Intelligence of Dogs

Kimberly Cable

06-04-2022

Step 1

Introduction

We all love dogs. Some more than others but all in all, a dog is man's best friend. I think what we enjoy most about our furry companions is their ability to learn. From just being able to fetch a ball and bring it back to helping the police locate missing persons to alerting their companions that they are about to have a seizure. Dogs are amazing animals.

Research Questions

Studies have been done on which breeds are more intelligent than others, but I was curious if how big a dog was had anything to do with how smart they were.

- Are bigger dogs smarter than smaller dogs?
- Does the classification of a dog really tell their intelligence level?
- Does their heterozygosity (diversity in the genes) have anything to do with their intelligence?
- Within a classification, do the larger breeds fair better than the smaller ones for intelligence?
- Does their heterozygosity influence the number of reps a dog can do?

Approach

I plan to look at if height, weight and heterozygosity have any affect on how intelligent a dog is based on the percentage of times they can obey a command.

How your approach addresses (fully or partially) the problem

With my approach I think it would partially answer whether or not how big a dog was and if it plays a part in the how smart they are.

Data (Minimum of 3 Datasets - but no requirement on number of fields or rows)

- dog_intelligence.csv (Fishman, n.d.b)
- Table_4_Heterozygosity_85_breeds.csv (Fishman, n.d.b)
- Table_5_Expected_Heterozygosity_60_breeds.csv (Fishman, n.d.b)
- AKC Breed Info.csv (Fishman, n.d.a)

Required Packages

- ggplot2
- dplyr
- magritter
- Hmisc
- ggm

Plots and Table Needs

- Histogram
- Scatter Plots
- CDF
- Linear Regression

Questions for future steps

To begin, I suppose you look at histograms of the different variables and then decide how to proceed.

Step 2

How to import and clean my data

```
##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union

##
## Attaching package: 'purrr'

## The following object is masked from 'package:magrittr':
##
##     set_names
```

Load and read each of the datasets:

- **dog_intelligence.csv**

```
intelligence_df <- read.csv("Final_Project/data/dog_intelligence.csv",
    header = TRUE, stringsAsFactors = FALSE)
head(intelligence_df)
```

```
##                Breed Classification obey reps_lower reps_upper
## 1     Border Collie Brightest Dogs  95%          1          4
## 2            Poodle Brightest Dogs  95%          1          4
## 3   German Shepherd Brightest Dogs  95%          1          4
## 4  Golden Retriever Brightest Dogs  95%          1          4
## 5 Doberman Pinscher Brightest Dogs  95%          1          4
## 6 Shetland Sheepdog Brightest Dogs  95%          1          4
```

- **AKC Breed Info.csv**

```r
breed_df <- read.csv("Final_Project/data/AKC Breed Info.csv")
head(breed_df)
```

```
##                   Breed height_low_inches height_high_inches weight_low_lbs
## 1                 Akita                26                 28             80
## 2   Anatolian Sheepdog                27                 29            100
## 3 Bernese Mountain Dog                23                 27             85
## 4            Bloodhound                24                 26             80
## 5                Borzoi                26                 28             70
## 6           Bullmastiff                25                 27            100
##   weight_high_lbs
## 1             120
## 2             150
## 3             110
## 4             120
## 5             100
## 6             130
```

- **Table__4__Heterozygosity__85__breeds.csv**

```r
heterozygosity_4_df <- read.csv("Final_Project/data/Table_4_Heterozygosity_85_breeds.csv")
head(heterozygosity_4_df)
```

```
##                    Population Heterozygosity
## 1          Bedlington Terrier       0.312842
## 2      Miniature Bull Terrier       0.321619
## 3                       Boxer       0.343151
## 4             Clumber Spaniel       0.363595
## 5 Greater Swiss Mountain Dog       0.364943
## 6            Airedale Terrier       0.372793
```

- **Table__5__Expected__Heterozygosity__60__breeds.csv**

```r
heterozygosity_5_df <- read.csv("Final_Project/data/Table_5_Expected_Heterozygosity_60_breeds.csv")
colnames(heterozygosity_5_df)[2] <- "Heterozygosity_x10_4"

head(heterozygosity_5_df)
```

```
##                    Breed Heterozygosity_x10_4
## 1     Scottish Deerhound               2.0683
## 2          Field Spaniel               2.3165
```

```
## 3 Flat-coated Retriever               2.6474
## 4  Bernese Mountain Dog               2.8129
## 5    Standard Schnauzer               2.8129
## 6                 Boxer               3.0611
```

Create New Dataframe from the Intelligence data

```r
combined_df <- intelligence_df

head(combined_df)
```

```
##                Breed Classification obey reps_lower reps_upper
## 1      Border Collie Brightest Dogs  95%          1          4
## 2             Poodle Brightest Dogs  95%          1          4
## 3    German Shepherd Brightest Dogs  95%          1          4
## 4   Golden Retriever Brightest Dogs  95%          1          4
## 5 Doberman Pinscher Brightest Dogs  95%          1          4
## 6 Shetland Sheepdog Brightest Dogs  95%          1          4
```

Inner Join Breed data to new combined df on key Breed

```r
combined_df <- combined_df %>%
    inner_join(breed_df, by = c(Breed = "Breed"))

head(combined_df)
```

```
##                 Breed Classification obey reps_lower reps_upper
## 1       Border Collie Brightest Dogs  95%          1          4
## 2    Golden Retriever Brightest Dogs  95%          1          4
## 3   Doberman Pinscher Brightest Dogs  95%          1          4
## 4 Labrador Retriever Brightest Dogs  95%          1          4
## 5            Papillon Brightest Dogs  95%          1          4
## 6          Rottweiler Brightest Dogs  95%          1          4
##   height_low_inches height_high_inches weight_low_lbs weight_high_lbs
## 1                19                 21             40              40
## 2                21                 24             55              75
## 3                26                 28             60             100
## 4                21                 24             55              80
## 5                 8                 11              5              10
## 6                22                 27             90             110
```

Inner Join Heterozygosity 4 to new combined df on key Breed = Population

```r
combined_df <- combined_df %>%
    inner_join(heterozygosity_4_df, by = c(Breed = "Population"))

head(combined_df)
```

```
##                 Breed         Classification obey reps_lower reps_upper
## 1       Border Collie         Brightest Dogs  95%          1          4
## 2    Golden Retriever         Brightest Dogs  95%          1          4
```

```
## 3  Doberman Pinscher         Brightest Dogs  95%          1           4
## 4 Labrador Retriever         Brightest Dogs  95%          1           4
## 5         Rottweiler         Brightest Dogs  95%          1           4
## 6         Schipperke Excellent Working Dogs  85%          5          15
##   height_low_inches height_high_inches weight_low_lbs weight_high_lbs
## 1                19                 21             40              40
## 2                21                 24             55              75
## 3                26                 28             60             100
## 4                21                 24             55              80
## 5                22                 27             90             110
## 6                10                 13             12              18
##   Heterozygosity
## 1       0.549583
## 2       0.517779
## 3       0.383763
## 4       0.560590
## 5       0.456510
## 6       0.445437
```

Inner Join Heterozygosity 5 to new combined df on key Breed

```
combined_df <- combined_df %>%
    inner_join(heterozygosity_5_df, by = c(Breed = "Breed"))

head(combined_df)
```

```
##                        Breed         Classification obey reps_lower reps_upper
## 1           Golden Retriever         Brightest Dogs  95%          1          4
## 2         Labrador Retriever         Brightest Dogs  95%          1          4
## 3                 Rottweiler         Brightest Dogs  95%          1          4
## 4 German Shorthaired Pointer Excellent Working Dogs  85%          5         15
## 5         Standard Schnauzer Excellent Working Dogs  85%          5         15
## 6       Bernese Mountain Dog Excellent Working Dogs  85%          5         15
##   height_low_inches height_high_inches weight_low_lbs weight_high_lbs
## 1                21                 24             55              75
## 2                21                 24             55              80
## 3                22                 27             90             110
## 4                20                 27             50              80
## 5                17                 19             33              33
## 6                23                 27             85             110
##   Heterozygosity Heterozygosity_x10_4
## 1       0.517779               7.0323
## 2       0.560590               8.4388
## 3       0.456510               4.9640
## 4       0.538761               6.6186
## 5       0.450041               2.8129
## 6       0.399599               2.8129
```

Convert n/a or na to empty cell

```
combined_df[combined_df == "n/a"] <- ""
combined_df[combined_df == "na"] <- ""
```

Convert obey to numeric

```
combined_df$obey <- gsub("%", "", as.character(combined_df$obey))

combined_df$obey <- as.numeric(combined_df$obey)/100
```

Convert height and weight to numeric

```
combined_df$height_low_inches <- as.numeric(combined_df$height_low_inches)
combined_df$height_high_inches <- as.numeric(combined_df$height_high_inches)
combined_df$weight_low_lbs <- as.numeric(combined_df$weight_low_lbs)
combined_df$weight_high_lbs <- as.numeric(combined_df$weight_high_lbs)
```

What does the final data set look like?

Data Dictionary:

Variable	Meaning
Breed	American Kennel Club standard breeds
Classification	Breed Intelligence Category
obey	Probability that the breed obeys the fuirst command (figure is lower bound)
reps_lower	Lower limit of repetitions to understand new commands
reps_upper	Upper limit of repetitions to understand new command
height_low_inches	Height in inches - lower limit
height_high_inches	Height in inches - upper limit
weight_low_lbs	Weight in pounds - lower limit
weight_high_lbs	Weight in pounds - upper limit
Heterozygosity	Two copies of different alleles
Heterozygosity_x10_4	Two copies of different alleles

```
head(combined_df)
```

```
##                        Breed         Classification obey reps_lower reps_upper
## 1           Golden Retriever         Brightest Dogs 0.95          1          4
## 2         Labrador Retriever         Brightest Dogs 0.95          1          4
## 3                 Rottweiler         Brightest Dogs 0.95          1          4
## 4 German Shorthaired Pointer Excellent Working Dogs 0.85          5         15
## 5         Standard Schnauzer Excellent Working Dogs 0.85          5         15
## 6       Bernese Mountain Dog Excellent Working Dogs 0.85          5         15
##   height_low_inches height_high_inches weight_low_lbs weight_high_lbs
## 1                21                 24             55              75
## 2                21                 24             55              80
## 3                22                 27             90             110
## 4                20                 27             50              80
## 5                17                 19             33              33
## 6                23                 27             85             110
##   Heterozygosity Heterozygosity_x10_4
## 1       0.517779               7.0323
```

```
## 2        0.560590                 8.4388
## 3        0.456510                 4.9640
## 4        0.538761                 6.6186
## 5        0.450041                 2.8129
## 6        0.399599                 2.8129
```

What information is not self-evident?

- Initially I do not know exactly what Heterozygosity and Heterozygosity (x10-4) are and the difference between the two columns.

What are different ways you could look at this data?

One could strictly look at the obey percentage without looking at the number of reps a dog can do. You can also just look at the upper and lower reps versus taking the average number of reps a dog can do. Same problem with height and weight if I were to look at if intelligence is strictly by the weight of a breed or how tall a breed is.

How do you plan to slice and dice the data?

- **Add average weight and height to dataframe**

```r
combined_df$avg.weight = rowMeans(combined_df[, c("weight_low_lbs",
    "weight_high_lbs")], na.rm = TRUE)
combined_df$avg.height = rowMeans(combined_df[, c("height_low_inches",
    "height_high_inches")], na.rm = TRUE)

head(combined_df)
```

```
##                         Breed         Classification obey reps_lower reps_upper
## 1            Golden Retriever         Brightest Dogs 0.95          1          4
## 2          Labrador Retriever         Brightest Dogs 0.95          1          4
## 3                  Rottweiler         Brightest Dogs 0.95          1          4
## 4 German Shorthaired Pointer Excellent Working Dogs 0.85          5         15
## 5          Standard Schnauzer Excellent Working Dogs 0.85          5         15
## 6        Bernese Mountain Dog Excellent Working Dogs 0.85          5         15
##   height_low_inches height_high_inches weight_low_lbs weight_high_lbs
## 1                21                 24             55              75
## 2                21                 24             55              80
## 3                22                 27             90             110
## 4                20                 27             50              80
## 5                17                 19             33              33
## 6                23                 27             85             110
##   Heterozygosity Heterozygosity_x10_4 avg.weight avg.height
## 1       0.517779               7.0323       65.0       22.5
## 2       0.560590               8.4388       67.5       22.5
## 3       0.456510               4.9640      100.0       24.5
## 4       0.538761               6.6186       65.0       23.5
## 5       0.450041               2.8129       33.0       18.0
## 6       0.399599               2.8129       97.5       25.0
```

How could you summarize your data to answer key questions?

- **Descriptive Statistics on all variables**

```
summary(combined_df)
```

```
##     Breed           Classification          obey        reps_lower   
##  Length:29          Length:29          Min.   :0.30   Min.   : 1.00  
##  Class :character   Class :character   1st Qu.:0.50   1st Qu.:16.00  
##  Mode  :character   Mode  :character   Median :0.50   Median :26.00  
##                                        Mean   :0.58   Mean   :30.38  
##                                        3rd Qu.:0.70   3rd Qu.:41.00  
##                                        Max.   :0.95   Max.   :81.00  
##                                        NA's   :4                     
##    reps_upper     height_low_inches height_high_inches weight_low_lbs  
##  Min.   :  4.00   Min.   : 7.00     Min.   :10.00      Min.   :  6.00  
##  1st Qu.: 25.00   1st Qu.:14.00     1st Qu.:16.00      1st Qu.: 19.50  
##  Median : 40.00   Median :21.00     Median :24.50      Median : 46.00  
##  Mean   : 47.31   Mean   :19.05     Mean   :22.12      Mean   : 53.04  
##  3rd Qu.: 80.00   3rd Qu.:25.00     3rd Qu.:28.00      3rd Qu.: 72.50  
##  Max.   :100.00   Max.   :27.00     Max.   :30.00      Max.   :175.00  
##                   NA's   :1         NA's   :1          NA's   :1       
##  weight_high_lbs  Heterozygosity   Heterozygosity_x10_4   avg.weight    
##  Min.   : 10.00   Min.   :0.3128   Min.   :2.813        Min.   :  8.00  
##  1st Qu.: 31.50   1st Qu.:0.4500   1st Qu.:4.550        1st Qu.: 24.75  
##  Median : 70.00   Median :0.4879   Median :5.543        Median : 58.75  
##  Mean   : 72.64   Mean   :0.4789   Mean   :5.312        Mean   : 62.84  
##  3rd Qu.:102.50   3rd Qu.:0.5178   3rd Qu.:6.040        3rd Qu.: 88.12  
##  Max.   :190.00   Max.   :0.5630   Max.   :8.439        Max.   :182.50  
##  NA's   :1                                              NA's   :1       
##    avg.height   
##  Min.   : 8.50  
##  1st Qu.:15.25  
##  Median :22.75  
##  Mean   :20.59  
##  3rd Qu.:26.00  
##  Max.   :28.50  
##  NA's   :1      
```

- **Descriptive Statistics on all variables grouped by Classification**

```
combined_df %>%
    split(.$Classification) %>%
    map(summary)
```

```
## $`Above Average Working Dogs`
##     Breed           Classification          obey       reps_lower   reps_upper
##  Length:3           Length:3           Min.   :0.7   Min.   :16   Min.   :25  
##  Class :character   Class :character   1st Qu.:0.7   1st Qu.:16   1st Qu.:25  
##  Mode  :character   Mode  :character   Median :0.7   Median :16   Median :25  
##                                        Mean   :0.7   Mean   :16   Mean   :25  
##                                        3rd Qu.:0.7   3rd Qu.:16   3rd Qu.:25  
```

```
##                                         Max.   :0.7   Max.   :16   Max.   :25  
##  height_low_inches height_high_inches weight_low_lbs  weight_high_lbs 
##  Min.   :16.00     Min.   :19.00      Min.   : 35.0   Min.   : 45.00  
##  1st Qu.:20.50     1st Qu.:23.00      1st Qu.: 47.5   1st Qu.: 57.50  
##  Median :25.00     Median :27.00      Median : 60.0   Median : 70.00  
##  Mean   :22.33     Mean   :24.67      Mean   : 65.0   Mean   : 88.33  
##  3rd Qu.:25.50     3rd Qu.:27.50      3rd Qu.: 80.0   3rd Qu.:110.00  
##  Max.   :26.00     Max.   :28.00      Max.   :100.0   Max.   :150.00  
##  Heterozygosity   Heterozygosity_x10_4   avg.weight       avg.height   
##  Min.   :0.4467   Min.   :5.543        Min.   : 40.00   Min.   :17.50  
##  1st Qu.:0.4603   1st Qu.:5.998        1st Qu.: 52.50   1st Qu.:21.75  
##  Median :0.4739   Median :6.453        Median : 65.00   Median :26.00  
##  Mean   :0.4704   Mean   :6.233        Mean   : 76.67   Mean   :23.50  
##  3rd Qu.:0.4823   3rd Qu.:6.577        3rd Qu.: 95.00   3rd Qu.:26.50  
##  Max.   :0.4906   Max.   :6.701        Max.   :125.00   Max.   :27.00  
## 
## $‘Average Working/Obedience Intelligence‘
##     Breed           Classification          obey       reps_lower   reps_upper
##  Length:11          Length:11          Min.   :0.5   Min.   :26   Min.   :40  
##  Class :character   Class :character   1st Qu.:0.5   1st Qu.:26   1st Qu.:40  
##  Mode  :character   Mode  :character   Median :0.5   Median :26   Median :40  
##                                        Mean   :0.5   Mean   :26   Mean   :40  
##                                        3rd Qu.:0.5   3rd Qu.:26   3rd Qu.:40  
##                                        Max.   :0.5   Max.   :26   Max.   :40  
## 
##  height_low_inches height_high_inches weight_low_lbs weight_high_lbs 
##  Min.   : 7.00     Min.   :10.00      Min.   :10.0   Min.   : 18.00  
##  1st Qu.:11.25     1st Qu.:15.25      1st Qu.:16.5   1st Qu.: 25.25  
##  Median :18.00     Median :21.50      Median :30.0   Median : 50.00  
##  Mean   :17.55     Mean   :21.05      Mean   :36.6   Mean   : 52.30  
##  3rd Qu.:22.75     3rd Qu.:28.00      3rd Qu.:55.5   3rd Qu.: 70.00  
##  Max.   :27.00     Max.   :30.00      Max.   :80.0   Max.   :120.00  
##  NA’s   :1         NA’s   :1          NA’s   :1      NA’s   :1       
##  Heterozygosity   Heterozygosity_x10_4   avg.weight       avg.height   
##  Min.   :0.3128   Min.   :3.061        Min.   : 14.00   Min.   : 8.50  
##  1st Qu.:0.4557   1st Qu.:4.178        1st Qu.: 21.38   1st Qu.:13.25  
##  Median :0.5040   Median :4.716        Median : 41.75   Median :19.75  
##  Mean   :0.4742   Mean   :4.941        Mean   : 44.45   Mean   :19.30  
##  3rd Qu.:0.5208   3rd Qu.:5.915        3rd Qu.: 61.88   3rd Qu.:25.50  
##  Max.   :0.5630   Max.   :6.867        Max.   :100.00   Max.   :28.50  
##                                        NA’s   :1        NA’s   :1      
## 
## $‘Brightest Dogs‘
##     Breed           Classification          obey        reps_lower   reps_upper
##  Length:3           Length:3           Min.   :0.95   Min.   :1    Min.   :4  
##  Class :character   Class :character   1st Qu.:0.95   1st Qu.:1    1st Qu.:4  
##  Mode  :character   Mode  :character   Median :0.95   Median :1    Median :4  
##                                        Mean   :0.95   Mean   :1    Mean   :4  
##                                        3rd Qu.:0.95   3rd Qu.:1    3rd Qu.:4  
##                                        Max.   :0.95   Max.   :1    Max.   :4  
##  height_low_inches height_high_inches weight_low_lbs  weight_high_lbs
##  Min.   :21.00     Min.   :24.0       Min.   :55.00   Min.   : 75.00  
##  1st Qu.:21.00     1st Qu.:24.0       1st Qu.:55.00   1st Qu.: 77.50  
##  Median :21.00     Median :24.0       Median :55.00   Median : 80.00  
```

```
##  Mean   :21.33     Mean   :25.0       Mean   :66.67   Mean   : 88.33
##  3rd Qu.:21.50     3rd Qu.:25.5       3rd Qu.:72.50   3rd Qu.: 95.00
##  Max.   :22.00     Max.   :27.0       Max.   :90.00   Max.   :110.00
##  Heterozygosity   Heterozygosity_x10_4   avg.weight       avg.height
##  Min.   :0.4565   Min.   :4.964        Min.   : 65.00   Min.   :22.50
##  1st Qu.:0.4871   1st Qu.:5.998        1st Qu.: 66.25   1st Qu.:22.50
##  Median :0.5178   Median :7.032        Median : 67.50   Median :22.50
##  Mean   :0.5116   Mean   :6.812        Mean   : 77.50   Mean   :23.17
##  3rd Qu.:0.5392   3rd Qu.:7.736        3rd Qu.: 83.75   3rd Qu.:23.50
##  Max.   :0.5606   Max.   :8.439        Max.   :100.00   Max.   :24.50
##
## $`Excellent Working Dogs`
##     Breed           Classification          obey        reps_lower   reps_upper
##  Length:3           Length:3           Min.   :0.85   Min.   :5    Min.   :15
##  Class :character   Class :character   1st Qu.:0.85   1st Qu.:5    1st Qu.:15
##  Mode  :character   Mode  :character   Median :0.85   Median :5    Median :15
##                                        Mean   :0.85   Mean   :5    Mean   :15
##                                        3rd Qu.:0.85   3rd Qu.:5    3rd Qu.:15
##                                        Max.   :0.85   Max.   :5    Max.   :15
##  height_low_inches height_high_inches weight_low_lbs weight_high_lbs
##  Min.   :17.0      Min.   :19.00      Min.   :33.0   Min.   : 33.00
##  1st Qu.:18.5      1st Qu.:23.00      1st Qu.:41.5   1st Qu.: 56.50
##  Median :20.0      Median :27.00      Median :50.0   Median : 80.00
##  Mean   :20.0      Mean   :24.33      Mean   :56.0   Mean   : 74.33
##  3rd Qu.:21.5      3rd Qu.:27.00      3rd Qu.:67.5   3rd Qu.: 95.00
##  Max.   :23.0      Max.   :27.00      Max.   :85.0   Max.   :110.00
##  Heterozygosity   Heterozygosity_x10_4   avg.weight      avg.height
##  Min.   :0.3996   Min.   :2.813        Min.   :33.00   Min.   :18.00
##  1st Qu.:0.4248   1st Qu.:2.813        1st Qu.:49.00   1st Qu.:20.75
##  Median :0.4500   Median :2.813        Median :65.00   Median :23.50
##  Mean   :0.4628   Mean   :4.081        Mean   :65.17   Mean   :22.17
##  3rd Qu.:0.4944   3rd Qu.:4.716        3rd Qu.:81.25   3rd Qu.:24.25
##  Max.   :0.5388   Max.   :6.619        Max.   :97.50   Max.   :25.00
##
## $`Fair Working/Obedience Intelligence`
##     Breed           Classification          obey       reps_lower   reps_upper
##  Length:5           Length:5           Min.   :0.3   Min.   :41   Min.   :80
##  Class :character   Class :character   1st Qu.:0.3   1st Qu.:41   1st Qu.:80
##  Mode  :character   Mode  :character   Median :0.3   Median :41   Median :80
##                                        Mean   :0.3   Mean   :41   Mean   :80
##                                        3rd Qu.:0.3   3rd Qu.:41   3rd Qu.:80
##                                        Max.   :0.3   Max.   :41   Max.   :80
##  height_low_inches height_high_inches weight_low_lbs  weight_high_lbs
##  Min.   :11.0      Min.   :12.0      Min.   :  6.0   Min.   : 10.0
##  1st Qu.:12.0      1st Qu.:15.0      1st Qu.: 17.0   1st Qu.: 28.0
##  Median :14.0      Median :17.0      Median : 20.0   Median : 30.0
##  Mean   :17.4      Mean   :19.8      Mean   : 50.6   Mean   : 77.6
##  3rd Qu.:25.0      3rd Qu.:27.0      3rd Qu.:100.0   3rd Qu.:130.0
##  Max.   :25.0      Max.   :28.0      Max.   :110.0   Max.   :190.0
##  Heterozygosity   Heterozygosity_x10_4   avg.weight      avg.height
##  Min.   :0.4399   Min.   :5.129        Min.   :  8.0   Min.   :11.5
##  1st Qu.:0.4657   1st Qu.:5.543        1st Qu.: 22.5   1st Qu.:13.5
##  Median :0.4688   Median :5.791        Median : 25.0   Median :15.5
##  Mean   :0.4806   Mean   :5.791        Mean   : 64.1   Mean   :18.6
```

```
##  3rd Qu.:0.5092   3rd Qu.:6.040        3rd Qu.:115.0   3rd Qu.:26.0
##  Max.   :0.5195   Max.   :6.453        Max.   :150.0   Max.   :26.5
##
## $`Lowest Degree of Working/Obedience Intelligence `
##     Breed           Classification          obey       reps_lower   reps_upper
##  Length:4           Length:4           Min.   : NA   Min.   :81   Min.   :100
##  Class :character   Class :character   1st Qu.: NA   1st Qu.:81   1st Qu.:100
##  Mode  :character   Mode  :character   Median : NA   Median :81   Median :100
##                                        Mean   :NaN   Mean   :81   Mean   :100
##                                        3rd Qu.: NA   3rd Qu.:81   3rd Qu.:100
##                                        Max.   : NA   Max.   :81   Max.   :100
##                                        NA's   :4
##  height_low_inches height_high_inches weight_low_lbs   weight_high_lbs
##  Min.   :13.00     Min.   :14.0       Min.   : 18.00   Min.   : 30.0
##  1st Qu.:13.75     1st Qu.:15.5       1st Qu.: 34.50   1st Qu.: 45.0
##  Median :20.00     Median :22.0       Median : 55.00   Median : 75.0
##  Mean   :20.00     Mean   :22.0       Mean   : 75.75   Mean   : 92.5
##  3rd Qu.:26.25     3rd Qu.:28.5       3rd Qu.: 96.25   3rd Qu.:122.5
##  Max.   :27.00     Max.   :30.0       Max.   :175.00   Max.   :190.0
##
##  Heterozygosity   Heterozygosity_x10_4   avg.weight       avg.height
##  Min.   :0.4412   Min.   :3.806        Min.   : 24.00   Min.   :14.00
##  1st Qu.:0.4516   1st Qu.:4.550        1st Qu.: 39.75   1st Qu.:14.38
##  Median :0.4715   Median :4.881        Median : 65.00   Median :20.75
##  Mean   :0.4833   Mean   :4.840        Mean   : 84.12   Mean   :21.00
##  3rd Qu.:0.5032   3rd Qu.:5.171        3rd Qu.:109.38   3rd Qu.:27.38
##  Max.   :0.5491   Max.   :5.791        Max.   :182.50   Max.   :28.50
##
```

- **Remove empty cells from variables for plots**

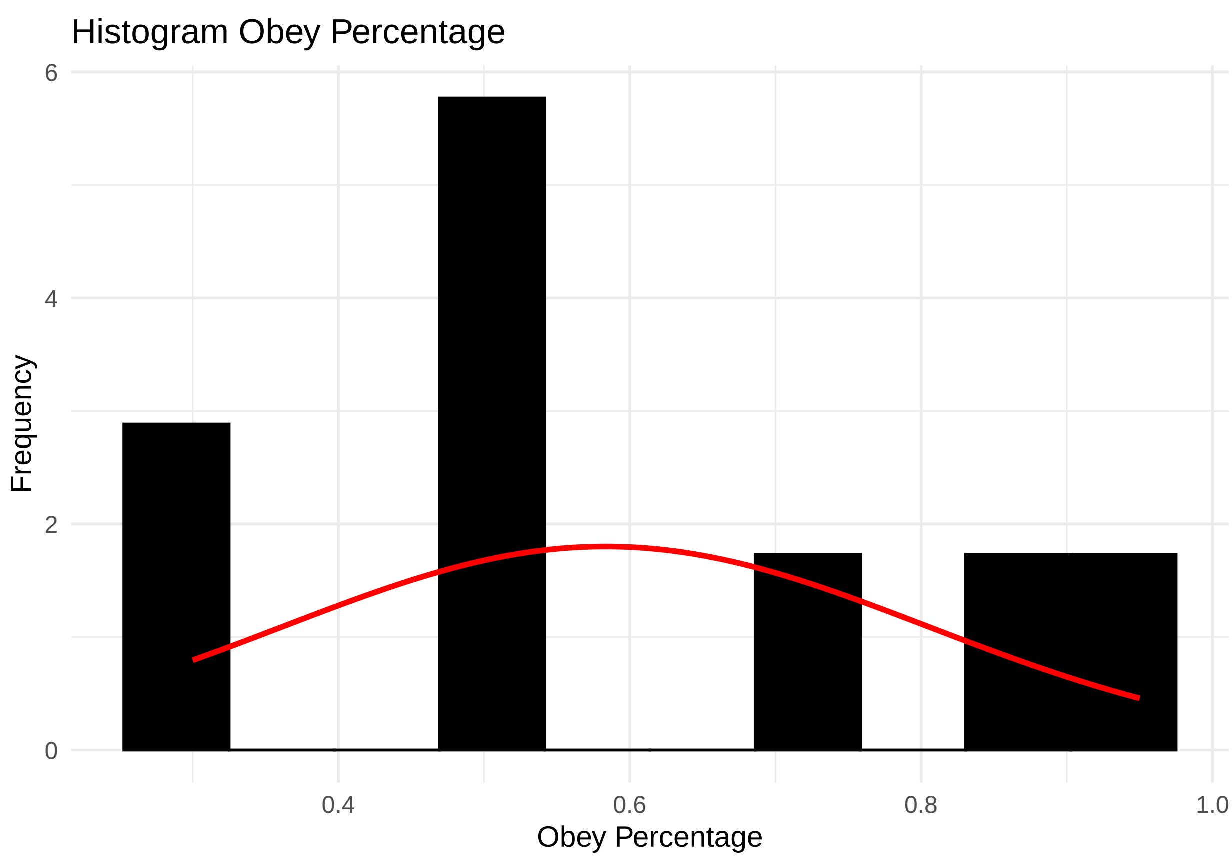
```r
combined_complete <- combined_df[complete.cases(combined_df),
    ]
head(combined_complete)
```

```
##                         Breed         Classification obey reps_lower reps_upper
## 1           Golden Retriever         Brightest Dogs 0.95          1          4
## 2         Labrador Retriever         Brightest Dogs 0.95          1          4
## 3                 Rottweiler         Brightest Dogs 0.95          1          4
## 4 German Shorthaired Pointer Excellent Working Dogs 0.85          5         15
## 5         Standard Schnauzer Excellent Working Dogs 0.85          5         15
## 6       Bernese Mountain Dog Excellent Working Dogs 0.85          5         15
##   height_low_inches height_high_inches weight_low_lbs weight_high_lbs
## 1                21                 24             55              75
## 2                21                 24             55              80
## 3                22                 27             90             110
## 4                20                 27             50              80
## 5                17                 19             33              33
## 6                23                 27             85             110
##   Heterozygosity Heterozygosity_x10_4 avg.weight avg.height
## 1       0.517779               7.0323       65.0       22.5
## 2       0.560590               8.4388       67.5       22.5
## 3       0.456510               4.9640      100.0       24.5
```

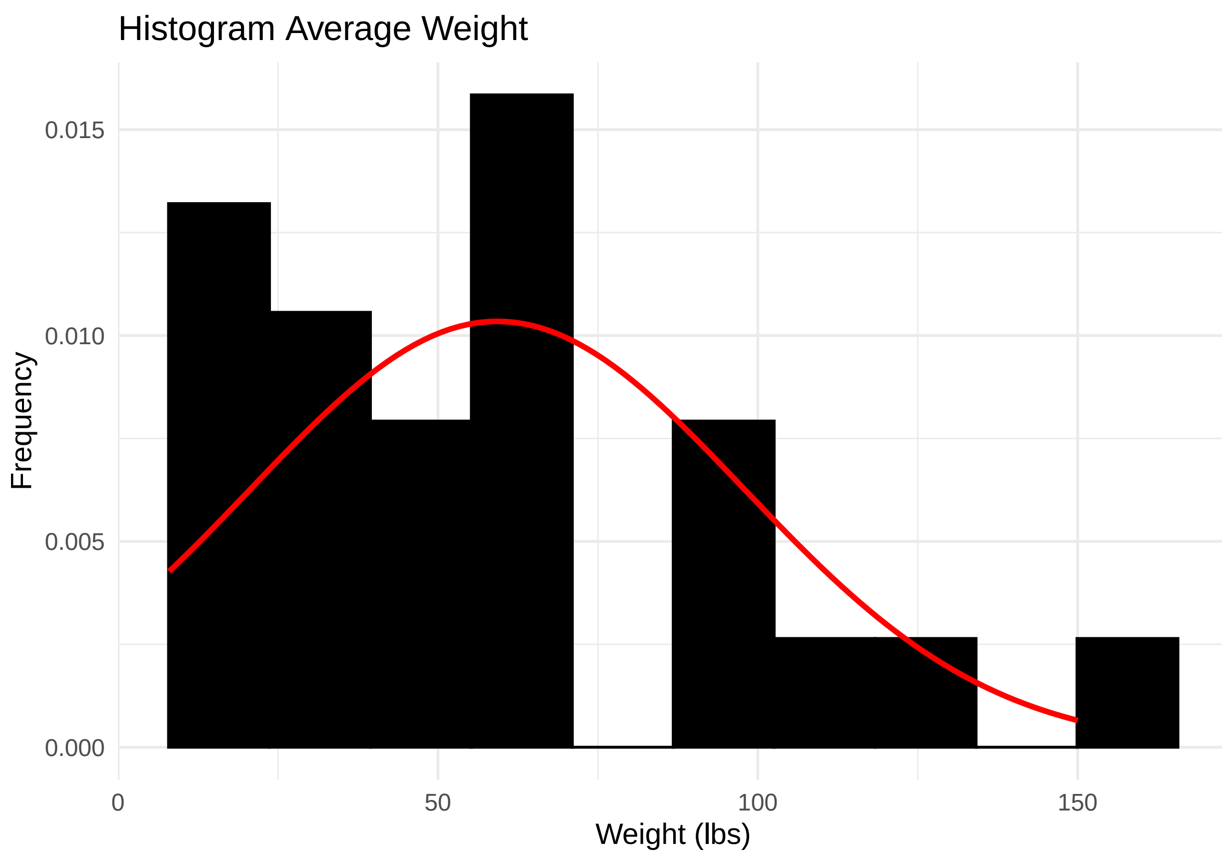
```
## 4       0.538761                 6.6186       65.0       23.5
## 5       0.450041                 2.8129       33.0       18.0
## 6       0.399599                 2.8129       97.5       25.0
```

What types of plots and tables will help you illustrate the findings to your questions?

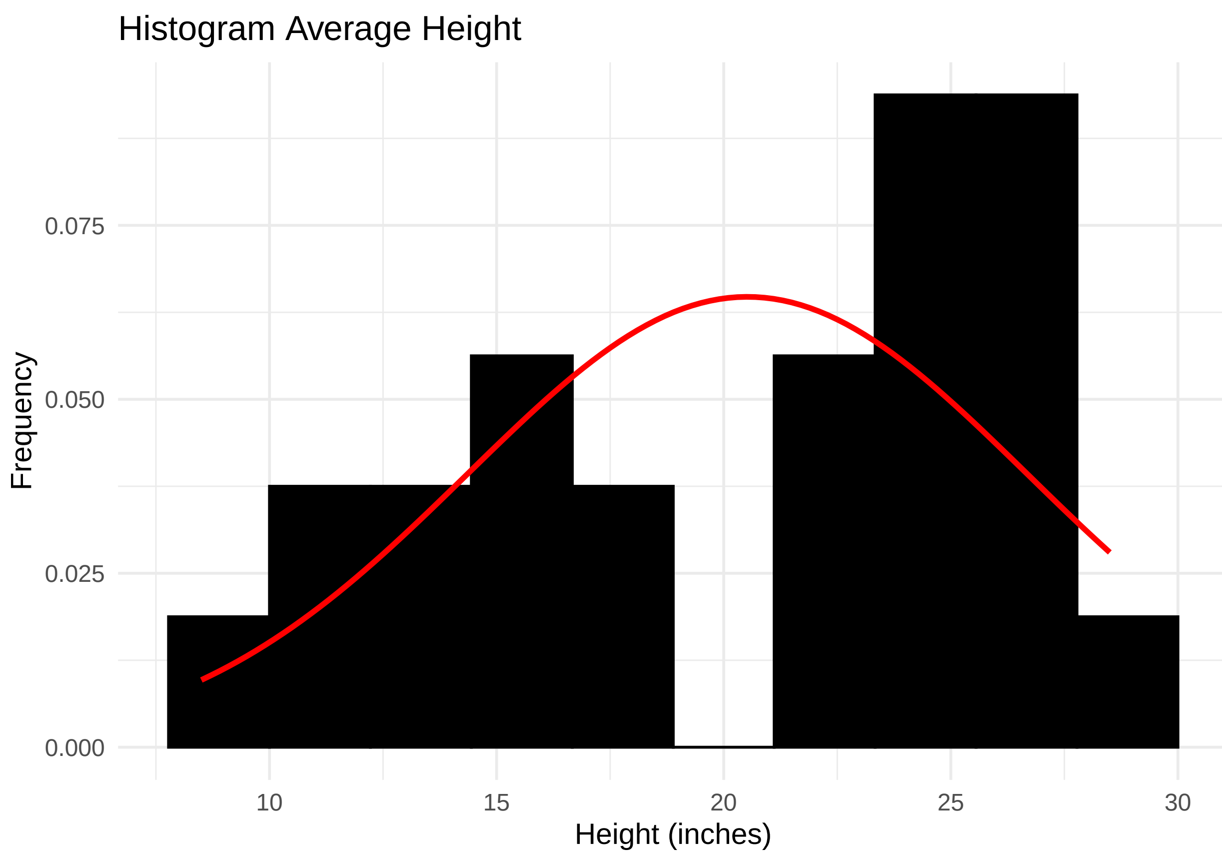
```
ggplot(combined_complete, aes(obey)) + labs(title = "Histogram Obey Percentage",
    x = "Obey Percentage", y = "Frequency") + geom_histogram(bins = 10,
    aes(y = ..density..), color = "black", fill = "black") +
    stat_function(fun = dnorm, args = list(mean = mean(combined_complete$obey,
        na.rm = TRUE), sd = sd(combined_complete$obey, na.rm = TRUE)),
        color = "red", size = 1)
```



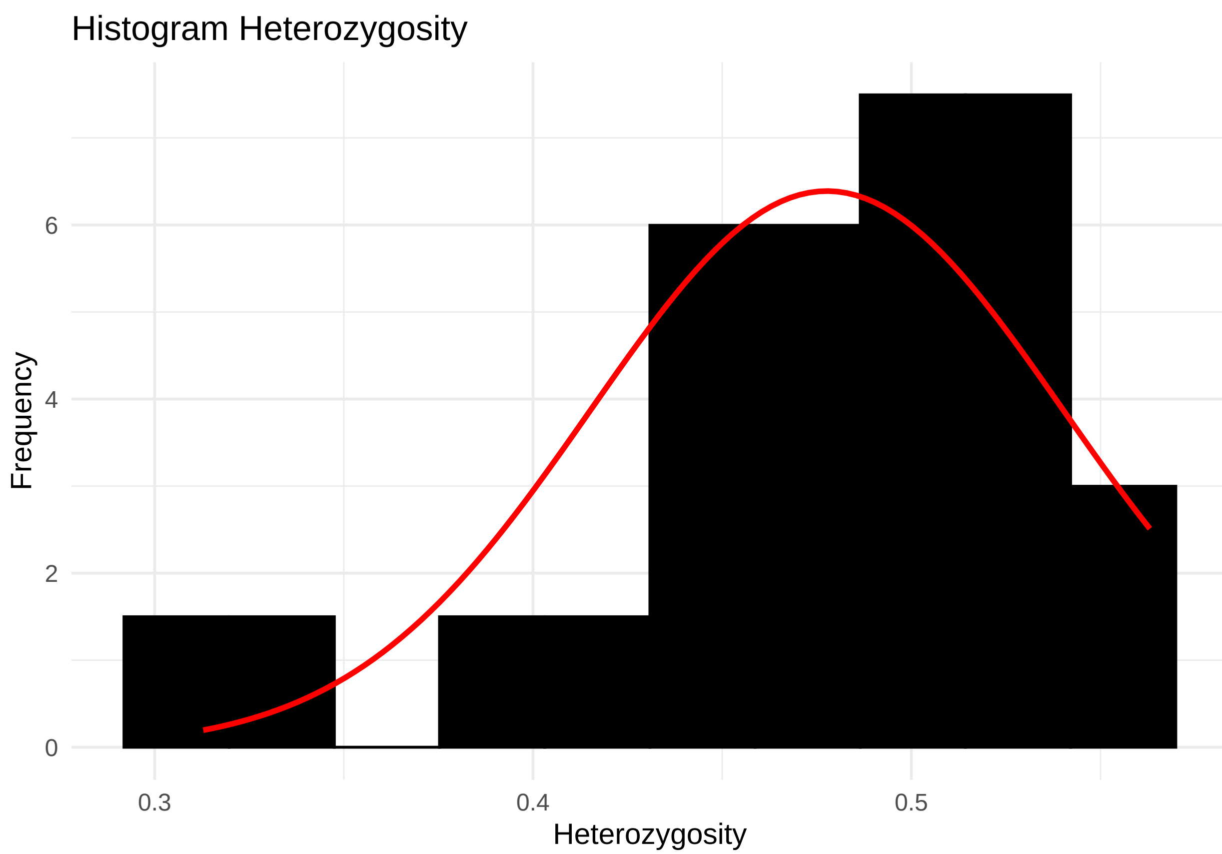

```
ggplot(combined_complete, aes(avg.weight)) + labs(title = "Histogram Average Weight",
    x = "Weight (lbs)", y = "Frequency") + geom_histogram(bins = 10,
    aes(y = ..density..), color = "black", fill = "black") +
    stat_function(fun = dnorm, args = list(mean = mean(combined_complete$avg.weight,
        na.rm = TRUE), sd = sd(combined_complete$avg.weight,
        na.rm = TRUE)), color = "red", size = 1)
```



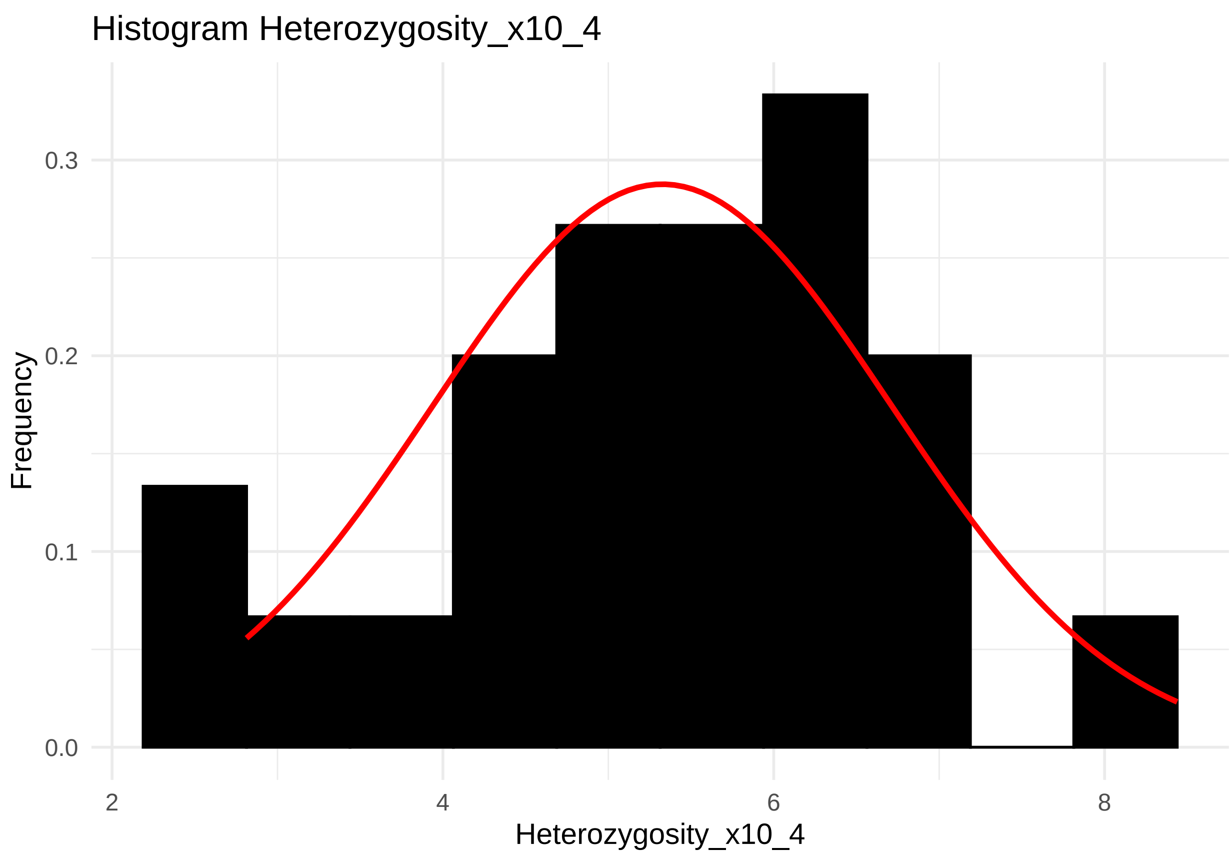

```r
ggplot(combined_complete, aes(avg.height)) + labs(title = "Histogram Average Height",
    x = "Height (inches)", y = "Frequency") + geom_histogram(bins = 10,
    aes(y = ..density..), color = "black", fill = "black") +
    stat_function(fun = dnorm, args = list(mean = mean(combined_complete$avg.height,
        na.rm = TRUE), sd = sd(combined_complete$avg.height,
        na.rm = TRUE)), color = "red", size = 1)
```




```
ggplot(combined_complete, aes(Heterozygosity)) + labs(title = "Histogram Heterozygosity",
    x = "Heterozygosity", y = "Frequency") + geom_histogram(bins = 10,
    aes(y = ..density..), color = "black", fill = "black") +
    stat_function(fun = dnorm, args = list(mean = mean(combined_complete$Heterozygosity,
        na.rm = TRUE), sd = sd(combined_complete$Heterozygosity,
        na.rm = TRUE)), color = "red", size = 1)
```



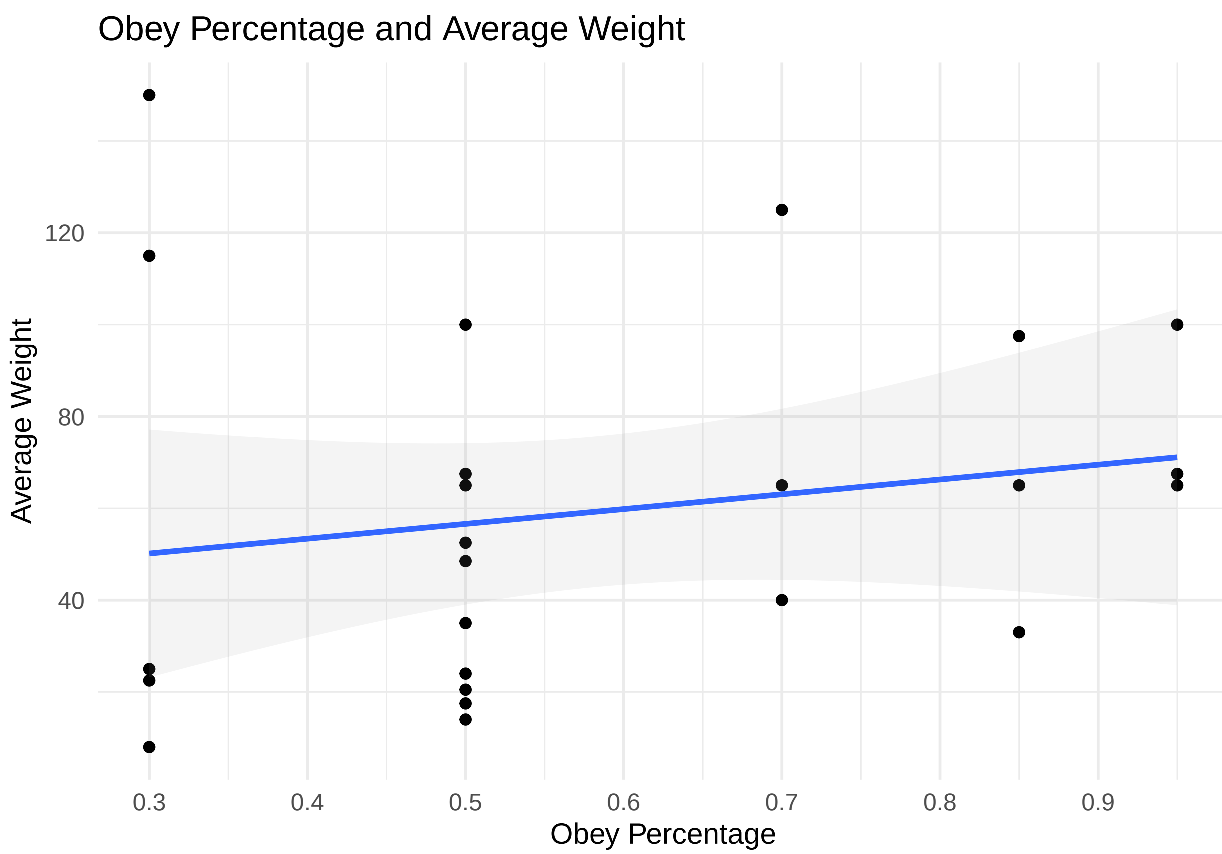

```
ggplot(combined_complete, aes(Heterozygosity_x10_4)) + labs(title = "Histogram Heterozygosity_x10_4",
    x = "Heterozygosity_x10_4", y = "Frequency") + geom_histogram(bins = 10,
    aes(y = ..density..), color = "black", fill = "black") +
    stat_function(fun = dnorm, args = list(mean = mean(combined_complete$Heterozygosity_x10_4,
        na.rm = TRUE), sd = sd(combined_complete$Heterozygosity_x10_4,
        na.rm = TRUE)), color = "red", size = 1)
```



- **Scatter Plot of obey and avg.weight**

```
scatter <- ggplot(combined_complete, aes(obey, avg.weight))
scatter + geom_point() + scale_x_continuous(n.breaks = 10) +
    geom_smooth(method = "lm", alpha = 0.1) + labs(x = "Obey Percentage",
    y = "Average Weight") + ggtitle("Obey Percentage and Average Weight")
```

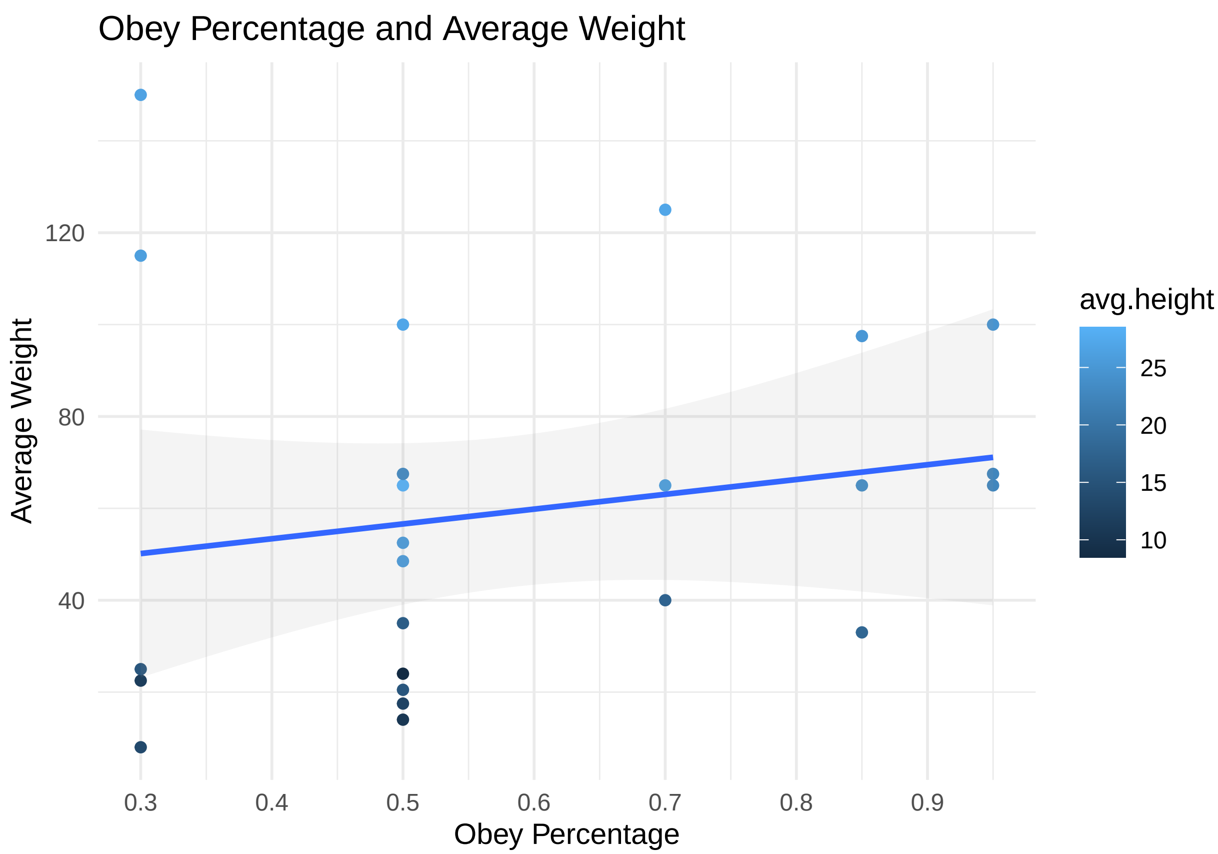
```
## `geom_smooth()` using formula 'y ~ x'
```



- **Scatter Plot of obey and avg.weight colored by height**

```
scatter <- ggplot(combined_complete, aes(obey, avg.weight, col = avg.height))
scatter + geom_point() + scale_x_continuous(n.breaks = 10) +
    geom_smooth(method = "lm", alpha = 0.1) + labs(x = "Obey Percentage",
    y = "Average Weight") + ggtitle("Obey Percentage and Average Weight")
```

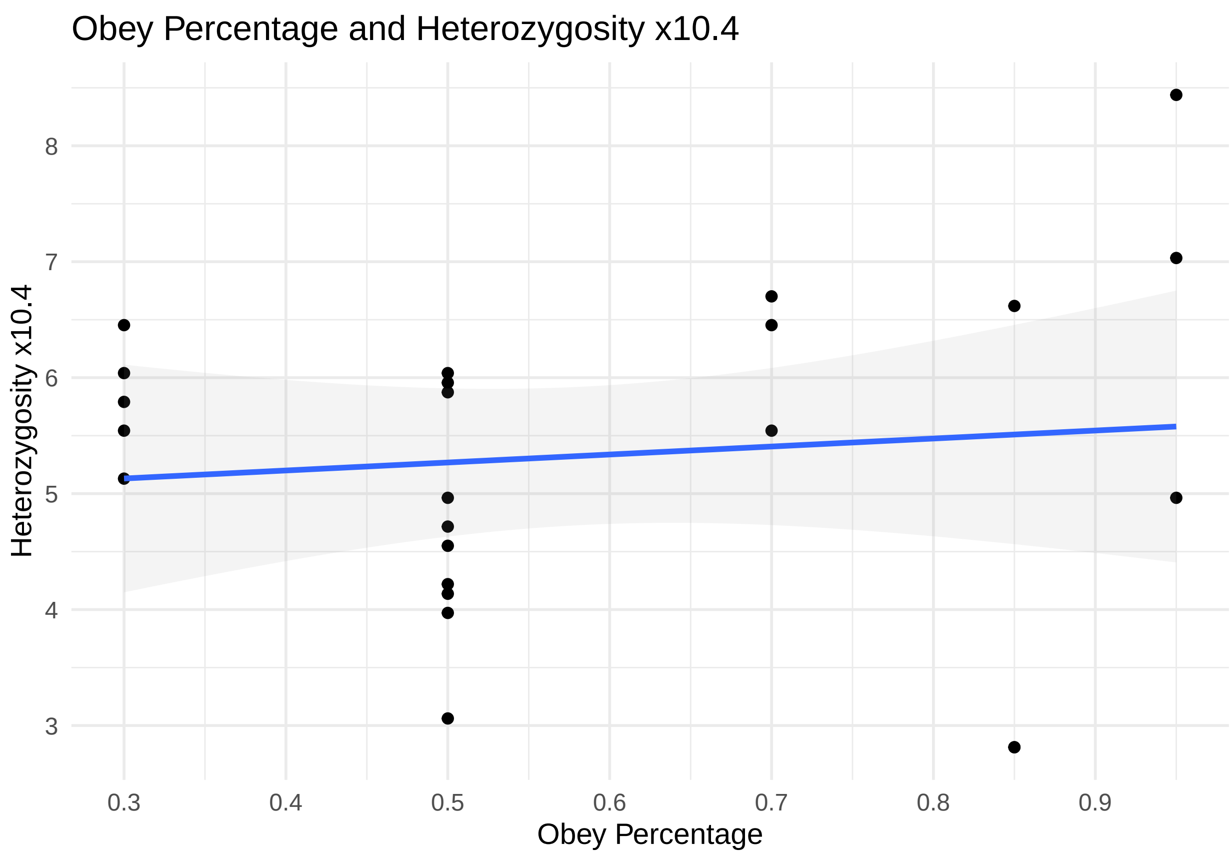
```
## `geom_smooth()` using formula 'y ~ x'
```



- **Scatter Plot of obey and Heterozygosity__x10__4**

```
scatter <- ggplot(combined_complete, aes(obey, Heterozygosity_x10_4))
scatter + geom_point() + scale_x_continuous(n.breaks = 10) +
    geom_smooth(method = "lm", alpha = 0.1) + labs(x = "Obey Percentage",
    y = "Heterozygosity x10.4") + ggtitle("Obey Percentage and Heterozygosity x10.4")
```

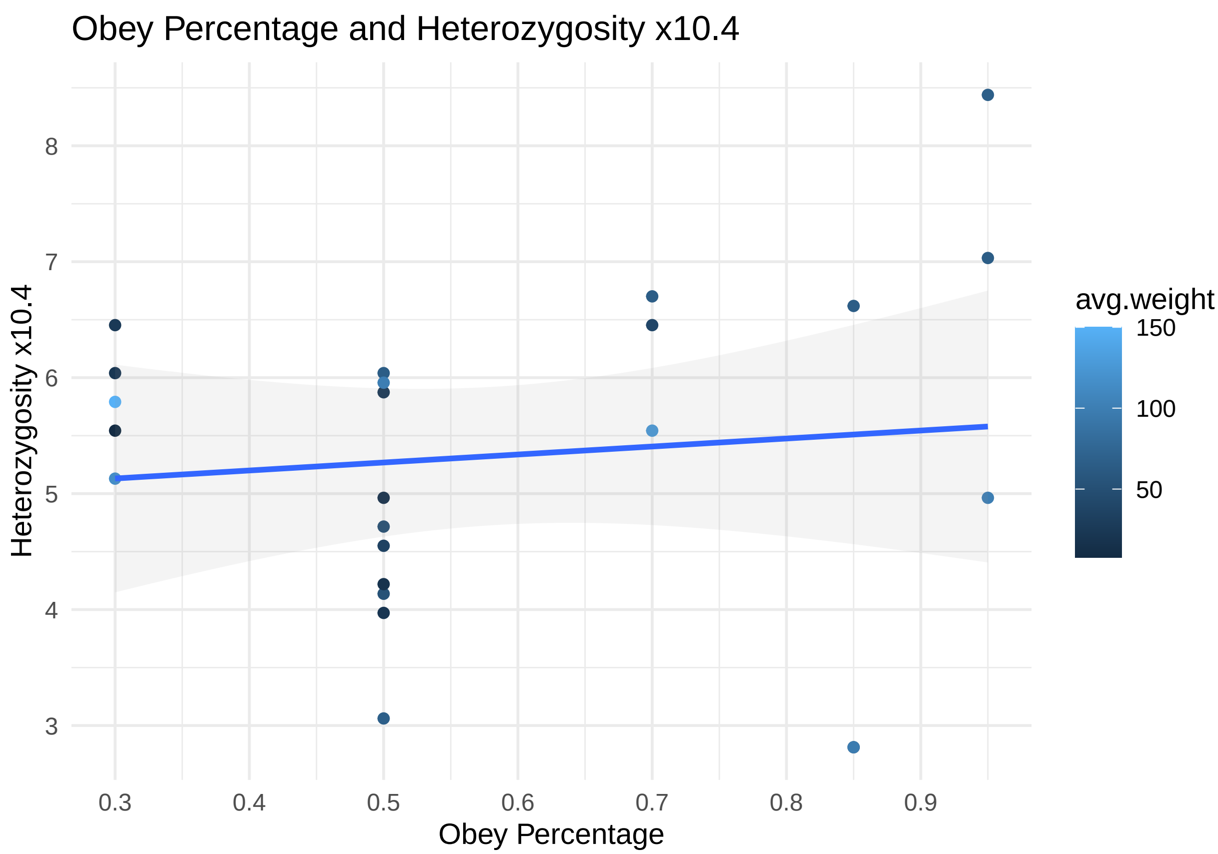
```
## `geom_smooth()` using formula 'y ~ x'
```



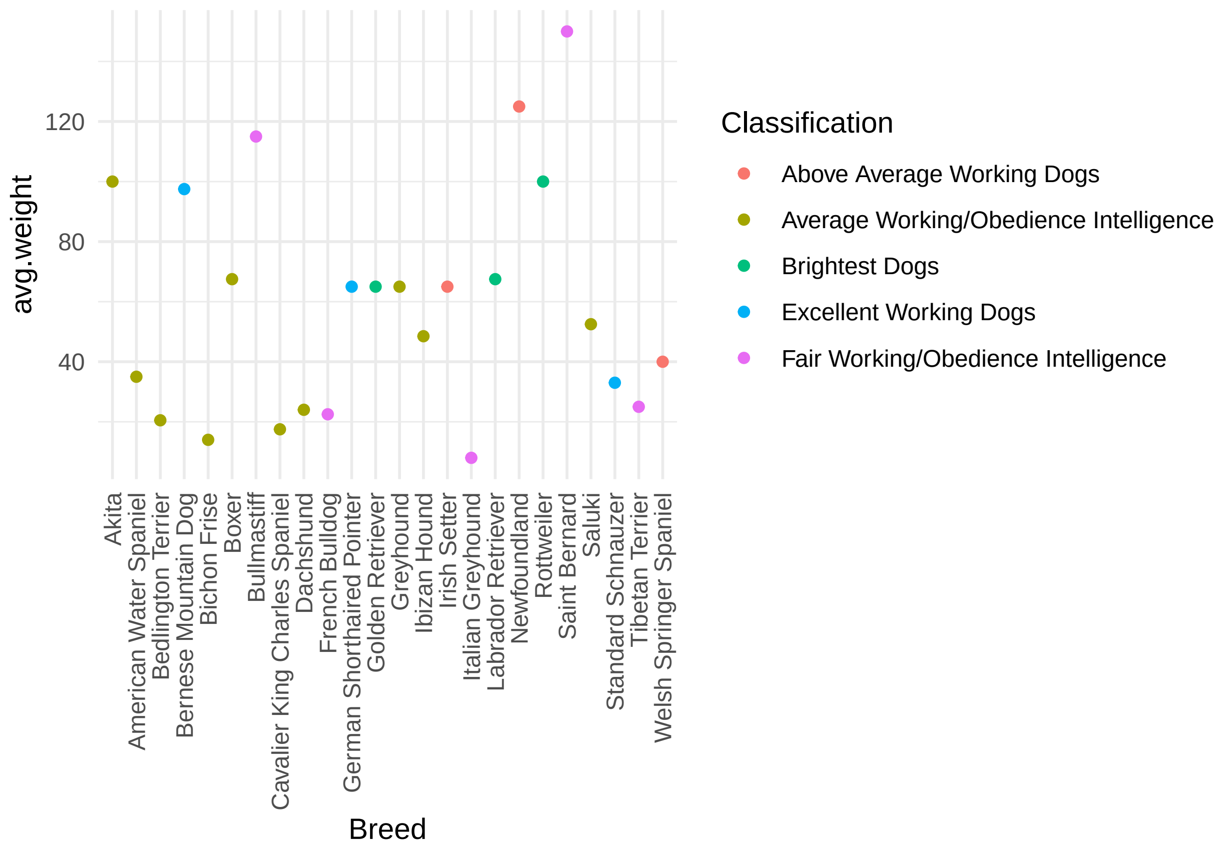
- **Scatter Plot of obey and Heterozygosity__x10__4 colored by average weight**

```
scatter <- ggplot(combined_complete, aes(obey, Heterozygosity_x10_4,
    col = avg.weight))
scatter + geom_point() + scale_x_continuous(n.breaks = 10) +
    geom_smooth(method = "lm", alpha = 0.1) + labs(x = "Obey Percentage",
    y = "Heterozygosity x10.4") + ggtitle("Obey Percentage and Heterozygosity x10.4")
```

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




```
# Plot of Obey Percentage and Breed color coded
ggplot(combined_complete, aes(x = Breed, y = avg.weight, color = Classification)) +
    geom_point() + theme(axis.text.x = element_text(angle = 90,
    vjust = 0.5, hjust = 1))
```



- **Correlation between obey percentage and avg.weight**

```
cor.test(combined_df$obey, combined_df$avg.weight, use = "complete.obs")
```

```
##
##  Pearson's product-moment correlation
##
## data:  combined_df$obey and combined_df$avg.weight
## t = 0.88343, df = 22, p-value = 0.3866
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.2359190  0.5476023
## sample estimates:
##       cor
## 0.1850928
```

Since the correlation is 0.19 and the p-value is 0.39 we can say that the correlation between the two variables is not significant. Also, the intervals cross 0 so as one goes up the other goes up but then it is reversed.

- **Correlation between obey percentage and Heterozygosity_x10_4**

```
cor.test(combined_df$obey, combined_df$Heterozygosity_x10_4,
    use = "complete.obs")
```

```
##
##  Pearson's product-moment correlation
##
## data:  combined_df$obey and combined_df$Heterozygosity_x10_4
## t = 0.43369, df = 23, p-value = 0.6686
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.3163255  0.4685203
## sample estimates:
##        cor
## 0.09006233
```

Since the correlation is 0.09 and the p-value is 0.66 we can say that the correlation between the two variables is not significant. Also, the intervals cross 0 so as one goes up the other goes up but then it is reversed.

- **Correlation between avg.weight and Heterozygosity_x10_4**

```
cor.test(combined_df$avg.weight, combined_df$Heterozygosity_x10_4,
    use = "complete.obs")
```

```
##
##  Pearson's product-moment correlation
##
## data:  combined_df$avg.weight and combined_df$Heterozygosity_x10_4
## t = -0.16629, df = 26, p-value = 0.8692
## alternative hypothesis: true correlation is not equal to 0
## 95 percent confidence interval:
##  -0.4007977  0.3446736
## sample estimates:
##         cor
## -0.03259464
```

- **Correlation between all variables**

```
cor(combined_df[, unlist(lapply(combined_df, is.numeric))], use = "complete.obs")
```

```
##                             obey  reps_lower  reps_upper height_low_inches
## obey                  1.00000000 -0.99564934 -0.95313734        0.26153249
## reps_lower           -0.99564934  1.00000000  0.97197530       -0.24849600
## reps_upper           -0.95313734  0.97197530  1.00000000       -0.23119865
## height_low_inches     0.26153249 -0.24849600 -0.23119865        1.00000000
## height_high_inches    0.30637778 -0.30054392 -0.28580559        0.96909760
## weight_low_lbs        0.23947951 -0.21170210 -0.15476993        0.84736129
## weight_high_lbs       0.14477026 -0.11696117 -0.06131463        0.79255876
## Heterozygosity        0.07193455 -0.05977593 -0.04541667        0.13287772
## Heterozygosity_x10_4  0.11007240 -0.05832246 -0.01860510        0.07461812
## avg.weight            0.18509278 -0.15703279 -0.10032941        0.82261801
## avg.height            0.28690276 -0.27751125 -0.26141002        0.99173281
##                      height_high_inches weight_low_lbs weight_high_lbs
## obey                         0.30637778    0.239479506      0.14477026
## reps_lower                  -0.30054392   -0.211702105     -0.11696117
## reps_upper                  -0.28580559   -0.154769935     -0.06131463
```

```
## height_low_inches           0.96909760   0.847361295     0.79255876
## height_high_inches          1.00000000   0.804873046     0.75482370
## weight_low_lbs              0.80487305   1.000000000     0.96124005
## weight_high_lbs             0.75482370   0.961240047     1.00000000
## Heterozygosity              0.17900053   0.004482911     0.11759281
## Heterozygosity_x10_4        0.04436231   0.034970172     0.10380218
## avg.weight                  0.78257009   0.986302832     0.99355113
## avg.height                  0.99273957   0.831875415     0.77911756
##                      Heterozygosity Heterozygosity_x10_4  avg.weight
## obey                    0.071934550           0.11007240  0.18509278
## reps_lower             -0.059775932          -0.05832246 -0.15703279
## reps_upper             -0.045416668          -0.01860510 -0.10032941
## height_low_inches       0.132877719           0.07461812  0.82261801
## height_high_inches      0.179000532           0.04436231  0.78257009
## weight_low_lbs          0.004482911           0.03497017  0.98630283
## weight_high_lbs         0.117592808           0.10380218  0.99355113
## Heterozygosity          1.000000000           0.54710881  0.07219321
## Heterozygosity_x10_4    0.547108806           1.00000000  0.07648067
## avg.weight              0.072193207           0.07648067  1.00000000
## avg.height              0.157908013           0.05946187  0.80820838
##                       avg.height
## obey                  0.28690276
## reps_lower           -0.27751125
## reps_upper           -0.26141002
## height_low_inches     0.99173281
## height_high_inches    0.99273957
## weight_low_lbs        0.83187542
## weight_high_lbs       0.77911756
## Heterozygosity        0.15790801
## Heterozygosity_x10_4  0.05946187
## avg.weight            0.80820838
## avg.height            1.00000000
```

Do you plan on incorporating any machine learning techniques to answer your research questions? Explain.

- Regression analysis

```
combined_model <- lm(obey ~ avg.weight + avg.height + Heterozygosity_x10_4,
    data = combined_df)

summary(combined_model)
```

```
##
## Call:
## lm(formula = obey ~ avg.weight + avg.height + Heterozygosity_x10_4,
##     data = combined_df)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -0.31265 -0.16426 -0.00432  0.14696  0.34899
##
## Coefficients:
```

```
##                        Estimate Std. Error t value Pr(>|t|)
## (Intercept)           0.2566674  0.2573047   0.998    0.330
## avg.weight           -0.0008206  0.0020733  -0.396    0.696
## avg.height            0.0142519  0.0129588   1.100    0.284
## Heterozygosity_x10_4  0.0155575  0.0340134   0.457    0.652
##
## Residual standard error: 0.2256 on 20 degrees of freedom
##   (5 observations deleted due to missingness)
## Multiple R-squared:  0.09806,    Adjusted R-squared:  -0.03723
## F-statistic: 0.7248 on 3 and 20 DF,  p-value: 0.549
```

Looking at the Adjusted R-squared of -0.37 and all p-values for the variables are not significant it does not look like any other the variables help with the percentage a dog can obey.

Questions for future steps.

More research would need to be done to find out if any other data can be linked to a dog's intelligence.

Step 3

Introduction

We all love dogs. Some more than others but all in all, a dog is man's best friend. I think what we enjoy most about our furry companions is their ability to learn. From just being able to fetch a ball and bring it back to help the police locate missing persons to alerting their companions that they are about to have a seizure. Dogs are amazing animals.

The problem statement you addressed

With this analysis, I wanted to determine if a dog's size really determines its intelligence level. Are big dogs smarter than smaller dogs? Are they faster at learning commands or is it based on something else?

How I addressed the problem

1. I looked at 4 datasets to help me determine if the size of a dog determines its intelligence level.

   a. AKC Breed Information: This dataset contained information such as breed, height and weight
   b. Dog Intelligence: This dataset contained information such as breed, classification of intelligence, obey percentage, and upper and lower repetitions a dog could handle
   c. Heterozygosity of 85 breeds: This dataset contained information about the breed and heterozygosity
   d. Heterozygosity x10_4 of 60 breeds: This dataset contained information about the breed and heterozygosity x10_4.

2. I combined all 4 datasets into 1 and began to clean up the data and create new variables for average weight and average height.

3. Did some descriptive statistics

   a. Obey, Avg Weight, and Avg Height

	Obey	Avg Weight	Avg Height
Min	0.30	8.00	8.5
Median	0.50	58.75	22.75
Mean	0.58	62.84	20.59
Max	0.95	182.50	28.5

`b. By Classification: Obey, Avg Weight, and Avg Height`

Brightest Dogs

	Obey	Avg Weight	Avg Height
Min	0.95	65.00	22.50
Median	0.95	67.5	22.50
Mean	0.95	77.5	23.17
Max	0.95	83.75	24.50

Excellent Working Dogs

	Obey	Avg Weight	Avg Height
Min	0.85	33.0	18.00
Median	0.85	65.0	23.50
Mean	0.85	65.17	22.17
Max	0.85	97.5	25.00

Above Avg Working Dog

	Obey	Avg Weight	Avg Height
Min	0.70	40.0	17.5
Median	0.70	65.0	26.0
Mean	0.70	76.67	23.5
Max	0.70	95.0	27.0

Average Working/Obedience Intelligence

	Obey	Avg Weight	Avg Height
Min	0.50	14.0	8.5
Median	0.50	41.75	19.75
Mean	0.50	44.45	25.5
Max	0.50	100.0	28.5

Fair Working/Obedience Intelligence

	Obey	Avg Weight	Avg Height
Min	0.30	8.0	11.5
Median	0.30	25.0	15.5

	Obey	Avg Weight	Avg Height
Mean	0.30	64.1	18.6
Max	0.30	150.0	26.5

Lowest Degree of Working/Obedience Intelligence

	Obey	Avg Weight	Avg Height
Min	NA	24.0	14.0
Median	NA	65.0	20.75
Mean	NA	84.12	21.0
Max	NA	182.5	28.5

```
c.  Histograms of obey percentage, average weight, average height,
Heterozygosity, and Heterozygosity x104

d.  Scatter plots along of obey percentage vs average weight and obey
percentage vs Heterozygosity x10.4

e.  Plot of each Breed with the average weight color coded by Classification.

f.  Correlations:

    i. Obey Percentage vs Average Weight:
        Correlation: 0.185; p-value: 0.387
    ii. Obey Percentage vs Heterozygosity x10.4:
        Correlation: 0.09; p-value: 0.669
    iii. Average Weight vs Heterozygosity x10.4:
        Correlation: -0.32; p-value: 0.869
```

4. Regression Models

   Obey Percentage with Average Weight + Average height + Heterozygosity x10.4:

   - R squared: 0.08
   - Adj R squared: -0.037
   - F-statistic: 0.725
   - P-value: 0.549

Analysis

My preliminary analysis on whether the size of a dog determines its intelligence is as follows:

1. Looking at the mean of each breed and their classification suggests dogs of all weights can fit into each classification of brightest down to lowest.
2. The scatterplot of Obey Percentage and Average Weight does show a slight upwards trend between a dog's obey percentage and their average weight suggesting maybe their weight does play some role in their intelligence.

3. Looking at the plot of Breed and average weight, it shows that the different classifications of intelligence has an average weight all over the spectrum. This suggests that the average weight of a breed has no correlation to their intelligence.
4. The correlations between the variables all suggested very low relationships between the various variables suggesting that the dog's obey percentage isn't influenced by its size or Heterozygosity.
5. Running a multiple linear regression model to see if average height, average weight, and Heterozygosity x10_4 have any influence on the obey percentage of a dog suggests that all variables do not influence the obey percentage very much if at all.

Implications

As the size of a dog does not seem to influence how smart they are, I do not see any evil scientist manipulating dog genetics to increase the size of a dog to make them smarter.

Concluding Remarks

With the limited initial research on if size influences a dog's intelligence, more research would need to be done to find out what, if any, genetics or factors lead to a breeds intelligence level.

References

Fishman, L. n.d.a. "'Dog/Canine Breed Size (AKC)'." https://data.world/len/dog-canine-breed-size-akc.

———. n.d.b. "Intelligence of Dogs." https://data.world/len/intelligence-of-dogs.