Class 04: Exploring the Day 1 Survey

Thomas E. Love

2019-09-05

Contents


```
knitr::opts_chunk$set(comment=NA)
options(width = 70)
```

Load the R Packages we need

```
library(magrittr); library(tidyverse)
## always need tidyverse, can include other packages too
```

Load the Data

We will read in the .csv file of the data, and then pipe that result into the `tbl_df` function, which turns the data frame into a nicely organized *tibble*.

- Since we've carefully stored the data file in the same directory as our R Project, we can read it in directly.

```
day1 <- read.csv("surveyday1_2019.csv") %>% tbl_df
```

Key Verbs in the Tidyverse for Data Wrangling

Print your tibble by typing its name

```
day1
```

```
# A tibble: 315 x 21
   student sex   glasses english statsofar ageguess smoke h.left
     <int> <fct> <fct>   <fct>       <int>    <int> <int>  <int>
 1  201901 <NA>  y       y               6       42     1      1
 2  201902 <NA>  y       y               7       53     1     19
 3  201903 <NA>  y       y               4       45     1      0
 4  201904 <NA>  y       y               7       45     1     16
 5  201905 <NA>  y       y               6       42     1      2
 6  201906 <NA>  y       y               7       50     1     10
 7  201907 <NA>  y       y               5       56     1      1
 8  201908 <NA>  n       n               6       50     1      0
 9  201909 <NA>  n       y               6       52     1      0
10  201910 <NA>  n       y               4       42     1     18
# ... with 305 more rows, and 13 more variables: h.right <int>,
#   handedness <dbl>, statfuture <int>, haircut <dbl>, lecture <int>,
#   alone <int>, height.in <dbl>, hand.span <dbl>, favcolor <fct>,
#   lastsleep <dbl>, pulse <int>, year <int>, lovetrueage <dbl>
```

Use select to pick columns / variables from your tibble

```
day1 %>%
    select(favcolor, haircut)
```

```
# A tibble: 315 x 2
   favcolor haircut
   <fct>      <dbl>
 1 teal       120
 2 blue        20
 3 purple      20
 4 blue         0
 5 blue         6.99
 6 <NA>        NA
 7 green       25
 8 red         80
 9 green       16
10 blue        12.5
# ... with 305 more rows
```

Use filter to pick rows / subjects from your tibble

```
day1 %>%
    filter(year == 2019)
```

```
# A tibble: 61 x 21
   student sex   glasses english statsofar ageguess smoke h.left
```

```
     <int> <fct> <fct>   <fct>       <int>    <int> <int>  <int>
 1  201901 <NA>  y       y               6       42     1      1
 2  201902 <NA>  y       y               7       53     1     19
 3  201903 <NA>  y       y               4       45     1      0
 4  201904 <NA>  y       y               7       45     1     16
 5  201905 <NA>  y       y               6       42     1      2
 6  201906 <NA>  y       y               7       50     1     10
 7  201907 <NA>  y       y               5       56     1      1
 8  201908 <NA>  n       n               6       50     1      0
 9  201909 <NA>  n       y               6       52     1      0
10  201910 <NA>  n       y               4       42     1     18
# ... with 51 more rows, and 13 more variables: h.right <int>,
#   handedness <dbl>, statfuture <int>, haircut <dbl>, lecture <int>,
#   alone <int>, height.in <dbl>, hand.span <dbl>, favcolor <fct>,
#   lastsleep <dbl>, pulse <int>, year <int>, lovetrueage <dbl>
```

Use count to count the number of observations meeting a criterion

```
day1 %>%
    count(favcolor == "red")
```

```
# A tibble: 3 x 2
  `favcolor == "red"`     n
  <lgl>               <int>
1 FALSE                 280
2 TRUE                   30
3 NA                      5
```

Or to provide a cross-classification:

```
day1 %>%
    count(favcolor == "blue", english)
```

```
Warning: Factor `english` contains implicit NA, consider using
`forcats::fct_explicit_na`
```

```
# A tibble: 7 x 3
  `favcolor == "blue"` english     n
  <lgl>                <fct>   <int>
1 FALSE                n          33
2 FALSE                y         154
3 FALSE                <NA>        2
4 TRUE                 n          24
5 TRUE                 y          97
6 NA                   n           2
7 NA                   y           3
```

Use arrange to arrange the rows of a tibble

```
day1 %>%
    count(statsofar) %>%
    arrange(desc(n))
```

```
# A tibble: 7 x 2
  statsofar     n
      <int> <int>
```

```
1         5   122
2         6    69
3         7    45
4         4    37
5         3    31
6         2     7
7         1     4
```

Add new variables with mutate

```
day1 %>%
    mutate(guess_error = ageguess - lovetrueage) %>%
    select(ageguess, lovetrueage, guess_error) %>%
    summary()
```

```
    ageguess     lovetrueage     guess_error
 Min.   :21.0   Min.   :47.50   Min.   :-31.500
 1st Qu.:45.0   1st Qu.:48.50   1st Qu.: -6.500
 Median :48.0   Median :50.50   Median : -2.500
 Mean   :47.3   Mean   :50.13   Mean   : -2.837
 3rd Qu.:52.0   3rd Qu.:51.50   3rd Qu.:  0.500
 Max.   :70.0   Max.   :52.50   Max.   : 20.500
 NA's   :6                      NA's   :6
```

Get grouped summaries with group_by and summarize

```
day1 %>%
    group_by(year) %>%
    summarize(n = n(), average_guess = mean(ageguess),
              min_error = min(ageguess),
              max_error = max(ageguess),
              actual = mean(lovetrueage))
```

```
# A tibble: 6 x 6
   year     n average_guess min_error max_error actual
  <int> <int>         <dbl>     <dbl>     <dbl>  <dbl>
1  2014    42          NA          NA        NA   47.5
2  2015    49          47.1        36        57   48.5
3  2016    64          NA          NA        NA   49.5
4  2017    48          46.5        29        58   50.5
5  2018    51          NA          NA        NA   51.5
6  2019    61          NA          NA        NA   52.5
```

Whoops - looks like we have some missing `ageguess` values. We could filter our data to only include the subjects who provided a guess...

```
day1 %>%
    filter(complete.cases(ageguess)) %>%
    group_by(year) %>%
    summarize(n = n(), average_guess = mean(ageguess),
              min_error = min(ageguess),
              max_error = max(ageguess),
              actual = mean(lovetrueage))
```

```
# A tibble: 6 x 6
```

```
   year     n average_guess min_error max_error actual
  <int> <int>         <dbl>     <int>     <int>  <dbl>
1  2014    41          47.3        38        58   47.5
2  2015    49          47.1        36        57   48.5
3  2016    61          46.0        24        70   49.5
4  2017    48          46.5        29        58   50.5
5  2018    50          48.2        25        60   51.5
6  2019    60          48.6        21        61   52.5
```

What if, instead, we wanted to look at the errors made, by subtracting off my true age from everyone's guess?

```
day1 %>%
    filter(complete.cases(ageguess)) %>%
    mutate(guess_error = ageguess - lovetrueage) %>%
    group_by(year) %>%
    summarize(n = n(), average_error = mean(guess_error),
              min_error = min(guess_error),
              max_error = max(guess_error))
```

```
# A tibble: 6 x 5
   year     n average_error min_error max_error
  <int> <int>         <dbl>     <dbl>     <dbl>
1  2014    41        -0.159      -9.5      10.5
2  2015    49        -1.38      -12.5       8.5
3  2016    61        -3.53      -25.5      20.5
4  2017    48        -3.96      -21.5       7.5
5  2018    50        -3.32      -26.5       8.5
6  2019    60        -3.85      -31.5       8.5
```

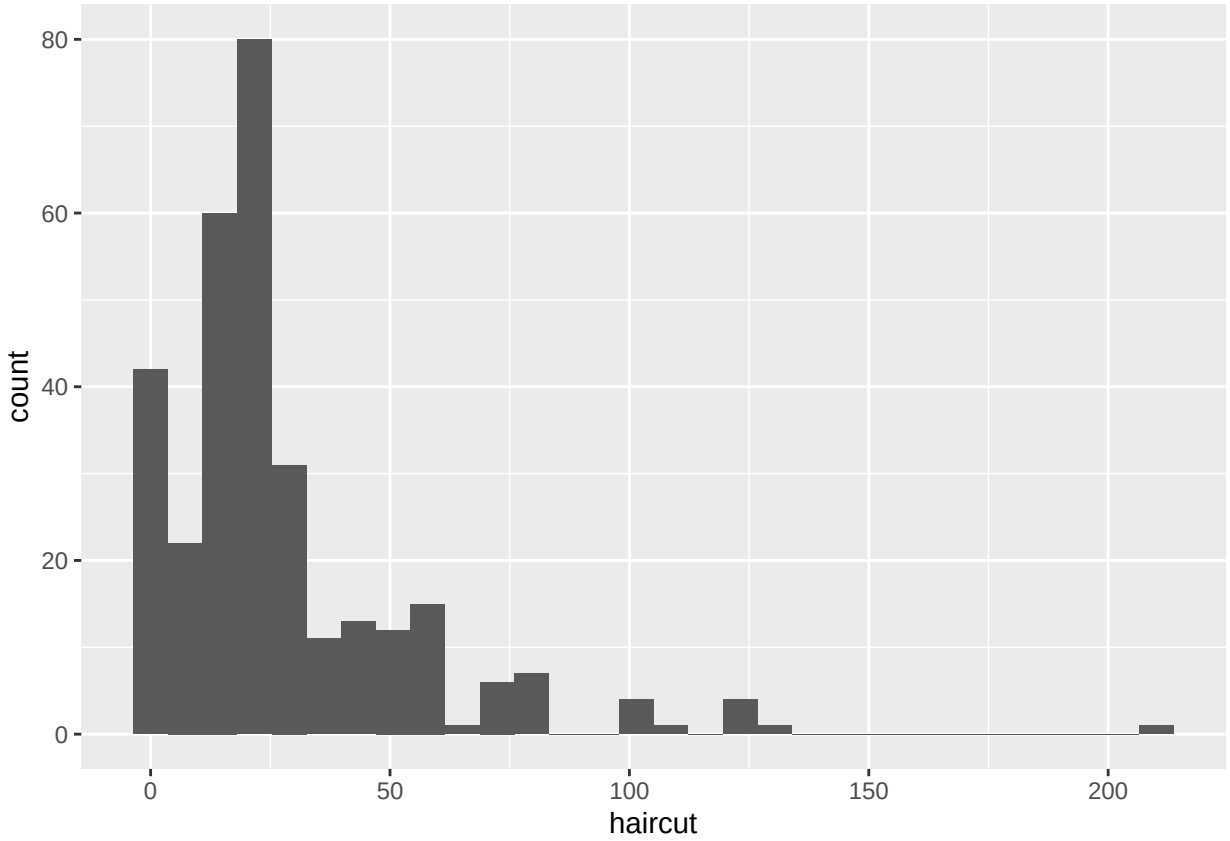
Using ggplot: A Histogram of Haircut Prices

Default Version

```
ggplot(data = day1, aes(x = haircut)) +
    geom_histogram()
```

```
`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

```
Warning: Removed 4 rows containing non-finite values (stat_bin).
```

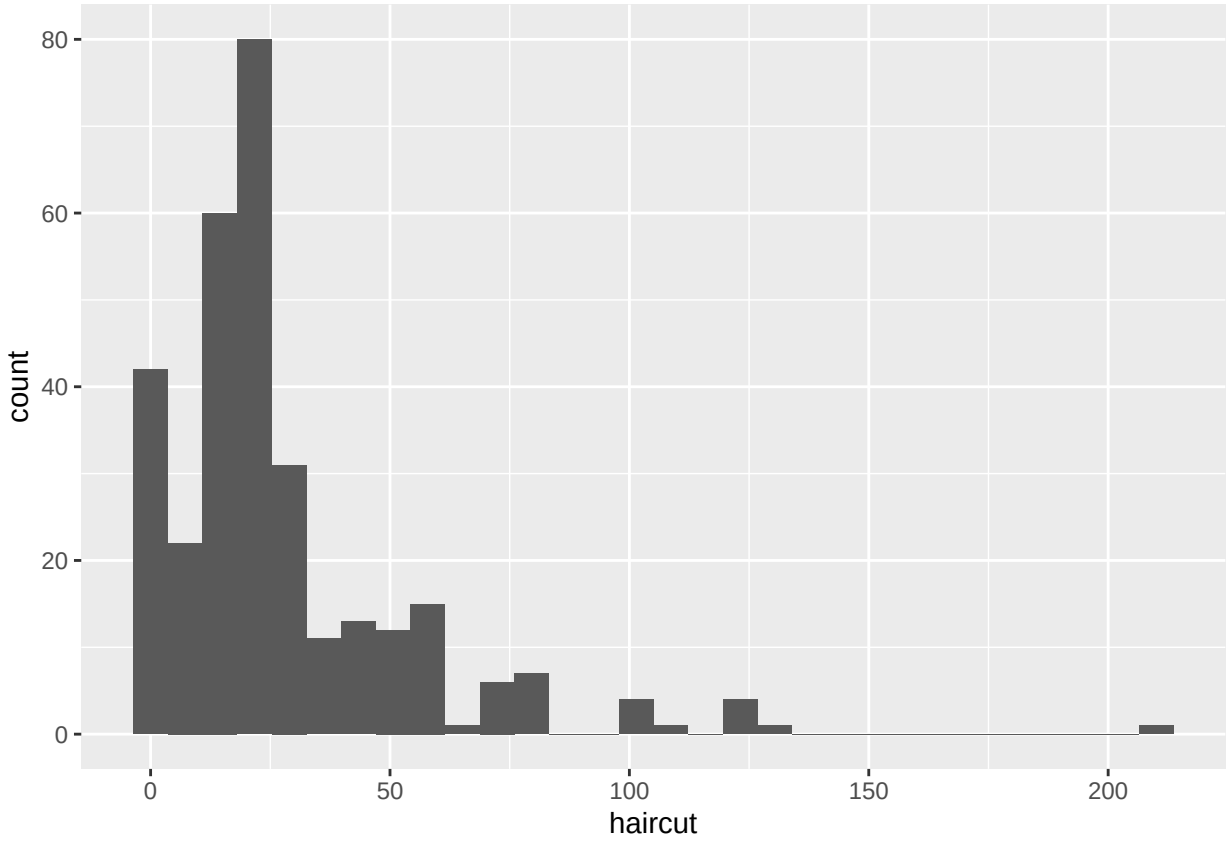


Improvements

1. We'll filter the rows of the `day1` tibble to include only those subjects who gave us a haircut price.

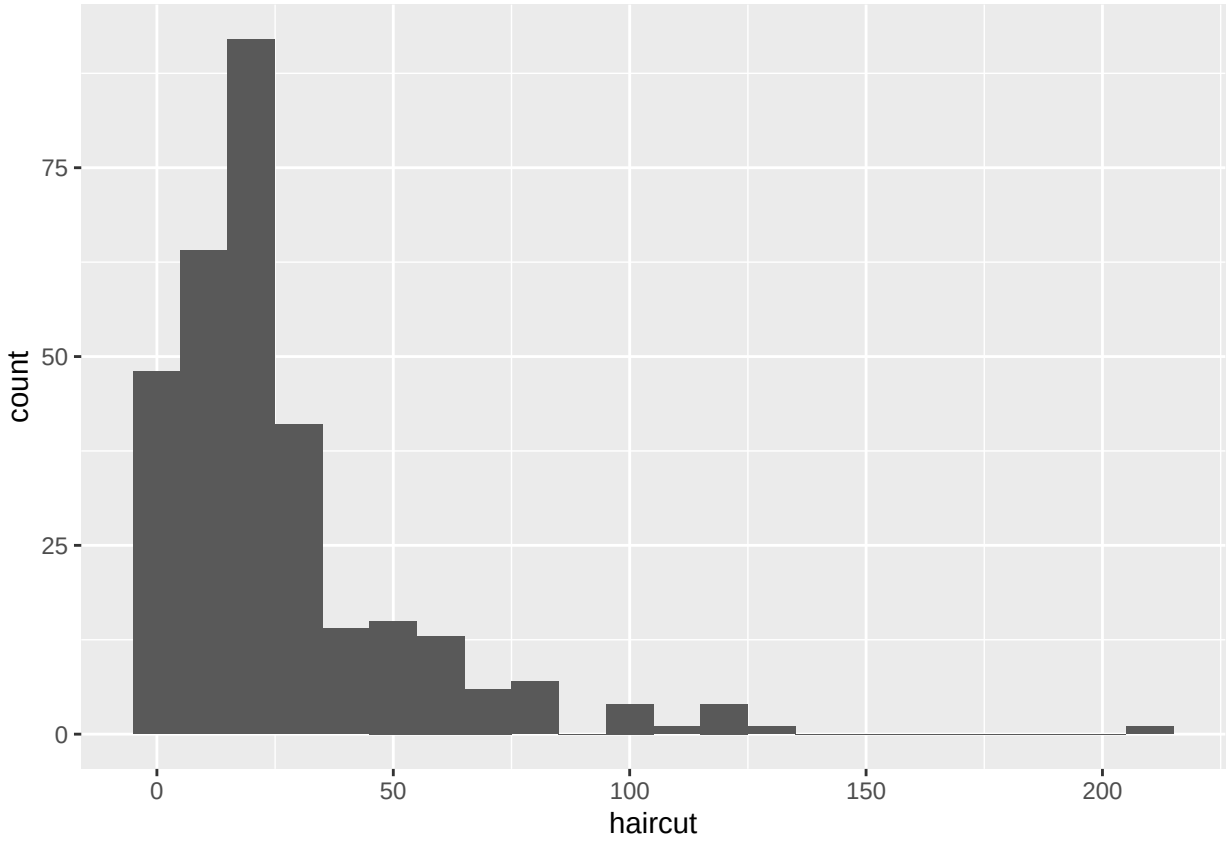
```
day1 %>%
    filter(complete.cases(haircut)) %>%
    ggplot(data = ., aes(x = haircut)) +
    geom_histogram()
```

```
`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



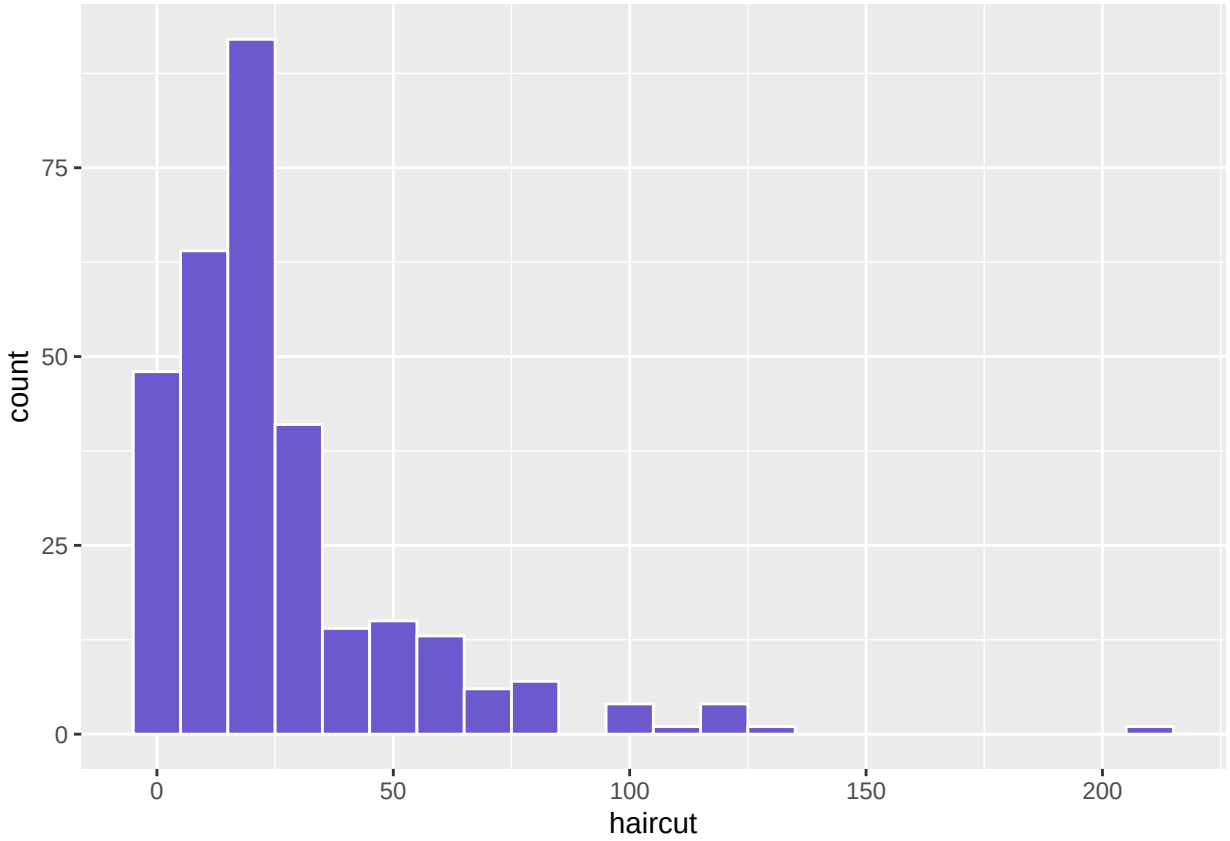
2. We'll specify that R should create bins of width $10 (rather than the default, which creates 30 bins) for the haircut prices to fall in.

```
day1 %>%
    filter(complete.cases(haircut)) %>%
    ggplot(data = ., aes(x = haircut)) +
    geom_histogram(binwidth = 10)
```



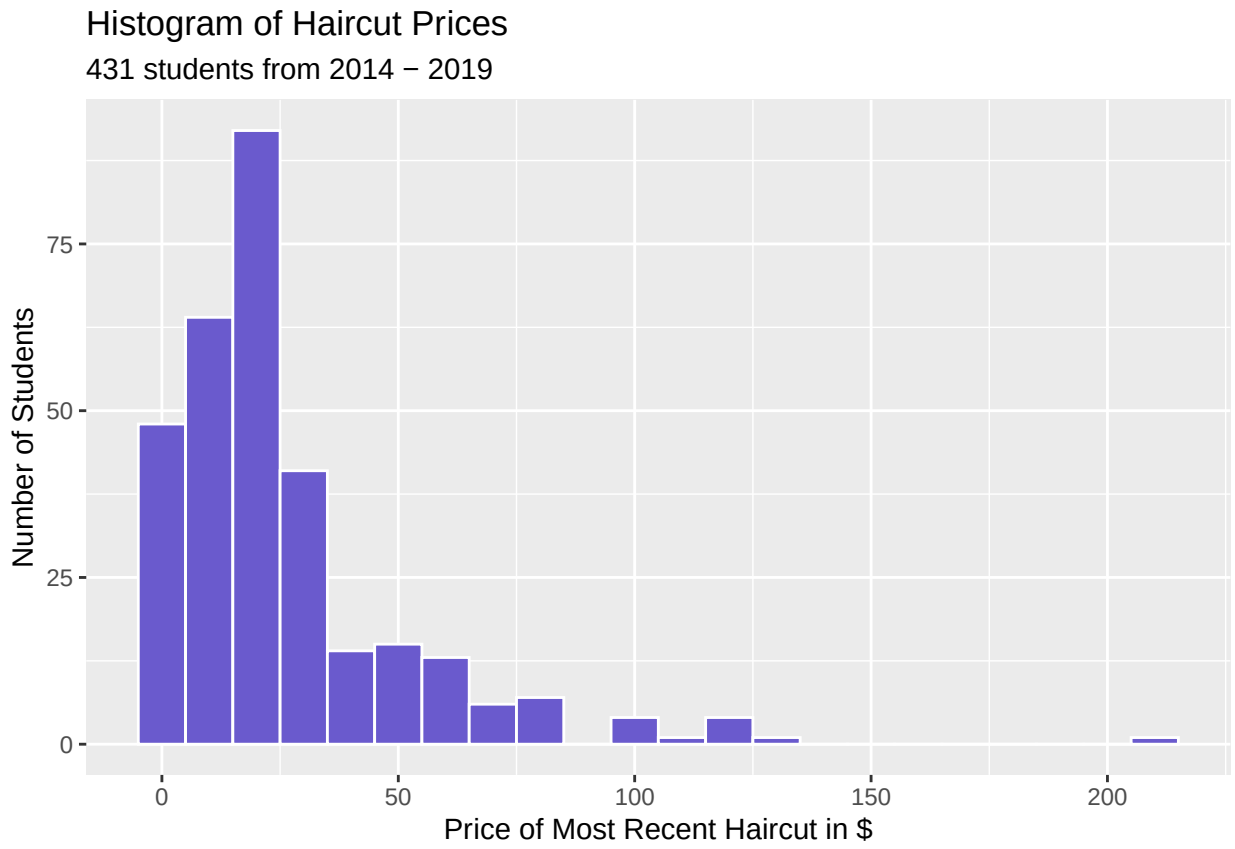
3. We'll set the fill to be a better color - a nice resource for this is to google **Colors in R**. I'll pick "slateblue". We'll also color the outlines of the bars "white".

```
day1 %>%
    filter(complete.cases(haircut)) %>%
    ggplot(data = ., aes(x = haircut)) +
    geom_histogram(binwidth = 10,
                   fill = "slateblue", col = "white")
```



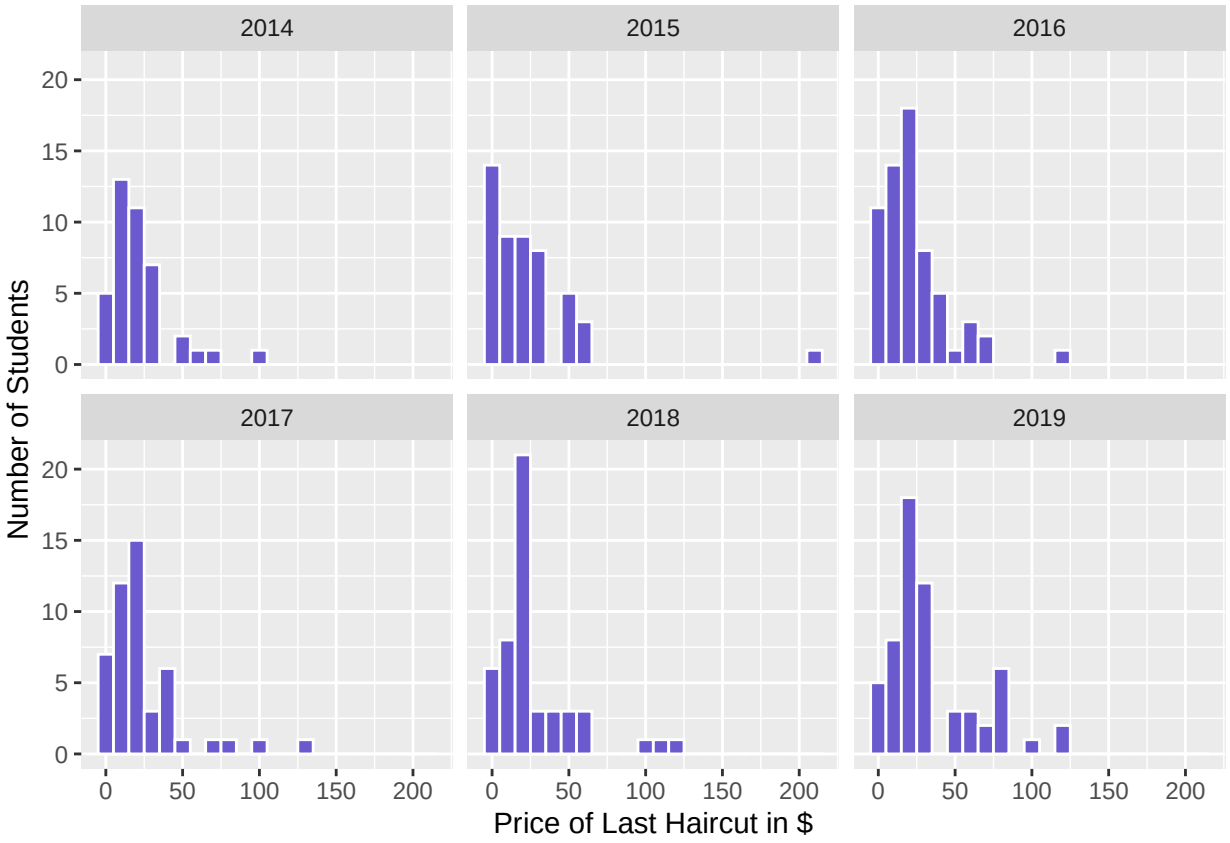
4. We'll build a main title, subtitle and proper axis titles.

```
day1 %>%
    filter(complete.cases(haircut)) %>%
    ggplot(data = ., aes(x = haircut)) +
    geom_histogram(binwidth = 10,
                   fill = "slateblue", col = "white") +
    labs(x = "Price of Most Recent Haircut in $",
         y = "Number of Students",
         title = "Histogram of Haircut Prices",
         subtitle = "431 students from 2014 - 2019")
```



Separate histograms for each year with faceting?

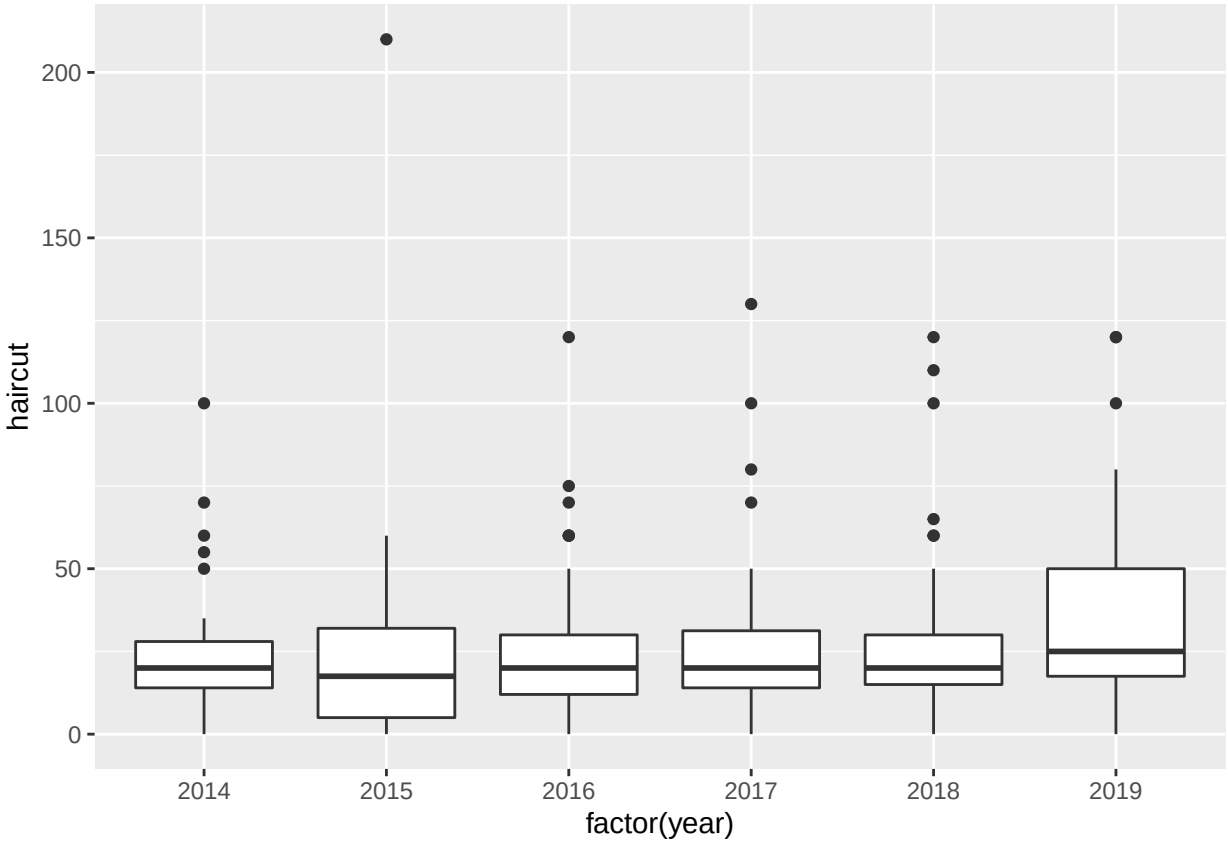
```
day1 %>%
    filter(!is.na(haircut)) %>%
    ggplot(., aes(x = haircut)) +
        geom_histogram(binwidth = 10,
                       fill = "slateblue", color = "white") +
        guides(fill = FALSE) +
        labs(x = "Price of Last Haircut in $",
                 y = "Number of Students") +
        facet_wrap(~ year)
```



Building a Comparison Boxplot

We could use a comparison boxplot. A trick here is to specify `year` as a factor...

```
day1 %>%
    filter(complete.cases(haircut)) %>%
    ggplot(data = .,
           aes(x = factor(year), y = haircut)) +
    geom_boxplot()
```



Numerical Summaries

Detailed Numerical Summary of Haircut Prices

```
day1 %>%
    select(haircut) %>%
    summary()
```

```
    haircut
 Min.   :  0.00
 1st Qu.: 14.00
 Median : 20.00
 Mean   : 27.32
 3rd Qu.: 32.00
 Max.   :210.00
 NA's   :4
```

which can also be done with

```
summary(day1$haircut)
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
   0.00   14.00   20.00   27.32   32.00  210.00       4
```

The `mosaic` package has a useful `favstats` function...

```
mosaic::favstats(day1$haircut)
```

```
Registered S3 method overwritten by 'mosaic':
  method                           from
  fortify.SpatialPolygonsDataFrame ggplot2
```

```
 min Q1 median Q3 max    mean       sd   n missing
   0 14     20 32 210 27.3199 26.35565 311       4
```

But to get this in a pipeline, you'd need the `%$%` operator from the `magrittr` package...

```
day1 %$%
    mosaic::favstats(haircut)
```

```
 min Q1 median Q3 max    mean       sd   n missing
   0 14     20 32 210 27.3199 26.35565 311       4
```

The `psych` package has a useful `describe` function...

```
day1 %$%
    psych::describe(haircut)
```

```
   vars   n  mean    sd median trimmed   mad min max range skew
X1    1 311 27.32 26.36     20   23.12 14.83   0 210   210 2.38
   kurtosis   se
X1     9.02 1.49
```

The `Hmisc` package also has a useful `describe` function...

```
day1 %$%
    Hmisc::describe(haircut)
```

```
haircut
       n  missing distinct     Info     Mean      Gmd      .05
     311        4       50    0.992    27.32    25.36        0
     .10      .25      .50      .75      .90      .95
       0       14       20       32       60       80

lowest :   0.0   1.0   3.0   3.5   5.0, highest: 100.0 110.0 120.0 130.0 210.0
```

Numerical Summary by Year?

```
day1 %>%
    filter(!is.na(haircut)) %>%
    group_by(year) %>%
    summarize(n = n(), mean = mean(haircut),
              sd = sd(haircut), median = median(haircut))
```

```
# A tibble: 6 x 5
   year     n  mean    sd median
  <int> <int> <dbl> <dbl>  <dbl>
1  2014    41  23.7  19.8   20
2  2015    49  24.7  32.8   17.5
3  2016    63  23.8  21.5   20
4  2017    48  25.9  25.3   20
5  2018    50  28.3  26.1   20
6  2019    60  35.8  29.1   25
```

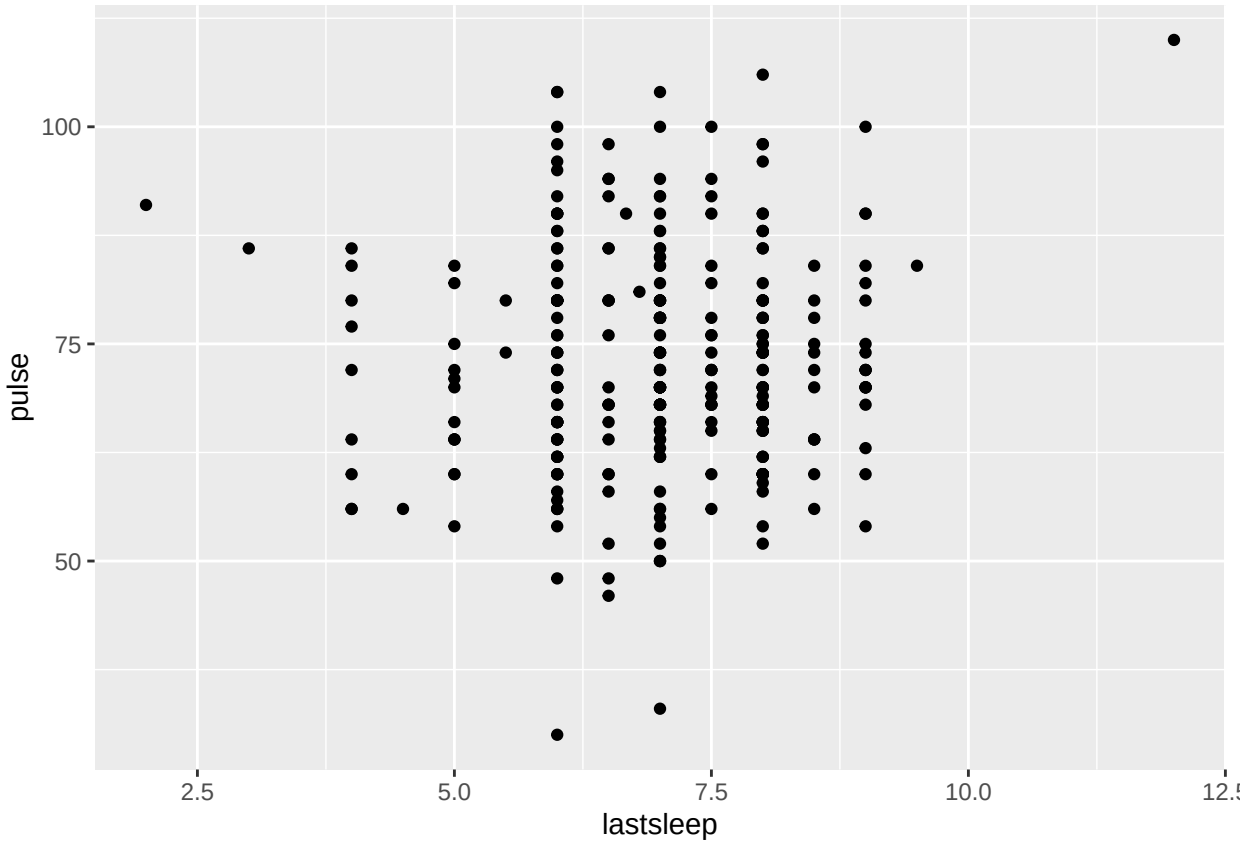
Using ggplot scatterplots

What is the relationship between 431 students' pulse rate and hours of sleep the prior night?

Here, we're looking at two quantitative variables. A scatterplot is usually the best choice.

```
ggplot(data = day1, aes(x = lastsleep, y = pulse)) +
    geom_point()
```

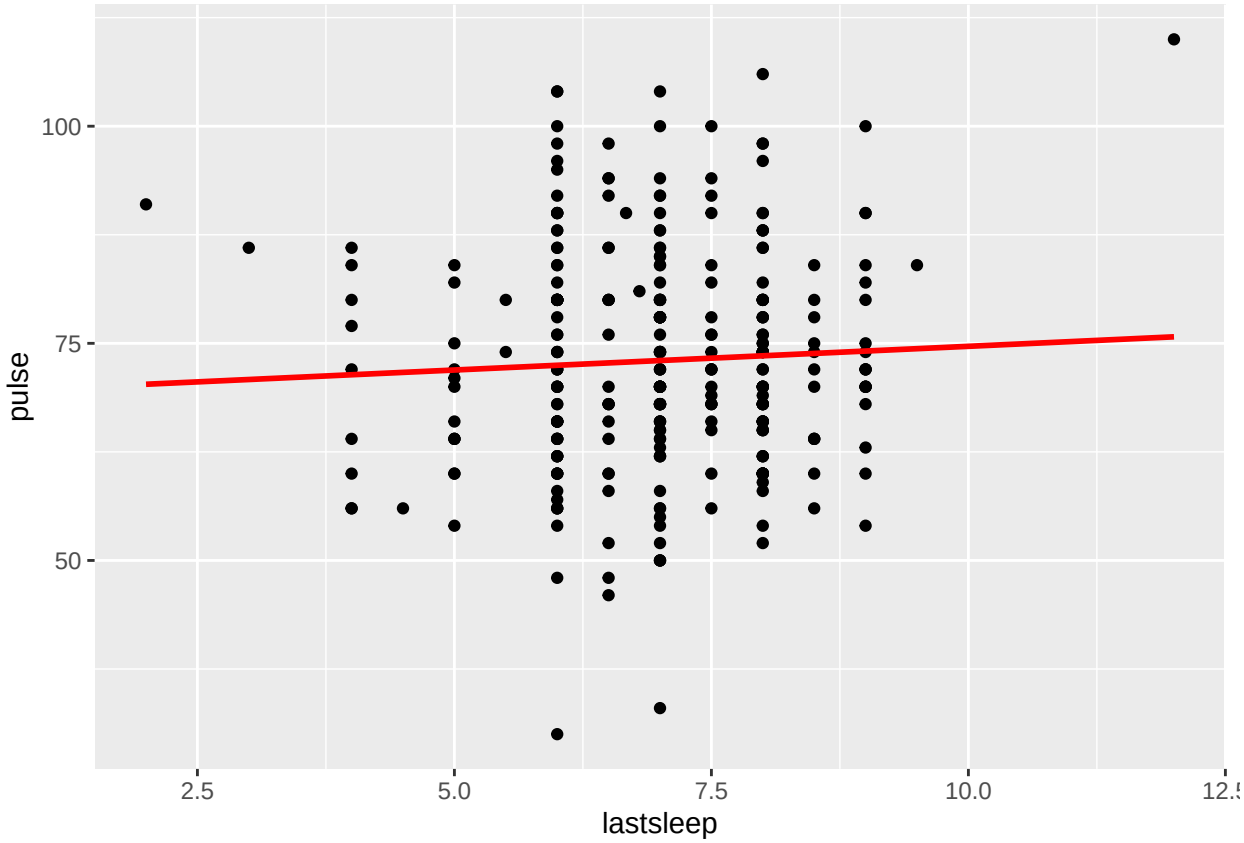
```
Warning: Removed 3 rows containing missing values (geom_point).
```



Improving the Scatterplot

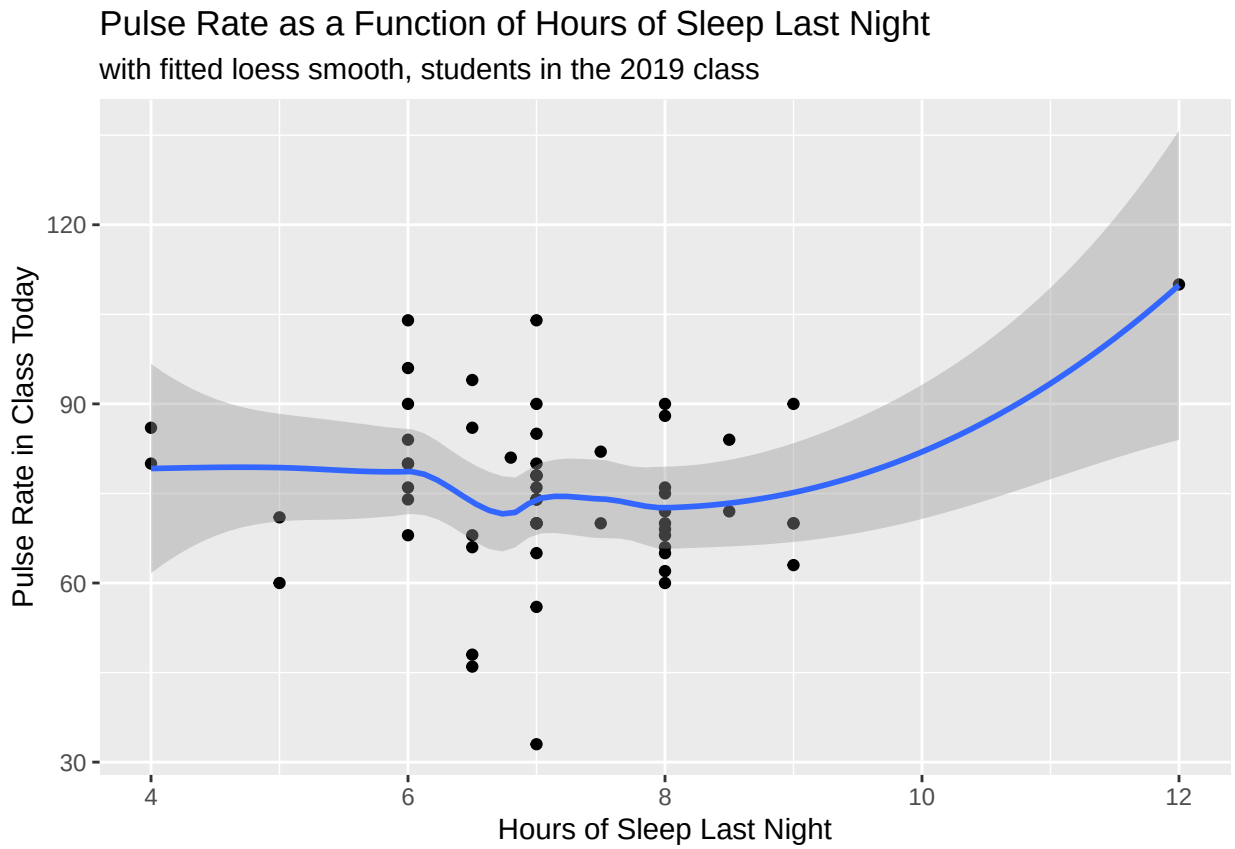
Let's filter to include only those cases with known `pulse` and known `lastsleep`, and also add a line from a linear regression model to predict pulse rate on the basis of hours of sleep the prior night.

```
day1 %>%
    filter(complete.cases(pulse, lastsleep)) %>%
    ggplot(data = ., aes(x = lastsleep, y = pulse)) +
    geom_point() +
    geom_smooth(method = "lm", se = FALSE, col = "red")
```



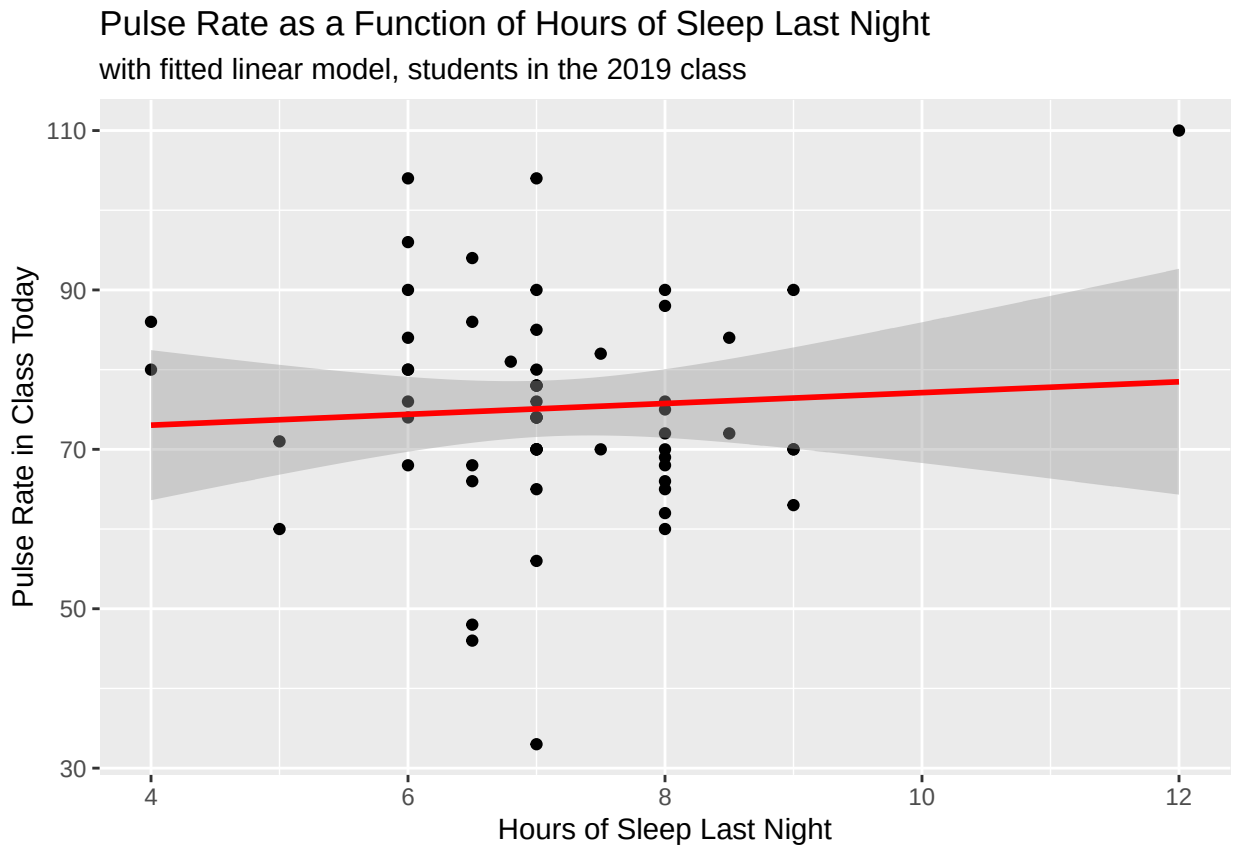
Let's look at the 2019 data only, and fit a curved (loess) smooth to predict pulse rate on the basis of hours of sleep the prior night. We'll also add a title and subtitle and retitle the axes

```
day1 %>%
    filter(year == "2019") %>%
    filter(complete.cases(pulse, lastsleep)) %>%
    ggplot(data = ., aes(x = lastsleep, y = pulse)) +
    geom_point() +
    geom_smooth(method = "loess") +
    labs(title = "Pulse Rate as a Function of Hours of Sleep Last Night",
         subtitle = "with fitted loess smooth, students in the 2019 class",
         x = "Hours of Sleep Last Night",
         y = "Pulse Rate in Class Today")
```



We could instead restrict ourselves to a linear model for the 2019 group.

```
day1 %>%
    filter(year == "2019") %>%
    filter(complete.cases(pulse, lastsleep)) %>%
    ggplot(data = ., aes(x = lastsleep, y = pulse)) +
    geom_point() +
    geom_smooth(method = "lm", col = "red") +
    labs(title = "Pulse Rate as a Function of Hours of Sleep Last Night",
         subtitle = "with fitted linear model, students in the 2019 class",
         x = "Hours of Sleep Last Night",
         y = "Pulse Rate in Class Today")
```



The correlation of `lastsleep` and `pulse` is likely to be of some interest. Note the use of both the `%>%` and `%$%` pipes in this case.

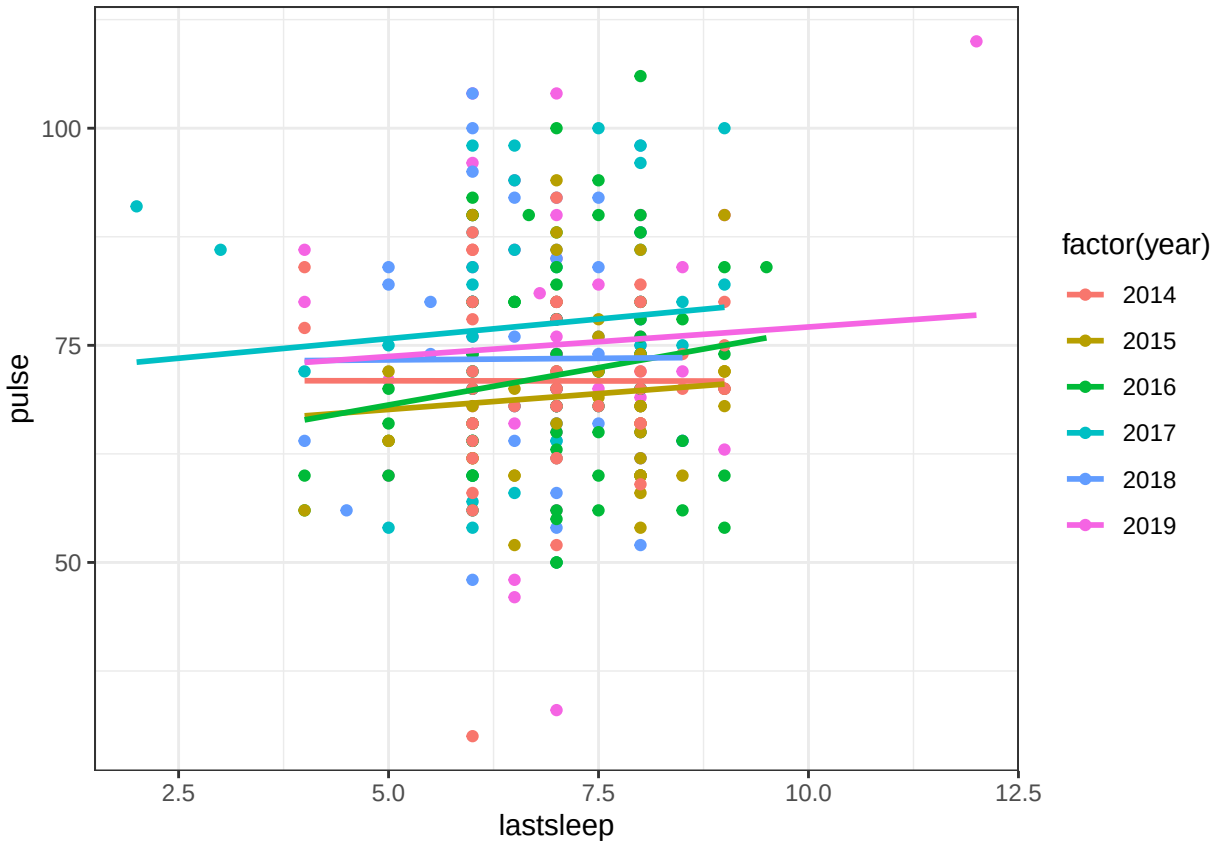
```
day1 %>%
    filter(year == "2019") %>%
    filter(complete.cases(pulse, lastsleep)) %$%
    cor(pulse, lastsleep)
```

```
[1] 0.06356228
```

Does the linear model change much by year?

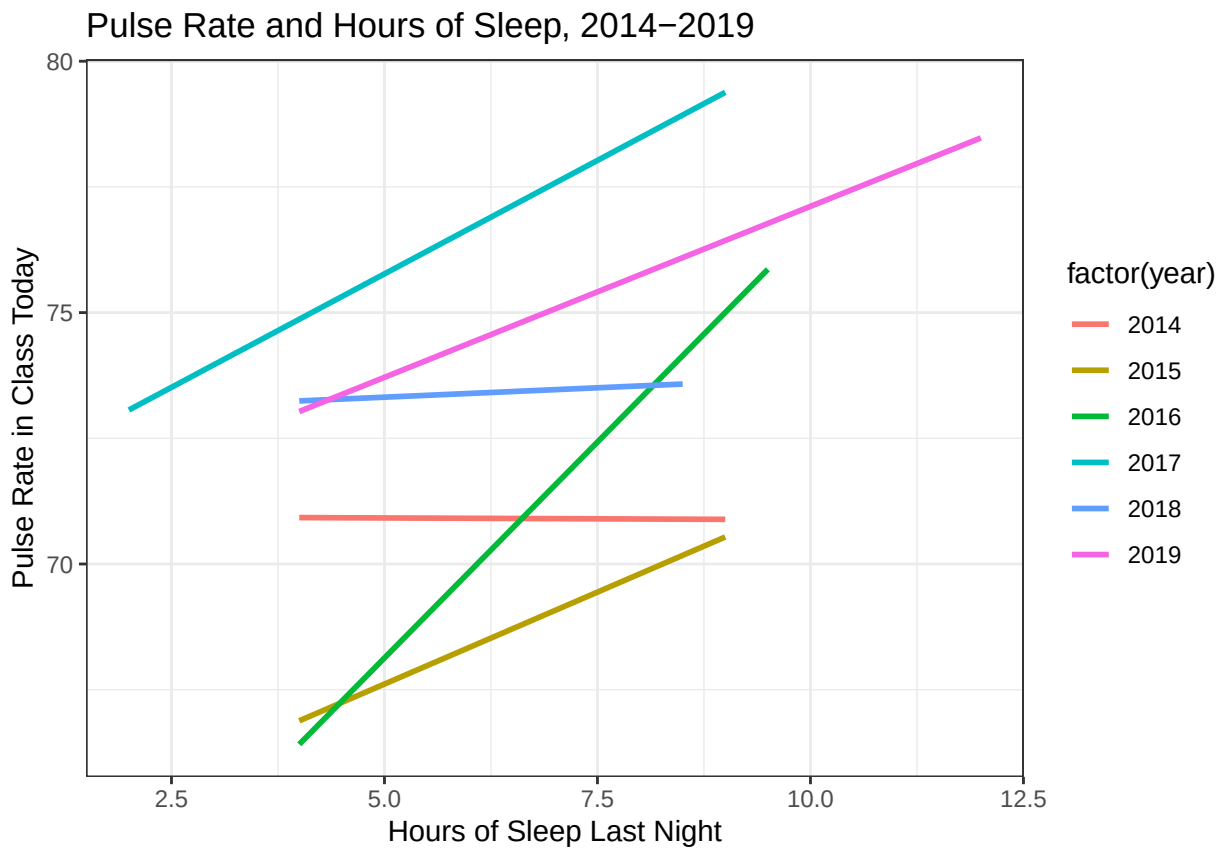
Here's the plot, color coding the models by year (note the use of the group as well as the color aesthetic here), and also incorporating the black-and-white theme, rather than the default.

```
day1 %>%
    filter(complete.cases(pulse, lastsleep)) %>%
    ggplot(., aes(x = lastsleep, y = pulse,
                                color = factor(year),
                                group = factor(year))) +
    geom_point() +
    geom_smooth(method = "lm", se = FALSE) +
      theme_bw()
```



Here's the same plot of the models alone, and not showing the data (commenting out the line of code that draws the points.) We'll also improve the labeling.

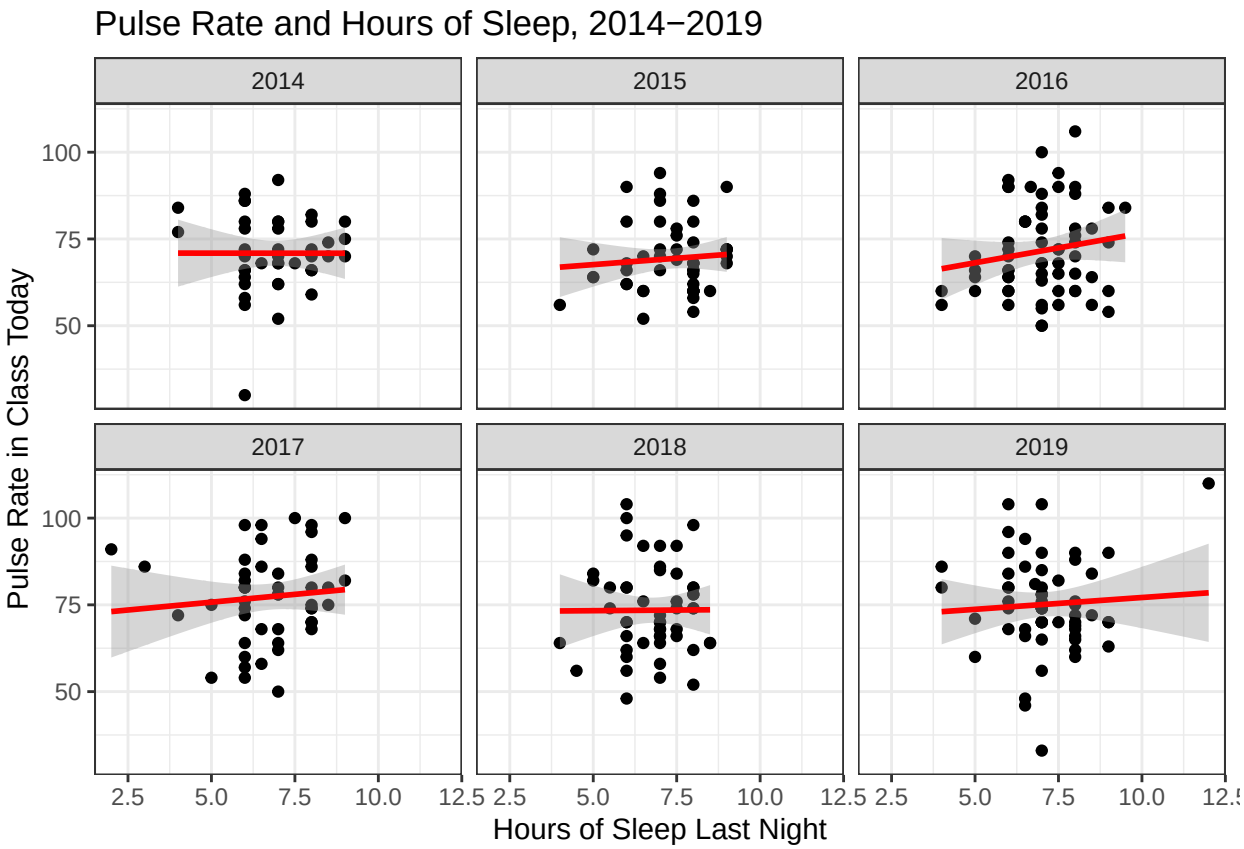
```
day1 %>%
    filter(complete.cases(pulse, lastsleep)) %>%
    ggplot(., aes(x = lastsleep, y = pulse,
                                color = factor(year),
                                group = factor(year))) +
#    geom_point() +
    geom_smooth(method = "lm", se = FALSE) +
    labs(title = "Pulse Rate and Hours of Sleep, 2014-2019",
         x = "Hours of Sleep Last Night",
         y = "Pulse Rate in Class Today") +
      theme_bw()
```



Faceting a Scatterplot

Here's the same basic information, but faceted by year.

```
day1 %>%
    filter(complete.cases(pulse, lastsleep)) %>%
    ggplot(data = ., aes(x = lastsleep, y = pulse,
                                group = factor(year))) +
    geom_point() +
    geom_smooth(method = "lm", color = "red") +
    facet_wrap(~ year) +
    labs(title = "Pulse Rate and Hours of Sleep, 2014-2019",
         x = "Hours of Sleep Last Night",
         y = "Pulse Rate in Class Today") +
    theme_bw()
```


Pulse Rate and Hours of Sleep, 2014−2019
2014
2015
2016
2017
2018
2019
Pulse Rate in Class Today
100
75
50
2.5
5.0
7.5
10.0
12.5
Hours of Sleep Last Night