Class 5: Data Viz with ggplot

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Intro to ggplot

There are many graphics systems in R (ways to make plots and figures).These include "base" R plots. Today we will focus mostly on the **ggplot2** package.

> Q1. For which phases is data visualization important in our scientific workflows?
>
> All of the above
>
> Q2. True or False? The ggplot2 package comes already installed with R?
>
> False
>
> Q3. Which plot types are typically NOT used to compare distributions of numeric variables?
>
> Network graphs
>
> Q4. Which statement about data visualization with ggplot2 is **incorrect**?
>
> ggplot2 is the only way to create plots in R

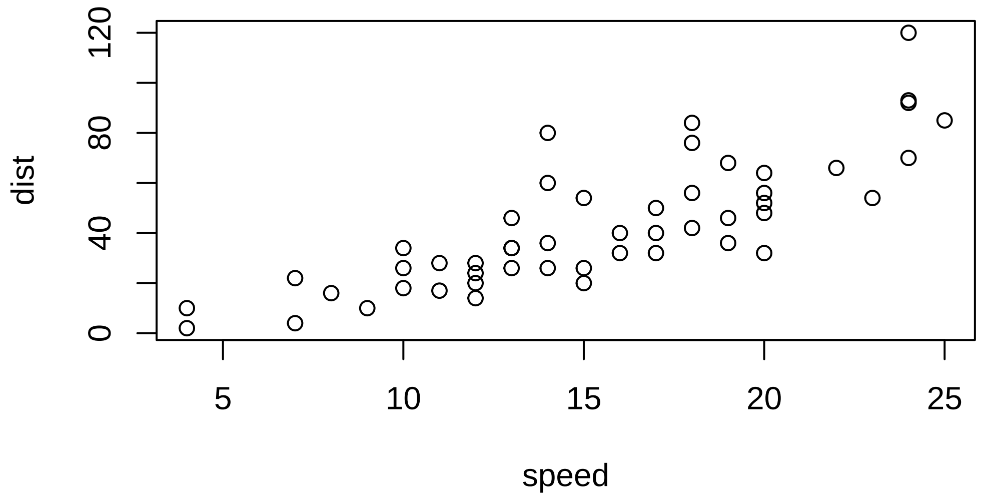
Let's start with a plot of a simple in-built data set called `cars`.

```
cars
```

```
   speed dist
1      4    2
2      4   10
3      7    4
4      7   22
5      8   16
6      9   10
7     10   18
```

8	10	26
9	10	34
10	11	17
11	11	28
12	12	14
13	12	20
14	12	24
15	12	28
16	13	26
17	13	34
18	13	34
19	13	46
20	14	26
21	14	36
22	14	60
23	14	80
24	15	20
25	15	26
26	15	54
27	16	32
28	16	40
29	17	32
30	17	40
31	17	50
32	18	42
33	18	56
34	18	76
35	18	84
36	19	36
37	19	46
38	19	68
39	20	32
40	20	48
41	20	52
42	20	56
43	20	64
44	22	66
45	23	54
46	24	70
47	24	92
48	24	93
49	24	120
50	25	85

```r
plot(cars)
```

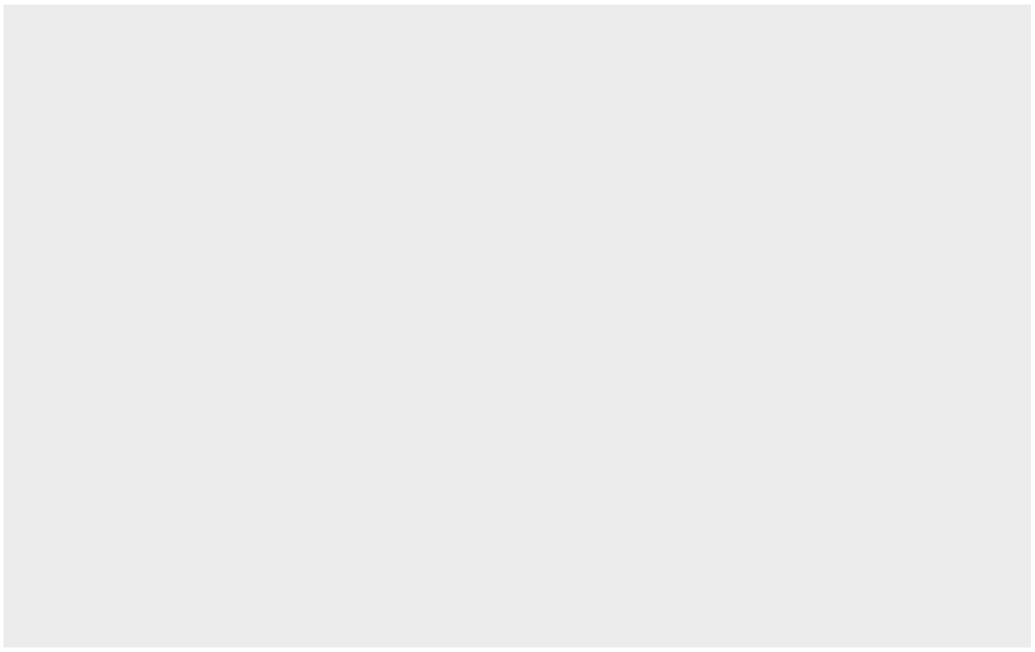


Let's see how you can make this figure using **ggplot**. First, I need to install this package on my computer. To install any R package, I use the function `install.packages()`.

> I will run 'install.packages("ggplot2") in my R console, not in this quarto document!

Before I can use any function from add on packages, I need to load the package from my "library()" with the `library(ggplot2)` function call.

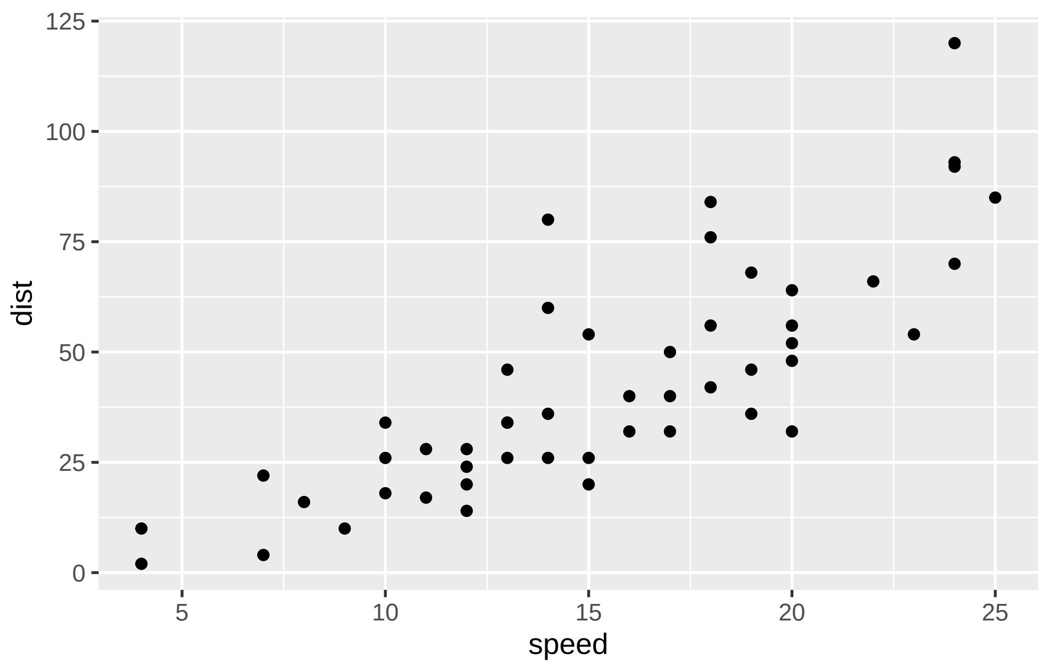
```r
library(ggplot2)
ggplot(cars)
```



All ggplot figures have at least 3 things (called layers). These include:

- **data** (the input data set I want to plot from)
- **aes** (the aesthetic mapping of the data to my plot)
- **geoms** (the geom_point(), geom_line(), etc. that I want to draw)

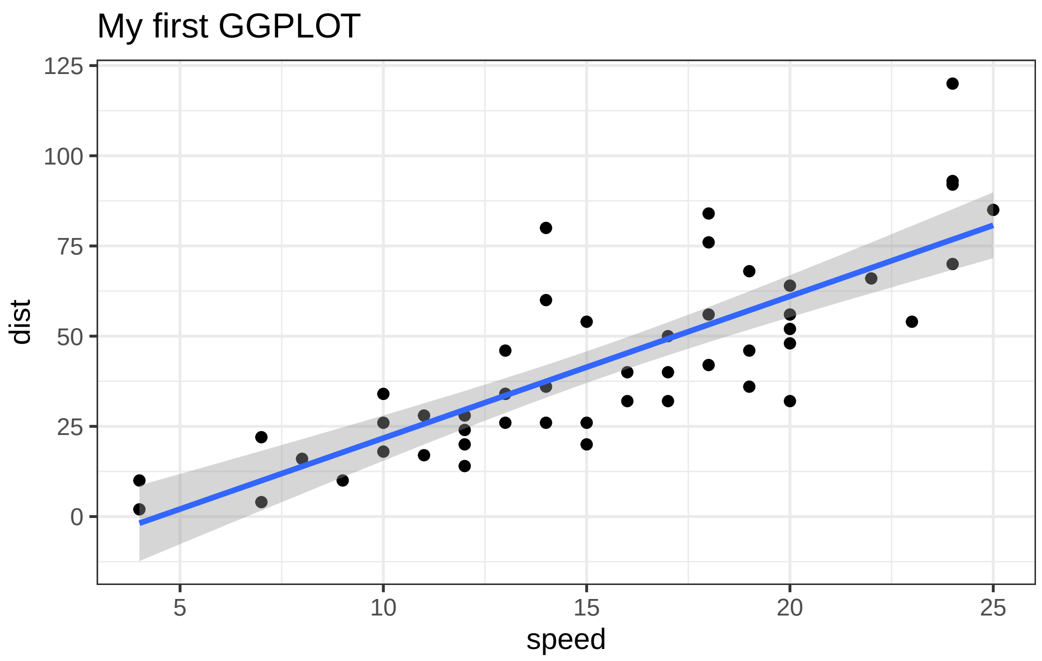
```r
ggplot(cars) +
  aes(x=speed, y=dist) +
  geom_point()
```



Let's add a line to show the relationship here:

```r
ggplot(cars) +
  aes(x=speed, y=dist) +
  geom_point() +
  geom_smooth(method="lm") +
  theme_bw() +
  labs(title="My first GGPLOT")
```

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



Q5. Which geometric layer should be used to create scatter plots in ggplot2?

geom_point()

Gene Expression Figure

The code to read the data set

```r
url <- "https://bioboot.github.io/bimm143_S20/class-material/up_down_expression.txt"
genes <- read.delim(url)
head(genes)
```

```
        Gene Condition1 Condition2      State
1      A4GNT -3.6808610 -3.4401355 unchanging
2       AAAS  4.5479580  4.3864126 unchanging
3      AASDH  3.7190695  3.4787276 unchanging
4       AATF  5.0784720  5.0151916 unchanging
5       AATK  0.4711421  0.5598642 unchanging
6 AB015752.4 -3.6808610 -3.5921390 unchanging
```

Q6. Use the nrow() function to find out how many genes are in this dataset. What is your answer?

```r
nrow(genes)
```

```
[1] 5196
```

Q7. How many columns did you find?

```r
ncol(genes)
```

```
[1] 4
```

Q8. Use the table() function on the State column of this data.frame to find out how many 'up' regulated genes there are. What is your answer?

```r
table(genes$State)
```

```

      down unchanging         up 
        72       4997        127 
```

127

Q9. Using your values, above and 2 significant figures, what fraction of total genes is up-regulated in this dataset?

```r
round(table(genes$State)/nrow(genes),4)
```

```

      down unchanging         up 
    0.0139     0.9617     0.0244 
```

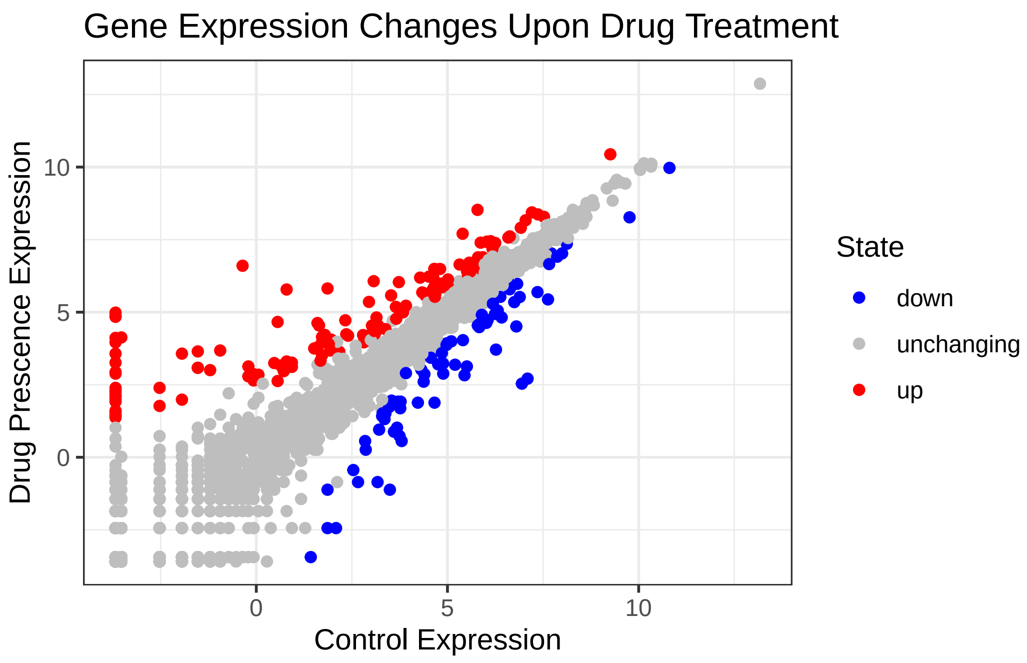
```r
n.tot <- nrow(genes)
vals <- table(genes$State)

vals.percent <- vals/n.tot * 100
round(vals.percent, 2)
```

```

      down unchanging         up 
      1.39      96.17       2.44 
```

2.44

A first plot of this

```
ggplot(genes) +
  aes(x=Condition1, y=Condition2, col=State) +
  geom_point() +
  labs(title="Gene Expression Changes Upon Drug Treatment",
       x="Control Expression",
       y= "Drug Prescence Expression")+
  scale_color_manual( values=c("blue","gray","red") ) +
  theme_bw()
```



Going Further

```
library(gapminder)

library(dplyr)
```

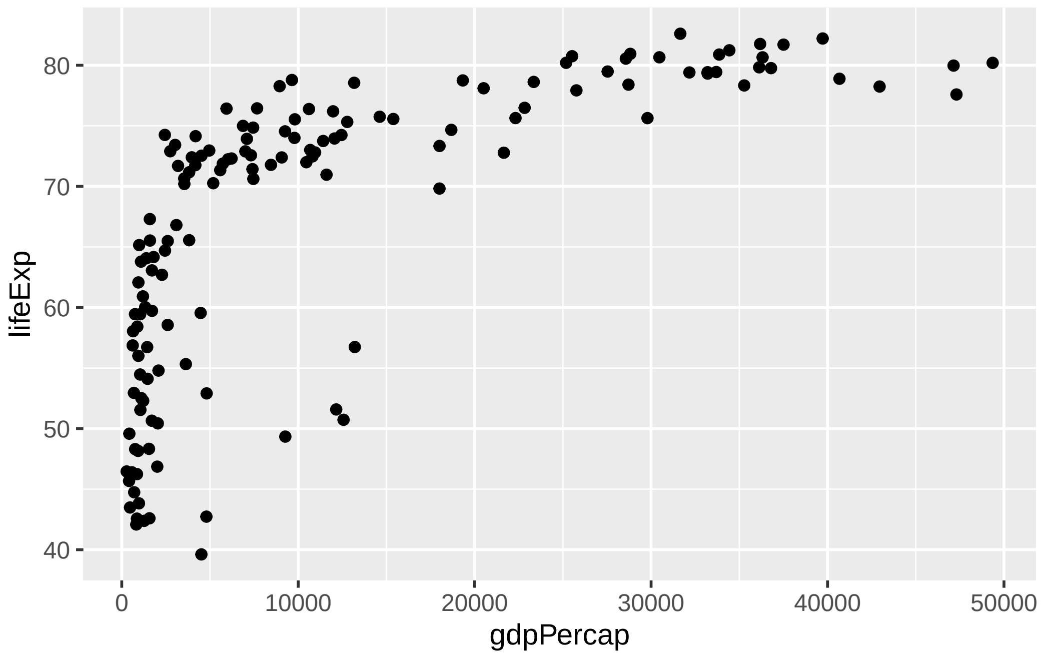
```

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
```

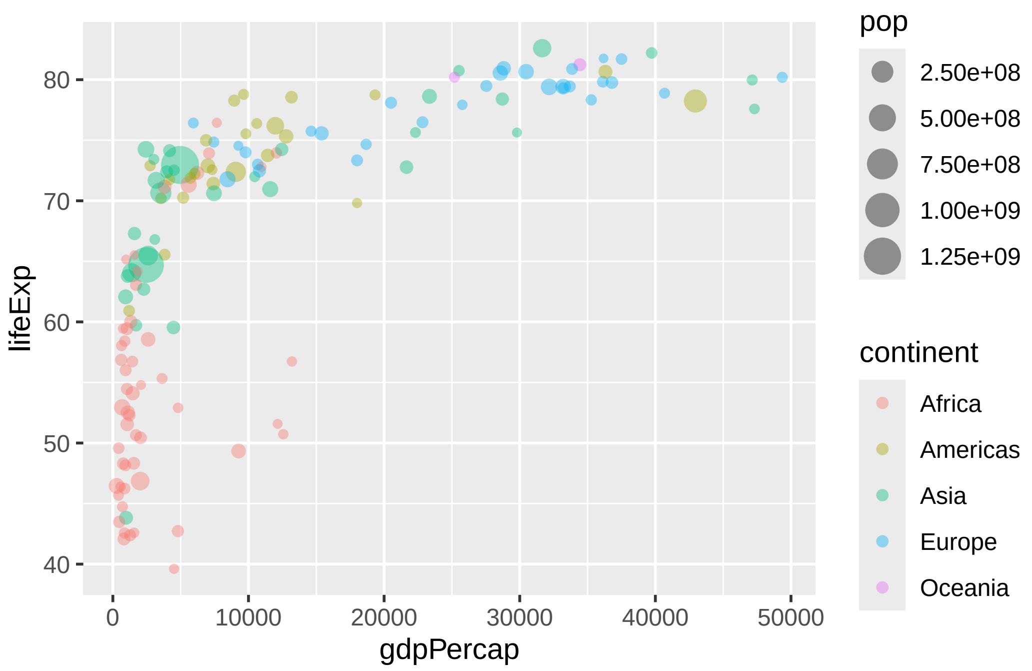
```
gapminder_2007 <- gapminder %>% filter(year==2007)
```

Plot for 2007

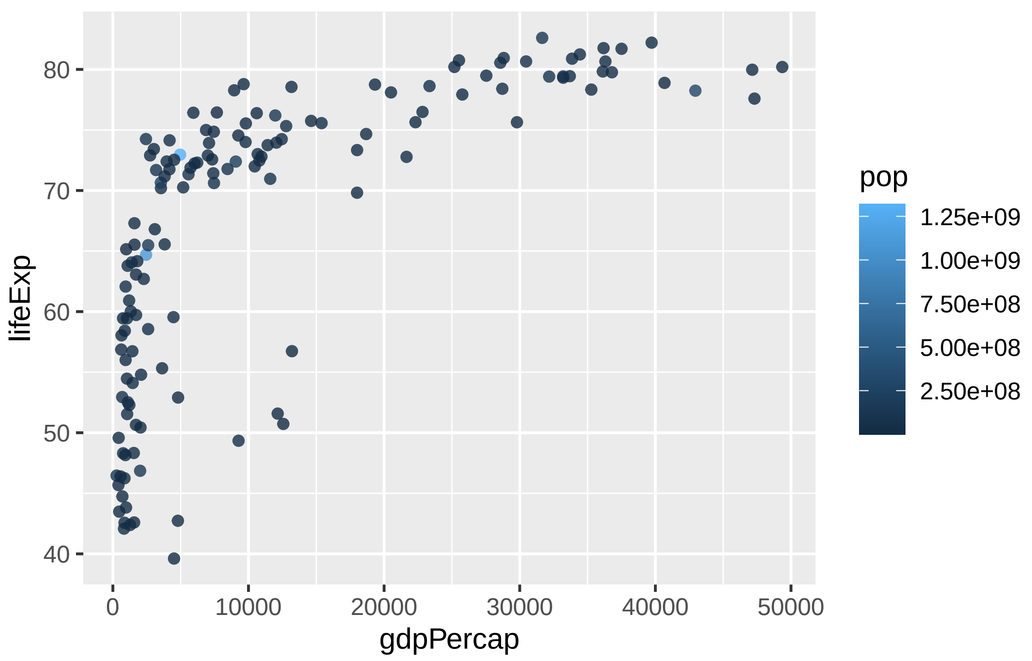
```
ggplot(gapminder_2007) +
  aes(x=gdpPercap, y=lifeExp) +
  geom_point()
```



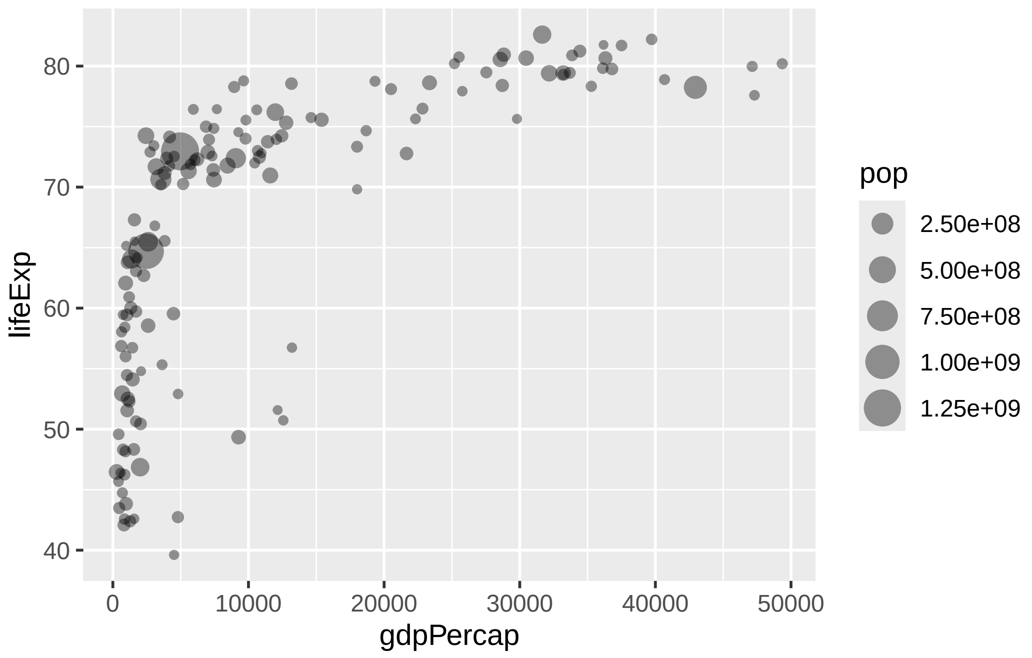
```
ggplot(gapminder_2007) +
  aes(x=gdpPercap, y=lifeExp, color=continent, size=pop) +
  geom_point(alpha=0.4)
```



```r
ggplot(gapminder_2007) +
  aes(x = gdpPercap, y = lifeExp, color = pop) +
  geom_point(alpha=0.8)
```



```r
ggplot(gapminder_2007) +
  aes(x=gdpPercap, y=lifeExp, size=pop) +
  geom_point(alpha=0.4)
```



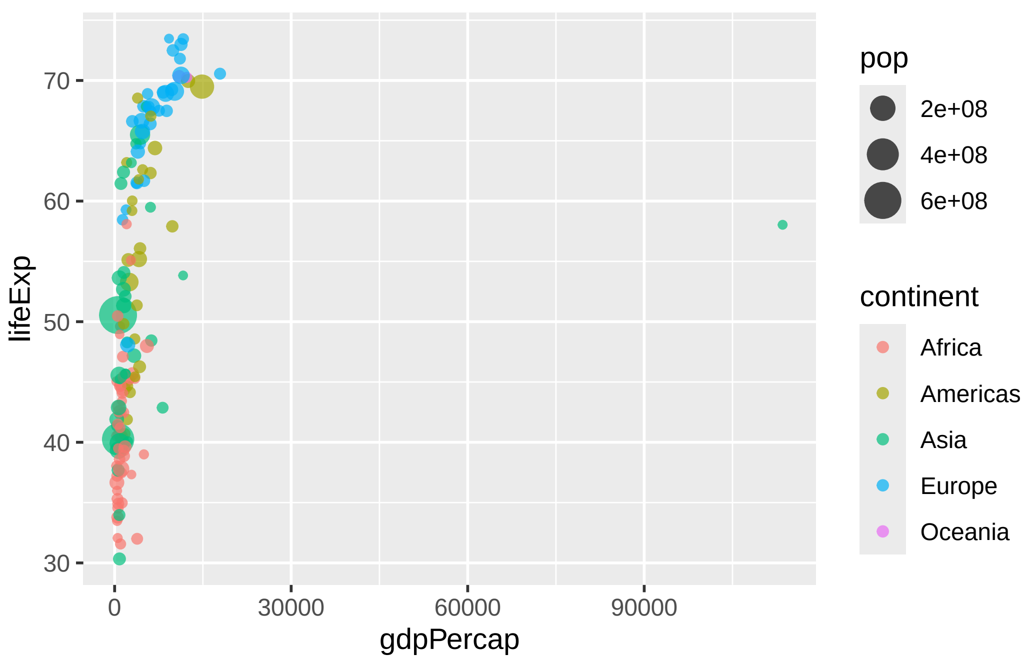
```r
  scale_size_area(max_size = 10)
```

```
<ScaleContinuous>
 Range:  
 Limits:    0 --    1
```

Can you adapt the code you have learned thus far to reproduce our gapminder scatter plot for the year 1957? What do you notice about this plot is it easy to compare with the one for 2007?

```r
library(gapminder)
gapminder_1957 <- gapminder %>% filter(year==1957)
```

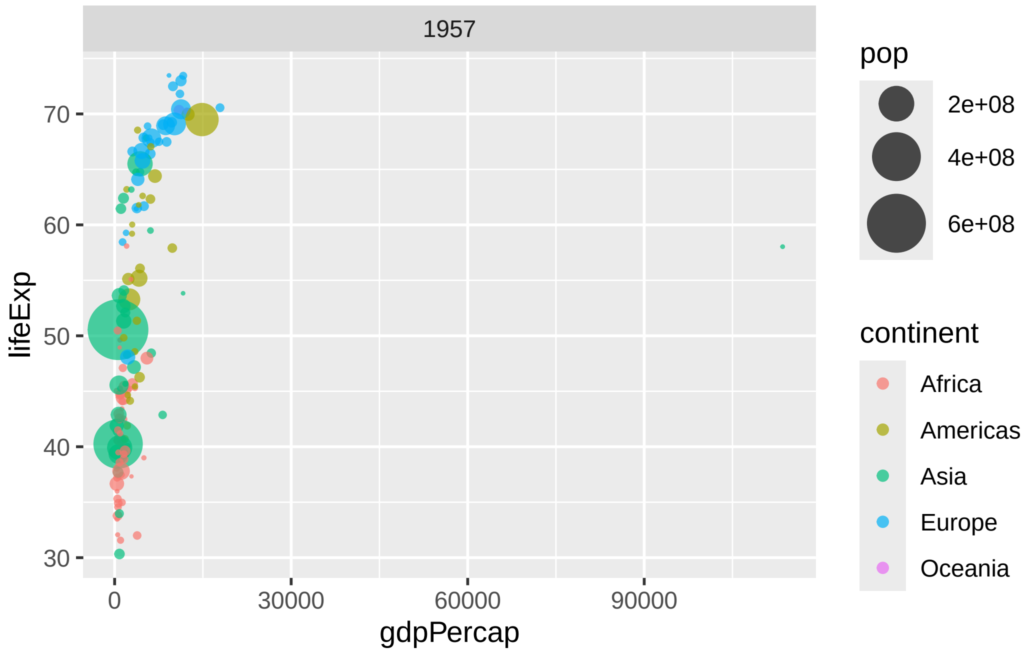
```r
ggplot(gapminder_1957) +
  aes(x=gdpPercap, y=lifeExp, color=continent, size=pop) +
  geom_point(alpha=0.7)
```



```
  scale_size_area(max_size = 15)
```

```
<ScaleContinuous>
 Range:
 Limits:    0 --    1
```

```
ggplot(gapminder_1957) +
  geom_point(aes(x = gdpPercap, y = lifeExp, color=continent,
                 size = pop), alpha=0.7) +
  scale_size_area(max_size = 10) +
  facet_wrap(~year)
```



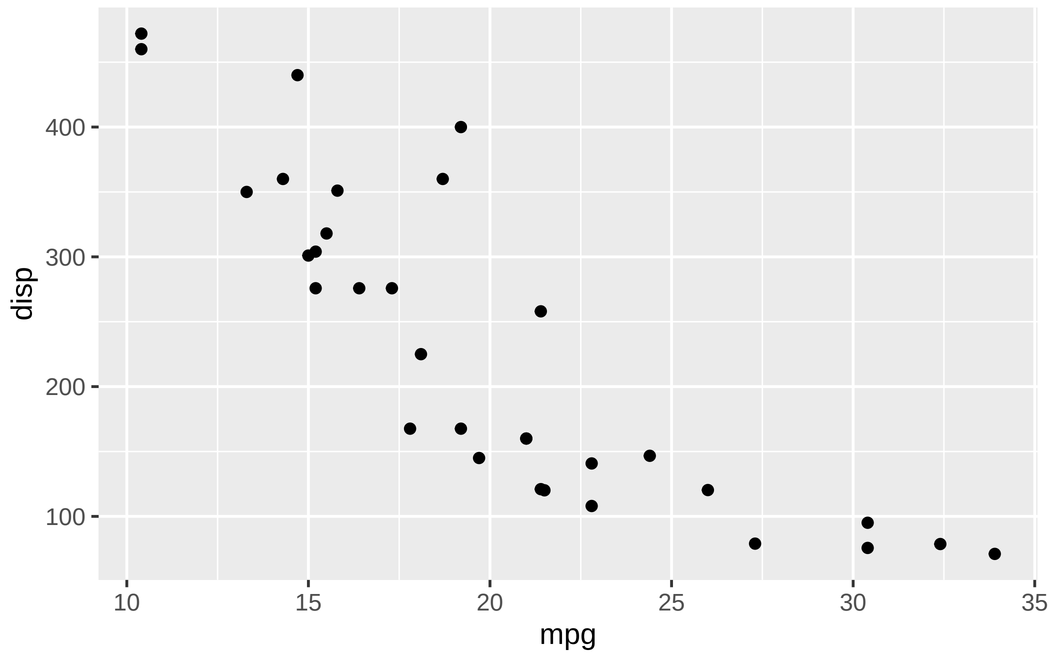
Combining Plots

```
library(patchwork)
```

Example plots:

```
p1 <- ggplot(mtcars) + aes(mpg,disp) + geom_point()
```

```
p1
```

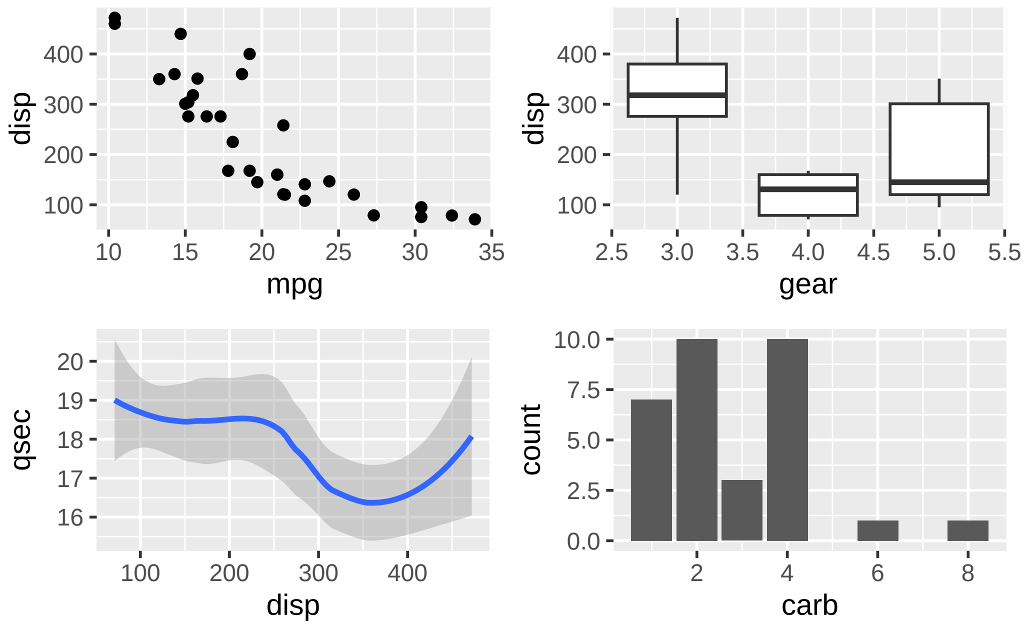


```r
p1 <- ggplot(mtcars) + aes(mpg,disp) + geom_point()
p2 <- ggplot(mtcars) + aes(gear, disp, group = gear) + geom_boxplot()
p3 <- ggplot(mtcars) + aes(disp, qsec) + geom_smooth()
p4 <- ggplot(mtcars) +aes(carb) + geom_bar()
```

Patchwork Combines all Graphs:

```r
(p1 | p2) / (p3 | p4)
```

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


disp
400
300
200
100
10
15
20
25
30
35
mpg
disp
400
300
200
100
2.5
3.0
3.5
4.0
4.5
5.0
5.5
gear
qsec
20
19
18
17
16
100
200
300
400
disp
count
10.0
7.5
5.0
2.5
0.0
2
4
6
8
carb