Report Class 5: Lab

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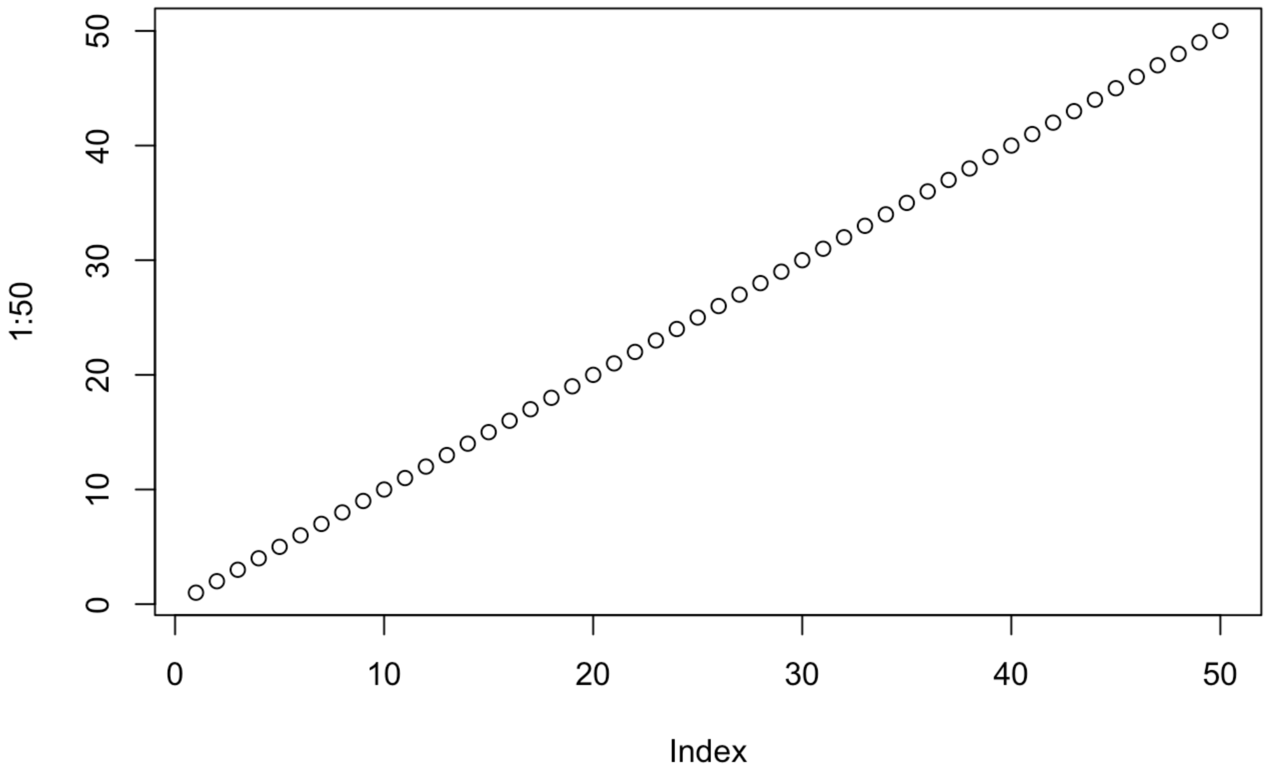
Running Code

When you click the **Render** button a *document* will be generated that includes both content and the output of embedded code. You can embed code like this:

Introduction

```
plot(1:50)
```



Naming a chunk

```
1 + 1
```

```
[1] 2
```

Starting class

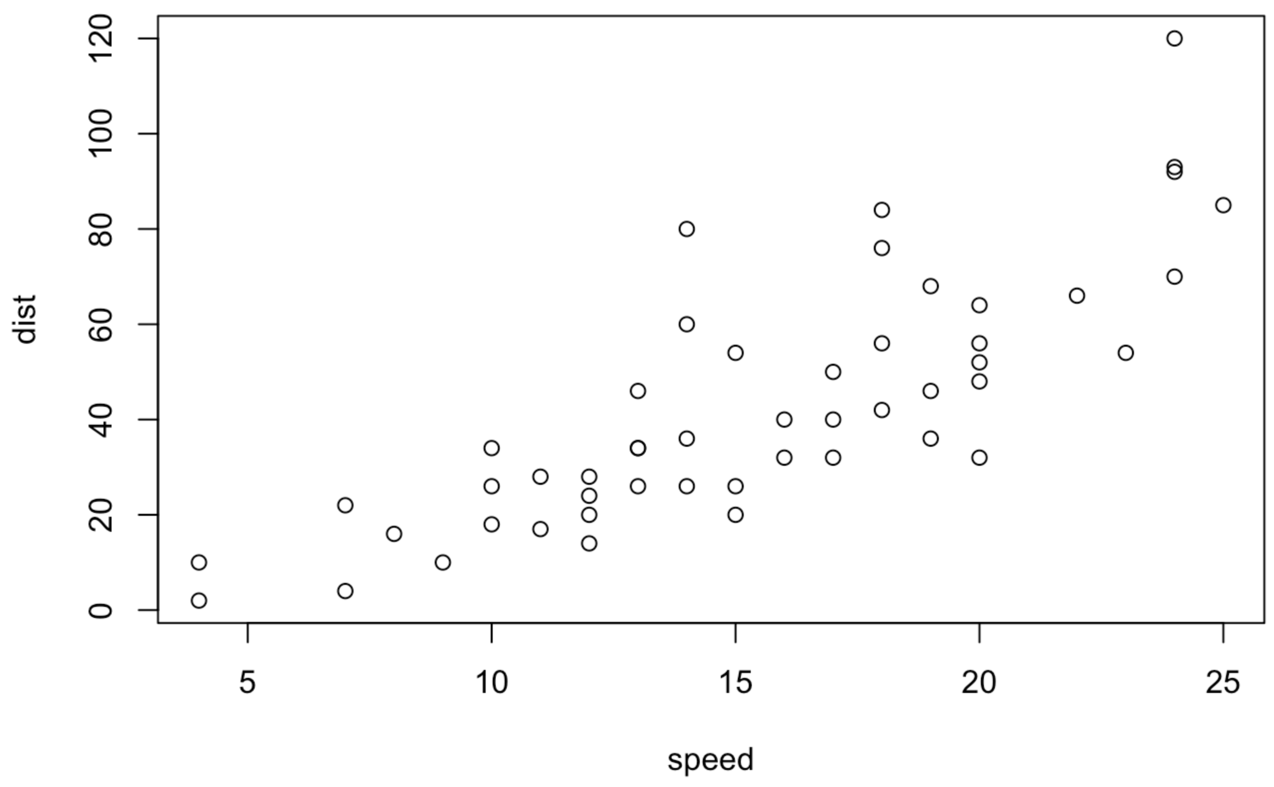
R has lot’s of ways to make figures and graphs in particular. One that comes with R out of the box is called **“base” R** - the `plot()` function.

```
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
```

```
plot(cars)
```



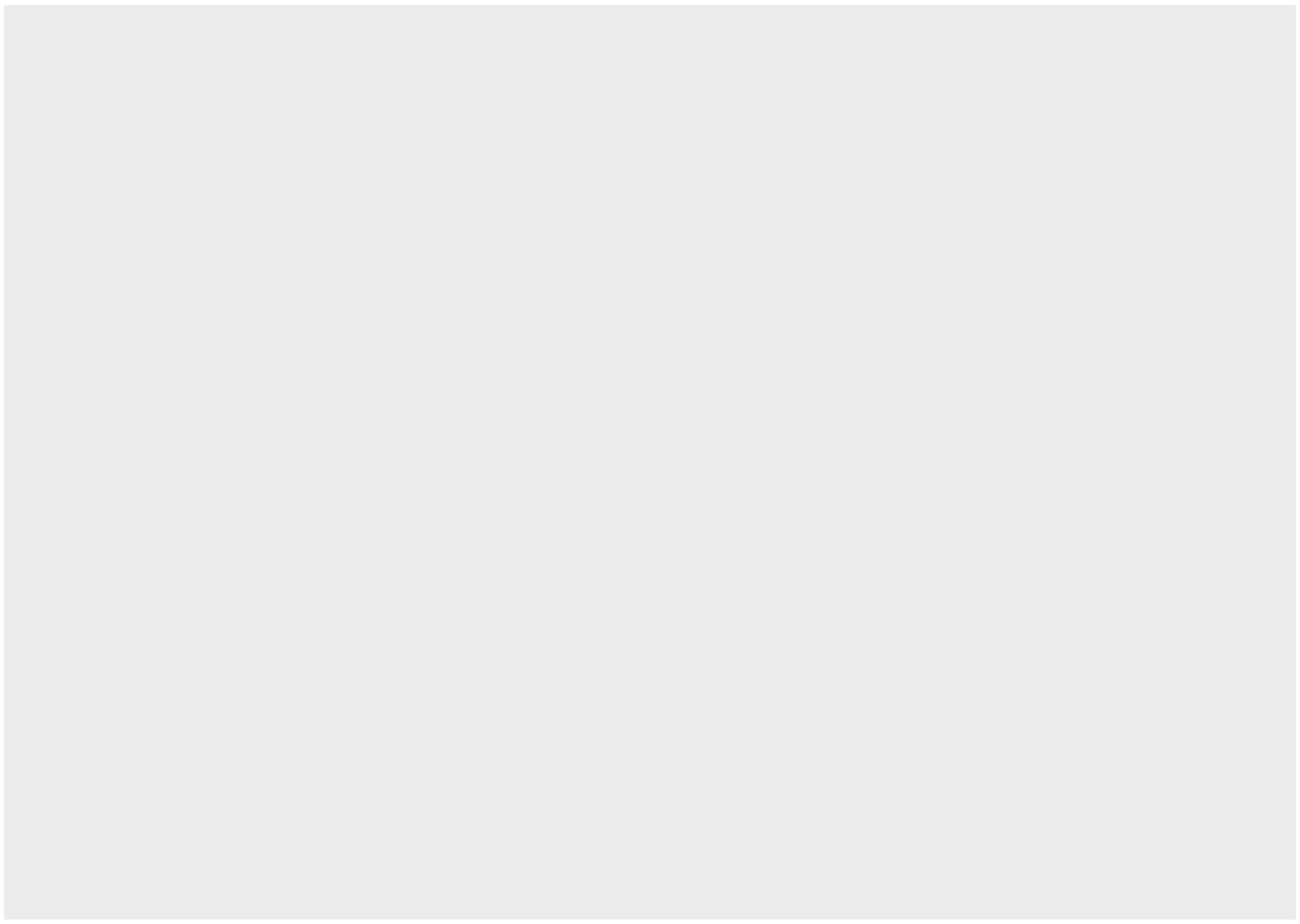
A very popular package in this area is called **ggplot2**.

```
library("ggplot2")
```

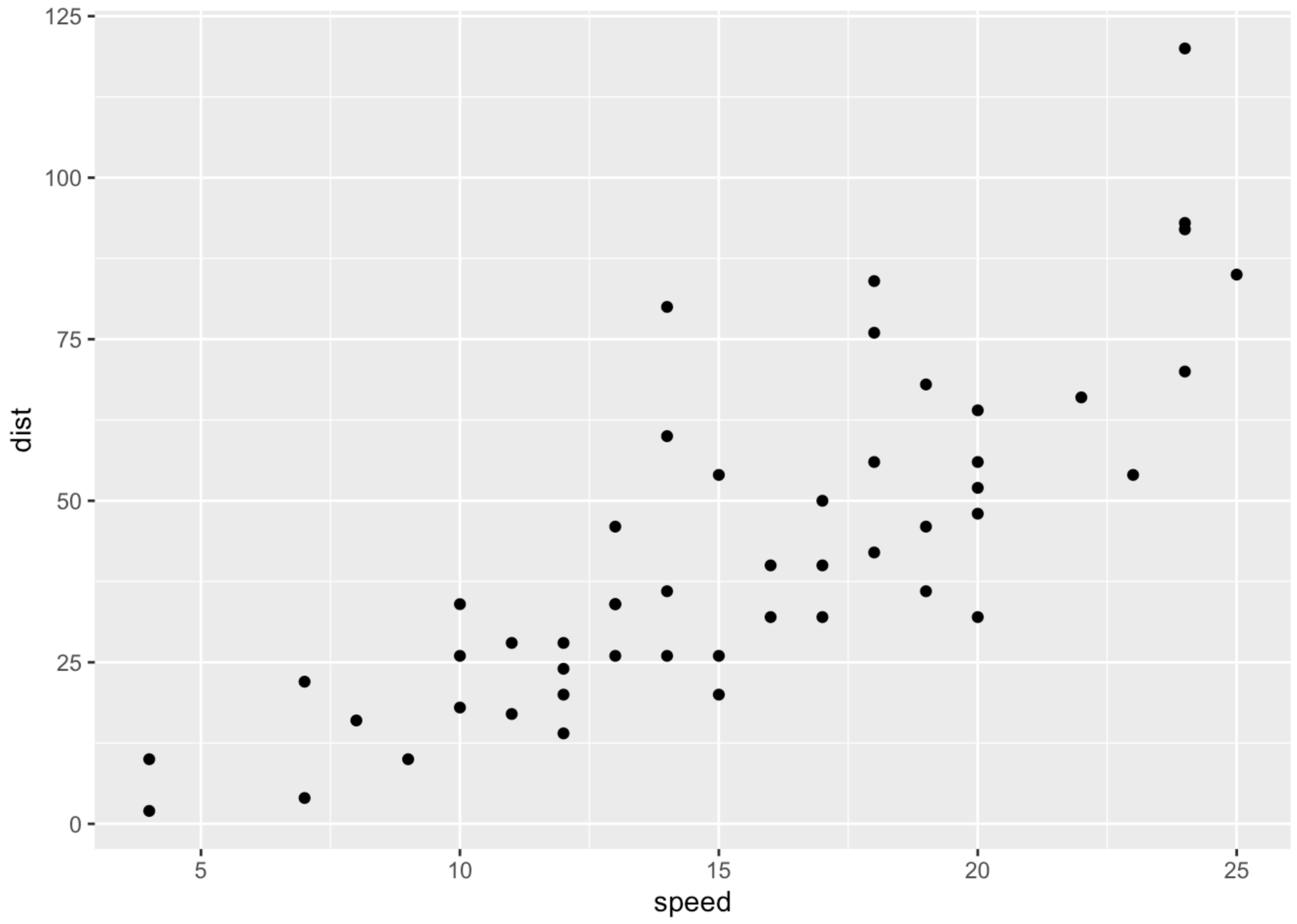
```r
packageVersion("ggplot2") #3.5.1
```

```
[1] '3.5.1'
```

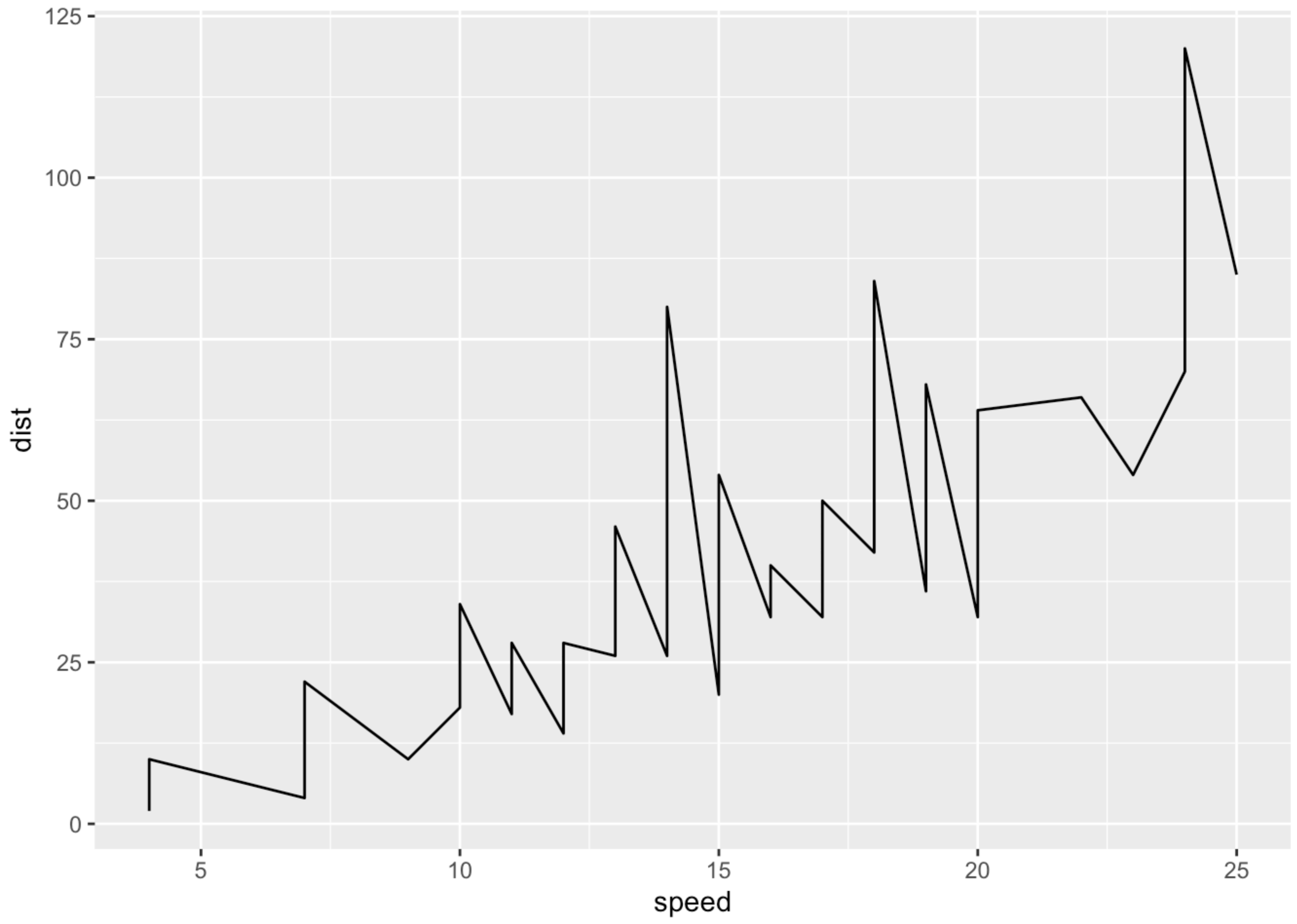
```r
ggplot(cars)
```



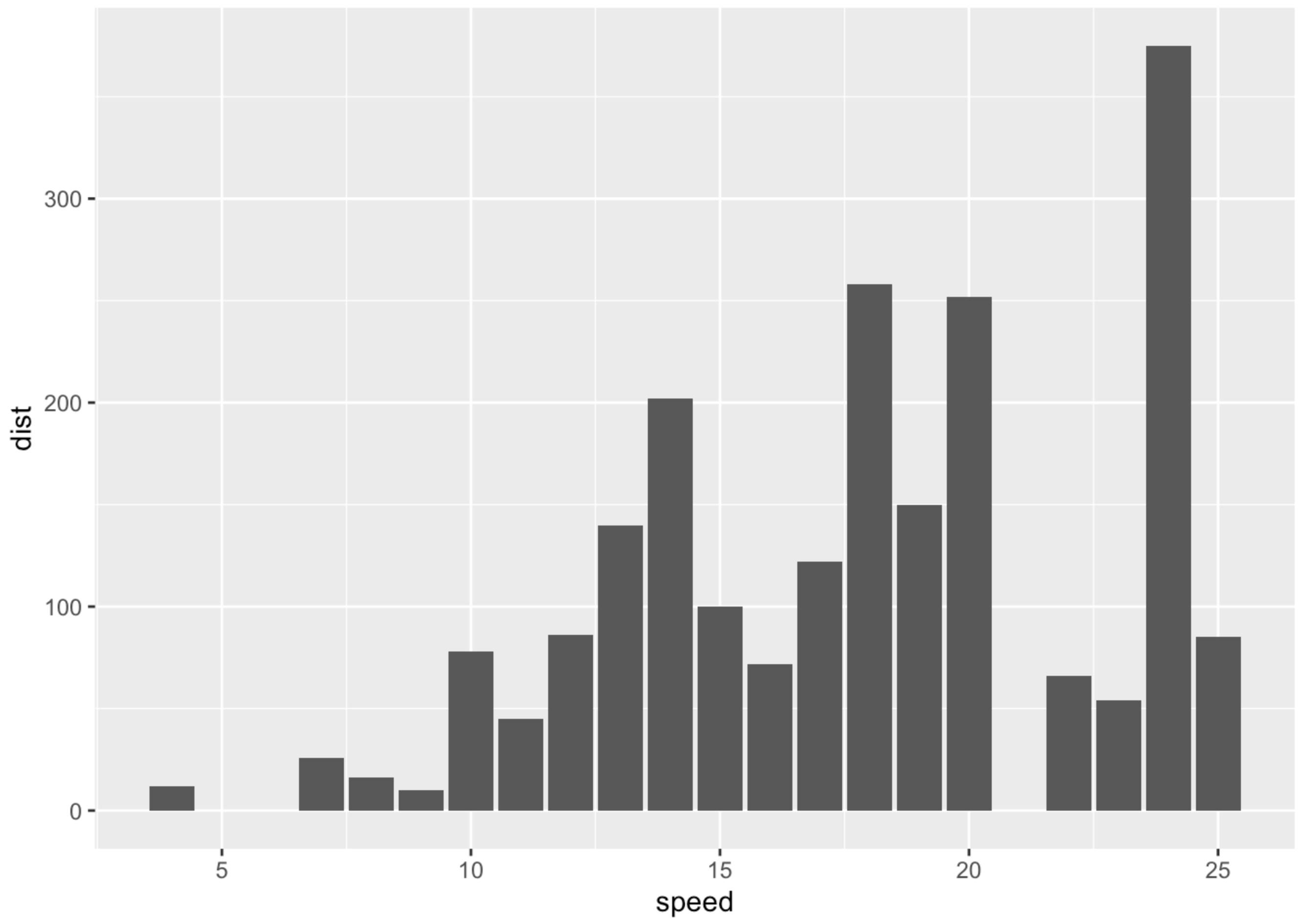
```r
ggplot(cars) +
  aes(x = speed, y = dist) +
  geom_point()
```



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

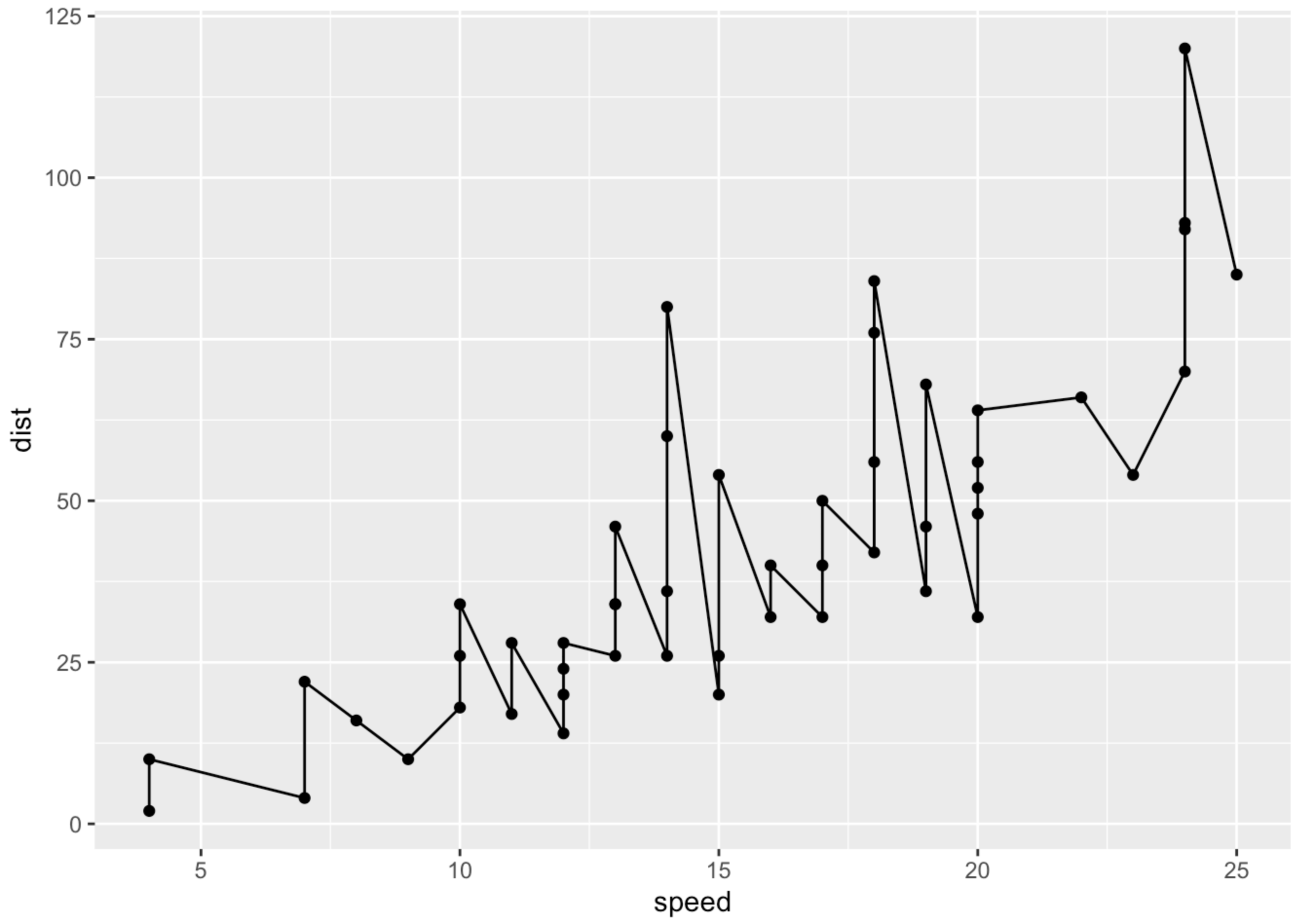


```r
ggplot(cars) +
  aes(x = speed, y = dist) +
  geom_col()
```



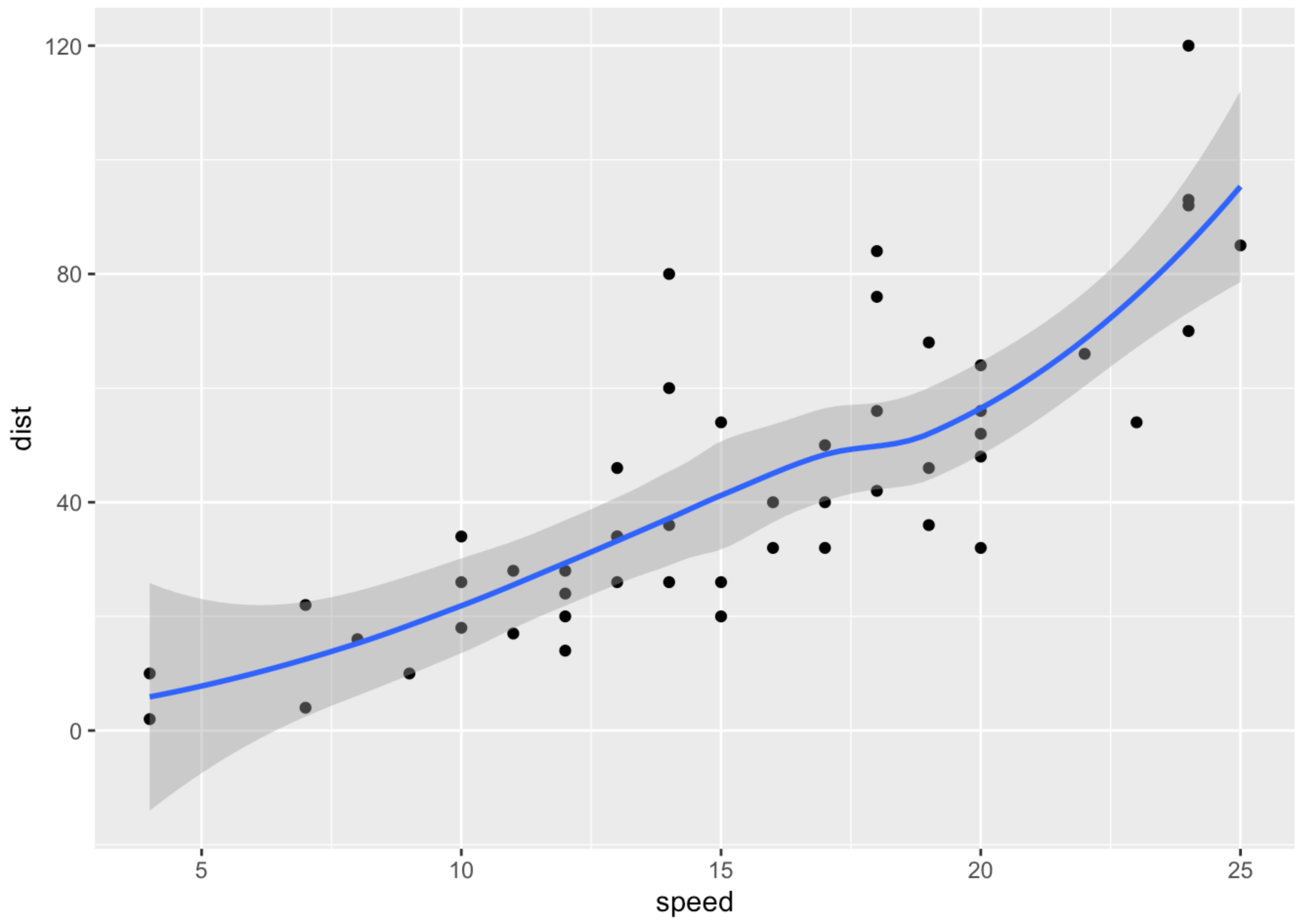
For “simple” plots like this one base R code will be much shorter than ggplot code. Let’s fit a model and show it on my plot:

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



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

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



Step back

Every ggplot has at least 3 layers - data (data.frame with the numbers and stuff you want to plot) - aes (aesthetics, mapping of your data columns to your plot, position, size, line type, line width, color, shape) - geom (geom_point(), geom_line(), geom_col())

Little exercise

ggplot of the `mtcars` data set using `mpg` vs `disp`. Set the size of the point to the `hp`. And set color to `am`.

```
mtcars
```

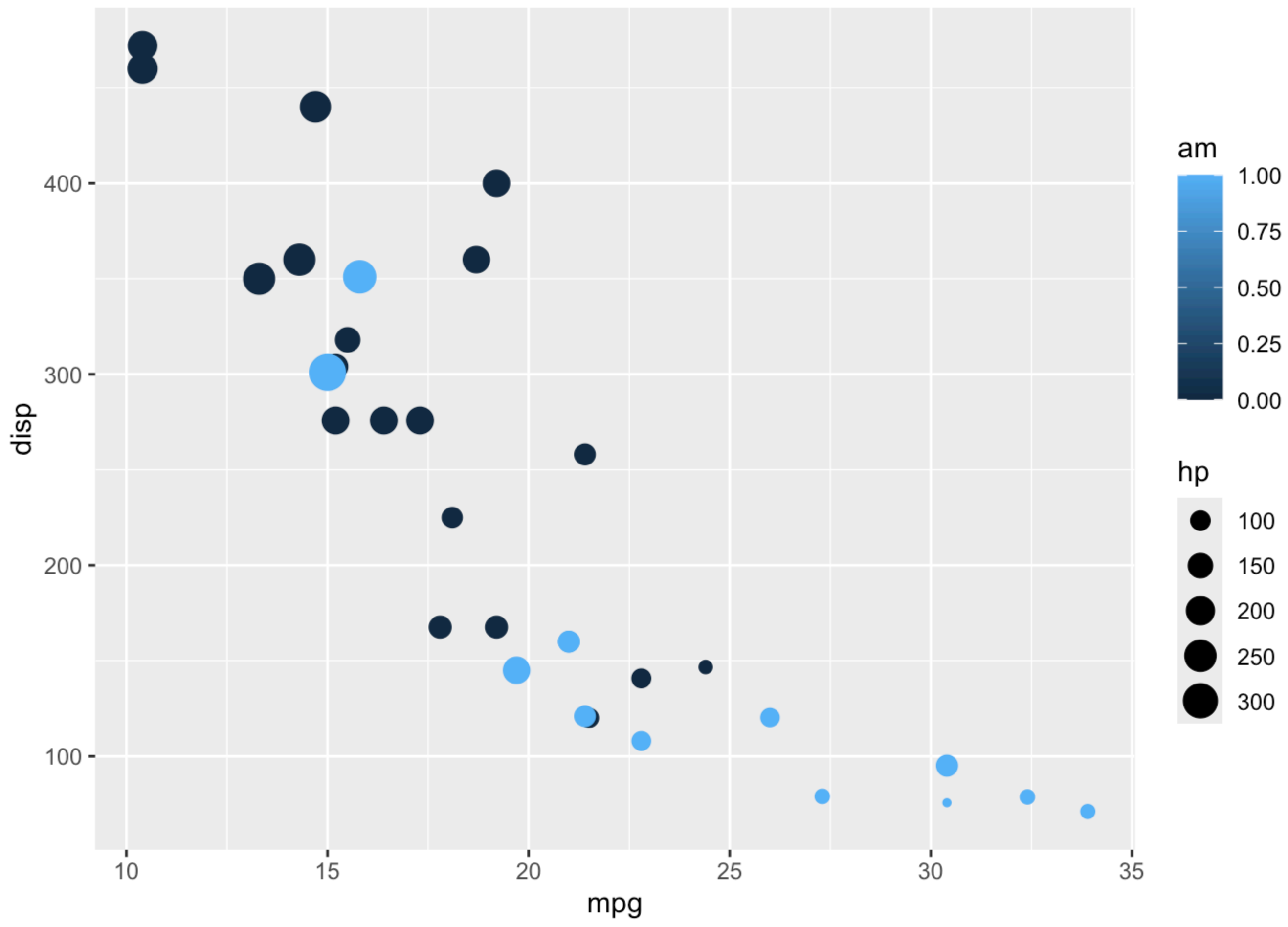
```
                     mpg cyl  disp  hp drat    wt  qsec vs am gear carb
Mazda RX4           21.0   6 160.0 110 3.90 2.620 16.46  0  1    4    4
Mazda RX4 Wag       21.0   6 160.0 110 3.90 2.875 17.02  0  1    4    4
Datsun 710          22.8   4 108.0  93 3.85 2.320 18.61  1  1    4    1
Hornet 4 Drive      21.4   6 258.0 110 3.08 3.215 19.44  1  0    3    1
Hornet Sportabout   18.7   8 360.0 175 3.15 3.440 17.02  0  0    3    2
Valiant             18.1   6 225.0 105 2.76 3.460 20.22  1  0    3    1
```

```
Duster 360          14.3   8 360.0 245 3.21 3.570 15.84  0  0    3    4
Merc 240D           24.4   4 146.7  62 3.69 3.190 20.00  1  0    4    2
Merc 230            22.8   4 140.8  95 3.92 3.150 22.90  1  0    4    2
Merc 280            19.2   6 167.6 123 3.92 3.440 18.30  1  0    4    4
Merc 280C           17.8   6 167.6 123 3.92 3.440 18.90  1  0    4    4
Merc 450SE          16.4   8 275.8 180 3.07 4.070 17.40  0  0    3    3
Merc 450SL          17.3   8 275.8 180 3.07 3.730 17.60  0  0    3    3
Merc 450SLC         15.2   8 275.8 180 3.07 3.780 18.00  0  0    3    3
Cadillac Fleetwood  10.4   8 472.0 205 2.93 5.250 17.98  0  0    3    4
Lincoln Continental 10.4   8 460.0 215 3.00 5.424 17.82  0  0    3    4
Chrysler Imperial   14.7   8 440.0 230 3.23 5.345 17.42  0  0    3    4
Fiat 128            32.4   4  78.7  66 4.08 2.200 19.47  1  1    4    1
Honda Civic         30.4   4  75.7  52 4.93 1.615 18.52  1  1    4    2
Toyota Corolla      33.9   4  71.1  65 4.22 1.835 19.90  1  1    4    1
Toyota Corona       21.5   4 120.1  97 3.70 2.465 20.01  1  0    3    1
Dodge Challenger    15.5   8 318.0 150 2.76 3.520 16.87  0  0    3    2
AMC Javelin         15.2   8 304.0 150 3.15 3.435 17.30  0  0    3    2
Camaro Z28          13.3   8 350.0 245 3.73 3.840 15.41  0  0    3    4
Pontiac Firebird    19.2   8 400.0 175 3.08 3.845 17.05  0  0    3    2
Fiat X1-9           27.3   4  79.0  66 4.08 1.935 18.90  1  1    4    1
Porsche 914-2       26.0   4 120.3  91 4.43 2.140 16.70  0  1    5    2
Lotus Europa        30.4   4  95.1 113 3.77 1.513 16.90  1  1    5    2
Ford Pantera L      15.8   8 351.0 264 4.22 3.170 14.50  0  1    5    4
Ferrari Dino        19.7   6 145.0 175 3.62 2.770 15.50  0  1    5    6
Maserati Bora       15.0   8 301.0 335 3.54 3.570 14.60  0  1    5    8
Volvo 142E          21.4   4 121.0 109 4.11 2.780 18.60  1  1    4    2
```

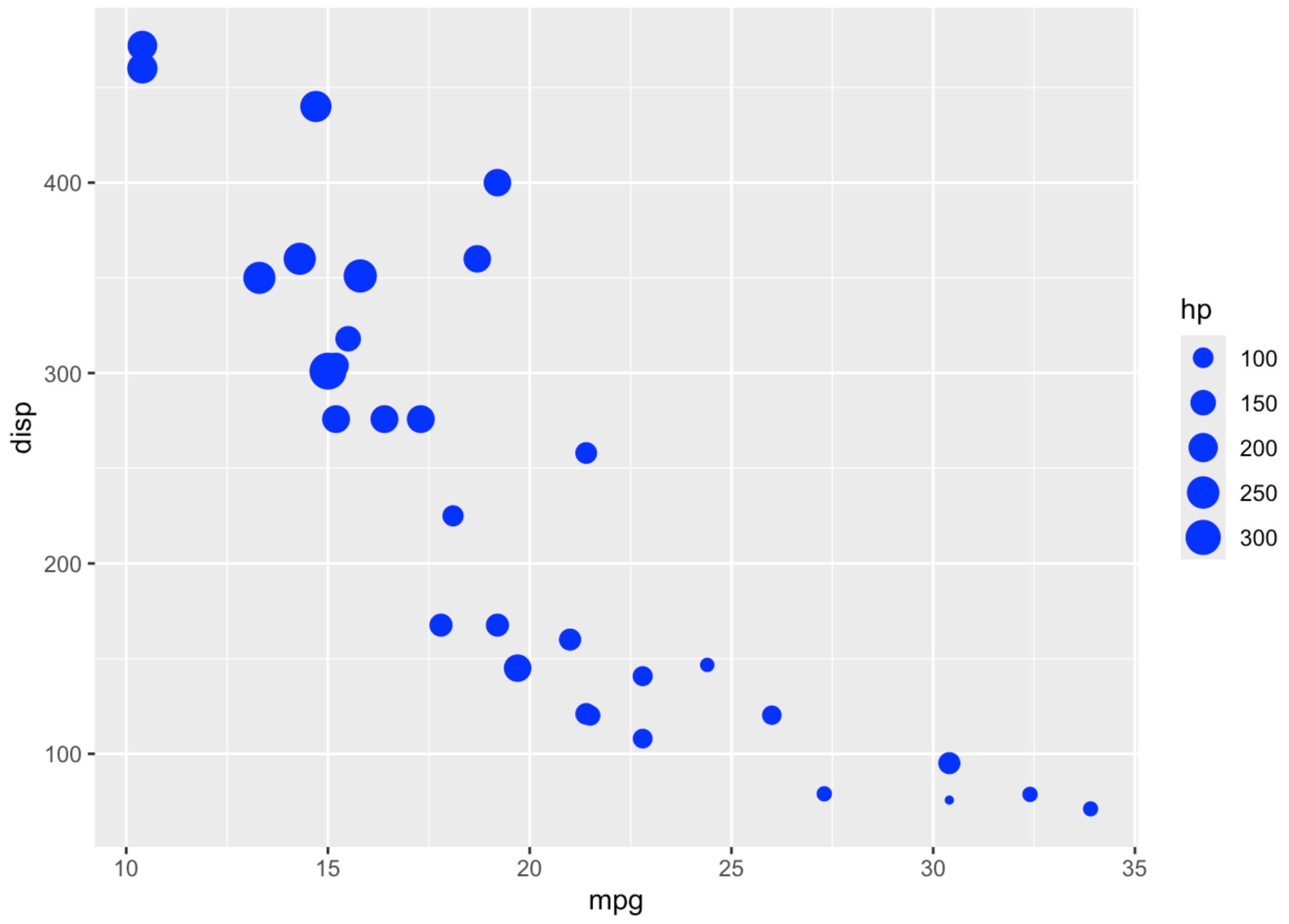
```r
head(mtcars)
```

```
                   mpg cyl disp  hp drat    wt  qsec vs am gear carb
Mazda RX4         21.0   6  160 110 3.90 2.620 16.46  0  1    4    4
Mazda RX4 Wag     21.0   6  160 110 3.90 2.875 17.02  0  1    4    4
Datsun 710        22.8   4  108  93 3.85 2.320 18.61  1  1    4    1
Hornet 4 Drive    21.4   6  258 110 3.08 3.215 19.44  1  0    3    1
Hornet Sportabout 18.7   8  360 175 3.15 3.440 17.02  0  0    3    2
Valiant           18.1   6  225 105 2.76 3.460 20.22  1  0    3    1
```

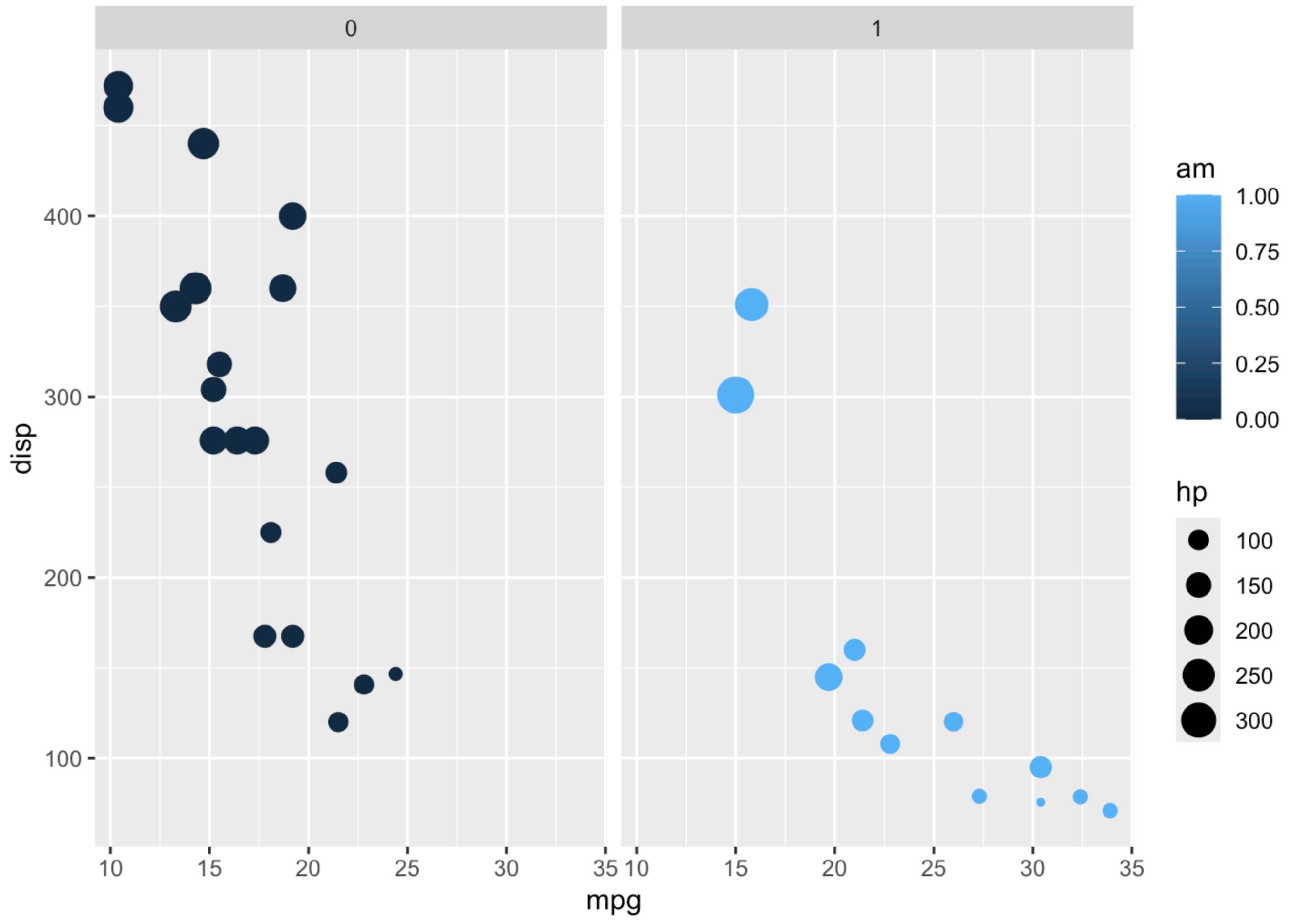
```r
ggplot(mtcars) +
  aes(x = mpg, y = disp, size = hp, color = am) +
  geom_point()
```



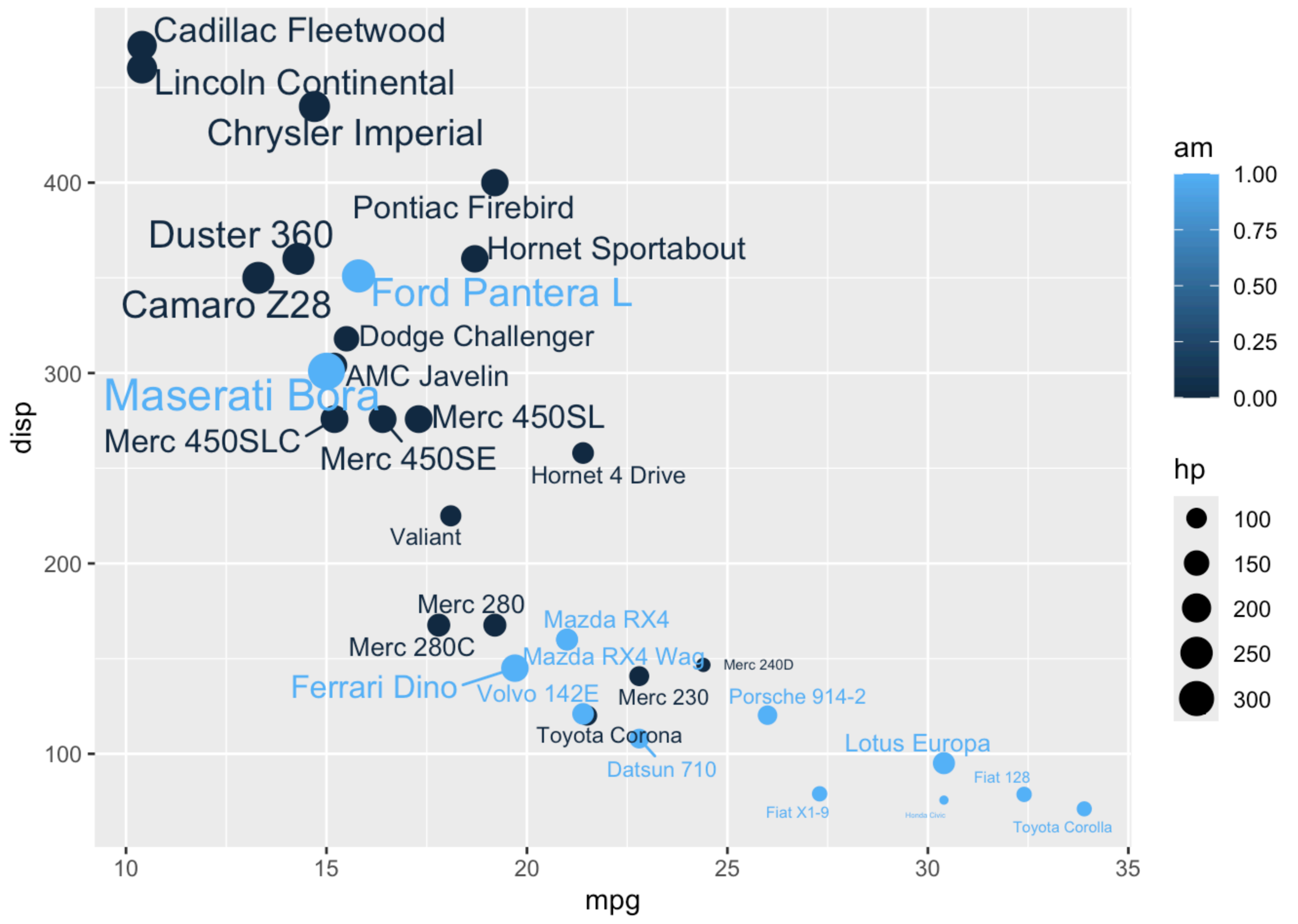
```r
# Now everything blue
ggplot(mtcars) +
  aes(x = mpg, y = disp, size = hp) +
  geom_point(color = "blue")
```



```r
# Facet
ggplot(mtcars) +
  aes(x = mpg, y = disp, size = hp, color = am) +
  geom_point() +
  facet_wrap(~am)
```



```r
# Label
library(ggrepel)
ggplot(mtcars) +
  aes(x = mpg, y = disp, size = hp, color = am, label=rownames(mtcars)) +
  geom_point() +
  geom_text_repel()
```



From this moment, we work on our own:

Adding more plot aesthetics through aes()

```
# Load the data
url <- "https://bioboot.github.io/bimm143_S20/class-material/up_down_expression.t
genes <- read.delim(url)

# Display the first few rows
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
```

```
# Count the number of rows and check column names
nrow(genes)         # answer = 5196
```

```
[1] 5196
```

```r
colnames(genes)     # answer = gene, condition1, condition2, state
```

```
[1] "Gene"       "Condition1" "Condition2" "State"
```

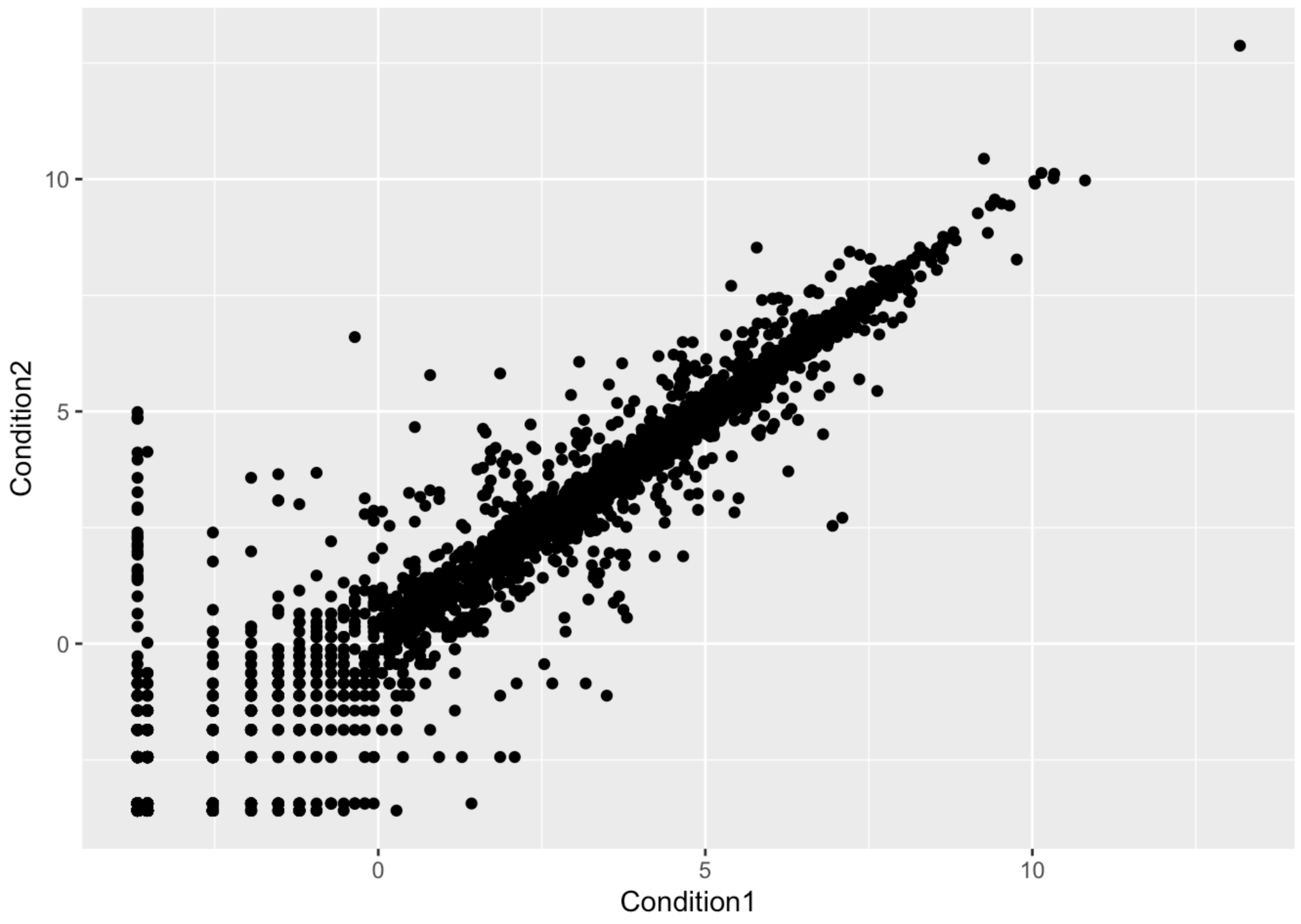
```r
# Calculate how many up regulated genes there are
table(genes$State)
```

```

      down unchanging         up 
        72       4997        127 
```

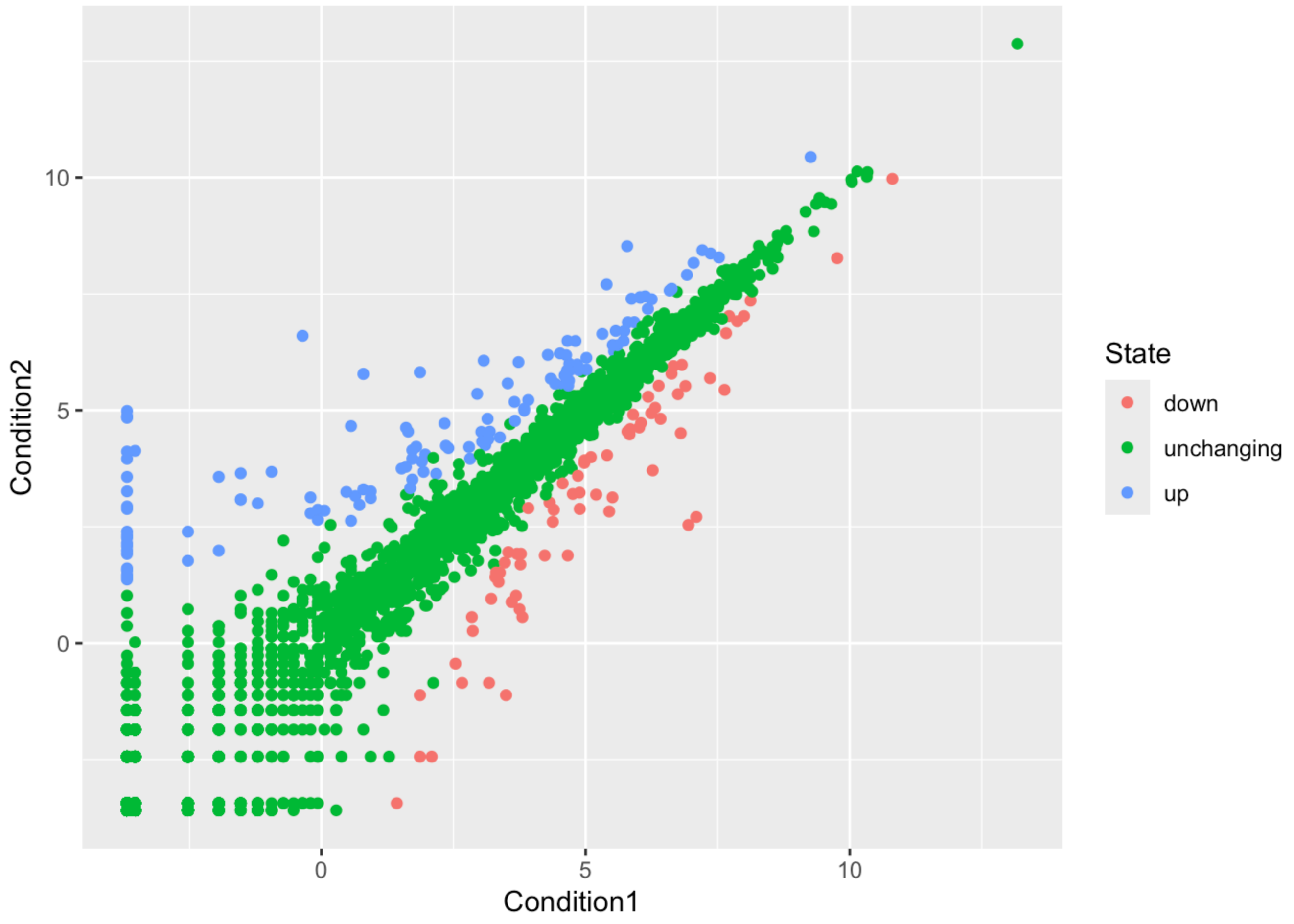
```r
# What fraction of total genes is up-regulated in this dataset?
round( table(genes$State)/nrow(genes) * 100, 2 )
```

```

      down unchanging         up 
      1.39      96.17       2.44 
```

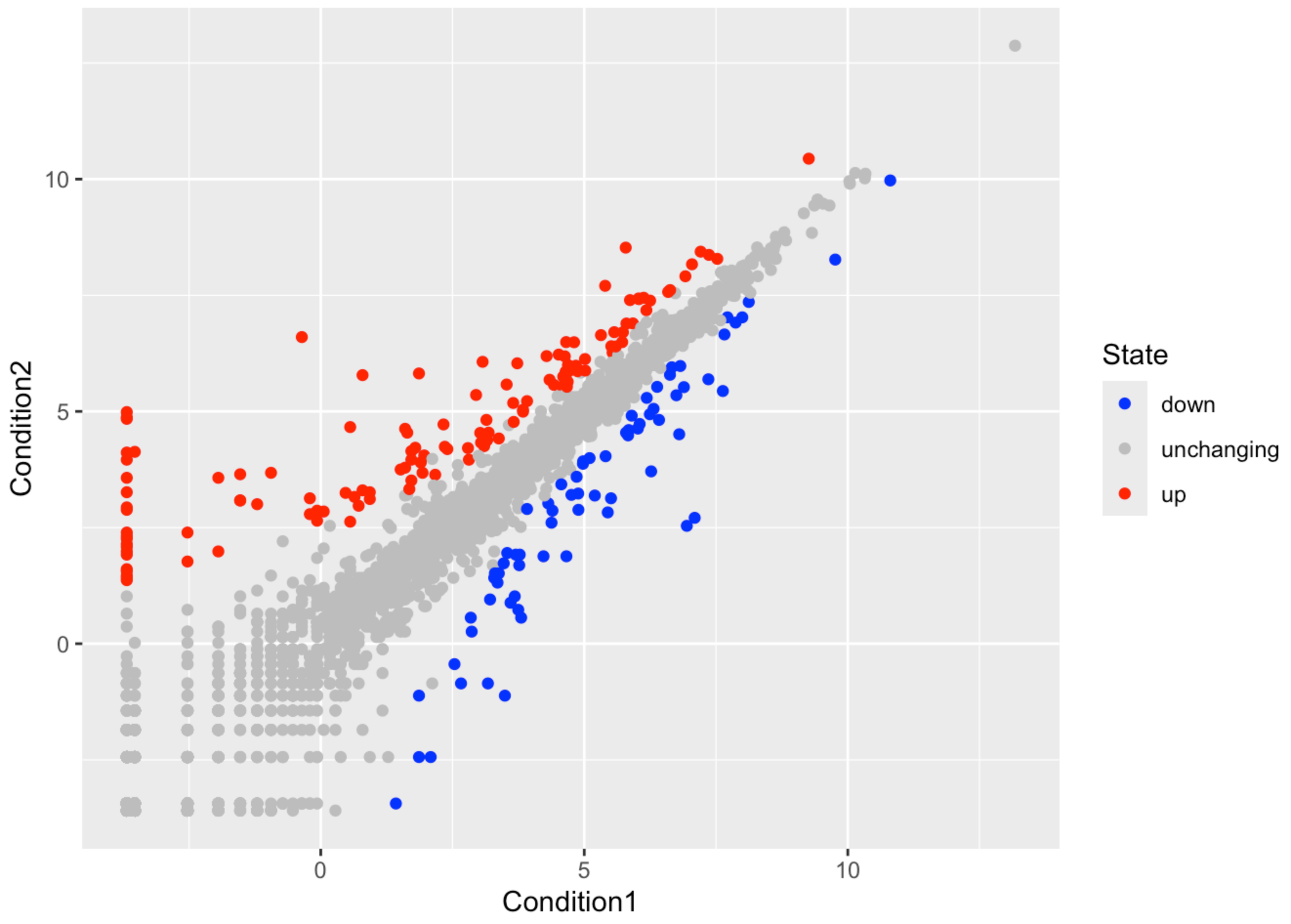
```r
# Make graph
ggplot(genes) +
  aes(x=Condition1, y=Condition2) +
  geom_point()
```



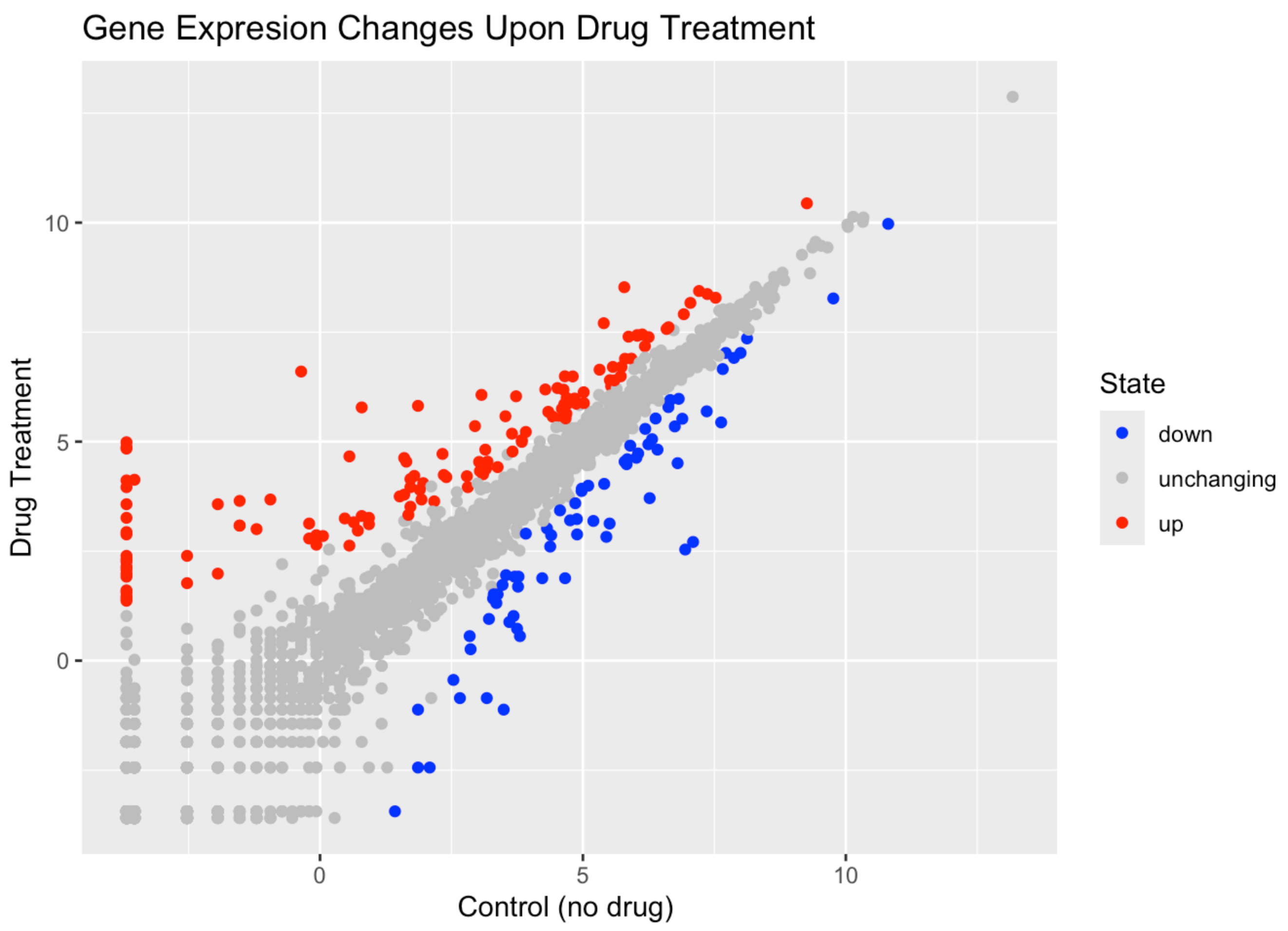
```r
# Extra Info
p <- ggplot(genes) +
    aes(x=Condition1, y=Condition2, col=State) +
    geom_point()
p
```



```r
# Other colors
p + scale_colour_manual( values=c("blue","gray","red") )
```



```
# Labels
p + scale_colour_manual(values=c("blue","gray","red")) +
    labs(title="Gene Expresion Changes Upon Drug Treatment",
         x="Control (no drug) ",
         y="Drug Treatment")
```



Going Further

```
# Set the CRAN mirror
options(repos = c(CRAN = "https://cran.r-project.org"))

# Install
install.packages("gapminder")
```

```
The downloaded binary packages are in
	/var/folders/wc/y60y10bj5jz0zzxkrq739z580000gn/T//RtmpHn5Taf/downloaded_packages
```

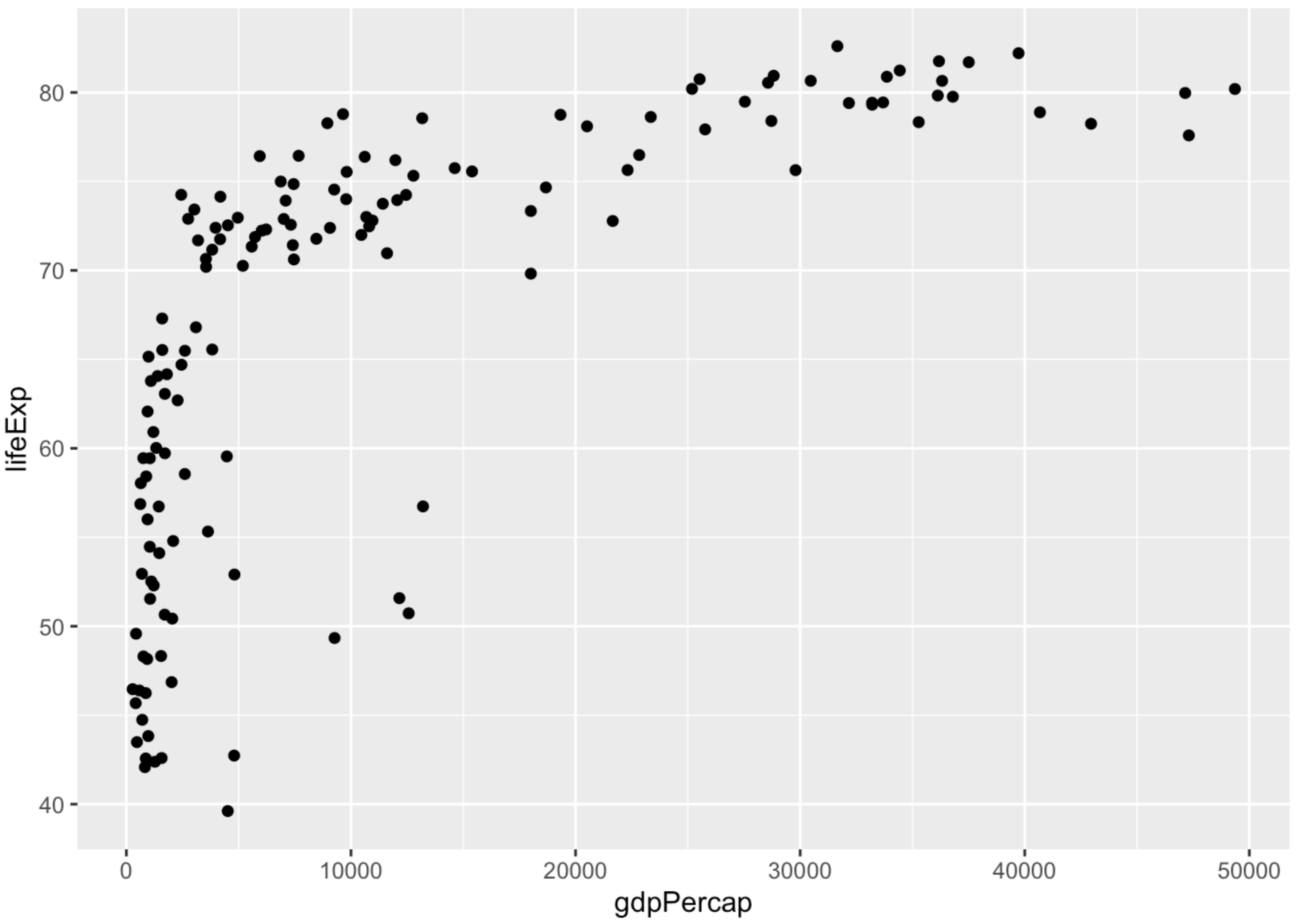
```
library(gapminder)

# Extra, will talk about this next week
install.packages("dplyr")
```

```
The downloaded binary packages are in
	/var/folders/wc/y60y10bj5jz0zzxkrq739z580000gn/T//RtmpHn5Taf/downloaded_packages
```

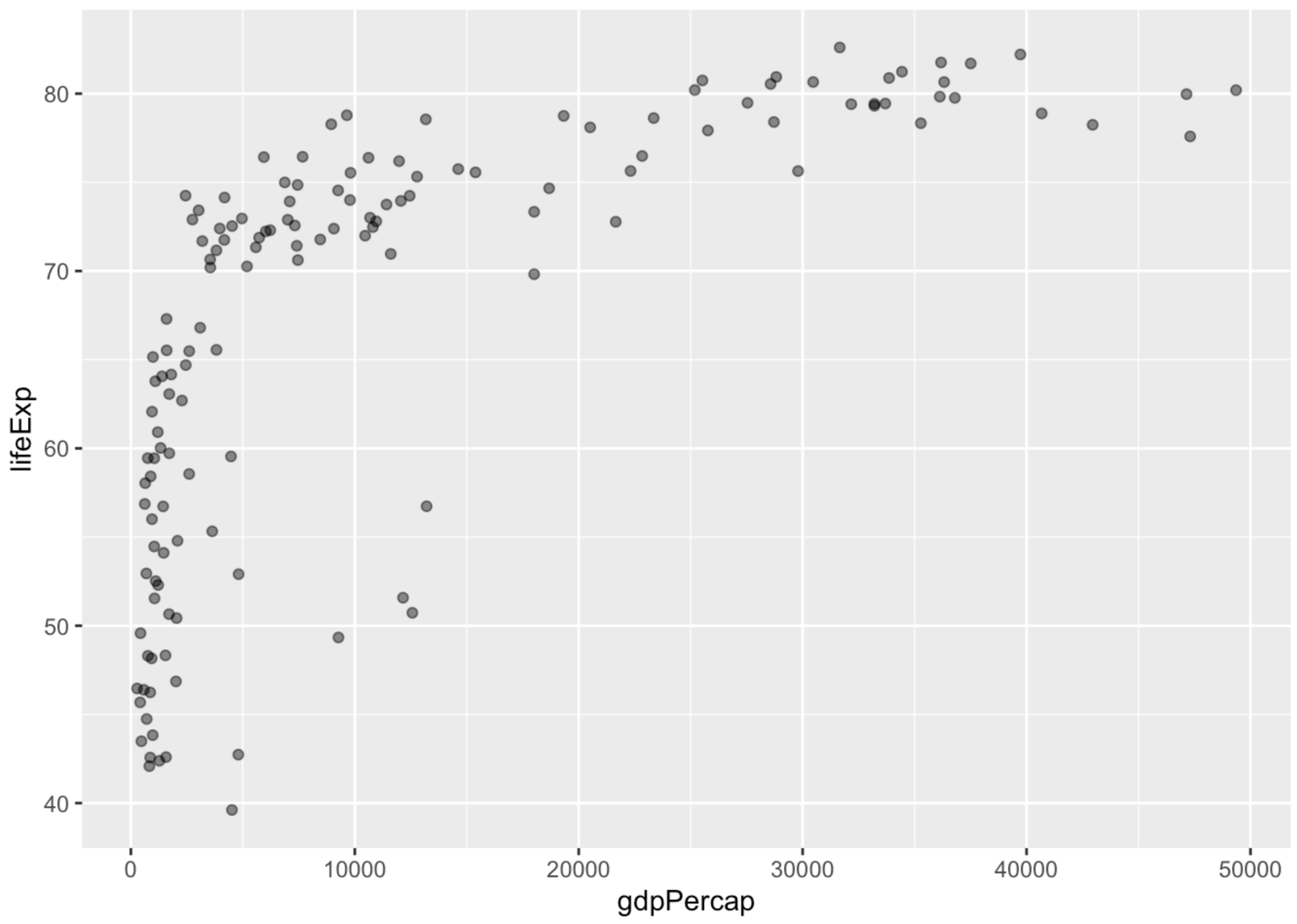
```r
library(dplyr)
```

```
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
```

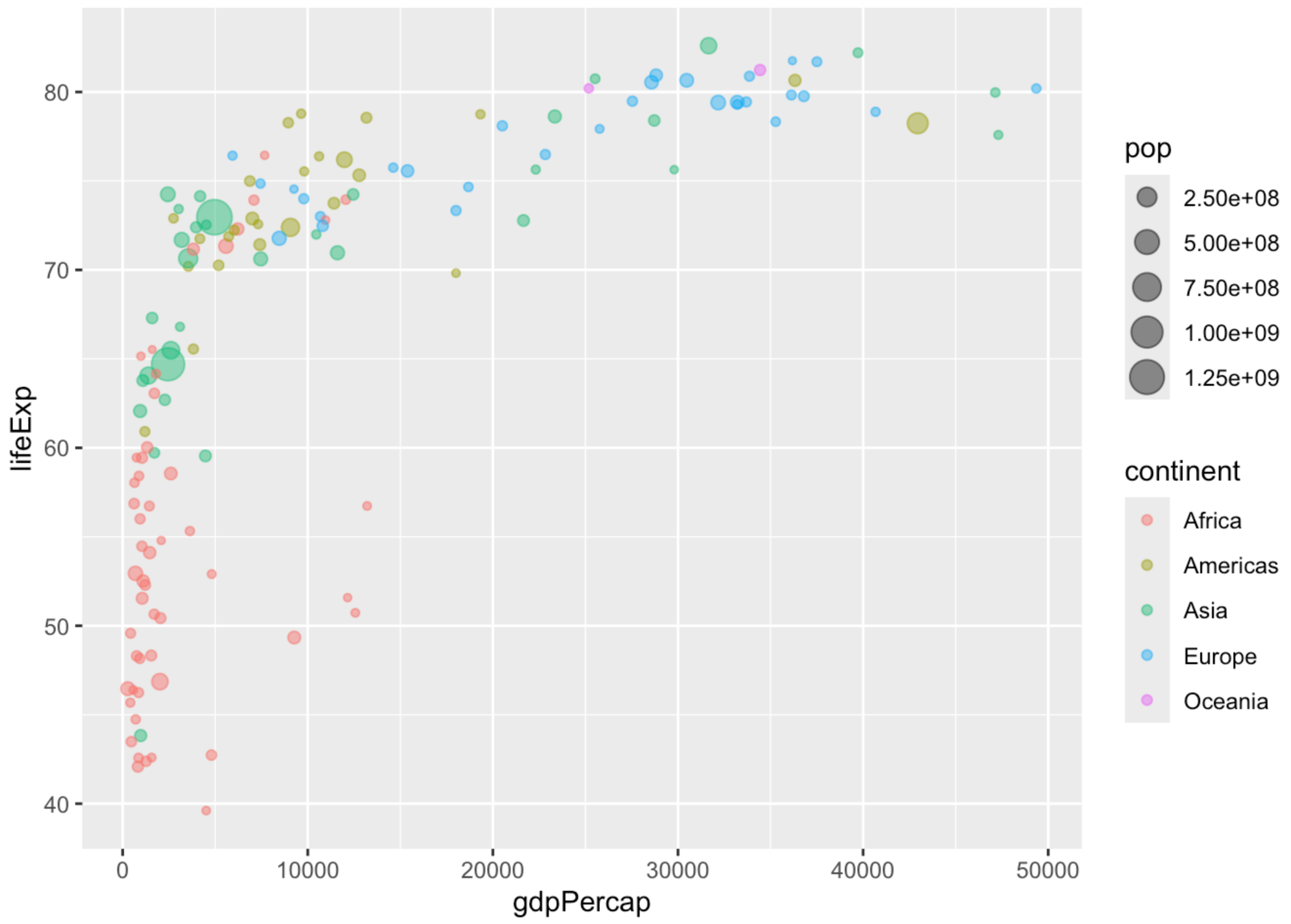
```r
gapminder_2007 <- gapminder %>% filter(year==2007)

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



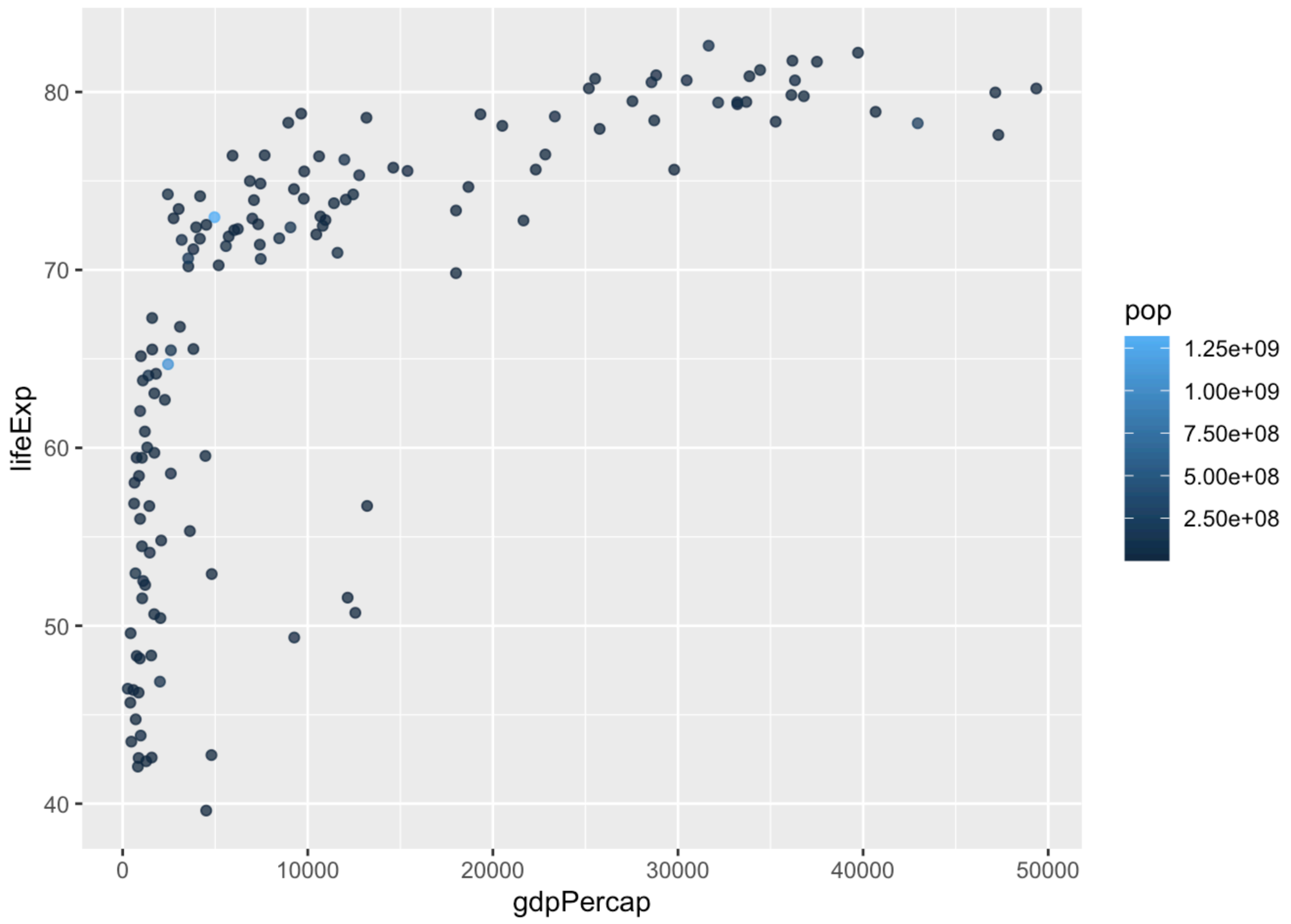
```r
# Plot to have less points on top of eachother
ggplot(gapminder_2007) +
  aes(x=gdpPercap, y=lifeExp) +
  geom_point(alpha=0.5)
```



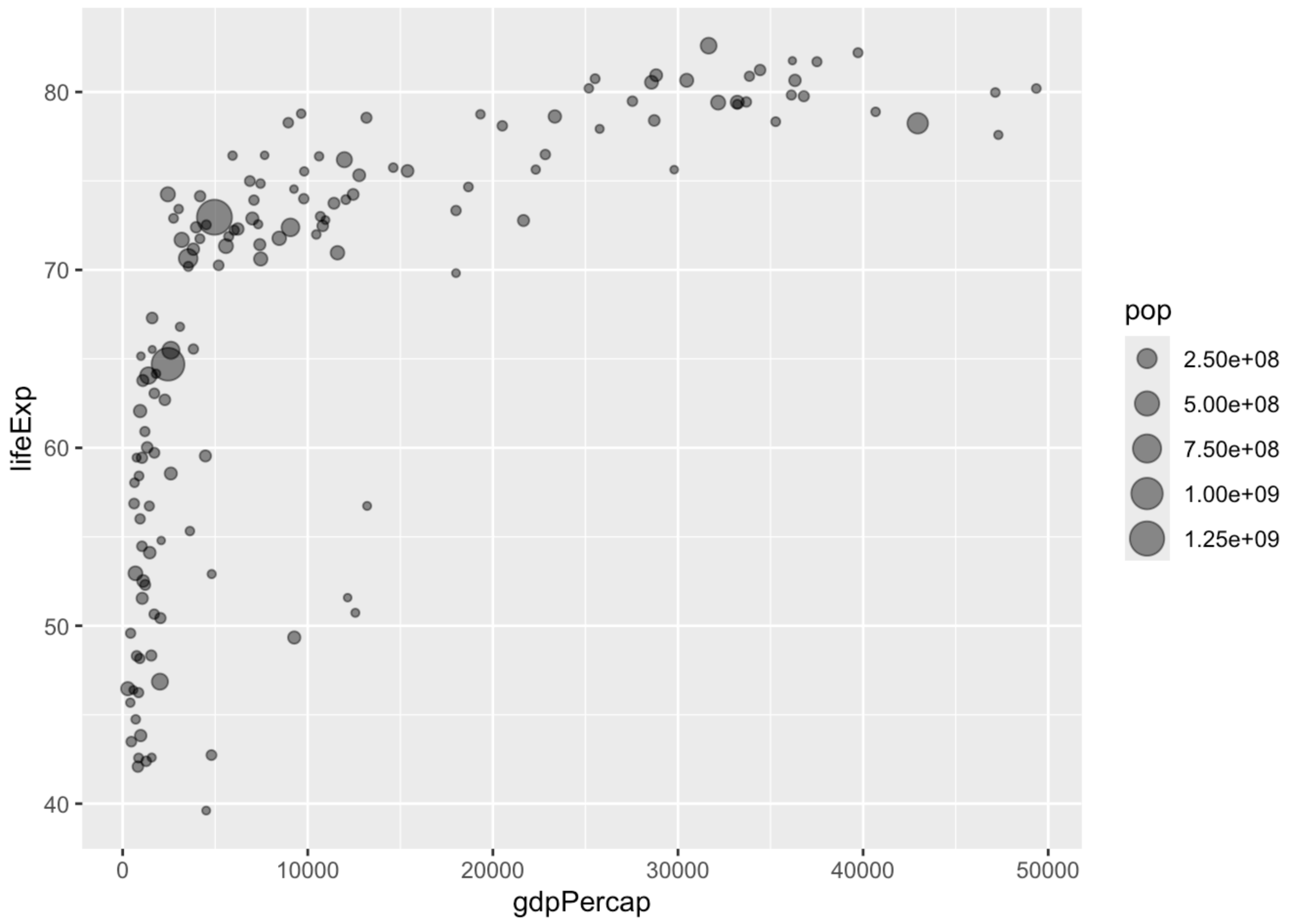
```
# Adding more variables to aes()
ggplot(gapminder_2007) +
  aes(x=gdpPercap, y=lifeExp, color=continent, size=pop) +
  geom_point(alpha=0.5)
```



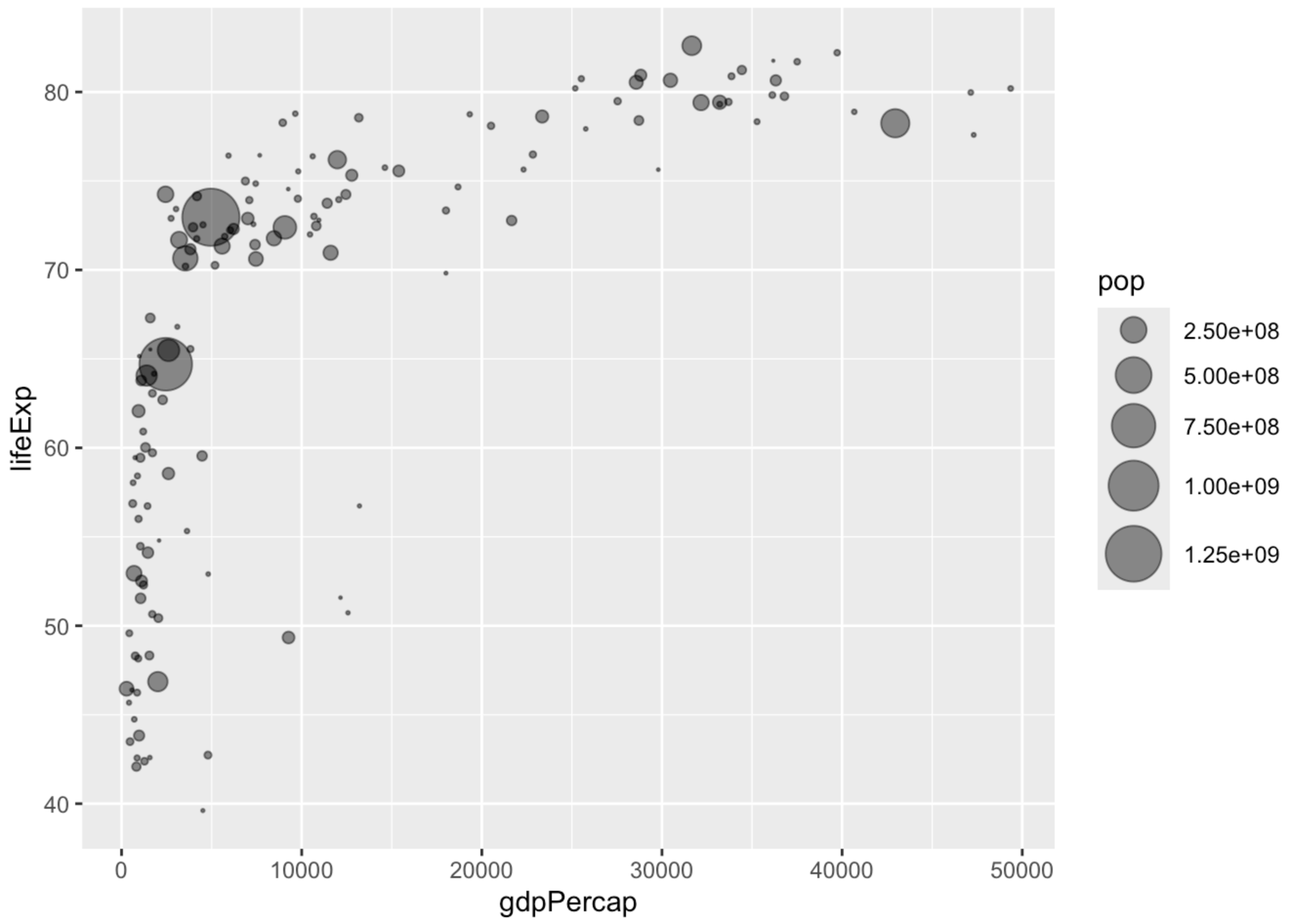
```r
# This is how it looks like if we color the points by the numeric variable popula
ggplot(gapminder_2007) +
  aes(x = gdpPercap, y = lifeExp, color = pop) +
  geom_point(alpha=0.8)
```



```
# Adjusting point size
ggplot(gapminder_2007) +
  aes(x = gdpPercap, y = lifeExp, size = pop) +
  geom_point(alpha=0.5)
```

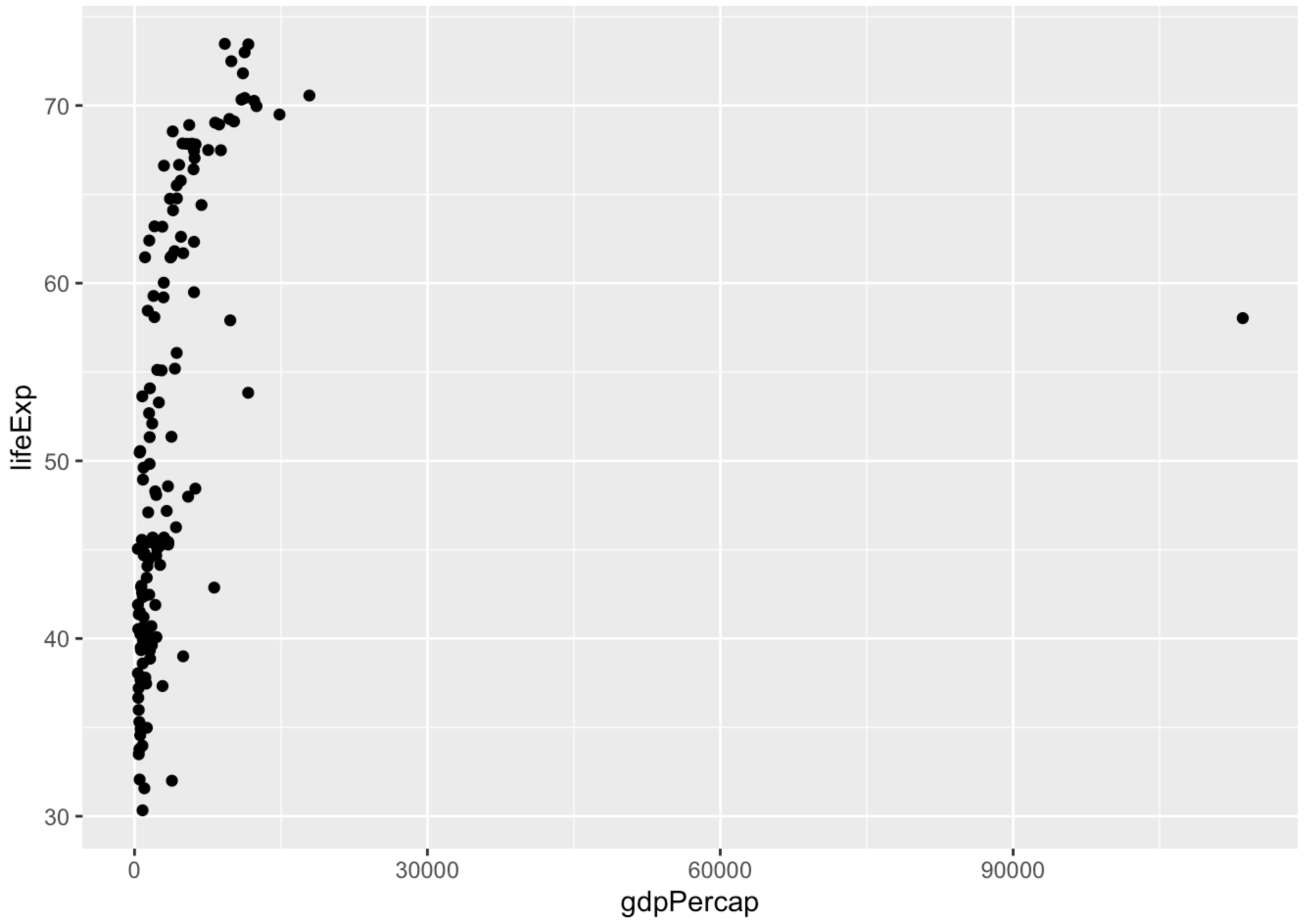


```
# Add scaling information, to reflect the actual population differences by the pc
ggplot(gapminder_2007) +
  geom_point(aes(x = gdpPercap, y = lifeExp,
                 size = pop), alpha=0.5) +
  scale_size_area(max_size = 10)
```

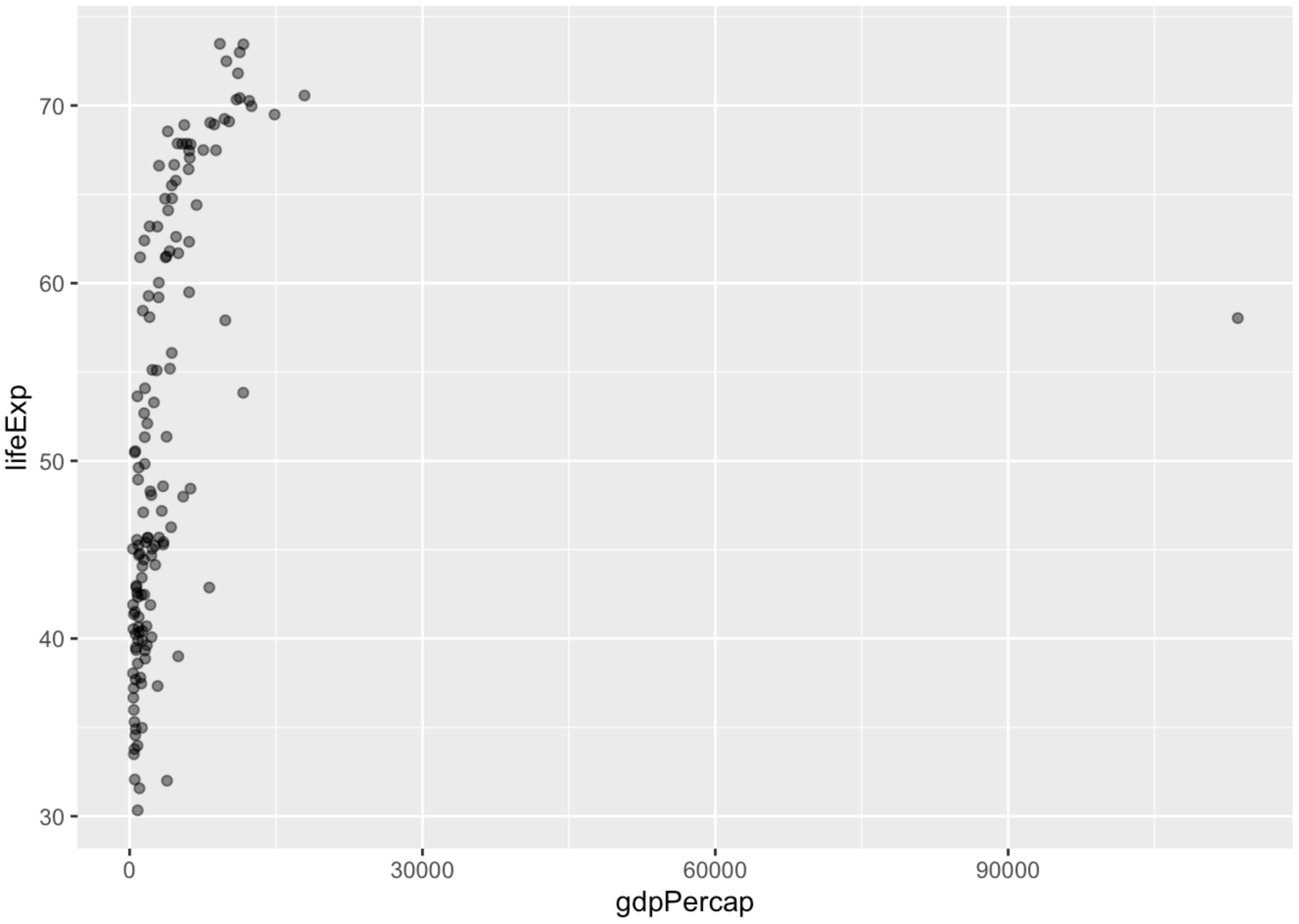


Now make the plot for year 1957

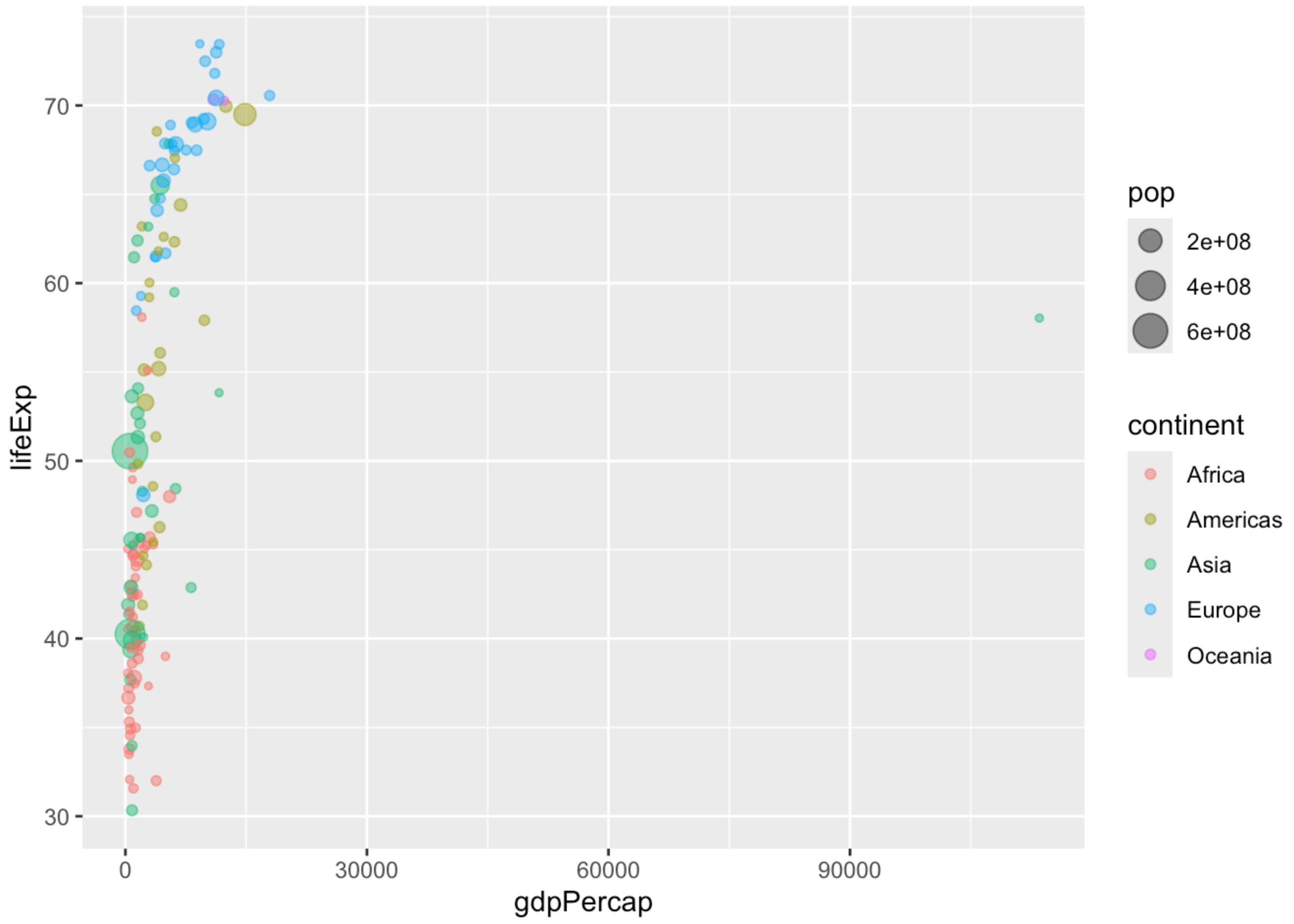
```
# Install
library(gapminder)

# Extra, will talk about this next week
library(dplyr)
gapminder_1957 <- gapminder %>% filter(year==1957)

# Plot
ggplot(gapminder_1957) +
  aes(x=gdpPercap, y=lifeExp) +
  geom_point()
```



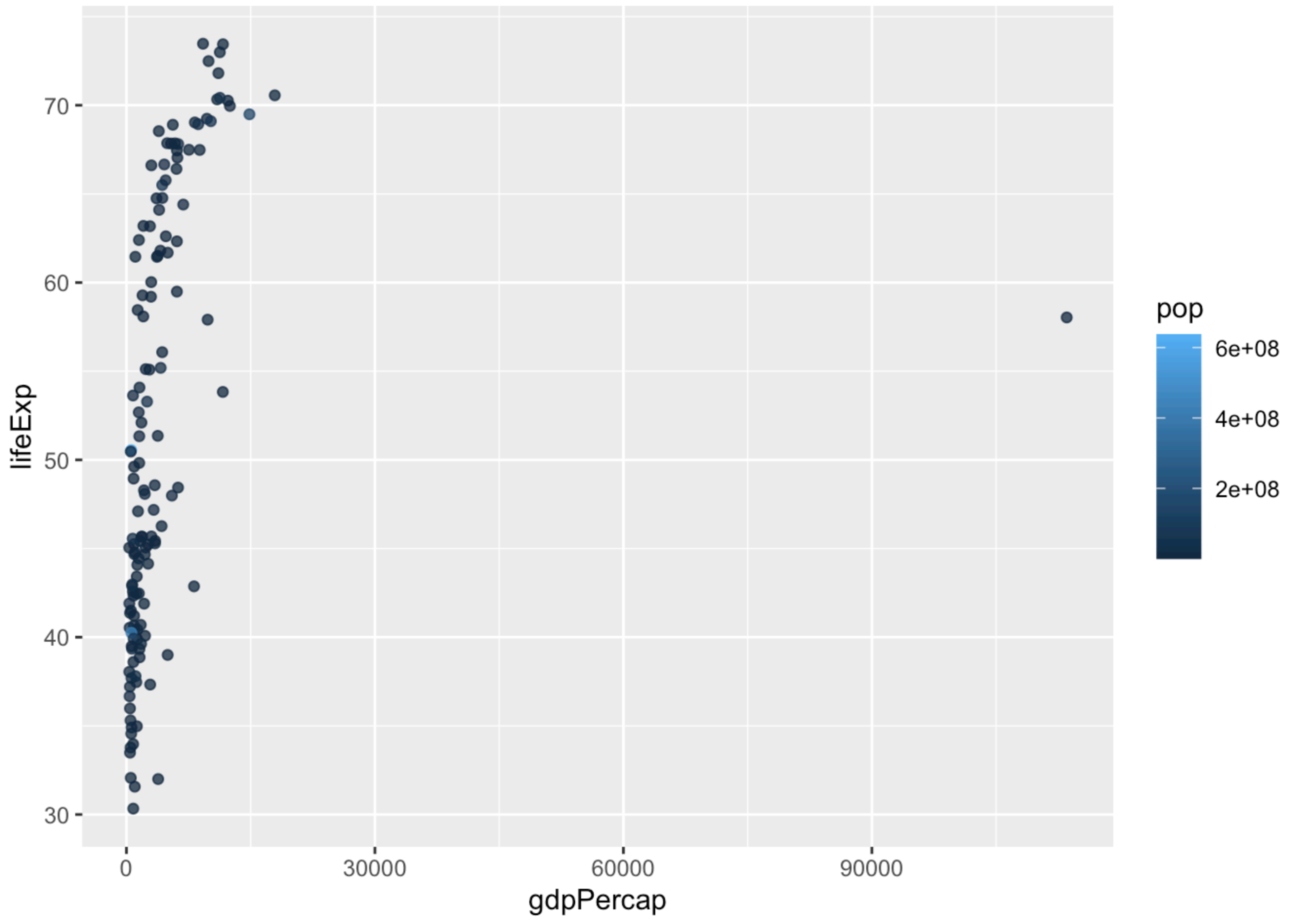
```
# Plot to have less points on top of eachother
ggplot(gapminder_1957) +
  aes(x=gdpPercap, y=lifeExp) +
  geom_point(alpha=0.5)
```



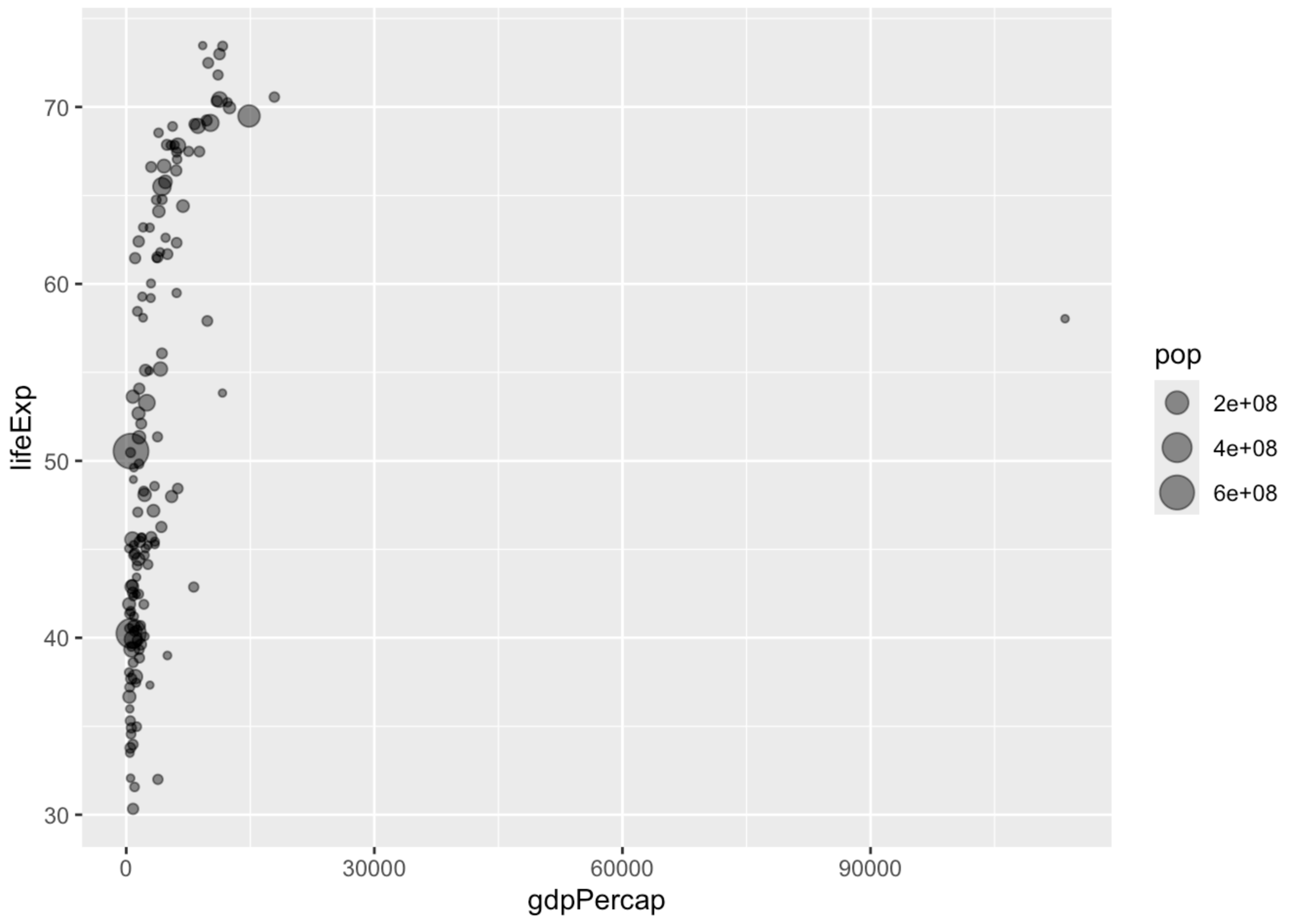
```
# Adding more variables to aes()
ggplot(gapminder_1957) +
  aes(x=gdpPercap, y=lifeExp, color=continent, size=pop) +
  geom_point(alpha=0.5)
```



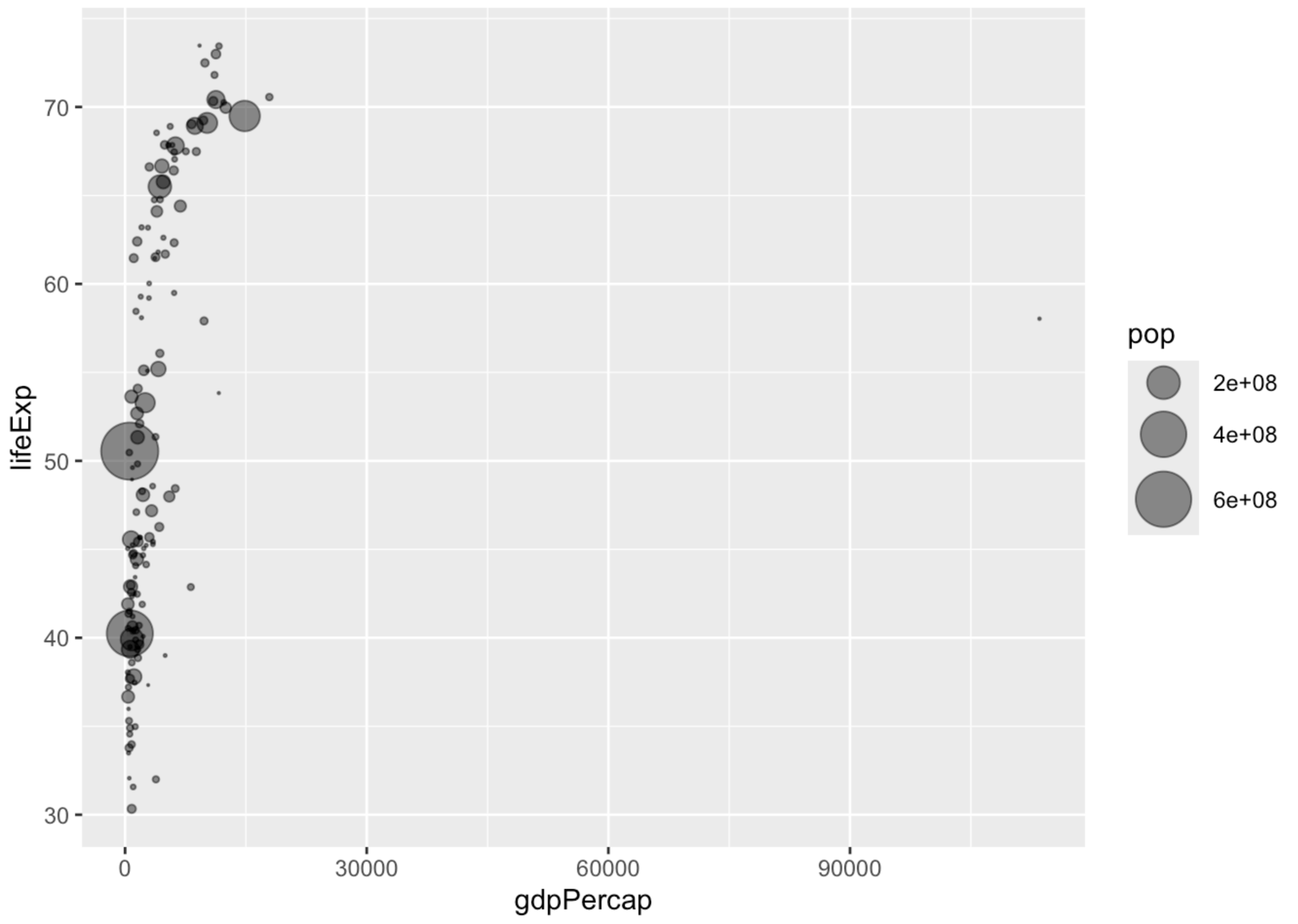
```r
# This is how it looks like if we color the points by the numeric variable popula
ggplot(gapminder_1957) +
  aes(x = gdpPercap, y = lifeExp, color = pop) +
  geom_point(alpha=0.8)
```



```
# Adjusting point size
ggplot(gapminder_1957) +
  aes(x = gdpPercap, y = lifeExp, size = pop) +
  geom_point(alpha=0.5)
```

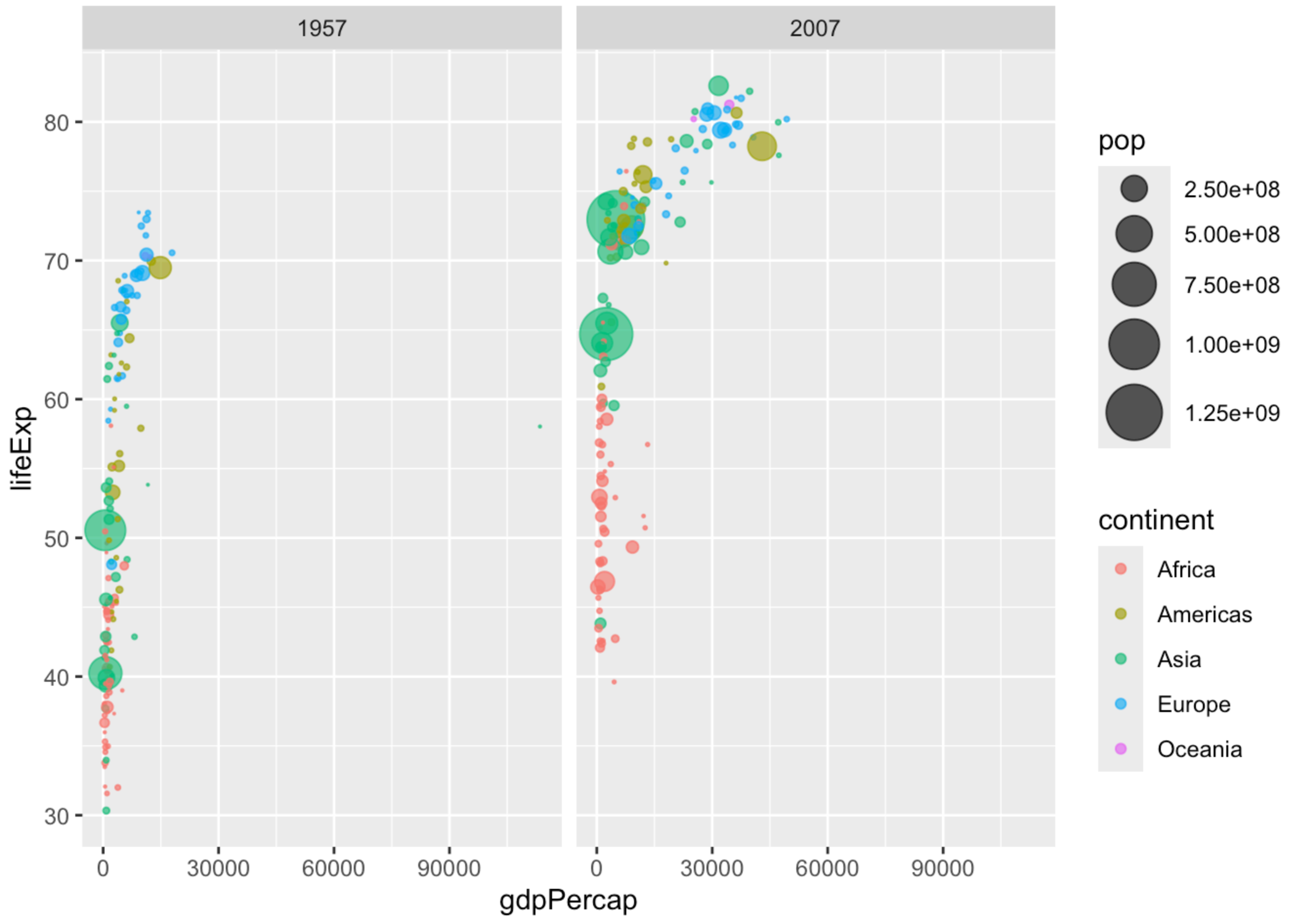


```
# Add scaling information, to reflect the actual population differences by the pc
ggplot(gapminder_1957) +
  geom_point(aes(x = gdpPercap, y = lifeExp,
                 size = pop), alpha=0.5) +
  scale_size_area(max_size = 10)
```



Now make a summarizing plot

```
gapminder_1957 <- gapminder %>% filter(year==1957 | year==2007)

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)
```

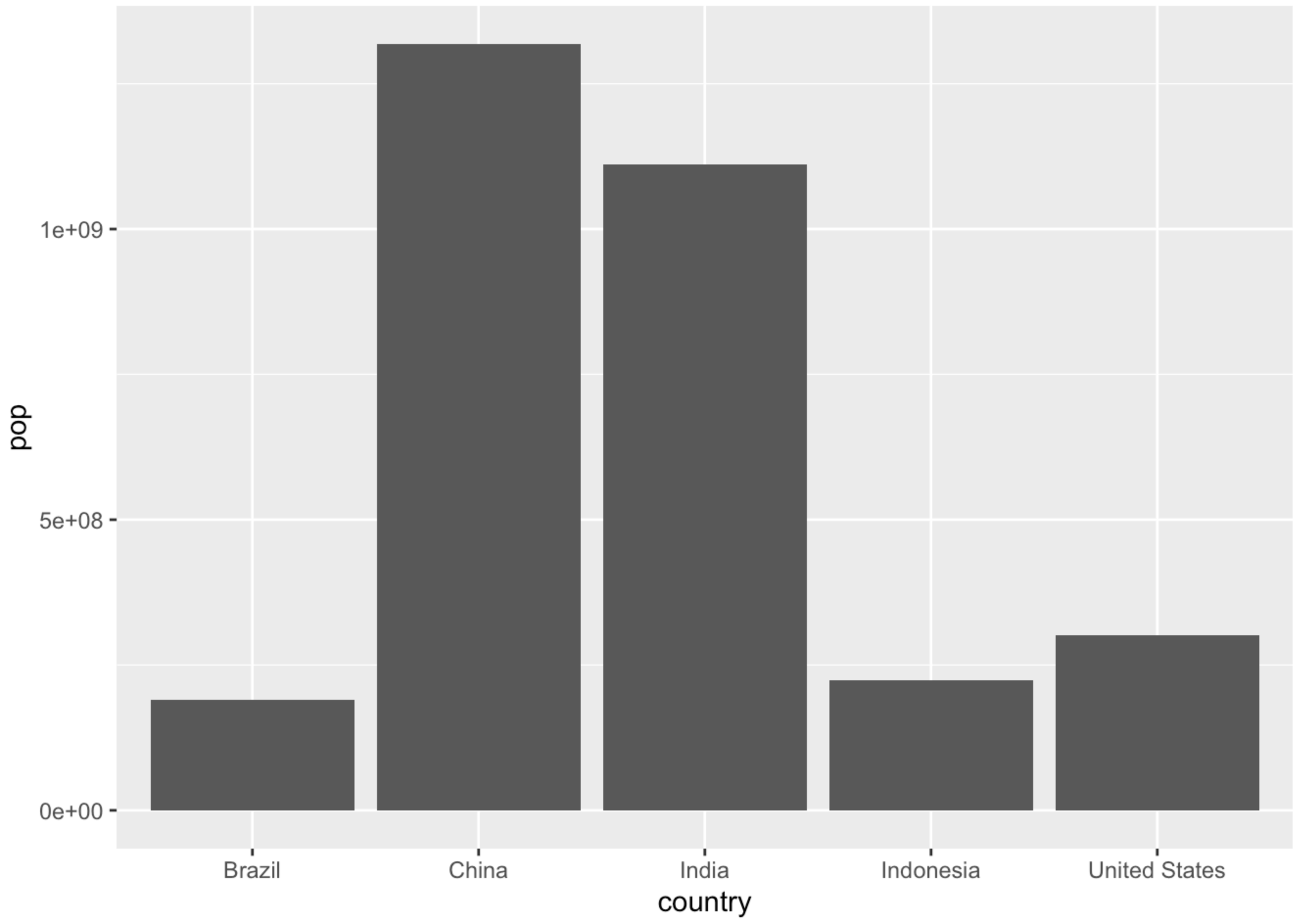


Optional: Bar Charts

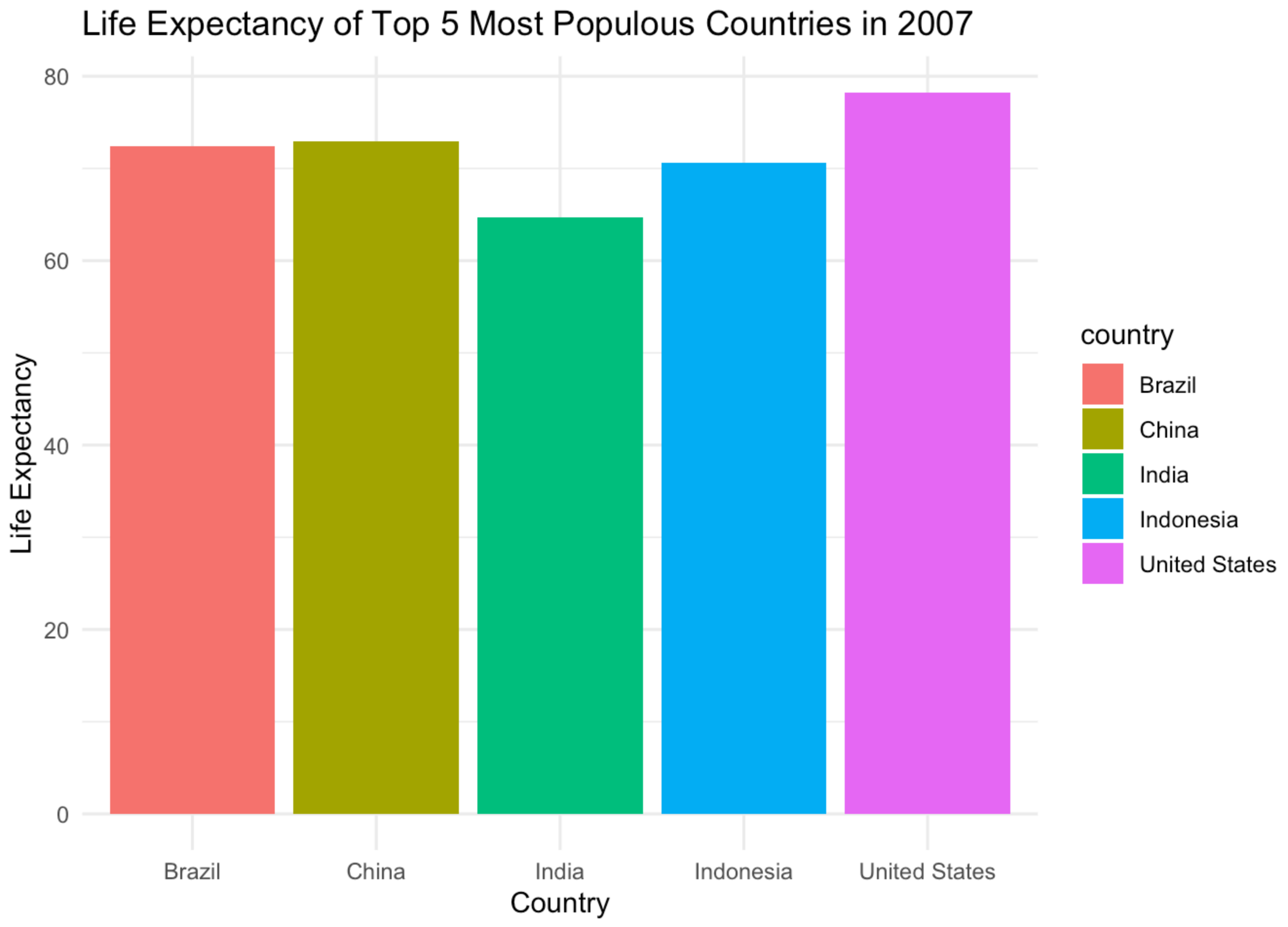
```r
gapminder_top5 <- gapminder %>%
  filter(year==2007) %>%
  arrange(desc(pop)) %>%
  top_n(5, pop)

gapminder_top5
```

```
# A tibble: 5 × 6
  country       continent  year lifeExp        pop gdpPercap
  <fct>         <fct>     <int>   <dbl>      <int>     <dbl>
1 China         Asia       2007    73.0 1318683096     4959.
2 India         Asia       2007    64.7 1110396331     2452.
3 United States Americas   2007    78.2  301139947    42952.
4 Indonesia     Asia       2007    70.6  223547000     3541.
5 Brazil        Americas   2007    72.4  190010647     9066.
```

```r
# Creating a simple bar chart
ggplot(gapminder_top5) +
  geom_col(aes(x = country, y = pop))
```

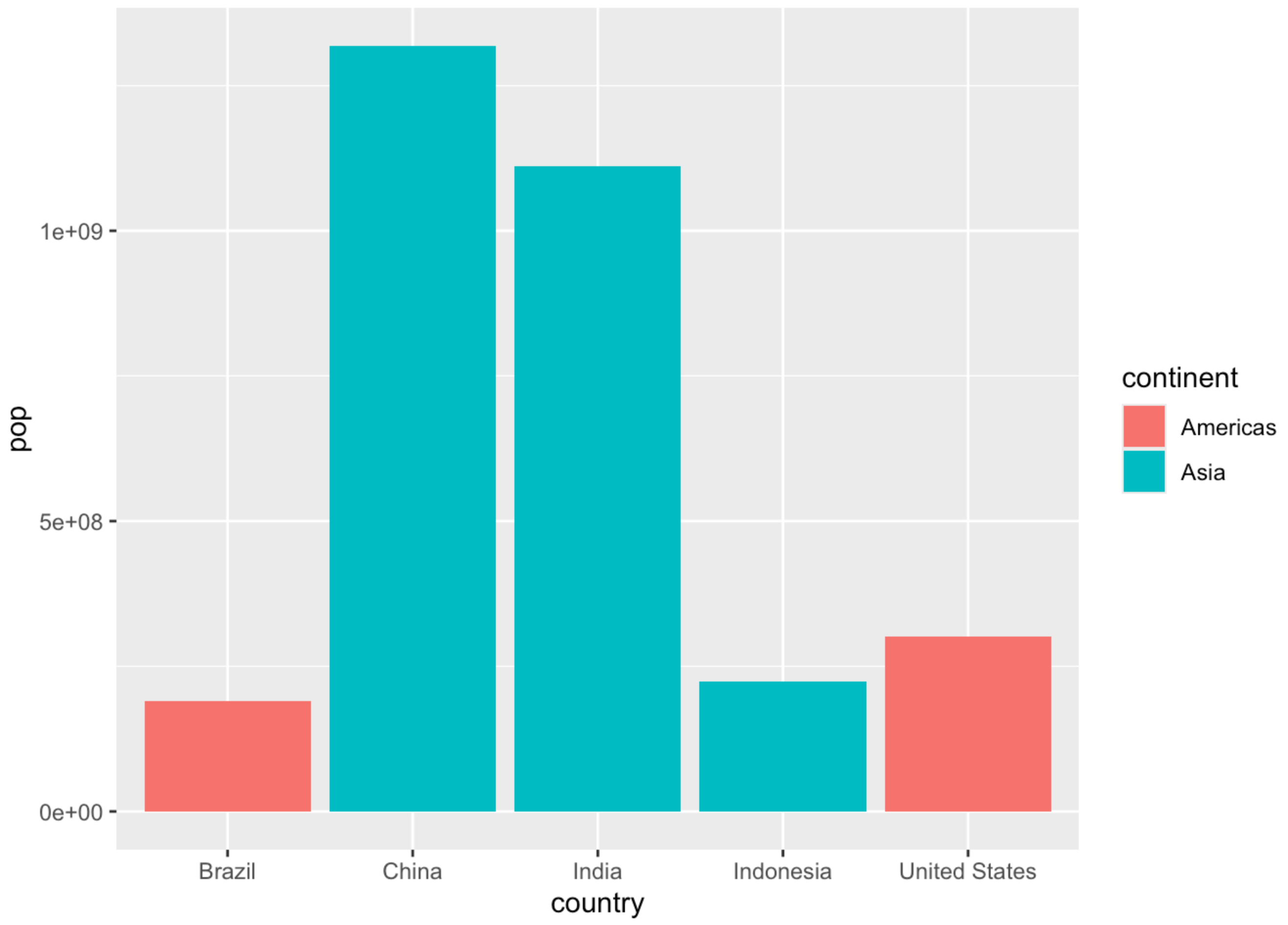


```r
# Create a bar chart showing the life expectancy of the five biggest countries by
ggplot(gapminder_top5) +
  geom_col(aes(x = country, y = lifeExp, fill = country)) +
  labs(title = "Life Expectancy of Top 5 Most Populous Countries in 2007",
       x = "Country",
       y = "Life Expectancy") +
  theme_minimal()
```

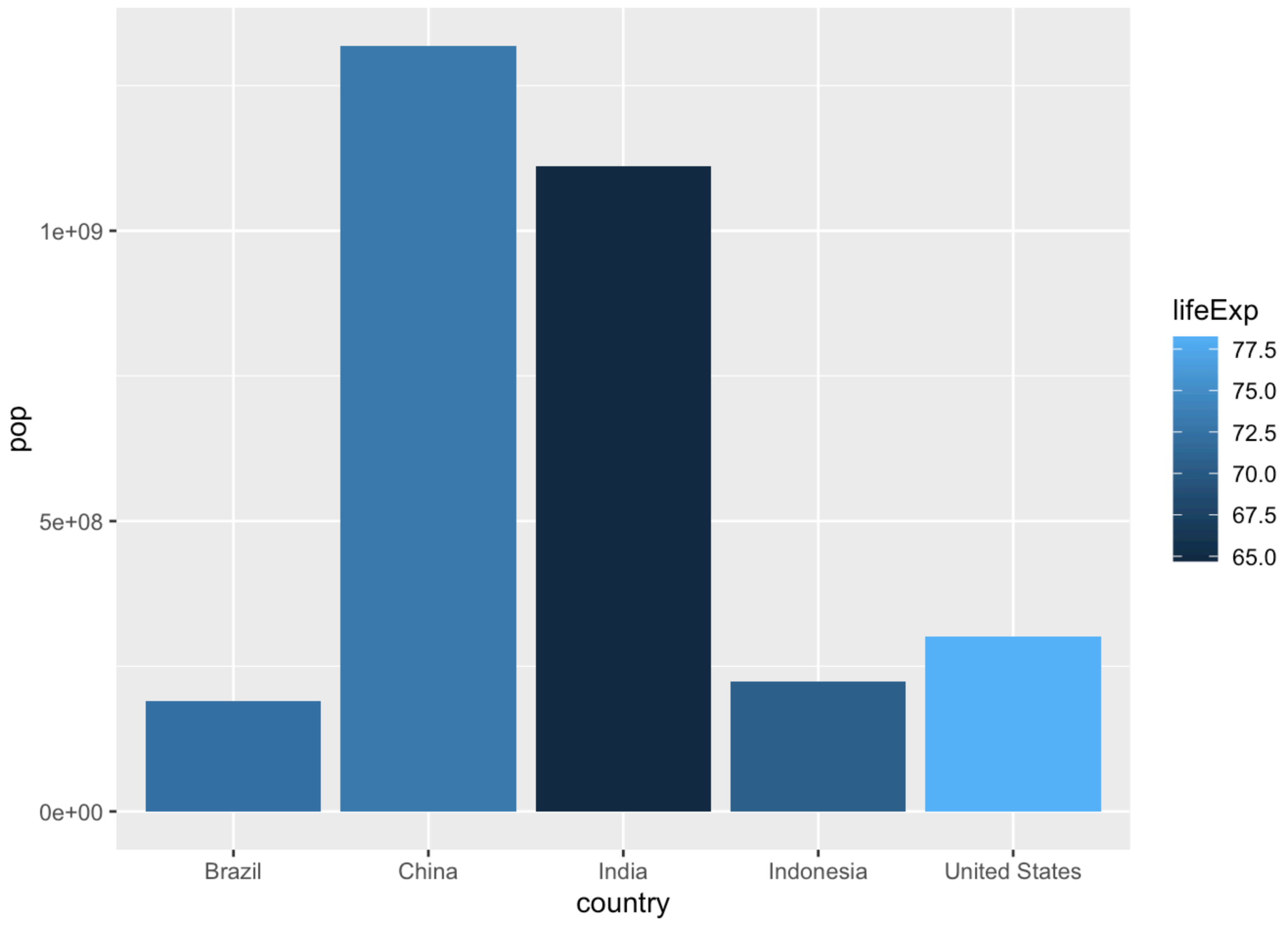


Filling bars with color

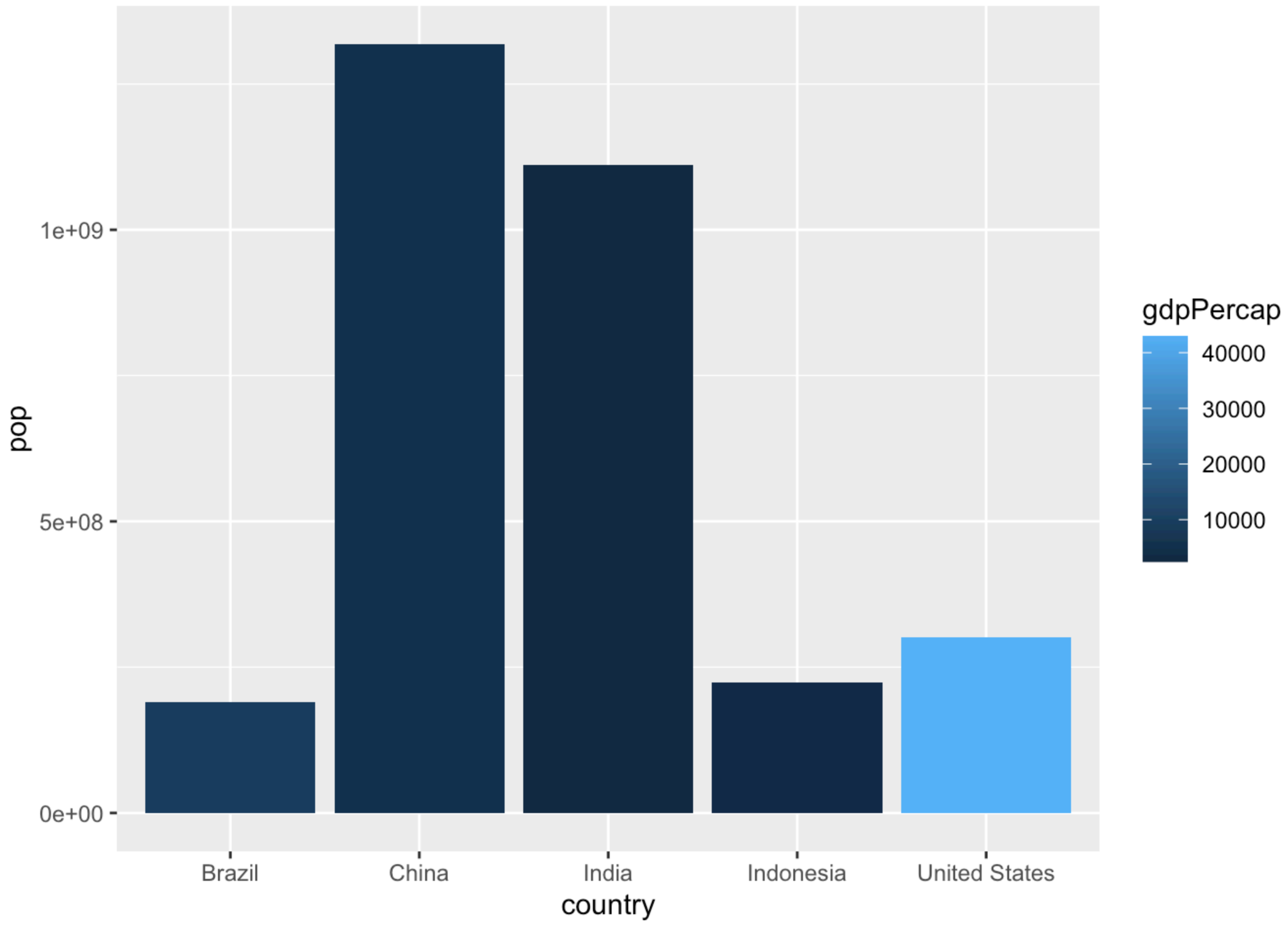
```
ggplot(gapminder_top5) +
  geom_col(aes(x = country, y = pop, fill = continent))
```



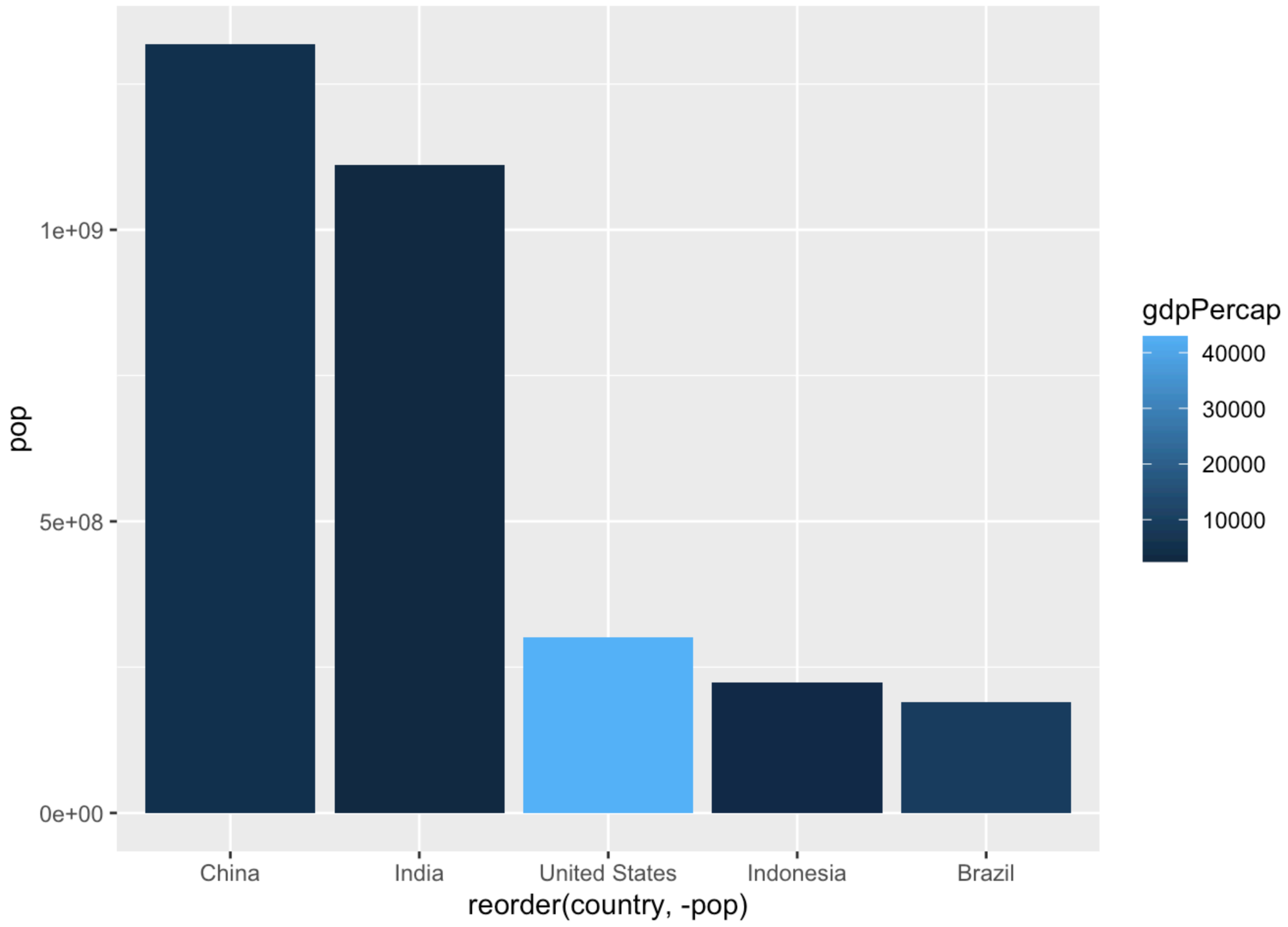
```
ggplot(gapminder_top5) +
  geom_col(aes(x = country, y = pop, fill = lifeExp))
```



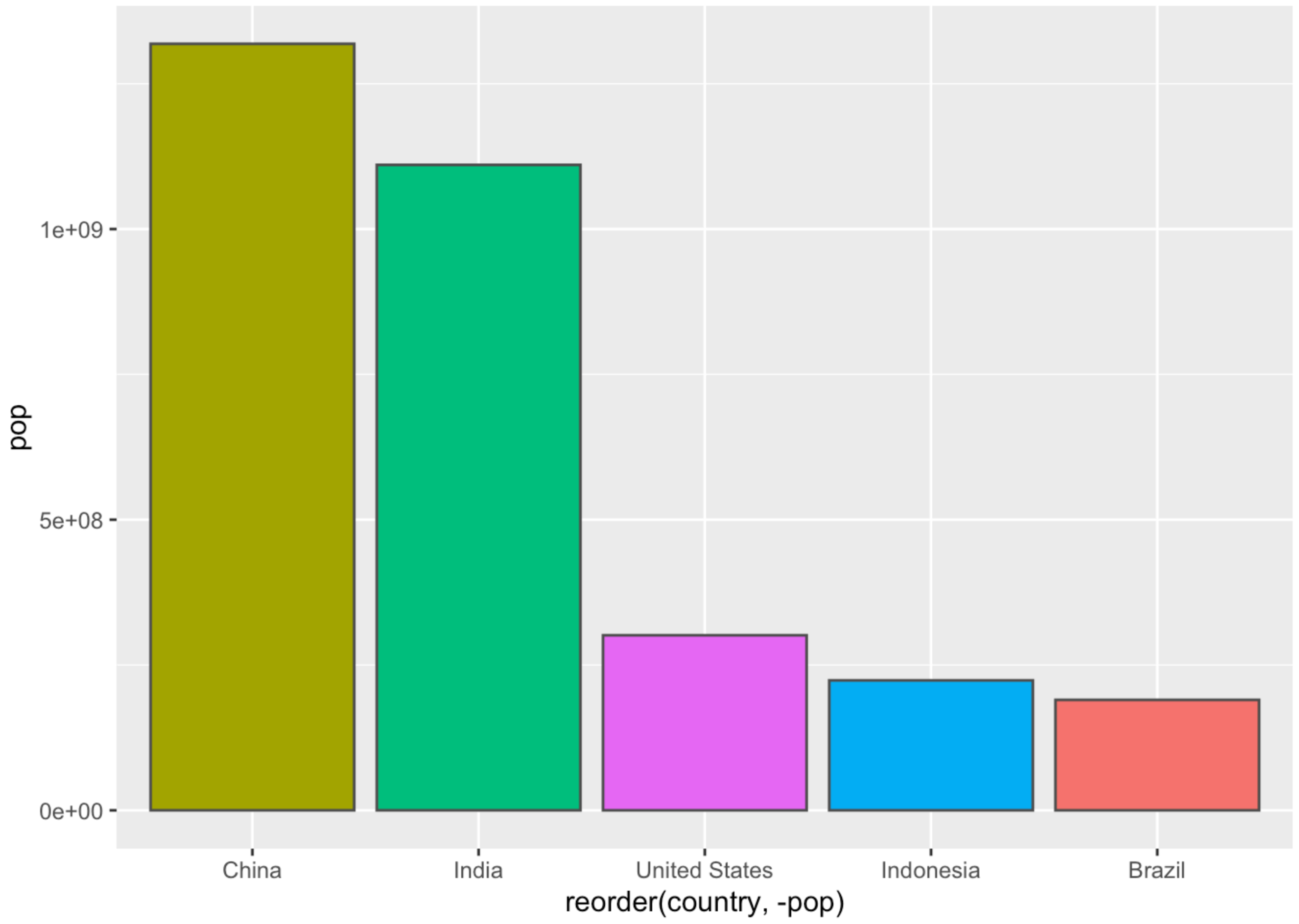
```
ggplot(gapminder_top5) +
  aes(x=country, y=pop, fill=gdpPercap) +
  geom_col()
```



```
# Change order of the bars
ggplot(gapminder_top5) +
  aes(x=reorder(country, -pop), y=pop, fill=gdpPercap) +
  geom_col()
```



```
# Fill by country
ggplot(gapminder_top5) +
  aes(x=reorder(country, -pop), y=pop, fill=country) +
  geom_col(col="gray30") +
  guides(fill="none")
```

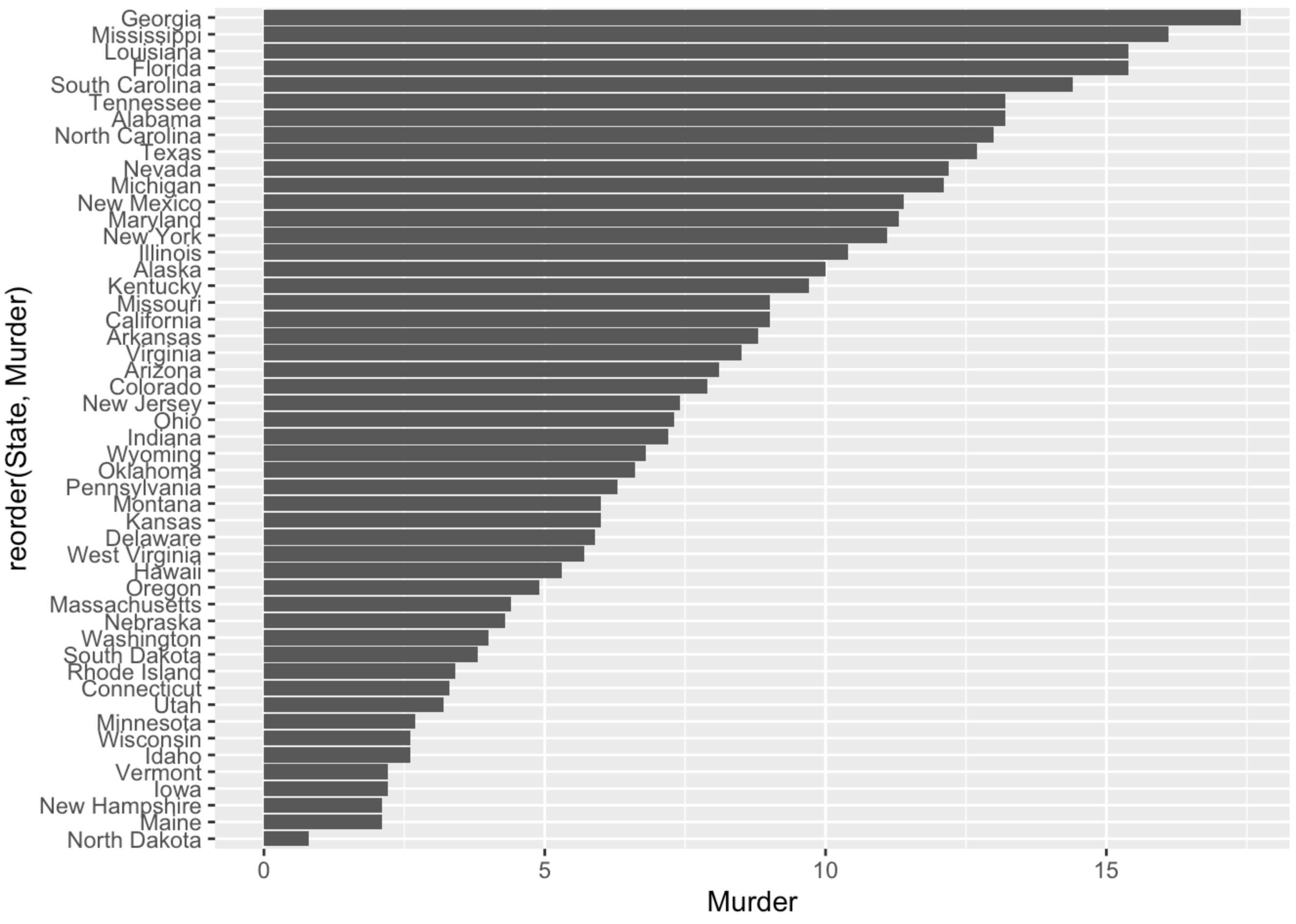


Flipping bar charts

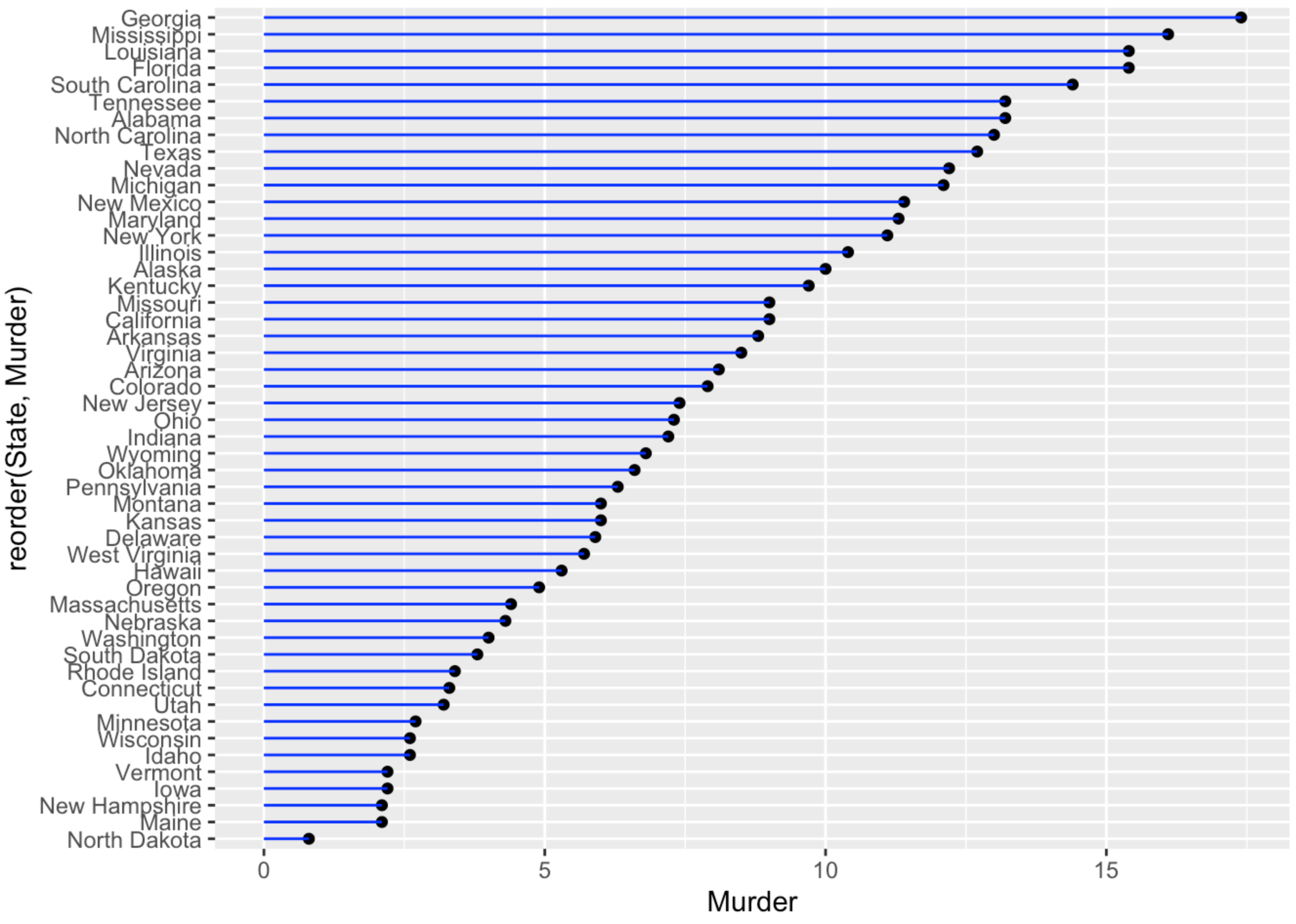
```
head(USArrests)
```

```
           Murder Assault UrbanPop Rape
Alabama      13.2     236       58 21.2
Alaska       10.0     263       48 44.5
Arizona       8.1     294       80 31.0
Arkansas      8.8     190       50 19.5
California    9.0     276       91 40.6
Colorado      7.9     204       78 38.7
```

```
USArrests$State <- rownames(USArrests)
ggplot(USArrests) +
  aes(x=reorder(State,Murder), y=Murder) +
  geom_col() +
  coord_flip()
```



```r
# This looks crowded
ggplot(USArrests) +
  aes(x=reorder(State,Murder), y=Murder) +
  geom_point() +
  geom_segment(aes(x=State,
                  xend=State,
                  y=0,
                  yend=Murder), color="blue") +
  coord_flip()
```



Extensions: Animation

```
install.packages("gifski")
```

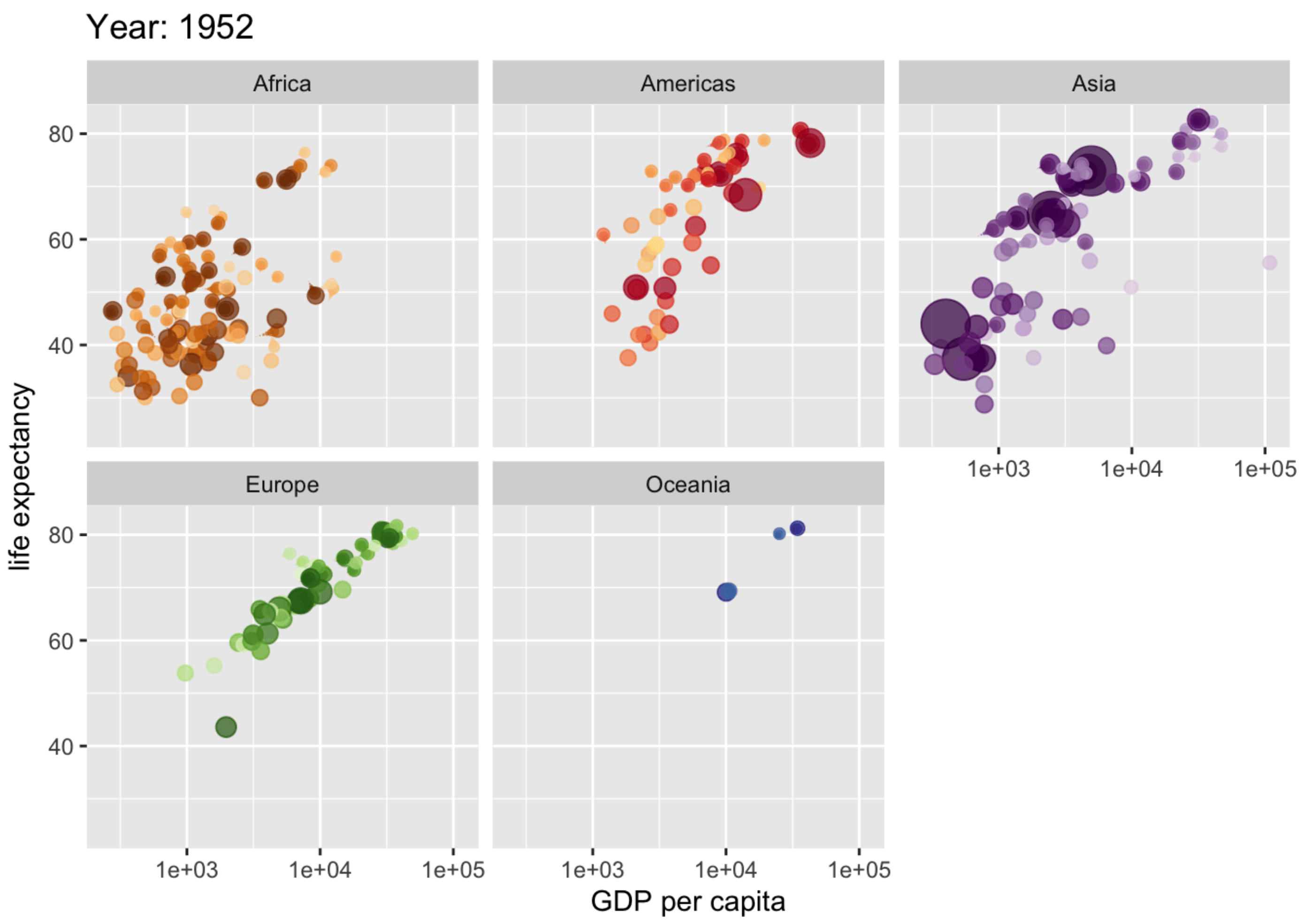
```
The downloaded binary packages are in
	/var/folders/wc/y60y10bj5jz0zzxkrq739z580000gn/T//RtmpHn5Taf/downloaded_packages
```

```
install.packages("gganimate")
```

```
The downloaded binary packages are in
	/var/folders/wc/y60y10bj5jz0zzxkrq739z580000gn/T//RtmpHn5Taf/downloaded_packages
```

```
library(gapminder)
library(gganimate)

# Setup nice regular ggplot of the gapminder data
ggplot(gapminder, aes(gdpPercap, lifeExp, size = pop, colour = country)) +
  geom_point(alpha = 0.7, show.legend = FALSE) +
  scale_colour_manual(values = country_colors) +
```

```r
  scale_size(range = c(2, 12)) +
  scale_x_log10() +
  # Facet by continent
  facet_wrap(~continent) +
  # Here comes the gganimate specific bits
  labs(title = 'Year: {frame_time}', x = 'GDP per capita', y = 'life expectancy')
  transition_time(year) +
  shadow_wake(wake_length = 0.1, alpha = FALSE)
```

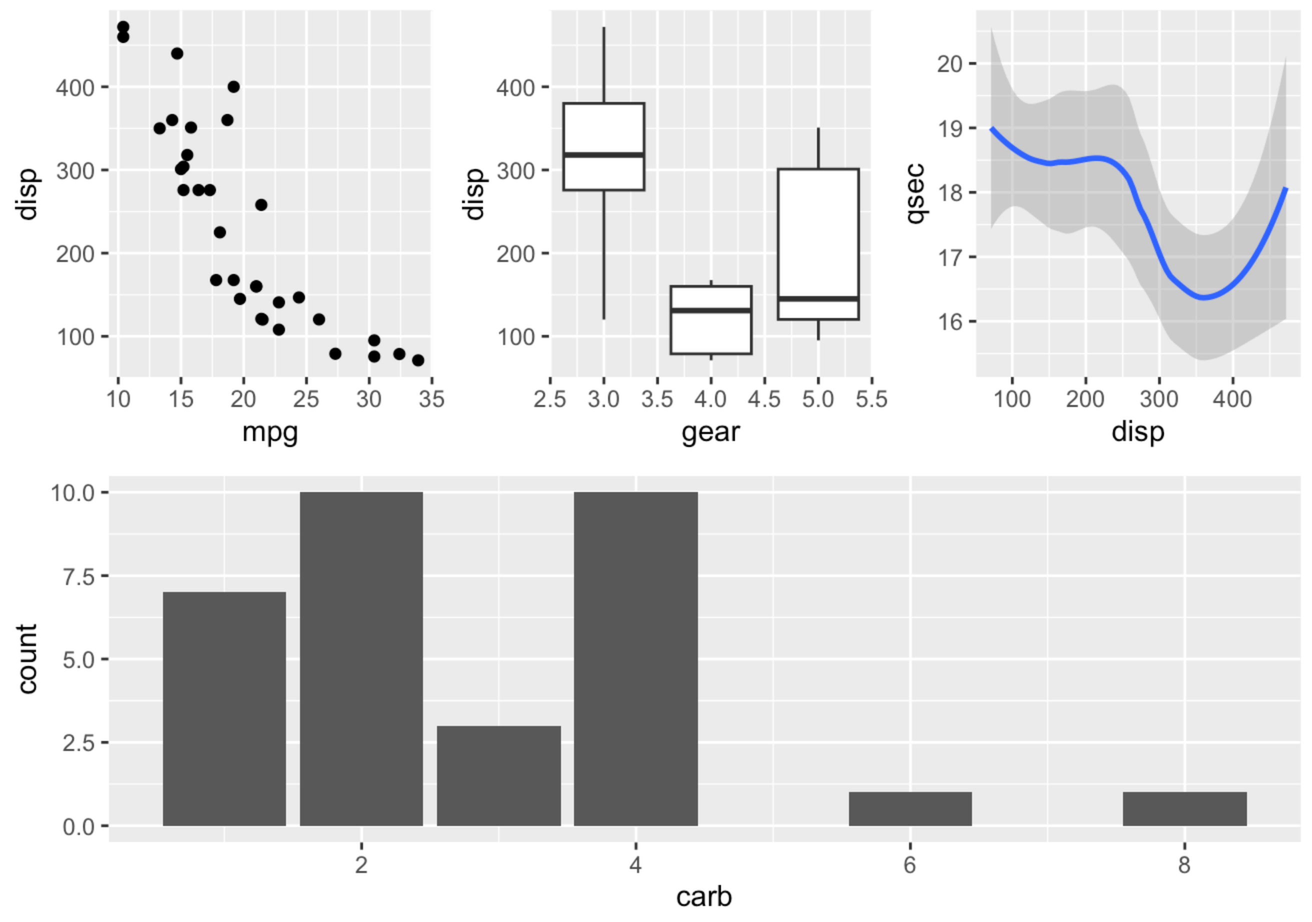


Combining plots

```r
library(patchwork)

# Setup some example plots
p1 <- ggplot(mtcars) + geom_point(aes(mpg, disp))
p2 <- ggplot(mtcars) + geom_boxplot(aes(gear, disp, group = gear))
p3 <- ggplot(mtcars) + geom_smooth(aes(disp, qsec))
p4 <- ggplot(mtcars) + geom_bar(aes(carb))

# Use patchwork to combine them here:
```

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

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



SessionInfo

```
sessionInfo()
```

```
R version 4.3.2 (2023-10-31)
Platform: aarch64-apple-darwin20 (64-bit)
Running under: macOS 15.0.1

Matrix products: default
BLAS:   /Library/Frameworks/R.framework/Versions/4.3-arm64/Resources/lib/libRblas.0.dylib
LAPACK: /Library/Frameworks/R.framework/Versions/4.3-
arm64/Resources/lib/libRlapack.dylib;  LAPACK version 3.11.0

locale:
[1] en_US.UTF-8/en_US.UTF-8/en_US.UTF-8/C/en_US.UTF-8/en_US.UTF-8

time zone: America/Los_Angeles
```

```
tzcode source: internal

attached base packages:
[1] stats     graphics  grDevices utils     datasets  methods   base     

other attached packages:
[1] patchwork_1.2.0 gganimate_1.0.9 dplyr_1.1.4     gapminder_1.0.0
[5] ggrepel_0.9.5   ggplot2_3.5.1  

loaded via a namespace (and not attached):
 [1] Matrix_1.6-5      gtable_0.3.5      jsonlite_1.8.8    crayon_1.5.3     
 [5] compiler_4.3.2    tidyselect_1.2.1  Rcpp_1.0.13       progress_1.2.3   
 [9] splines_4.3.2     scales_1.3.0      yaml_2.3.10       fastmap_1.2.0    
[13] lattice_0.21-9    R6_2.5.1          labeling_0.4.3    generics_0.1.3   
[17] knitr_1.48        htmlwidgets_1.6.4 tibble_3.2.1      munsell_0.5.1    
[21] pillar_1.9.0      rlang_1.1.4       utf8_1.2.4        stringi_1.8.4    
[25] xfun_0.47         cli_3.6.3         tweenr_2.0.3      withr_3.0.1      
[29] magrittr_2.0.3    mgcv_1.9-1        digest_0.6.37     grid_4.3.2       
[33] rstudioapi_0.16.0 hms_1.1.3         lifecycle_1.0.4   nlme_3.1-163     
[37] prettyunits_1.2.0 vctrs_0.6.5       evaluate_0.24.0   glue_1.7.0       
[41] farver_2.1.2      gifski_1.32.0-1   fansi_1.0.6       colorspace_2.1-1 
[45] rmarkdown_2.28    tools_4.3.2       pkgconfig_2.0.3   htmltools_0.5.8.1
```