30535 Skills Problem Set 1

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Due Sunday April 3, 12:00PM Central.

Submit the pdf via Gradescope. You will create this repo in step 9.

This submission is my work alone and complies with the 30535 integrity policy.

Add your initials to indicate your agreement: **KEZG**

Add names of anyone you discussed this problem set with: **No**

Late coins used this pset: 0. Late coins left after submission: 5.

Name your submission files `skills_ps_1.Rmd` and `skills_ps_1.html` **(10 points)**.

We use a `*` to indicate a problem that we think might be time consuming.

1. Setup

1.1 Installation (10 points)

1. Install R from https://www.r-project.org (https://www.r-project.org)
2. Install Rstudio from http://www.rstudio.com (http://www.rstudio.com)
3. Open RStudio. Go to preferences. Uncheck “Restore .Rdata into workspace on startup”. Set “Save workspace to .Rdata on exit” to “never”.
4. Install the `devtools` package using `install.packages("devtools")`

```
install.packages("devtools")
```

5. Install all the packages used in the book using `devtools::install_github("hadley/r4ds")`

```
devtools::install_github("hadley/r4ds")

install.packages("remotes")
remotes::install_github("hadley/r4ds")
```

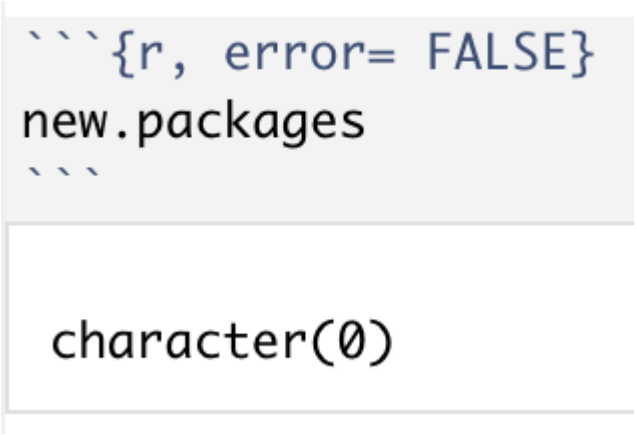
6. For students who do not already have a github account, set up a github account.
7. Download Github Desktop here (https://desktop.github.com/). If you are familar with using `git` through the command line you are welcome to do so.
8. Watch the first two “git primer” videos (parts 1 and 2). Videos can be found in Canvas under Modules.
9. Initialize your ps1 repository and download the pset_template here (https://classroom.github.com/a/fZw1nLTy). Please read the README file which is visible on the repo’s homepage.
    a. Use `pset_template.Rmd` to get started capturing your answers and submit onto Gradescope. Students upload RMD and knitted HTML document to Github and then upload the knitted PDF document and submit it to Gradescope.

10. Install these packages

```
    list_of_packages <- c("r4ds")
    install.packages(list_of_packages)
    #Installing all R4ds packages
```

11. Run a line of code which tests the packages are installed using Stackoverflow instructions posted [here]. Print `new.packages` and record the output in your problem set. This lets us know which packages successfully installed and which ones didn't.

```
new.packages <- list_of_packages[!(list_of_packages %in% installed.packages()[,"Packa
ge"])]
if(length(new.packages)) install.packages(new.packages)
```



Alt text

- In my R console when I print "new packages" I get the message "character(0)", but when I knit I get a long code.

```
new.packages
```

```
## function (lib.loc = NULL, repos = getOption("repos"), contriburl = contrib.url(rep
os,
##     type), instPkgs = installed.packages(lib.loc = lib.loc, ...),
##     method, available = NULL, ask = FALSE, ..., type = getOption("pkgType"))
## {
##     if (!is.character(type))
##         stop("invalid 'type'; must be a character string")
##     ask
##     if (type == "both" && (!missing(contriburl) || !is.null(available))) {
##         stop("specifying 'contriburl' or 'available' requires a single type, not t
ype = \"both\"")
##     }
##     if (is.null(lib.loc))
##         lib.loc <- .libPaths()
##     if (!is.matrix(instPkgs))
##         stop(gettextf("no installed packages for (invalid?) 'lib.loc=%s'",
##             lib.loc), domain = NA)
##     if (is.null(available))
##         available <- available.packages(contriburl = contriburl,
##             method = method, ...)
##     installed <- unique(instPkgs[, "Package"])
##     poss <- sort(unique(available[, "Package"]))
##     res <- setdiff(poss, installed)
##     update <- character()
##     graphics <- FALSE
##     if (is.character(ask) && ask == "graphics") {
##         ask <- TRUE
##         if (.Platform$OS.type == "windows" || .Platform$GUI ==
##             "AQUA" || (capabilities("tcltk") && capabilities("X11")))
##             graphics <- TRUE
##     }
##     if (isTRUE(ask)) {
##         if (length(res))
##             update <- res[match(select.list(res, multiple = TRUE,
##                 title = "New packages to be installed", graphics = graphics),
##                 res)]
##         else message("no new packages are available")
##     }
##     if (length(update)) {
##         if (type == "both")
##             install.packages(update, lib = lib.loc[1L], method = method,
##                 type = type, ...)
##         else install.packages(update, lib = lib.loc[1L], contriburl = contriburl,
##             method = method, available = available, type = type,
##             ...)
##         dirs <- list.files(lib.loc[1L])
##         updated <- update[update %in% dirs]
##         res <- res[!res %in% updated]
##     }
##     res
## }
## <bytecode: 0x7fba5625b728>
## <environment: namespace:utils>
```

12. What is your github id? **khristel26**
13. Add and commit your code. Push it to github with commit message “start-up completed”. **Done**
14. Watch the third git primer video (part 3 of 3) Videos can be found in Canvas under modules. **Done**
15. Now we’ll practice reverting. **Done**

```
a.  Add the following text to you homework: "Why did the code on Github delete tind
r?"
a.  Now push the code to Github.
a.  Now revert to the previous state of the code. (Now that the code is uncommitted,
maybe it'll join tindr again.)
```

1.2 Affirm Data Use Agreements and Integrity Policy

16. Complete the “Data Use Agreements” quiz on canvas **Done**
17. Complete the “Integrity Policy Quiz” on canvas **Done**

2. R for Data Science Exercises

2.1 First Steps (10 points)

Load the `tidyverse` library. `tidyverse` comes with a dataset called `mpg`.

```
library(tidyverse)
view(mpg)
```

1. How many rows are in `mpg`? How many columns? What do the rows represent? How about the columns?

- There are 234 rows and 11 columns in the ‘mpg’ dataset

```
nrow(mpg)
```

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

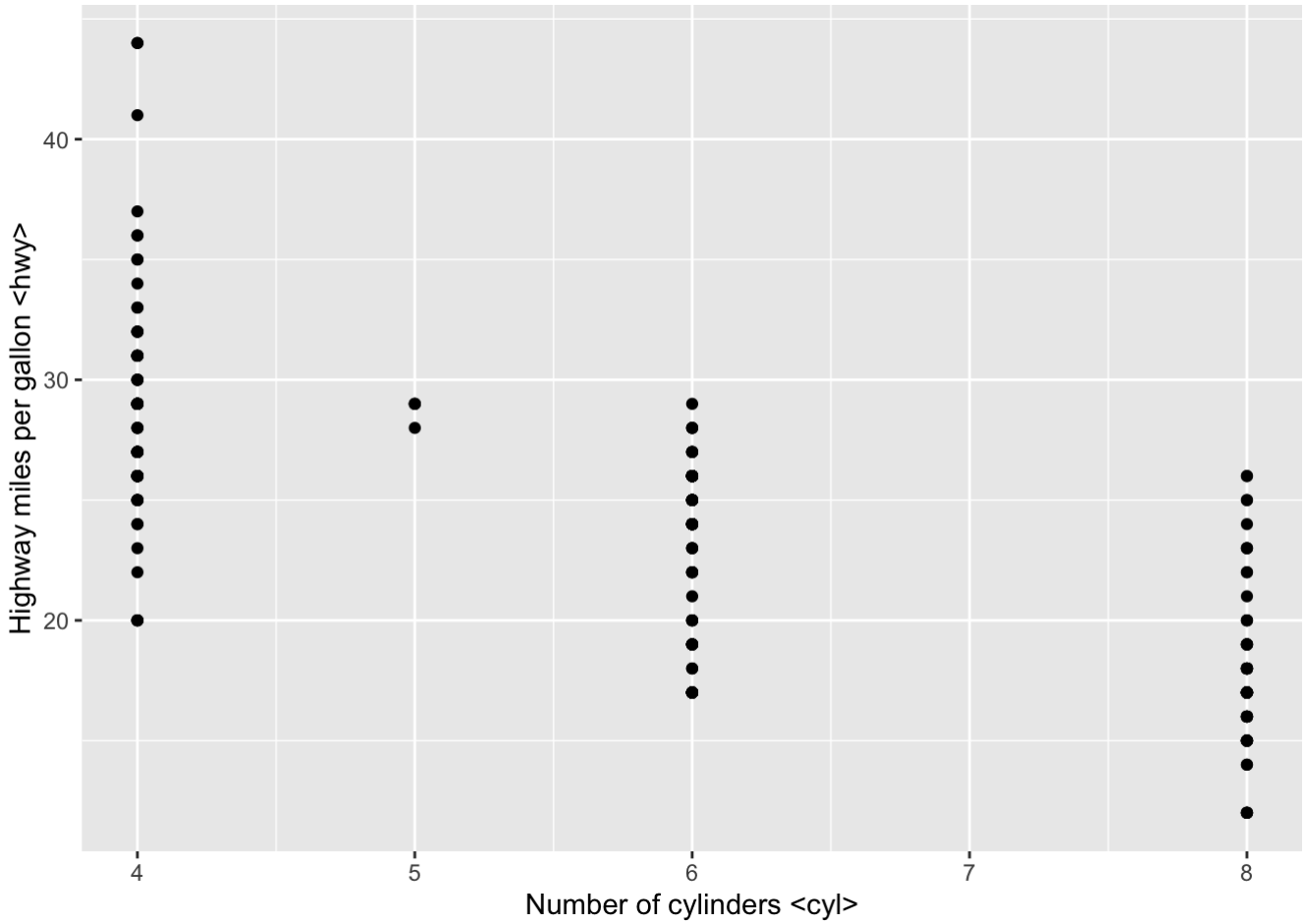
```
ncol(mpg)
```

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

The rows contain cars with new release every year between 1999 and 2008, and the columns contain their characteristics such as manufacturer, model, displ, year, etc.

2. Make a scatterplot of `hwy` vs `cyl`.

```
ggplot(data = mpg) +
geom_point(mapping = aes(x = cyl, y = hwy)) +
labs(x = "Number of cylinders <cyl>",
y = "Highway miles per gallon <hwy>")
```



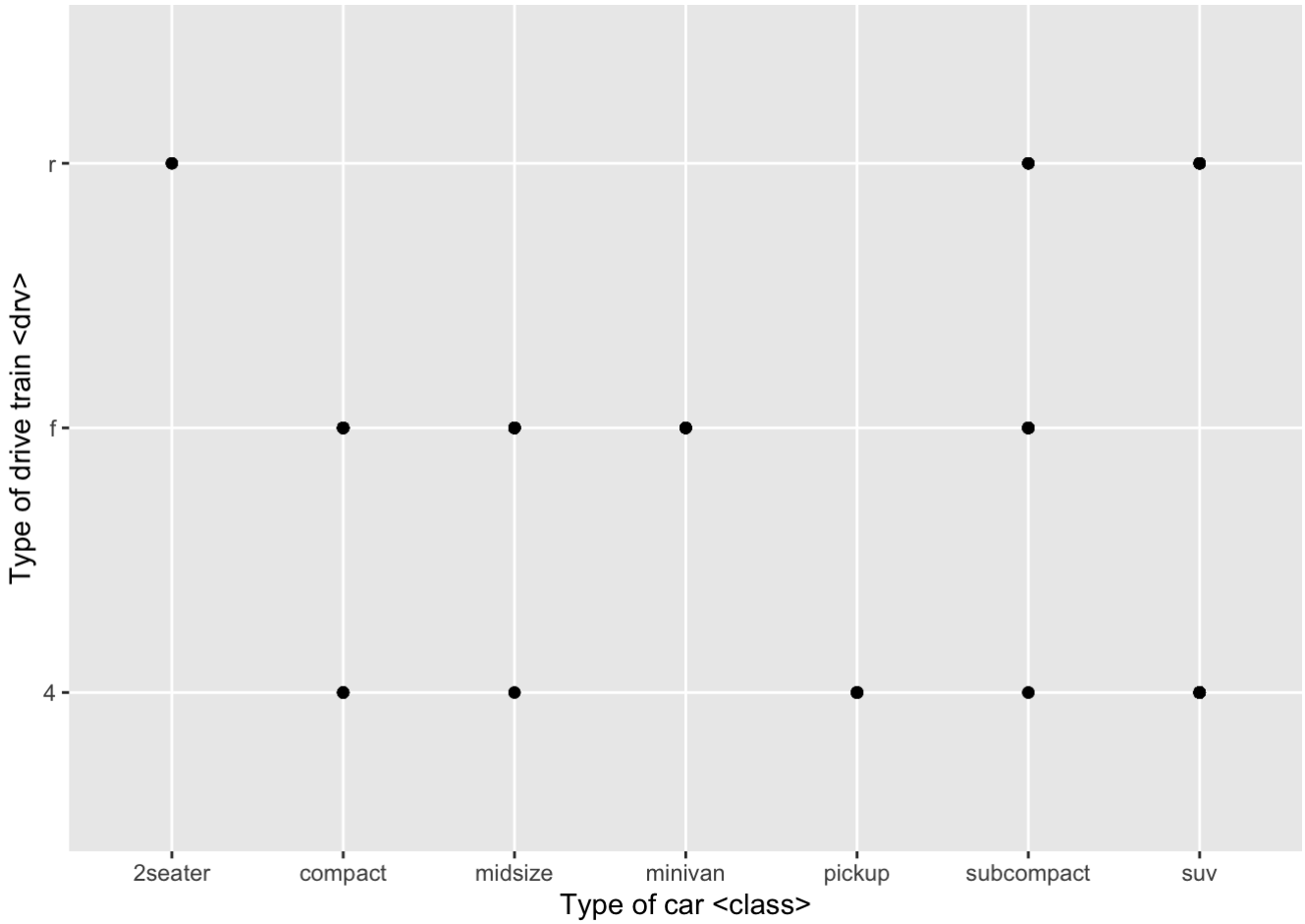
3. What does the `drv` variable describe? Read the help for `?mpg` to find out.

```
?mpg
```

'drv' indicates the vehicle's drive train/transmission type, where f means the car is front-wheel drive, r = rear-wheel drive, and 4 = 4wd. It is a categorical variable, since it can only take three values.

4. What happens if you make a scatterplot of `class` vs `drv` ? Why is the plot not useful?

```
ggplot(data = mpg) +
geom_point(mapping = aes(x = class, y = drv)) +
labs(x = "Type of car <class>",
y = "Type of drive train <drv>")
```



This plot is not useful because it only shows the coincidences between two categorical variables (12 points are shown), not even the graph shows which are the combinations that have more observations (it can be found with geom_count). In that sense, this chart does not provide valuable information for analysis.

2.2 Grammar of graphics: Mapping data to aesthetics (25 points)

1. Run `?mpg` to pull up the documentation for the dataset. Run `print(mpg)` to see the first 10 rows of the tibble. Notice the tibble header in the console includes the variable type (e.g. `<chr>` is character). Describe how the `<chr>`, `<int>` and `<dbl>` variable types map to whether a variable is categorical versus continuous.

```
?mpg
print(mpg)
```

```
## # A tibble: 234 × 11
##    manufacturer model      displ  year   cyl trans drv     cty   hwy fl    class
##    <chr>        <chr>      <dbl> <int> <int> <chr> <chr> <int> <int> <chr> <chr>
##  1 audi         a4           1.8  1999     4 auto… f        18    29 p     comp…
##  2 audi         a4           1.8  1999     4 manu… f        21    29 p     comp…
##  3 audi         a4           2    2008     4 manu… f        20    31 p     comp…
##  4 audi         a4           2    2008     4 auto… f        21    30 p     comp…
##  5 audi         a4           2.8  1999     6 auto… f        16    26 p     comp…
##  6 audi         a4           2.8  1999     6 manu… f        18    26 p     comp…
##  7 audi         a4           3.1  2008     6 auto… f        18    27 p     comp…
##  8 audi         a4 quattro   1.8  1999     4 manu… 4        18    26 p     comp…
##  9 audi         a4 quattro   1.8  1999     4 auto… 4        16    25 p     comp…
## 10 audi         a4 quattro   2    2008     4 manu… 4        20    28 p     comp…
## # … with 224 more rows
```

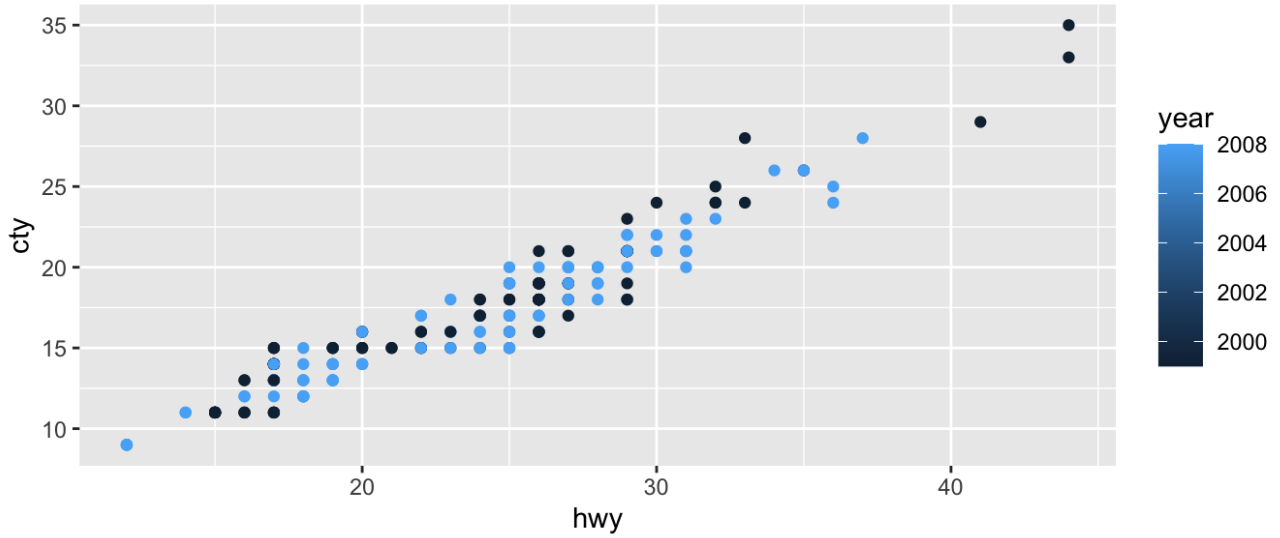
We can conclude that represents the categorical variables and these are: ‘manufacter’, ‘mode’, ‘trans’, ‘drv’, ‘fl’ and ‘class’.

On the other hand, maps to continuous variables that have integers, in the dataset these are: ‘year’, ‘cyl’, cty’, ‘hwy’.

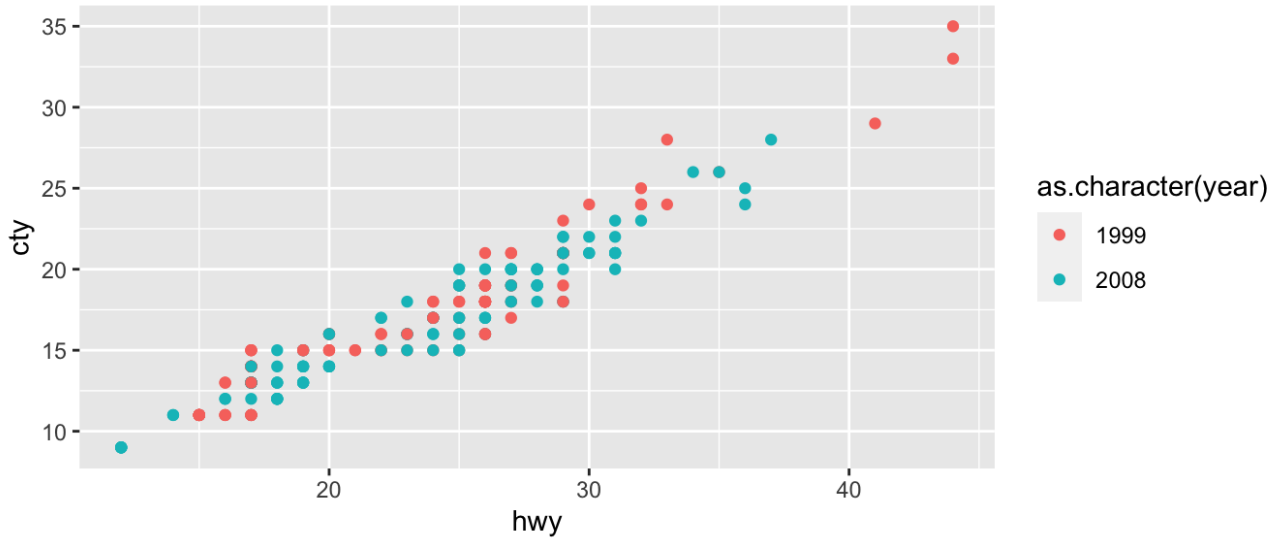
Finally, represents continuous variables as ‘displ’.

2. Graph the following two scatter plots.

```
# Graph 1
ggplot(data = mpg) +
  geom_point(mapping = aes(x = hwy, y = cty, color = year))
```




```
# Graph 2
ggplot(data = mpg) +
  geom_point(mapping = aes(x = hwy, y = cty, color = as.character(year)))
```



- Why are the two graphs different?

The graphs are different because the first assumes a continuous variable with years between 1999 and 2008, creating a possible range of colors to differentiate the data for each year. However, in graph 1 we only see two colors.

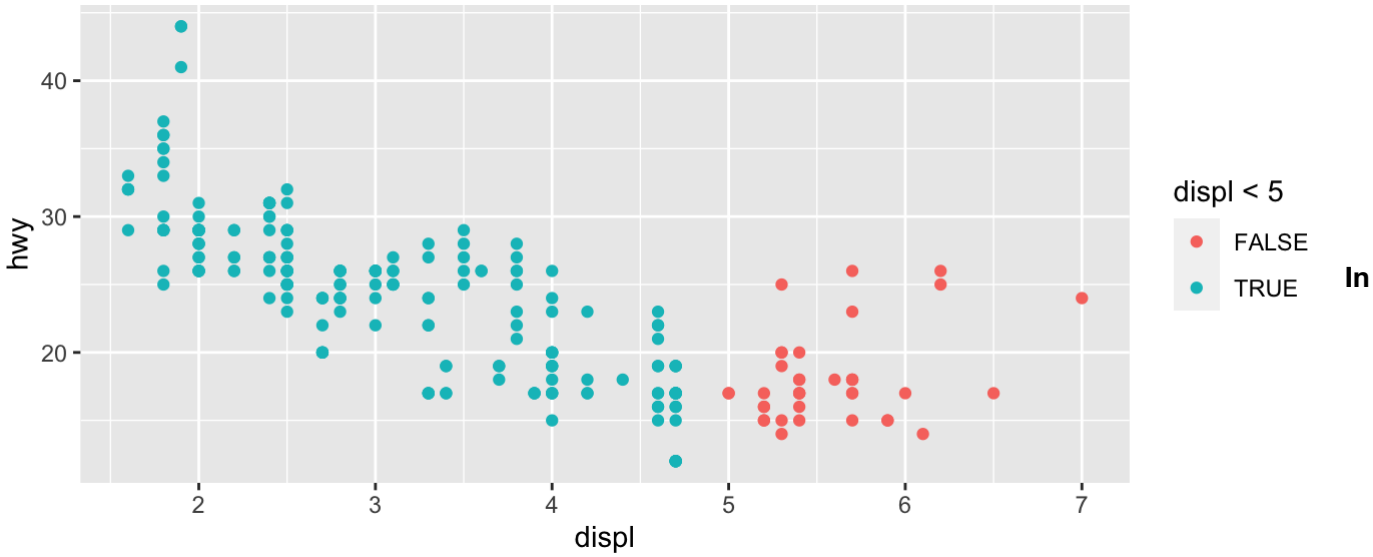
In graph two, the year is taken as a discrete variable (as.character), a categorical variable that can only take two values. Therefore only two colors

```
* Which graph is a better representation of the data?
```

Due to the type of data available, graph 2 provides a better representation, since the 'years' variable only takes two values in the dataset.

3. What happens if you map an aesthetic to something other than a variable name, like `aes(color = displ < 5)` ?

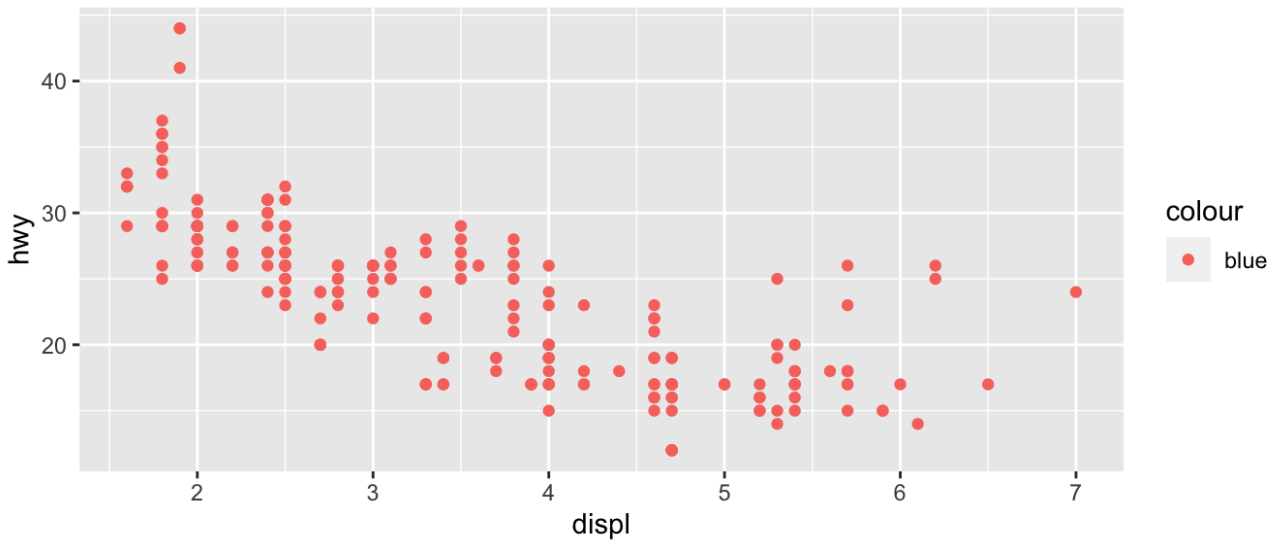
```
ggplot(data = mpg) +
  geom_point(mapping = aes(x = displ, y = hwy, color = displ< 5))
```



In this case, ggplot continues plotting it and creates a temporary variable (True, False) for the created condition (displ<5). For example, in this case we can see that values greater than 5 on the 'displ' x-axis are FALSE and those less than 5 are classified as True.

4. * Common bugs: What's gone wrong with this code? Fix the code so the points are blue.

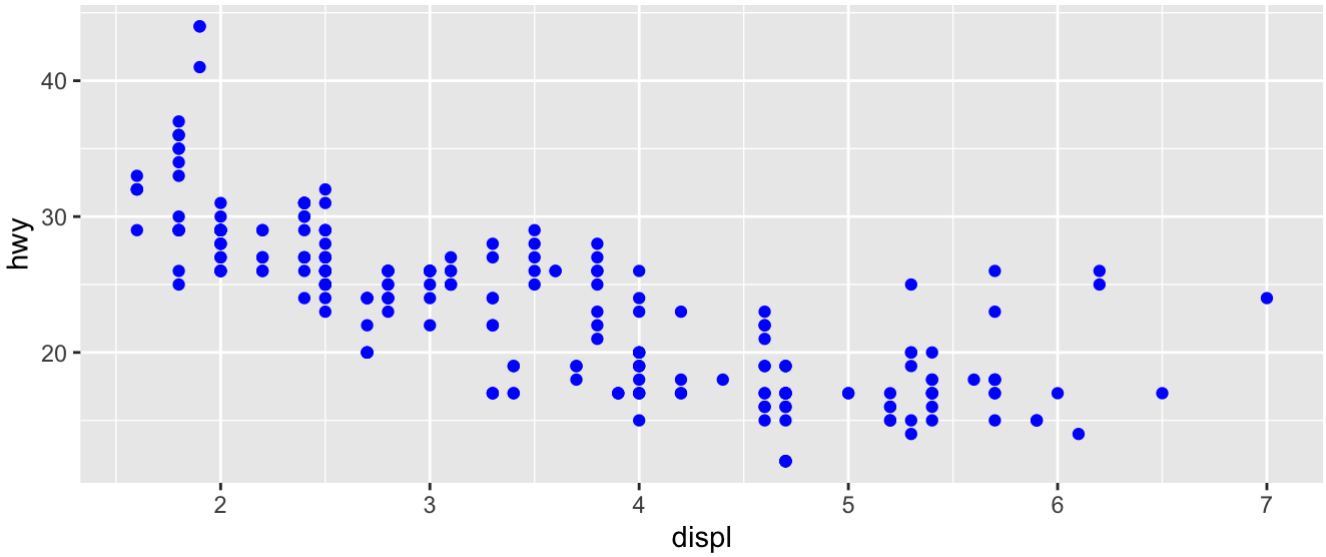
```
ggplot(data = mpg) +
  geom_point(mapping = aes(x = displ, y = hwy, color = "blue"))
```



In this case, aes assumes that 'color' is being assigned the categorical variable 'blue'; that is, it does not take it as the name of the color, but as the name of a variable, which in this case does not exist. In that sense, to fix the code, we must remove color from aes.

Fixing the code:

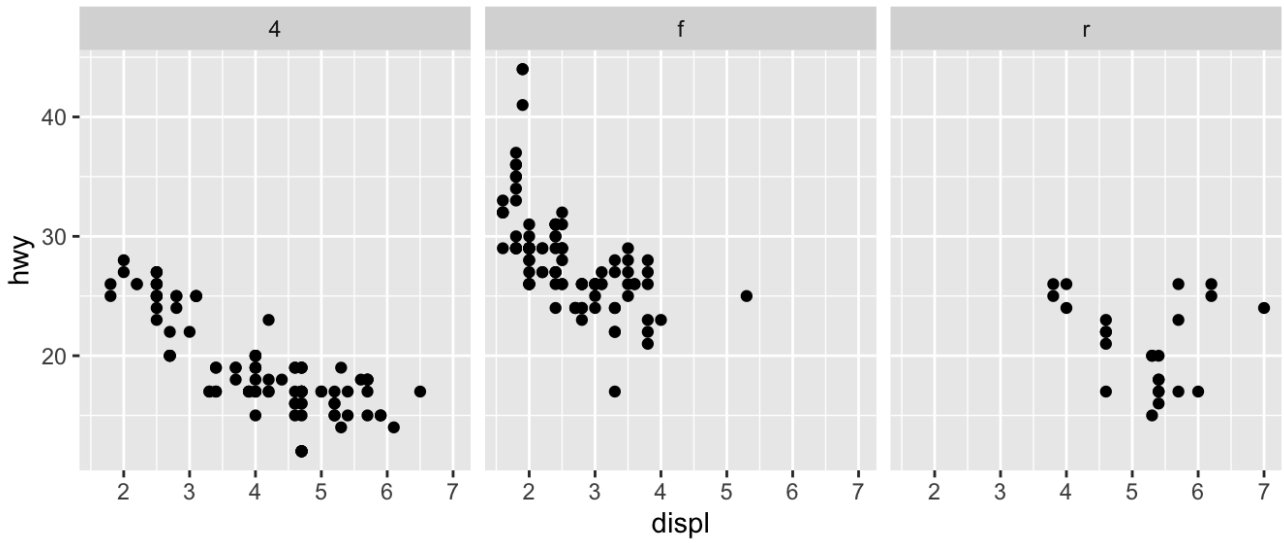
```
ggplot(data = mpg) +
  geom_point(mapping = aes(x = displ, y = hwy), color = "blue")
```



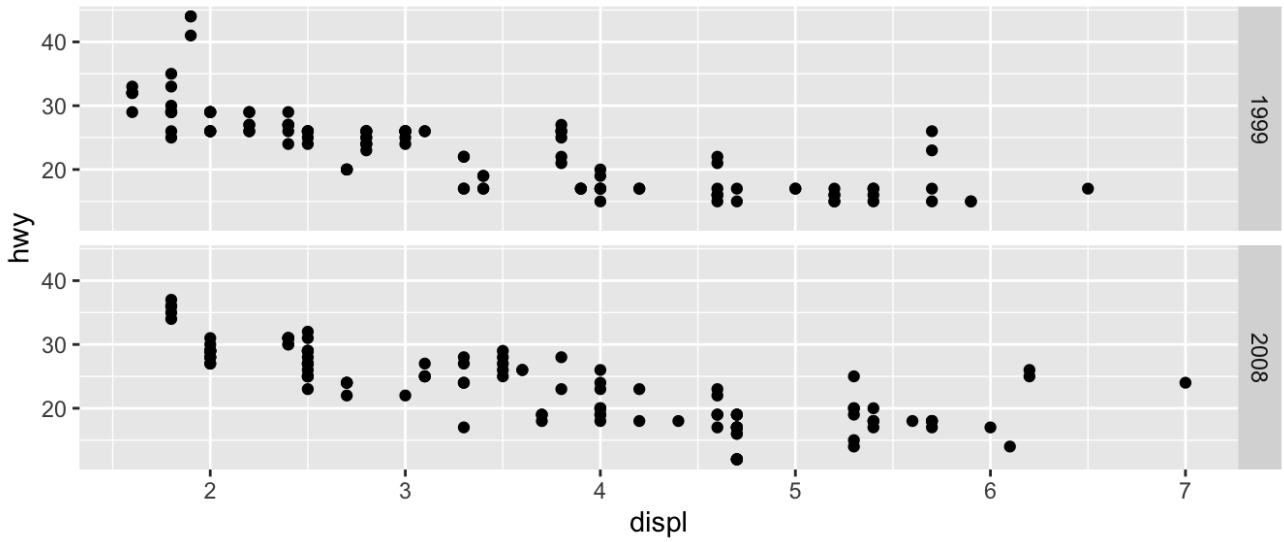
2.3 grammar of graphics: Facets (25 points)

1. Make the following plots.

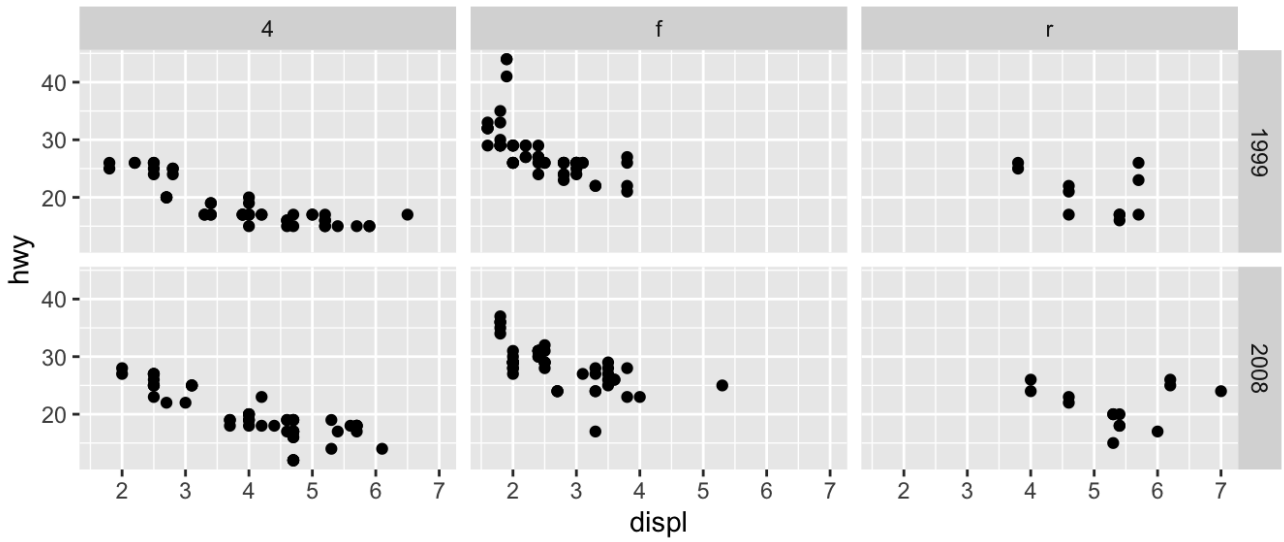
```
ggplot(data = mpg) +
  geom_point(mapping = aes(x = displ, y = hwy)) +
  facet_grid(cols = vars(drv))
```




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




```
ggplot(data = mpg) +
  geom_point(mapping = aes(x = displ, y = hwy)) +
  facet_grid(rows = vars(year), cols = vars(drv))
```



- How does `facet_grid()` decide the layout of the grid?

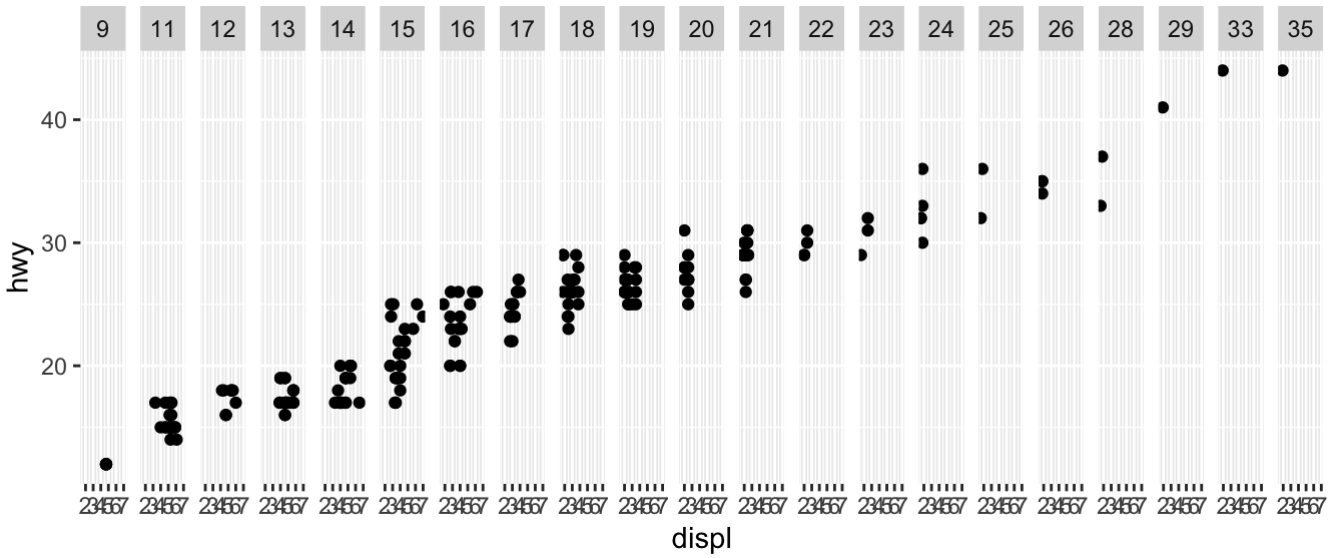
This data comes from the configuration that the user gives it, either organization by columns 'cols' or by rows 'rows'. Also, put the code 'vars' followed by the name of the variable by which you want to classify the data and see it in grids

2. What happens if you facet on a continuous variable? Provide an example.

A grid is created for each value of this continuous variable, and can have as many columns or rows according to how many values this variable has.

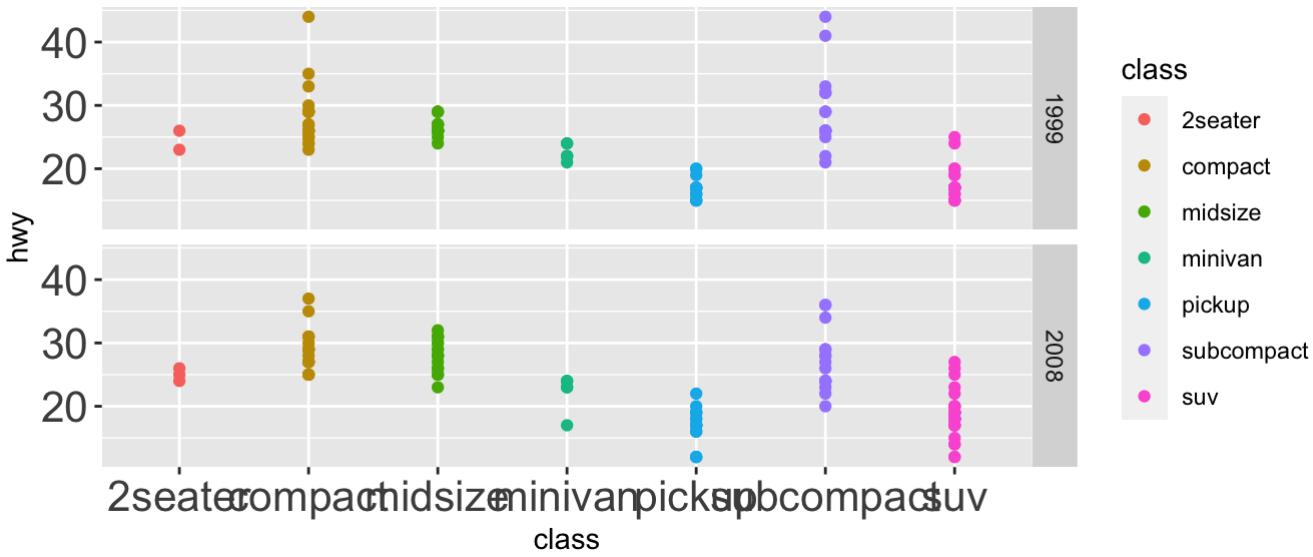
- Example:

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



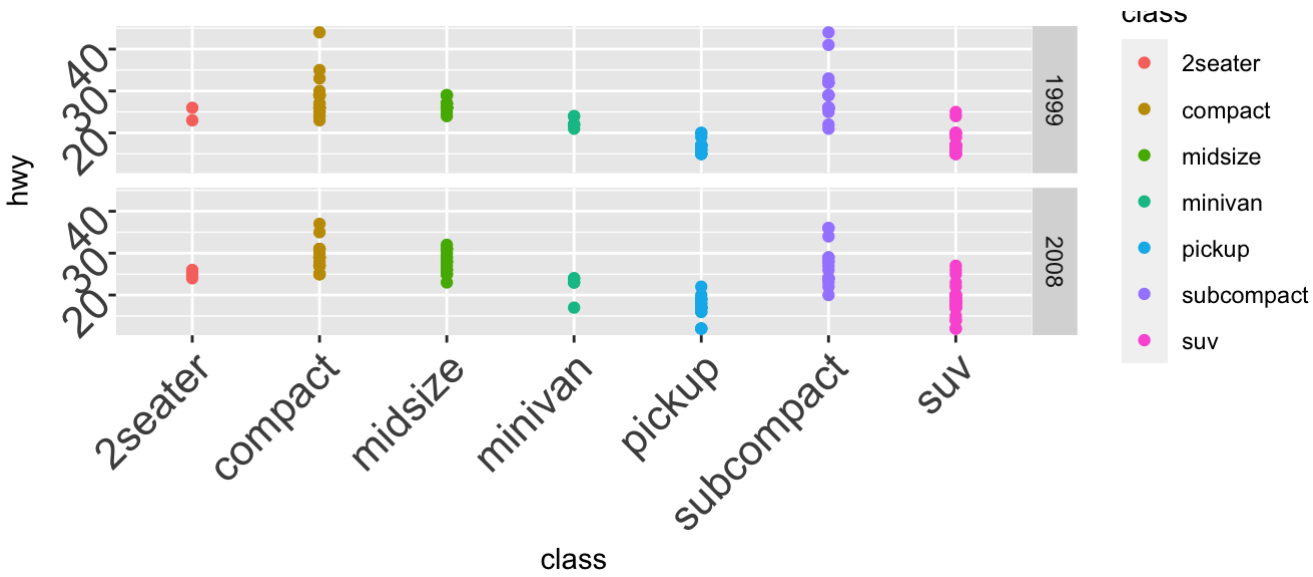
3. Reproduce the following graph (hint: `theme(axis.text = element_text(size = 16))` makes the axis labels large).

```
ggplot(data = mpg) +
      geom_point(aes(x = class, y = hwy, color = class)) +
      facet_grid(rows = vars(year)) +
      theme(axis.text = element_text(size = 16))
```



4. The x-axis labels for `class` on the plot may really hard to read! Can you rotate the labels by 45 degrees so that they don't overlap one another? This would be a good time to use google. Include `ggplot` in your search to get more relevant answers. Remember to cite any code gathered from the internet.

```
ggplot(data = mpg) +
      geom_point(aes(x = class, y = hwy, color = class)) +
      facet_grid(rows = vars(year)) +
      theme(axis.text = element_text(size = 16, angle = 45, vjust = 0.5, hjust=1))
```



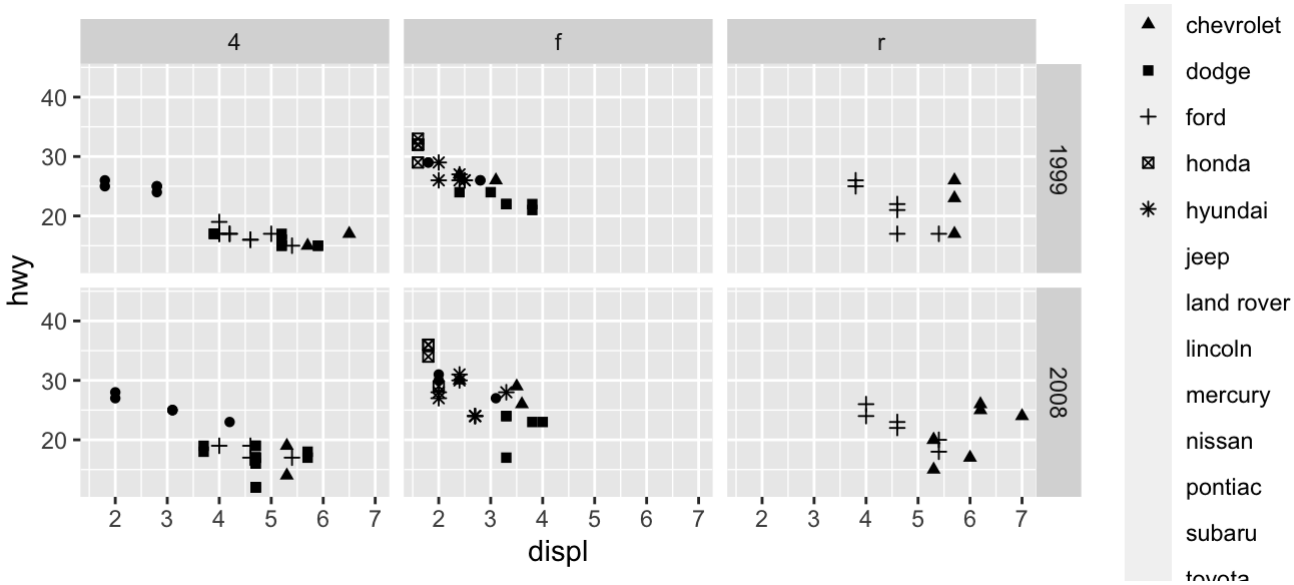
Source: https://stackoverflow.com/questions/1330989/rotating-and-spacing-axis-labels-in-ggplot2 (https://stackoverflow.com/questions/1330989/rotating-and-spacing-axis-labels-in-ggplot2)

5. * Reproduce the following graph. Why are so many manufacturers missing?

```
ggplot(data = mpg) +
  geom_point(aes(x = displ, y = hwy, shape = manufacturer)) +
  facet_grid(rows = vars(year), cols = vars(drv))
```

```
## Warning: The shape palette can deal with a maximum of 6 discrete values because
## more than 6 becomes difficult to discriminate; you have 15. Consider
## specifying shapes manually if you must have them.
```

```
## Warning: Removed 112 rows containing missing values (geom_point).
```




```
?shape
```

This happens because the 'shape' function in ggplot can only plot six figures at a time, the rest are being left unplotted.

2.4 grammar of graphics: `geom`s (10 pts)

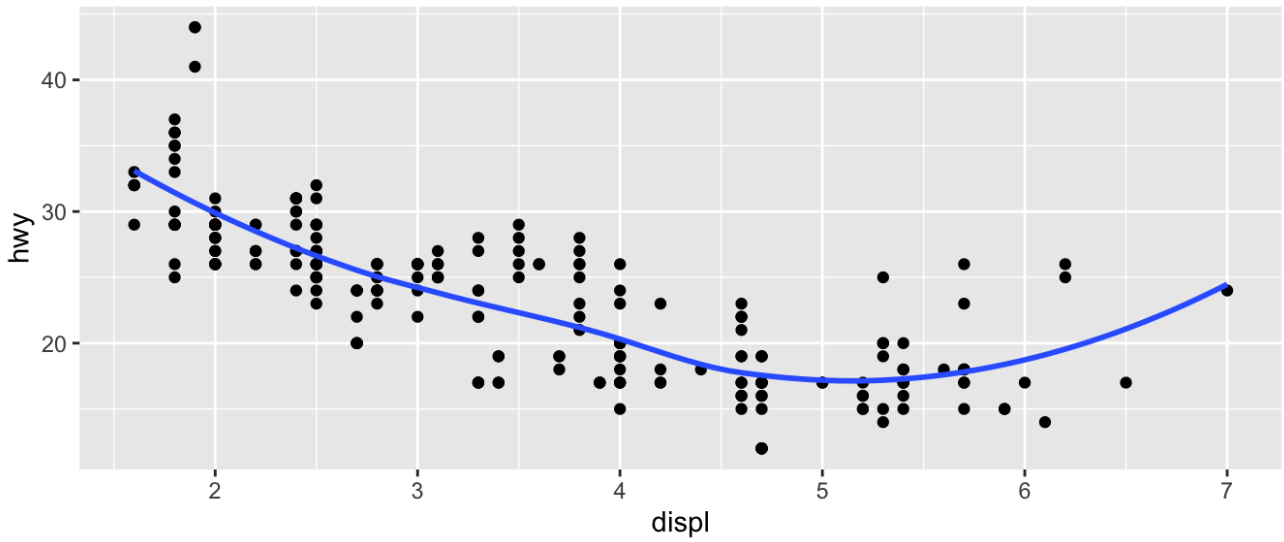
1. What geom would you use to draw a line chart? A boxplot? A histogram? An area chart?

I will use an area chart, because that would connect the points of the graph

2. Will these two graphs look different? Why/why not?

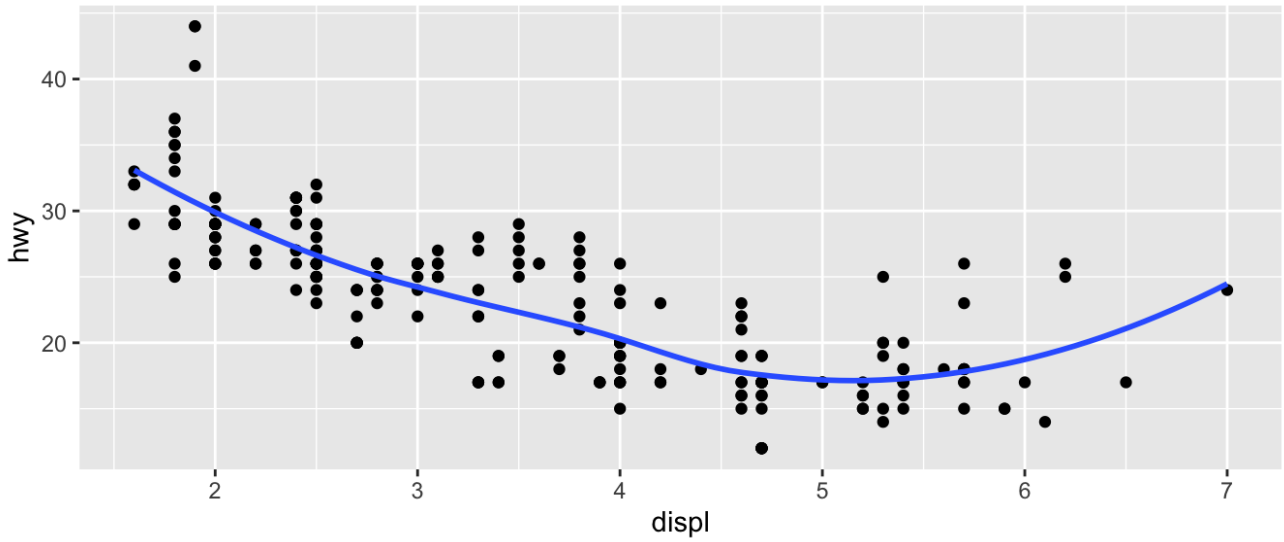
```
ggplot(data = mpg, mapping = aes(x = displ, y = hwy)) +
  geom_point() +
  geom_smooth(se = FALSE)
```

```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```




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

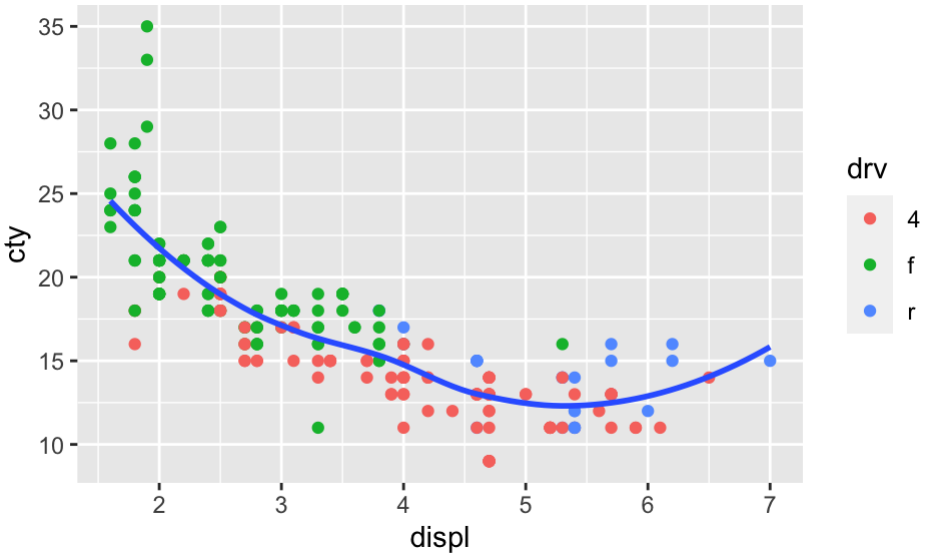
```
## `geom_smooth()` using method = 'loess' and formula 'y ~ x'
```



In this case, the graphics will be the same. This is because although graph 1 is saying that the base of the ggplot will have certain characteristics (x and y) and then specifying the geom point and smooth (when the aes are set in the original ggplot, they are inherited by any other geom that will be built on it) while plot 2 does not set features for ggplot, the same features of ggplot plot 1 are found in geom_point and geom_smooth (note that it is now mandatory for plot 2 to repeat the features in geom_point and geom_smooth because they are not part of of the principal ggplot).

3. You are investigating the connection between city gas mileage and car characteristics in your role as a policy analyst for a climate change organization. Write code to make this graph.

```
ggplot(data = mpg, mapping = aes(x = displ, y = cty)) +
    geom_point(aes(color = drv)) +
    geom_smooth(se = FALSE)
```

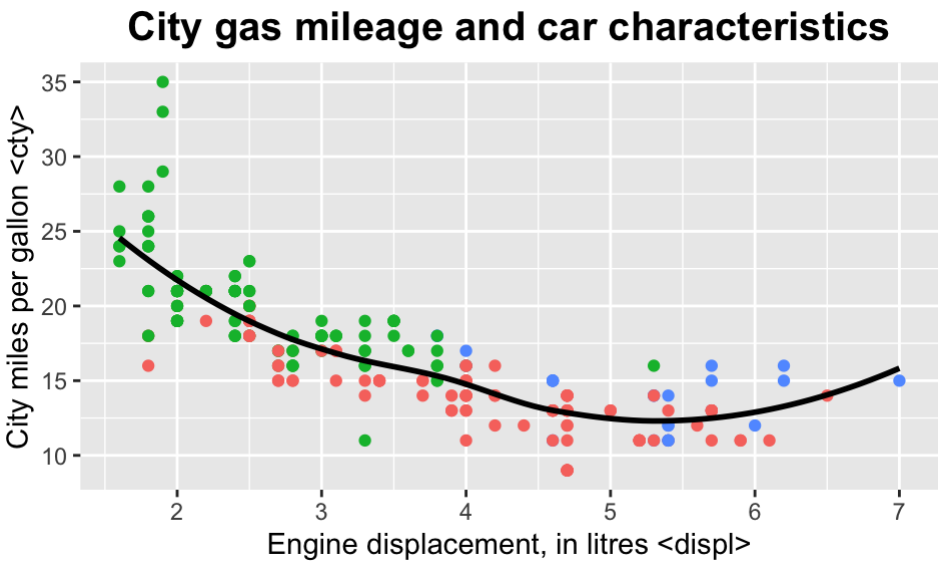


4. *Your colleague suggests you improve the graph by:

    - make line black
    - make the x- and y-axes labels more informative using `+ labs()`
    - use an informative title to capture the headline finding of your analysis
    - remove the legend (google might be helpful to learn how)

    Make these changes. Are all four changes improvements? Which change made the plot worse and why?

```
    ggplot(data = mpg, mapping = aes(x = displ, y = cty)) + theme(legend.position="no
ne") +  geom_point(aes(color = drv )) + geom_smooth(se = FALSE, color = "black") +
  labs(x = "Engine displacement, in litres <displ>", y = "City miles per gallon <cty
>", title = "City gas mileage and car characteristics") + theme(plot.title = element_
text(face = "bold", size = 15, hjust = 0.5))
```



Not all changes are improvements. The fact that the legend has been removed left the colors of the graph unexplained and meaningless. In that sense, removing the legend has made the chart worse and less useful.

Source for removing legend:https://stackoverflow.com/questions/35618260/remove-legend-ggplot-2-2 (https://stackoverflow.com/questions/35618260/remove-legend-ggplot-2-2)

2.4.1 grammar of graphics: Statistical transformations (10 pts)

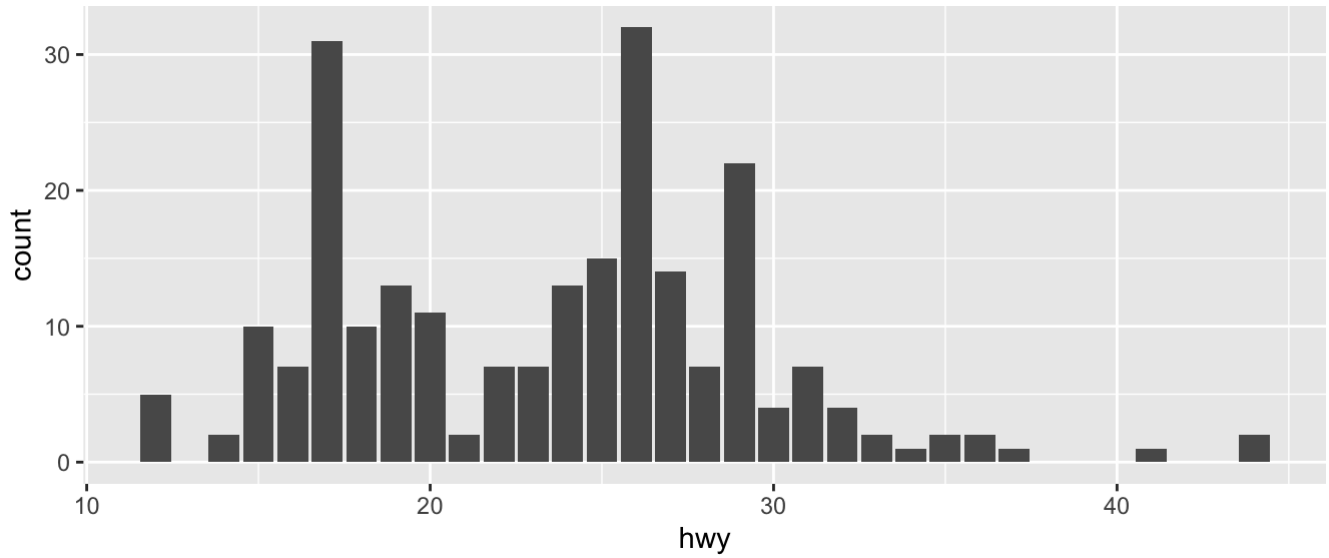
1. What does `geom_col()` do? How is it different from `geom_bar()` ?

```
?geom_col
```

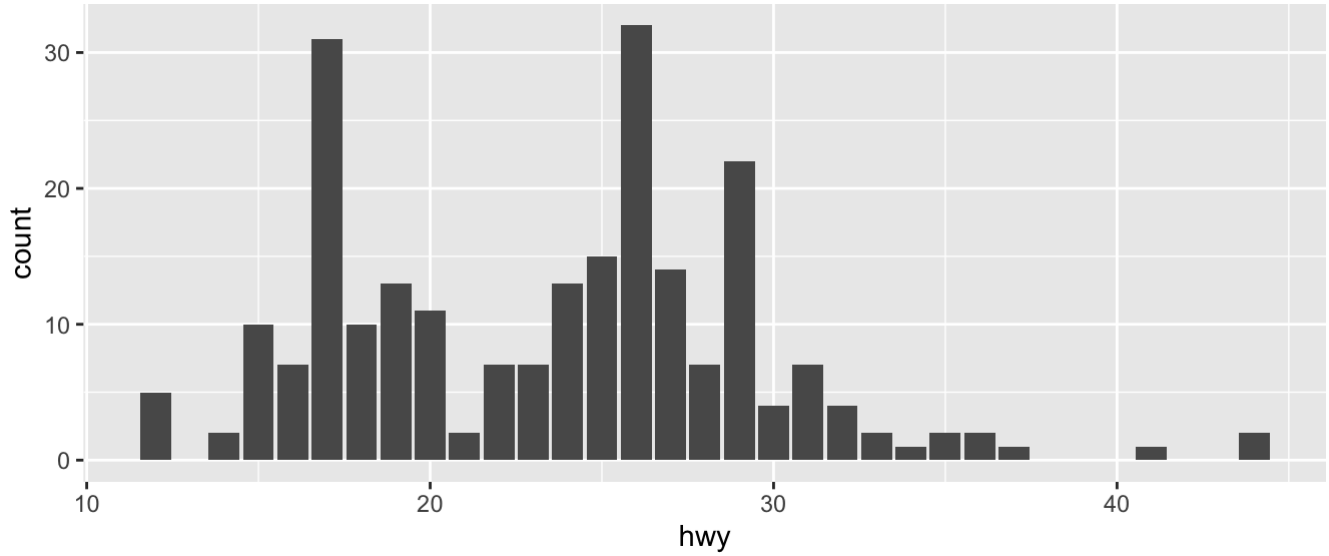
The geom_col code uses the values of the variable X to graph the bars, that is, the height of the bars represents the data values. Meanwhile, geom_bar uses the bars to represent the repetitions of the data (it counts them), that is, the height of the bars is proportional to the number of cases of each data.

2. Plot `ggplot(data=mpg, aes(x=hwy)) + geom_bar()` . Replace the `geom` with a `stat` to make the same graph.

```
ggplot(data=mpg, aes(x=hwy)) + geom_bar()
```




```
ggplot(data=mpg, aes(x=hwy)) + stat_count()
```



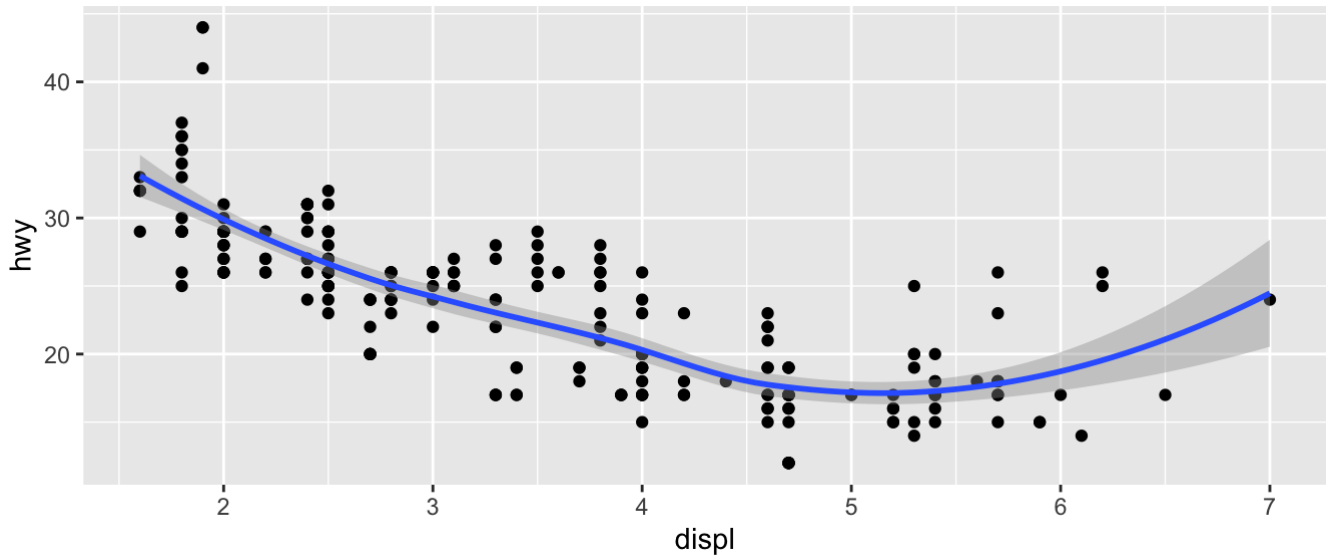
3. ◦ Which 4 variables does `stat_smooth()` compute?

```
?stat_smooth
```

According to the help page, stat_smooth() computes 4 variables: - y predicted value - ymin: lower pointwise confidence interval around the mean - ymax: upper pointwise confidence interval around the mean - SE: standard error

```
* How are these variables displayed on a graph made with `geom_smooth()`?
```

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



From the graph we can see that the display of the confidence interval is gray and the prediction of the variables is reflected in the blue line. Likewise, the max number is the highest and the min is the lowest that the blue line can take

```
* What parameters (i.e. inputs to the function) control its behaviour?
```

The parameters/inputs of stat_smooth() that control its behavior are the following, among others:

- Standar Error: TRUE by default

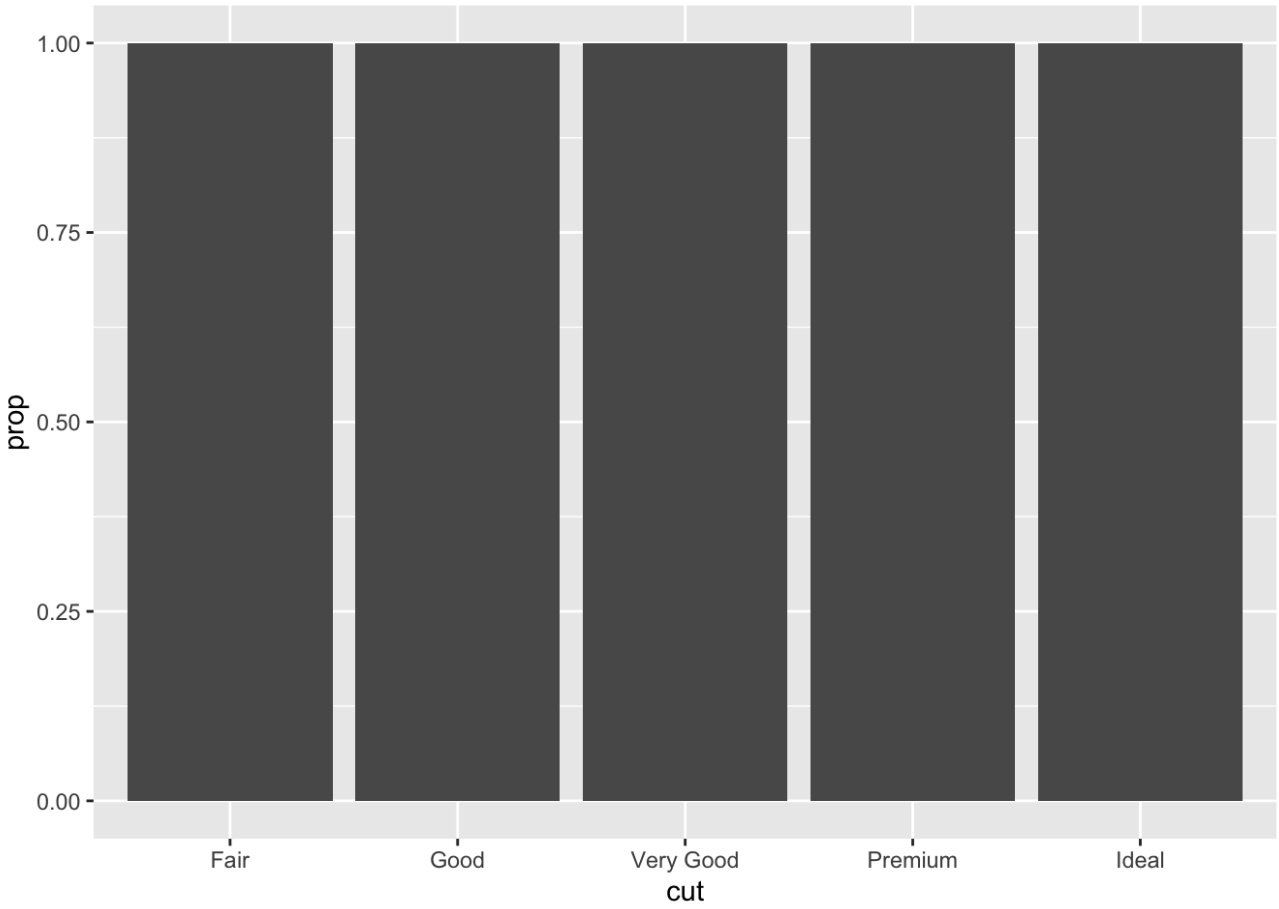
- level: level of confident interval
- data: data to be displayed
- mapping: Set of aesthetic mappings
- formula: Formula to use in smoothing function
- etc.

4. Most `geom` s and `stat` s come in pairs. Read through the documentation and make a list of 5 pairs. Notice the ggplot syntax helps you to understand when a `geom` and a `stat` go together.

Pairs of geom y stat: - geom_bar() and stat_count() - geom_col() and stat_identity() - geom_qq() and stat_qq() - geom_qq_line() and stat_qq_line() - geom_sf() and stat_sf() - geom_boxplot() and stat_boxplot() - geom_function() and stat_function()

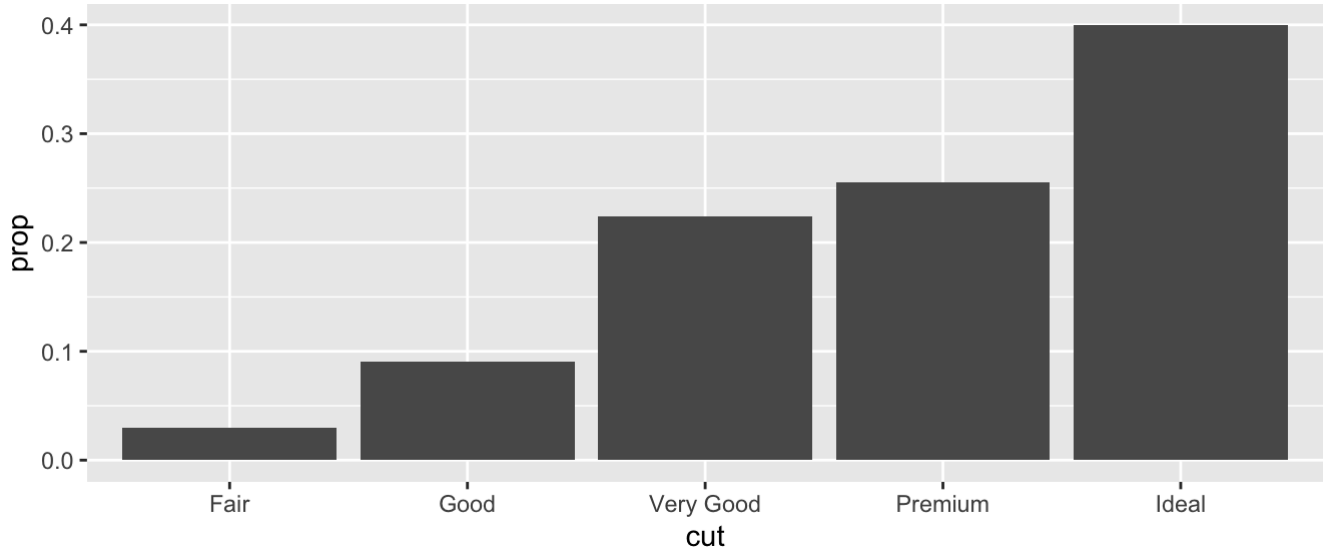
5. In our proportion bar chart, we need to set `group = 1` . Why do we need to specify this?
    - If we didn't specify this, what denominator would `ggplot` use by default?

```
ggplot(data = diamonds) +
  geom_bar(mapping = aes(x = cut, y = ..prop..))
```



The problem with the plot is that it uses specific proportions for each subgroup, but nevertheless ggplot is taking the entire data to plot it. In that sense, it is necessary to specify to R that the graph has proportions by subgroup, putting 'group=1', as follows:

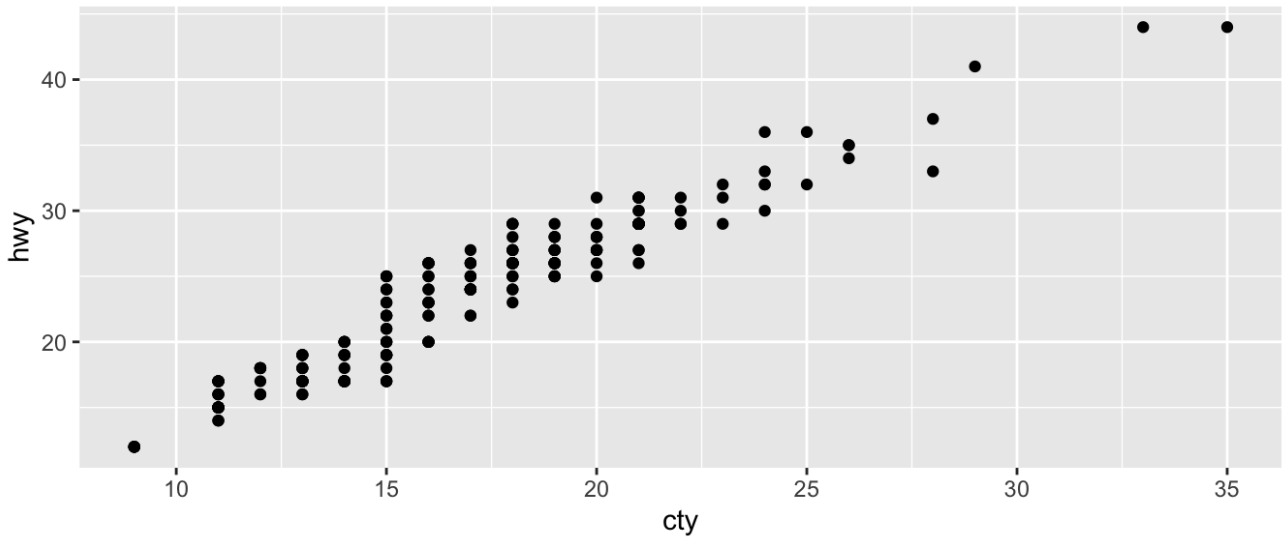
```
ggplot(data = diamonds) +
    geom_bar(mapping = aes(x = cut, y = ..prop.., group = 1))
```



2.5 grammar of graphics: Positional adjustments (5 pts)

1. What is the problem with this plot? How could you improve it?

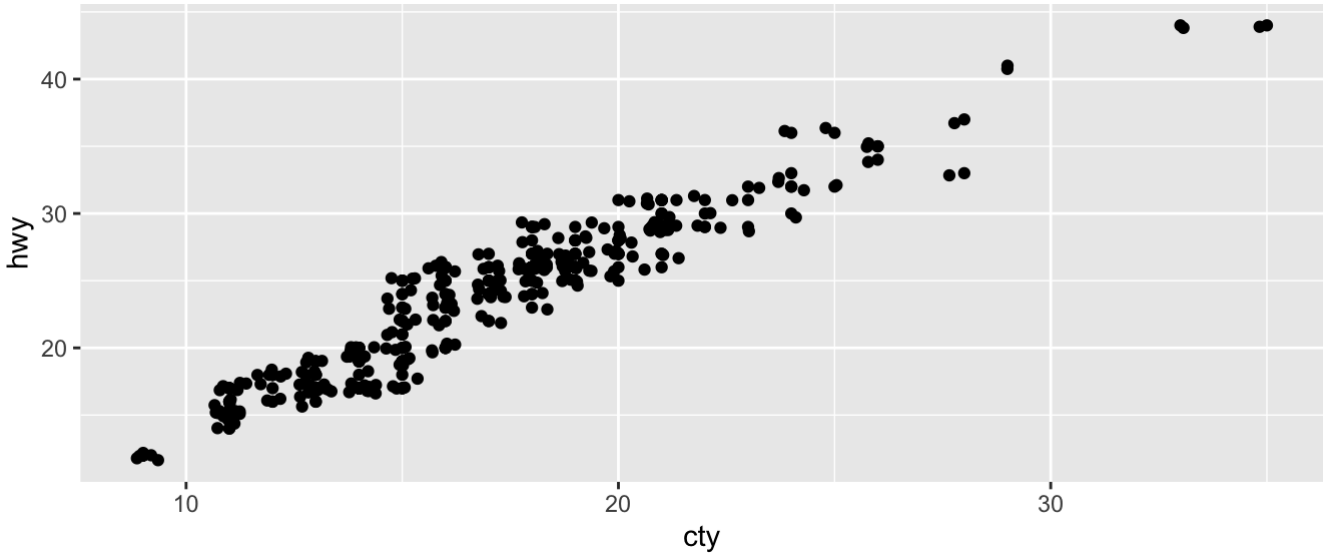
```
ggplot(data = mpg, mapping = aes(x = cty, y = hwy)) +
  geom_point()
```



Because some rows of the dataframe have the same values, there is an overlapping of data; this causes the observer to be unable to identify with certainty where the largest concentrations of data are found. We can enhance the graph in three ways: using geom_jitter, geom_jitter or making it transparent with alpha.

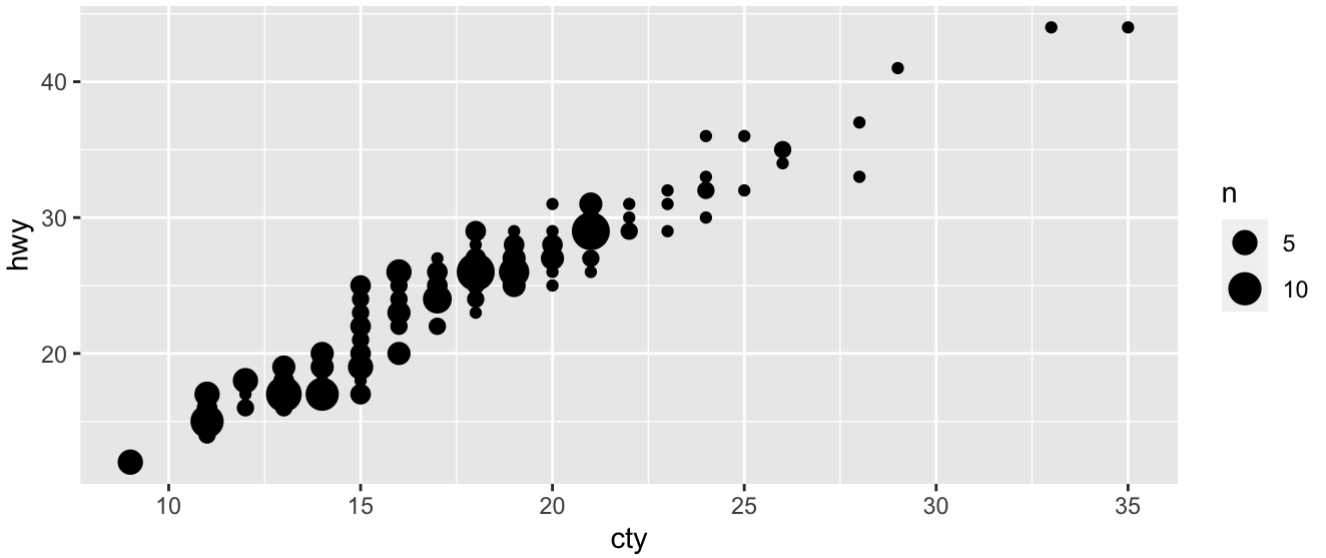
- Using geom_jitter():

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



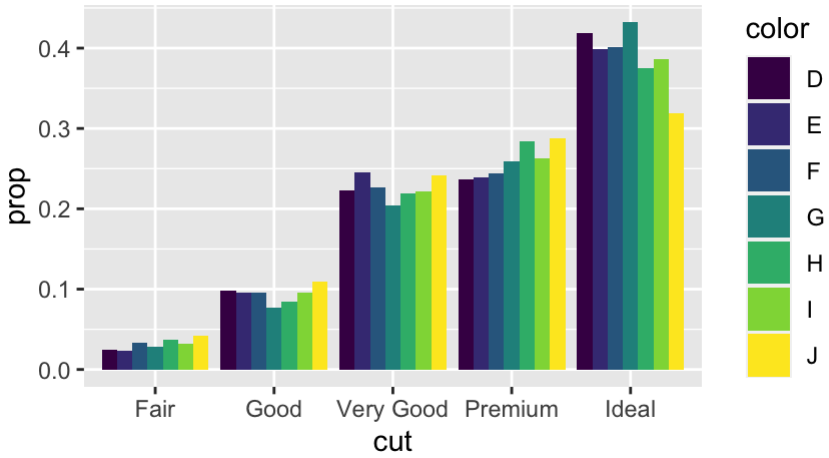
2. Compare and contrast `geom_jitter()` with `geom_count()`. Use vocabulary from the "grammar of graphics" (see section headings) to support your argument.

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



The graphics generated by both codes are different. What `geom_jitter` does is randomly move the points to avoid overlapping so we can display them. On the other hand, `geom_count` determines the size of the points according to the number of observations, the position of the points does not change, but depending on the frequency and density of the points in a certain area, the points may overlap.

3. * What's the default position adjustment for `geom_bar()` ? What did we add to the code to change the default behavior of geom_bar?



The default position setting is that the variants within the group are stacked (one on top of the other). However, in this graph the option position = "dodge" has been added, which places overlapping objects directly beside one another, making it easier to visualize and compare individual values within the same group.

2.6 grammar of graphics: Coordinate systems (5 pts)

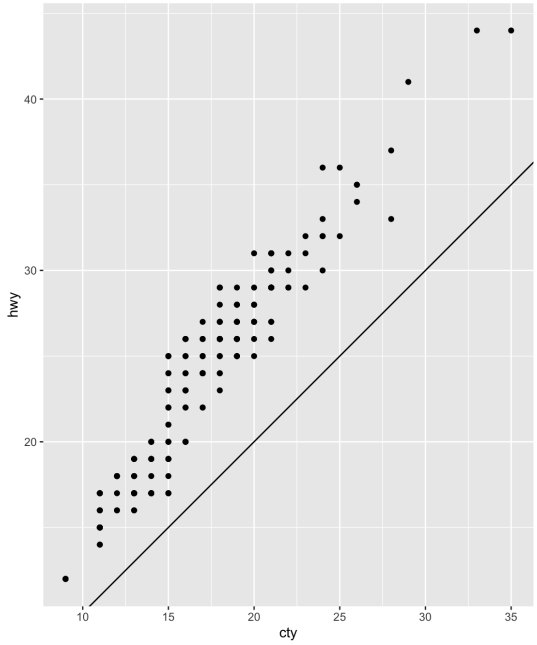
1. What happens when you use `coord_flip()` ?

```
?coord_flip
```

What the code does is switches the x-axis and the y-axis, moving the graph with it (graph horizontally, for example). Especially useful when we have long labels or we want horizontal boxplots.

2. What does the plot below tell you about the relationship between city and highway mpg?
    - What does `geom_abline()` do?
    - Why is `coord_fixed()` important? (Hint: The effect will be more apparent if you make the plot in the console (*not Rmd*) and then drag the edges of the plot window to resize the graph.)

```
ggplot(data = mpg, mapping = aes(x = cty, y = hwy)) +
  geom_point() +
  geom_abline()+
  coord_fixed()
```




```
?geom_abline
?coord_fixed()
?mpg
```

The geom_abline code adds a reference line to the graph. If the code is given with no arguments (as in the current graph), R uses the default values, intercept = 0 and slope = 1.In that sense, what the coord_fixed() code does is establish a specific graphing relationship between the X and Y axes, to a value of ratio=1. That is, the X axis will be the same length as the Y axis. This data visualization is important, since it allows us to better observe the graph and therefore reach conclusions sooner.Finally, from the graph we can conclude that there is a direct and positive relationship between the variables 'cty' and 'hwy', that while the miles per gallon used in the city increases, the performance of the highway miles per gallon also increases.