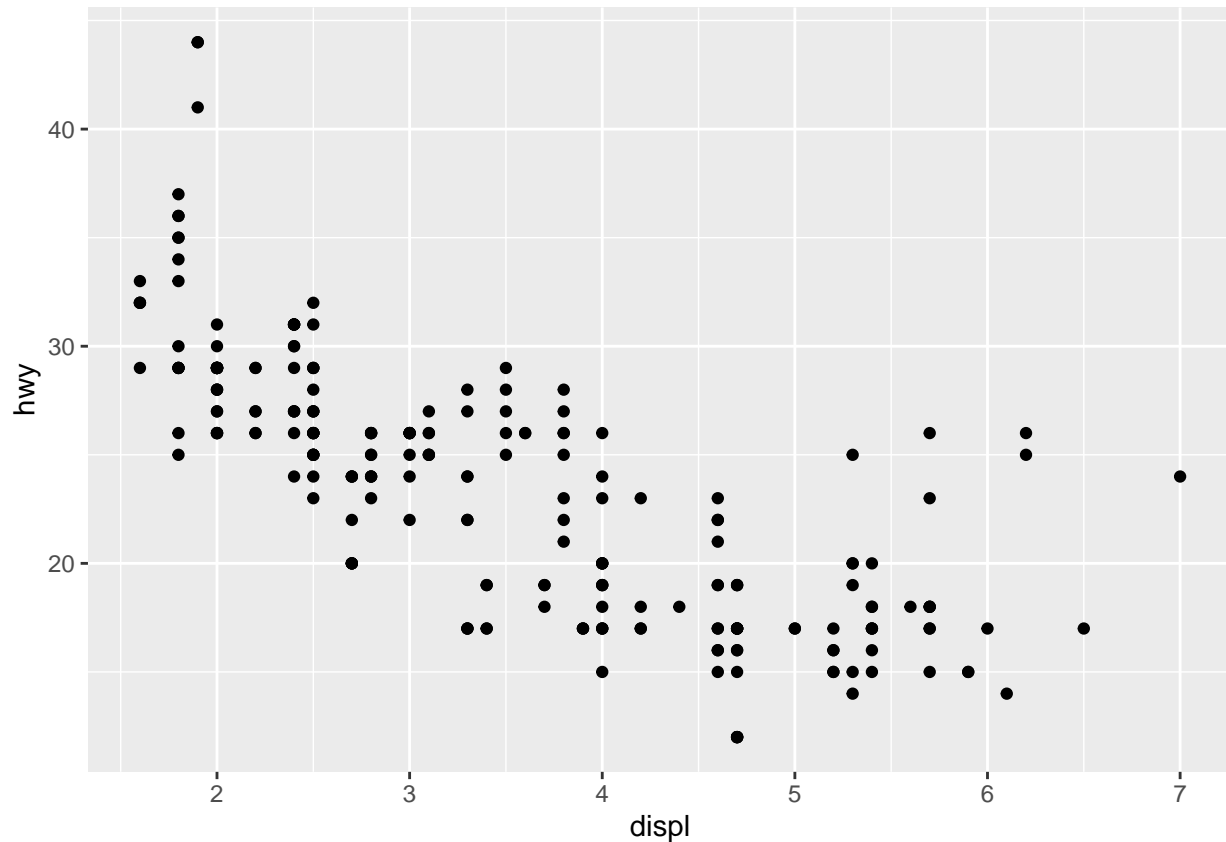
91 English speakers are male, and 160 are females. All respondents fall into a English-speaking bucket, and so with the unbalanced gender we saw earlier, there are more female English speakers than male.

```
# Assignment 4
```

```
## install.packages("tidyverse")  
library(tidyverse)
```

install/load in tidyverse package (what we need for ggplot functions)

```
ggplot(data = mpg) +  
  geom_point(mapping = aes(x = displ, y = hwy))
```



don't need to load in mpg dataset because it's base R. This function starts with a base map, then each argument adds another layer to it - such as `geom_point()` adding scatters to it, thus creating a scatter plot.

```
ggplot(data = mpg) ## blank template to plot on
```

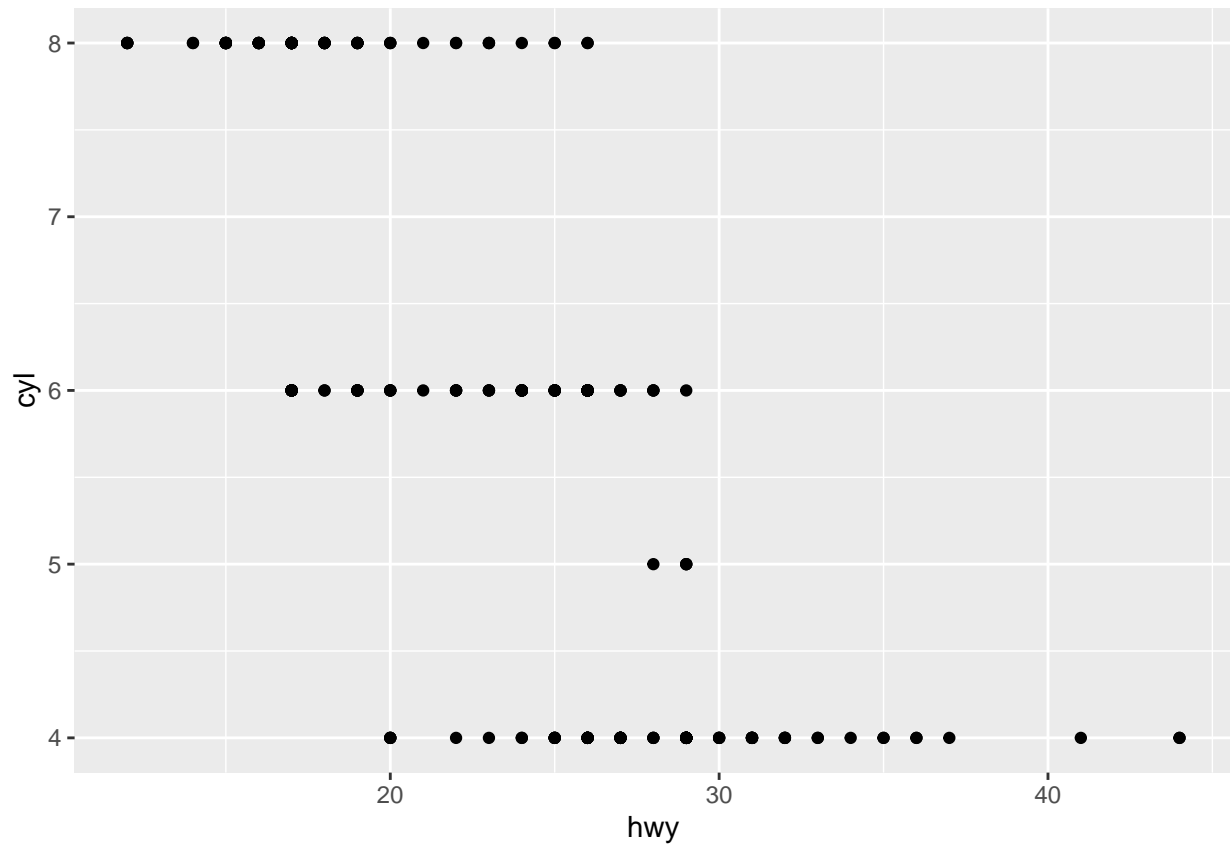


```
dim (mpg) ## [1] 234 11
```

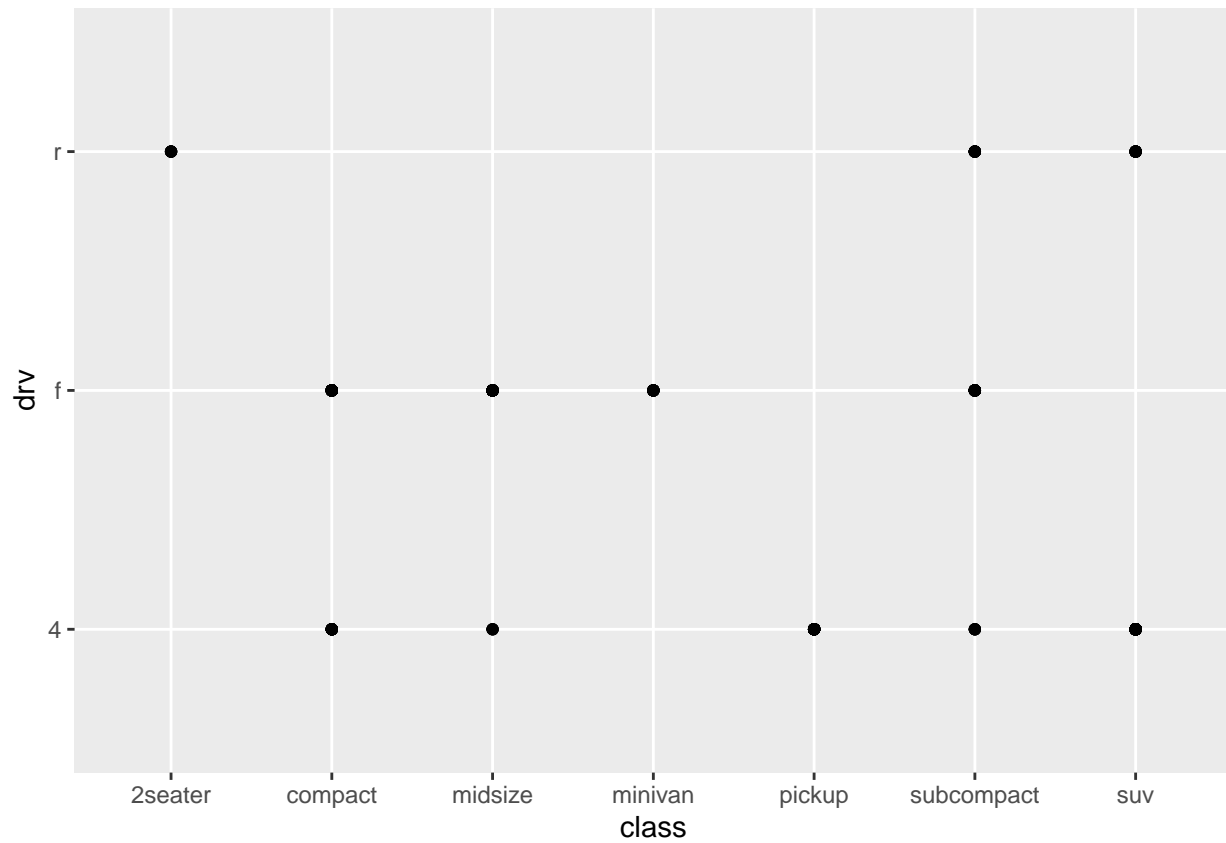
```
## [1] 234 11
```

```
## ?mpg - drv shows us the type of drive train, where f = front-wheel drive, r = rear wheel drive, 4 = 4-wheel drive
```

```
ggplot(data = mpg) +  
  geom_point(mapping = aes(x = hwy, y = cyl))
```

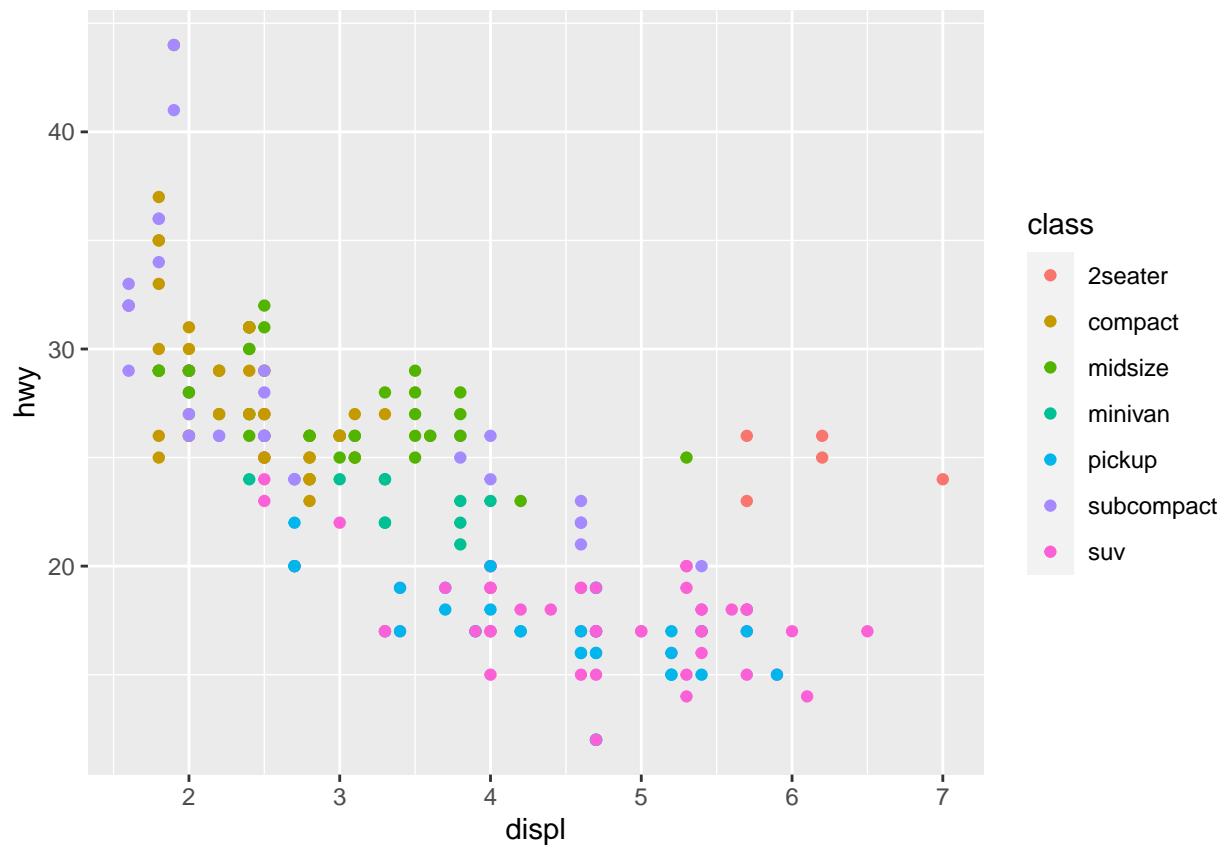


```
ggplot(data = mpg) +  
  geom_point(mapping = aes(x = class, y = drv))
```



*## this isn't really useful because it shows us the type of car vs the type of drive (front wheel/4 wheel)*

```
ggplot(data = mpg) +  
  geom_point(mapping = aes(x = displ, y = hwy, color = class))
```

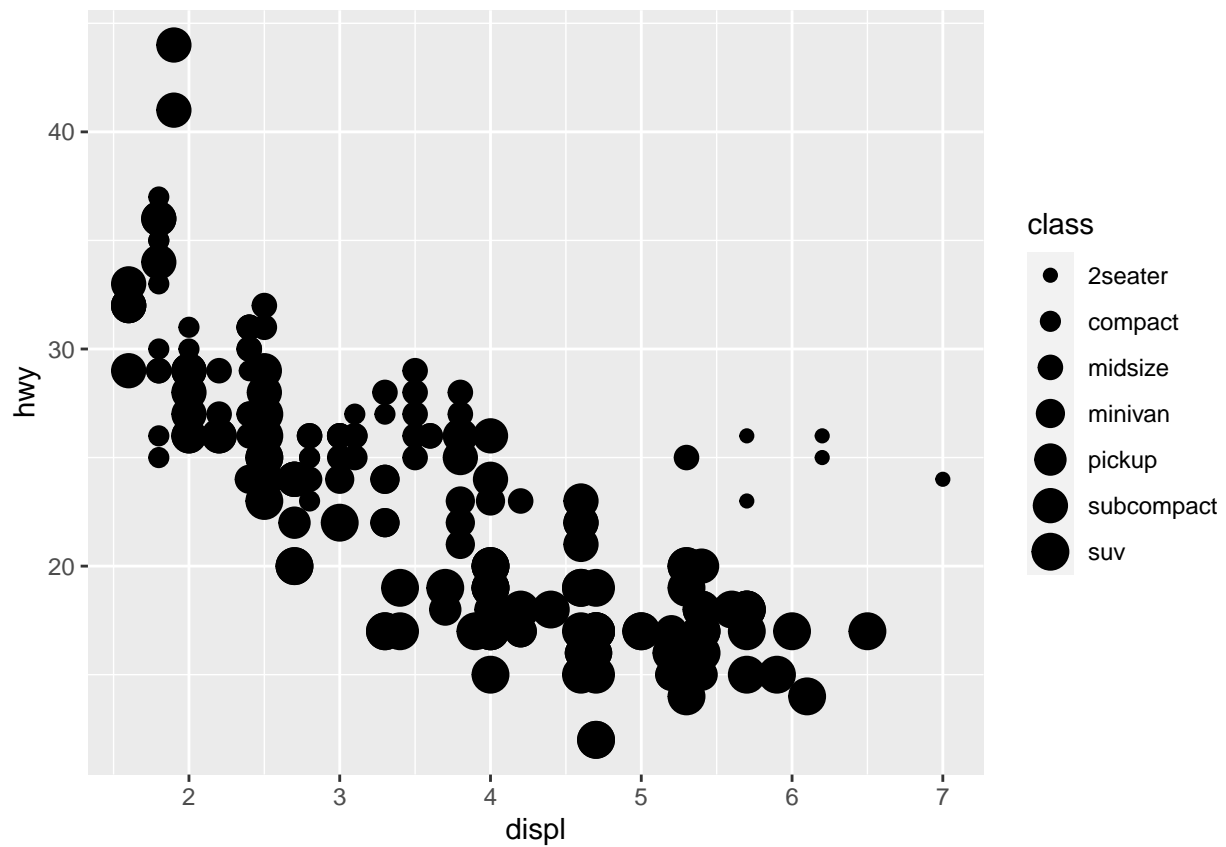


*## different variables will have different colors based off of the class of vehicle. Color could also j*

```
ggplot(data = mpg) +  
  geom_point(mapping = aes(x = displ, y = hwy, size = class))
```

## Warning: Using size for a discrete variable is not advised.



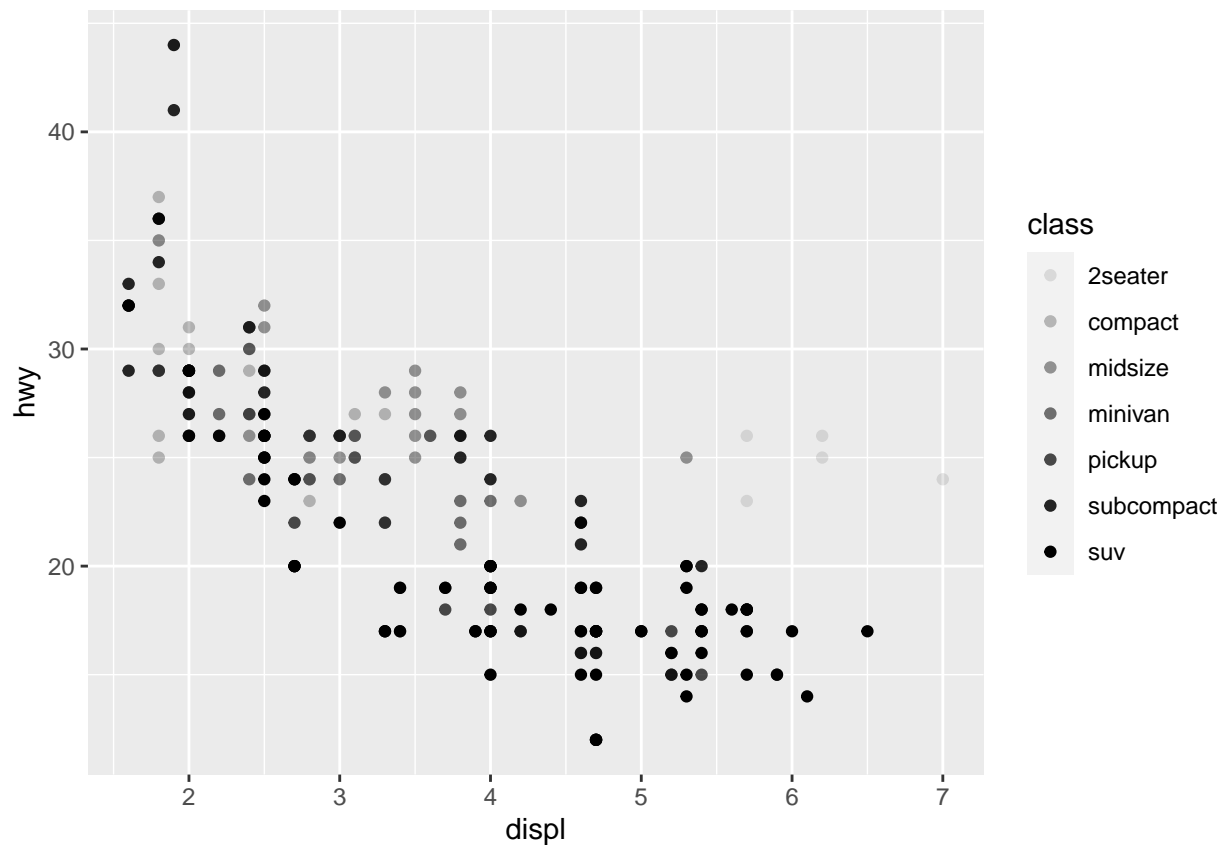


```
## size of the scatter point changes based off of the class of car
```

```
# Left
```

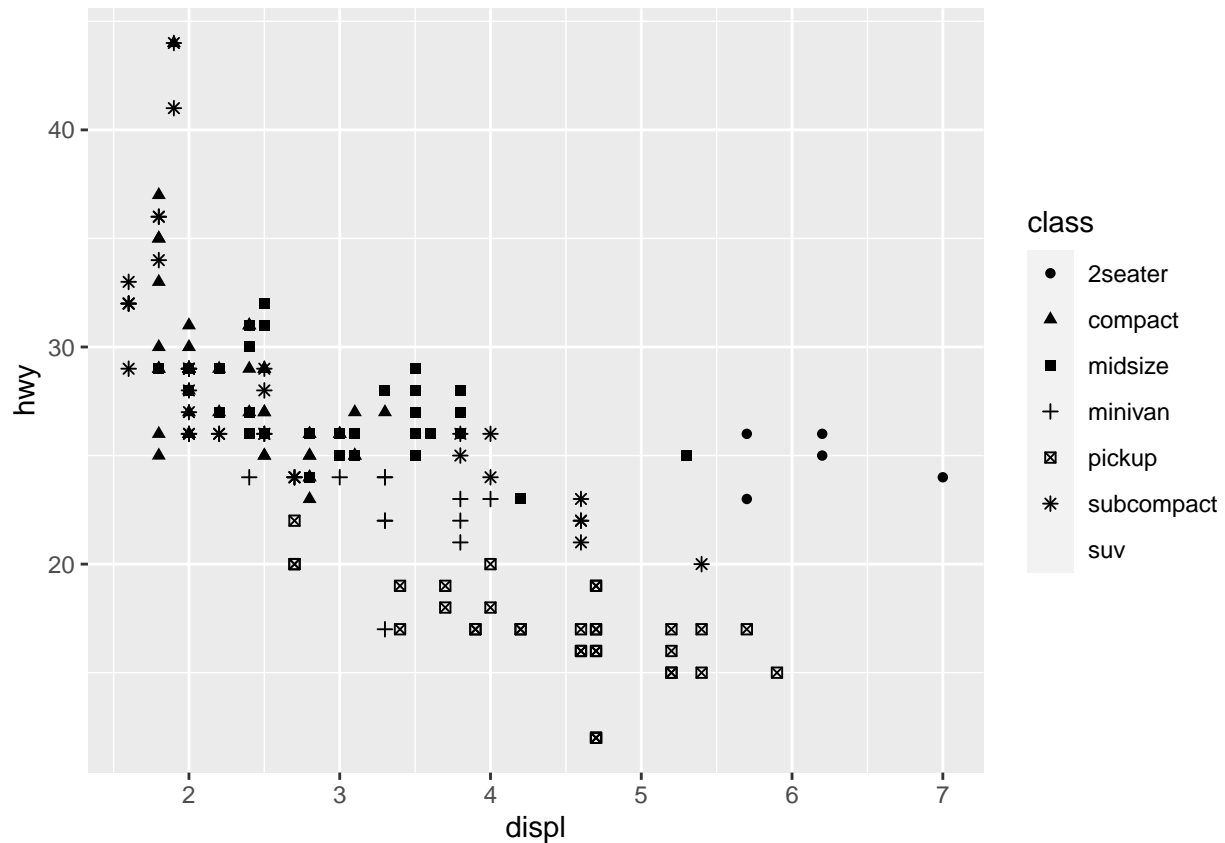
```
ggplot(data = mpg) +  
  geom_point(mapping = aes(x = displ, y = hwy, alpha = class))
```

```
## Warning: Using alpha for a discrete variable is not advised.
```



```
# Right
ggplot(data = mpg) +
  geom_point(mapping = aes(x = displ, y = hwy, shape = class))
```

```
## Warning: The shape palette can deal with a maximum of 6 discrete values
## because more than 6 becomes difficult to discriminate; you have 7.
## Consider specifying shapes manually if you must have them.
## Warning: Removed 62 rows containing missing values (geom_point).
```



*## alpha controls the transparency of the points while shape controls the shape of them*

## Exam 1

### Instructions

- Create a folder in your computer (a good place would be under Crim 250, Exams).
- Download the dataset from the Canvas website (fatal-police-shootings-data.csv) onto that folder, and save your Exam 1.Rmd file in the same folder.
- Download the README.md file. This is the codebook.

d. Load the data into an R data frame.

```
dat <- read_csv("fatal-police-shootings-data.csv")

## Rows: 6594 Columns: 17
## -- Column specification -----
## Delimiter: ","
## chr  (9): name, manner_of_death, armed, gender, race, city, state, thre...
## dbl  (4): id, age, longitude, latitude
## lgl  (3): signs_of_mental_illness, body_camera, is_geocoding_exact
## date (1): date

##
## i Use `spec()` to retrieve the full column specification for this data.
## i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

### Problem 1 (10 points)

- a. Describe the dataset. This is the source: <https://github.com/washingtonpost/data-police-shootings>. Write two sentences (max.) about this.

The dataset (compiled by Washington Post) tracks fatal civilian shootings in the United States by an officer in the line of duty since January 1, 2015. It tracks more than a dozen details, (e.g. race of the victim, if they were having a mental health crisis), which are not available in CDC/FBI records, and those records are incomplete - the database is updated regularly with new details/shootings.

- b. How many observations are there in the data frame?

```
dim(dat)

## [1] 6594 17
```

There are 6,594 observations in the data frame

- c. Look at the names of the variables in the data frame. Describe what “body\_camera”, “flee”, and “armed” represent, according to the codebook. Again, only write one sentence (max) per variable.

```
names(dat)

## [1] "id"           "name"
## [3] "date"        "manner_of_death"
## [5] "armed"       "age"
## [7] "gender"      "race"
## [9] "city"        "state"
## [11] "signs_of_mental_illness" "threat_level"
## [13] "flee"        "body_camera"
## [15] "longitude"   "latitude"
## [17] "is_geocoding_exact"
```

“body\_camera” denotes whether or not the officer who killed the civilian was wearing a body camera at some point during the incident. “flee” tells us if the victim was moving away from officers, and if so - by what means. The “armed” variable tells us if the victim was armed with some sort of implement that a police officer believed could inflict harm.

- d. What are three weapons that you are surprised to find in the “armed” variable? Make a table of the values in “armed” to see the options.

```
armed.val <- table(unique(dat$armed))  
View(armed.val)
```

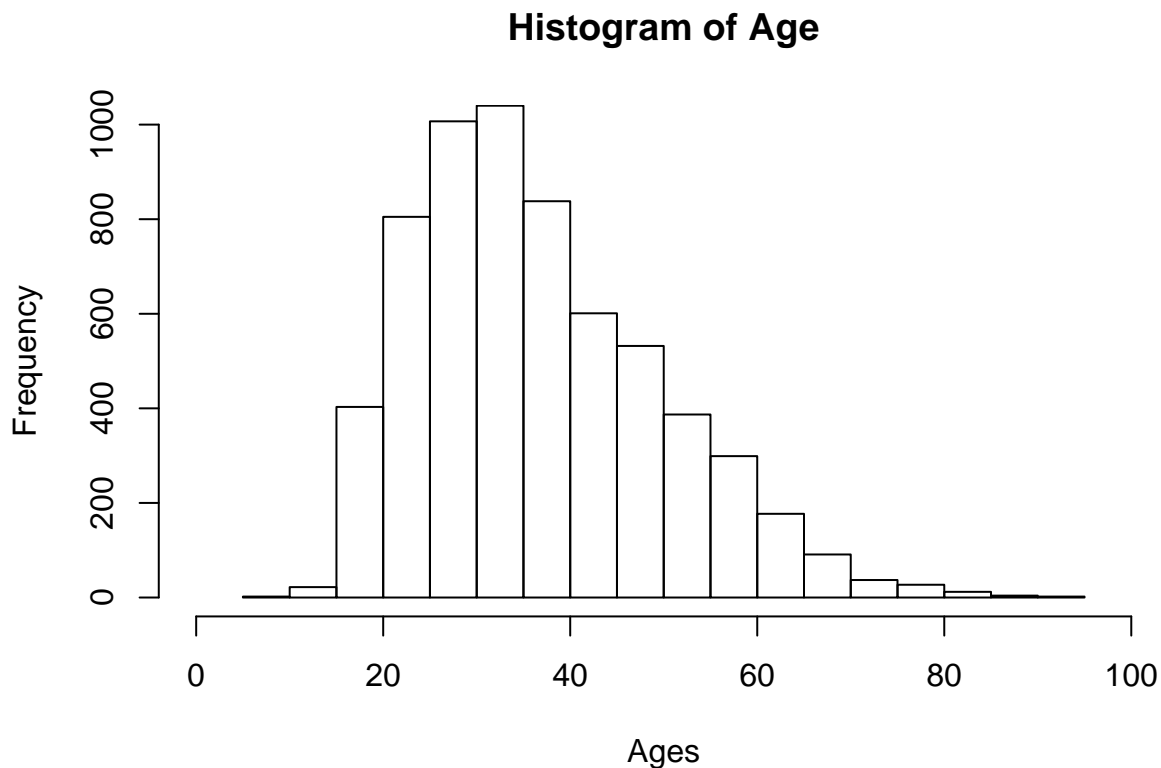
```
## Warning in system2("/usr/bin/otool", c("-L", shQuote(DSO)), stdout = TRUE):  
## running command '/usr/bin/otool' -L '/Library/Frameworks/R.framework/  
## Resources/modules/R_de.so' had status 1
```

Samurai sword is very unique, and I didn't expect to see that in there. Also, someone must have very good dexterity to use a pen in a dangerous way. I also found the specification between just a BB gun and the "BB gun and vehicle" option interesting.

## Problem 2 (10 points)

a. Describe the age distribution of the sample. Is this what you would expect to see?

```
hist(dat$age,  
     main = "Histogram of Age",  
     xlim = c(0, 100),  
     ylim = c(0, 1000),  
     xlab = "Ages")
```



The age distribution of the sample does not follow a normal distribution, and is actually skewed right. This shows us that more victims are in that 20-40 age range. This makes sense to me intuitively, because I would expect victims to be on the younger side. We see this database much resembles the case of Michael Brown, who was 18 when he was fatally killed by an officer in the line of duty. Also, since we're considering "fleeing" and victims with weapons, I would expect younger people to be more stealthy of movers and quicker with weapons, since old people don't move as well.

- b. To understand the center of the age distribution, would you use a mean or a median, and why? Find the one you picked.

```
median(dat$age, na.rm = T)
```

```
## [1] 35
```

While the mean would represent the average age of the victims in the dataset, the median actually helps us find the middle number, so the “center” of the distribution. We can see here that the median is 35 years of age, which falls into that 20-40 bucket of most common ages in part a.

- c. Describe the gender distribution of the sample. Do you find this surprising?

```
length(dat$gender[dat$gender == "M"])
```

```
## [1] 6301
```

```
length(dat$gender[dat$gender == "F"])
```

```
## [1] 296
```

```
length(dat$gender[dat$gender == "None"])
```

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

Nearly all the victims in the sample were men. I do not find this surprising, because most of the publicized police-brutality victims (Trayvon Martin, George Floyd, Michael Brown, etc.) have been men. In fact, I’m not sure if I can recall an incident of a fatal police shooting where the victim was a woman off the top of my head. Also, it could be that gender roles/stereotypes play into how aggressively a police officer treats someone, which is why more men are killed in fatal police shootings.

### Problem 3 (10 points)

- a. How many police officers had a body camera, according to news reports? What proportion is this of all the incidents in the data? Are you surprised that it is so high or low?

```
body.cam.yes <- length(which(dat$body_camera == "TRUE"))  
(body.cam.yes/nrow(dat)) * 100
```

```
## [1] 13.80042
```

910 officers had a body camera. I’m surprised by how low this proportion is. I don’t know much about body camera usage by officers, but I assumed that at least half the time there’s an incident with a civilian, the officer would turn on their body camera/have some kind of footage at some point during the encounter. Again, I don’t know the requirements for body cameras, but I expected higher. In highly publicized cases, there tends to be body camera footage (perhaps this is why they receive more media attention), so I just assumed that would be very common, and not only occur 13% of the time.

- b. In how many of the incidents was the victim fleeing? What proportion is this of the total number of incidents in the data? Is this what you would expect?

```
fleeing <- length(which(dat$flee != "Not fleeing"))  
(fleeing/nrow(dat)) * 100
```

```
## [1] 32.62056
```

2151 victims were fleeing. This represents about a third of the total number of incidents. This is honestly lower than what I expected. Again, I don't know much about how frequently civilians tend to flee from police, but I assumed that since these officers used (fatal) violent force on victims, these victims had to be doing something (such as fleeing), for them to be shot.

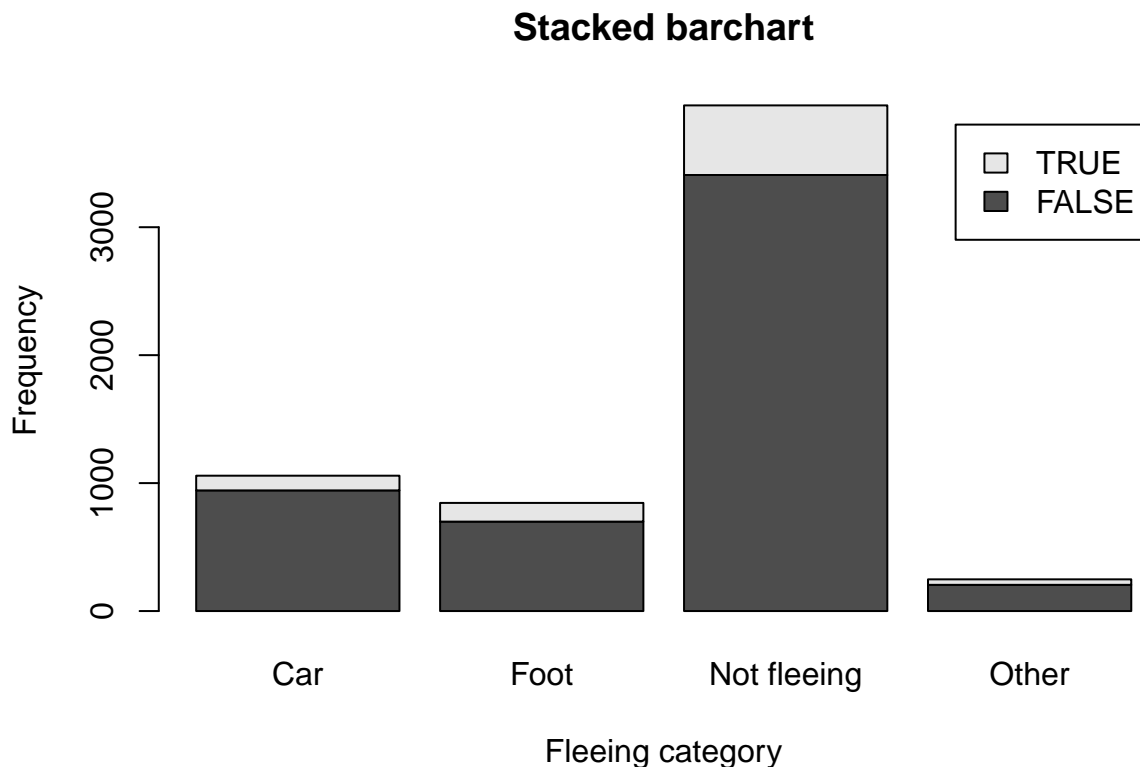
#### Problem 4 (10 points) - Answer only one of these (a or b).

- a. Describe the relationship between the variables “body camera” and “flee” using a stacked barplot. What can you conclude from this relationship?

*Hint 1: The categories along the x-axis are the options for “flee”, each bar contains information about whether the police officer had a body camera (vertically), and the height along the y-axis shows the frequency of that category).*

*Hint 2: Also, if you are unsure about the syntax for barplot, run ?barplot in R and see some examples at the bottom of the documentation. This is usually a good way to look up the syntax of R code. You can also Google it.*

```
tab.fleecam <- table(dat$body_camera, dat$flee)
barplot(tab.fleecam,
        main = "Stacked barchart",
        xlab = "Fleeing category",
        ylab = "Frequency",
        legend.text = rownames(tab.fleecam),
        beside = FALSE)
```



We can see from this stacked barplot that there is very little body camera footage when victims are fleeing/not regardless. Additionally, there is actually less body camera footage of victims who were fleeing than those who weren't. This shocks me, because I expect police would turn

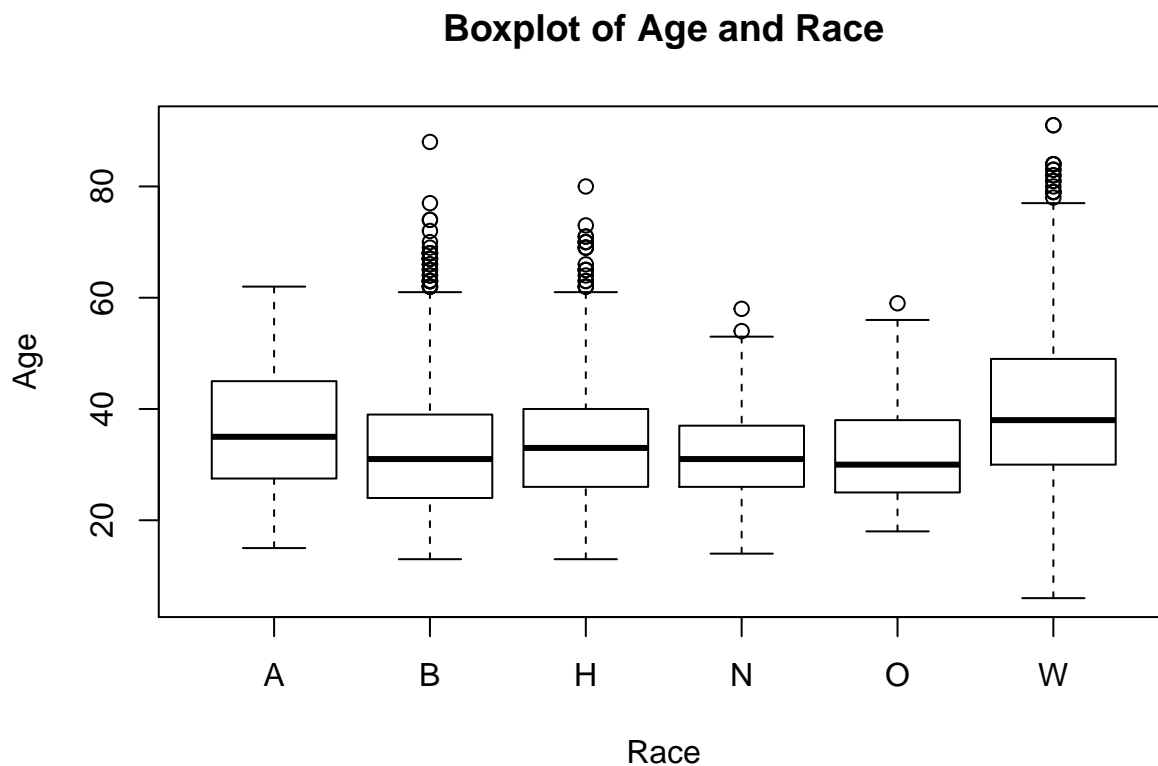
on body cameras if a civilian is literally moving away from them. I expected there to be less body camera footage of non-fleeing victims, rather than the opposite.

- b. Describe the relationship between age and race by using a boxplot. What can you conclude from this relationship?

*Hint 1: The categories along the x-axis are the race categories and the height along the y-axis is age.*

*Hint 2: Also, if you are unsure about the syntax for boxplot, run `?boxplot` in R and see some examples at the bottom of the documentation. This is usually a good way to look up the syntax of R code. You can also Google it.*

```
plot(factor(dat$race),
      dat$age,
      ylab="Age",
      xlab="Race",
      main = "Boxplot of Age and Race")
```



We can see here that the median (middle) age of White and Asian victims is higher than that of others. We can also see that Black victims (and other) tend to have the lowest ages. Also, we can see the age range of White victims is lowest. We can see here that members of certain racial categories are fatally shot at younger ages than those of others. Could this tie into life-expectancy for people in certain racial categories? People of White and Asian decent have higher life-expectancies, than say, Black people.

### Extra credit (10 points)

- a. What does this code tell us?

```
mydates <- as.Date(dat$date)
head(mydates)
(mydates[length(mydates)] - mydates[1])
```



The first line puts the date variable into actual date form (R initially puts them in as characters). We can see that now all the dates read as such by using the head function. The last line calculates the time difference between the dates, and shows us that this dataset covers 2458 days where there were fatal police/civilian shootings thus far. This is over 6 years of time, which means that this dataset must have been updated recently, since it first started in 2015 and it's now 2021.

- b. On Friday, a new report was published that was described as follows by The Guardian: "More than half of US police killings are mislabelled or not reported, study finds." Without reading this article now (due to limited time), why do you think police killings might be mislabelled or underreported?

I agree with this statement. We read in the codebook that the FBI/CDC log fatal shootings by police, but officials acknowledge that their data is incomplete. Since 2015, The Post has documented more than twice as many fatal shootings by police as recorded on average annually. I think perhaps this occurs because: paperwork isn't done/finalized, trials are still occurring, details of cases are still emerging, and that it looks bad on the US that officials are shooting so many civilians.

- c. Regarding missing values in problem 4, do you see any? If so, do you think that's all that's missing from the data?

Yes, there are missing values in problem 4. I'm sure there are many other things that are missing from the data. All these events are unique of each other and it's hard to do EDA when there are so many specific values/cases, and it's easier to put them all in an Other bucket.

# Exam 2

## Instructions

- Create a folder in your computer (a good place would be under Crim 250, Exams).
- Download the dataset from the Canvas website (sim.data.csv) onto that folder, and save your Exam 2.Rmd file in the same folder.
- Data description: This dataset provides (simulated) data about 200 police departments in one year. It contains information about the funding received by the department as well as incidents of police brutality. Suppose this dataset (sim.data.csv) was collected by researchers to answer this question: **"Does having more funding in a police department lead to fewer incidents of police brutality?"**
- Codebook:
  - funds: How much funding the police department received in that year in millions of dollars.
  - po.brut: How many incidents of police brutality were reported by the department that year.
  - po.dept.code: Police department code

## Problem 1: EDA (10 points)

Describe the dataset and variables. Perform exploratory data analysis for the two variables of interest: funds and po.brut.

```
## setwd("~/Desktop/senior year/crim 250/exam 2")
library(readr)
library(knitr)
library(ggpubr)
dat <- read_csv(file = 'sim.data.csv')
dim(dat)
```

```
## [1] 200  3
```

```
length(unique(dat$po.brut))
```

```
## [1] 27
```

```
summary(dat$funds)
```

```
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    21.40  51.67   59.75   61.04   72.17   99.70
```

```
summary(dat$po.brut)
```

```
##      Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##      0.00  14.00   19.00   18.14   22.00   29.00
```

The dataset has 3 columns and 200 rows - each row represents a unique police department, and the three columns label these departments and acknowledge their funding/number of police brutality incidents. There are 27 different amounts of police brutality incidents. The summary functions show us the spread of the data for our two variables of interest - the median number of police brutality incidents is 19 with a range of 14-29 incidents. It's wild to me that at each department has at least 14 incidents in one year. The spread of funding is also interesting, because it differs in about \$40Million, and the sheer amount is just so huge. The fact that half these departments receive almost \$60Million a year is crazy, but I also don't know how big the towns/cities are in this dataset.

## Problem 2: Linear regression (30 points)

- Perform a simple linear regression to answer the question of interest. To do this, name your linear model "reg.output" and write the summary of the regression by using "summary(reg.output)".

```
# Remember to remove eval=FALSE!!
reg.output <- lm(dat$po.brut ~ dat$funds)
summary(reg.output)
```

```
##
```

```
## Call:
```

```
## lm(formula = dat$po.brut ~ dat$funds)
```

```
##
```

```
## Residuals:
```

```
##      Min       1Q   Median       3Q      Max
## -3.9433 -0.2233  0.2544  0.5952  1.1803
##
```

```
## Coefficients:
```

```
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept) 40.543069   0.282503  143.51   <2e-16 ***
## dat$funds   -0.367099   0.004496  -81.64   <2e-16 ***
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.9464 on 198 degrees of freedom
## Multiple R-squared:  0.9712, Adjusted R-squared:  0.971
## F-statistic: 6666 on 1 and 198 DF,  p-value: < 2.2e-16
```

I am looking at how an increase of funds effects the number of police brutality incidents. I would expect that areas with higher levels of funding would have less incidents because they are probably in more well-to-do areas. Our intercept shows a negative correlation between funds and levels of incidents. This is similar to what I assumed, because as funding increases by one unit (\$1Million), a police brutality incident is less likely to occur by 0.367099 unit. It would be interesting to use a log-linear relationship for this regression for an expected percent change in police brutality with each \$1Million increase in funding.

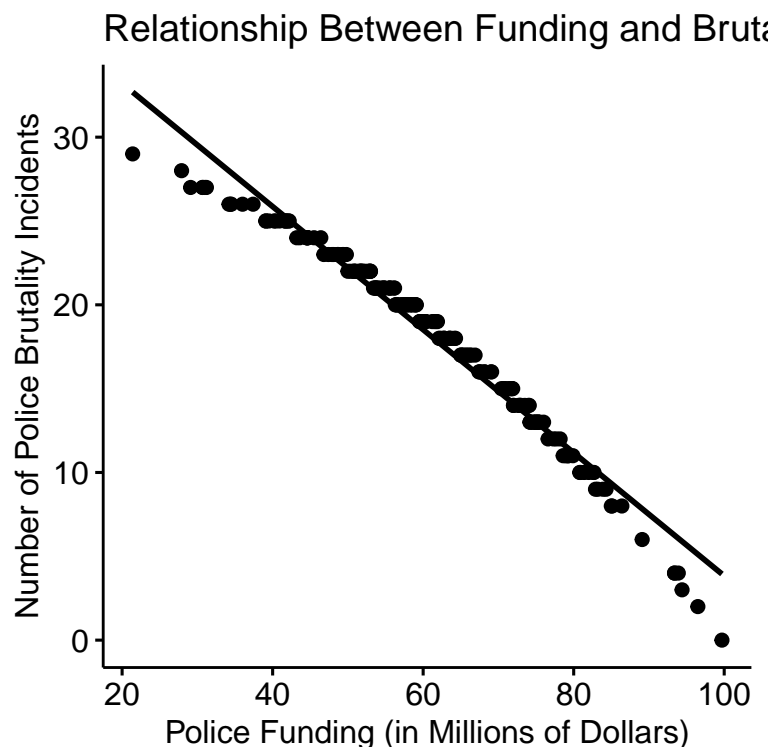
- b. Report the estimated coefficient, standard error, and p-value of the slope. Is the relationship between funds and incidents statistically significant? Explain.

The estimated coefficient of the intercept is 40.543069, the standard error is 0.282503, and the p-value is  $< 2e-16$ . The relationship between funds and incidents is statistically significant because  $2e-16 < .05$ , so we are able to reject the null hypothesis using our p-value.

- c. Draw a scatterplot of po.brut (y-axis) and funds (x-axis). Right below your plot command, use abline to draw the fitted regression line, like this:

```
ggscatter(dat, x = "funds", y = "po.brut",
  add = "reg.line", cor.method = "pearson",
  xlab = "Police Funding (in Millions of Dollars)",
  ylab = "Number of Police Brutality Incidents",
  main = "Relationship Between Funding and Brutality in Policing")
```

```
## `geom_smooth()` using formula 'y ~ x'
```



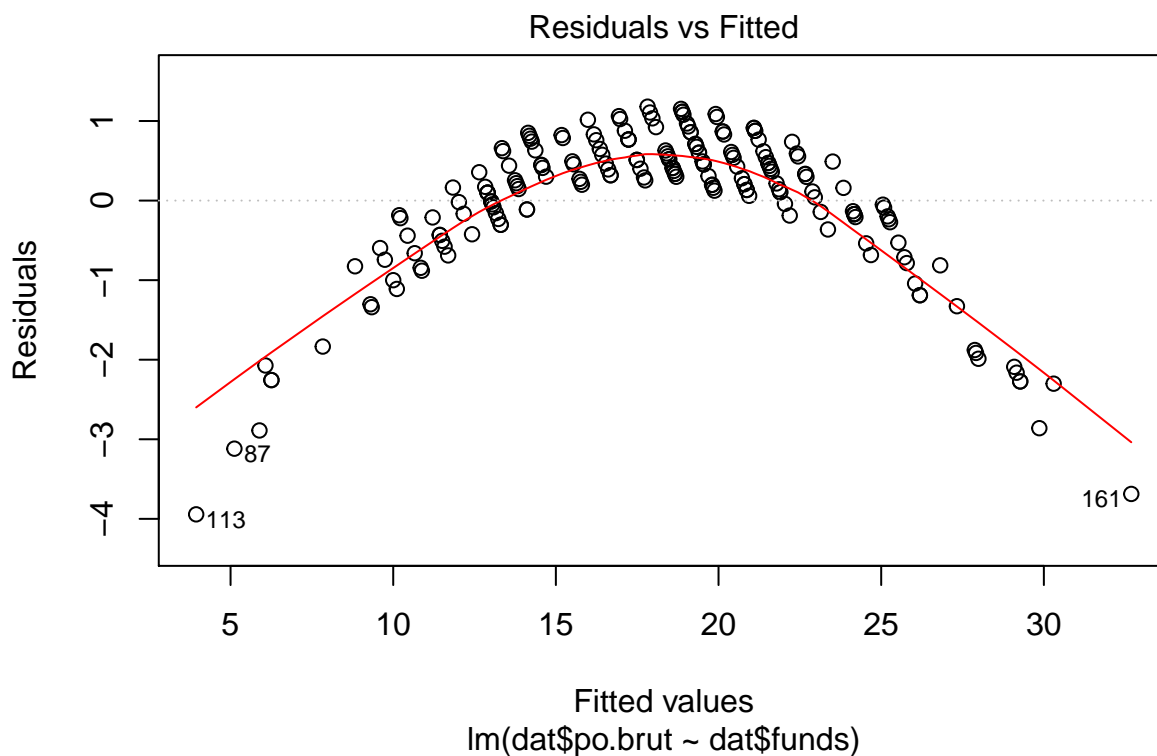
```
## I used ggscatter because I am more familiar with the function, and a line of best fit/regression type
```

Does the line look like a good fit? Why or why not?

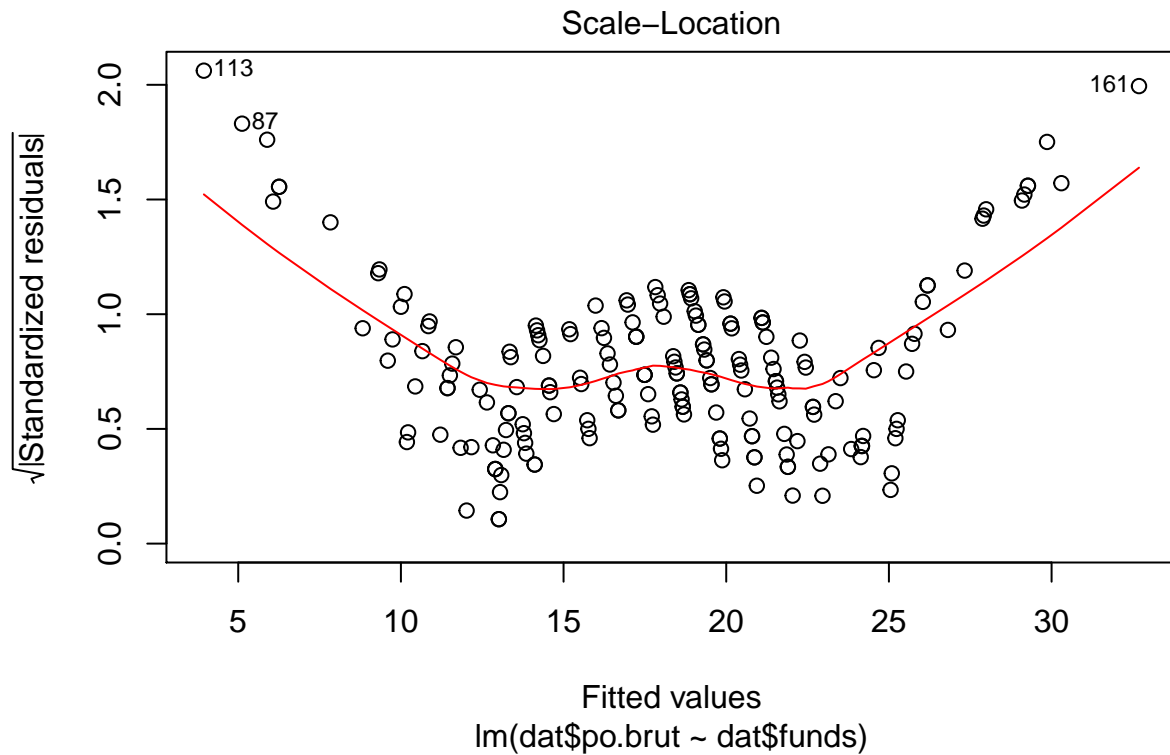
Yes, this line looks like a good fit. The scatter is a bit wacky since number of incidents only follows whole numbers and the regression does not output that (hence why I mention a log-linear regression above). Our line of best fit follows the regression output linearly, and does a pretty good job, but our scatter seems to resemble part of a parabolic function, so perhaps an exponential regression would do the data more justice. I also did not run a fitted model.

- d. Are the four assumptions of linear regression satisfied? To answer this, draw the relevant plots. (Write a maximum of one sentence per assumption.) If not, what might you try to do to improve this (if you had more time)?

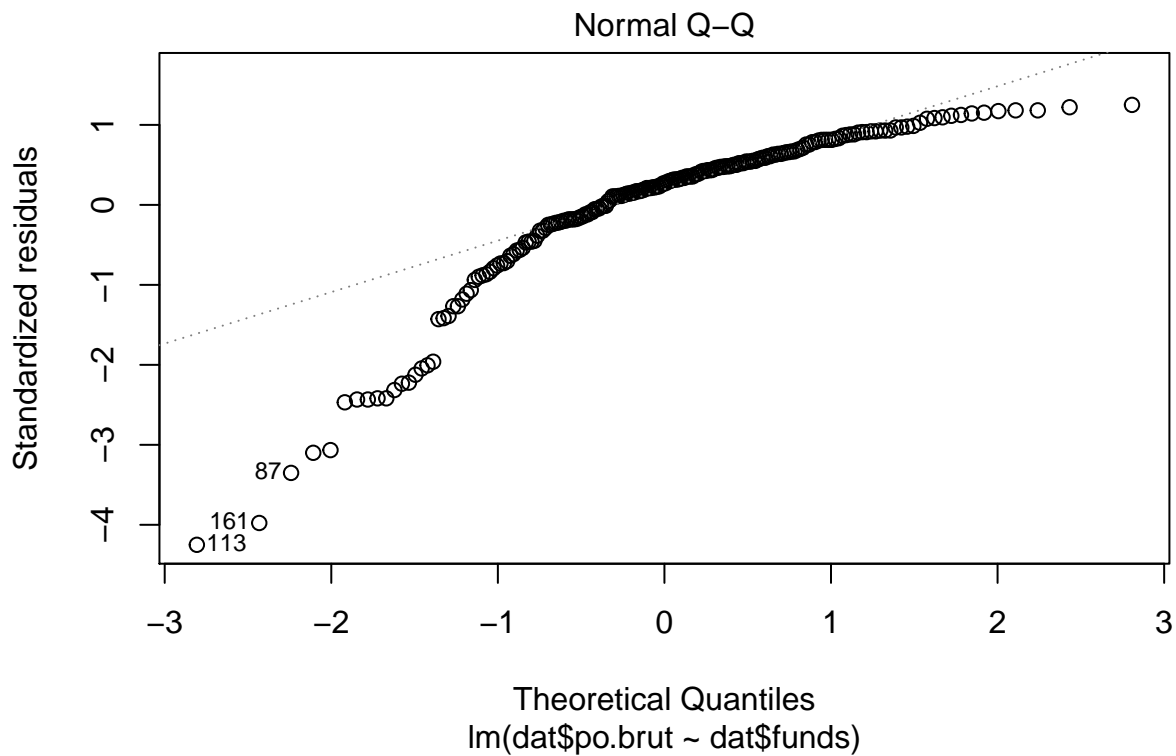
```
reg.output <- lm(dat$po.brut ~ dat$funds)
plot(reg.output, which=1) ## linearity (residuals vs fitted)
```



```
plot(reg.output, which=3) ## equal variance (scale vs location)
```



```
plot(reg.output, which=2) ## normal pop. (qq)
```



Right off the bat I can see from the residuals vs fitted graph that the red line follows a trend in the average value of the residuals, so there is a discernable trend to them - this assumption fails. The independence assumption also fails due to the pattern of the residuals vs fitted graph. With the scale-location plot we see significant trends in the red line on this plot. This

tells me that the residuals (and hence errors) have non-constant variance. So, the assumption that all the errors have the same variance is not true. The QQ plot shows that there is a left-skew to the data, and so the normality assumption fails. The assumptions of linearity are not satisfied, as I predicted above. With more time, I would hope for a better dataset so there is no omitted-variable bias (and the error estimates may be constant). Also, I would write a quadratic log-linear OLS regression, because that seems to better fit the data. For example, perhaps a quadratic on funds can also account for denser populated areas having more funds because of such, but also more incidents because they're cities.

e. Answer the question of interest based on your analysis.

There is a statistically significant relationship between the two variables based on our summary of regression output. The ggscatter output shows this. It also tells us that increasing police funding would decrease the number of police-brutality incidents, and I suppose supports the argument to add more funding to the police. It's important to remember that this is base on correlation, not causation, so adding more funding doesn't necessarily "cause" a decrease in brutality incidents. Also, a linear model is not the best approach to comprehending our data, and so this regression isn't the approach a statistician should take.

### Problem 3: Data ethics (10 points)

Describe the dataset. Considering our lecture on data ethics, what concerns do you have about the dataset? Once you perform your analysis to answer the question of interest using this dataset, what concerns might you have about the results?

I'm not sure if the anonymity of the police department names are enough. It's very easy to look up police records/court cases regarding police brutality, so those numbers can be picked out. Also, as civically engaged members of society, we are able to look up public information on how our tax dollars are spent. So, finding the information on police department funding is also not difficult. If you looked at that and number of incidents, it's not too difficult to find out which actual police department each number represents. There also may be bias in police-recorded data, because departments probably don't want to admit that one of their own inflicted violence on a person. I also have concerns that people will use this data to predict police-brutality incidents, and will argue to change department funding because of such, and also as an argument that police-brutality happens normally, since each department had at least 14 incidents in one year.