# Class 5: Data Viz with ggplot

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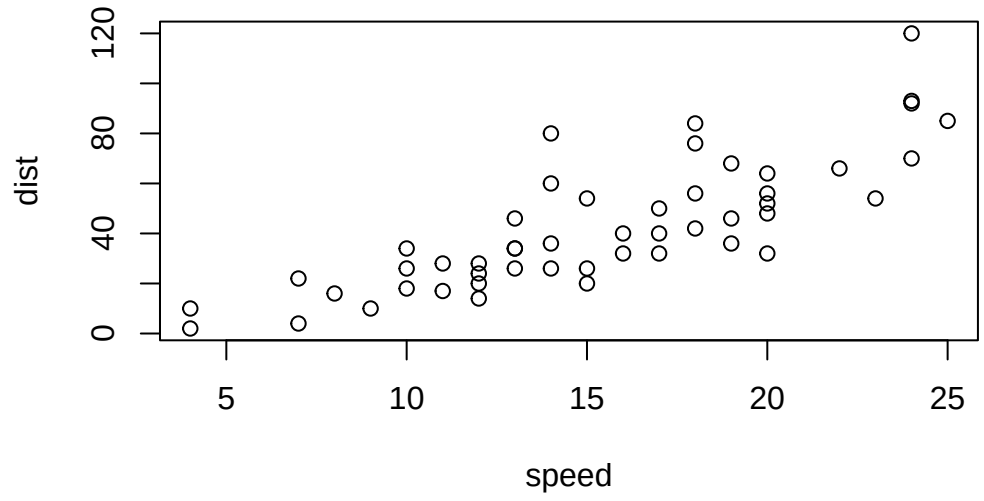
### Plotting in R

R has lots of ways to make plots and figures. This includes so-called **base** graphics and packages like **ggplot2**

```
plot(cars)
```




This is a **base** R plot of the in-built `cars` dataset that has only two columns:

```
head(cars)
```

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

Q. How would we plot this wee dataset with **ggplot2**

All ggplot figures have at least 3 layers:

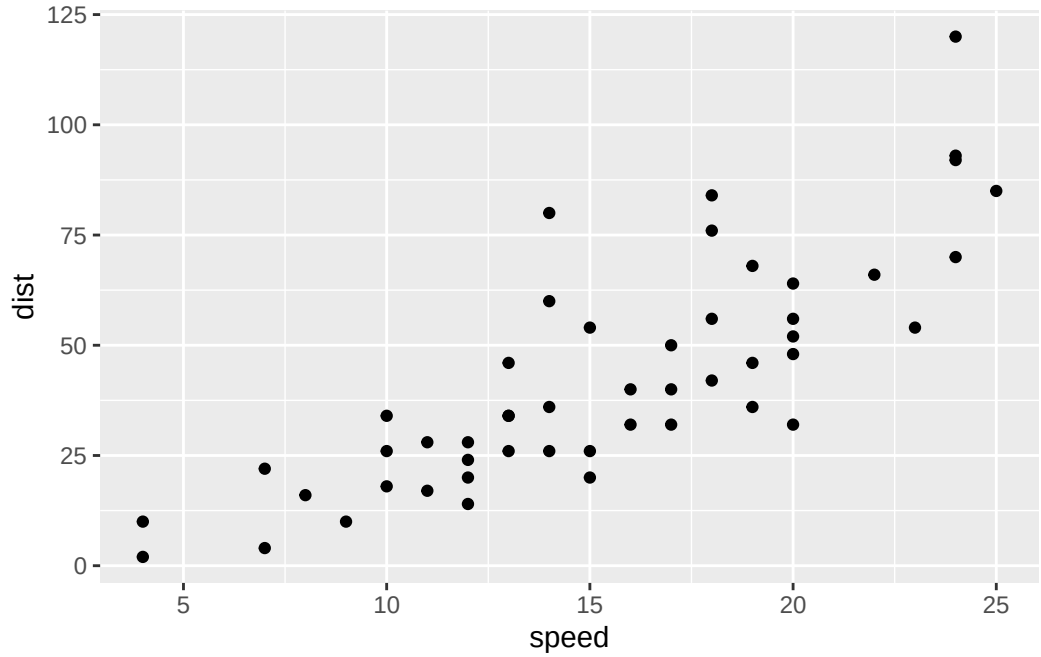
- **data**
- **aes**thetics (how the data map to the plot)
- **geom**try (how we draw the plot, line, points, etc)

Before I use any new package I need to download and install it with the `install.packages()` command.

I never use `install.package()` within my quarto document otherwise I will install the package over and ocer and ocer again - which is silly!

Once a package is installed I can load it up with the `library()` function.

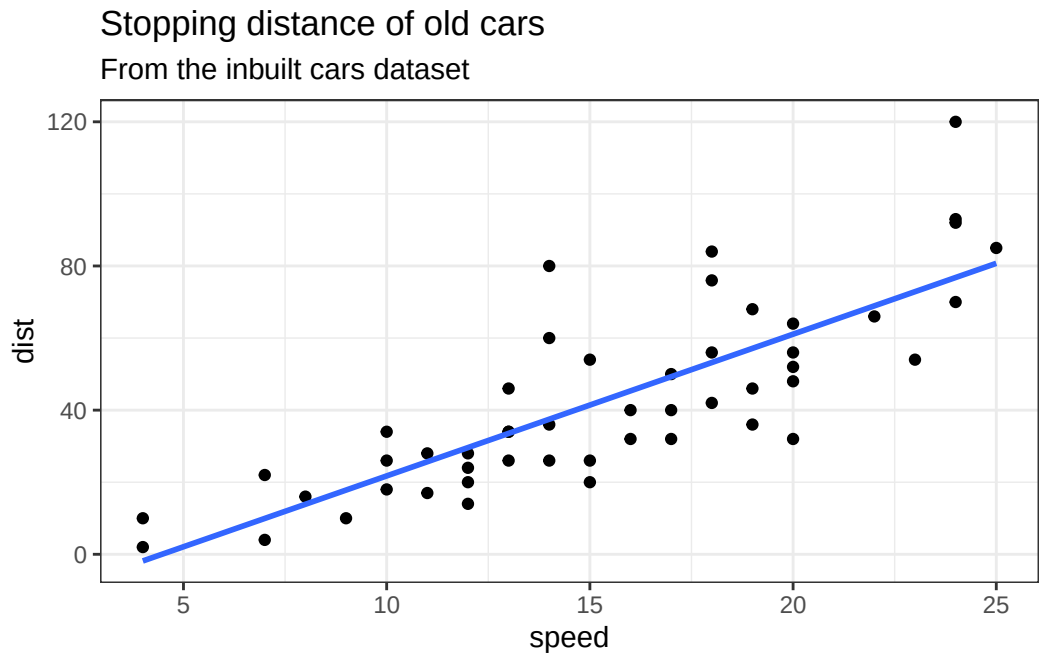
```
# install.packages("ggplot2")
library(ggplot2)
ggplot(cars) +
  aes(x=speed, y=dist) +
  geom_point()
```




Key-point: FOr simple plots (like the one above) ggplot is more verbose (we need to do more typing) but as plots get more complicated ggplot starts to be more clear and simplae than base R plot()

```
p <- ggplot(cars)  +
  aes(speed, dist) +
  geom_point() +
  geom_smooth(method = lm, se=FALSE) +
  labs(title="Stopping distance of old cars",
       subtitle = "From the inbuilt cars dataset") +
  theme_bw()
p
```

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




### Graph for expression analysis for anti-viral drugs

Calling up the data to plot

```
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
```

Finding number of rows, column, column names, number and fraction of up-regulated genes in dataset

```
nrow(genes)
```

```
[1] 5196
```

```
colnames(genes)
```

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

```
ncol(genes)
```

```
[1] 4
```

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

```
      down unchanging         up
        72       4997        127
```

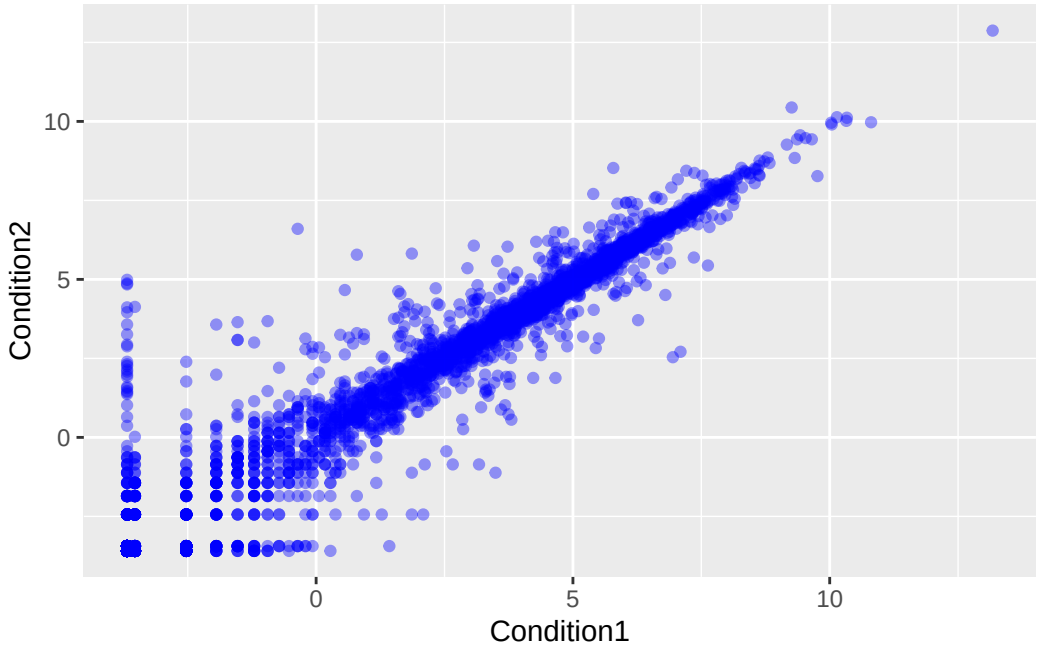
```
round(table(genes$State)/nrow(genes)*100,2)
```

```
      down unchanging         up
      1.39      96.17       2.44
```

The key functions here were: `nrow()` and `ncol` `table()` is very useful for getting counts finally `round()`

Plotting the two conditions against each other

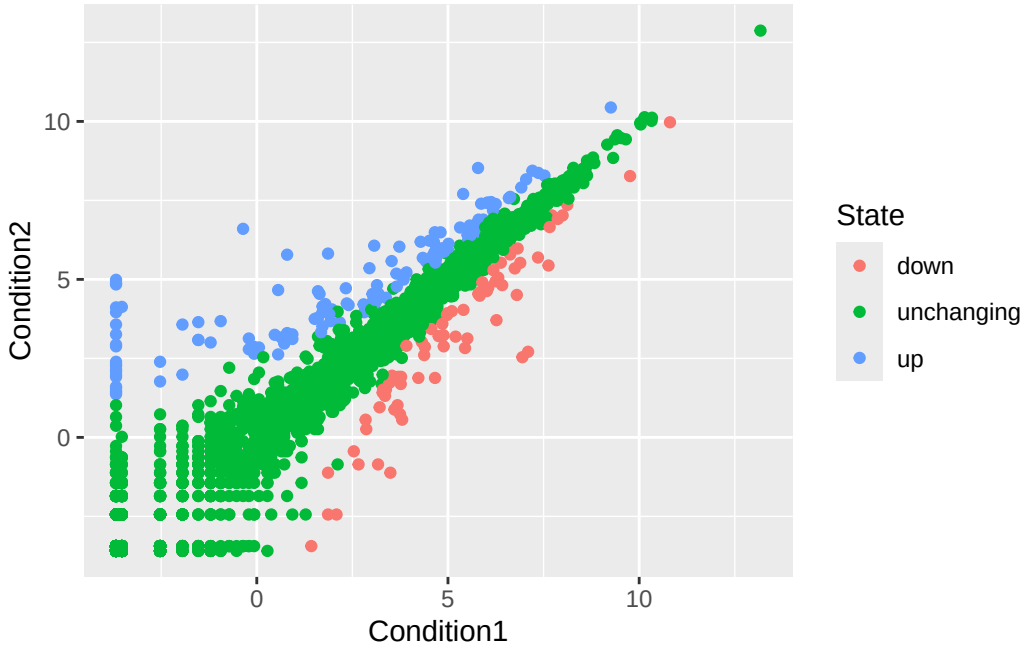
```
ggplot(genes) +
  aes(x=Condition1,y=Condition2) +
  geom_point(col="blue", alpha=0.4)
```




Note: The color function goes in the geom not aes section. Alph in the geom lets it be transparent.

Plotting with colors

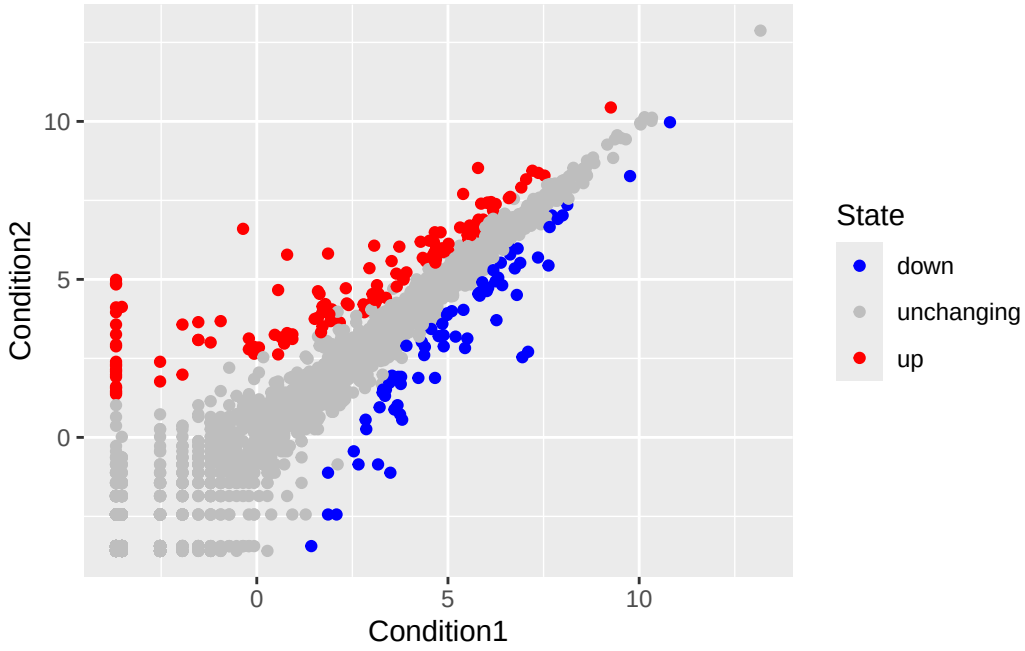
```
p <- ggplot(genes) +
    aes(x=Condition1, y=Condition2, col=State) +
    geom_point()
p
```




Note: col in aes function is showing and specifying the legend, because it is coming from the data.

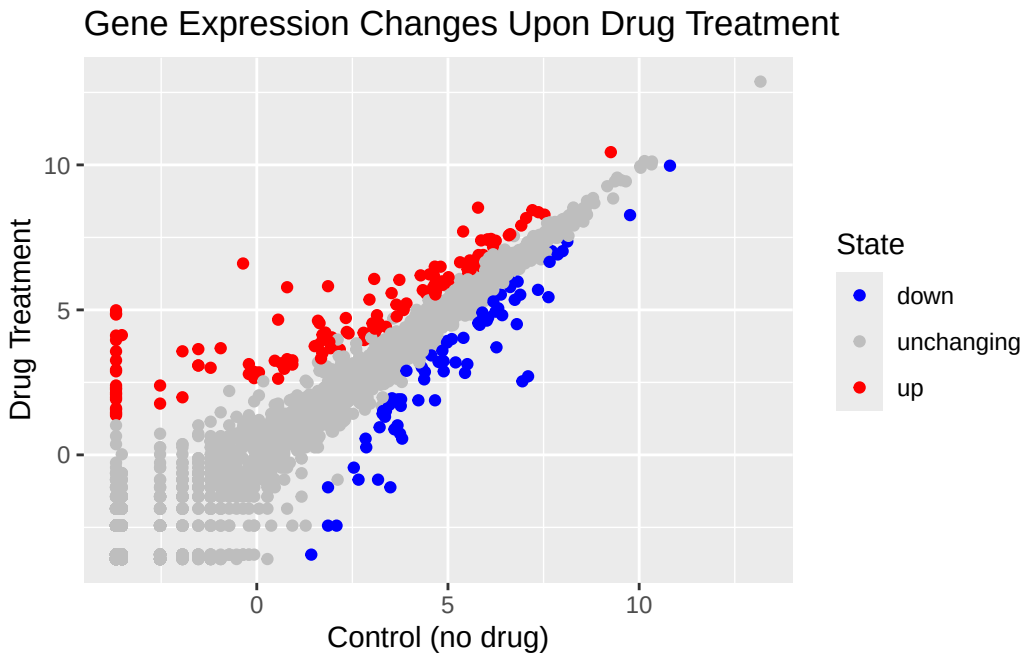
Specifying colors

```
p + scale_colour_manual( values=c("blue","gray","red") )
```




Labeling axis

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




## Section 7: Going Further

Can etiher install the package (`install.packages`("gapminder") `library`(gapminder)) or read from github

```
url <- "https://raw.githubusercontent.com/jennybc/gapminder/master/inst/extdata/gapminder.ts

gapminder <- read.delim(url)
```

To focus on a specific year, need to download the **dplyr** code

```
# install.packages("dplyr")
library(dplyr)
```

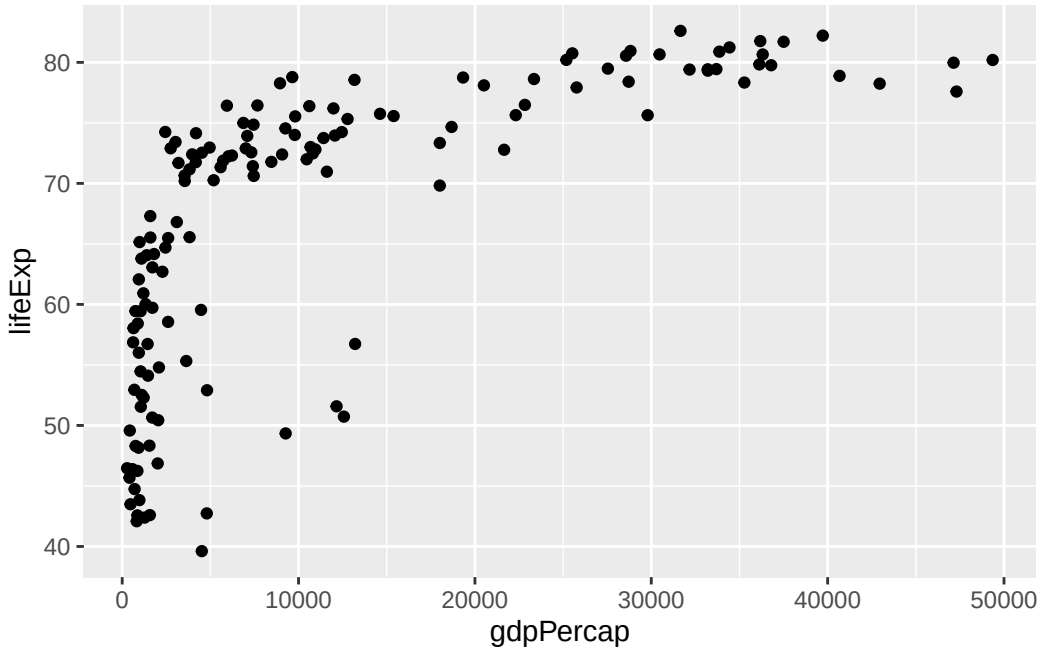
```
Attaching package: 'dplyr'

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)
```

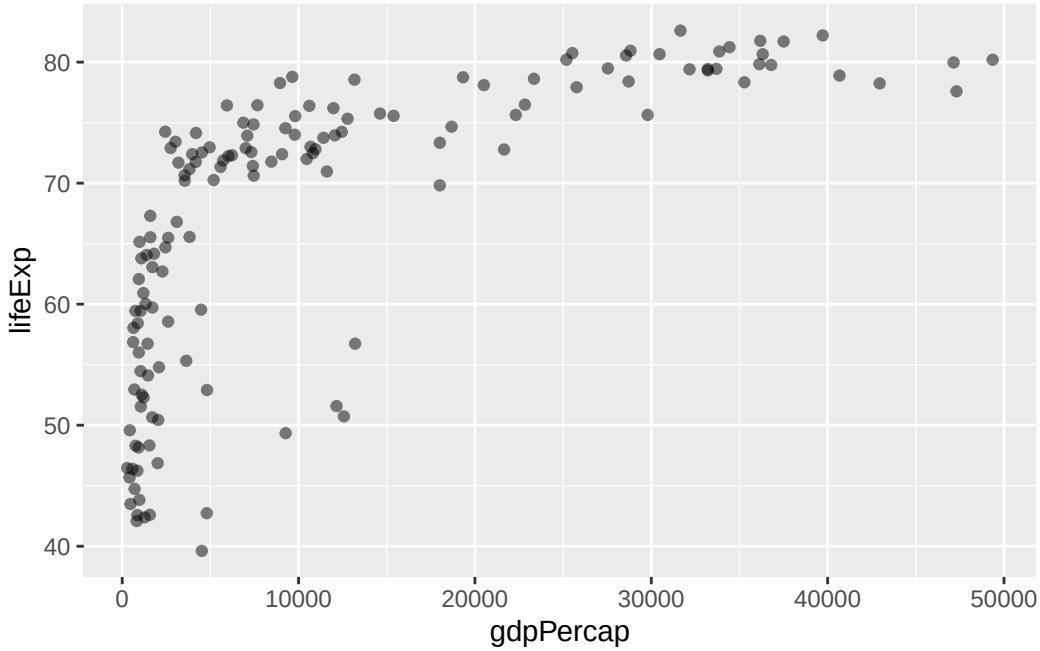
Creating scatterplot for gapminder_2007 data

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



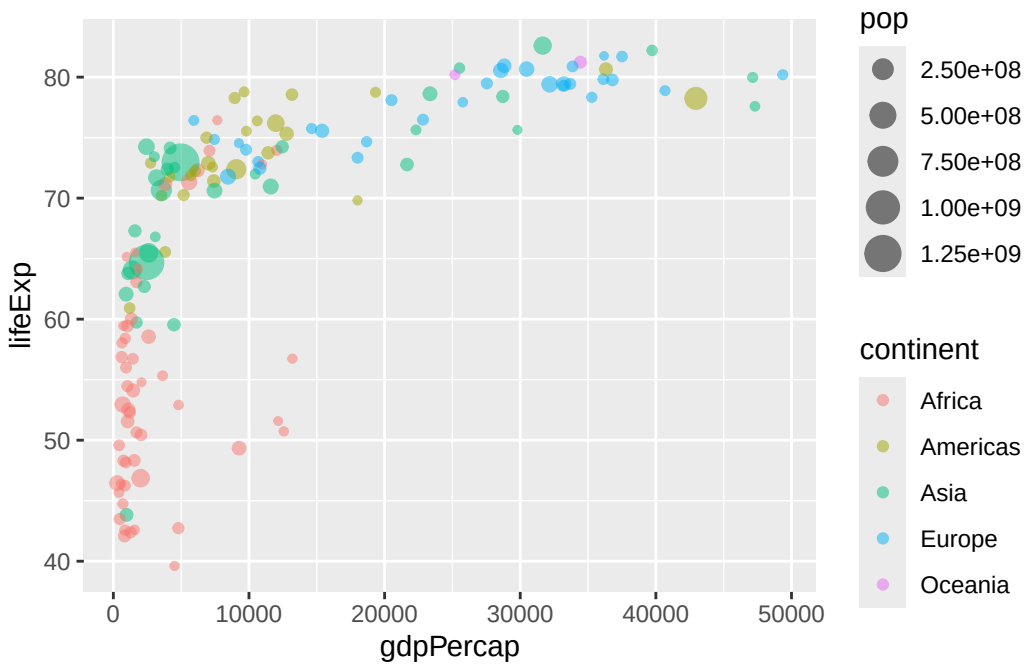

Making points transparent, use `alpha=` in the geom section

```
ggplot(gapminder_2007) +
  aes(x=gdpPercap, y=lifeExp) +
  geom_point(alpha=0.5)
```



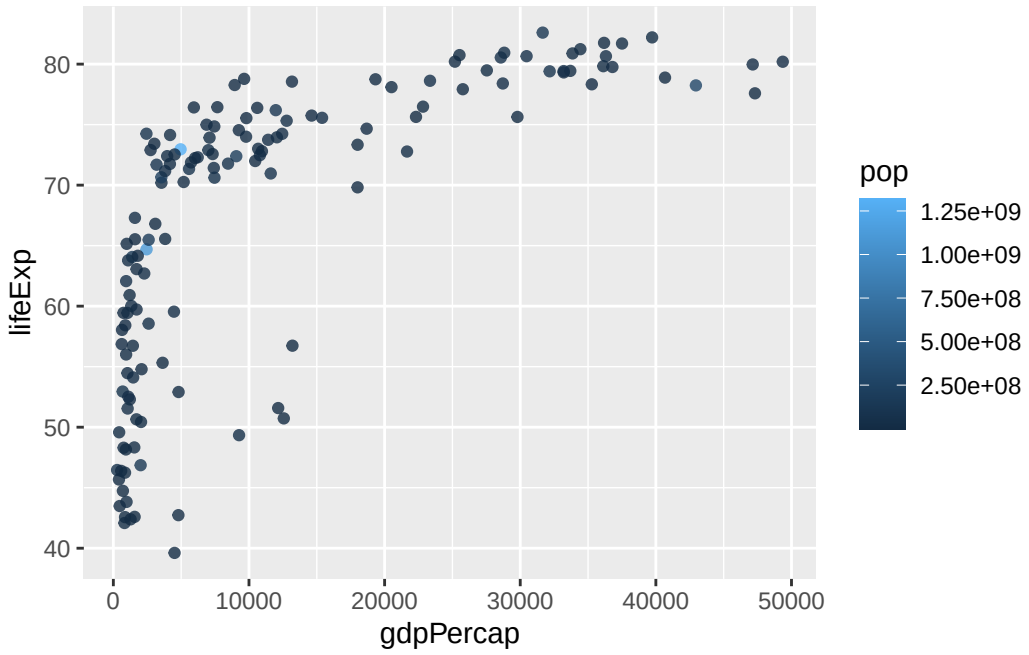

Adding more variables to `sec()` Making color based on continent and size of point on population

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



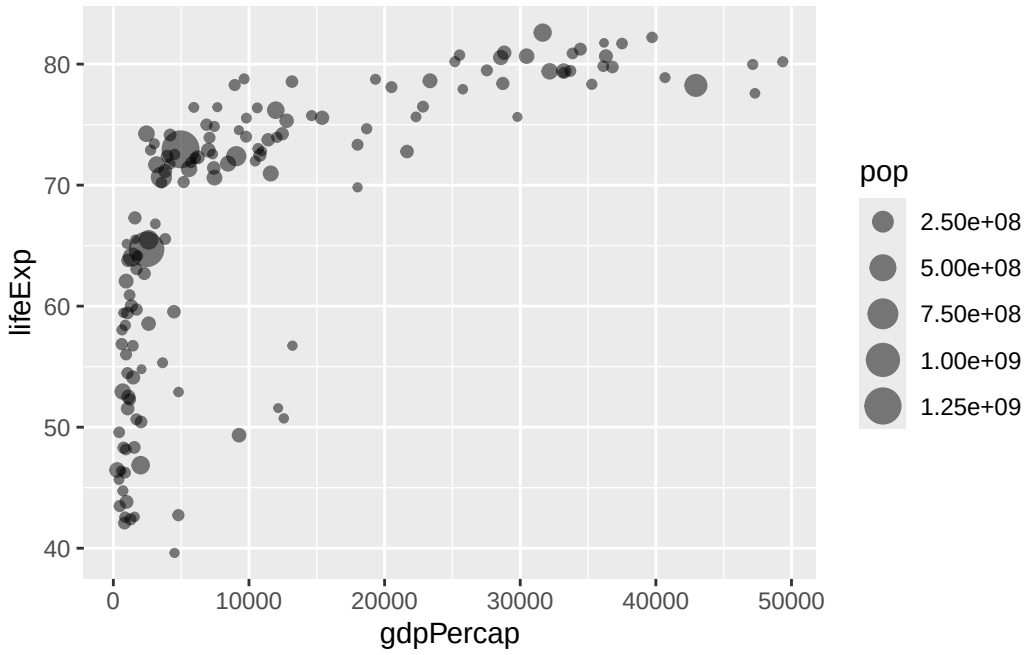

Coloring points based on population

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



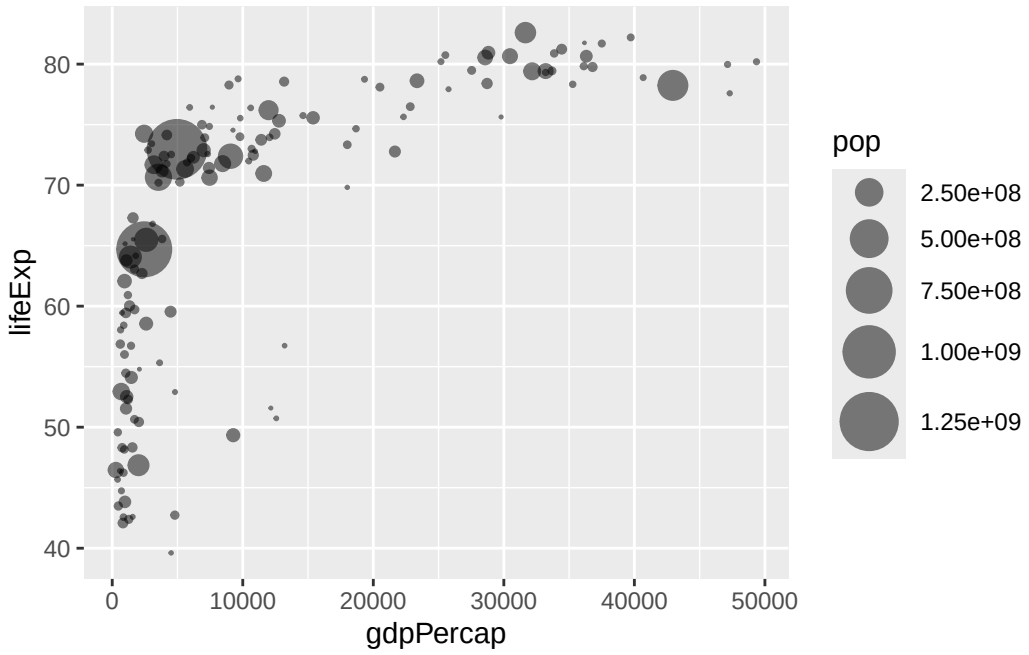

Point size based on population

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




Rescaling the point, use `scale_size_area()`

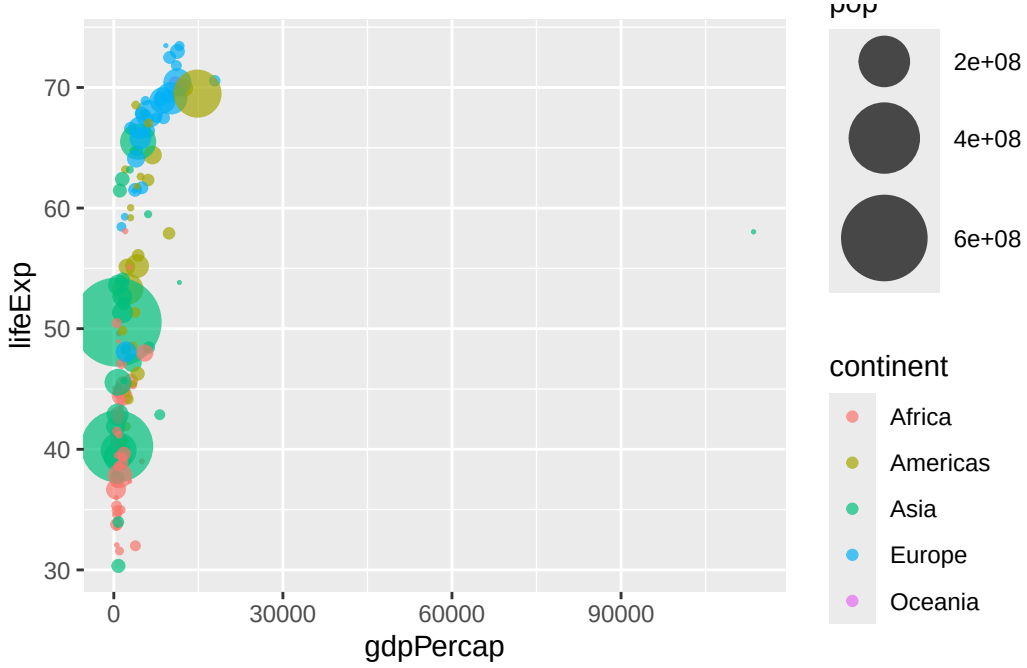
```
ggplot(gapminder_2007) +
  geom_point(aes(x = gdpPercap, y = lifeExp,
                 size = pop), alpha=0.5) +
  scale_size_area(max_size = 10)
```




Q 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?

Ploting for year 1957

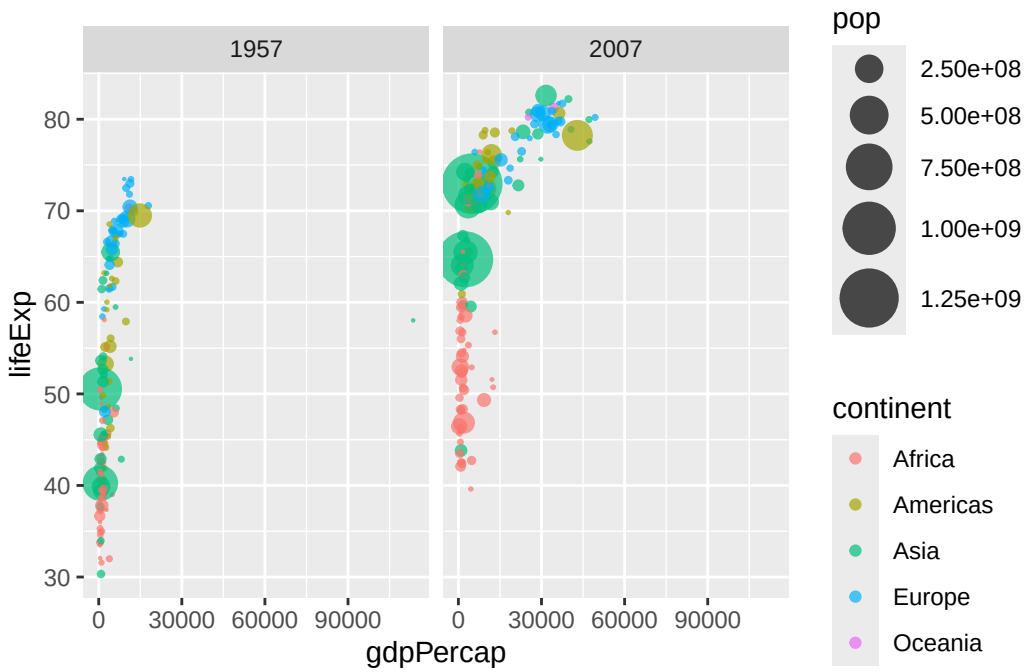
```
library(dplyr)

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

ggplot(gapminder_1957) +
  aes(gdpPercap,lifeExp, color=continent, size=pop) +
  geom_point(alpha=0.7)+
  scale_size_area(max_size=15)
```




Q. Q. Do the same steps above but include 1957 and 2007 in your input dataset for ggplot(). You should now include the layer facet_wrap(~year) to produce the following plot:

Plotting 1957 and 2007 together

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

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




```
table(gapminder$year)
```

```
1952 1957 1962 1967 1972 1977 1982 1987 1992 1997 2002 2007
 142  142  142  142  142  142  142  142  142  142  142  142
```

```
length(unique(gapminder$year))
```

```
[1] 12
```

```
library(dplyr)
filter(gapminder, country=="United States")
```

```
         country continent year lifeExp       pop gdpPercap
1  United States  Americas 1952  68.440 157553000  13990.48
2  United States  Americas 1957  69.490 171984000  14847.13
3  United States  Americas 1962  70.210 186538000  16173.15
4  United States  Americas 1967  70.760 198712000  19530.37
5  United States  Americas 1972  71.340 209896000  21806.04
6  United States  Americas 1977  73.380 220239000  24072.63
```

```
7  United States  Americas 1982  74.650 232187835  25009.56
8  United States  Americas 1987  75.020 242803533  29884.35
9  United States  Americas 1992  76.090 256894189  32003.93
10 United States  Americas 1997  76.810 272911760  35767.43
11 United States  Americas 2002  77.310 287675526  39097.10
12 United States  Americas 2007  78.242 301139947  42951.65
```

What is the population of Ireland in the last year we have dataa for?

```
filter(gapminder, country=="Ireland", year ==2007)
```

```
  country continent year lifeExp     pop gdpPercap
1 Ireland    Europe 2007  78.885 4109086     40676
```

What countries in data set had pop smaller than Ireland in 2007

```
#limit the dataset to year 2007
gap07 <- filter(gapminder, year ==2007)

#find the `pop` value of Ireland
ire_pop <- filter(gap07, country =="Ireland")["pop"]
ire_pop
```

```
      pop
1 4109086
```

```
#Extract all rows with `pop` less than Ireland's
filter(gap07,pop<4109086)
```

```
                country continent year lifeExp     pop  gdpPercap
1               Albania    Europe 2007  76.423 3600523  5937.0295
2               Bahrain      Asia 2007  75.635  708573 29796.0483
3              Botswana    Africa 2007  50.728 1639131 12569.8518
4               Comoros    Africa 2007  65.152  710960   986.1479
5          Congo, Rep.    Africa 2007  55.322 3800610  3632.5578
6              Djibouti    Africa 2007  54.791  496374  2082.4816
7     Equatorial Guinea    Africa 2007  51.579  551201 12154.0897
8                 Gabon    Africa 2007  56.735 1454867 13206.4845
9                Gambia    Africa 2007  59.448 1688359   752.7497
10        Guinea-Bissau    Africa 2007  46.388 1472041   579.2317
```

```
11                Iceland    Europe 2007  81.757  301931 36180.7892
12                Jamaica  Americas 2007  72.567 2780132  7320.8803
13                 Kuwait      Asia 2007  77.588 2505559 47306.9898
14                Lebanon      Asia 2007  71.993 3921278 10461.0587
15                Lesotho    Africa 2007  42.592 2012649  1569.3314
16                Liberia    Africa 2007  45.678 3193942   414.5073
17             Mauritania    Africa 2007  64.164 3270065  1803.1515
18              Mauritius    Africa 2007  72.801 1250882 10956.9911
19               Mongolia      Asia 2007  66.803 2874127  3095.7723
20             Montenegro    Europe 2007  74.543  684736  9253.8961
21                Namibia    Africa 2007  52.906 2055080  4811.0604
22                   Oman      Asia 2007  75.640 3204897 22316.1929
23                 Panama  Americas 2007  75.537 3242173  9809.1856
24           Puerto Rico  Americas 2007  78.746 3942491 19328.7090
25                Reunion    Africa 2007  76.442  798094  7670.1226
26 Sao Tome and Principe    Africa 2007  65.528  199579  1598.4351
27               Slovenia    Europe 2007  77.926 2009245 25768.2576
28              Swaziland    Africa 2007  39.613 1133066  4513.4806
29   Trinidad and Tobago  Americas 2007  69.819 1056608 18008.5092
30                Uruguay  Americas 2007  76.384 3447496 10611.4630
31    West Bank and Gaza      Asia 2007  73.422 4018332  3025.3498
```

## Section 8: Bar Charts

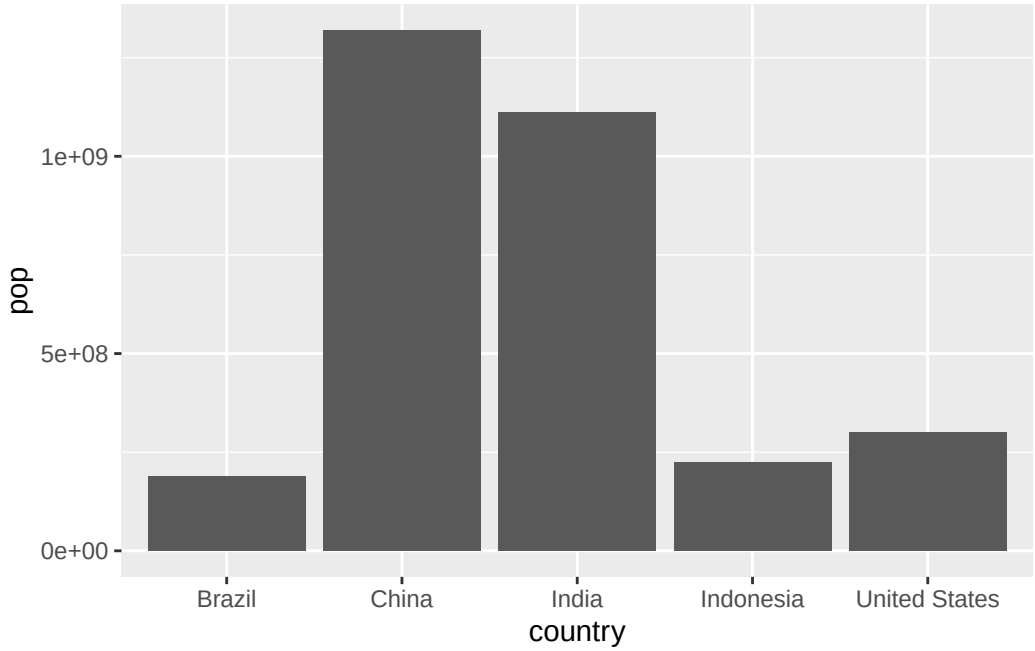
Veiwing five largest countries by population in 2007

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

gapminder_top5
```

```
        country continent year lifeExp        pop gdpPercap
1         China      Asia 2007  72.961 1318683096  4959.115
2         India      Asia 2007  64.698 1110396331  2452.210
3 United States  Americas 2007  78.242  301139947 42951.653
4     Indonesia      Asia 2007  70.650  223547000  3540.652
5        Brazil  Americas 2007  72.390  190010647  9065.801
```

Simple bar chart: use `geom_col`

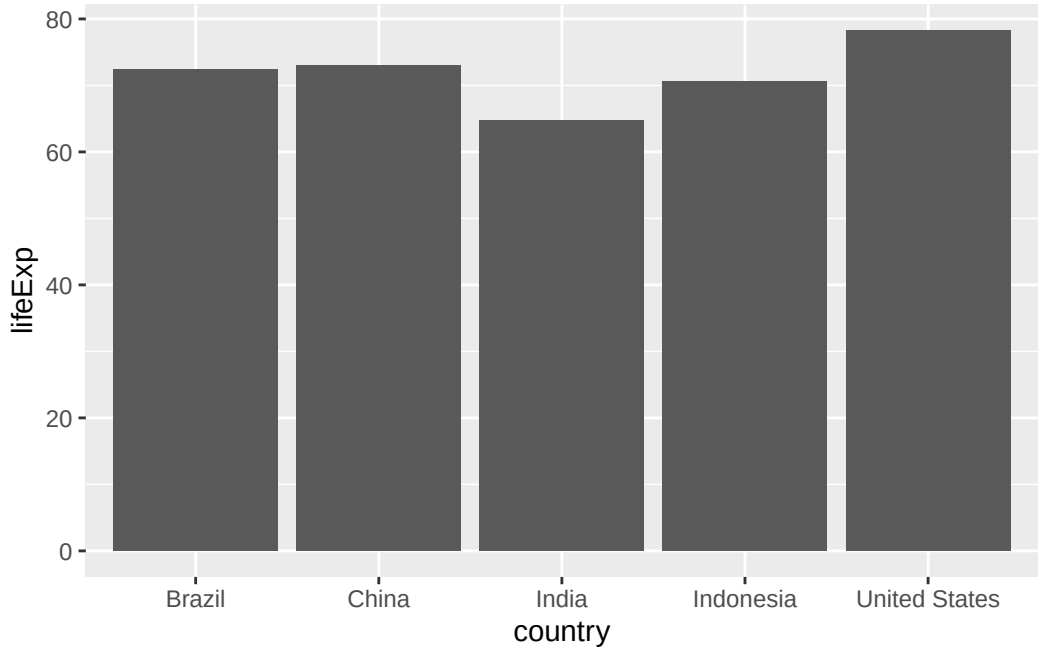
```
ggplot(gapminder_top5) +
  geom_col()+
  aes(x = country, y = pop)
```




Q Create a bar chart showing the life expectancy of the five biggest countries by population in 2007.

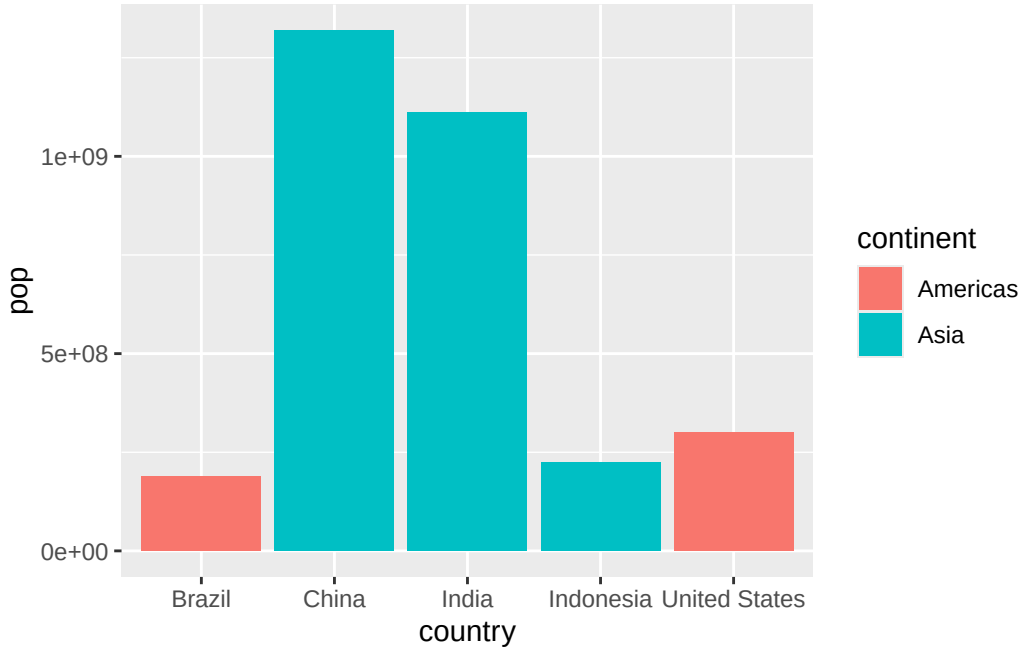
Simple bar chart of life expectancy

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



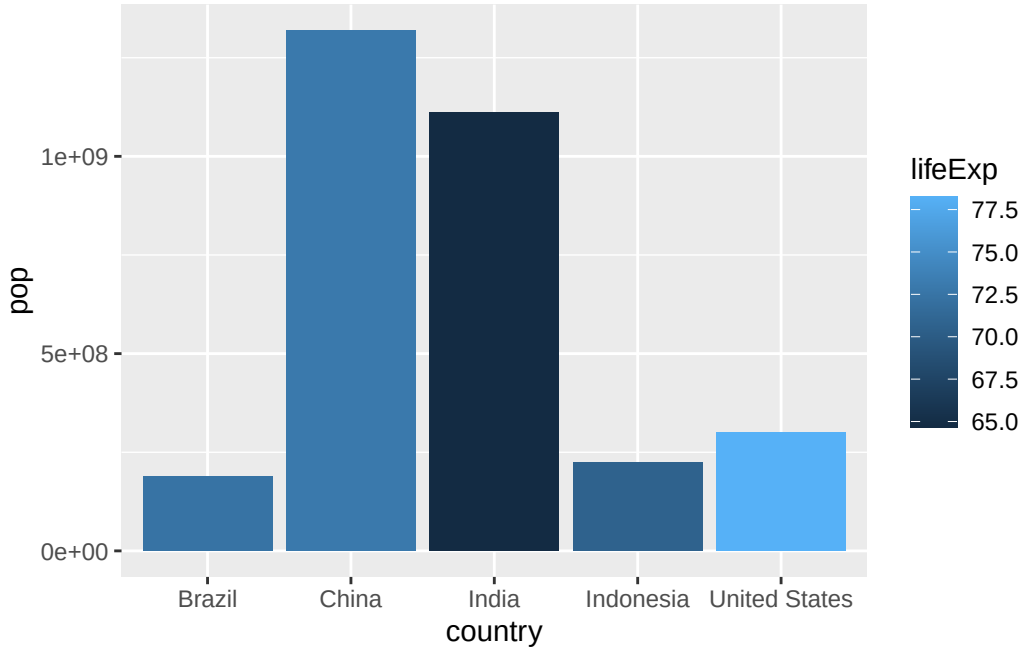

Filling bars with color corresponding to continent (categorical variable) using `fill` aesthetic

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



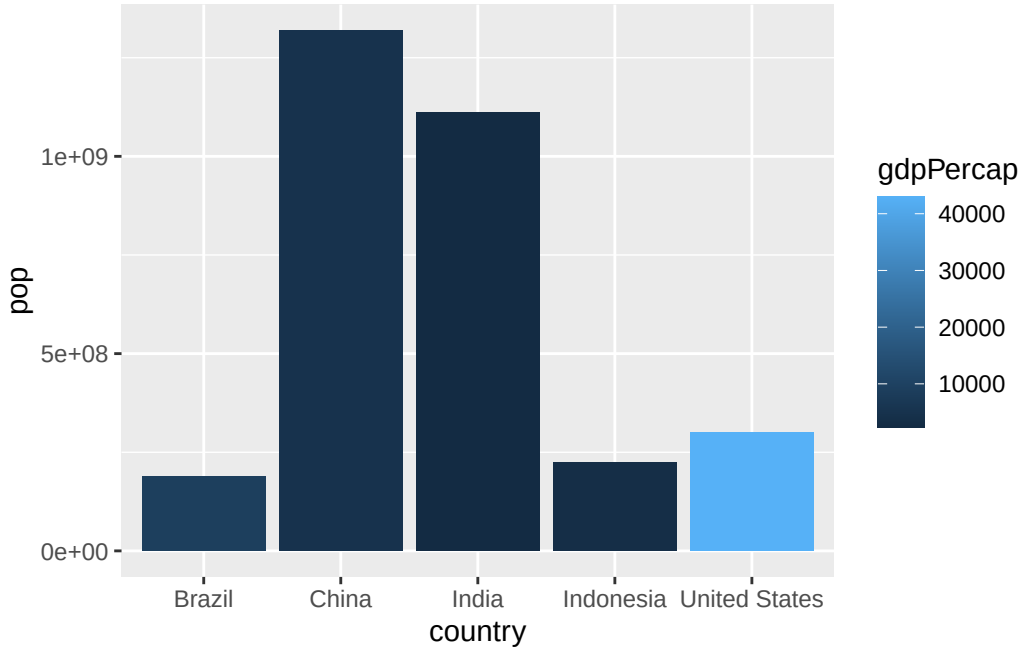

Filling bars with color corresponding to life exp (numerical variable) using `fill` aesthetic

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



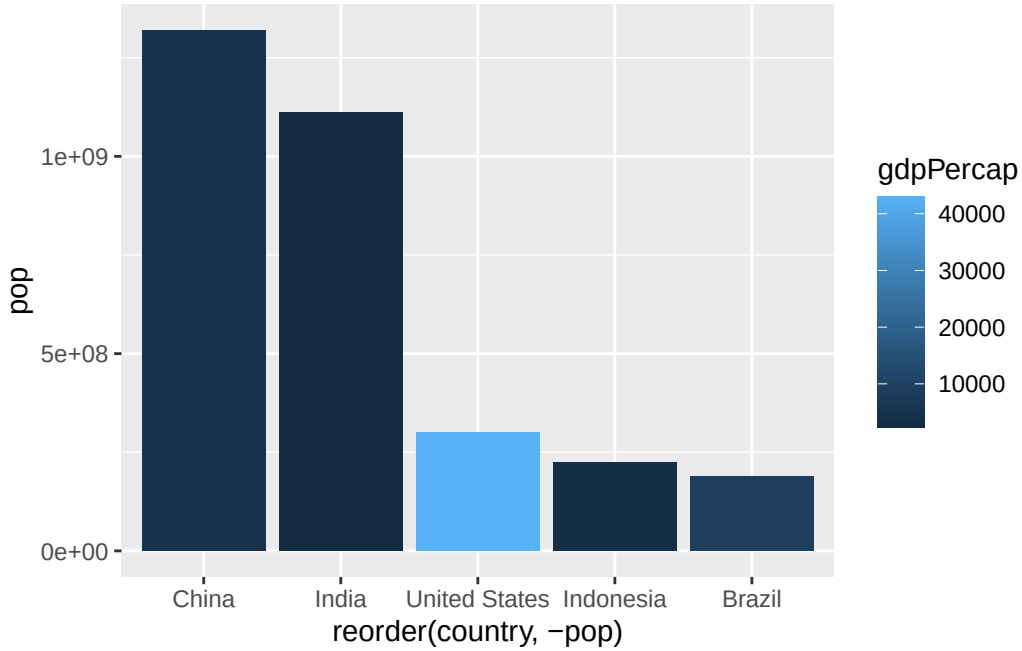

Q. Plot population size by country. Create a bar chart showing the population (in millions) of the five biggest countries by population in 2007.

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



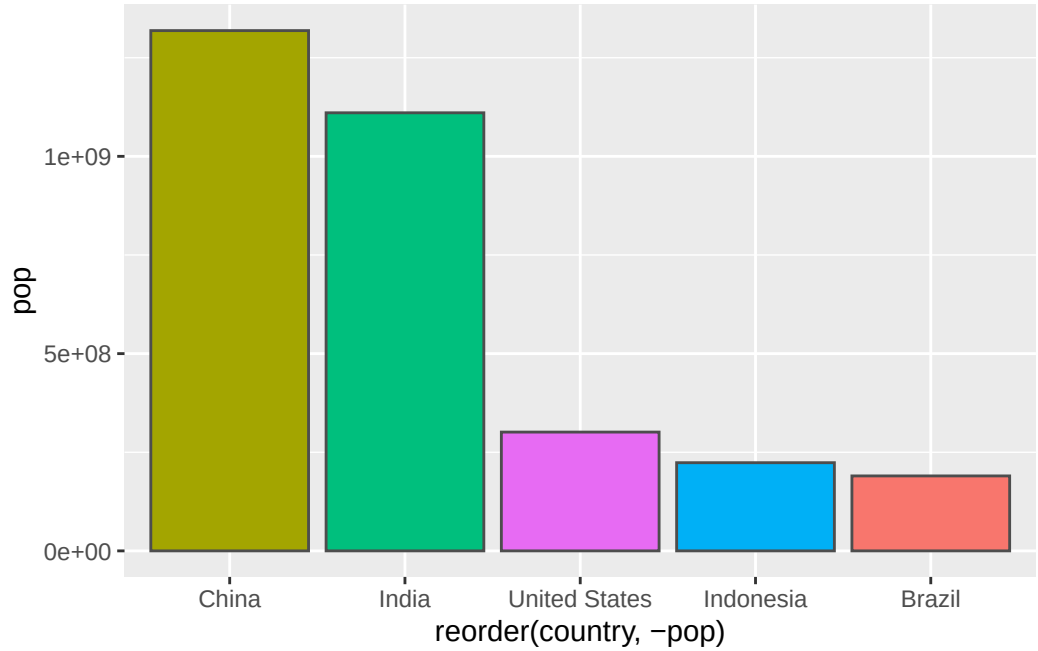

Changing the order of the bars use `reorder()`aesthetic

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




Filling by country

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

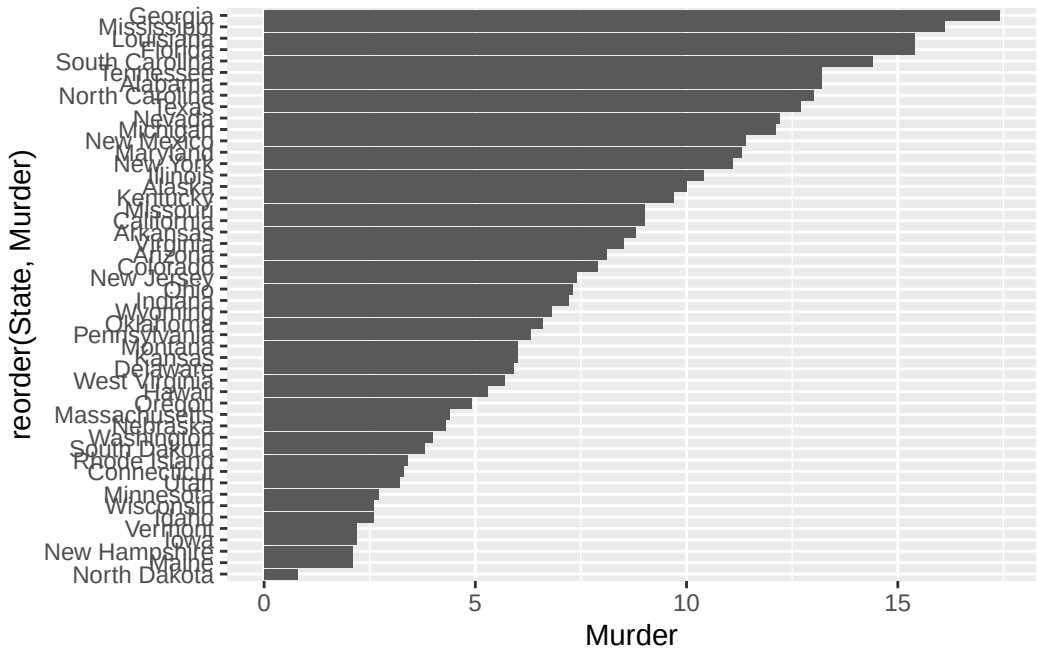



**Flipping Bar Charts** Use `coord_flip()` function to flip

```
head(USArrests)
```

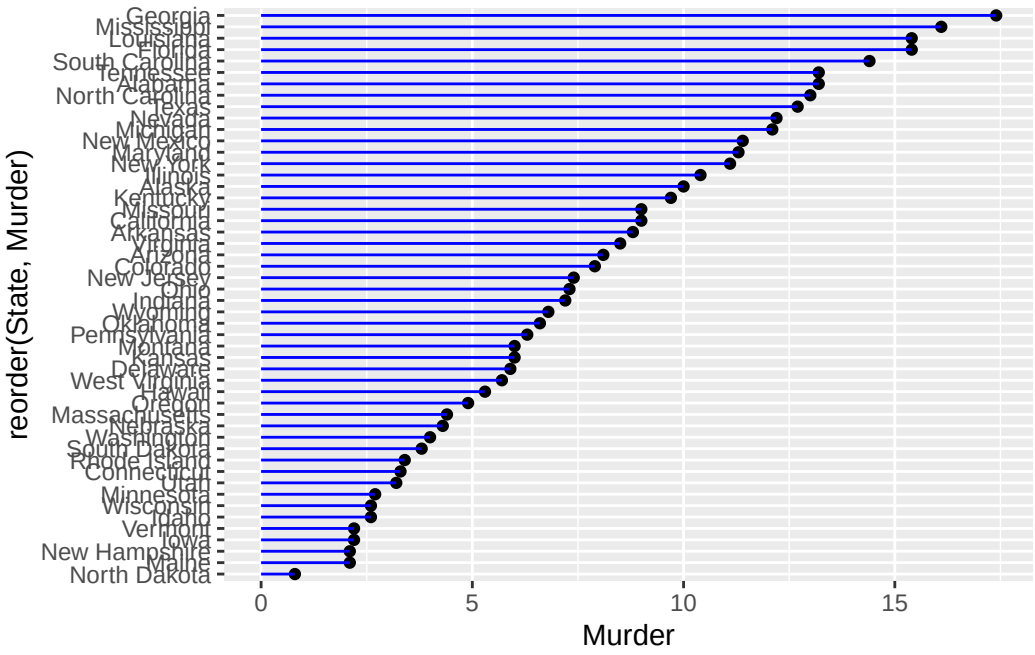
```
           Murder Assault UrbanPop Rape
Alabama      13.2     236       58 21.2
Alaska       10.0     263       48 44.5
Arizona       8.1     294       80 31.0
Arkansas      8.8     190       50 19.5
California    9.0     276       91 40.6
Colorado      7.9     204       78 38.7
```

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




Customizing more with both `geom_point()` and `geom_segment`

```
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()
```




##9: extensions: Animation Install `gganimate` and `gifski` packages

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

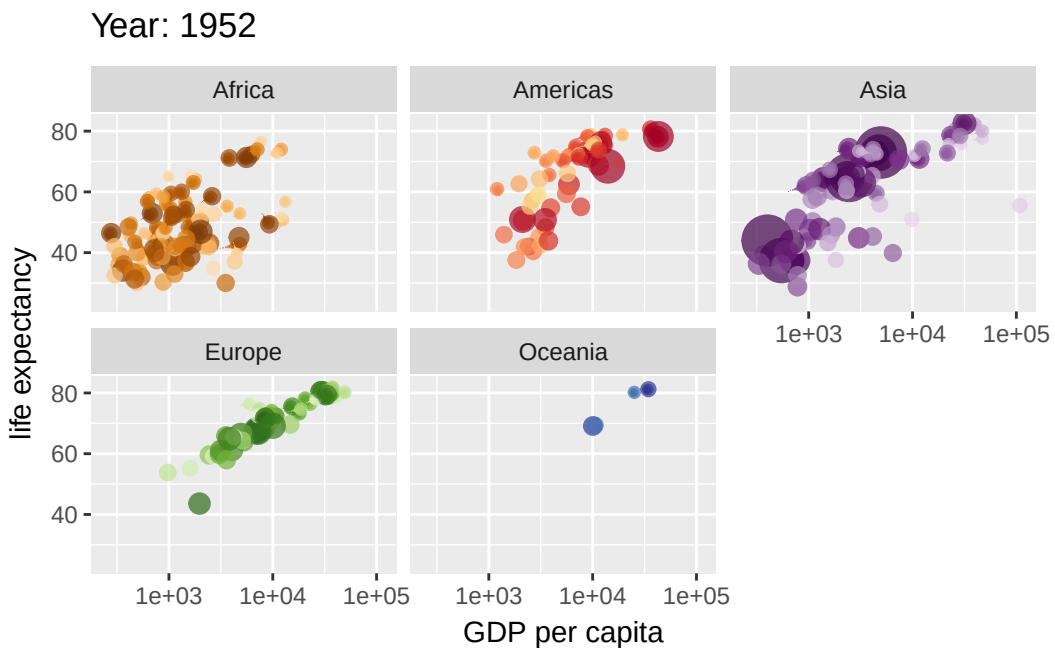
```
library(gapminder)
```

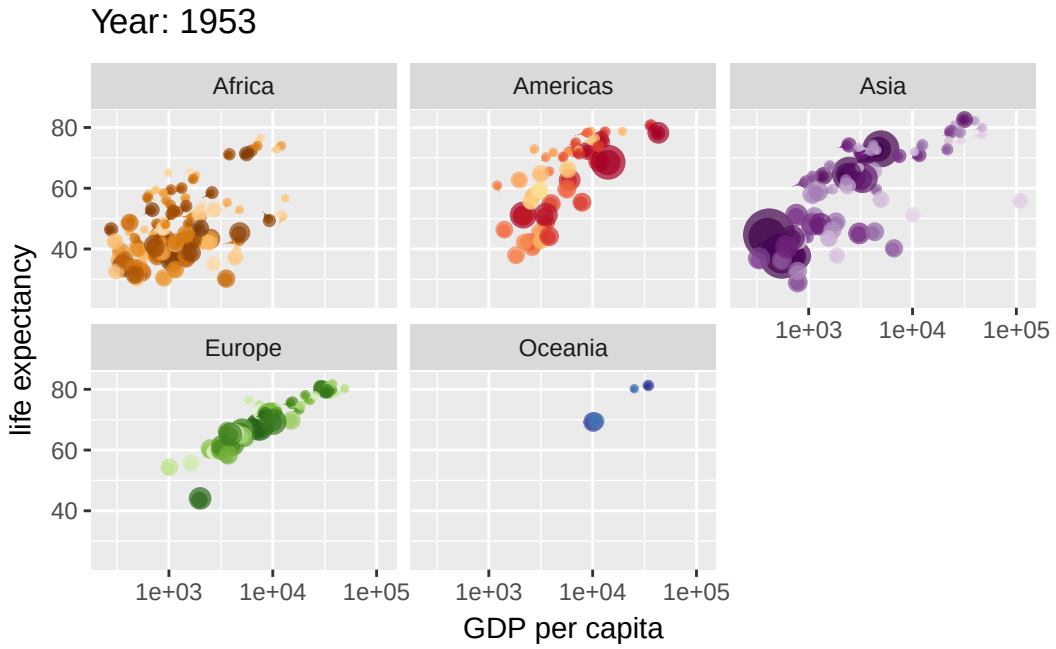
```
Attaching package: 'gapminder'

The following object is masked _by_ '.GlobalEnv':

    gapminder
```

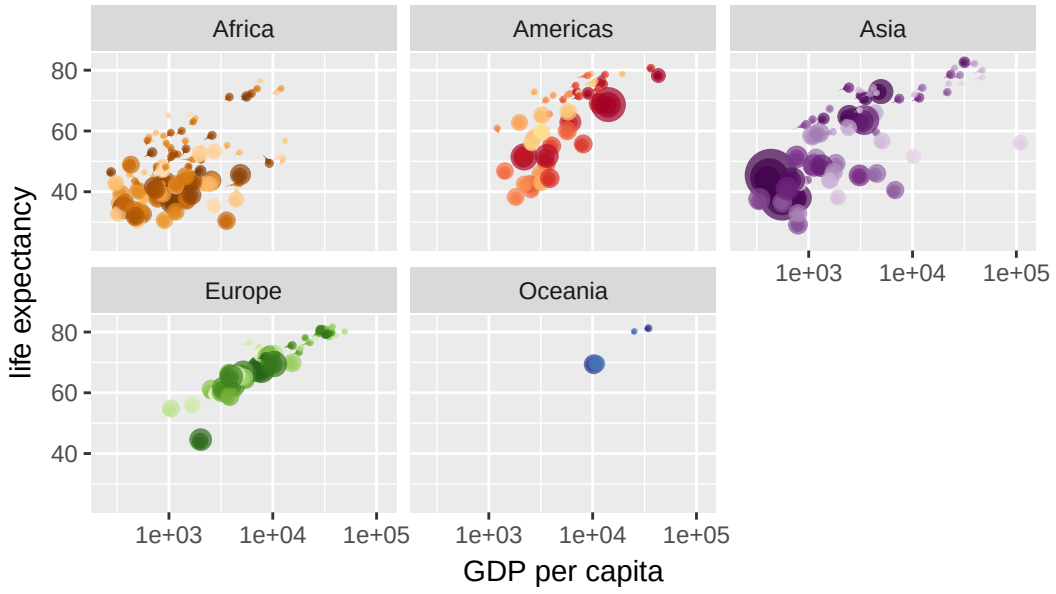
```
library(gganimate)

# 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) +
  scale_size(range = c(2, 12)) +
  scale_x_log10() +
```

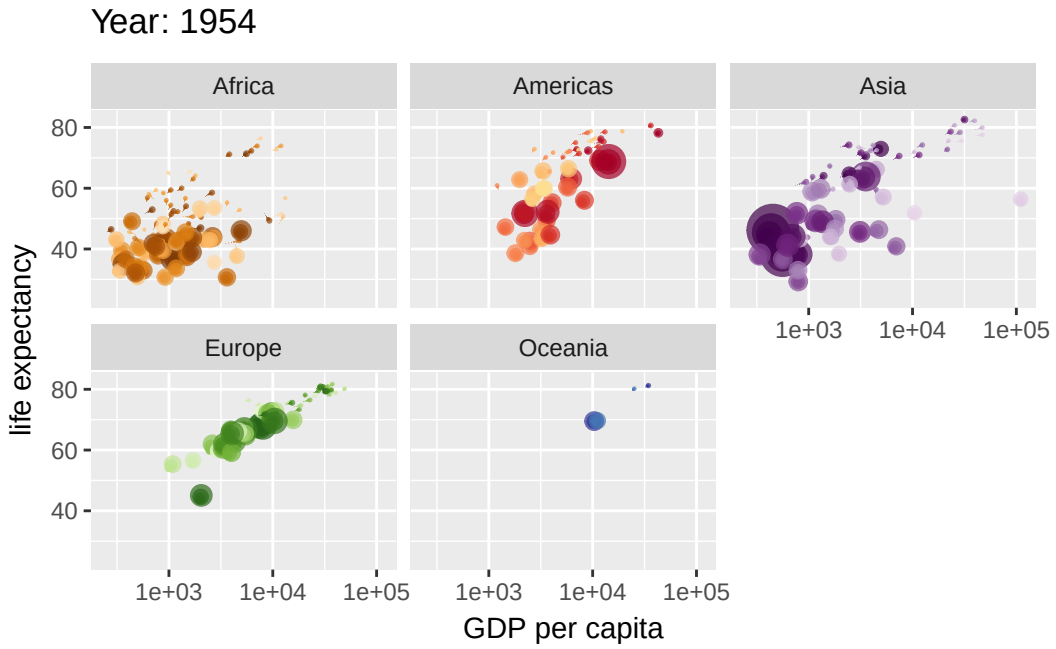
```
  # Facet by continent
  facet_wrap(~continent) +
  # Here comes the gganimate specific bits
  labs(title = 'Year: {frame_time}', x = 'GDP per capita', y = 'life expectancy') +
  transition_time(year) +
  shadow_wake(wake_length = 0.1, alpha = FALSE)
```

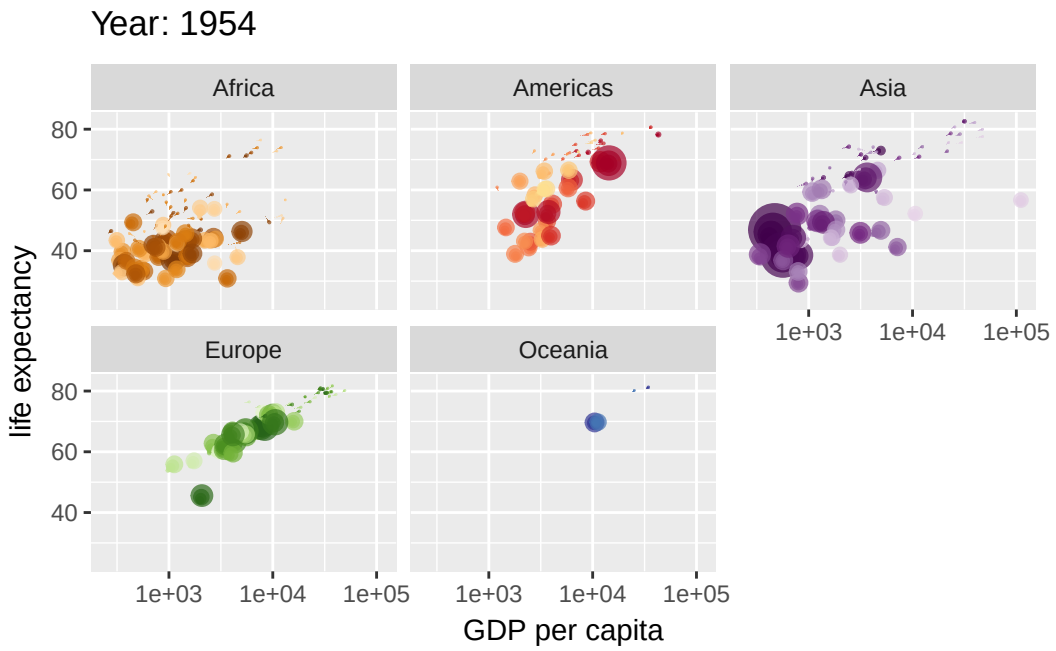
```
Warning in formals(fun): argument is not a function
```

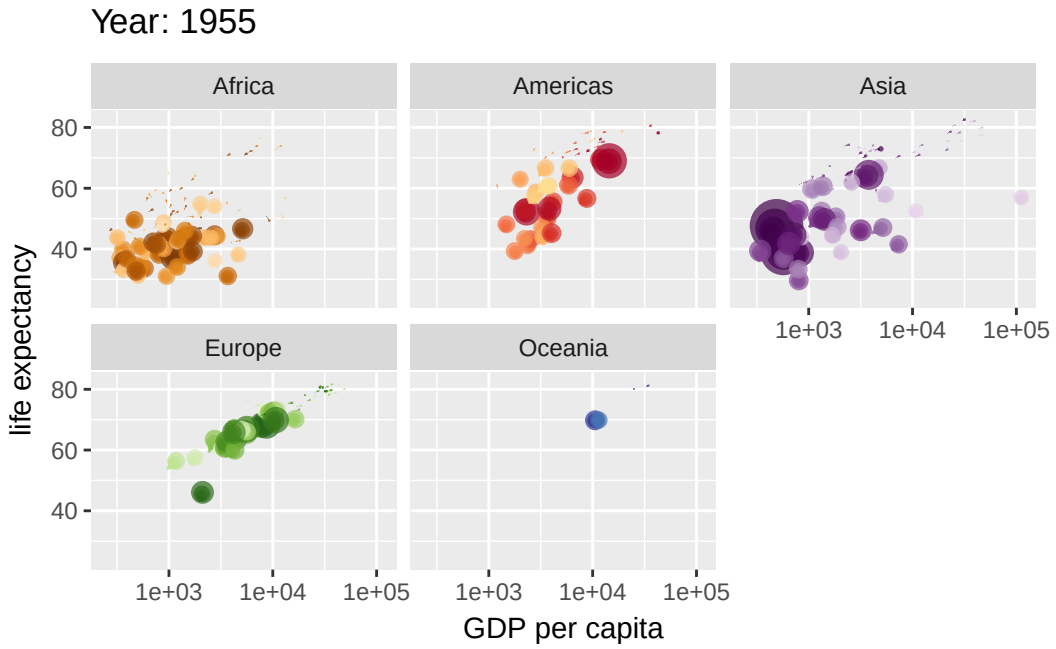


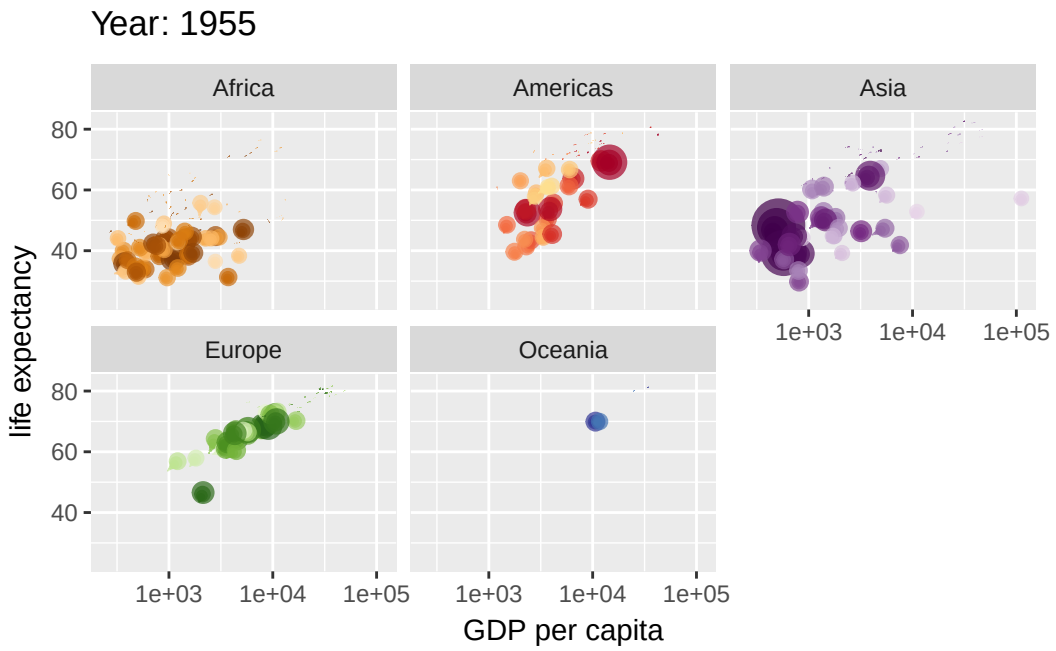

Year: 1953
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

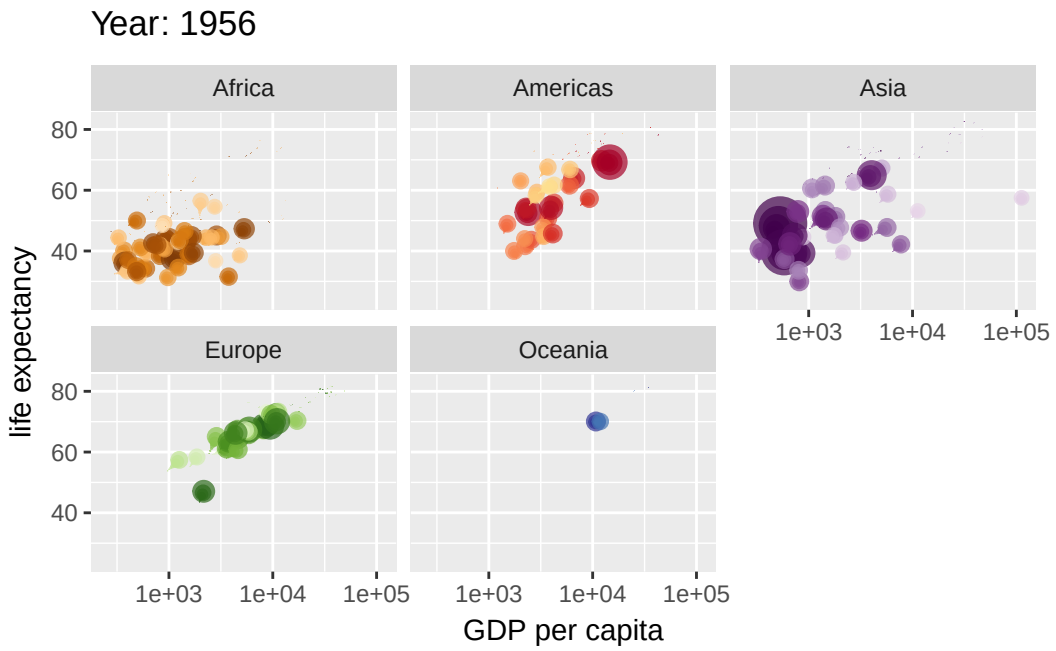

Year: 1953
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

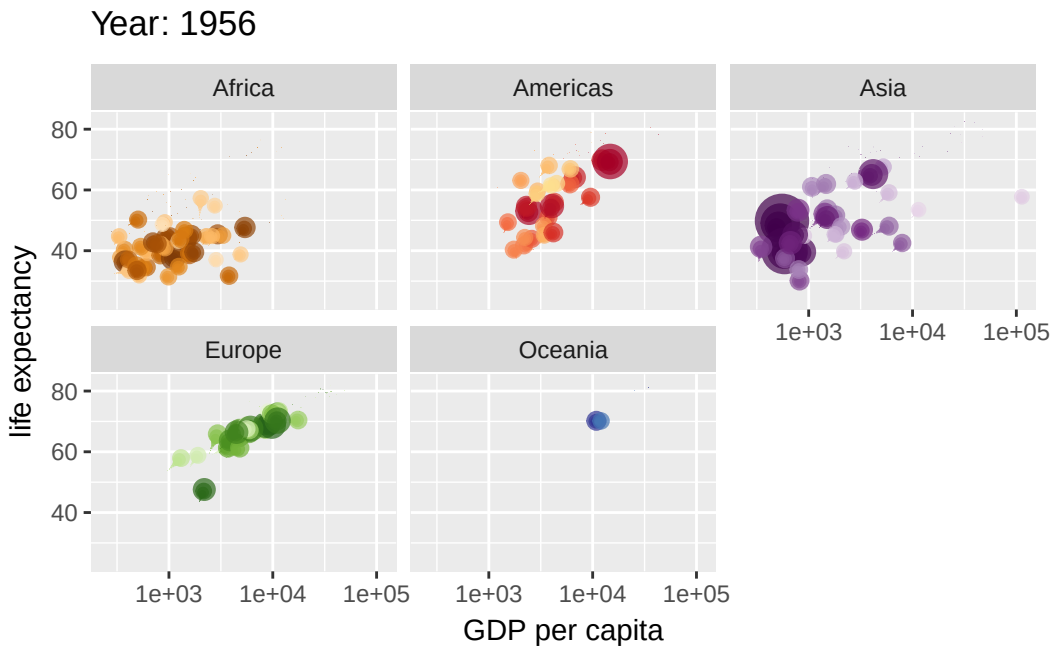

Year: 1954
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

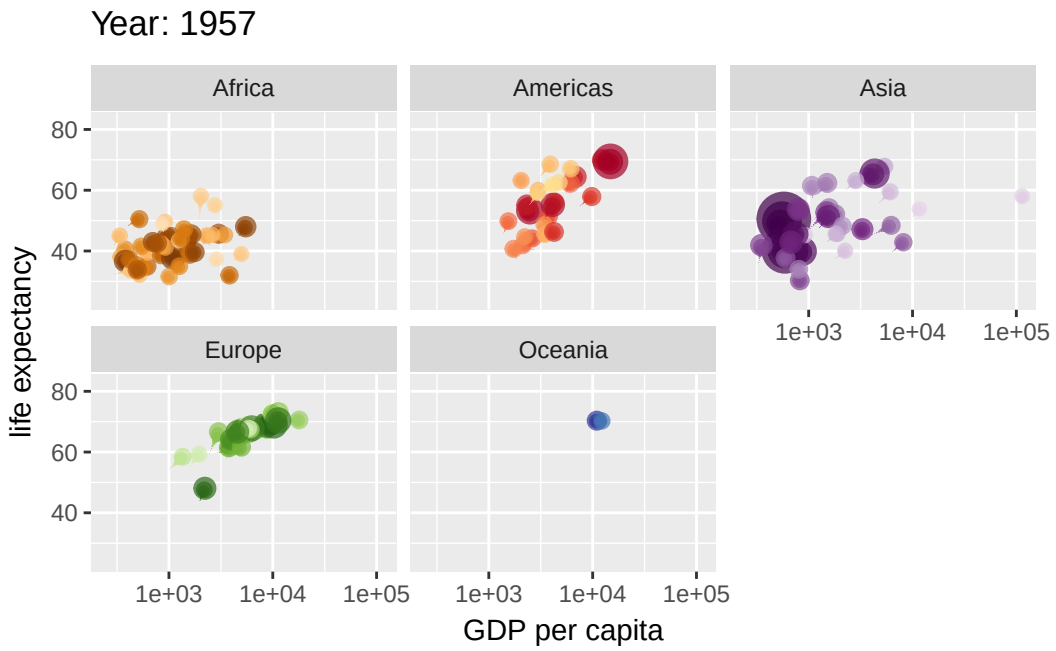

Year: 1954
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

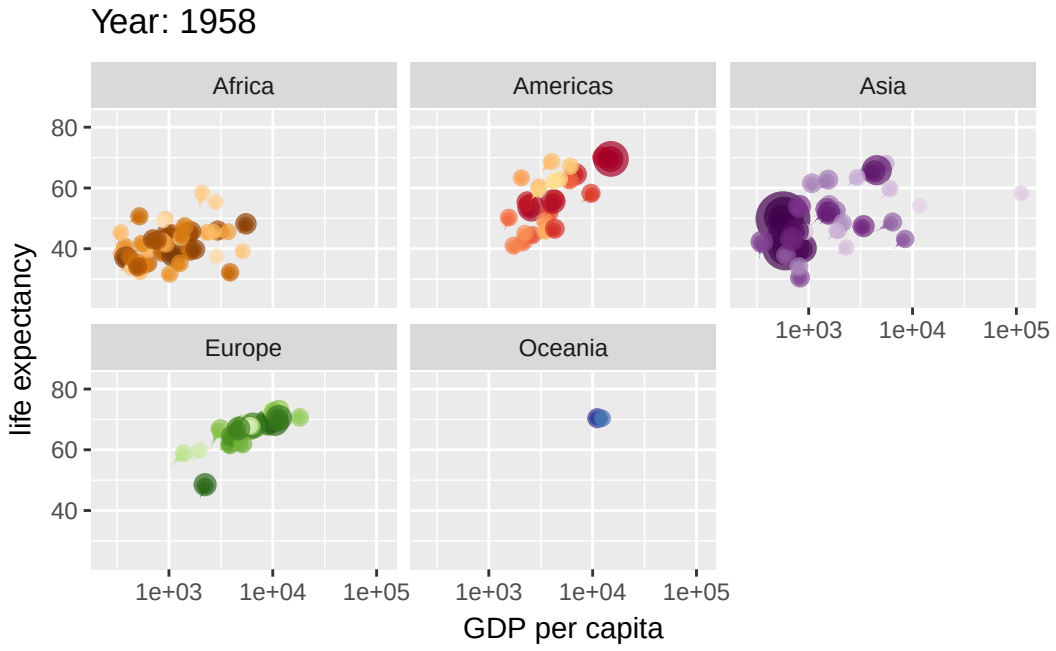

Year: 1955
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

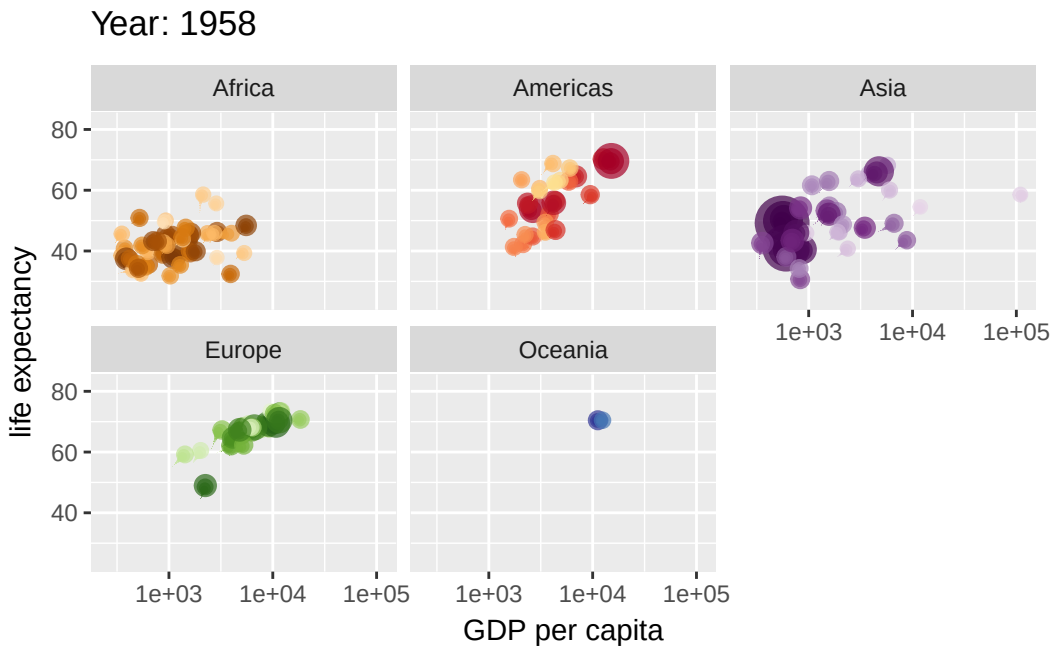

Year: 1955
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

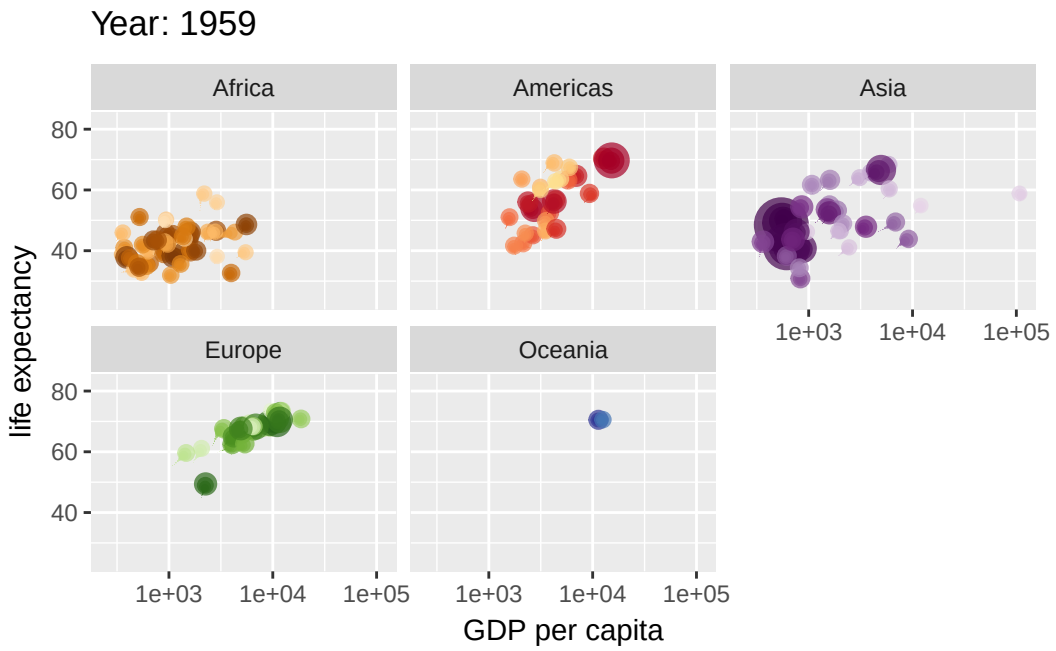

Year: 1956
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

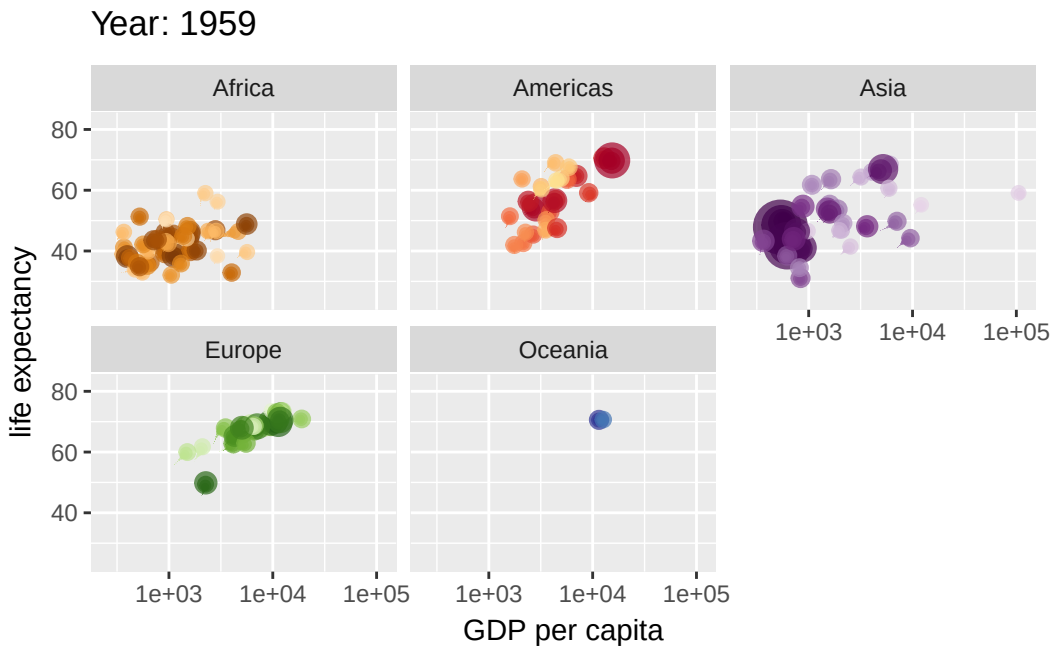

Year: 1956
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

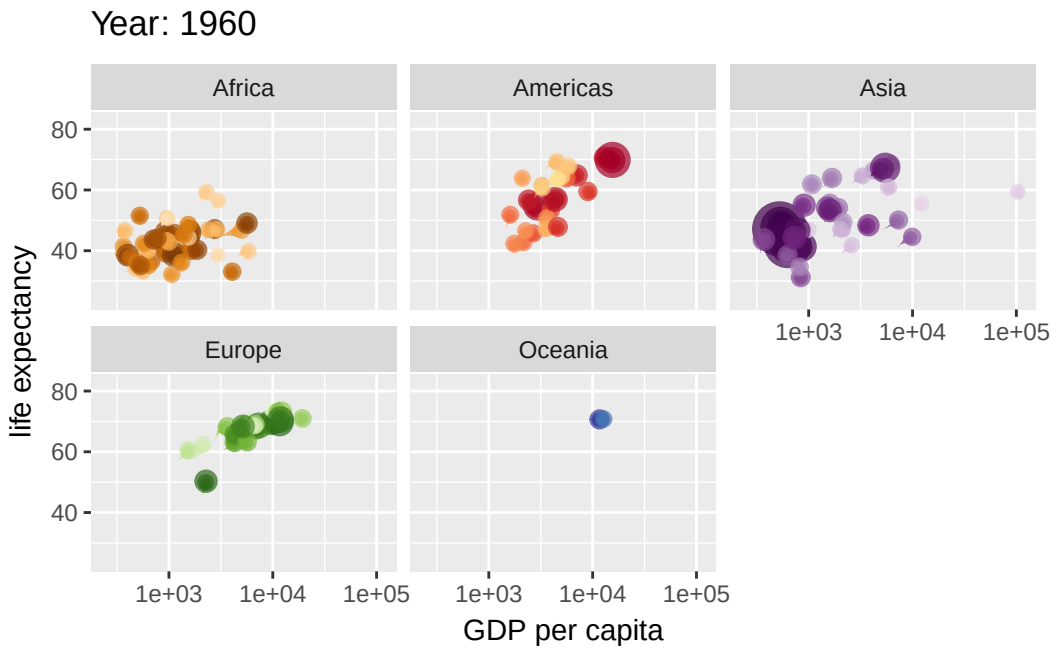

Year: 1957
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

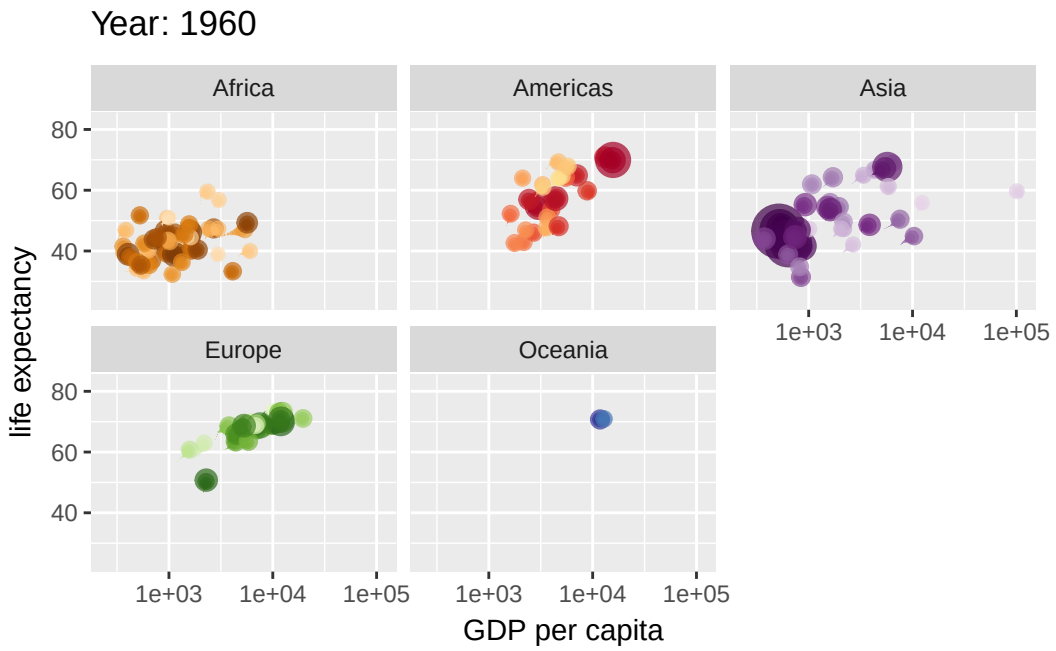

Year: 1958
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

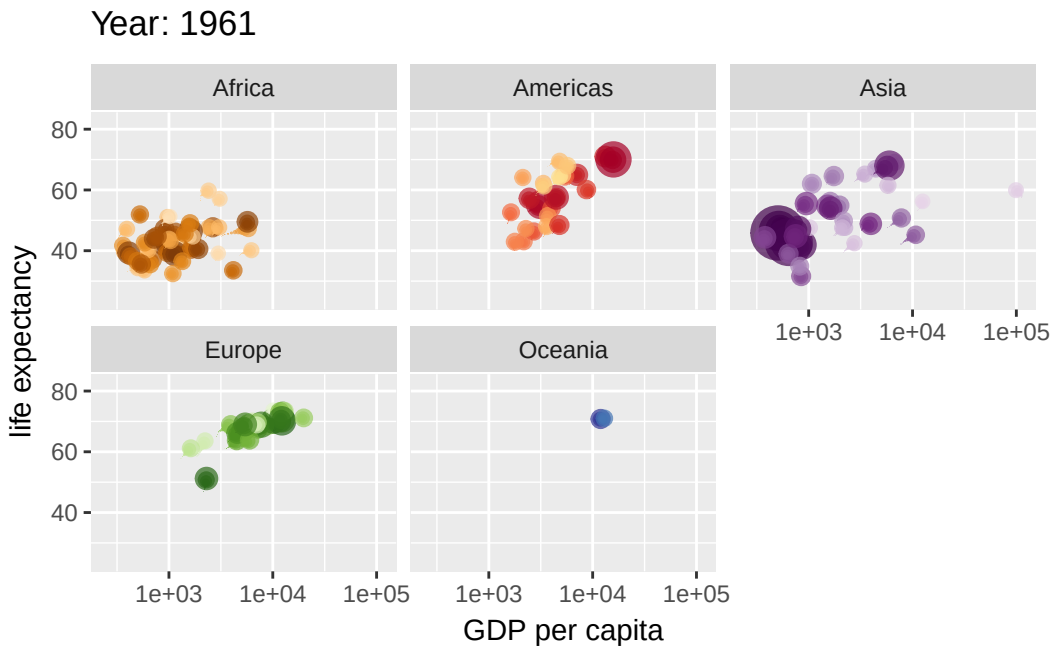

Year: 1958
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

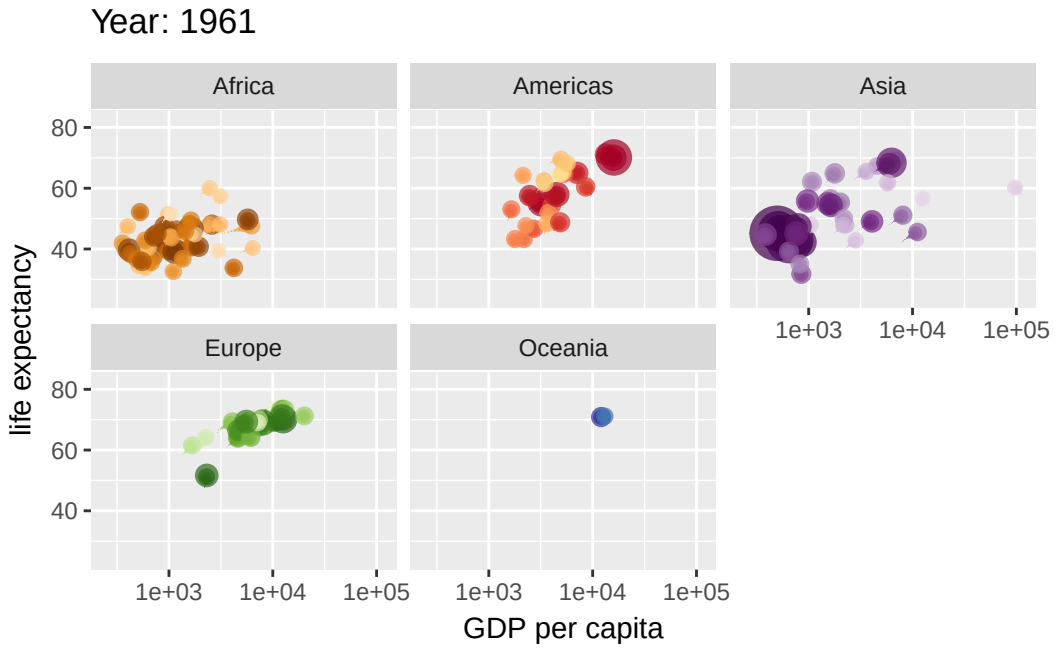

Year: 1959
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

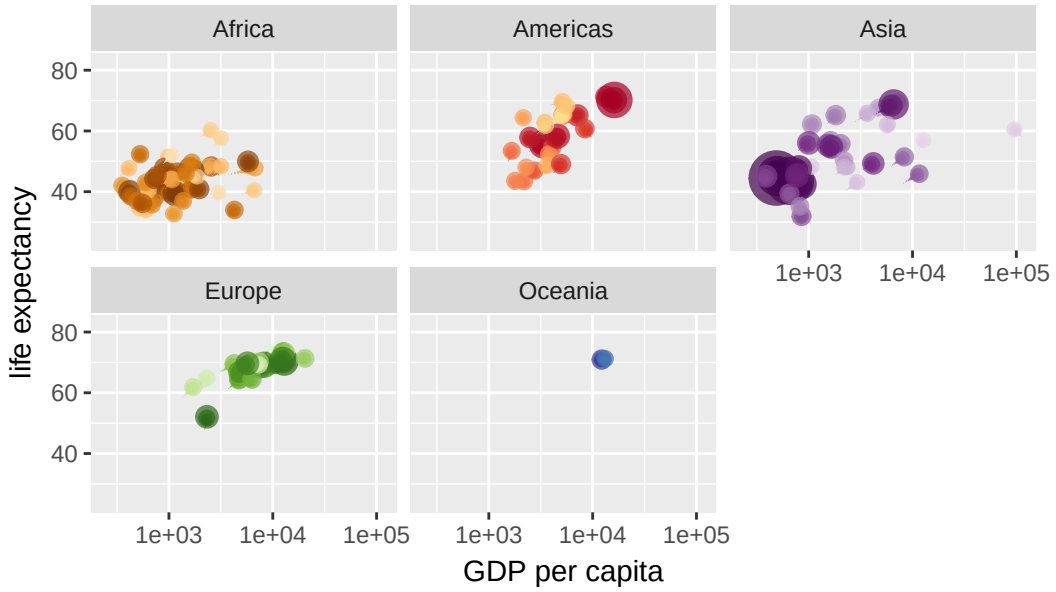

Year: 1959
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

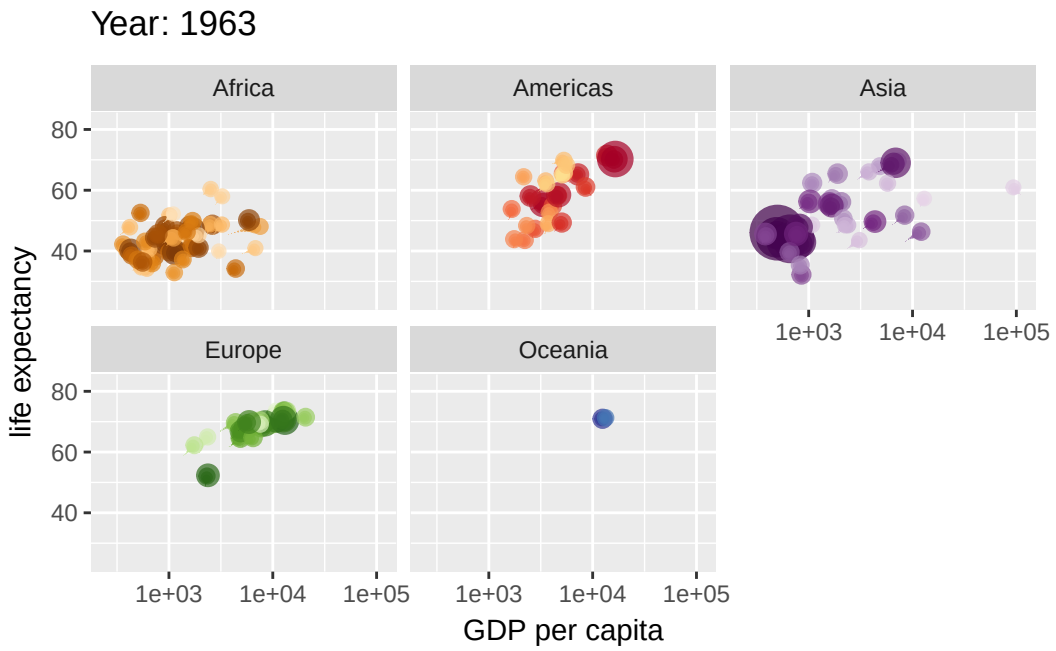

Year: 1960
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1960
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1961
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1961
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1962
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1963
Africa
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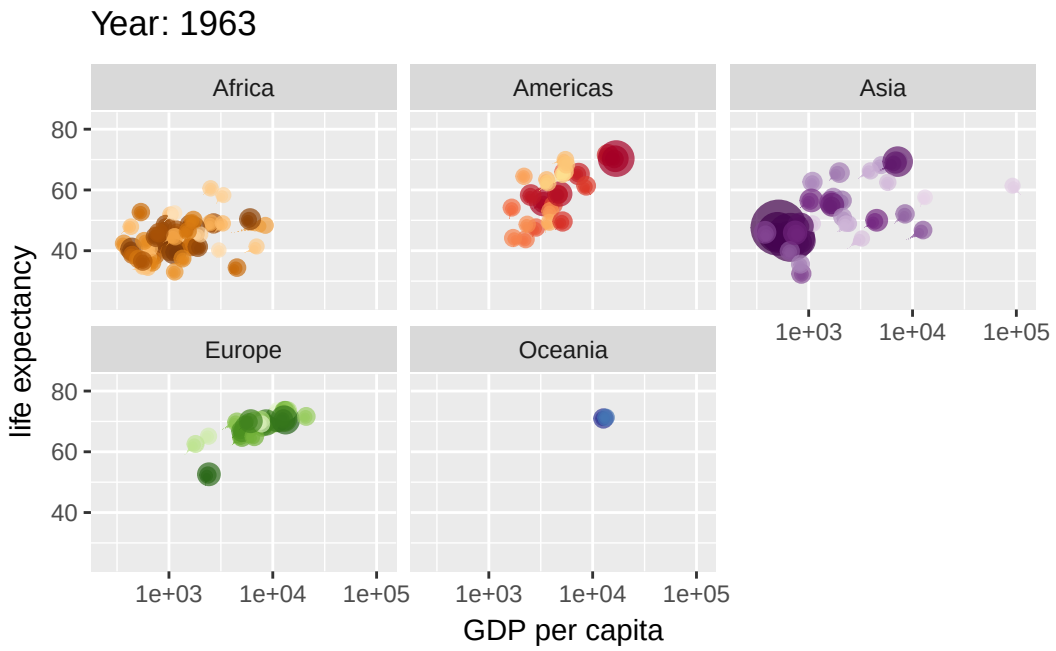
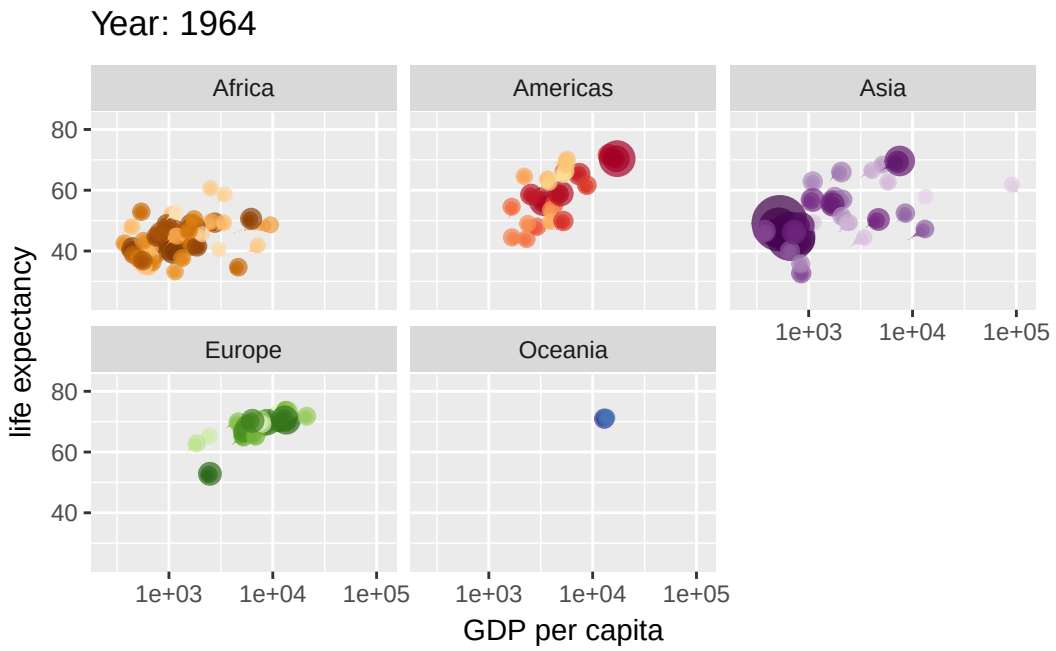
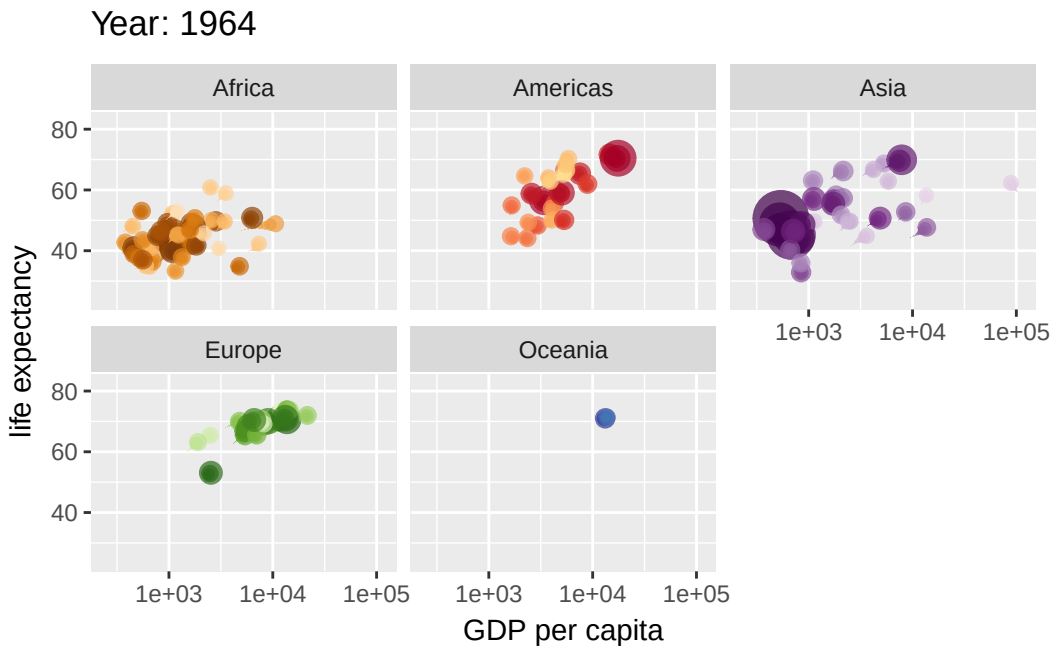
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1963
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1964
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1964
Africa
Americas
Asia
Europe
Oceania
life expectancy
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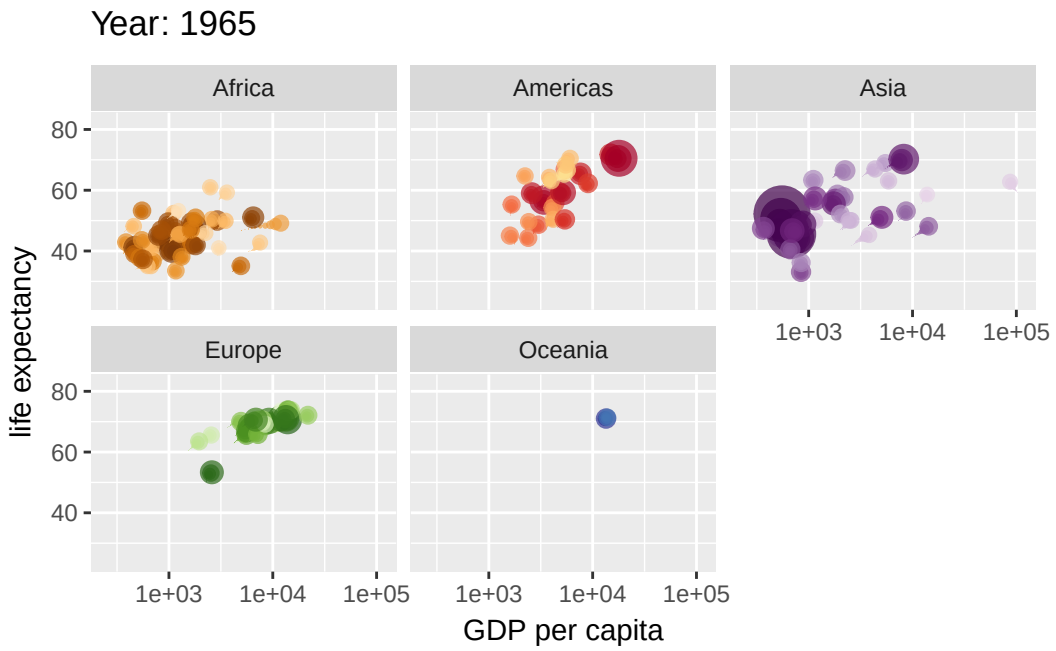
1e+03
1e+04
1e+05
GDP per capita


Year: 1965
Africa
Americas
Asia
Europe
Oceania
life expectancy
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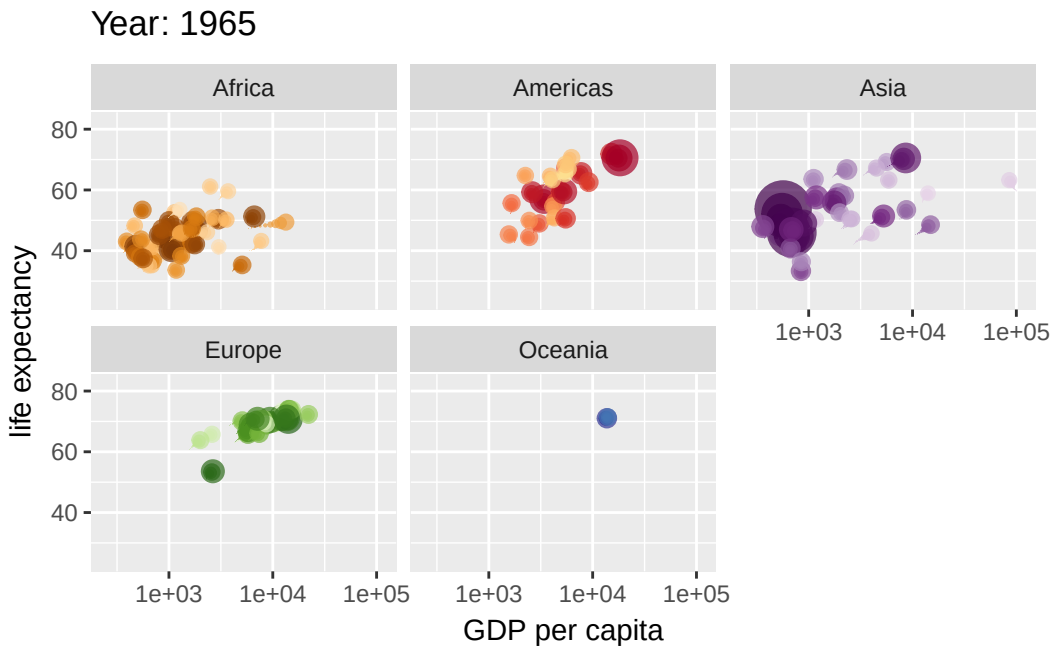
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1965
Africa
Americas
Asia
Europe
Oceania
life expectancy
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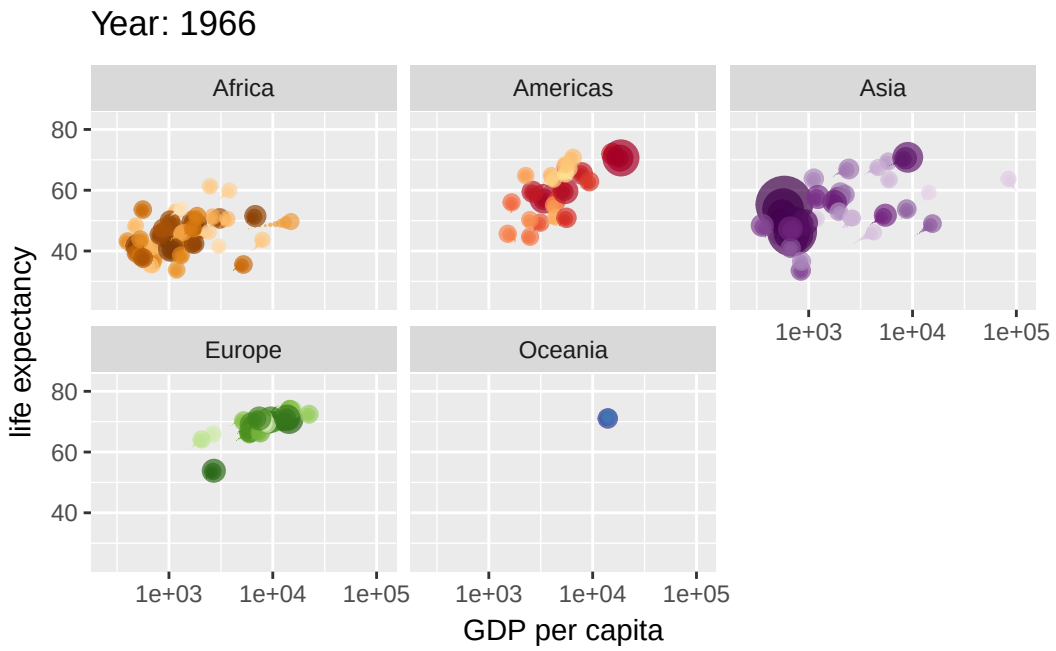
1e+04
1e+05
GDP per capita


Year: 1966
Africa
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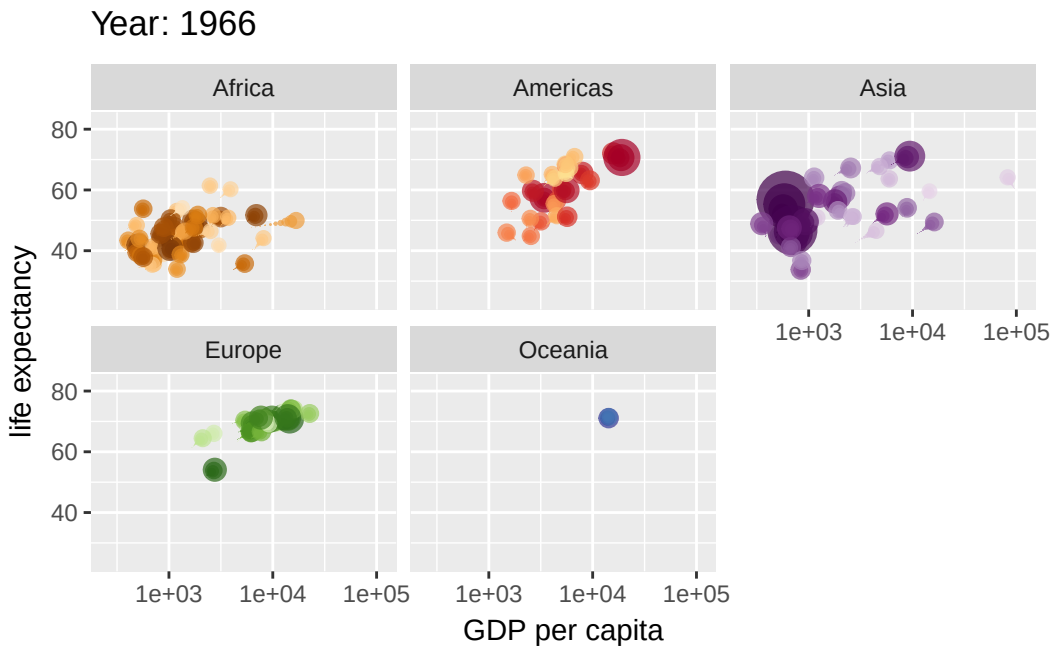
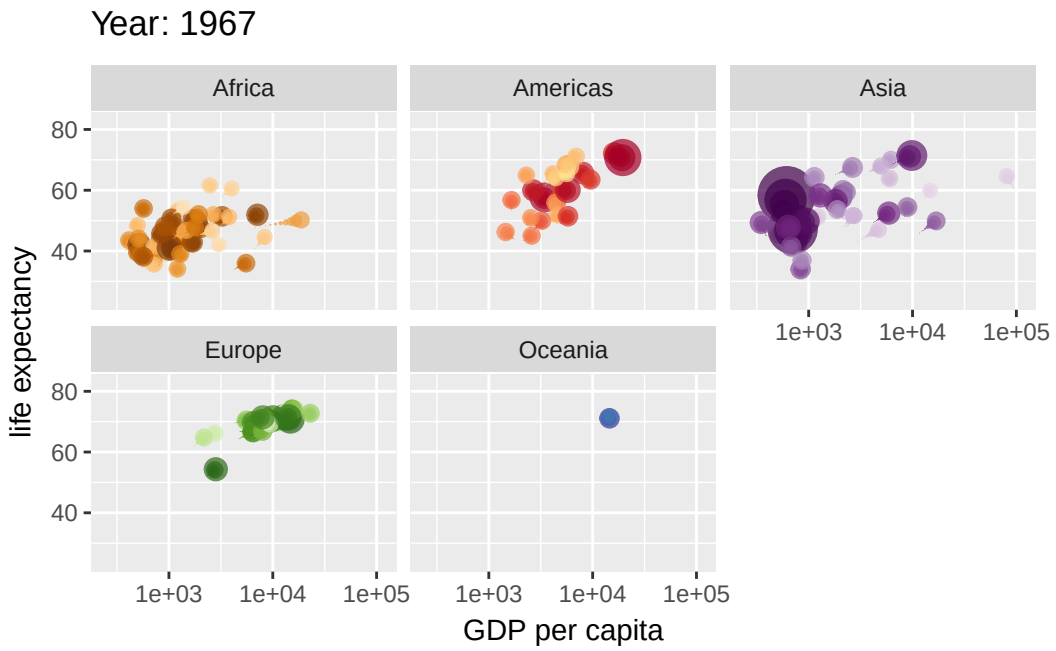
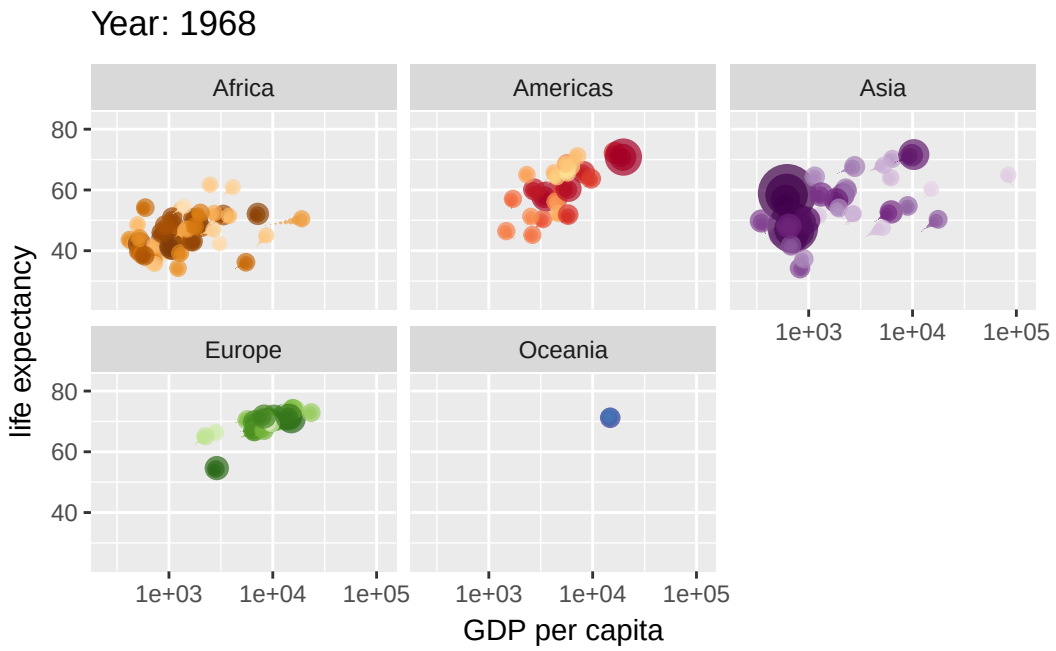
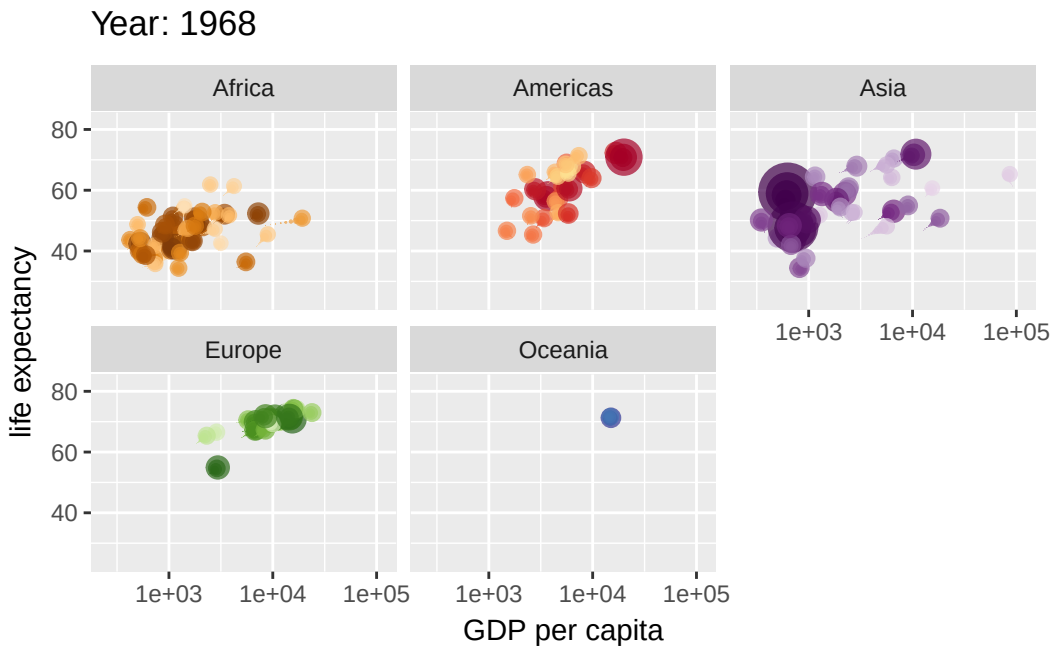
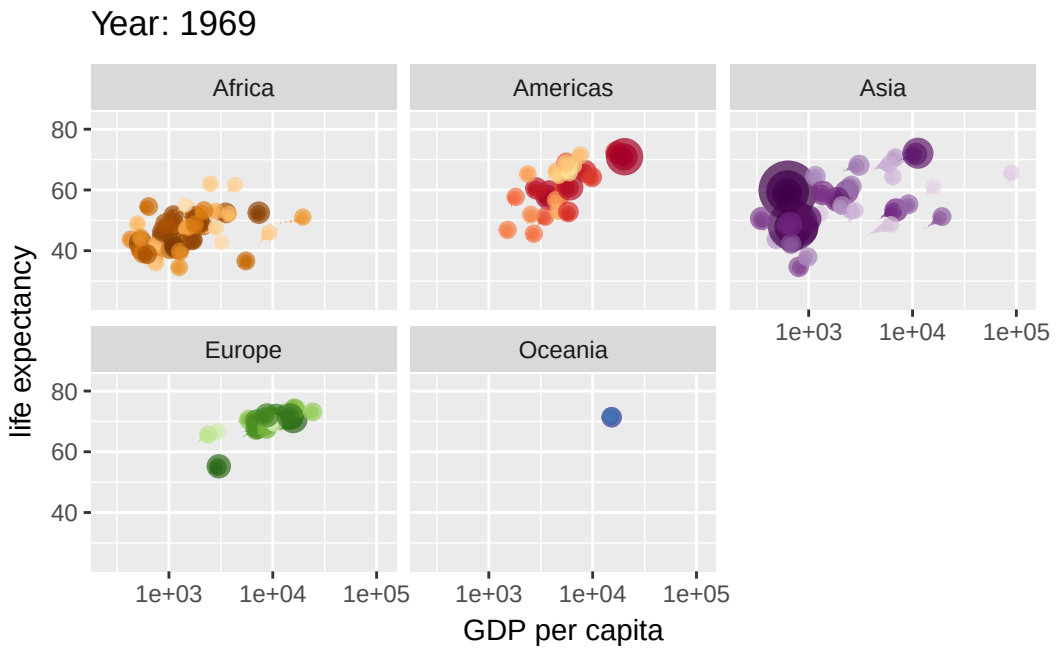
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

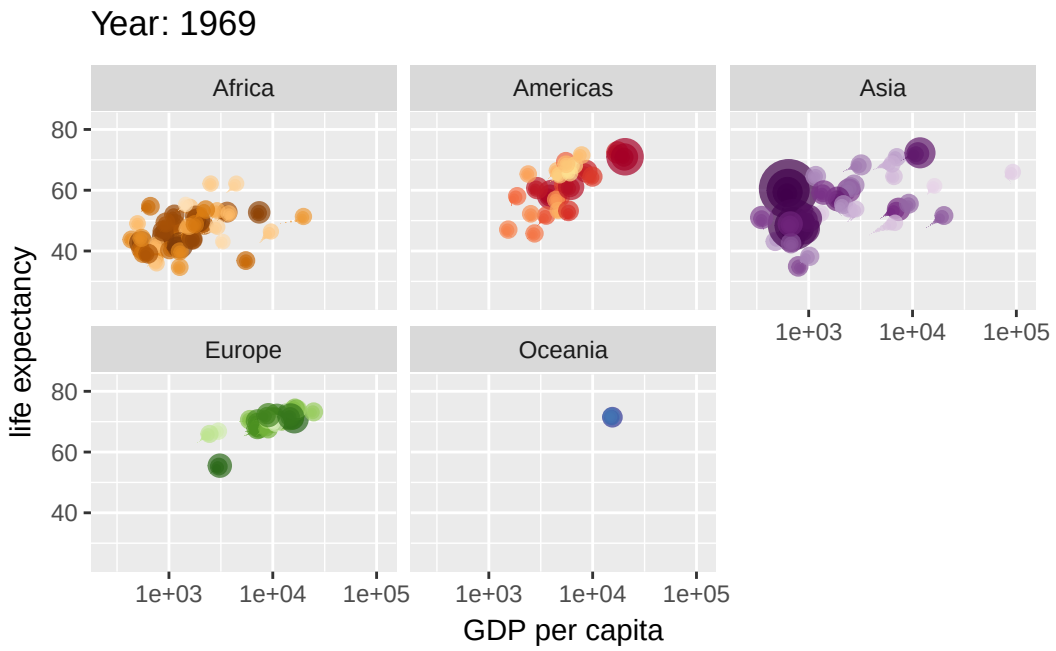

Year: 1966
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

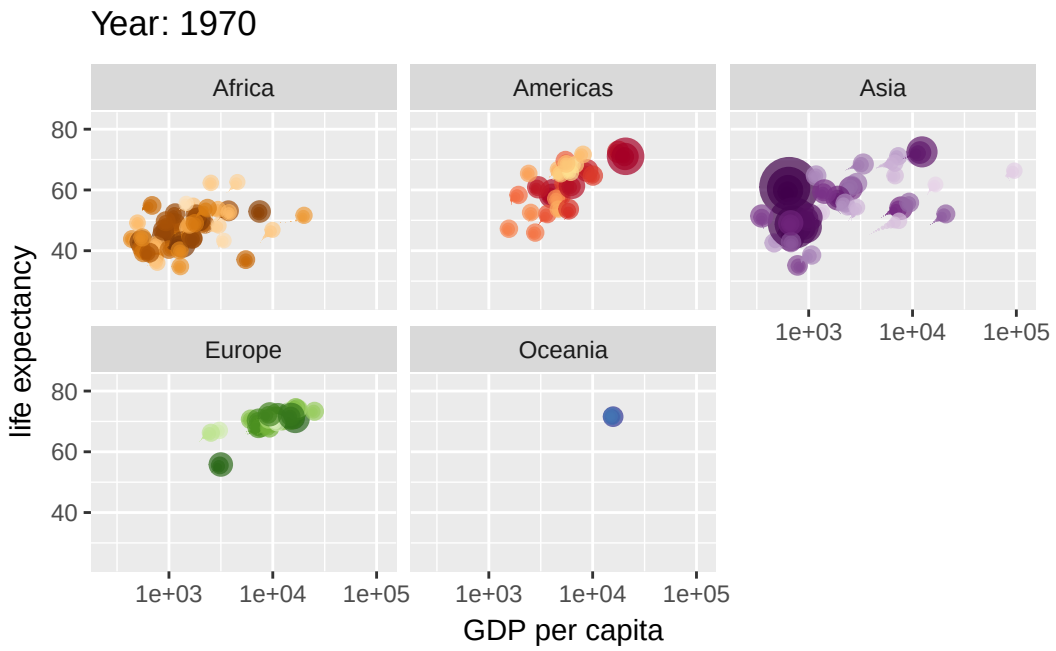

Year: 1967
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

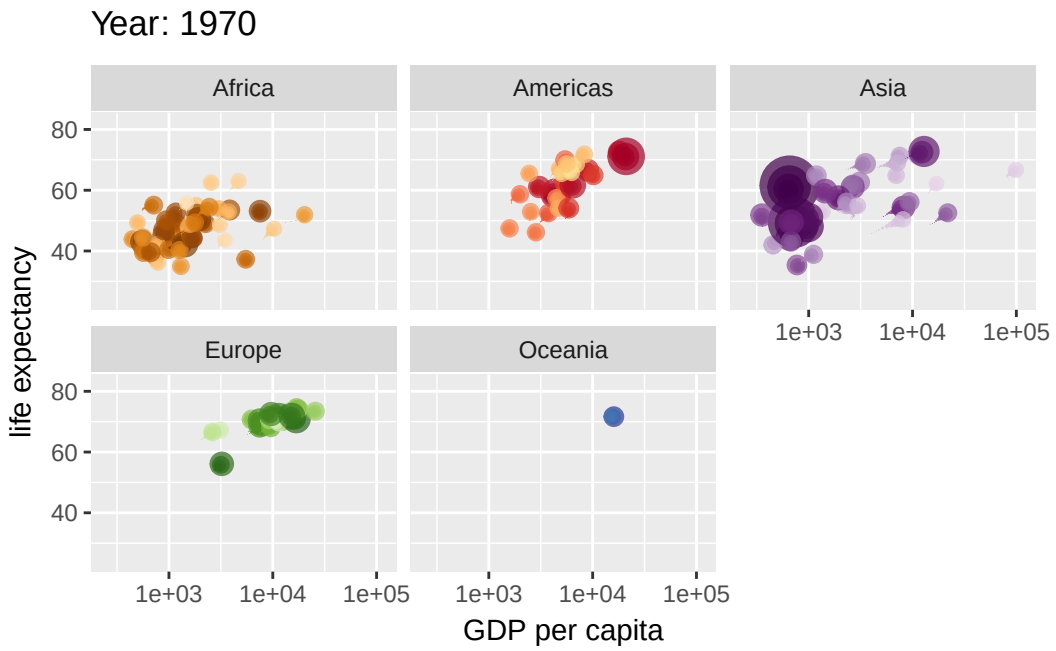

Year: 1968
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

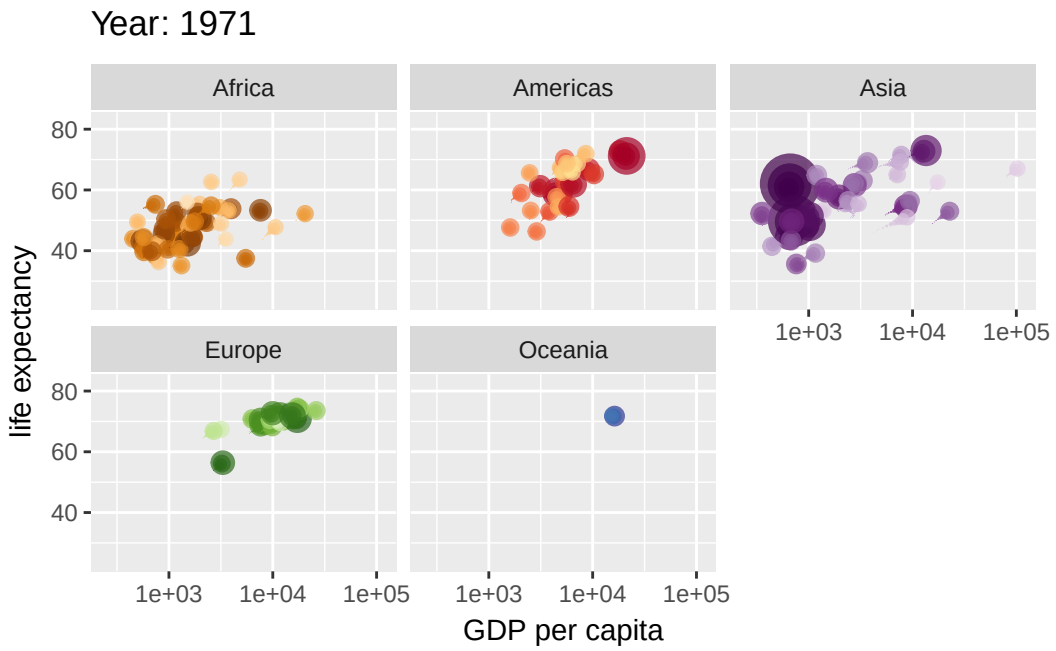

Year: 1968
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

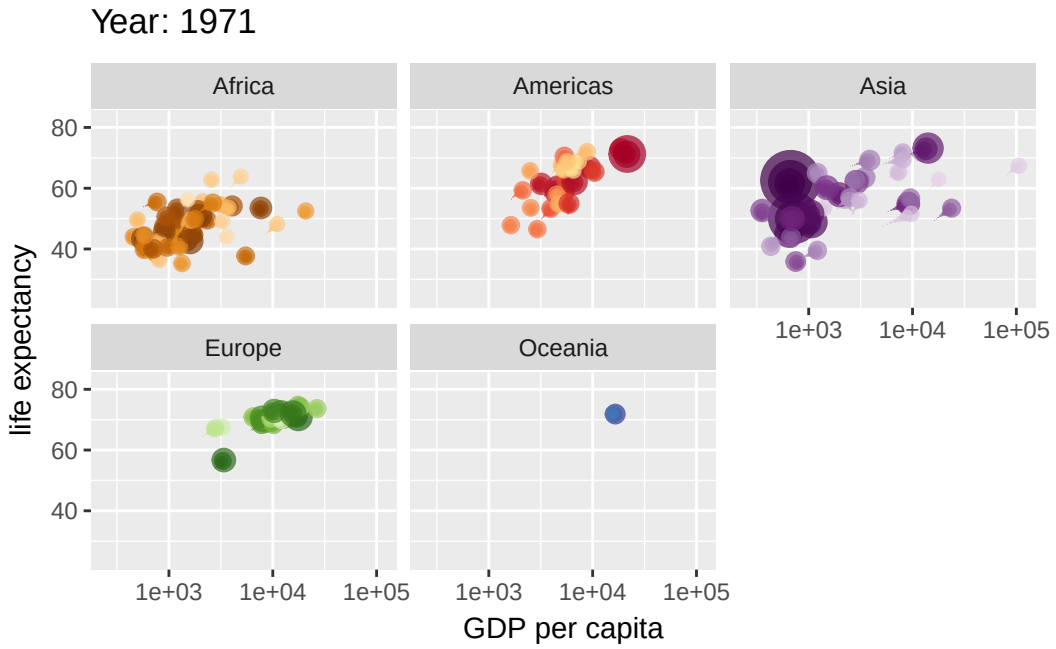

Year: 1969
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

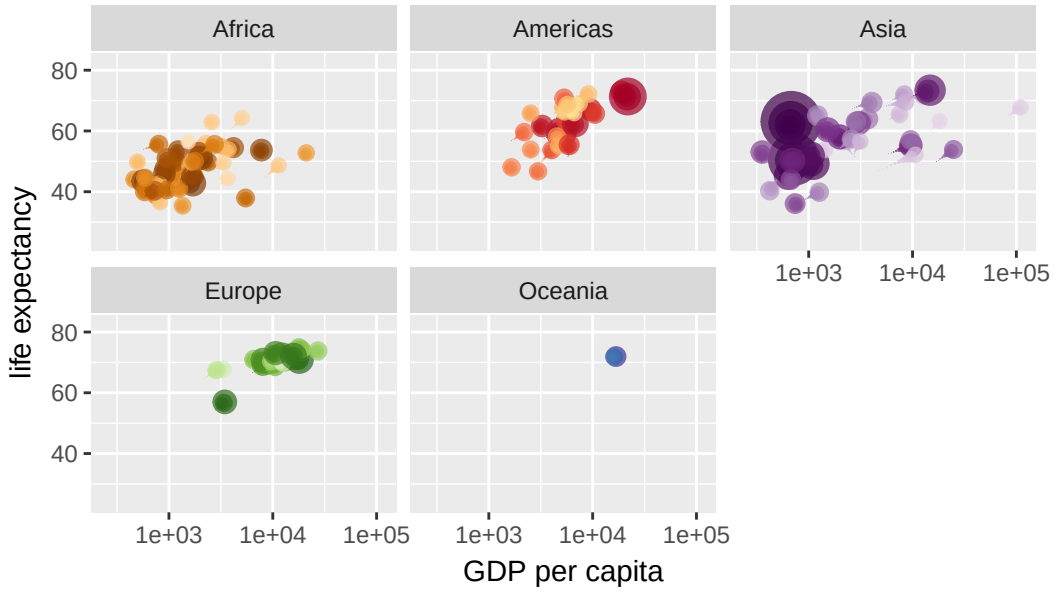

Year: 1969
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

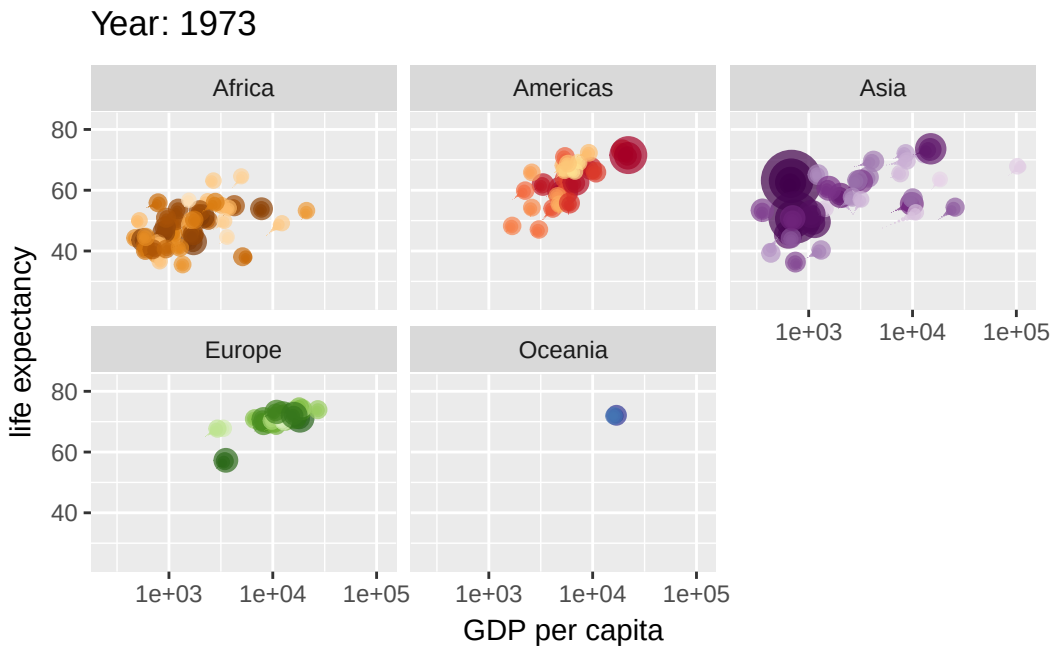

Year: 1970
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

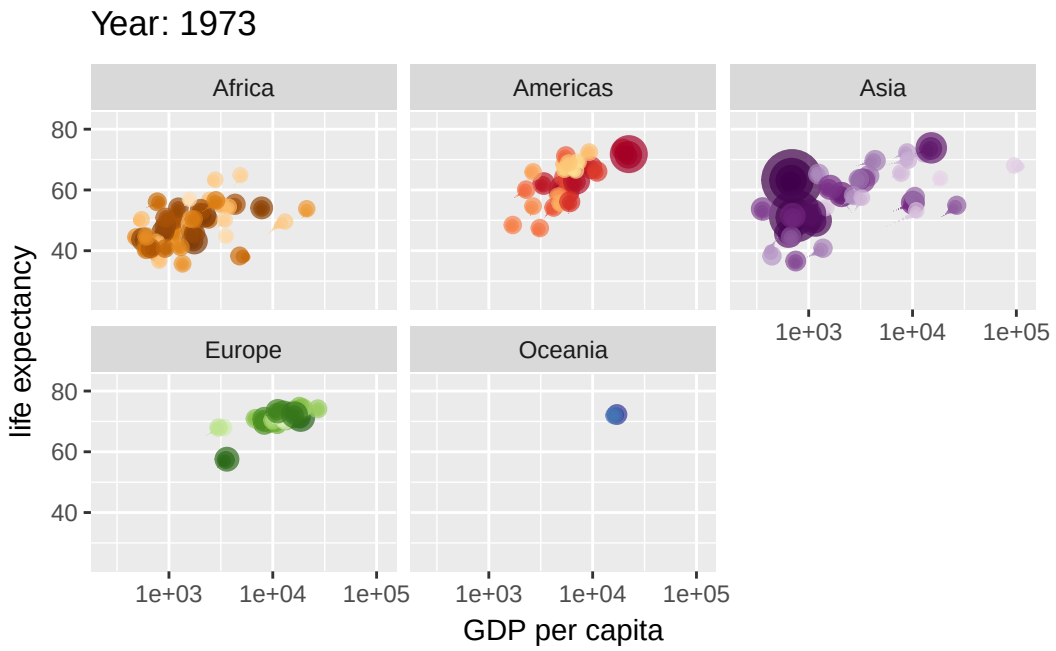

Year: 1970
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

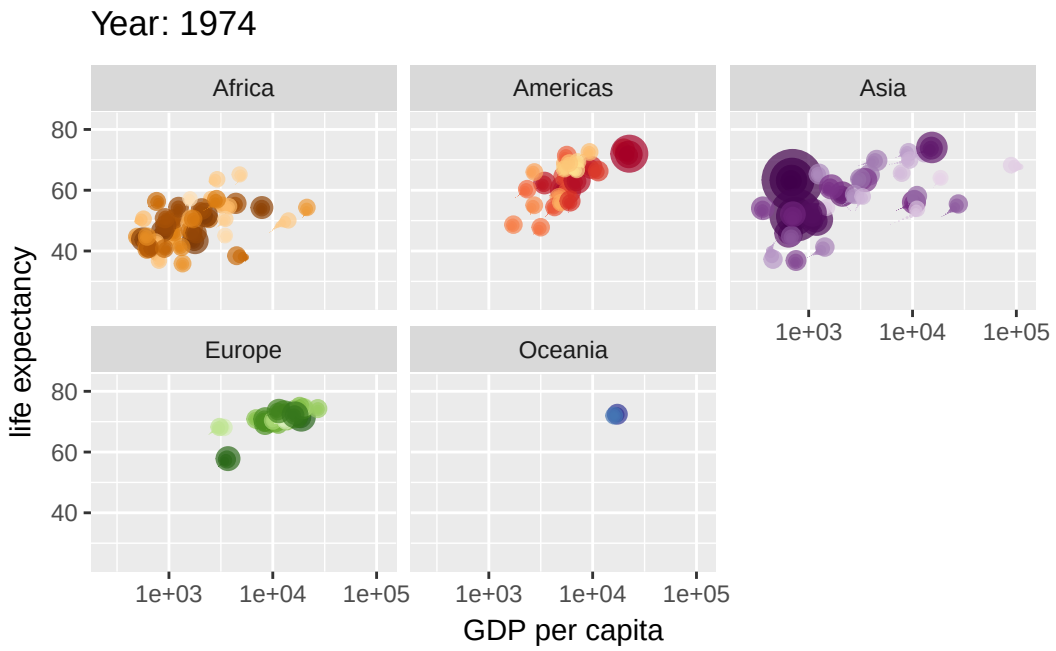

Year: 1971
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1971
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1972
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1973
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1973
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1974
Africa
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Oceania
life expectancy
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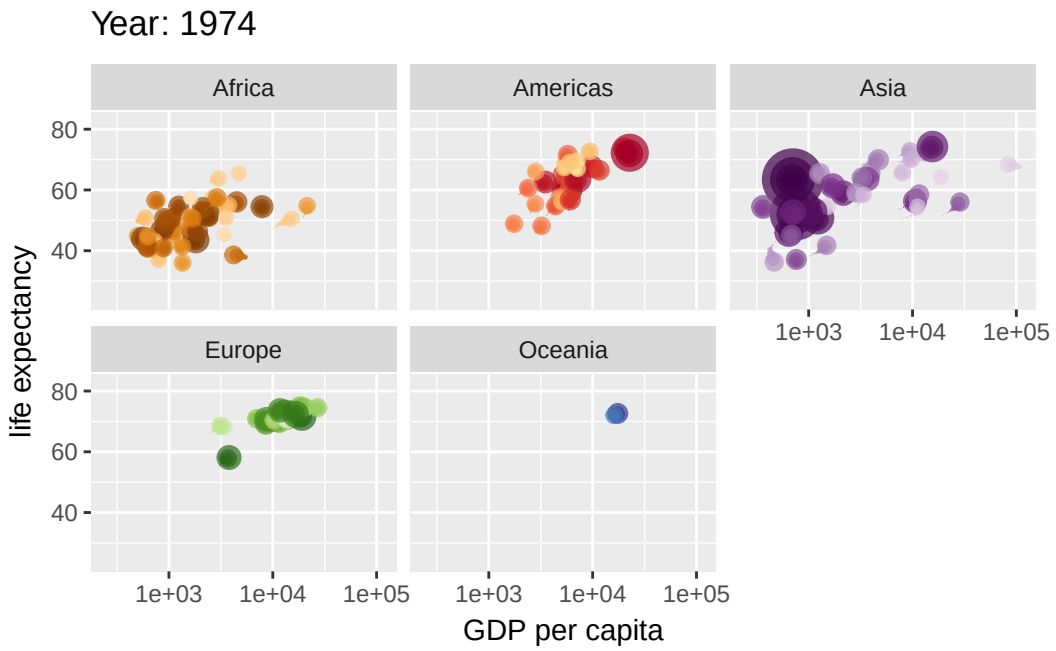
60
40
1e+03
1e+04
1e+05
GDP per capita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Africa
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Oceania
life expectancy
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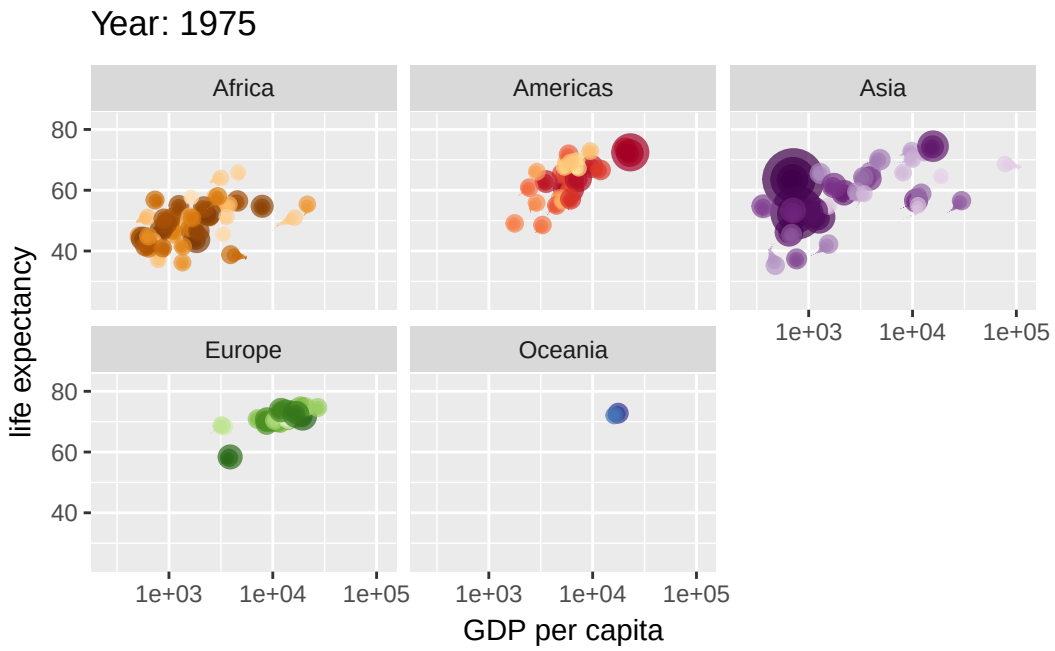
60
40
1e+03
1e+04
1e+05
GDP per capita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Africa
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Oceania
life expectancy
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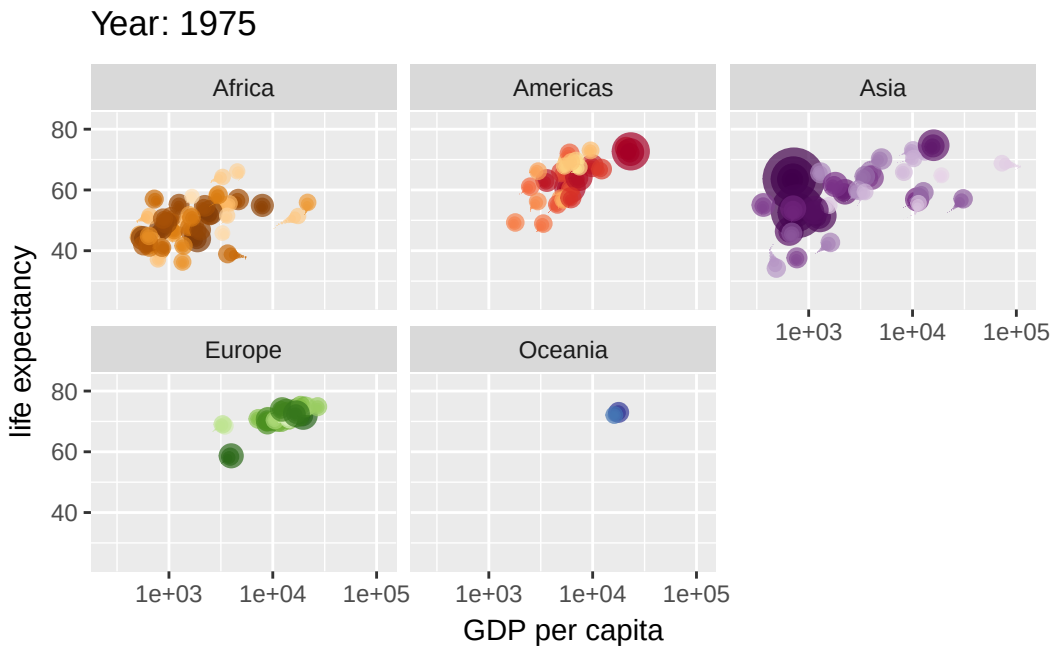
1e+05
GDP per capita


Year: 1975
Africa
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Oceania
life expectancy
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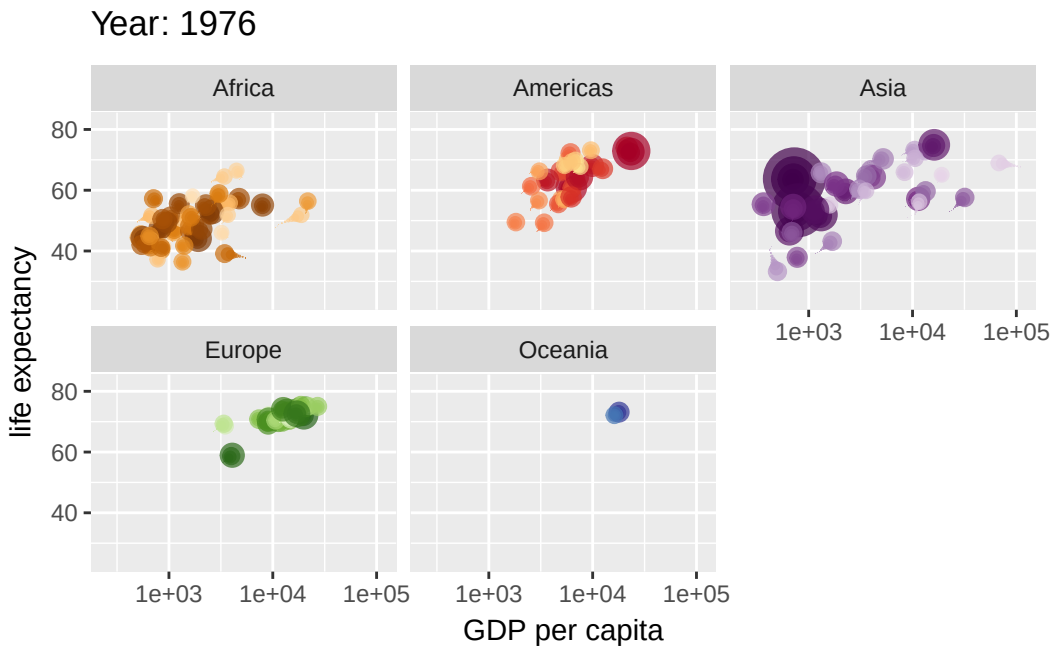
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1976
Africa
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Oceania
life expectancy
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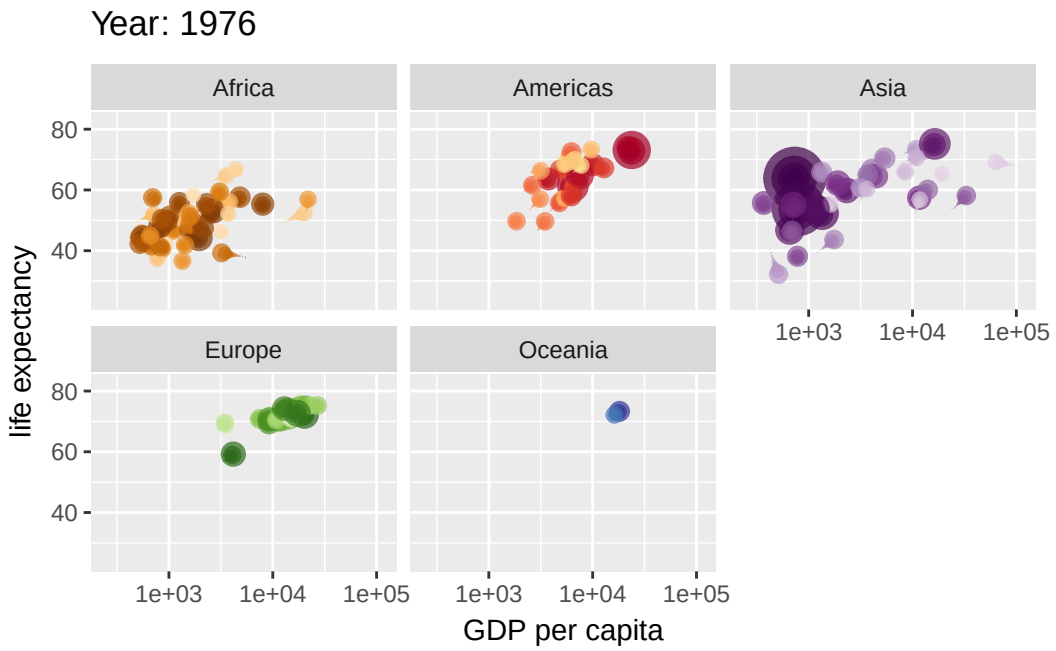
1e+03
1e+04
1e+05
GDP per capita


Year: 1976
Africa
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Oceania
life expectancy
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1e+03
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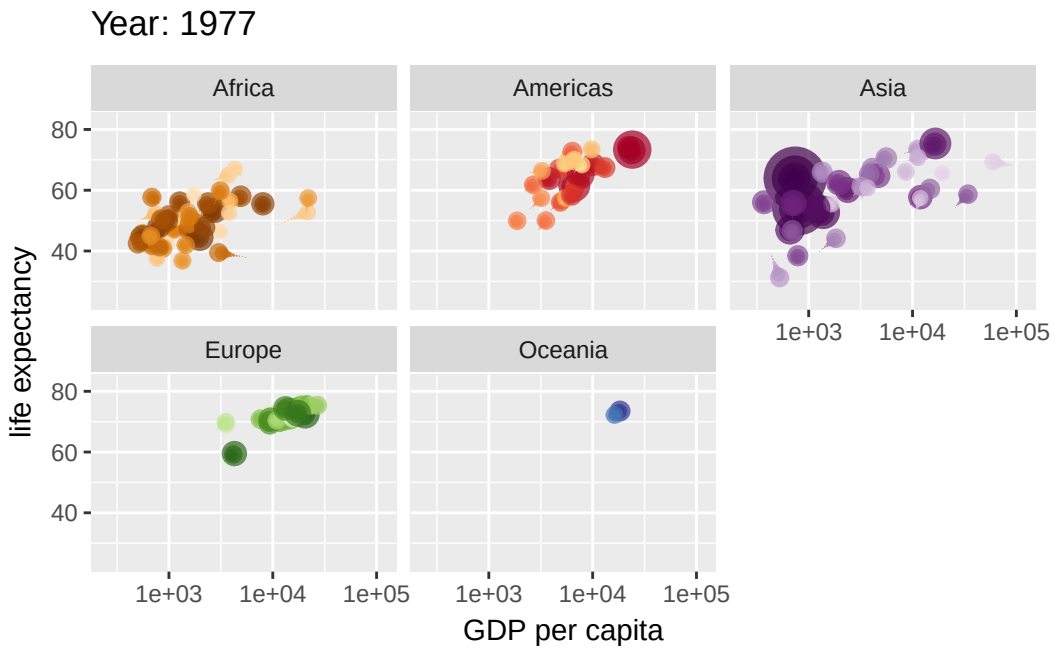
1e+05
GDP per capita


Year: 1977
Africa
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Europe
Oceania
life expectancy
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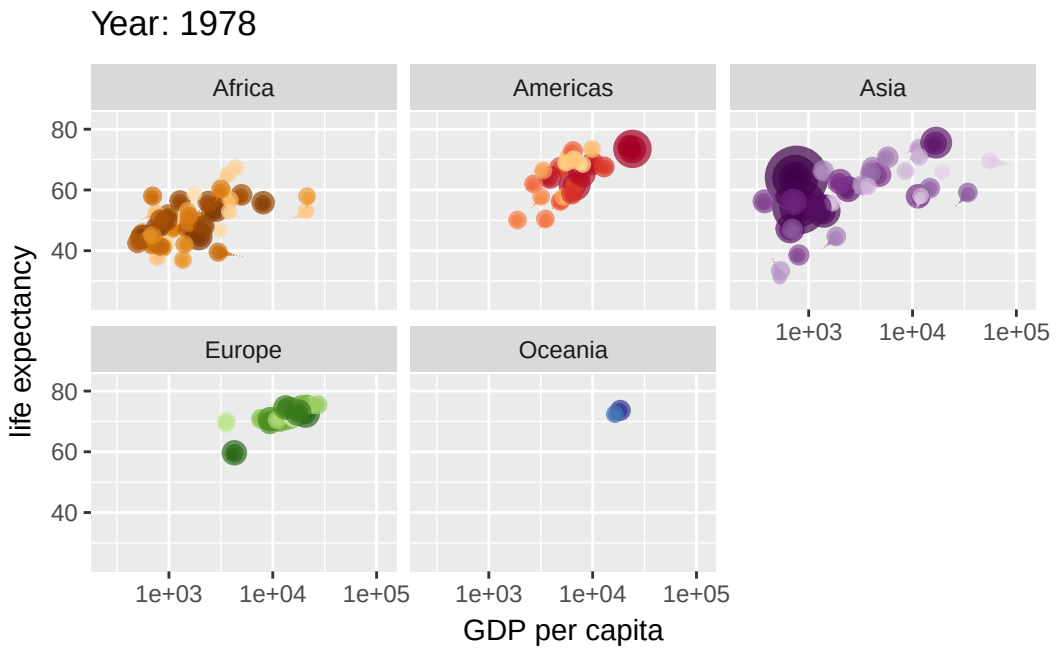
1e+03
1e+04
1e+05
GDP per capita


Year: 1978
Africa
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Oceania
life expectancy
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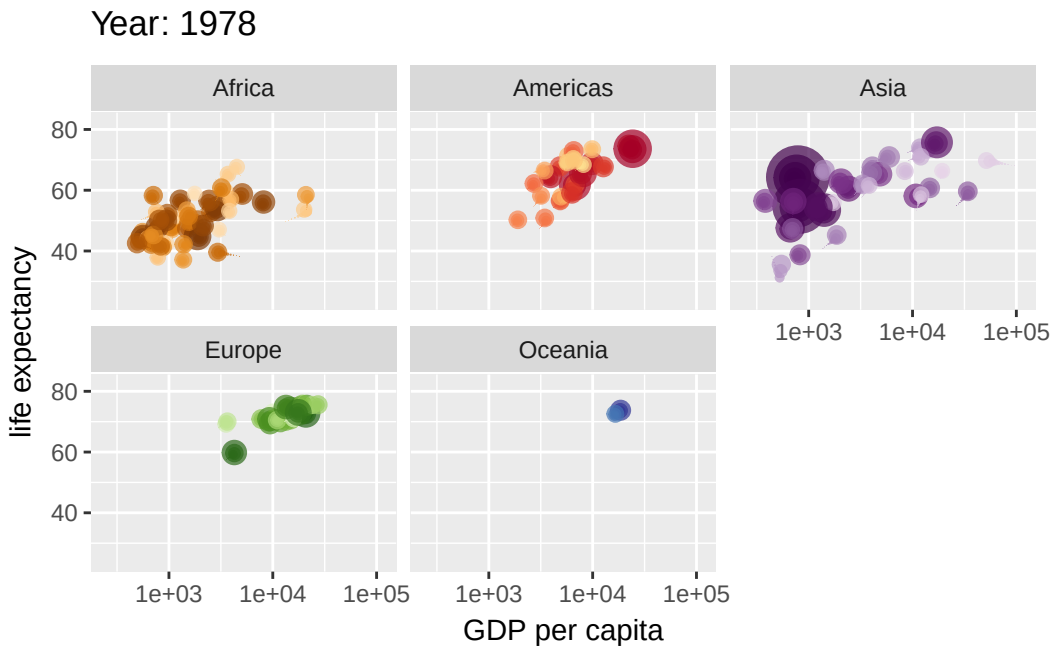
1e+03
1e+04
1e+05
GDP per capita


Year: 1978
Africa
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Oceania
life expectancy
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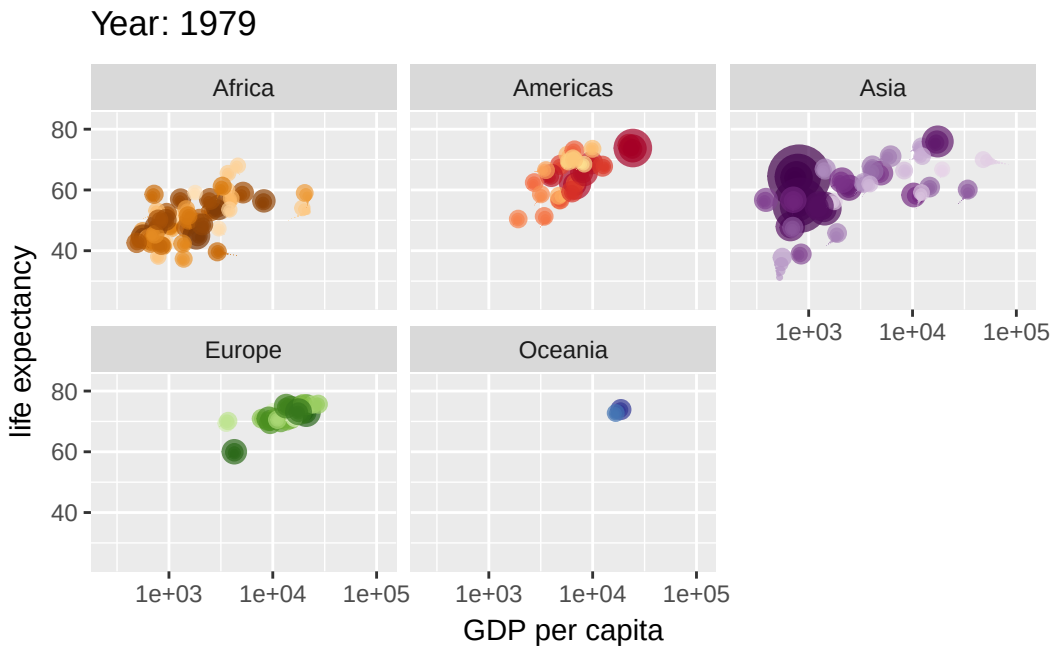
1e+03
1e+04
1e+05
GDP per capita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Africa
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Oceania
life expectancy
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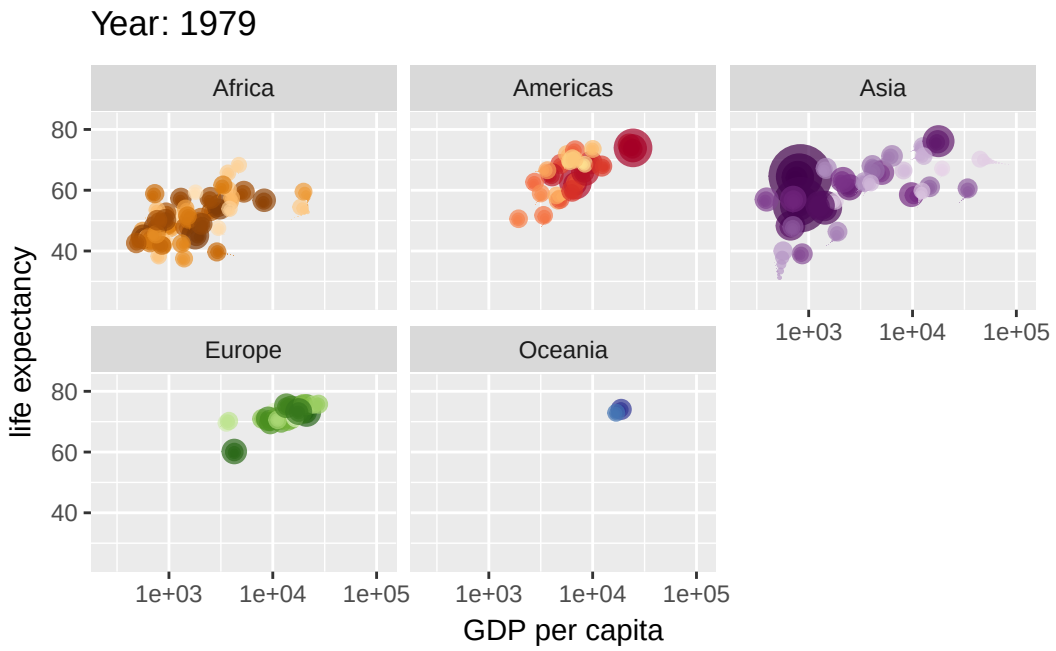
1e+03
1e+04
1e+05
GDP per capita


Year: 1979
Africa
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Asia
Europe
Oceania
life expectancy
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60
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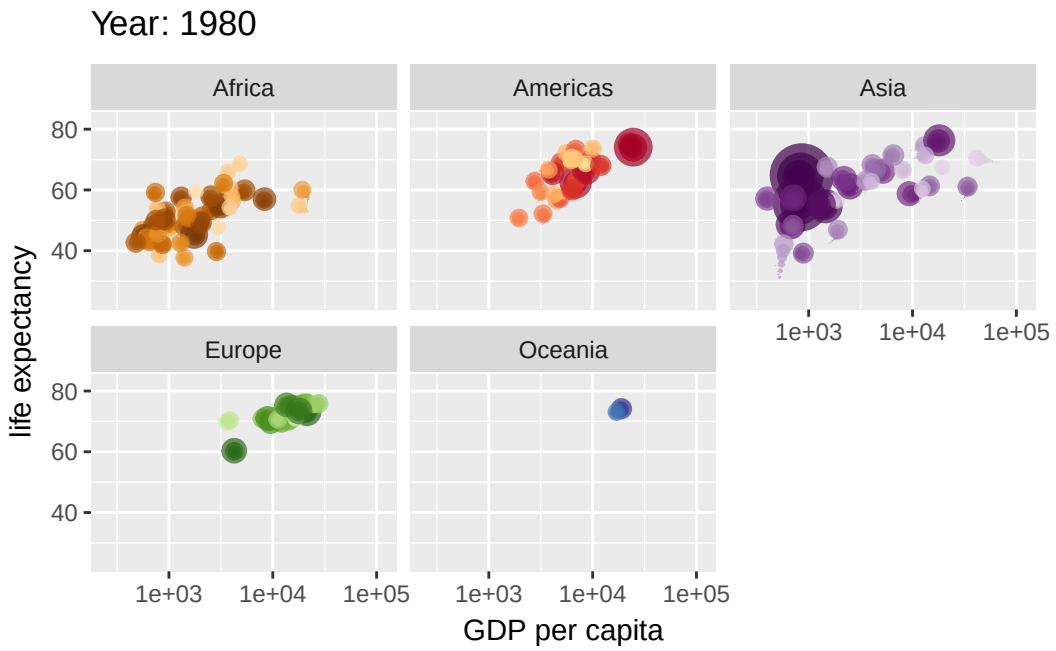
1e+03
1e+04
1e+05
GDP per capita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Africa
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Europe
Oceania
life expectancy
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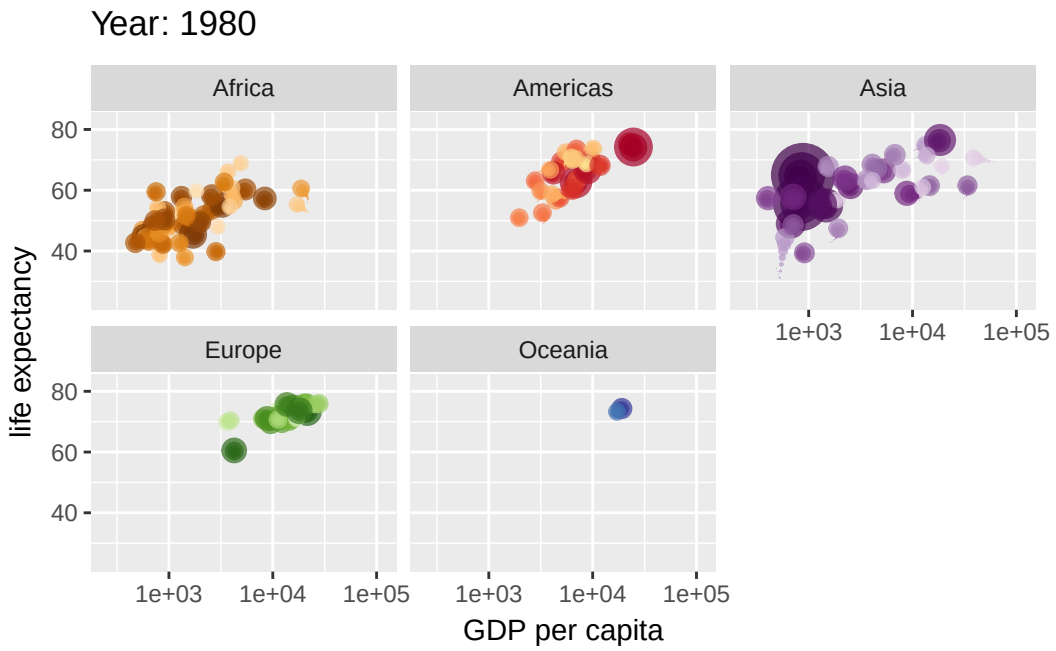
1e+03
1e+04
1e+05
GDP per capita


Year: 1980
Africa
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Asia
Europe
Oceania
life expectancy
80
60
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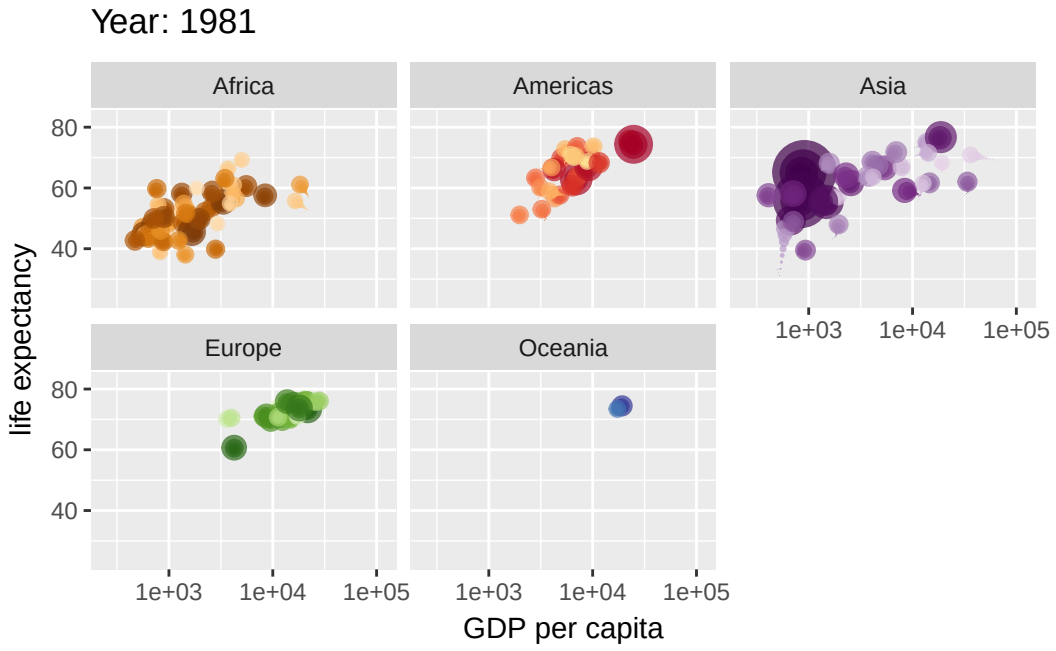
1e+03
1e+04
1e+05
GDP per capita


Year: 1981
Africa
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Asia
Europe
Oceania
life expectancy
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60
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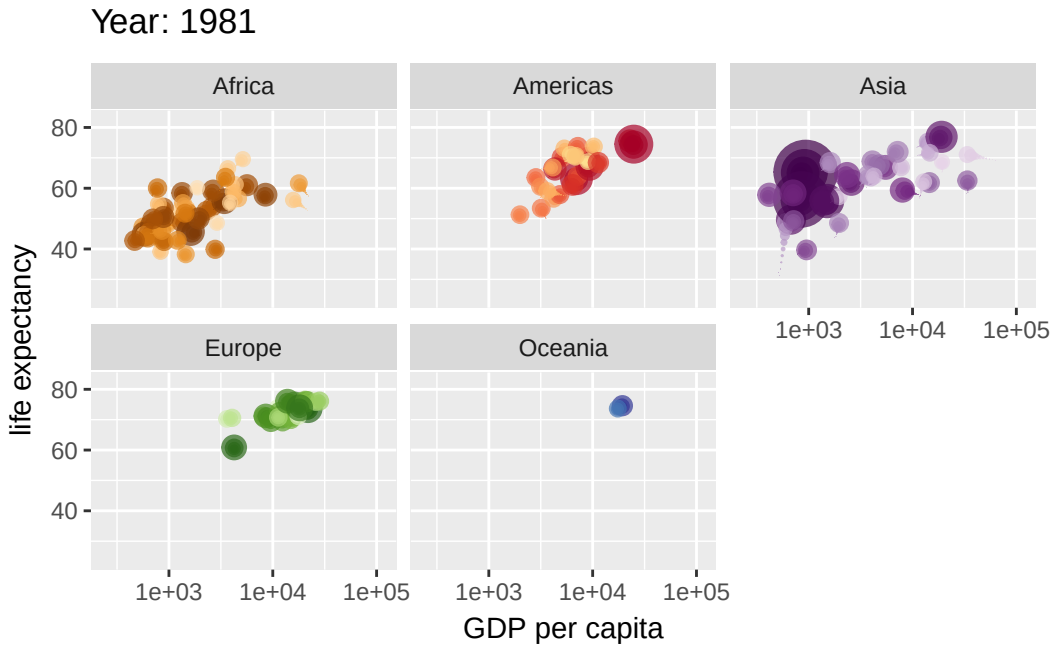
1e+03
1e+04
1e+05
GDP per capita


Year: 1981
Africa
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Asia
Europe
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life expectancy
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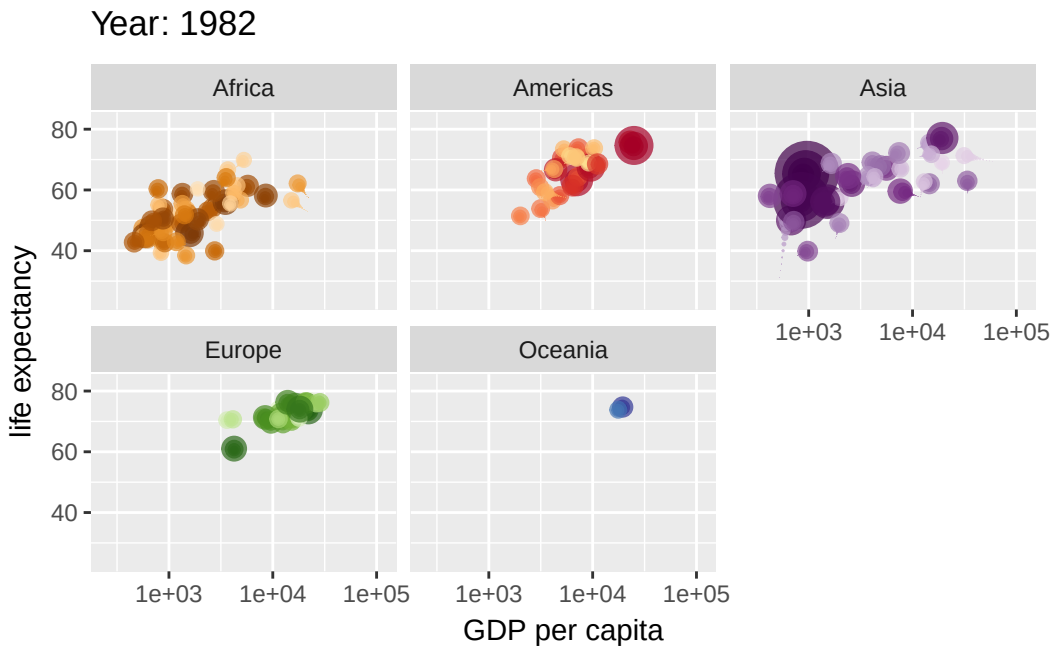
1e+03
1e+04
1e+05
GDP per capita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Africa
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Asia
Europe
Oceania
life expectancy
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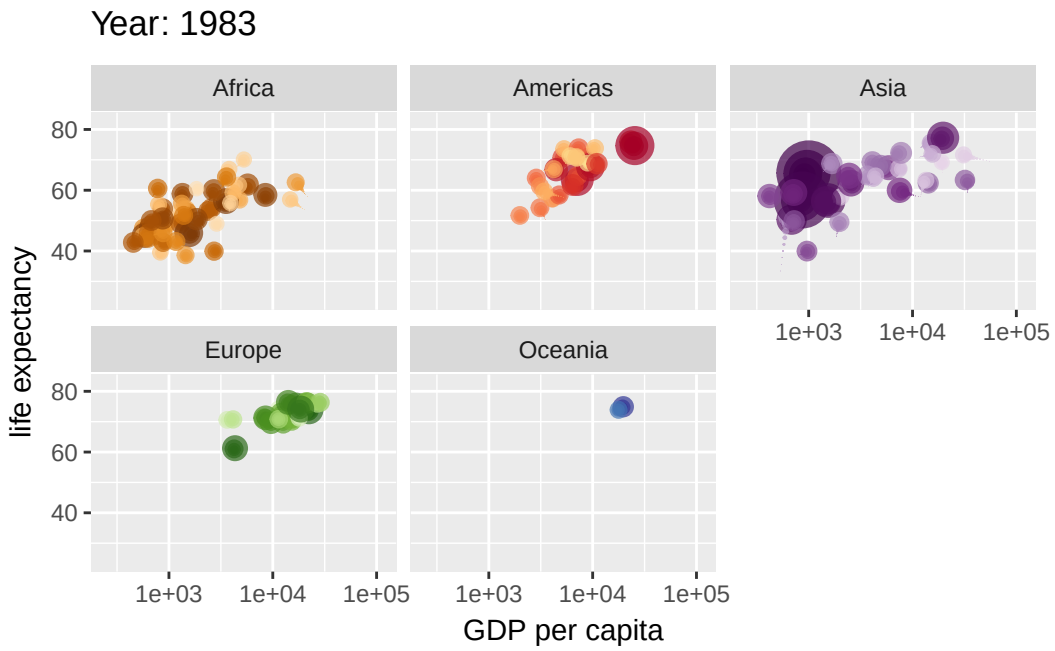
1e+03
1e+04
1e+05
GDP per capita


Year: 1983
Africa
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Oceania
life expectancy
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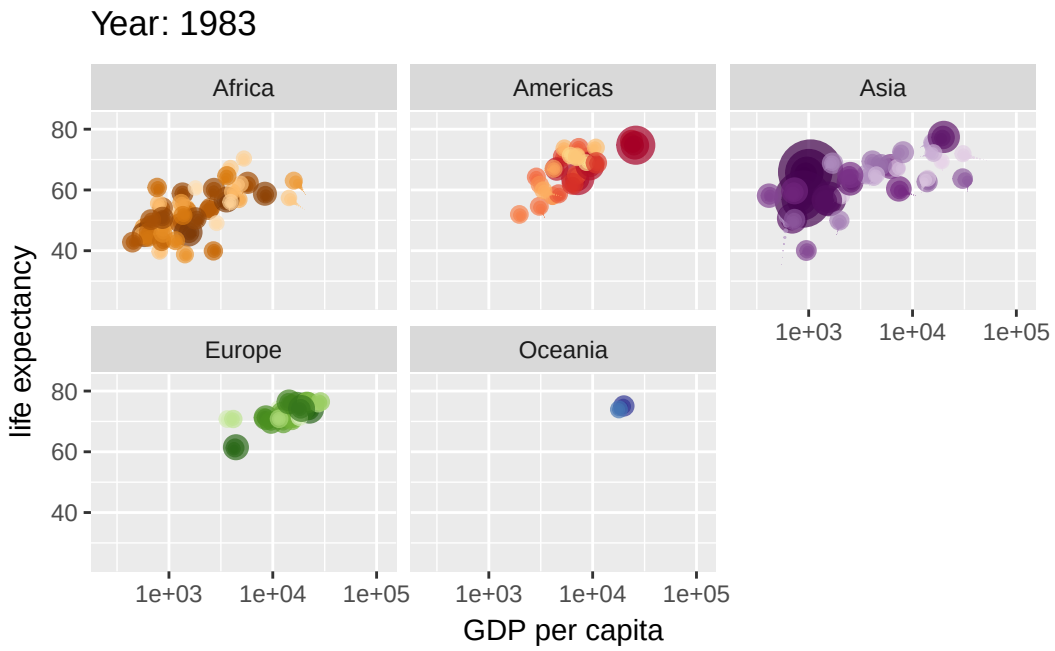
1e+03
1e+04
1e+05
GDP per capita


Year: 1983
Africa
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Asia
Europe
Oceania
life expectancy
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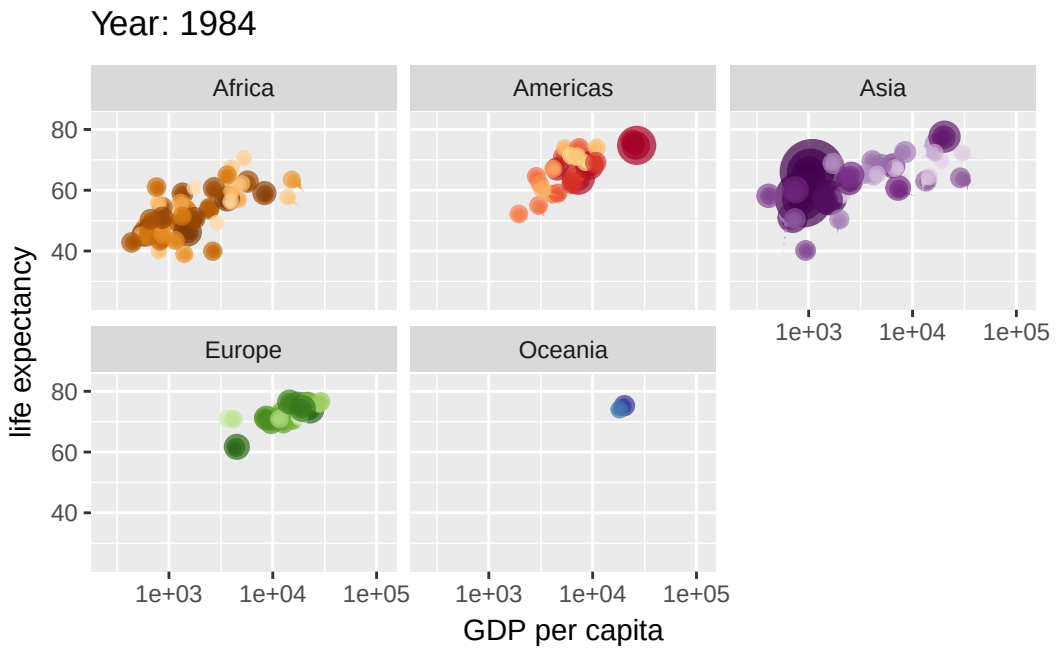
1e+03
1e+04
1e+05
GDP per capita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Africa
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Europe
Oceania
life expectancy
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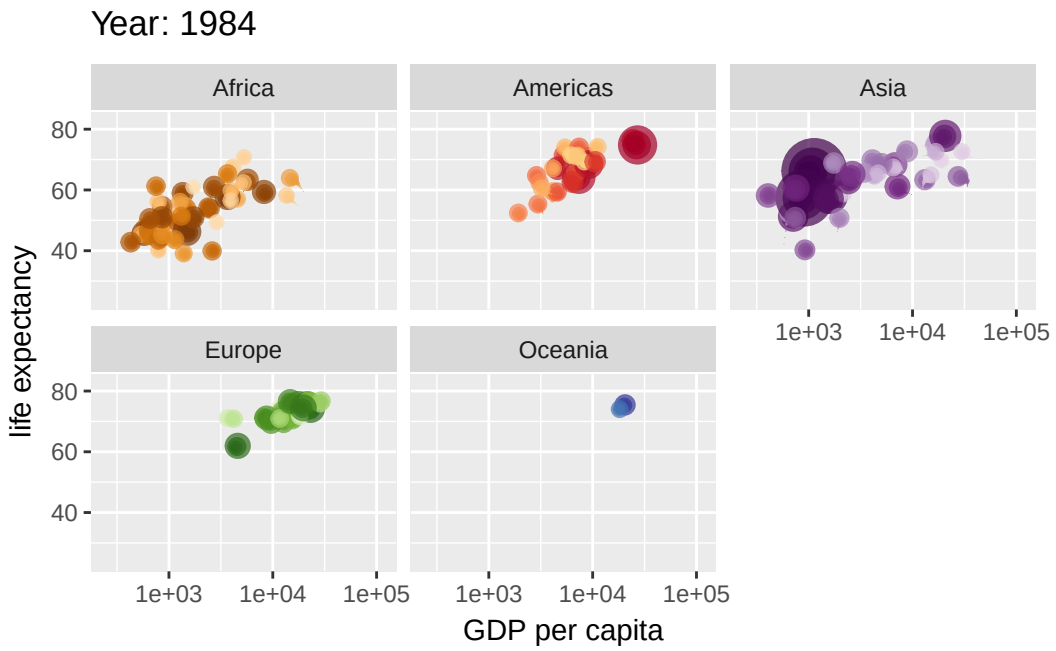
1e+03
1e+04
1e+05
GDP per capita


Year: 1984
Africa
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Europe
Oceania
life expectancy
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1e+03
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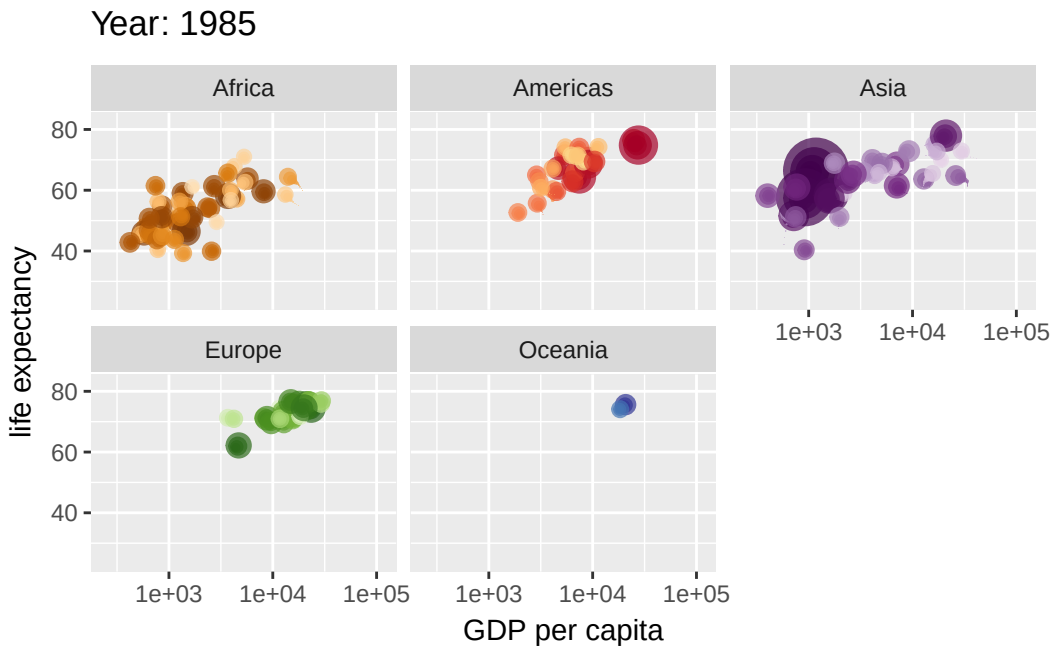
GDP per capita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Africa
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Europe
Oceania
life expectancy
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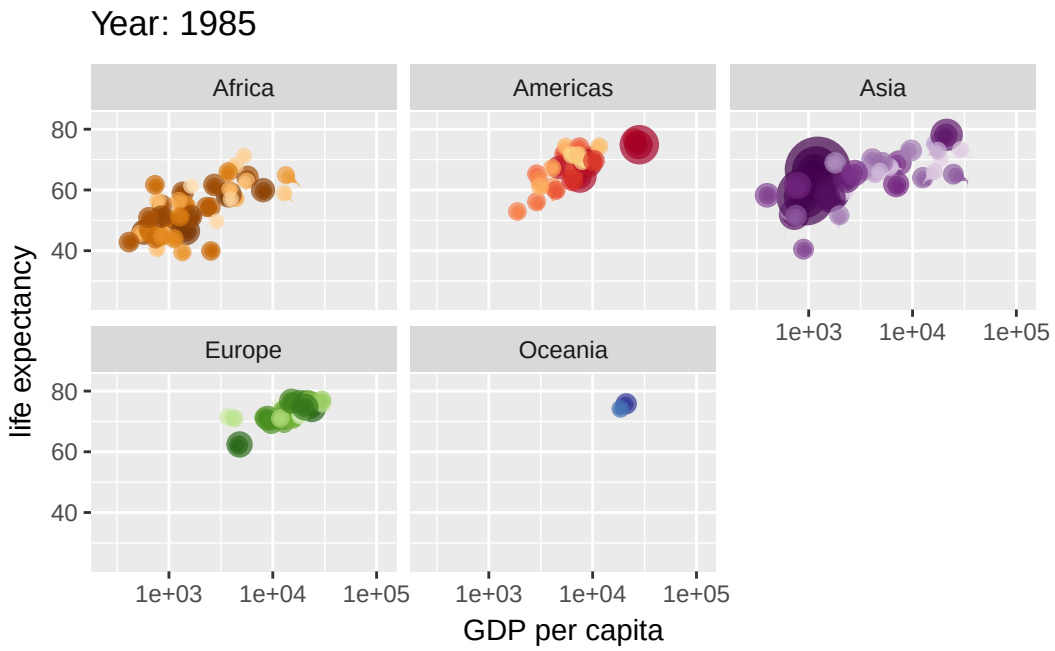
1e+03
1e+04
1e+05
GDP per capita


Year: 1985
Africa
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Oceania
life expectancy
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1e+03
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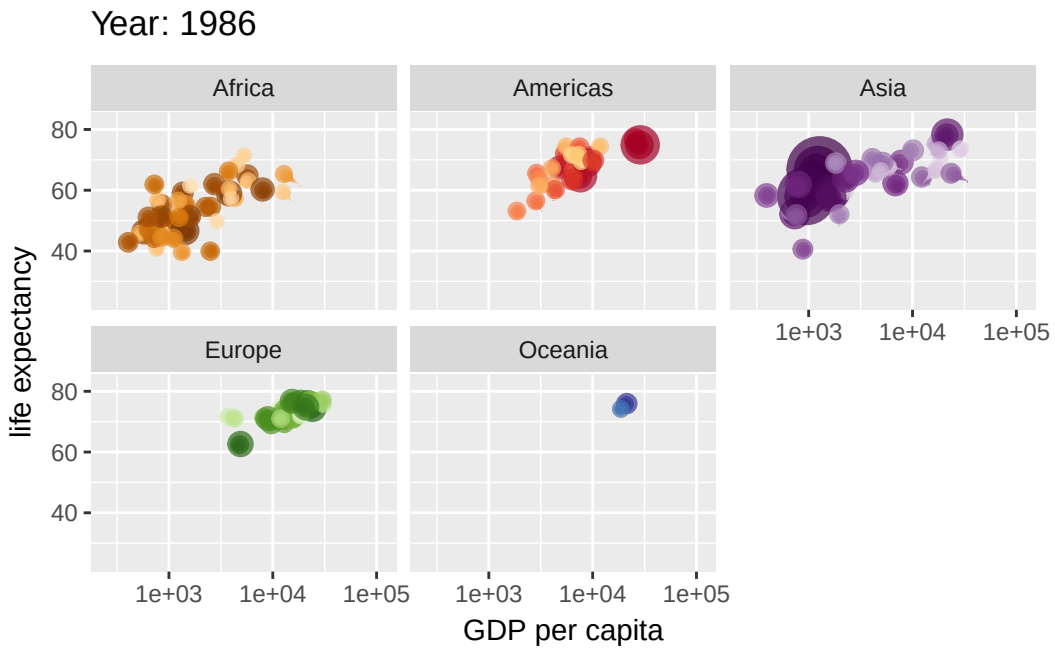
1e+05
GDP per capita


Year: 1986
Africa
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Oceania
life expectancy
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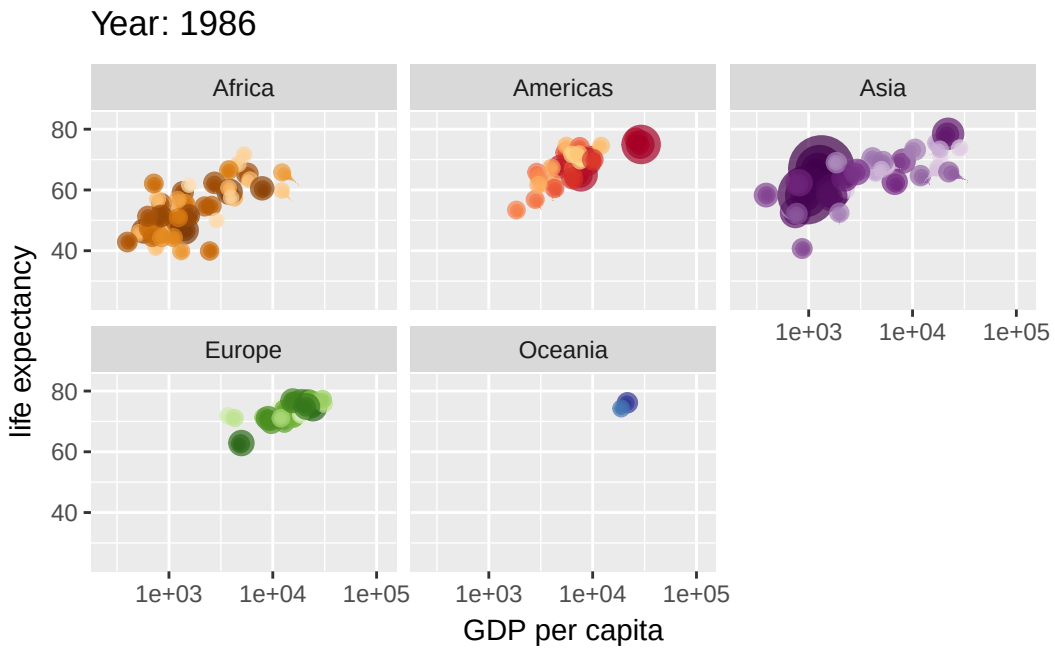
GDP per capita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Africa
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life expectancy
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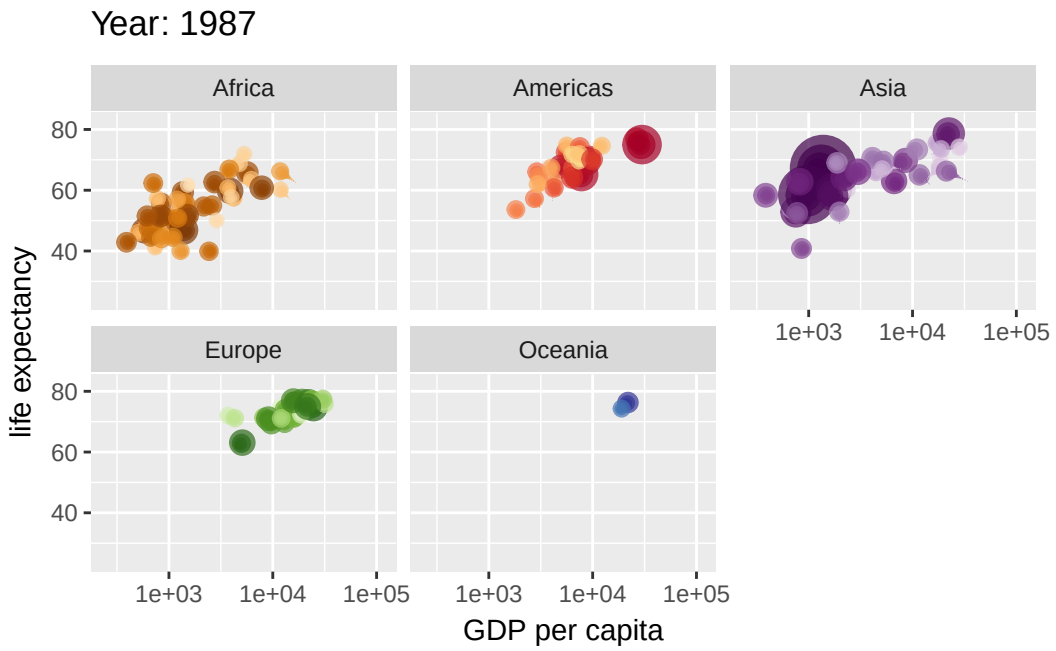
GDP per capita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life expectancy
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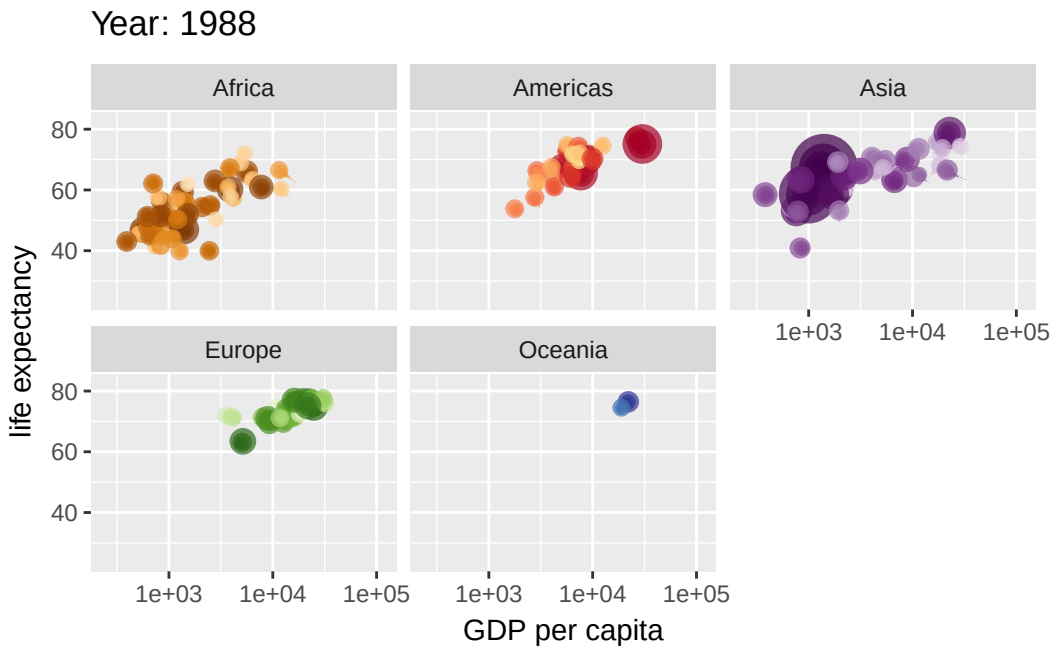
1e+05
GDP per capita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Oceania
life expectancy
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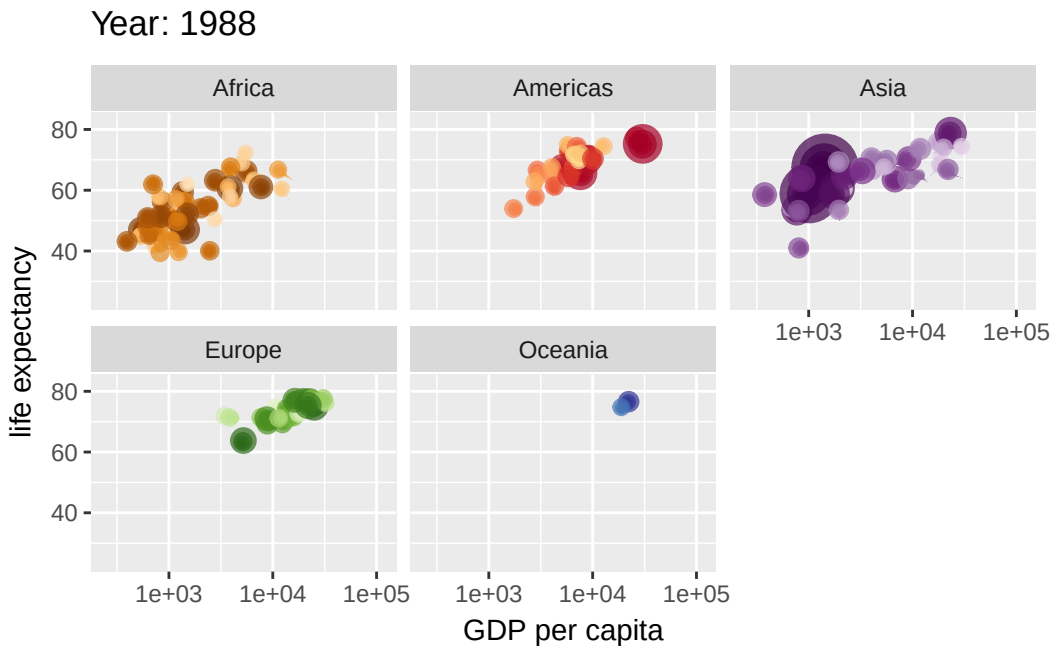
1e+03
1e+04
1e+05
GDP per capita


Year: 1988
Africa
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Europe
Oceania
life expectancy
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1e+03
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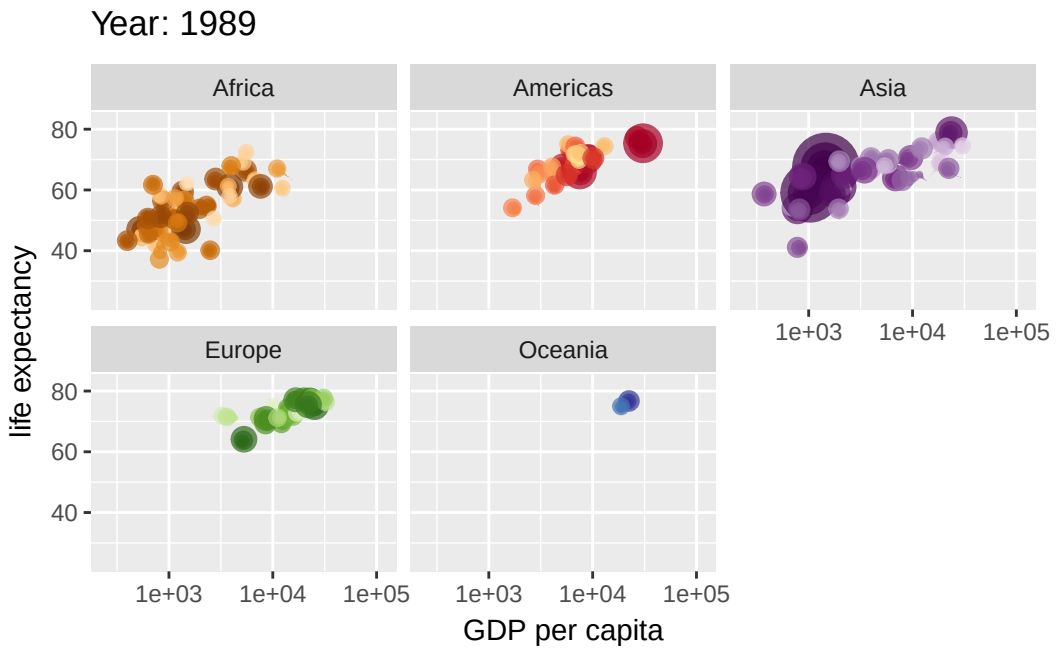
1e+05
GDP per capita


Year: 1989
Africa
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Europe
Oceania
life expectancy
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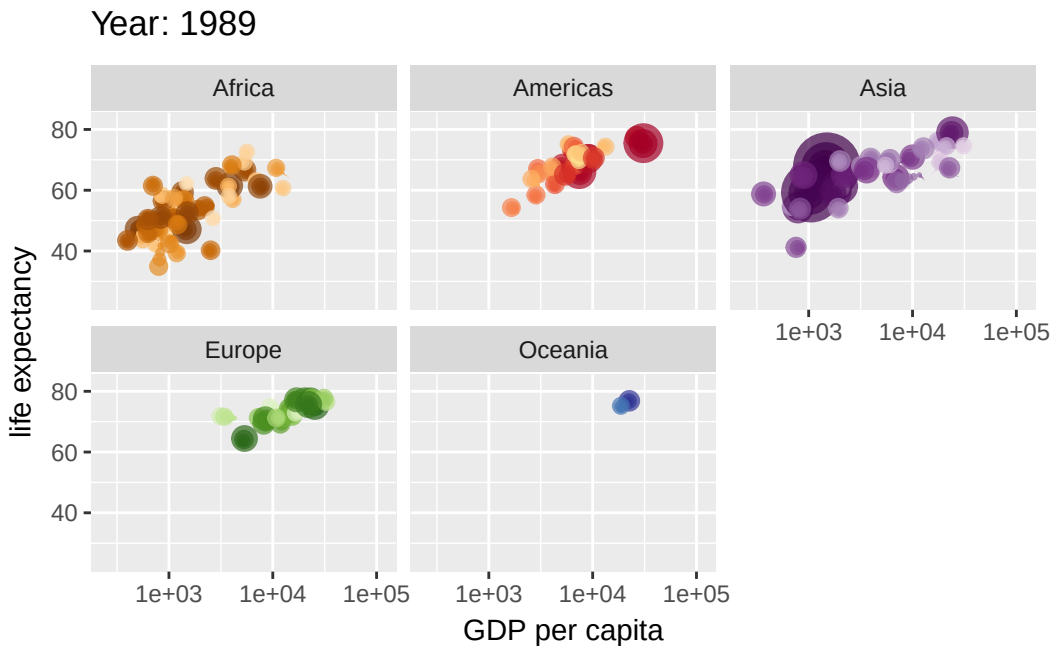
1e+03
1e+04
1e+05
GDP per capita


Year: 1989
Africa
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life expectancy
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1e+03
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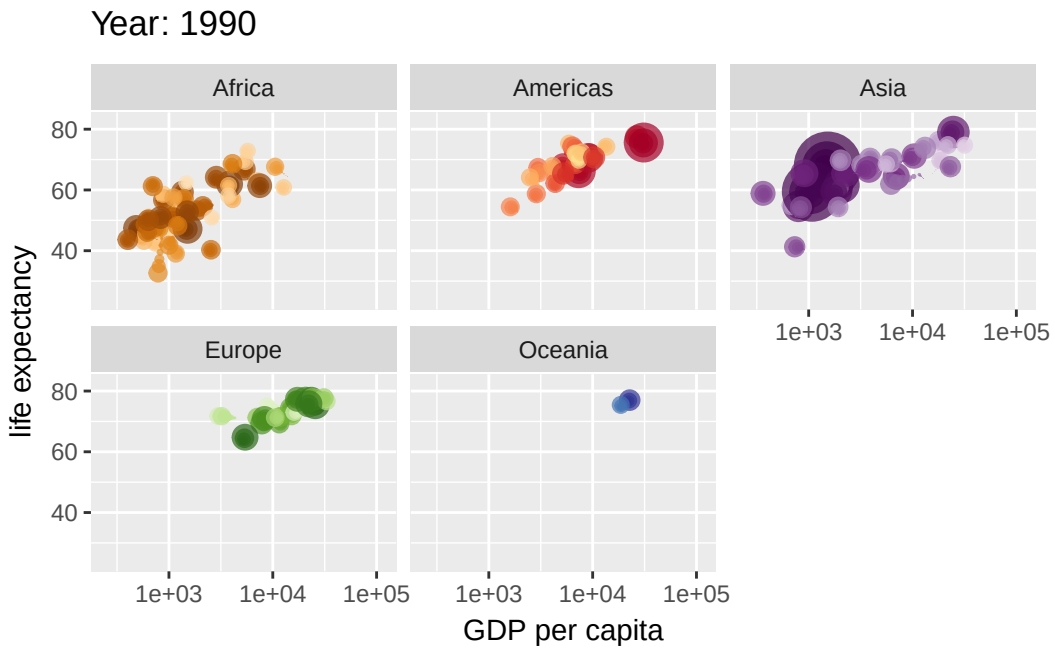
1e+05
GDP per capita


Year: 1990
Africa
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Europe
Oceania
life expectancy
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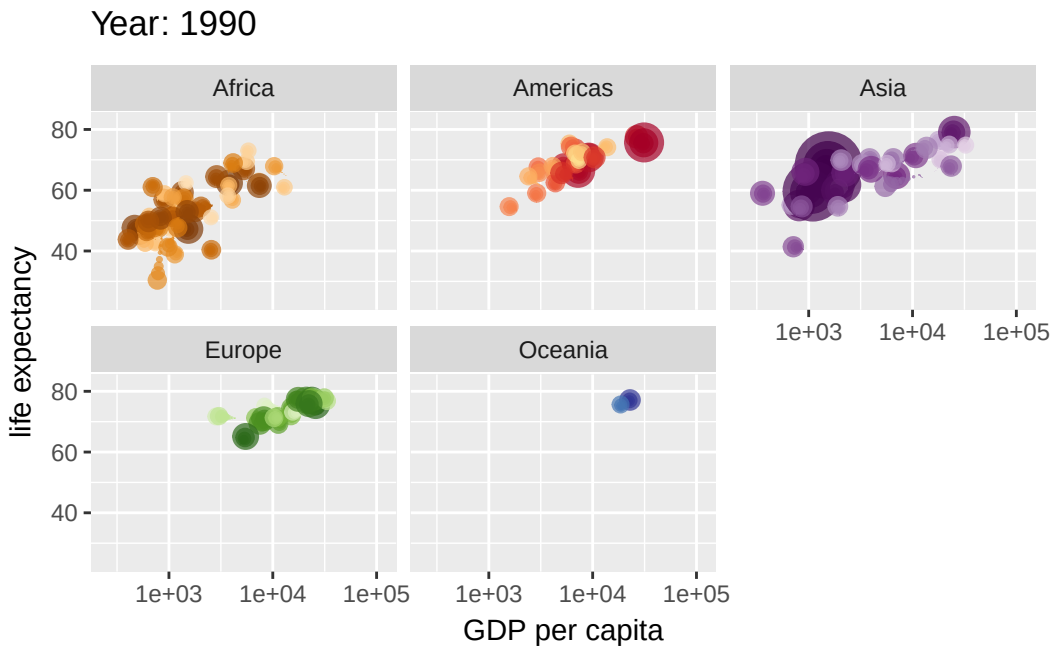
1e+03
1e+04
1e+05
GDP per capita


Year: 1990
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Oceania
life expectancy
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1e+03
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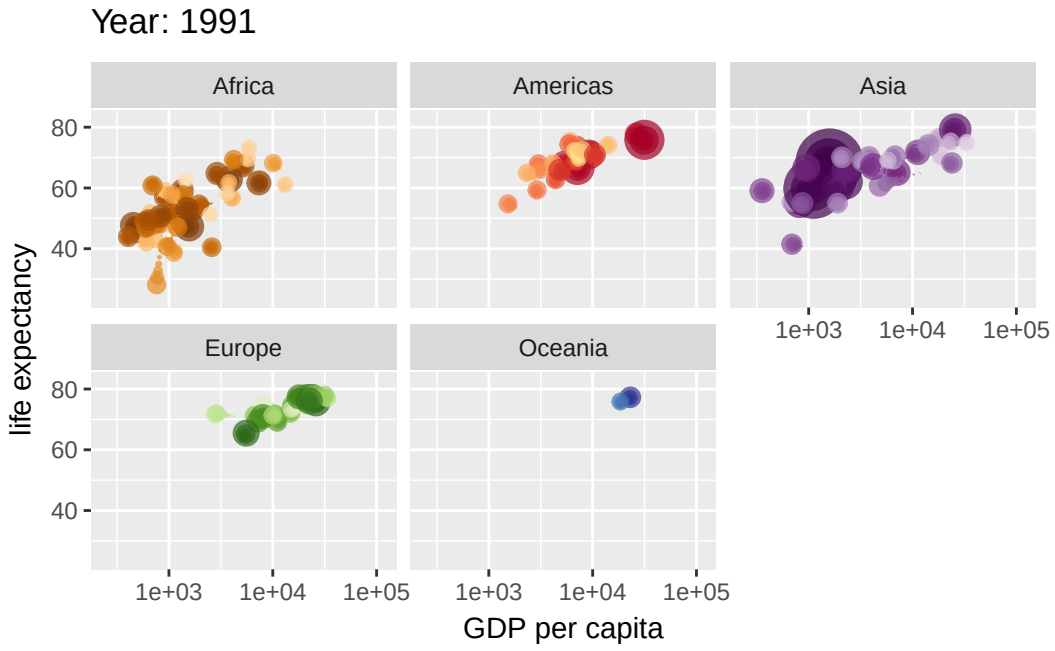
1e+05
GDP per capita


Year: 1991
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Europe
Oceania
life expectancy
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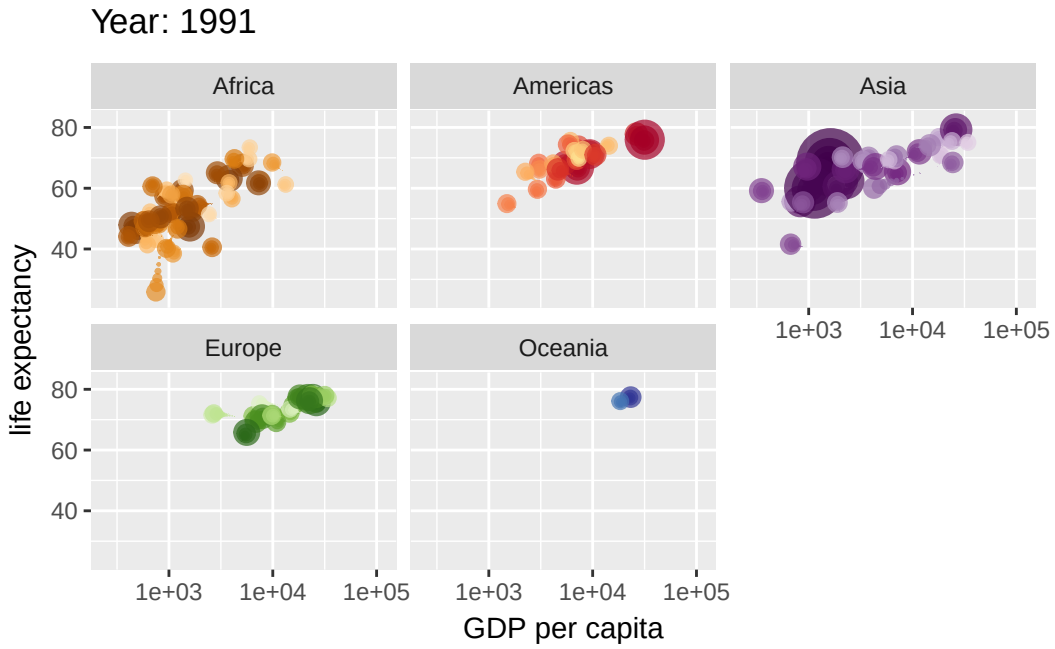
1e+03
1e+04
1e+05
GDP per capita


Year: 1991
Africa
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Asia
Europe
Oceania
life expectancy
80
60
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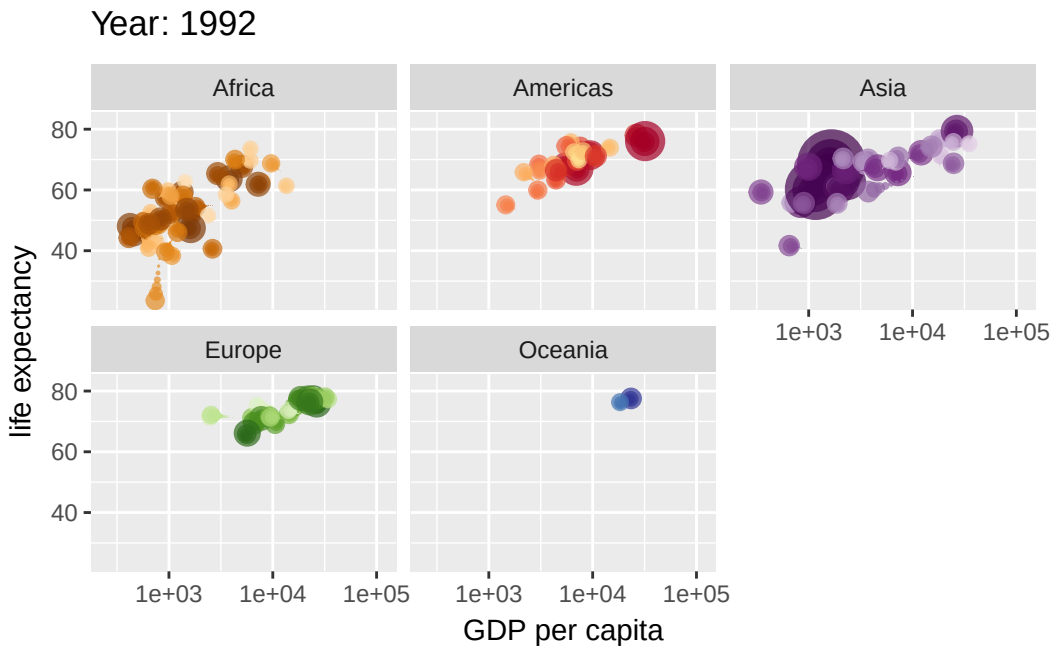
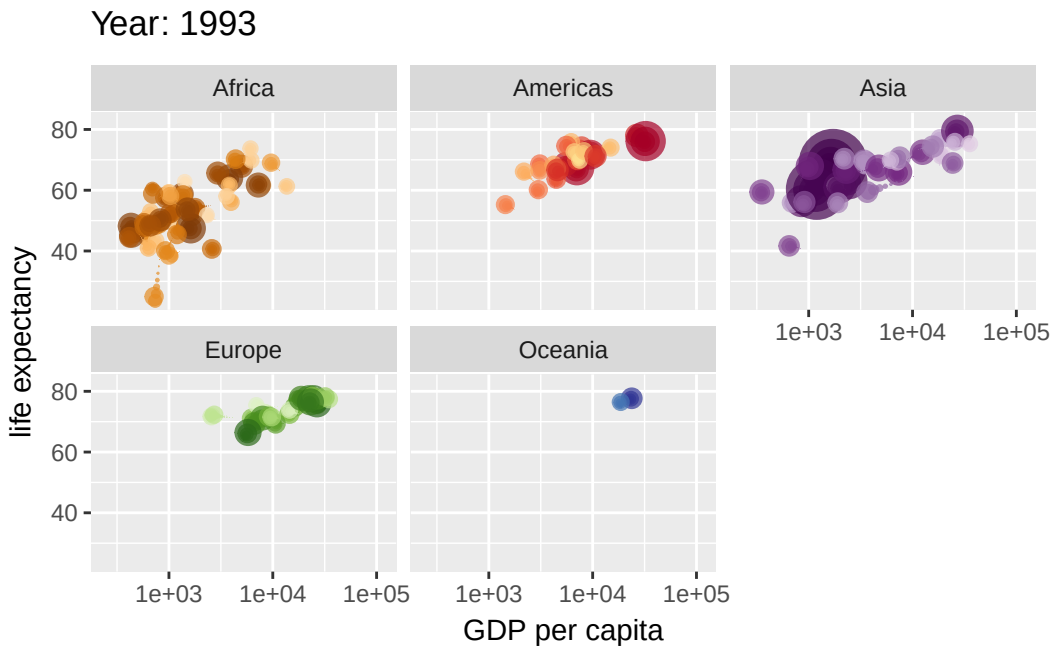
1e+03
1e+04
1e+05
GDP per capita


Year: 1992
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1993
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Asia
Europe
Oceania
life expectancy
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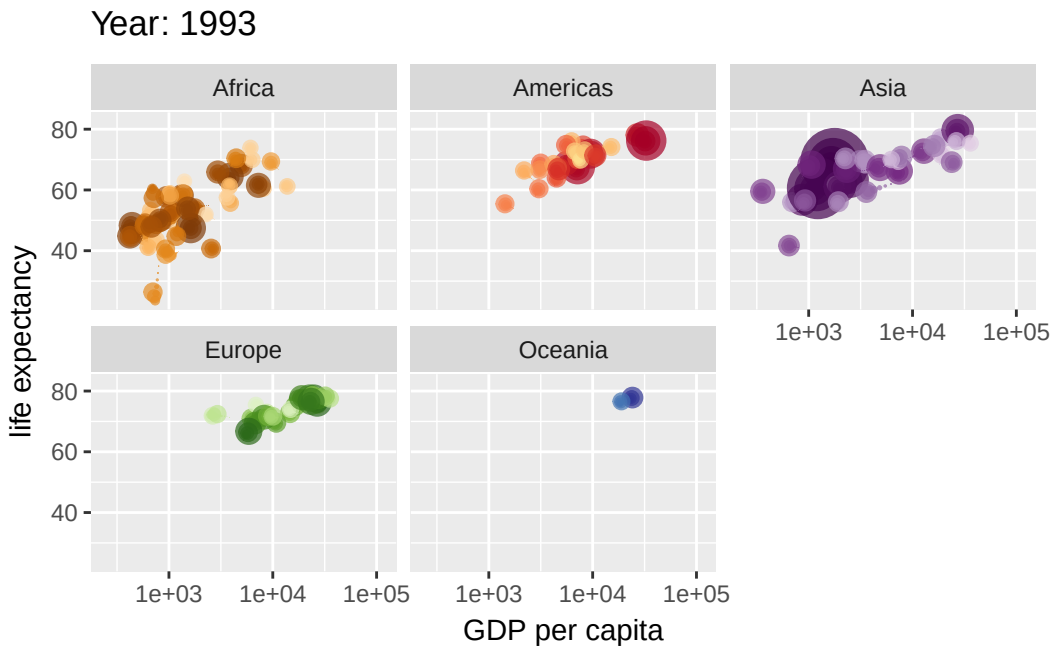
1e+03
1e+04
1e+05
GDP per capita


Year: 1993
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Asia
Europe
Oceania
life expectancy
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60
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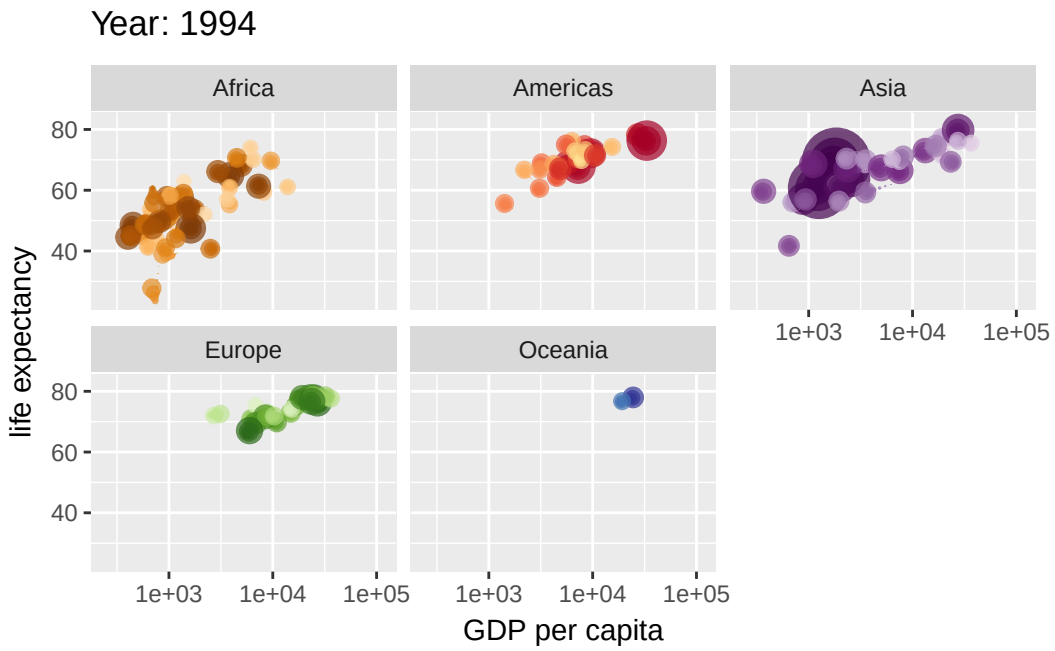
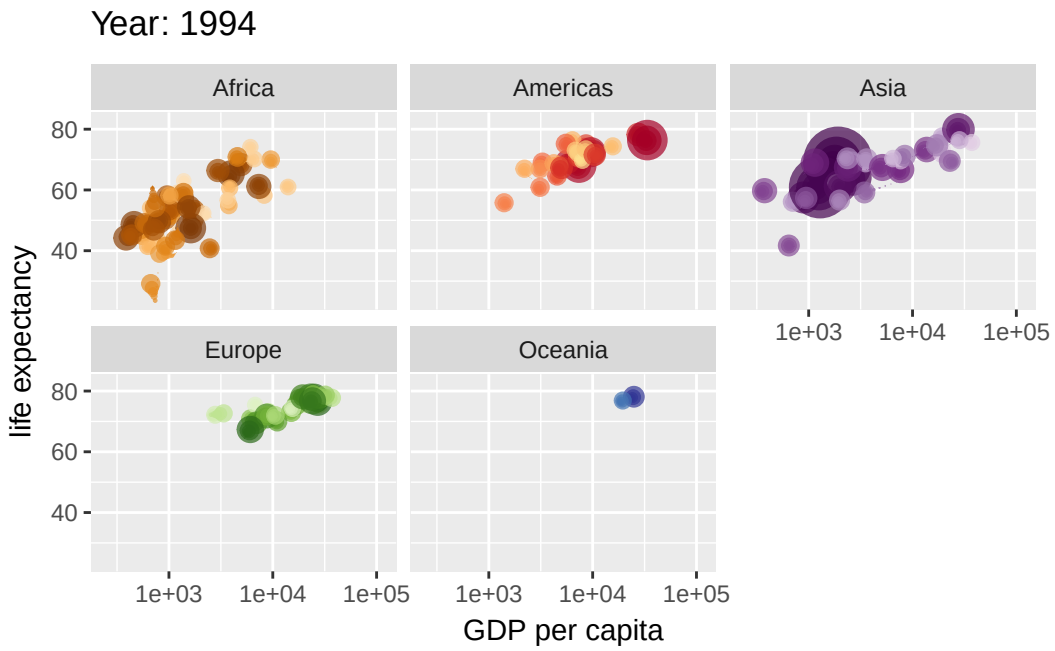
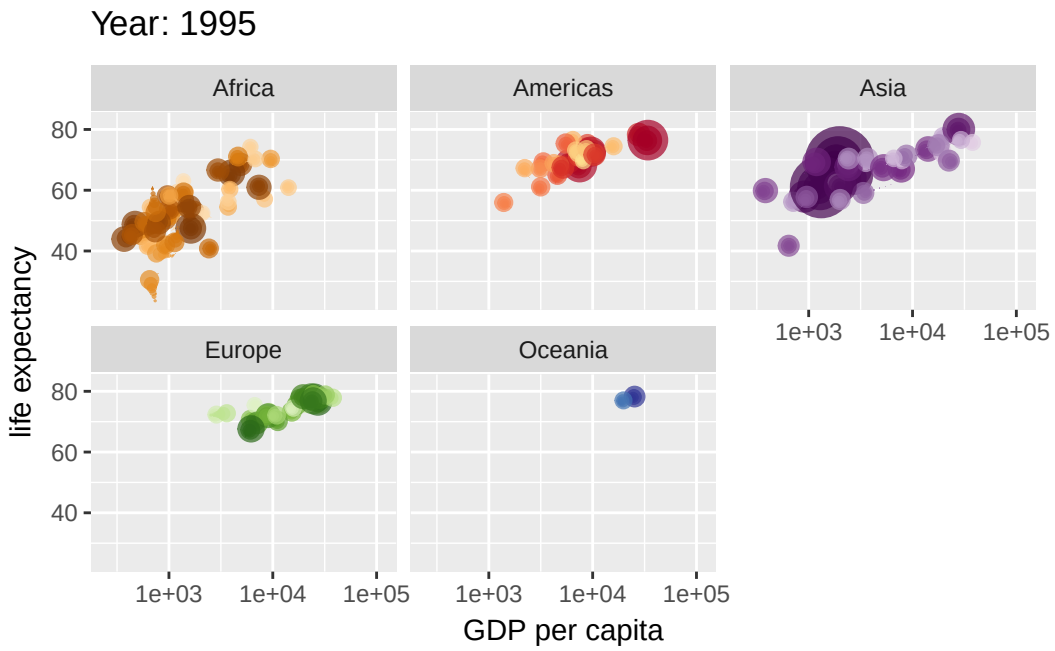
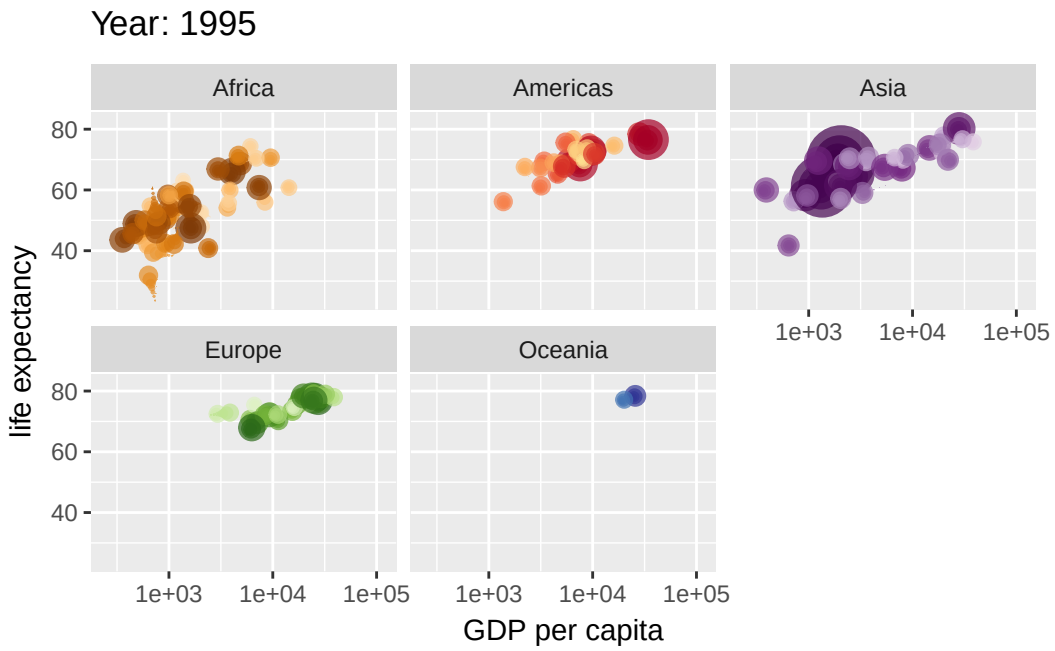
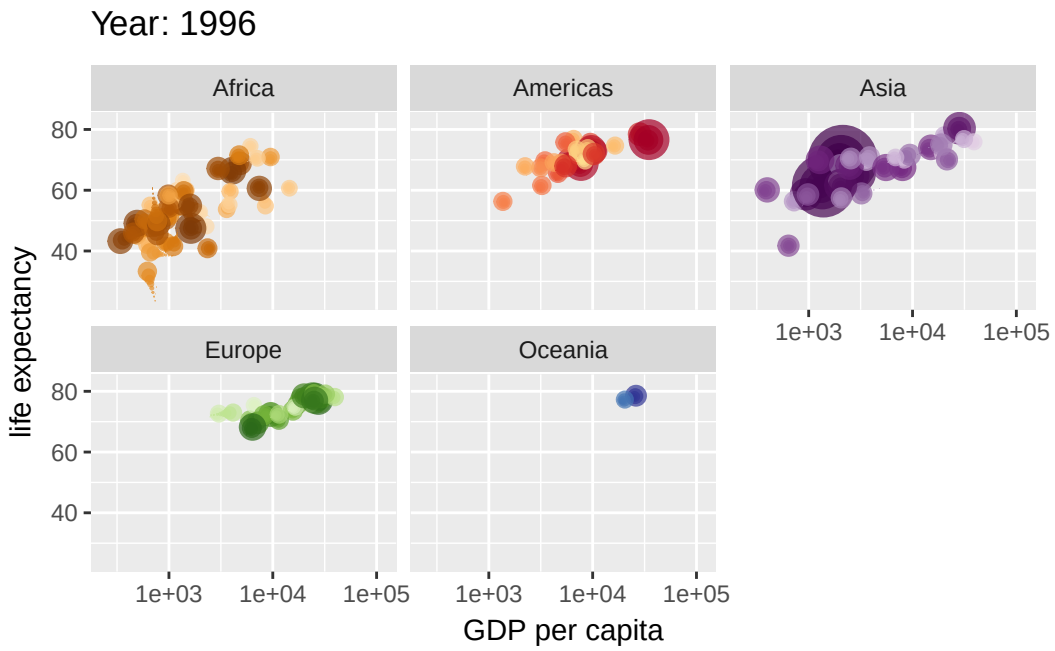
1e+03
1e+04
1e+05
GDP per capita

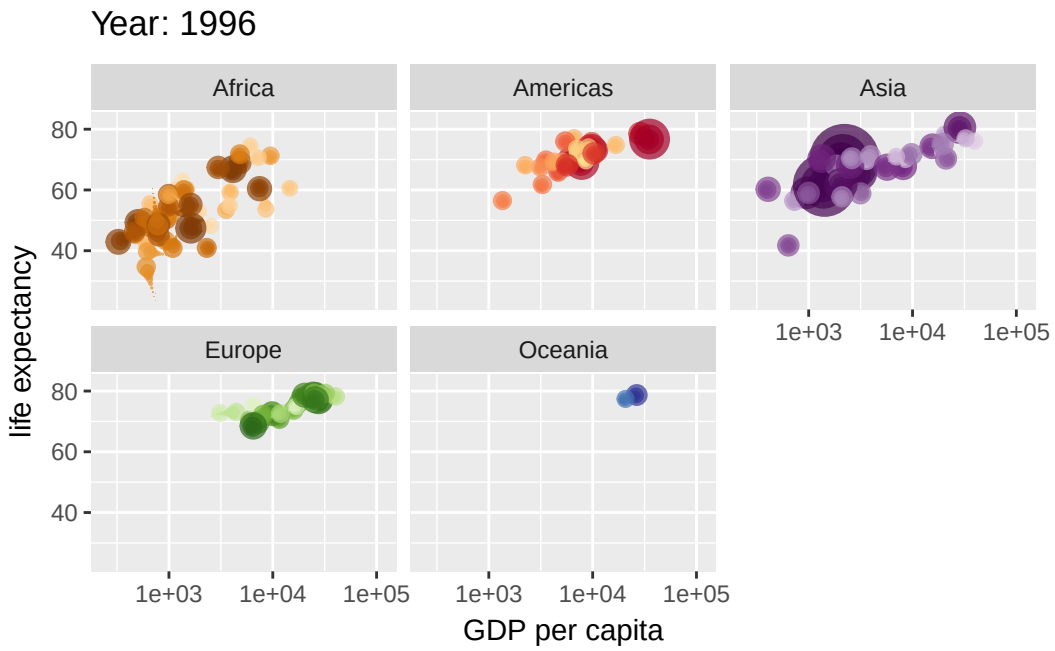

Year: 1994
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

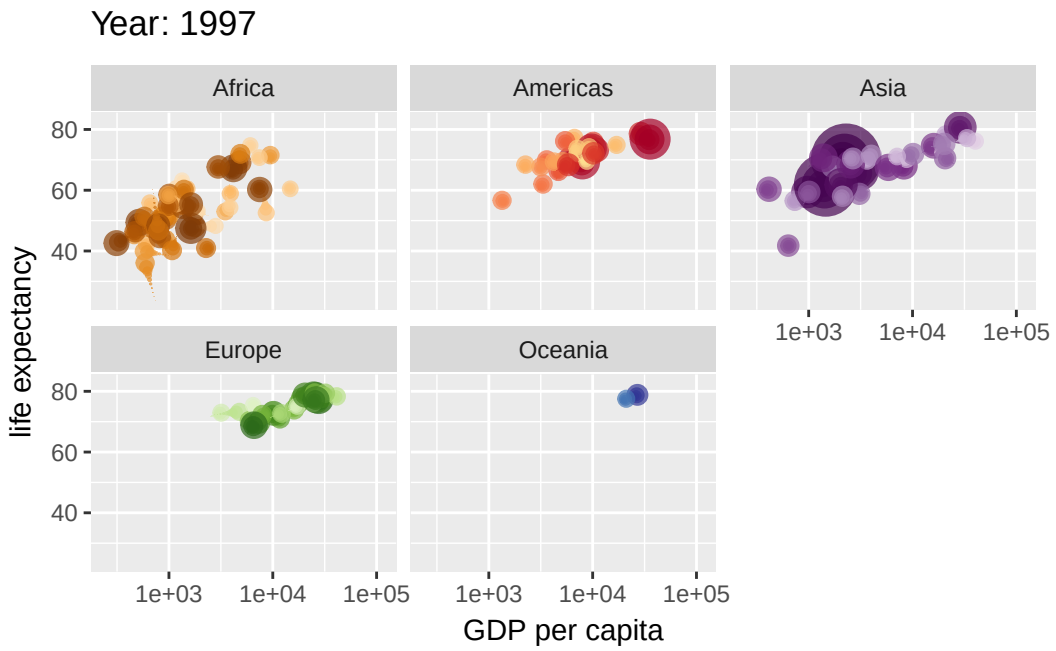

Year: 1994
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

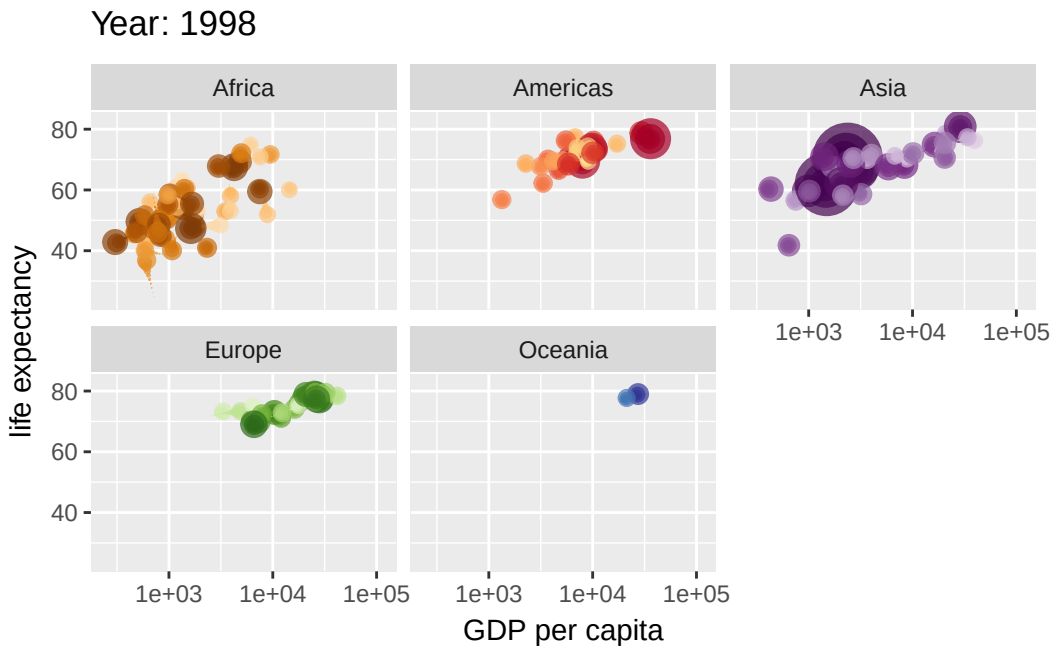

Year: 1995
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

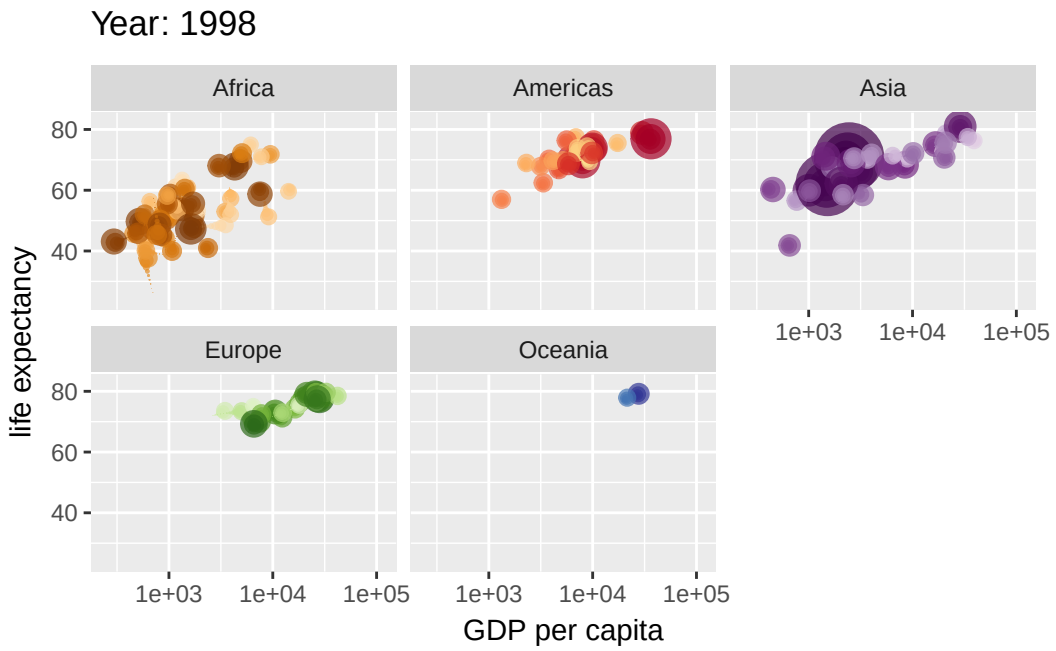

Year: 1995
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

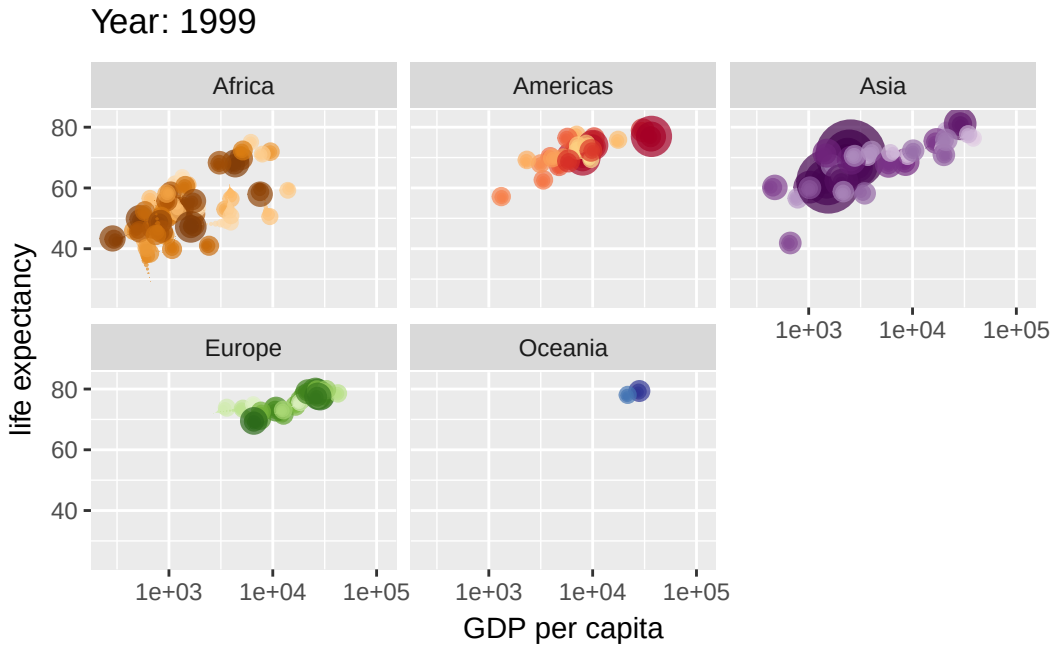

Year: 1996
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

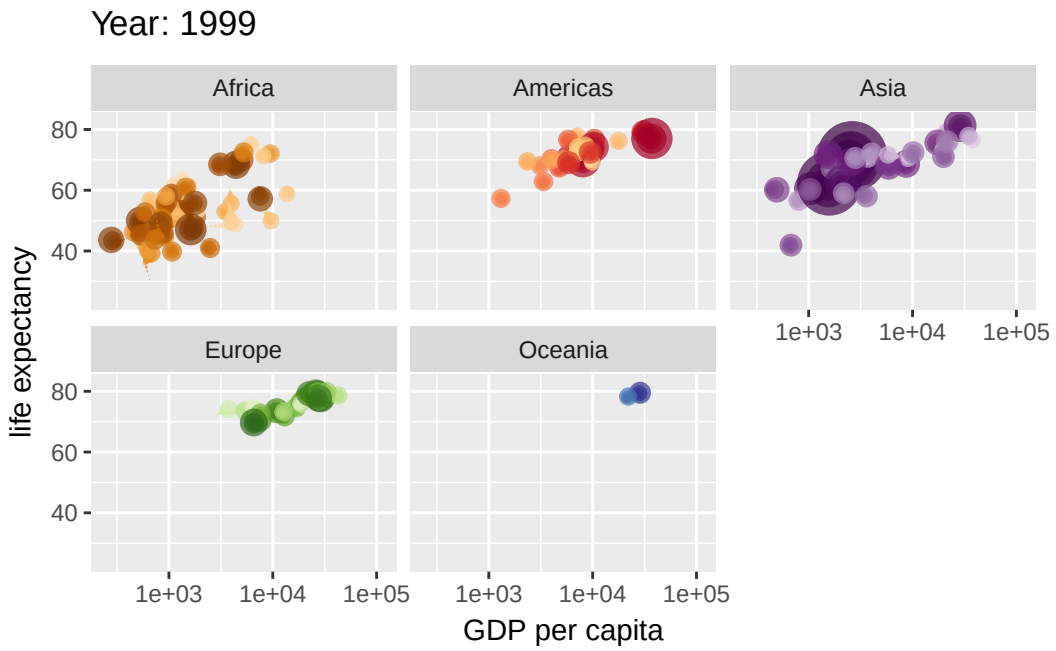

Year: 1996
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

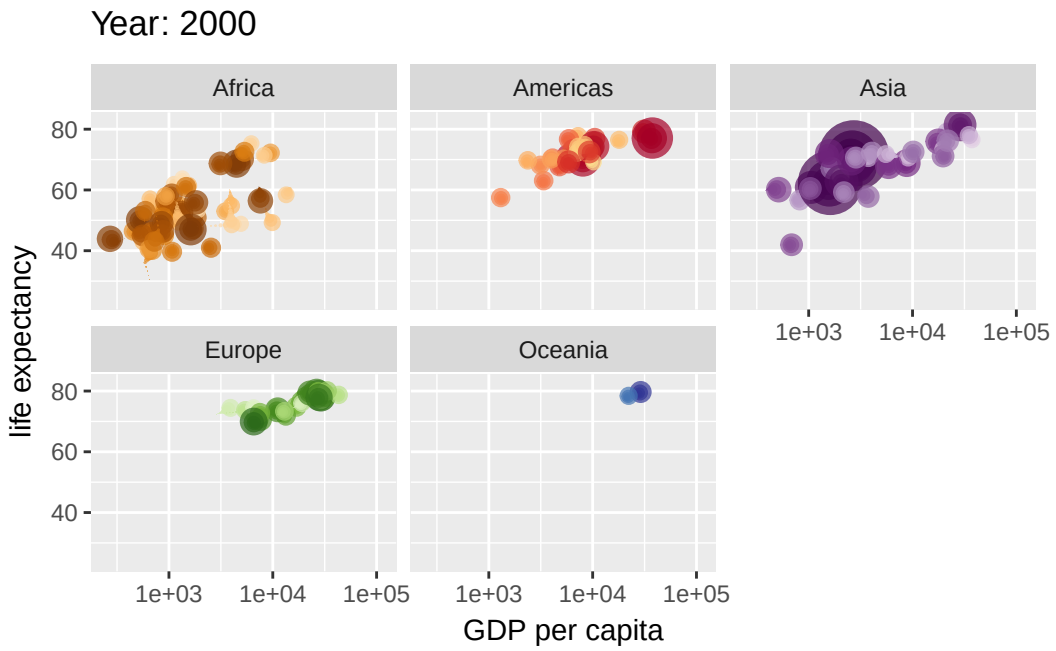

Year: 1997
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

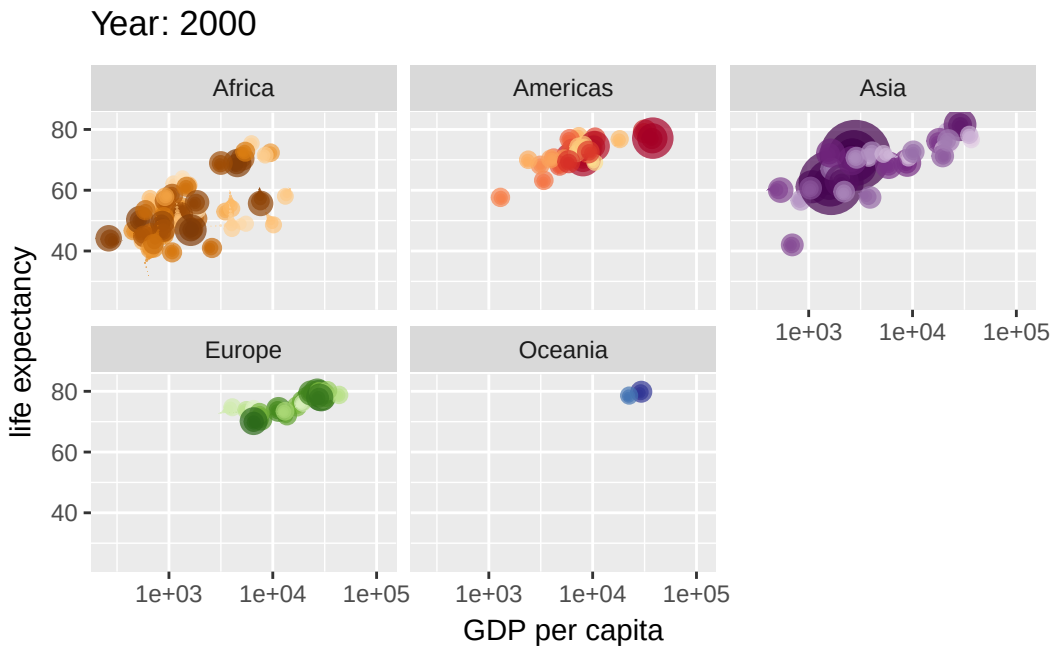

Year: 1998
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

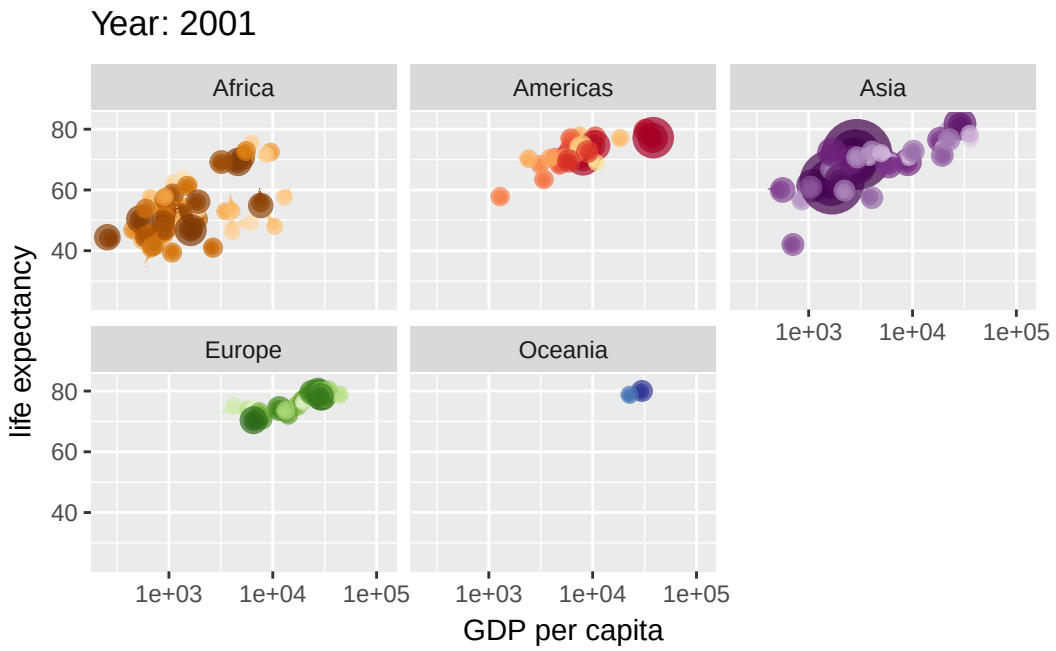

Year: 1998
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

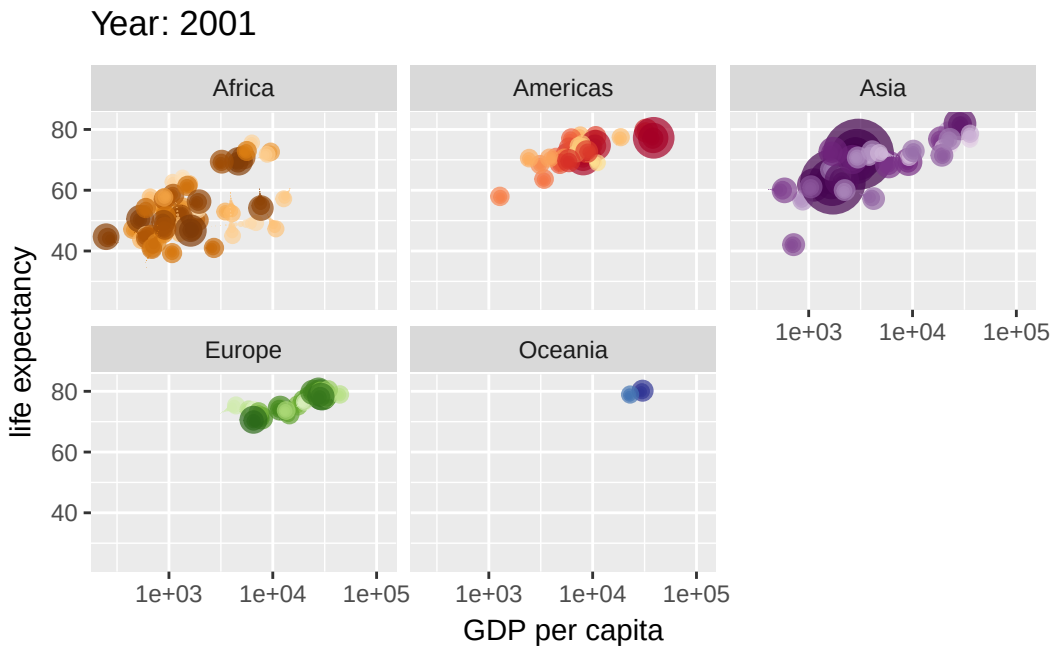

Year: 1999
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

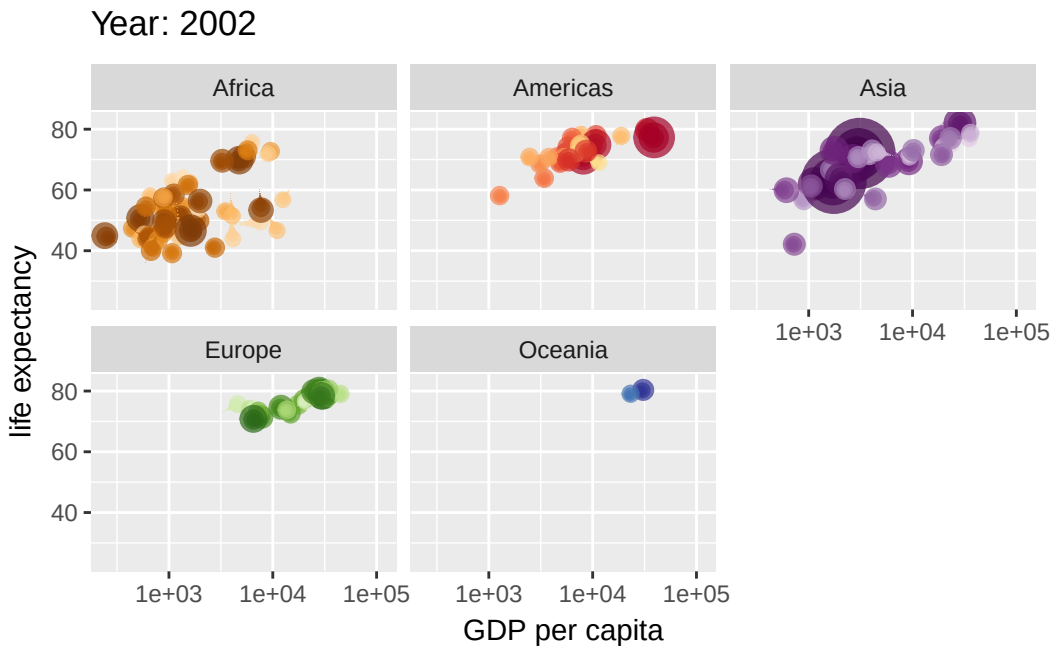

Year: 1999
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

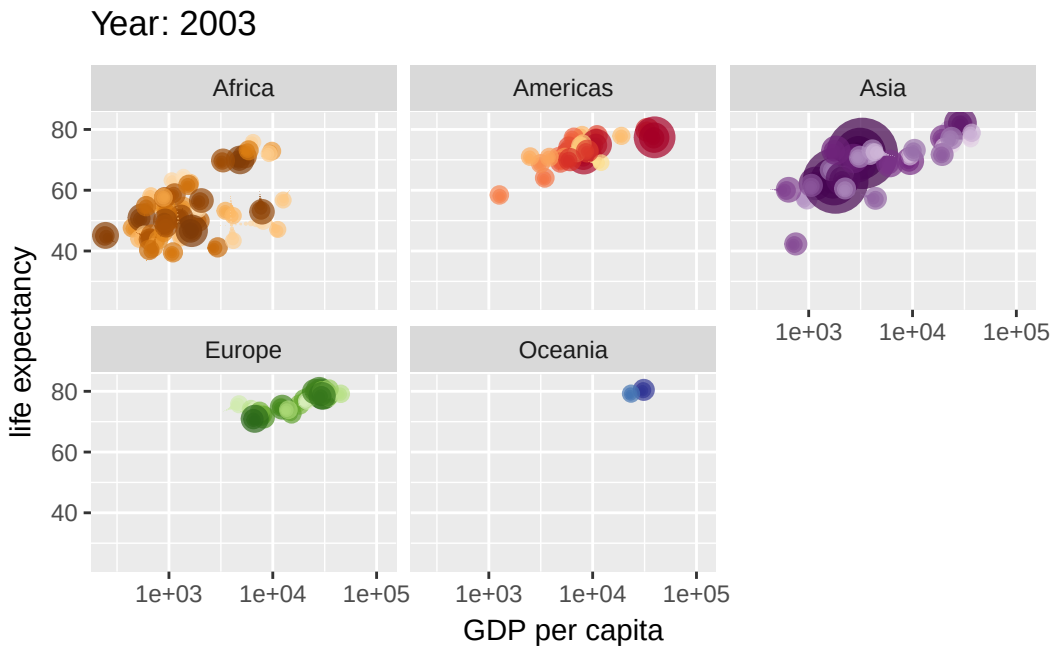

Year: 2000
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

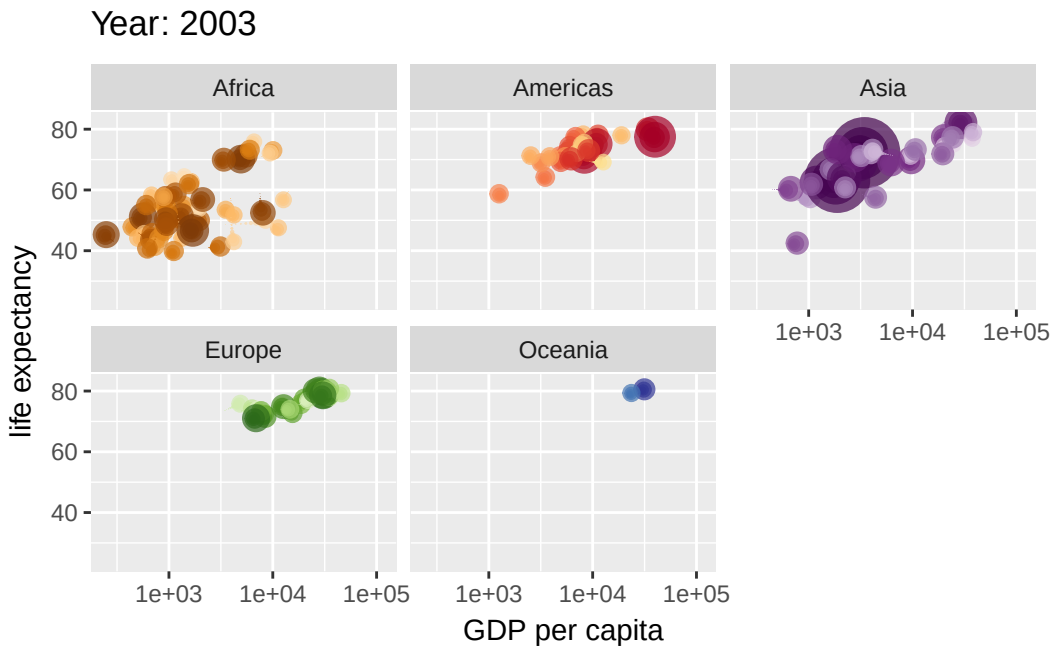

Year: 2000
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

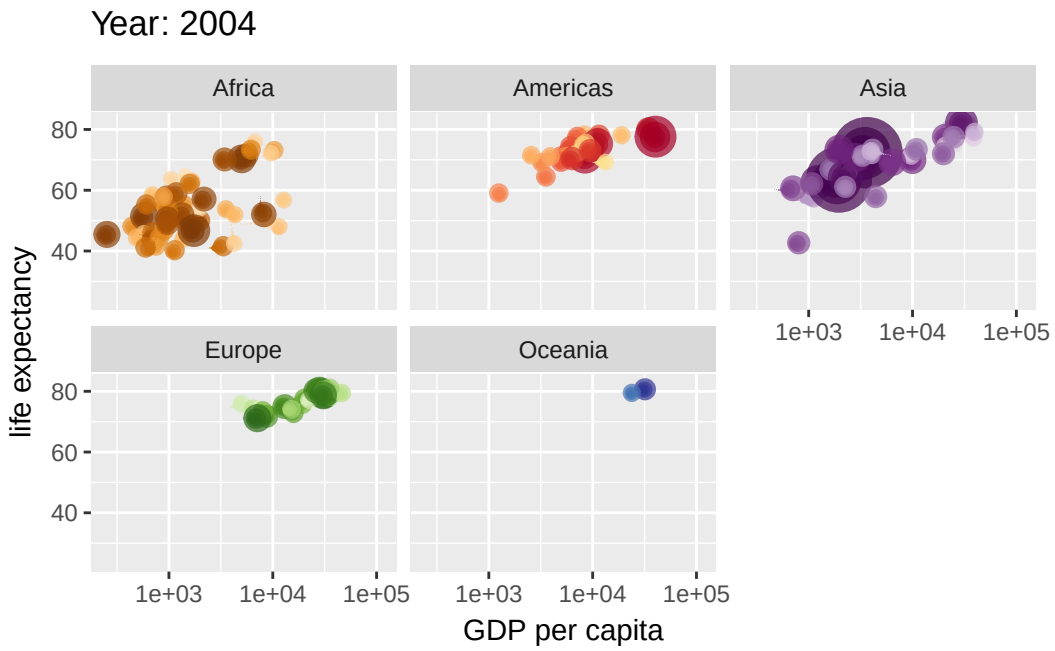

Year: 2001
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

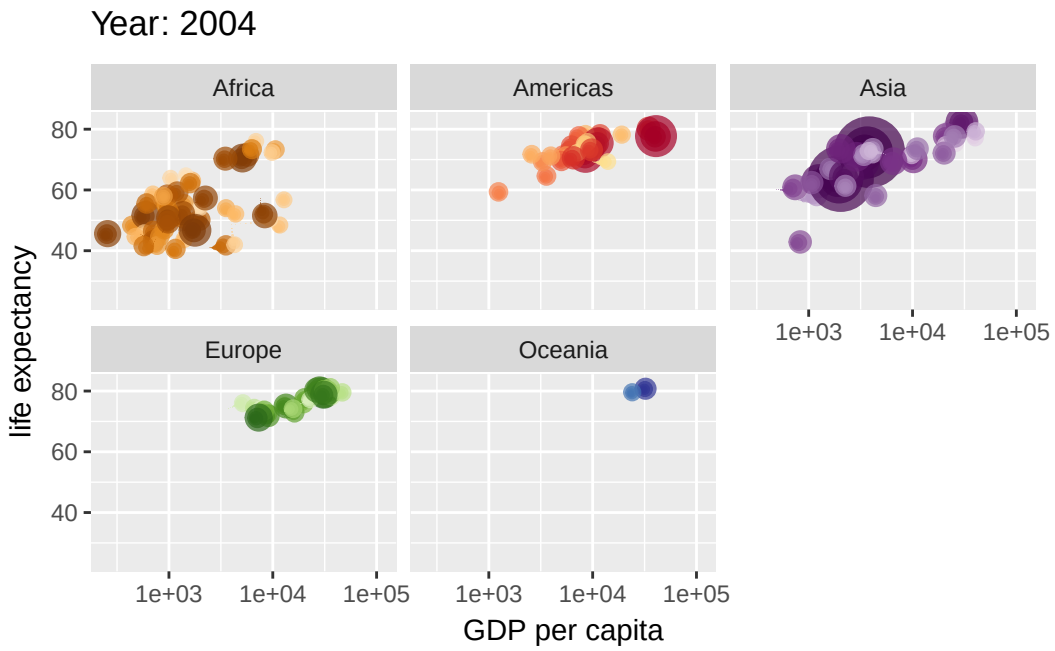

Year: 2001
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

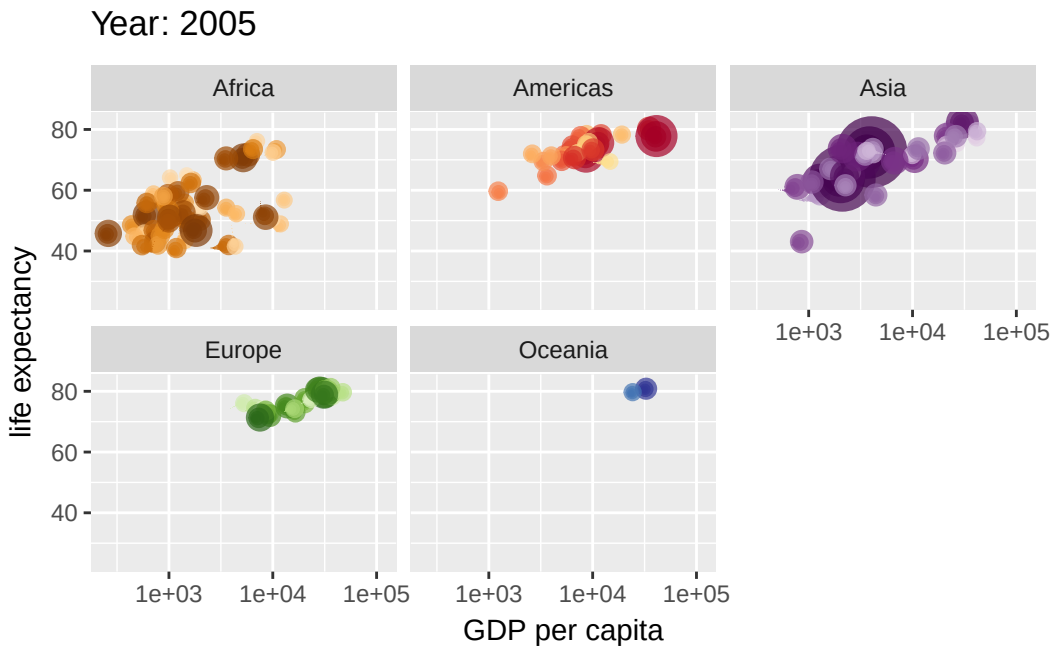

Year: 2002
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

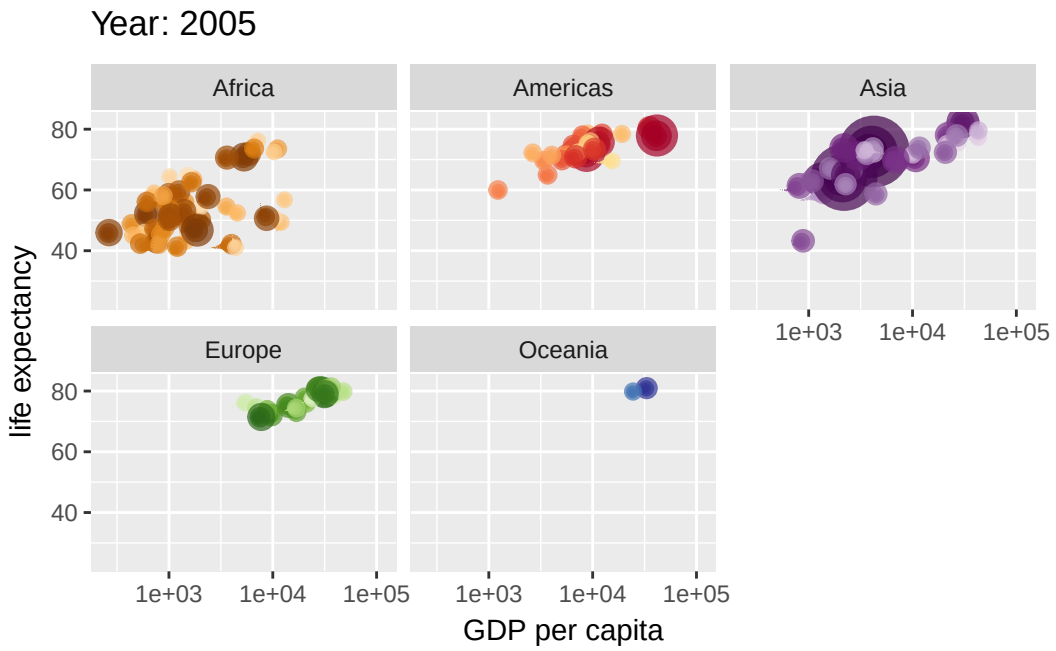

Year: 2003
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

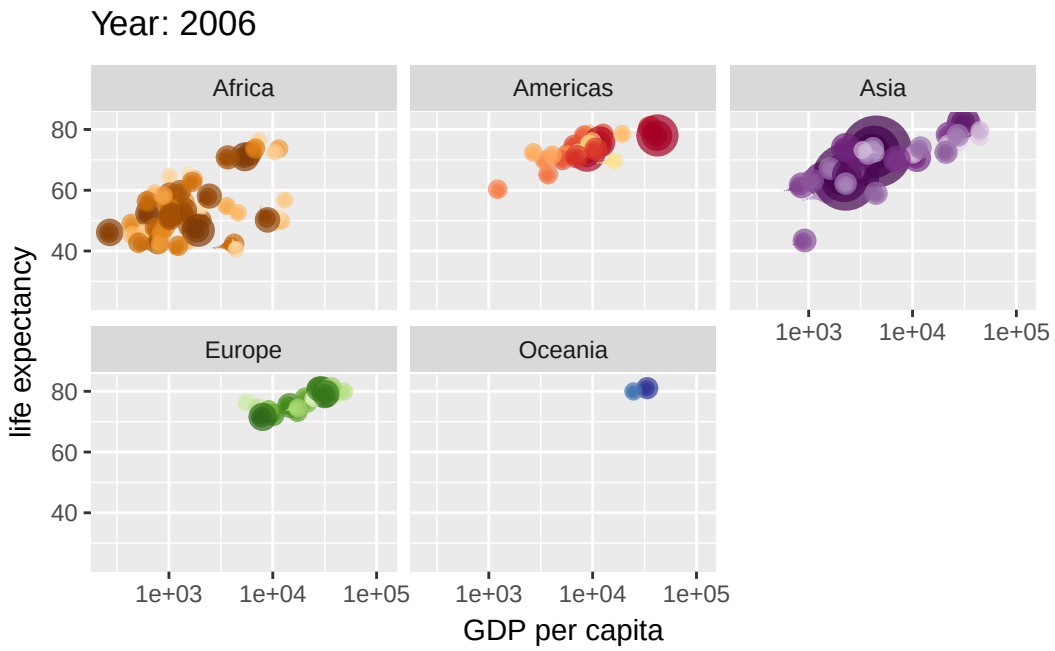

Year: 2003
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

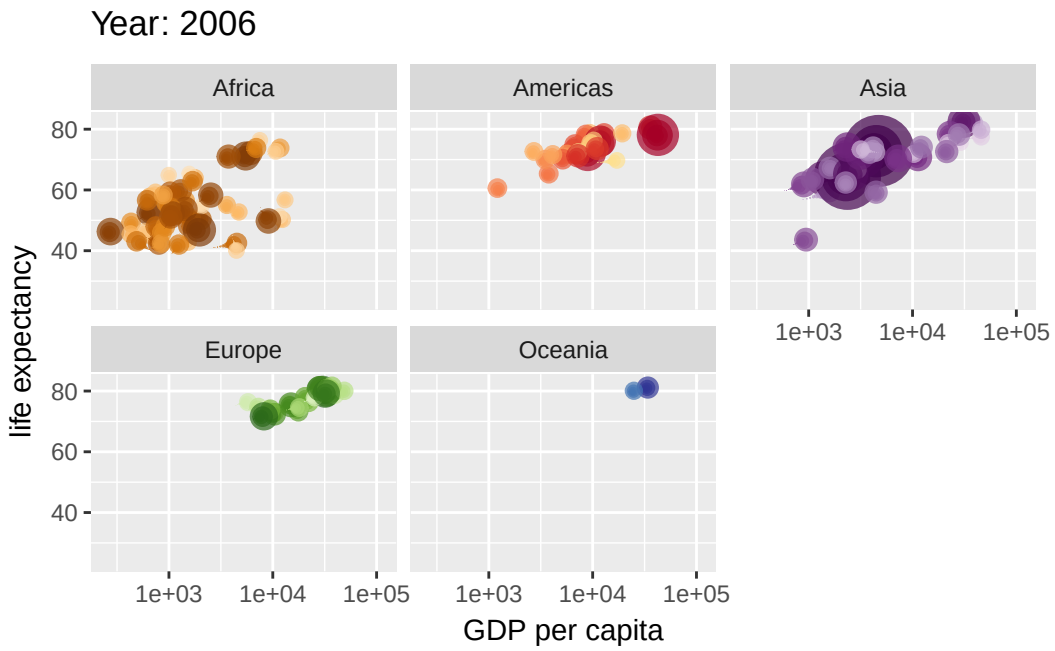

Year: 2004
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

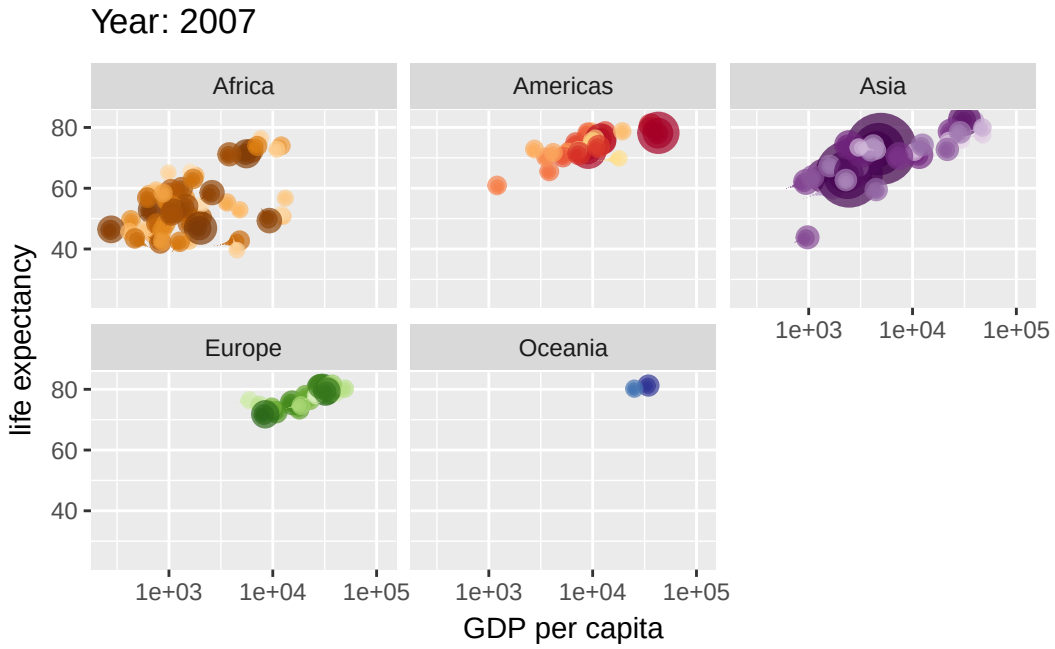

Year: 2004
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 2005
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 2005
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 2006
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 2006
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita



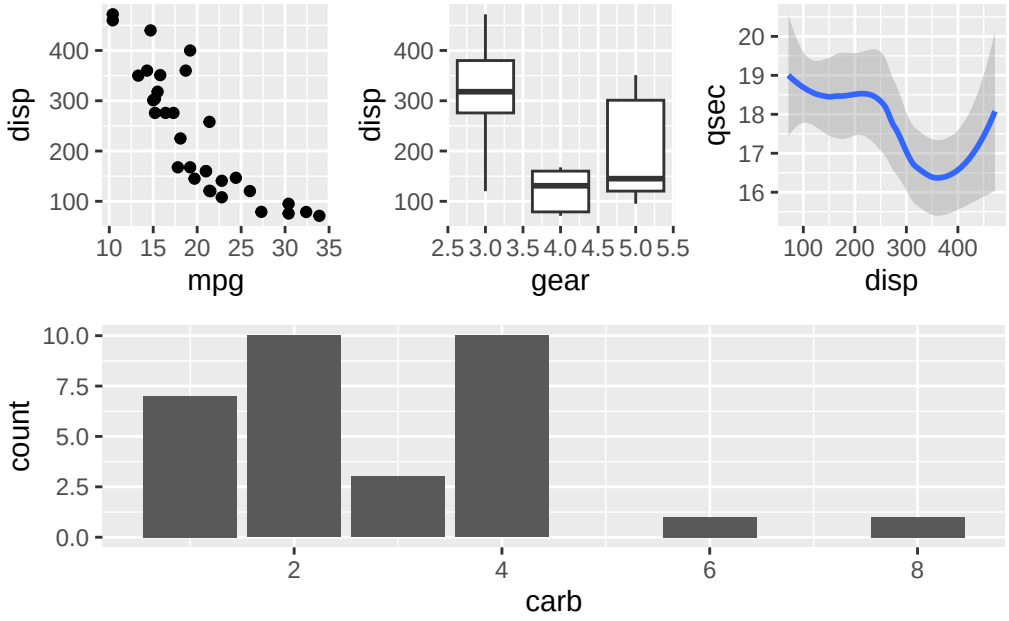

##Combining plots Install `patchwork` package

```
#install.packages("patchwork")
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'
```


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