Class05: Data visualization with ggplot

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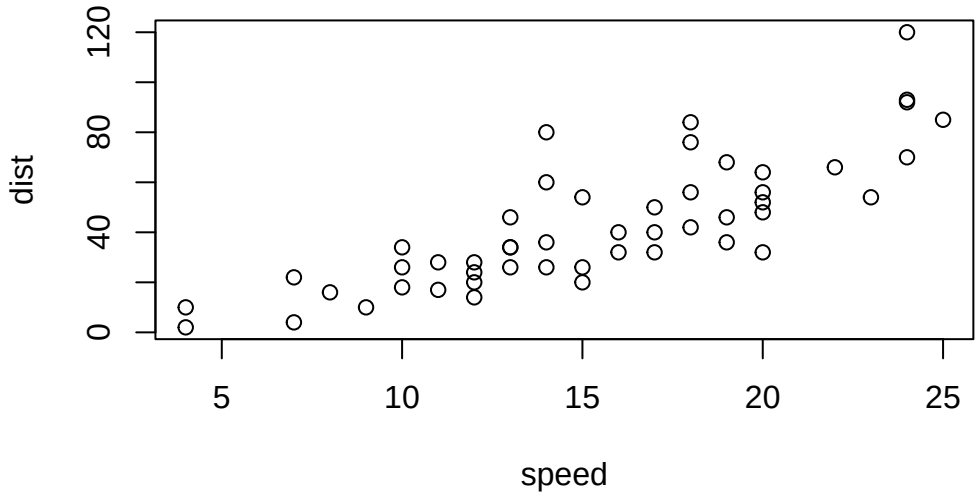
ggplot introduction

Today we will have our first play with the **ggplot2** package - one of the most popular graphics packages on the planet.

There are many plotting systems in R. These include so-called *"base"* plot/graphs.

Base plot is generally rather short code and dull plots - but it is always for you and is fast for big dataset.

```
plot(cars)
```



Try ggplot: Need to install **ggplot** package, use function `install.packages()`. Already installed.

Every time I want to use a package, I need to call the library by function `library(ggplot2)`

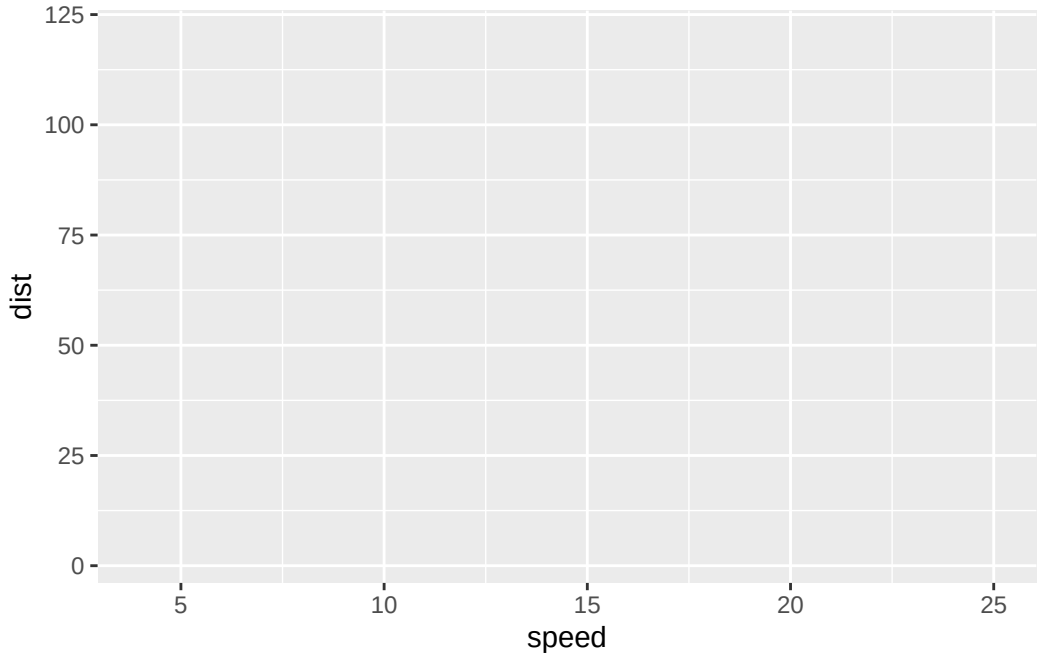
```
library(ggplot2)

ggplot(cars)
```

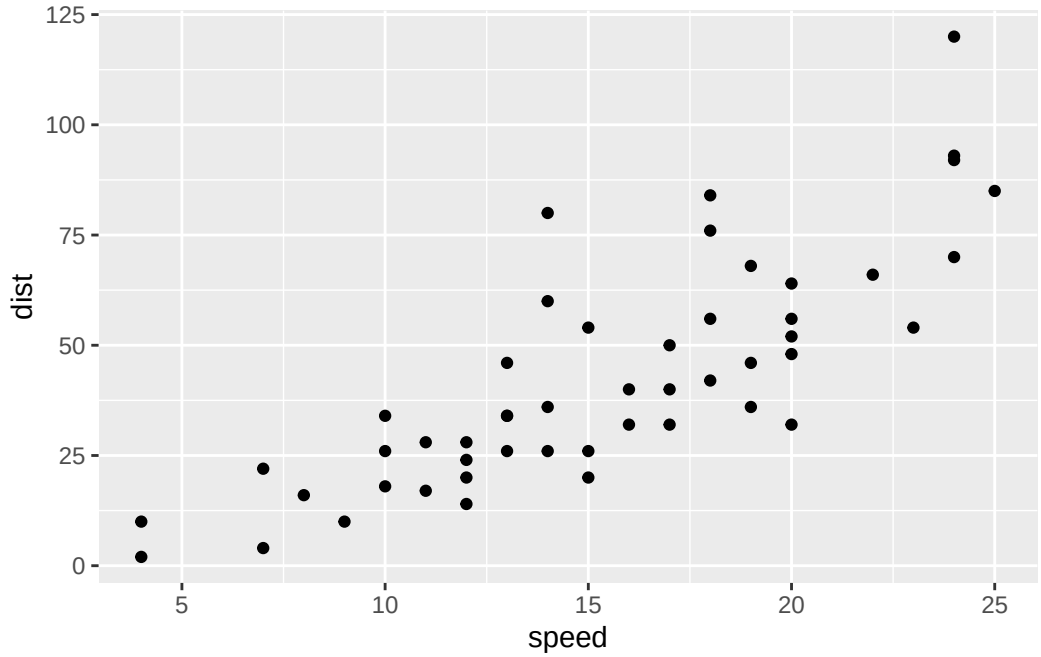
Every **ggplot** has at least 3 things:

- **data**: the data. frame with the data you want to plot
- **aes**: the aesthetic mapping of the data to the plot
- **geom**: how do you want the plot to look

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

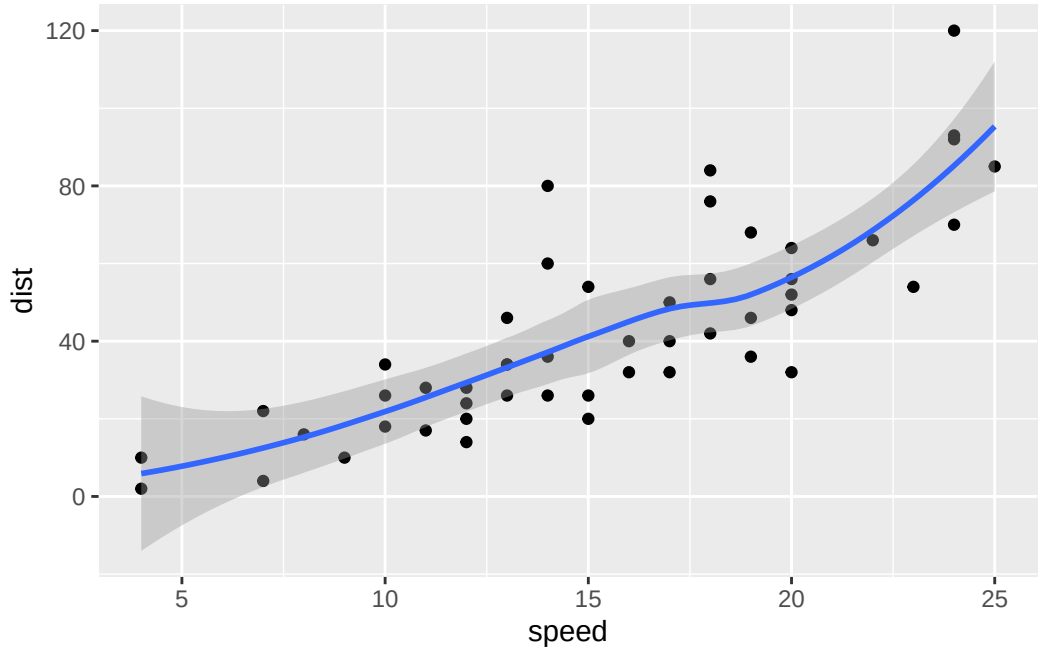



```
ggplot(cars) +
  aes(x = speed, y = dist) +
  geom_point()
```



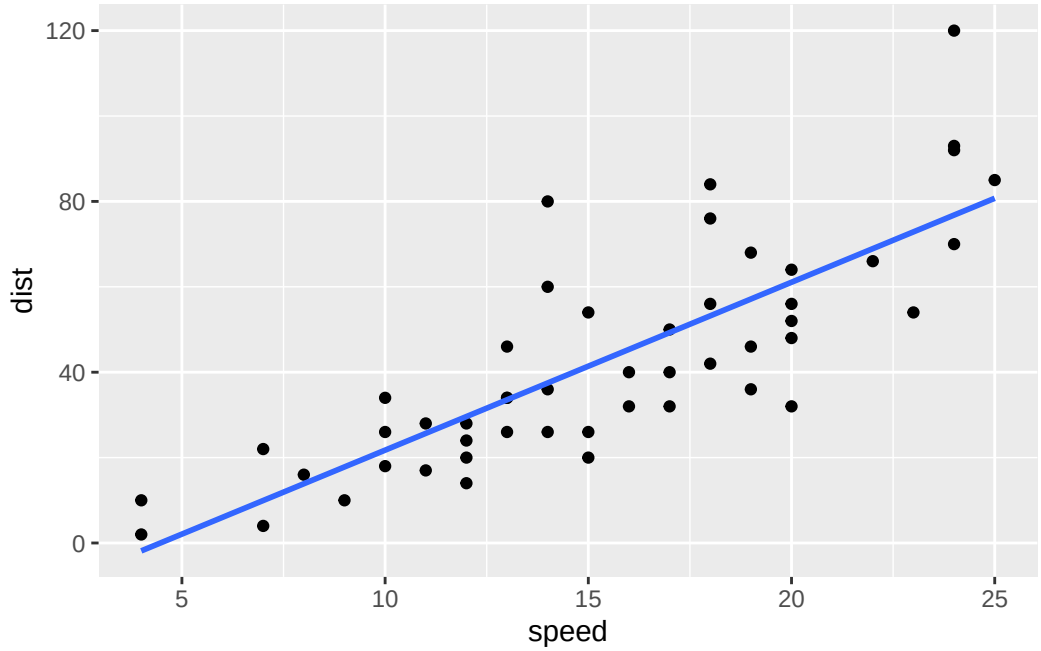

```
ggplot(cars) +
  aes(x = speed, y = dist) +
  geom_point() +
  geom_smooth()
```

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




```
ggplot(cars) +
  aes(x = speed, y = dist) +
  geom_point() +
  geom_smooth(method = "lm", se = FALSE )
```

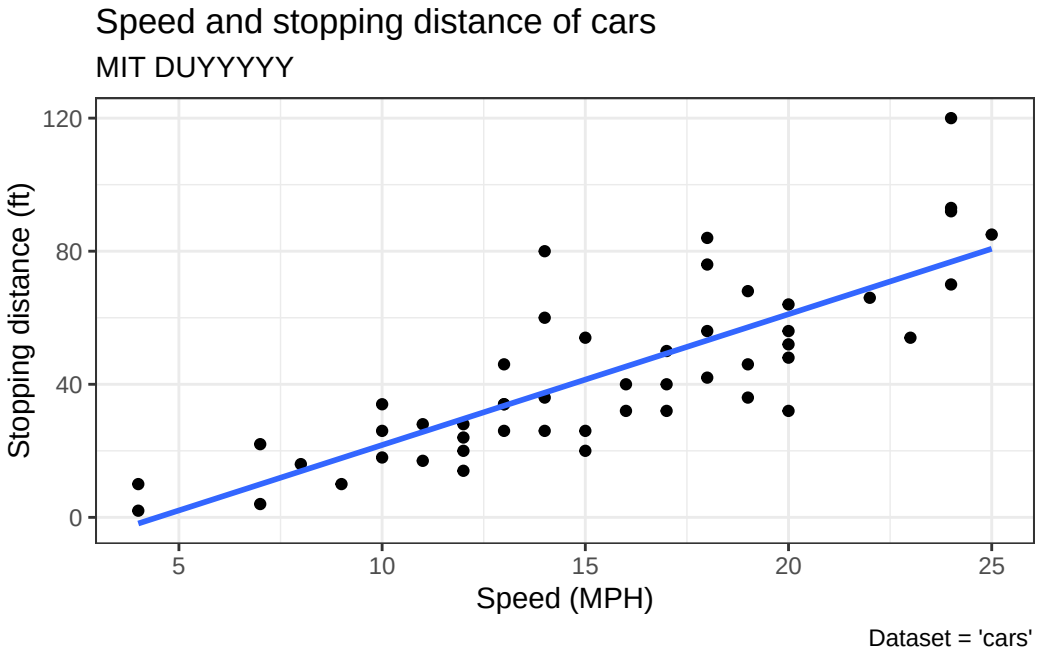
```
`geom_smooth()` using formula = 'y ~ x'
```




```
bp <- ggplot(cars) +
  aes(x = speed, y = dist) +
  geom_point() +
  geom_smooth(method = "lm", se = FALSE )+
  labs(title = "Speed and stopping distance of cars",
      x = "Speed (MPH)",
      y = "Stopping distance (ft)",
      subtitle = "MIT DUYYYYY",
      caption = "Dataset = 'cars'") +
  theme_bw()

bp
```

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



A more complicated scatter plot

Here we make a plot of gene expression data:

```
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
```

```
nrow(genes)
```

```
[1] 5196
```

```r
colnames(genes)
```

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

```r
ncol(genes)
```

```
[1] 4
```

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

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

```r
round(table(genes$State == 'up' )/nrow(genes) * 100, 2 )
```

```
FALSE  TRUE
97.56  2.44
```

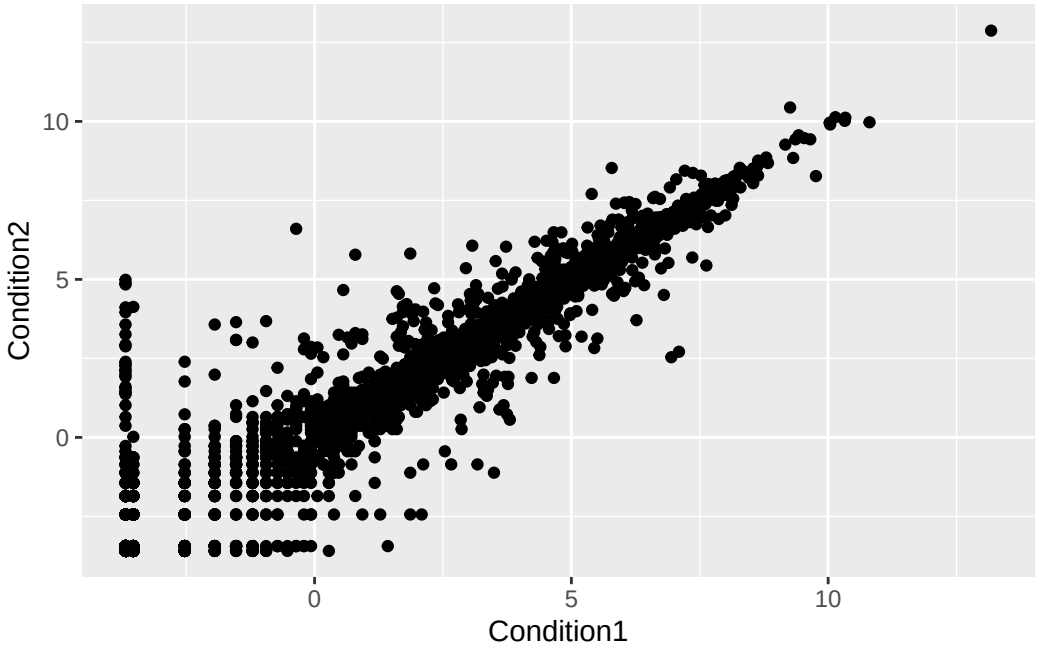
```r
n.gene <- nrow(genes)
n.up <- sum(genes$State == 'up')

up.percent <- n.up/n.gene *100
round(up.percent, 2)
```

```
[1] 2.44
```

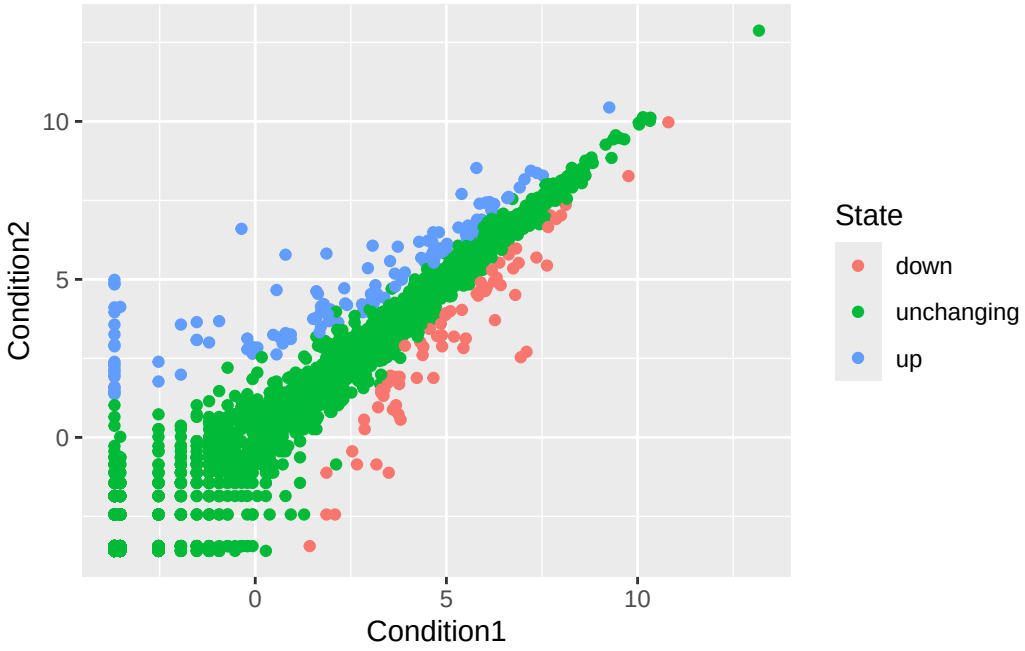
```r
n <-
  ggplot(genes) +
  aes(x = Condition1, y = Condition2) +
  geom_point()

n
```

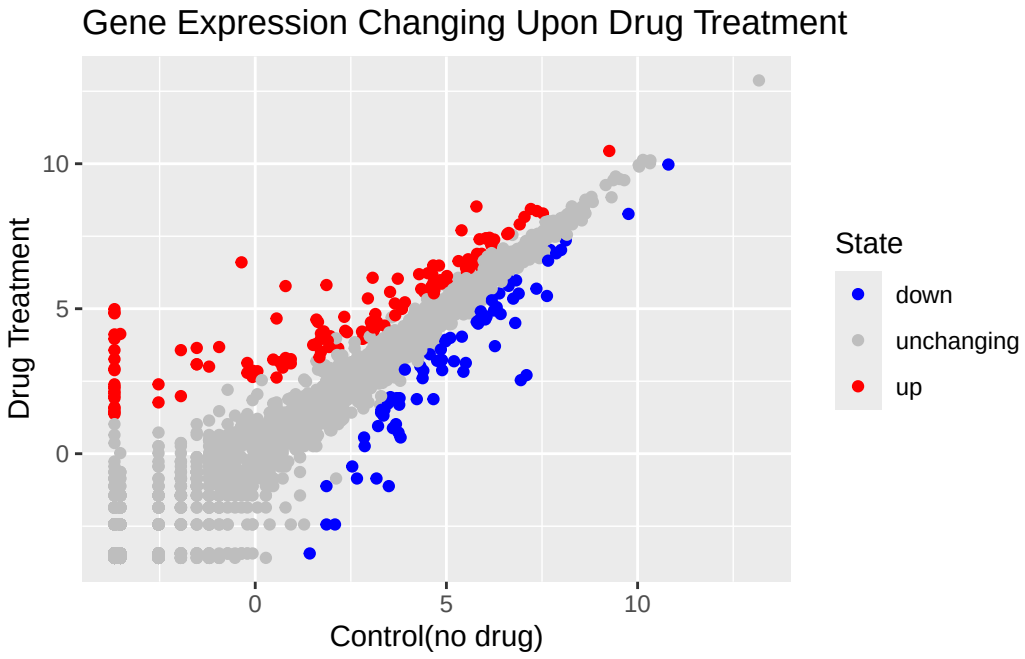



```
gene_plot <- n + aes(col = State)

gene_plot
```




```
gene_plot + scale_color_manual(values = c("blue", "gray", "red")) +
  labs(x = "Control(no drug)", y = "Drug Treatment", title = "Gene Expression Changing Upo
```



Exploring the gapminder dataset

```
library(gapminder)
# File location online
url <- "https://raw.githubusercontent.com/jennybc/gapminder/master/inst/extdata/gapminder.
gapminder <- read.delim(url)
```

```
head(gapminder)
```

```
      country continent year lifeExp      pop gdpPercap
1 Afghanistan      Asia 1952  28.801  8425333  779.4453
2 Afghanistan      Asia 1957  30.332  9240934  820.8530
3 Afghanistan      Asia 1962  31.997 10267083  853.1007
4 Afghanistan      Asia 1967  34.020 11537966  836.1971
5 Afghanistan      Asia 1972  36.088 13079460  739.9811
6 Afghanistan      Asia 1977  38.438 14880372  786.1134
```

Q. How many continent are there? Use function `unique()`

```
num <- unique(gapminder$continent)
length(num)
```

```
[1] 5
```

Q. How many countries are there?

```
num <- unique(gapminder$country)
length(num)
```

```
[1] 142
```

```
library(dplyr)
```

```
Attaching package: 'dplyr'

The following objects are masked from 'package:stats':

    filter, lag
```

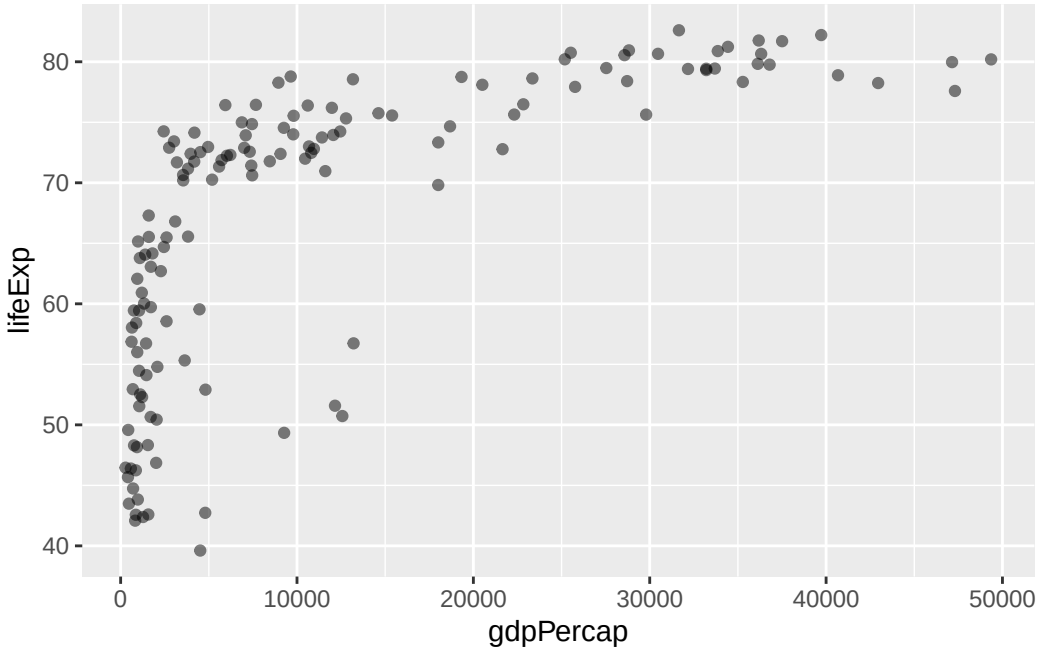
```
The following objects are masked from 'package:base':

    intersect, setdiff, setequal, union
```

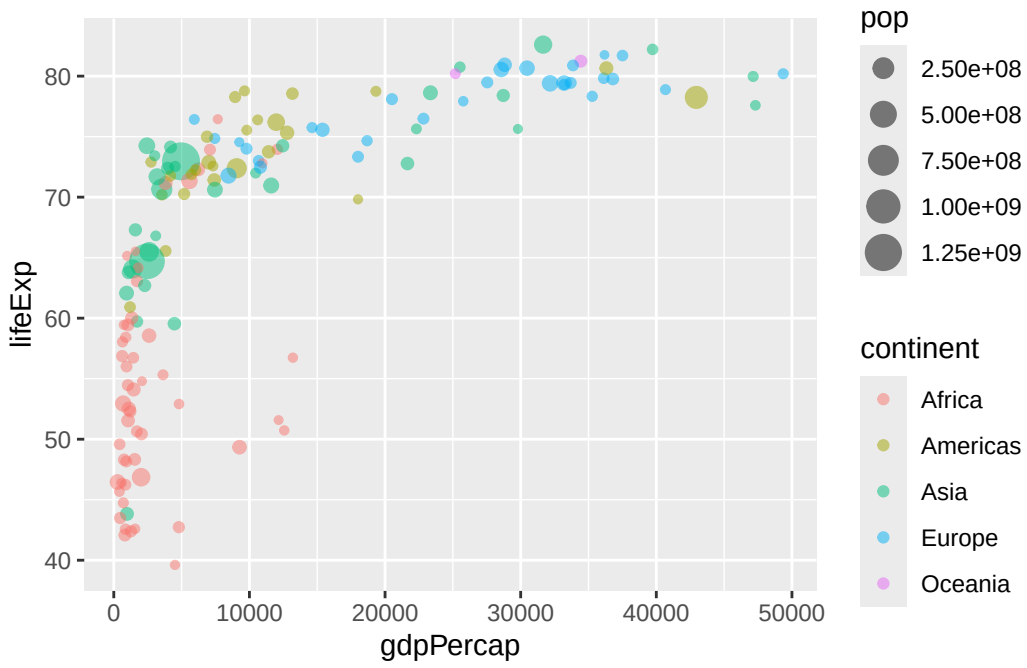
```r
gapminder_2007 <- gapminder %>% filter(year==2007)
head(gapminder_2007)
```

```
      country continent year lifeExp      pop  gdpPercap
1 Afghanistan      Asia 2007  43.828 31889923   974.5803
2     Albania    Europe 2007  76.423  3600523  5937.0295
3     Algeria    Africa 2007  72.301 33333216  6223.3675
4      Angola    Africa 2007  42.731 12420476  4797.2313
5   Argentina  Americas 2007  75.320 40301927 12779.3796
6   Australia   Oceania 2007  81.235 20434176 34435.3674
```

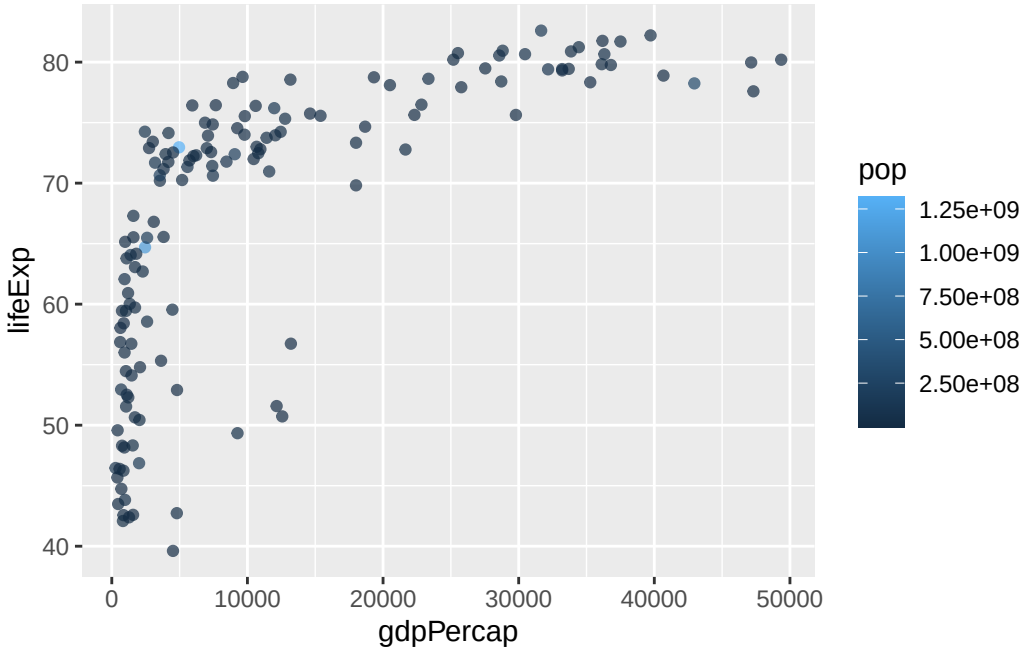
```r
library(ggplot2)
ggplot(gapminder_2007) +
  aes(x = gdpPercap, y = lifeExp) +
  geom_point(alpha=0.5)
```



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

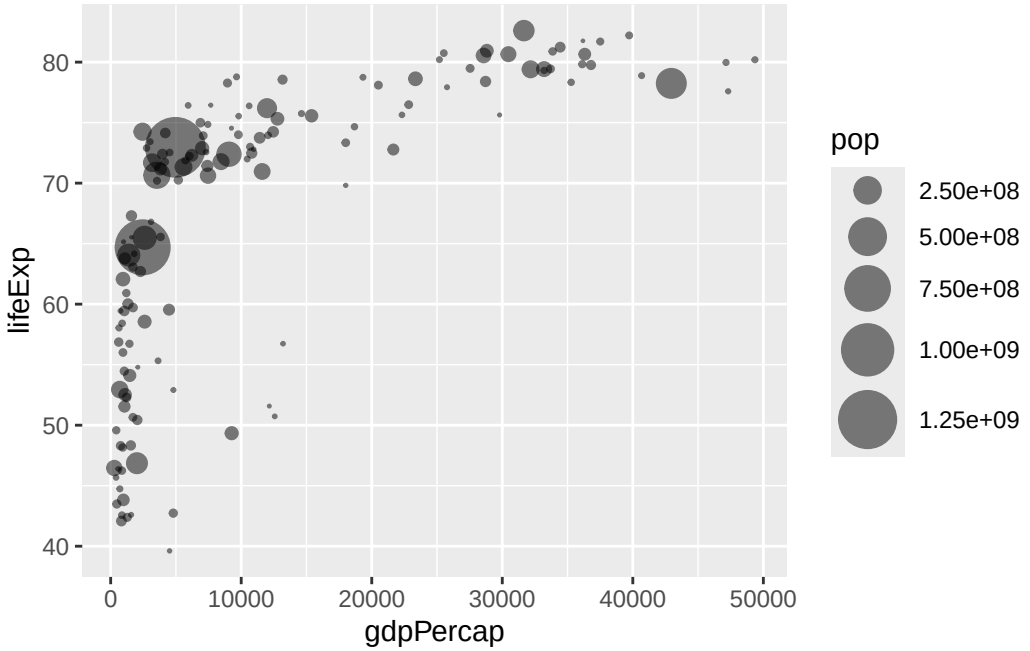



```
ggplot(gapminder_2007) +
  aes(x = gdpPercap, y = lifeExp, color = pop) +
  geom_point(alpha=0.7)
```



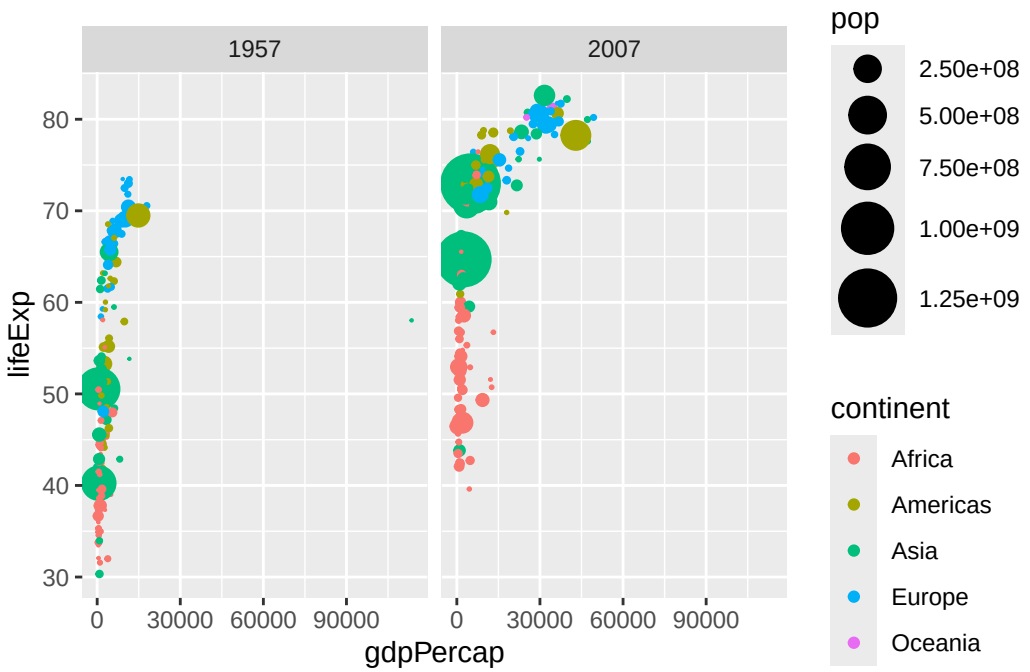
Q. How to reflect the real population on the size of the points

```
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?

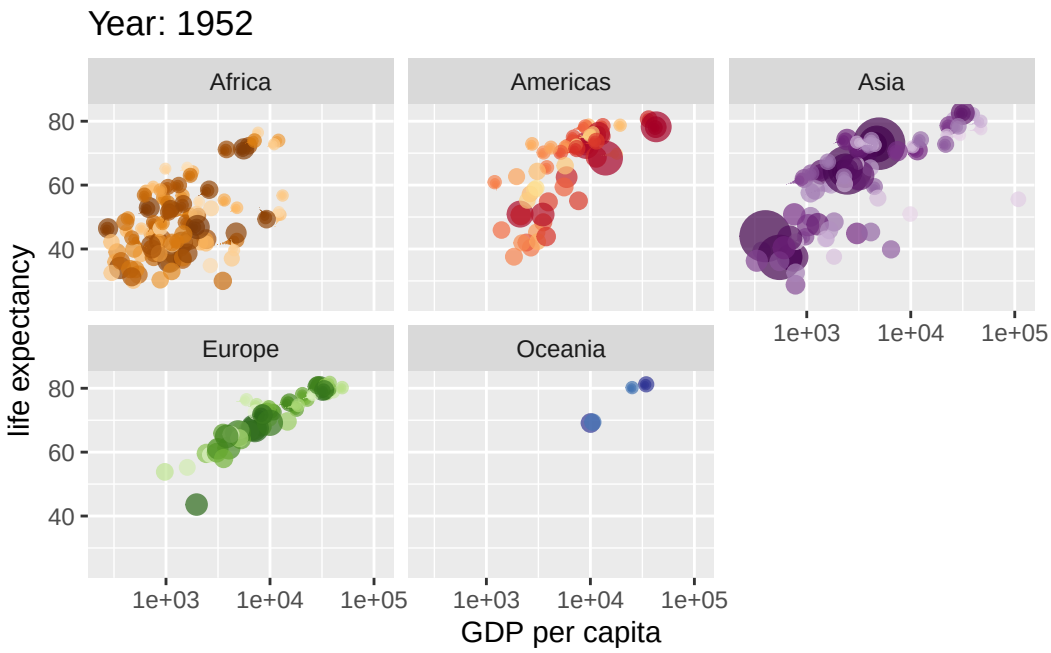
```
gapminder_1957 <- gapminder %>% filter(year == 2007 | year==1957)
ggplot(gapminder_1957) +
  aes(x = gdpPercap, y = lifeExp, color = continent, size = pop) +
  geom_point() +
  scale_size_area(max_size = 10) +
  facet_wrap(~year)
```

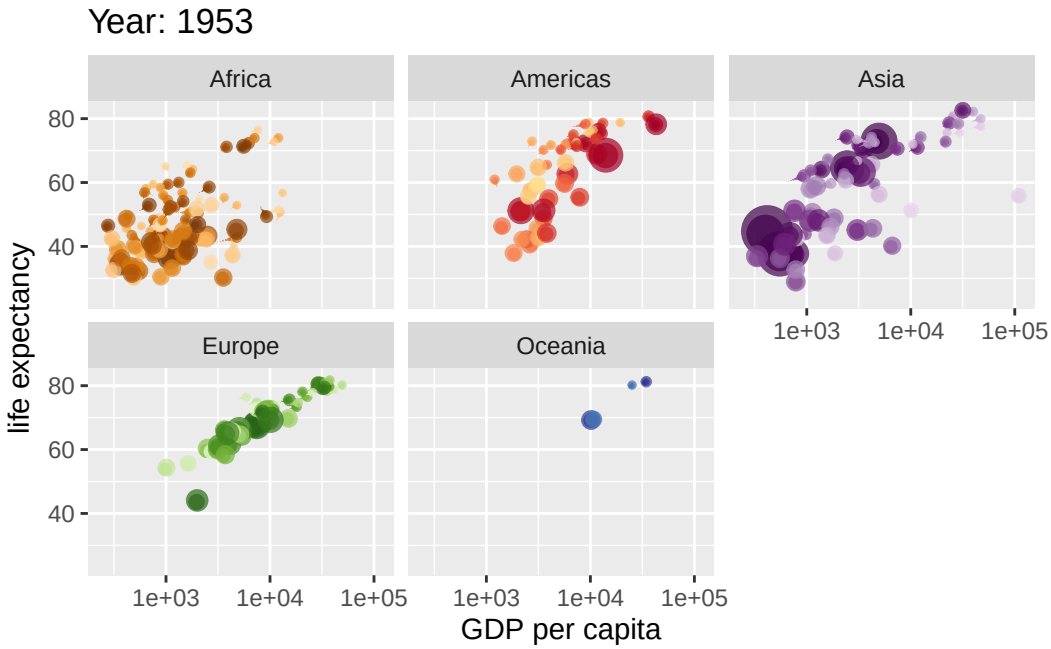


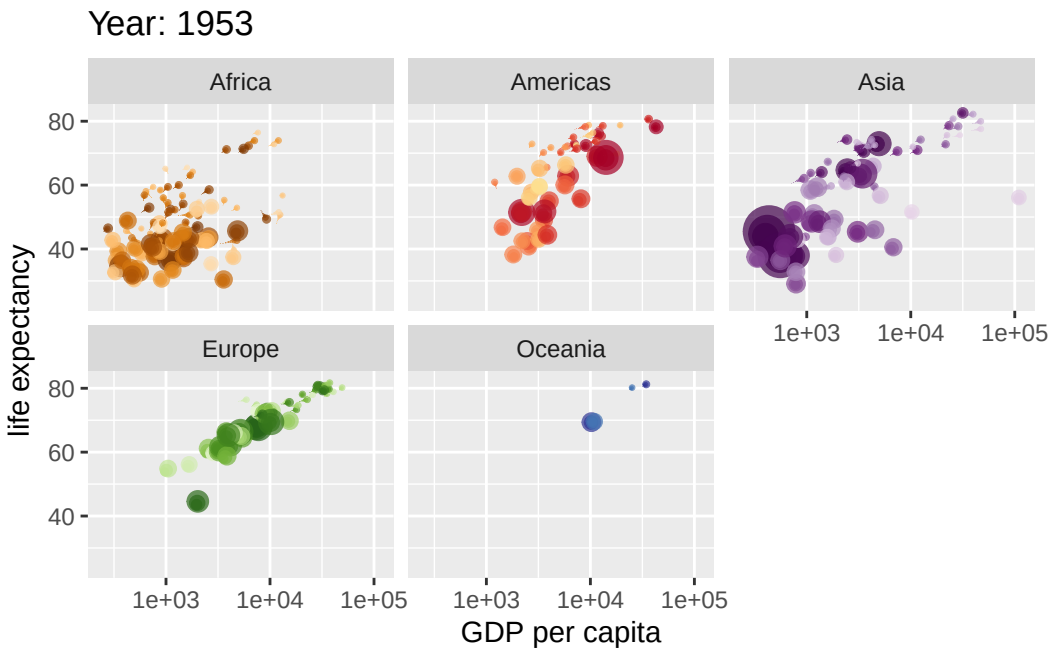
Animation

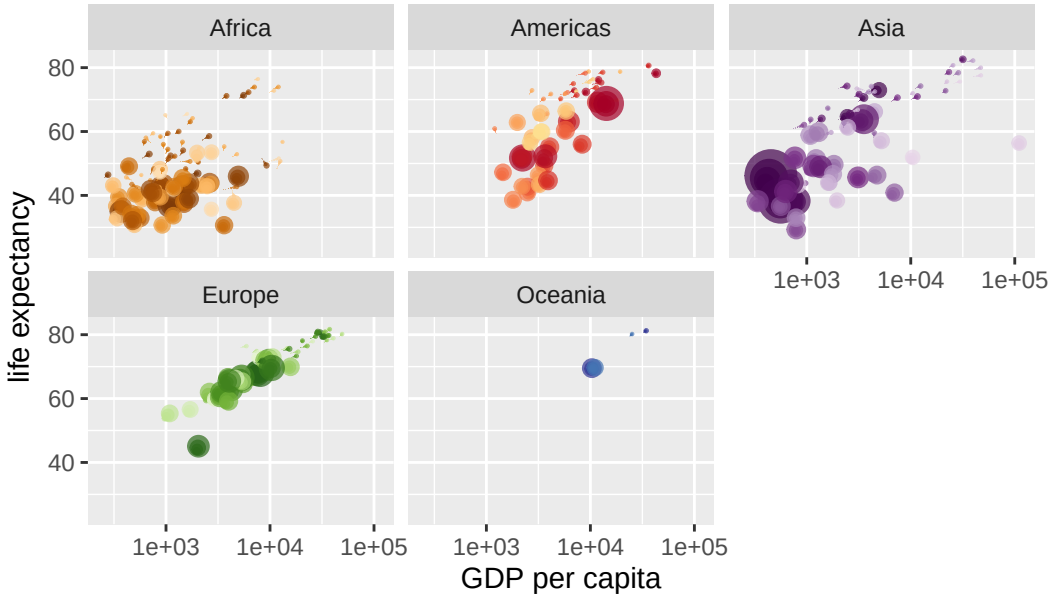
```
library(gapminder)
library(gganimate)
# Setup nice regular ggplot of the gapminder data
ggplot(gapminder, aes(gdpPercap, lifeExp, size = pop, colour = country)) +
  geom_point(alpha = 0.7, show.legend = FALSE) +
  scale_colour_manual(values = country_colors) +
  scale_size(range = c(2, 12)) +
  scale_x_log10() +
  # 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)
```

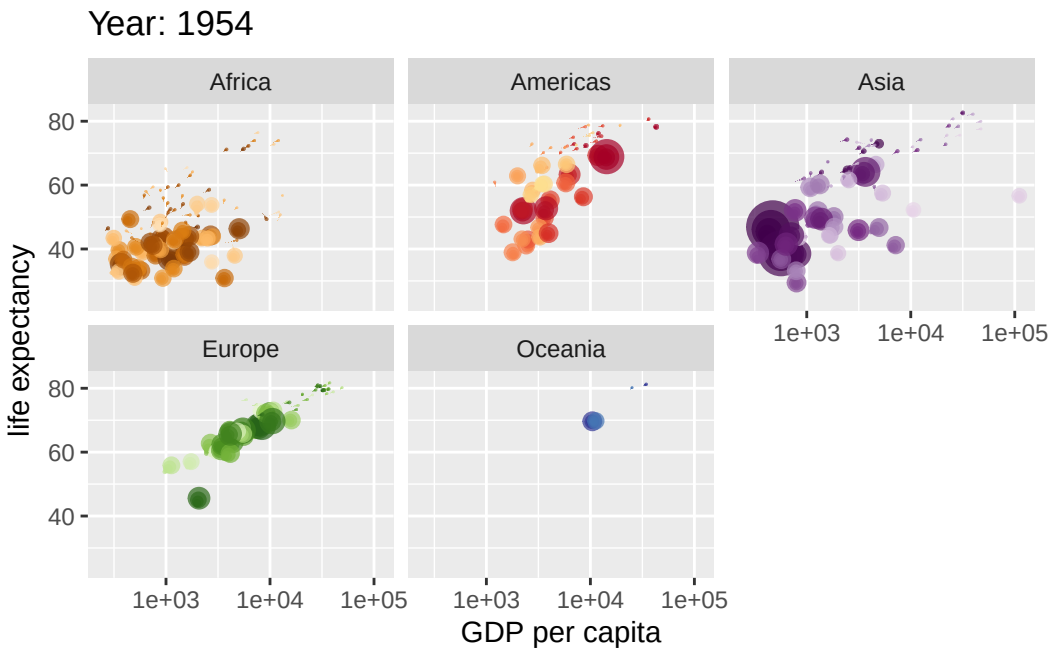
```
Warning in formals(fun): argument is not a function
```

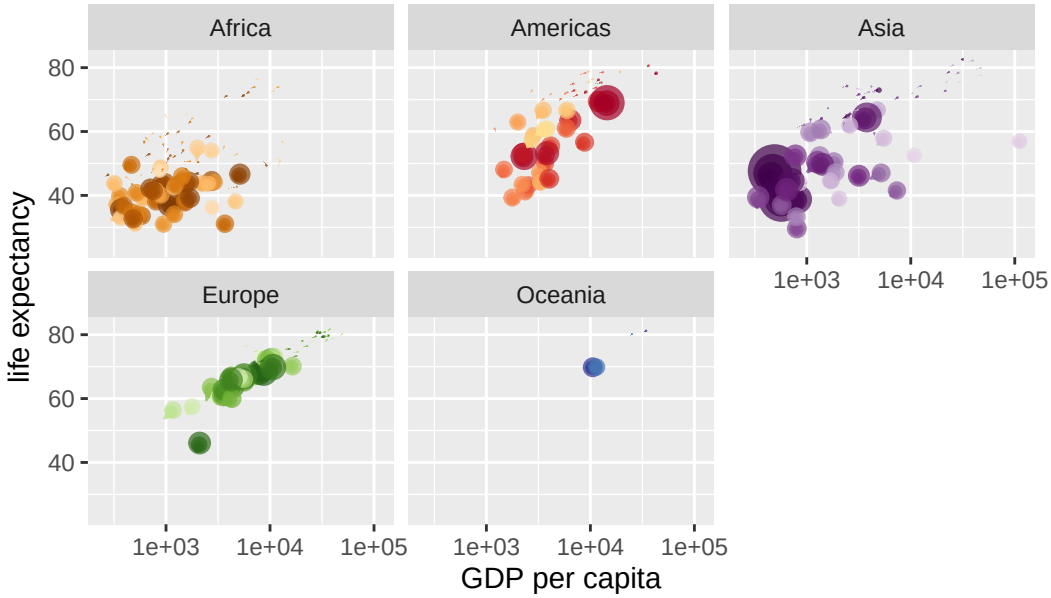

Year: 1952
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

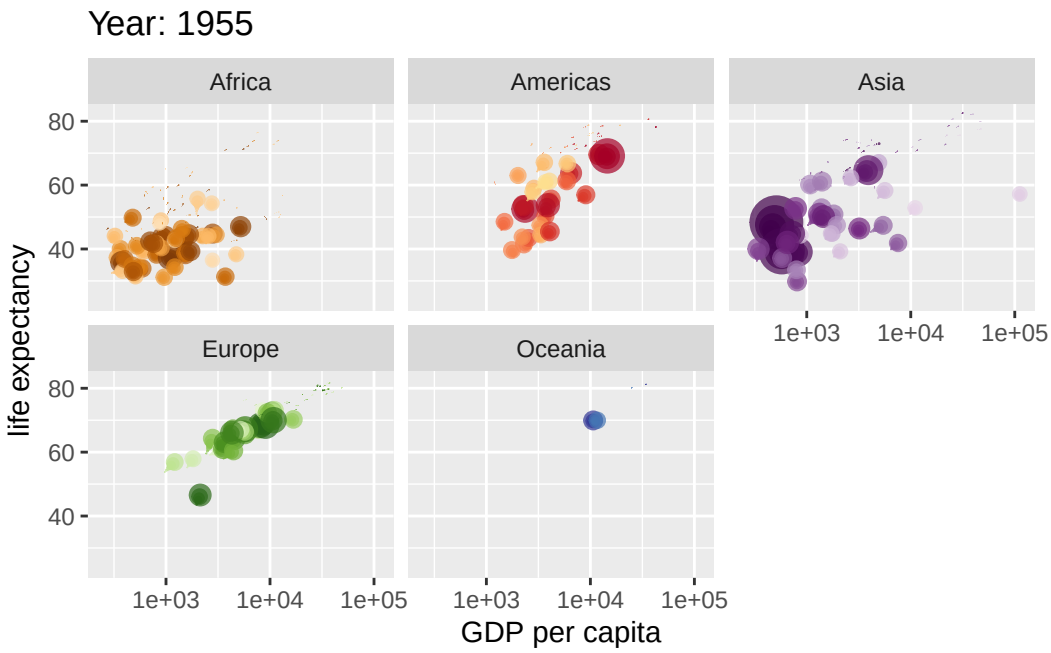

Year: 1953
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

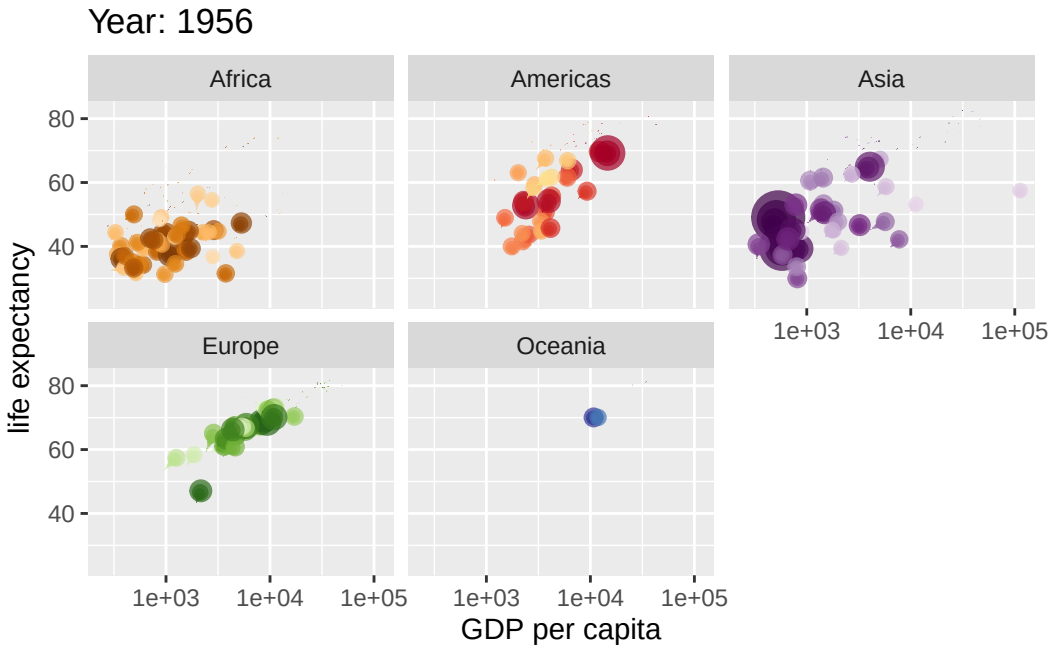

Year: 1953
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

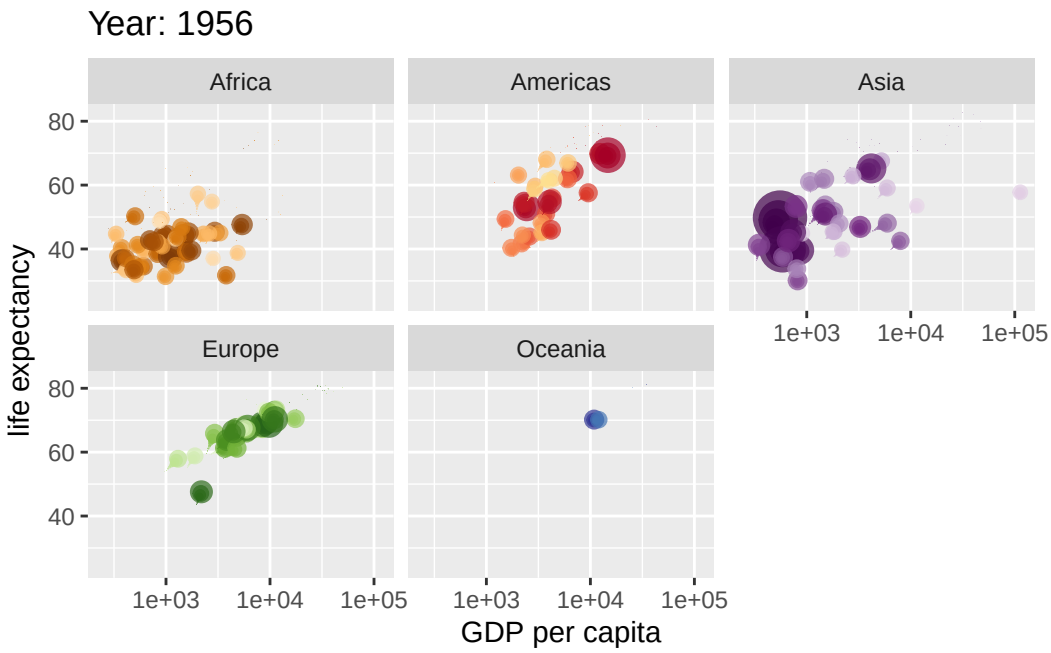

Year: 1954
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

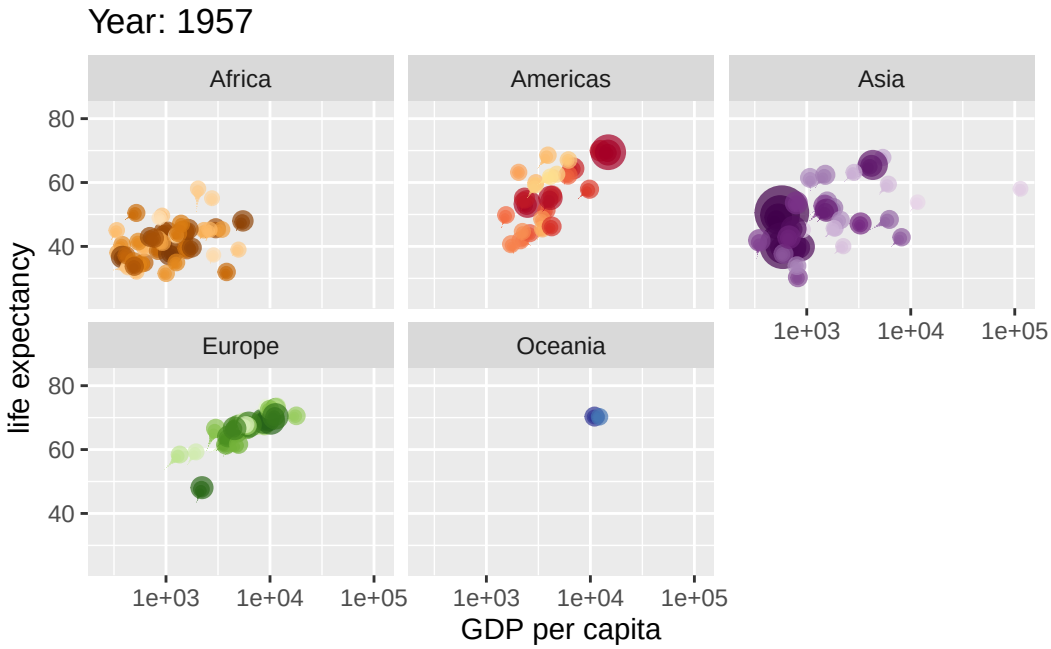

Year: 1954
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

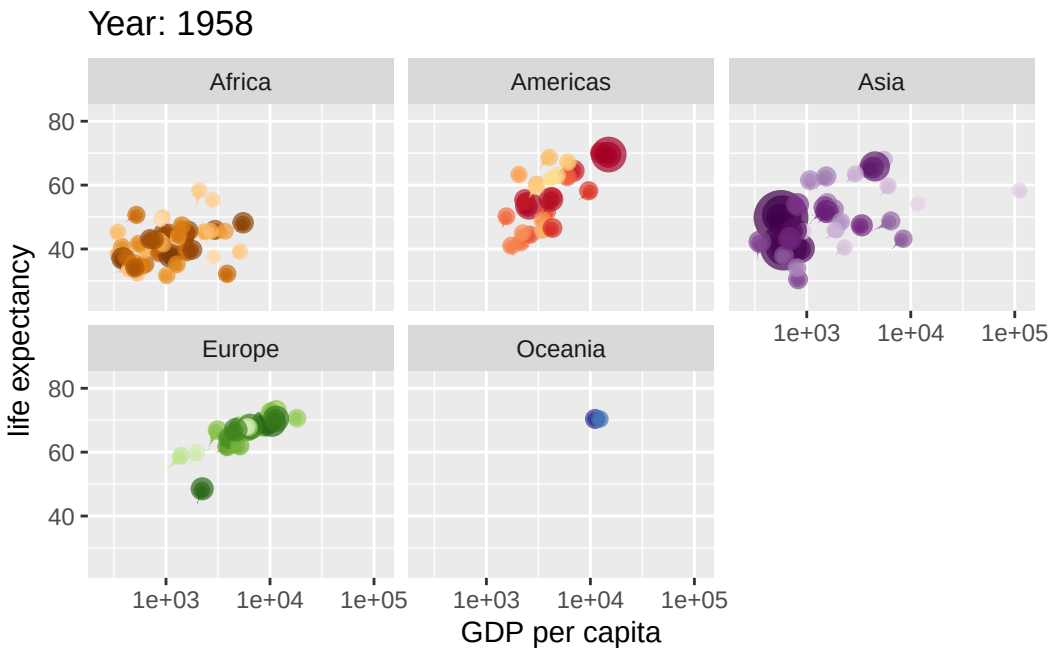

Year: 1955
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

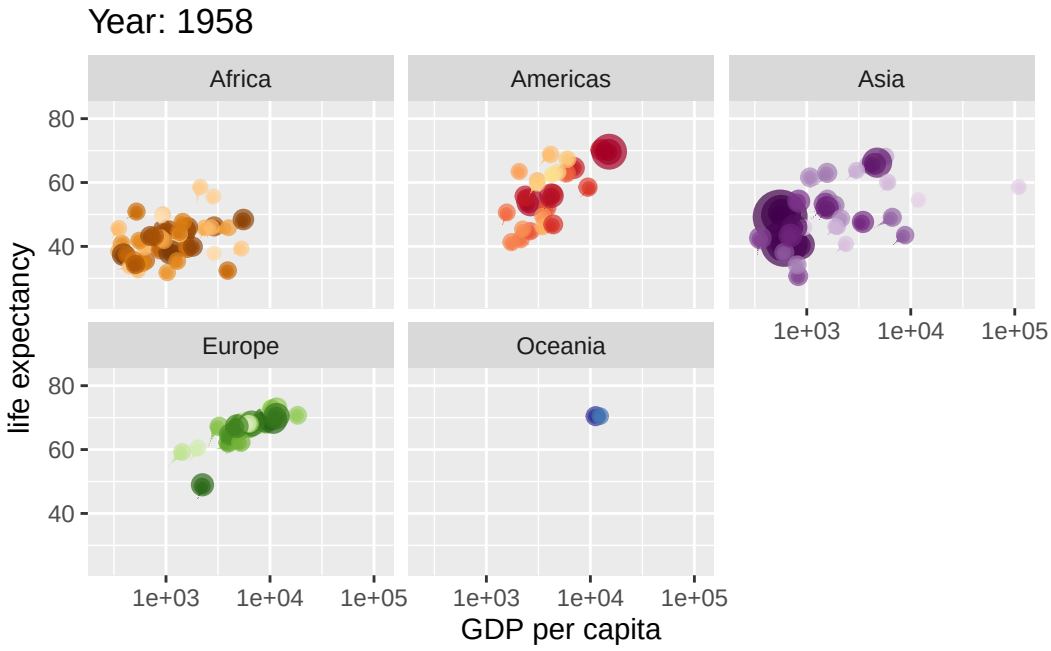

Year: 1955
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

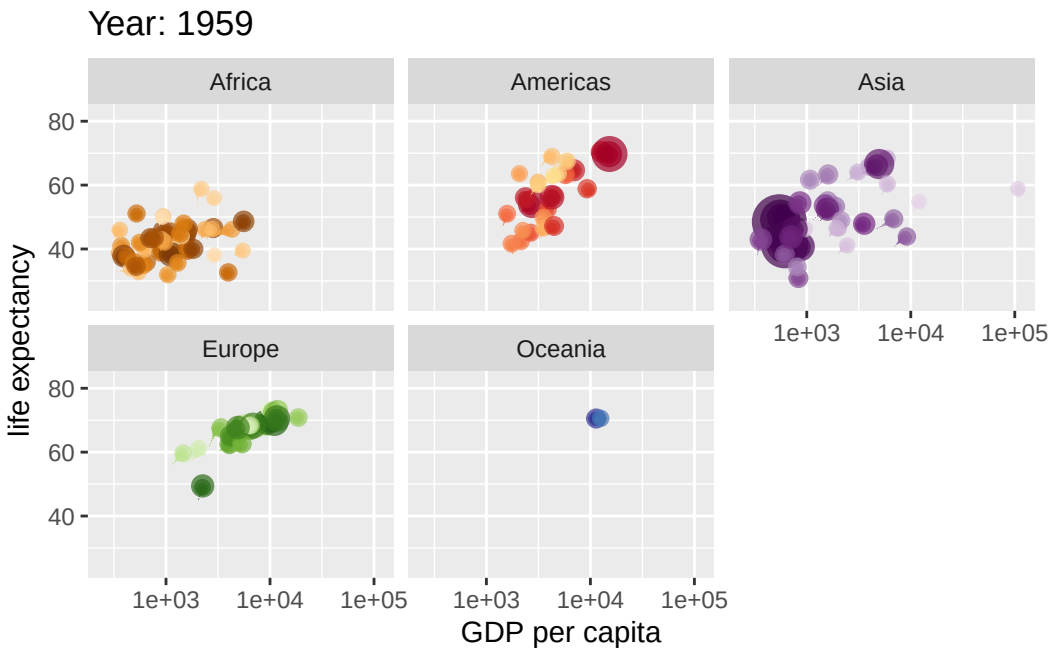

Year: 1956
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

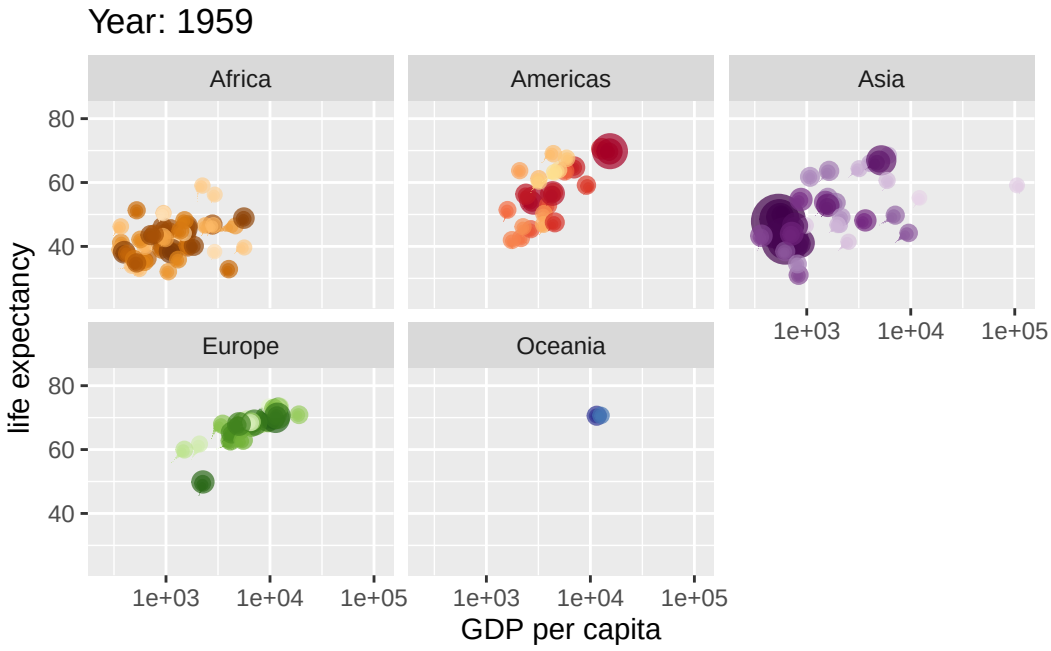

Year: 1956
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

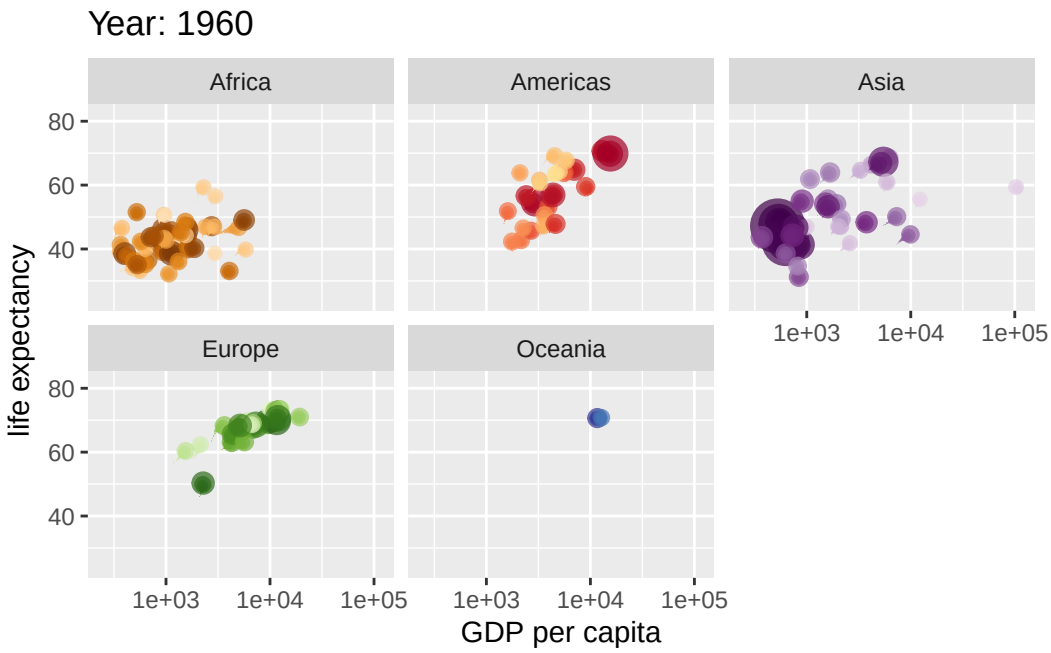

Year: 1957
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

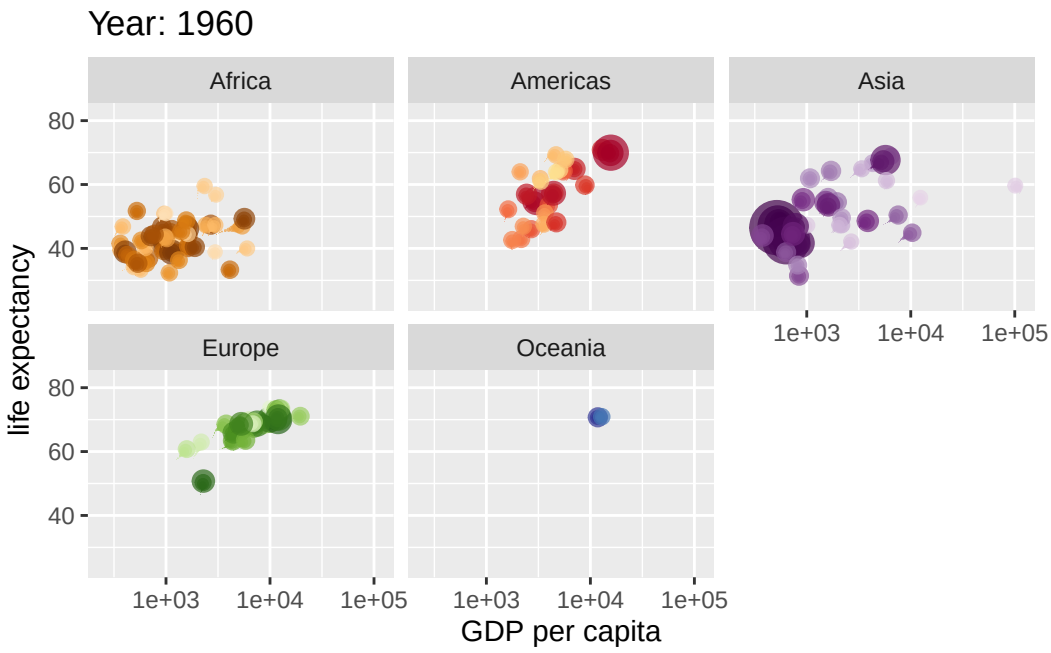

Year: 1958
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

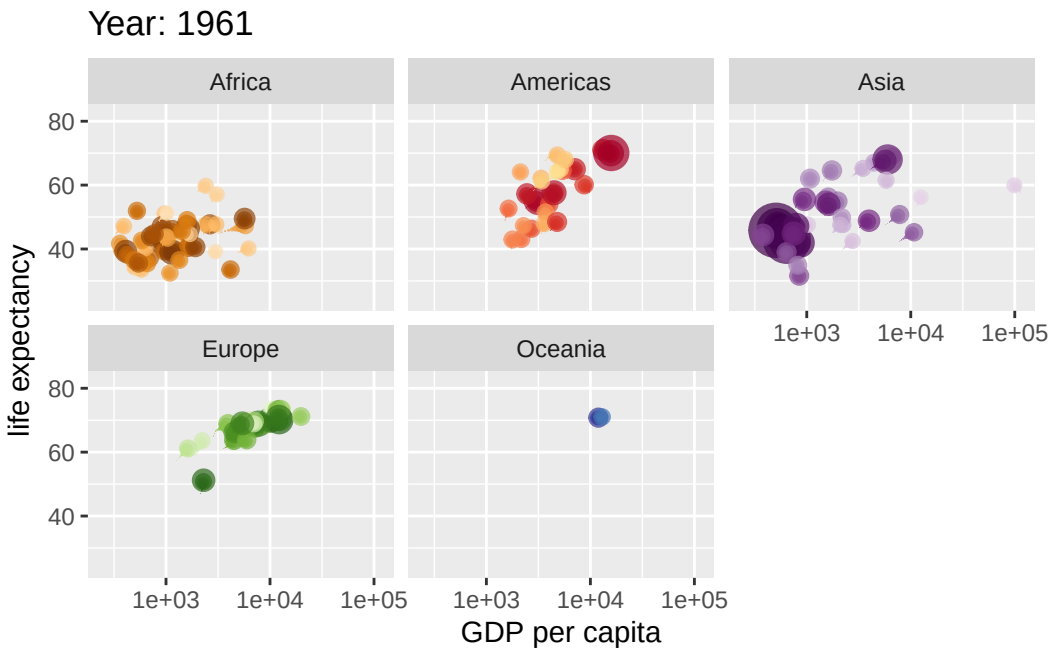

Year: 1958
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

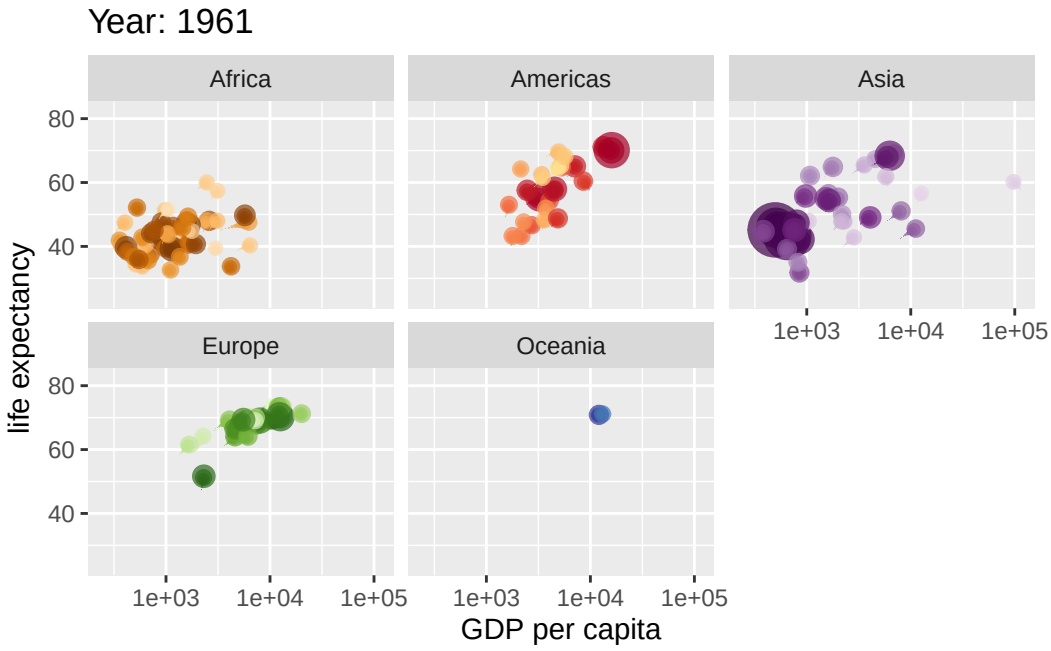

Year: 1959
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita

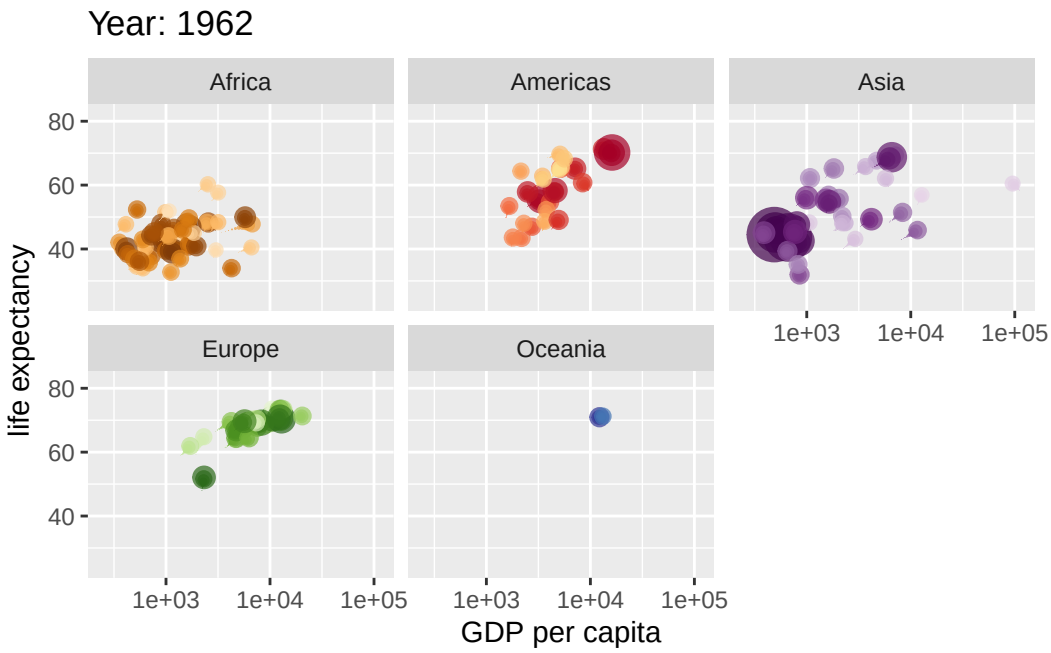

Year: 1959
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


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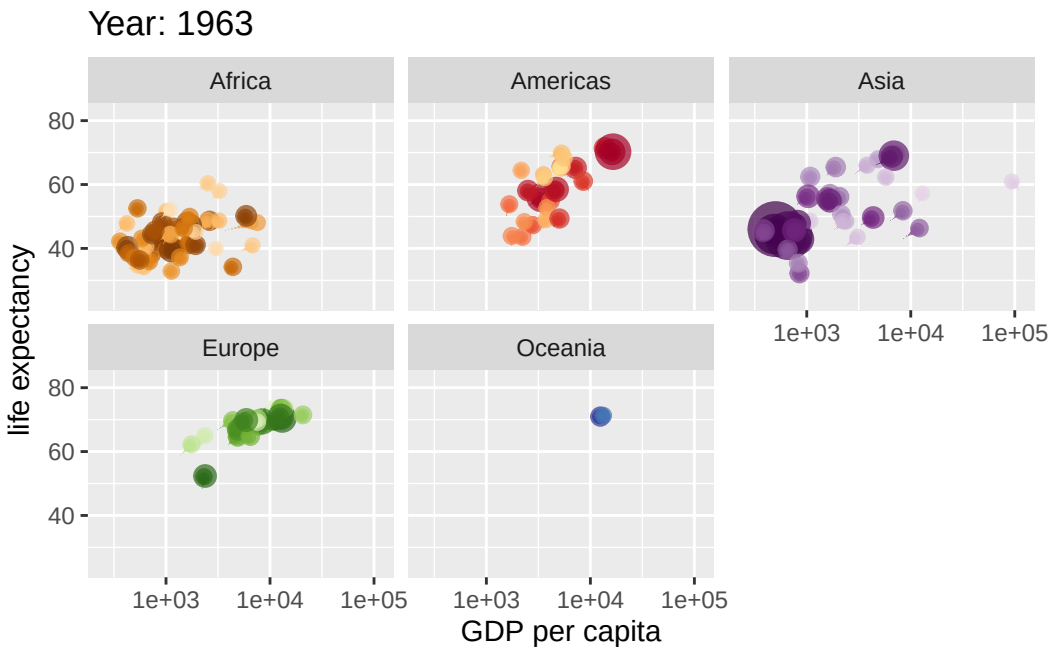
60
40
1e+03
1e+04
1e+05
GDP per capita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Africa
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Asia
Europe
Oceania
life expectancy
80
60
40
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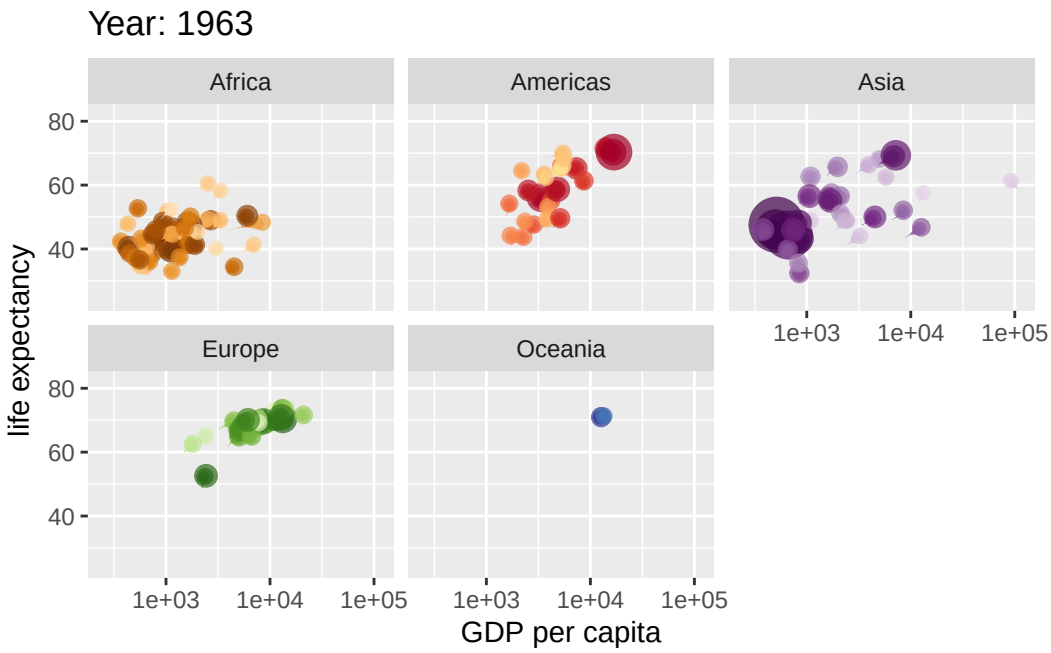
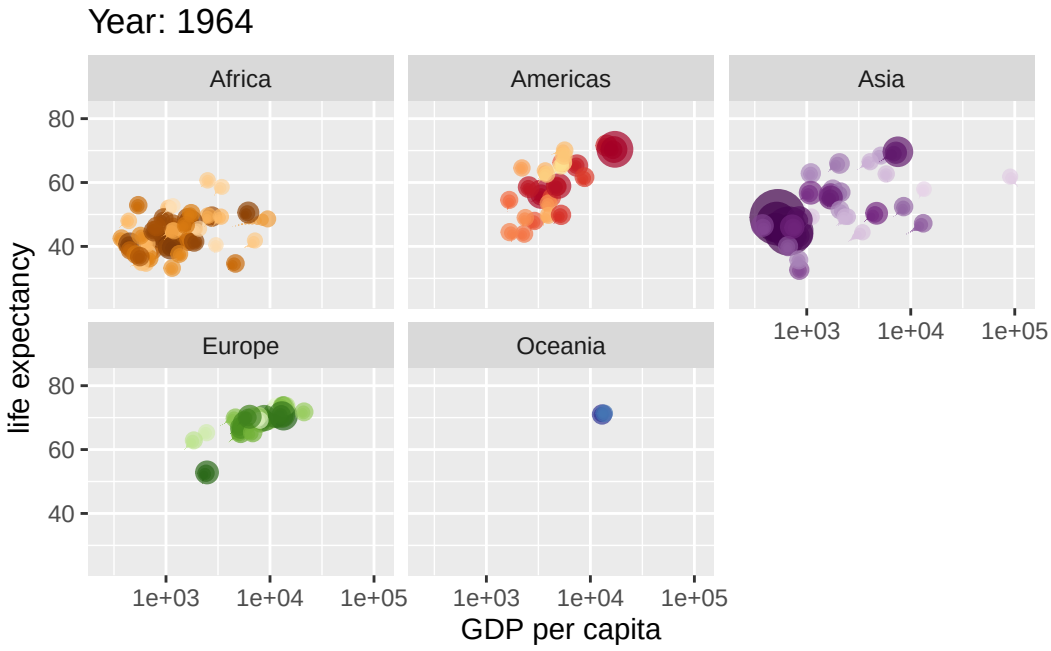
1e+04
1e+05
GDP per capita


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


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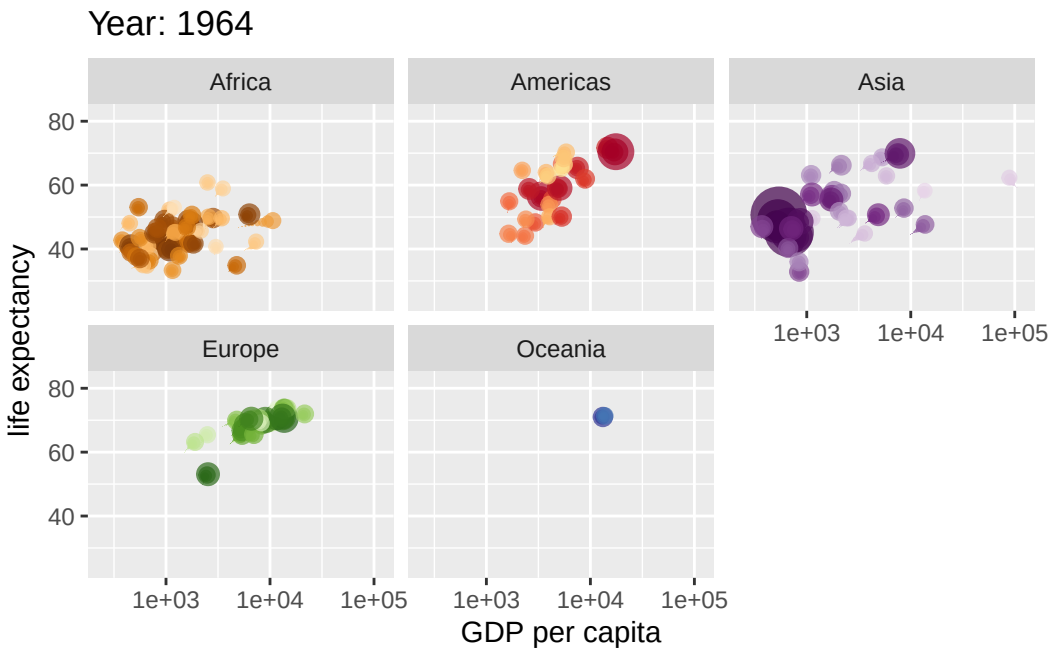
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


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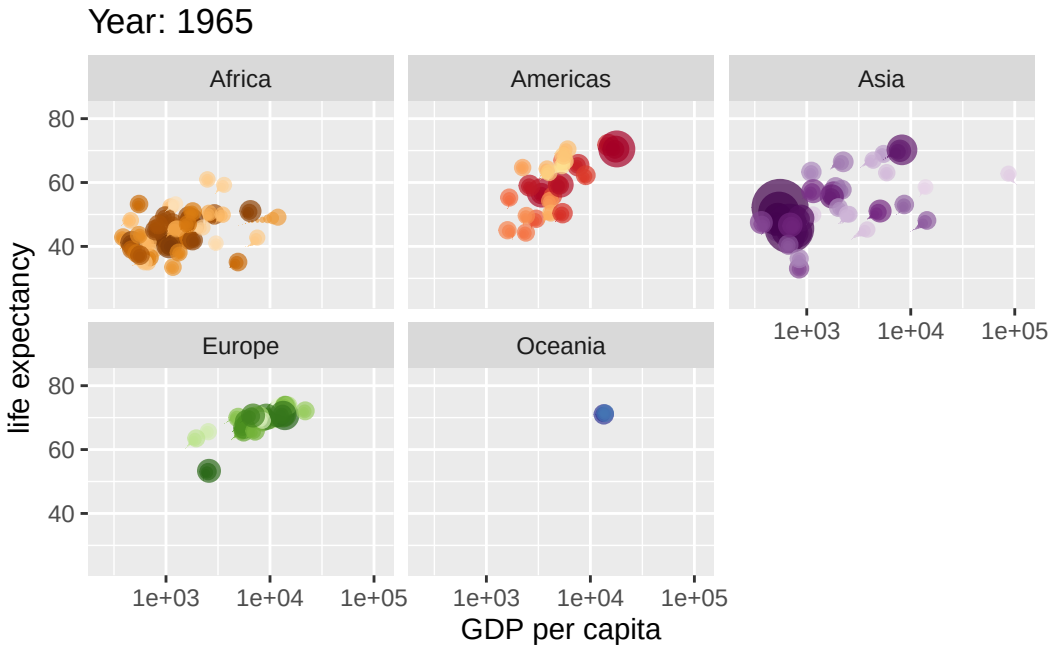
1e+03
1e+04
1e+05
GDP per capita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Africa
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Europe
Oceania
life expectancy
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60
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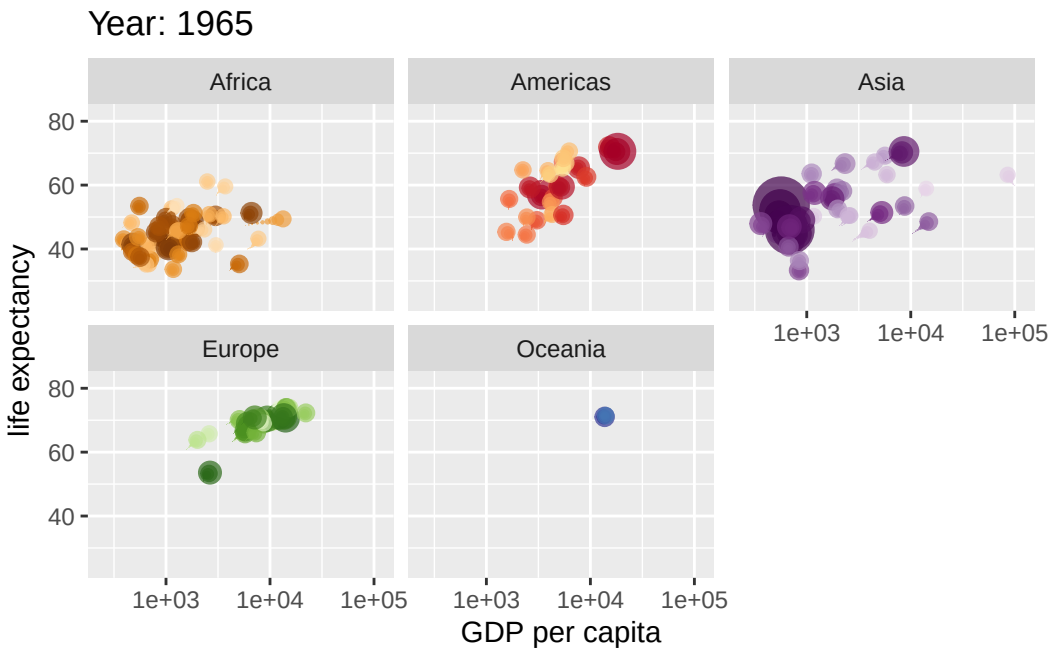
1e+03
1e+04
1e+05
GDP per capita


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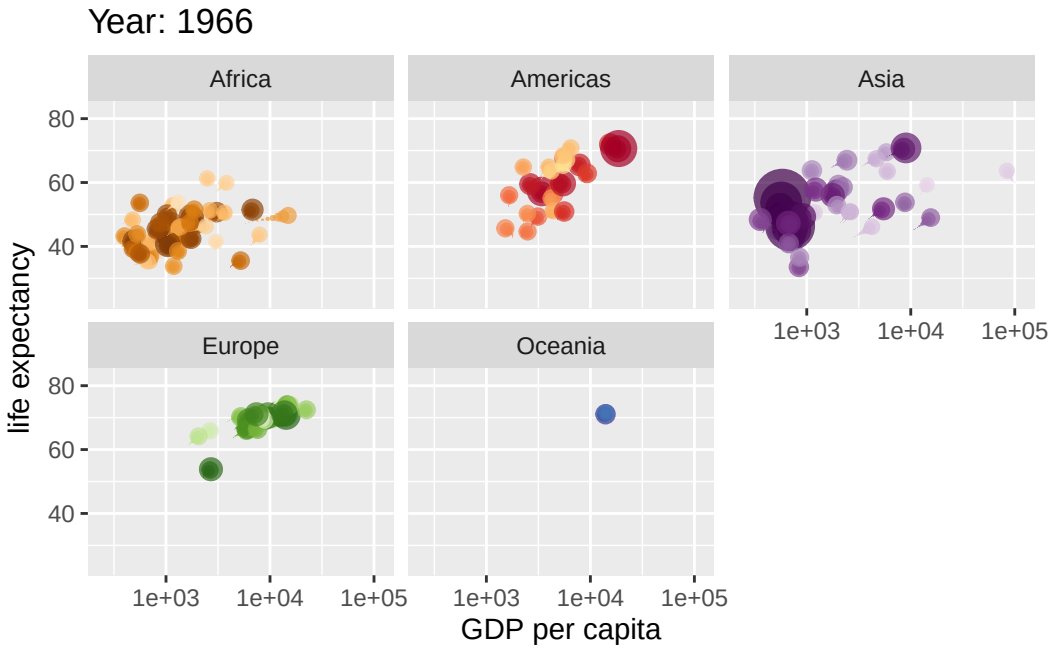
1e+03
1e+04
1e+05
GDP per capita


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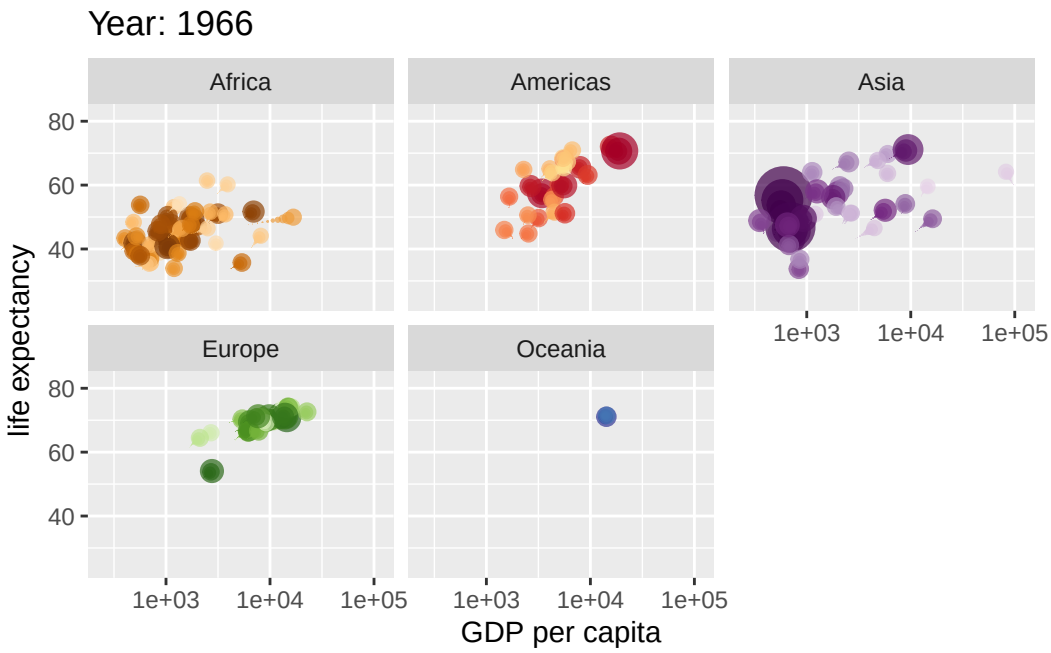
60
40
1e+03
1e+04
1e+05
GDP per capita


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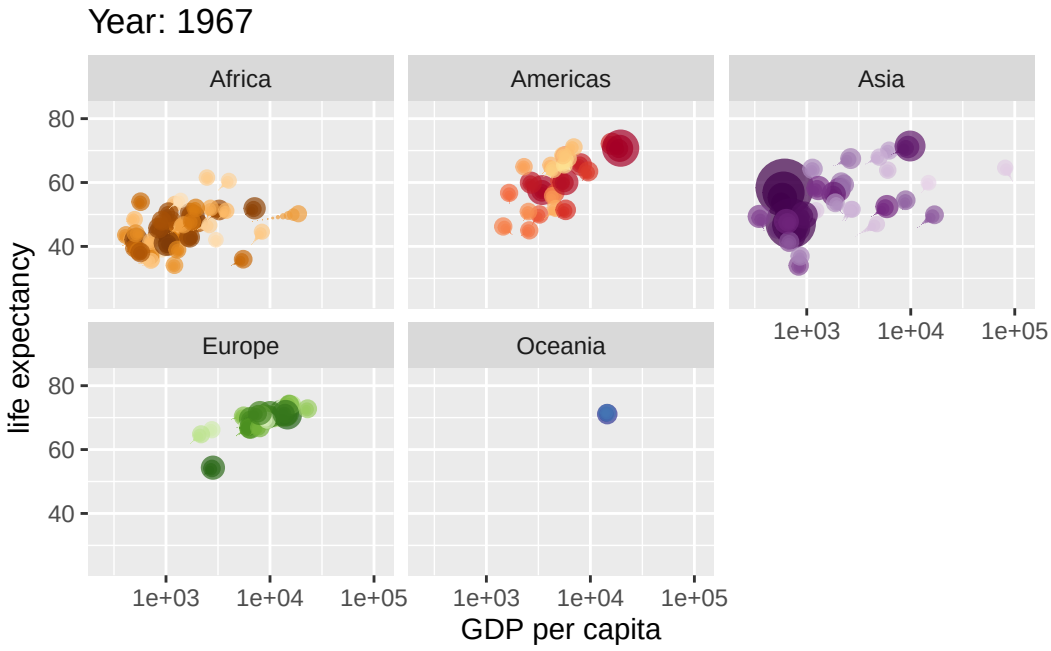
60
40
1e+03
1e+04
1e+05
GDP per capita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Africa
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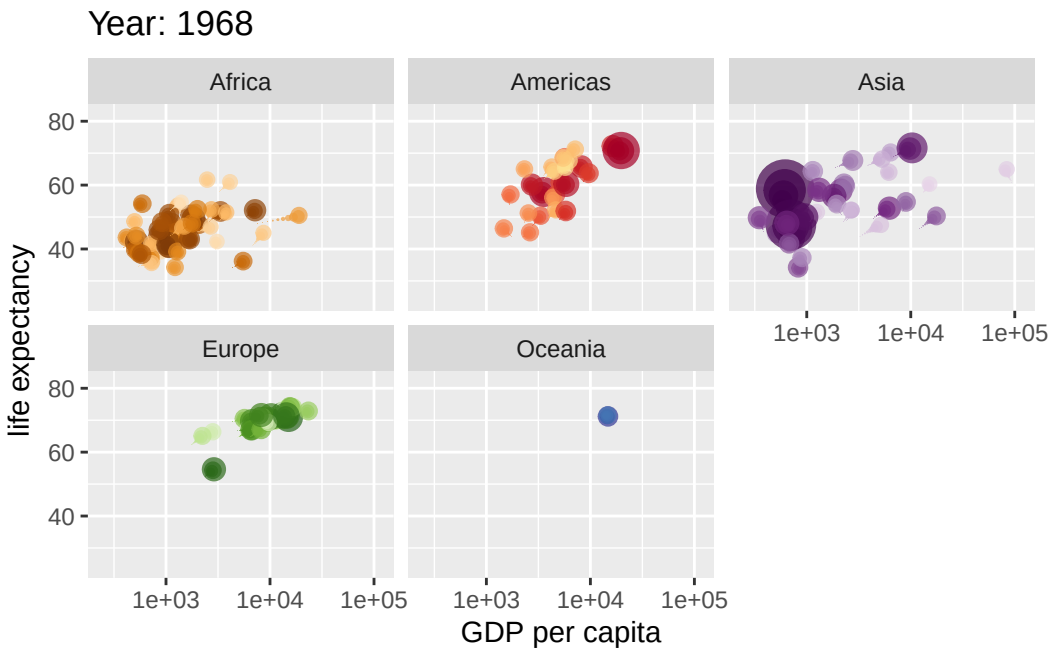
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita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Africa
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Asia
Europe
Oceania
life expectancy
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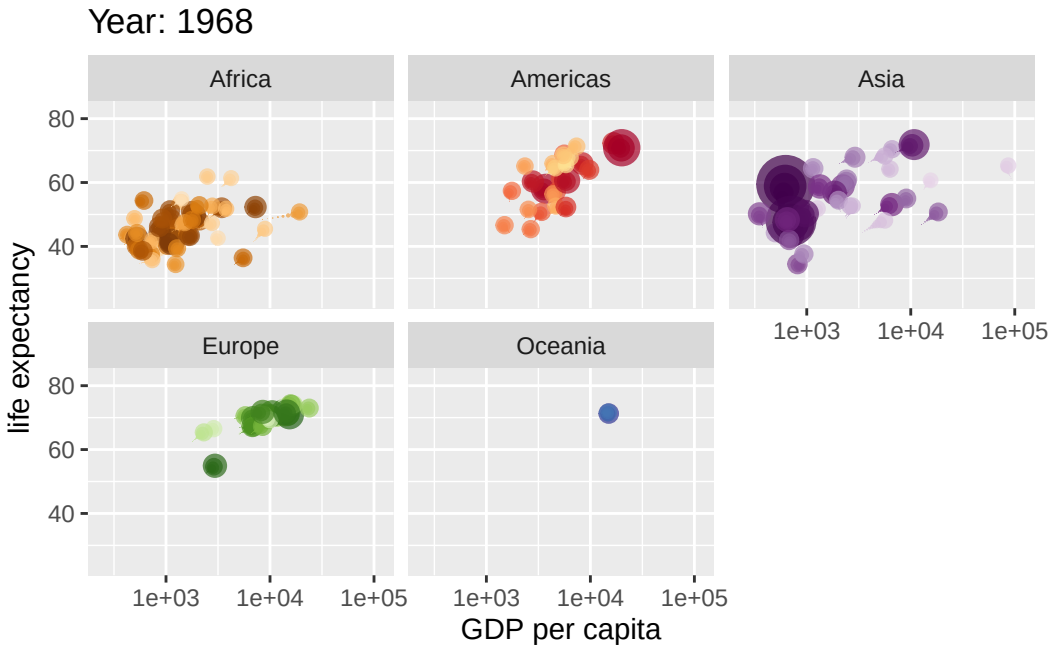
40
1e+03
1e+04
1e+05
GDP per capita


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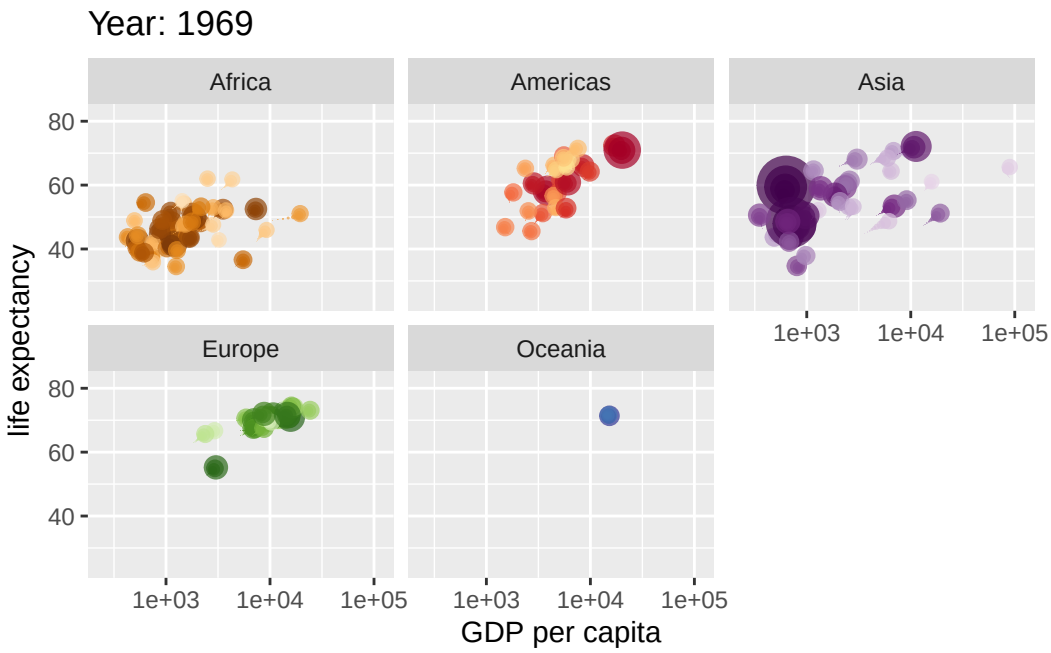
60
40
1e+03
1e+04
1e+05
GDP per capita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Africa
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Asia
Europe
Oceania
life expectancy
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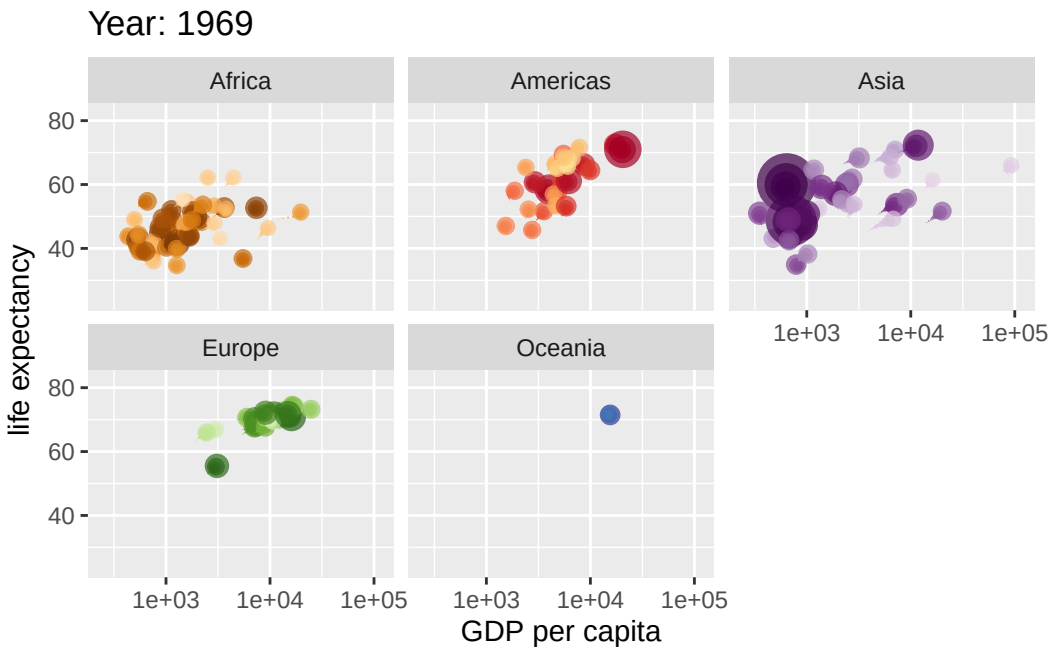
1e+03
1e+04
1e+05
GDP per capita


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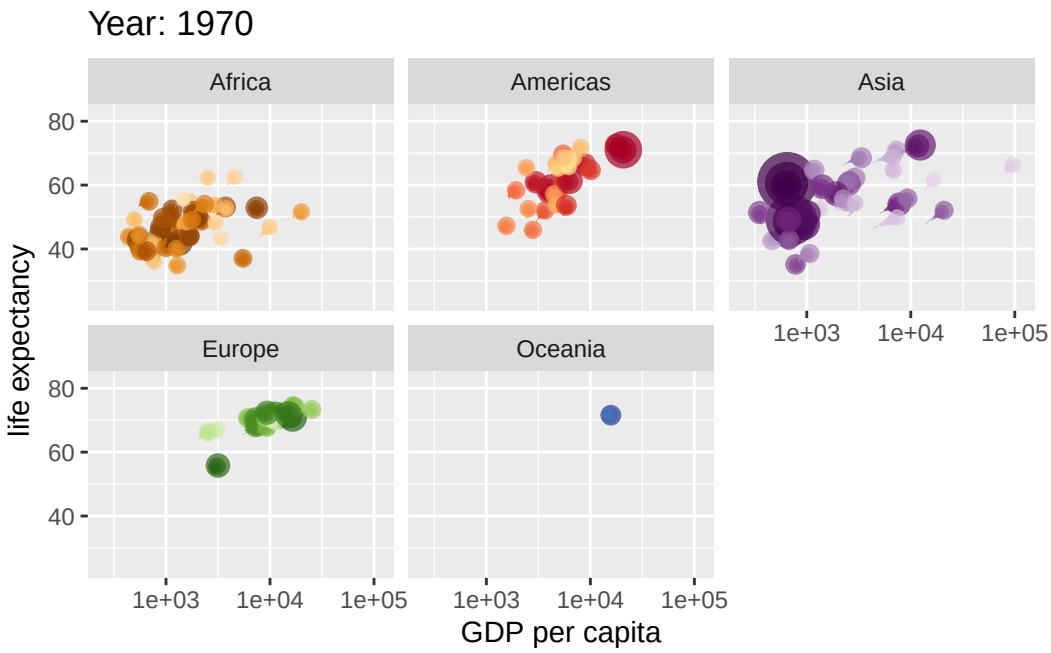
40
1e+03
1e+04
1e+05
GDP per capita


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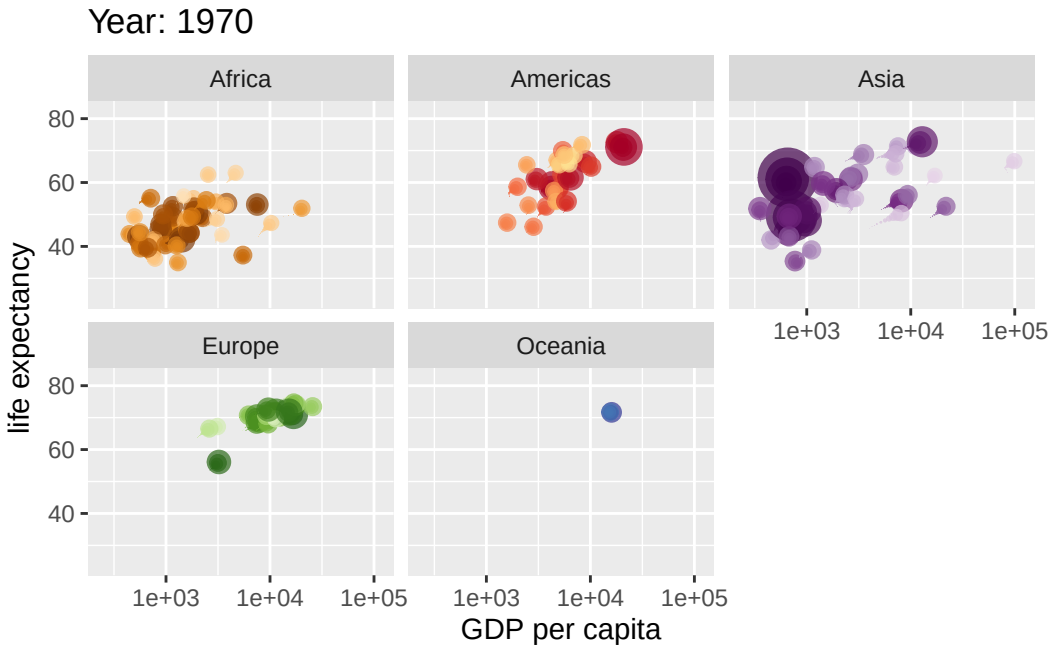
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1970
Africa
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Asia
Europe
Oceania
life expectancy
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1e+03
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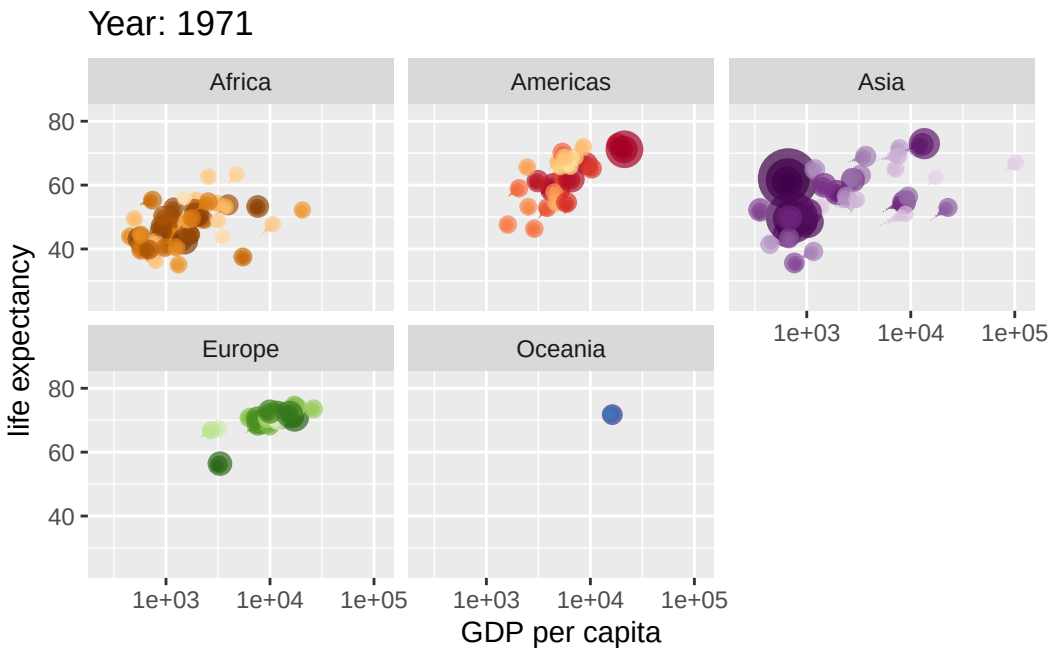
1e+05
GDP per capita


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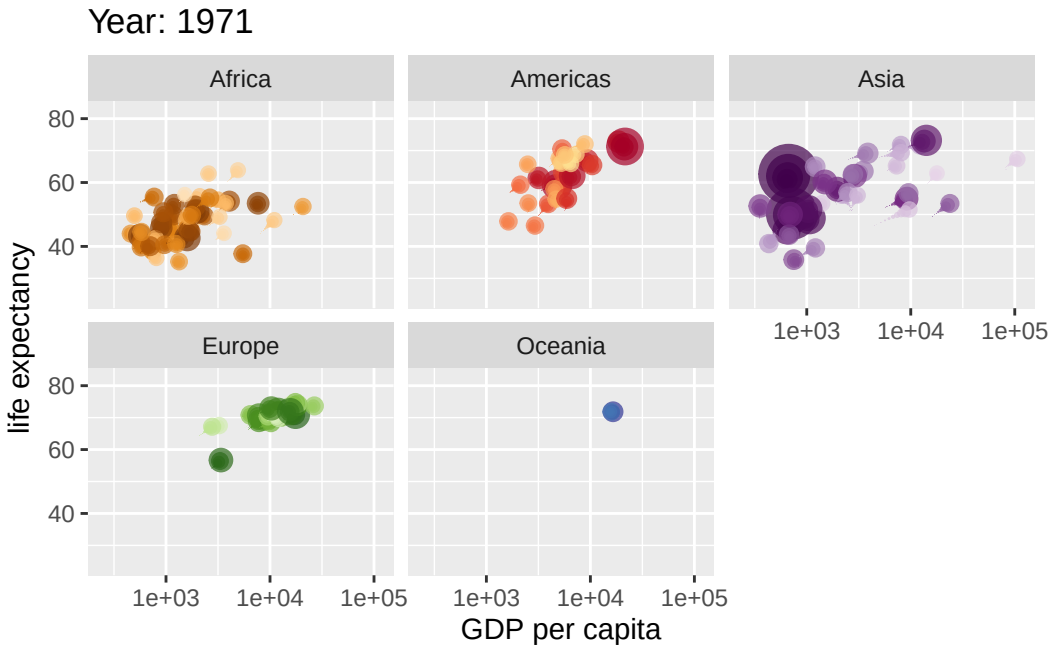
1e+03
1e+04
1e+05
GDP per capita


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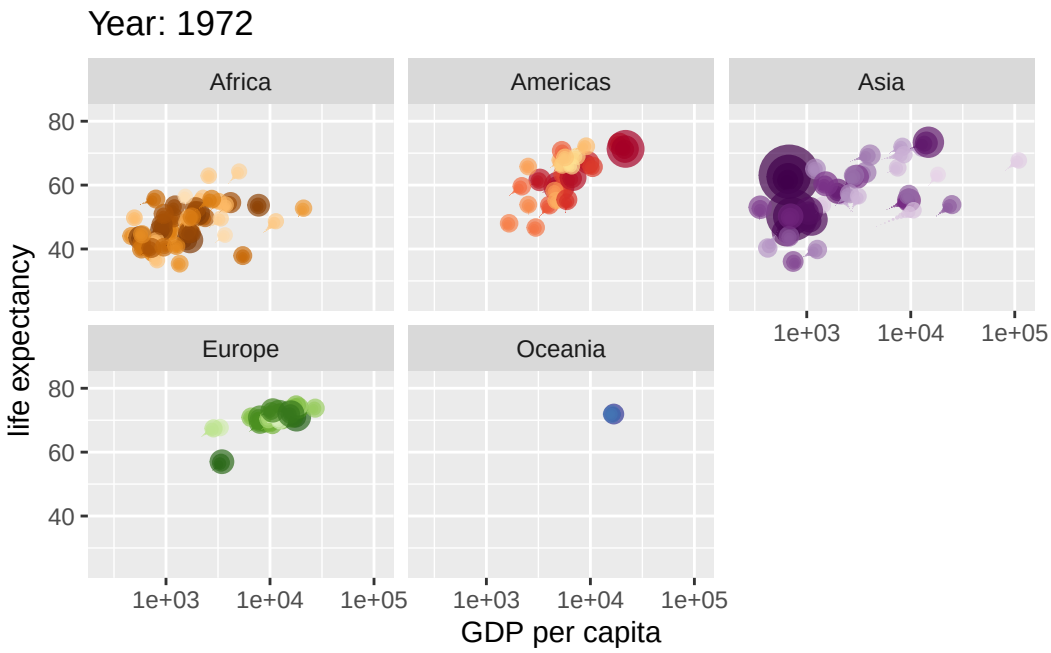
40
1e+03
1e+04
1e+05
GDP per capita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Africa
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Asia
Europe
Oceania
life expectancy
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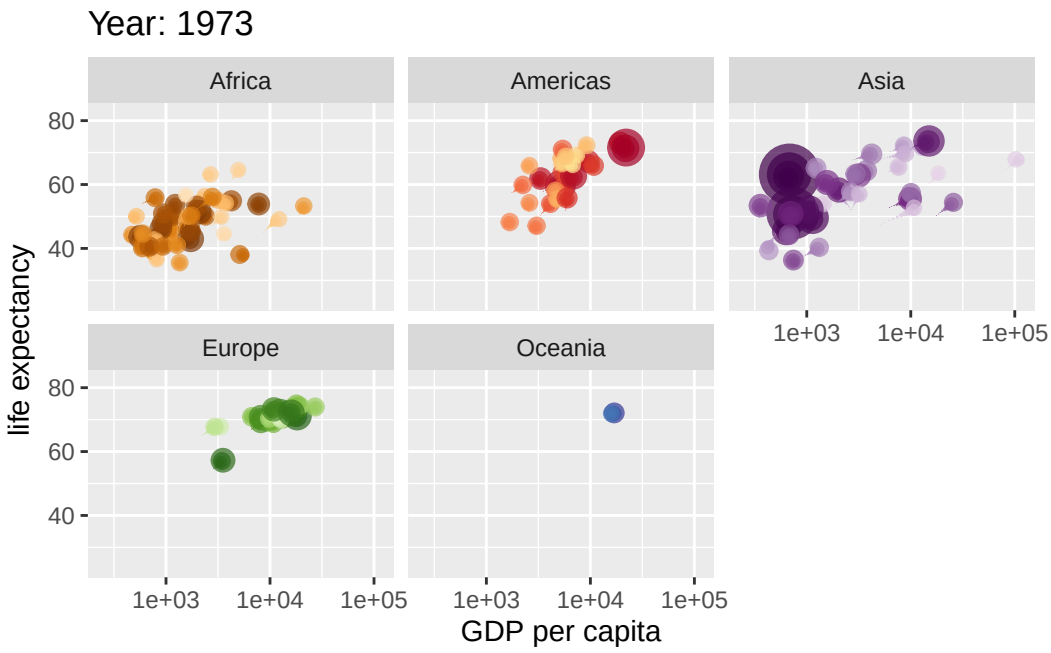
1e+03
1e+04
1e+05
GDP per capita


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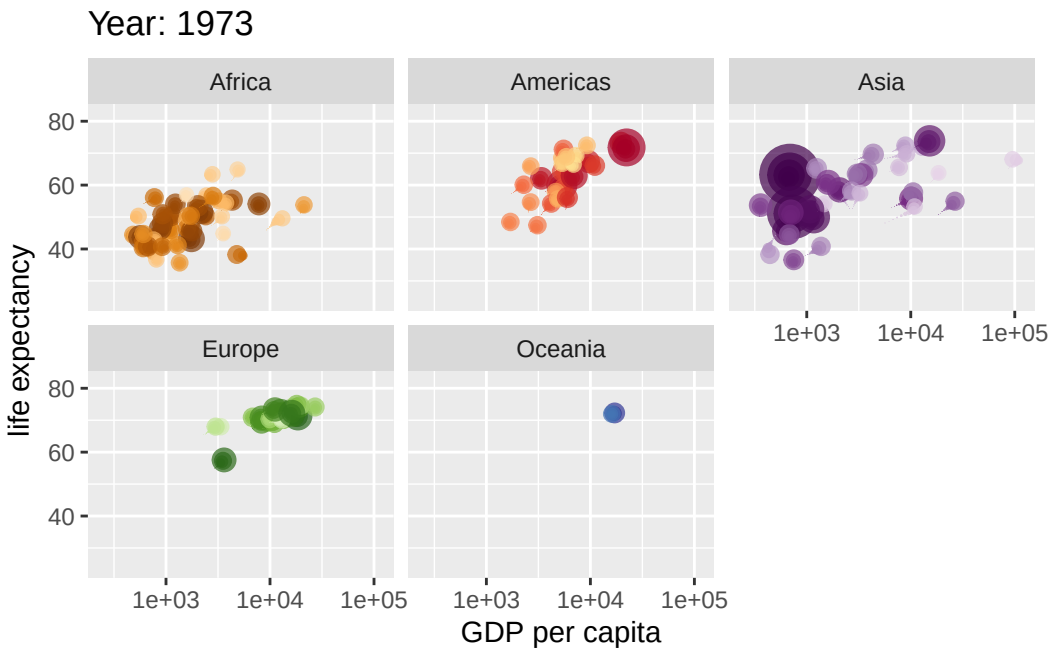
60
40
1e+03
1e+04
1e+05
GDP per capita


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


Year: 1974
Africa
Americas
Asia
Europe
Oceania
life expectancy
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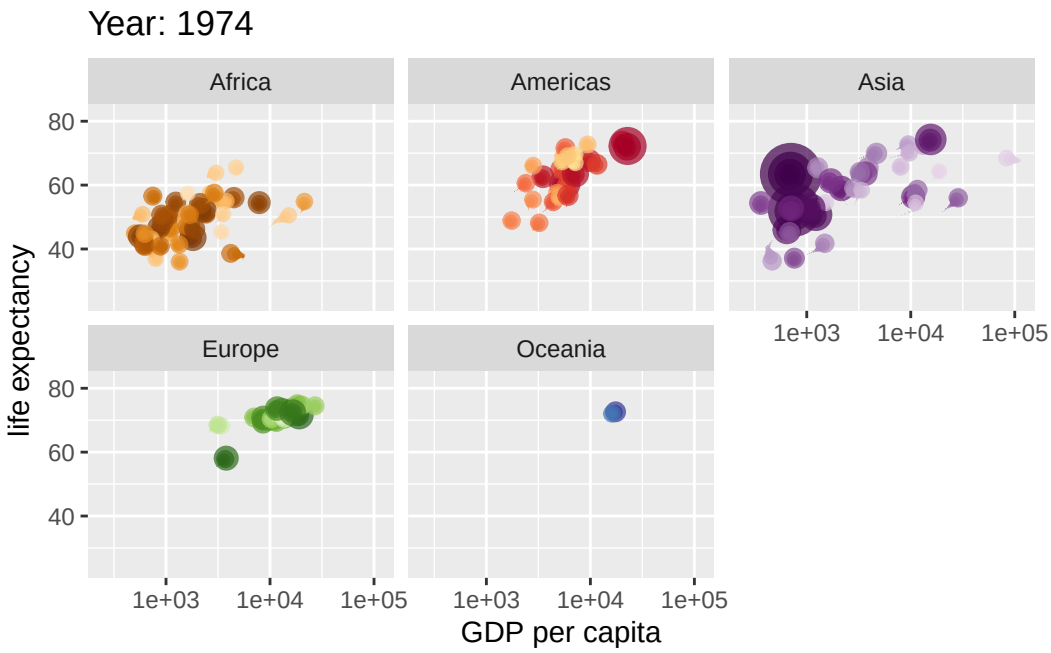
1e+03
1e+04
1e+05
GDP per capita


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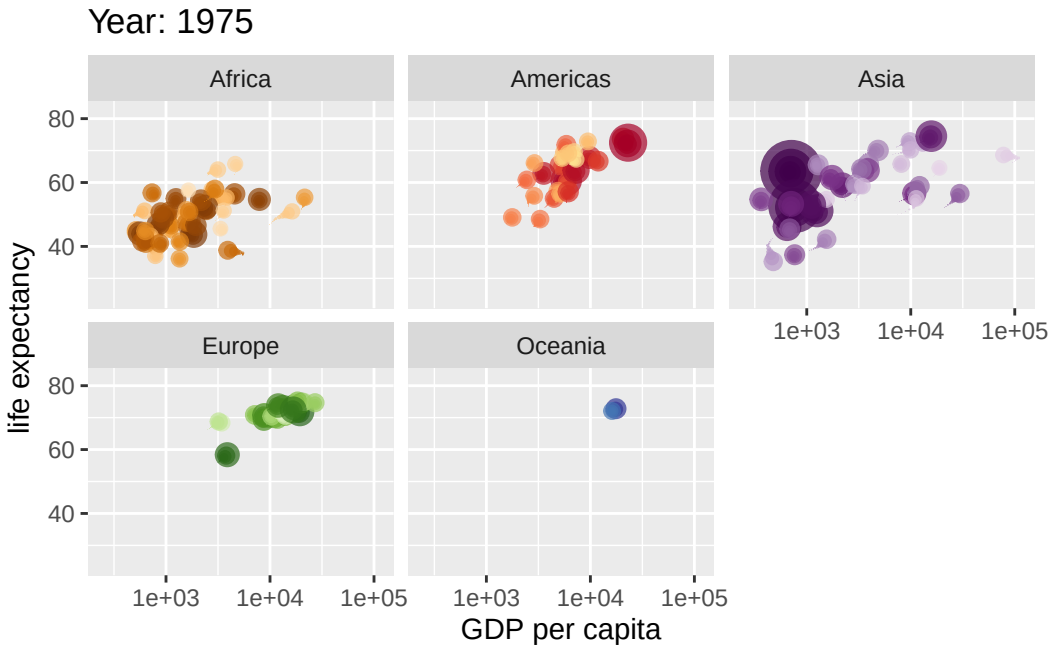
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1975
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Oceania
life expectancy
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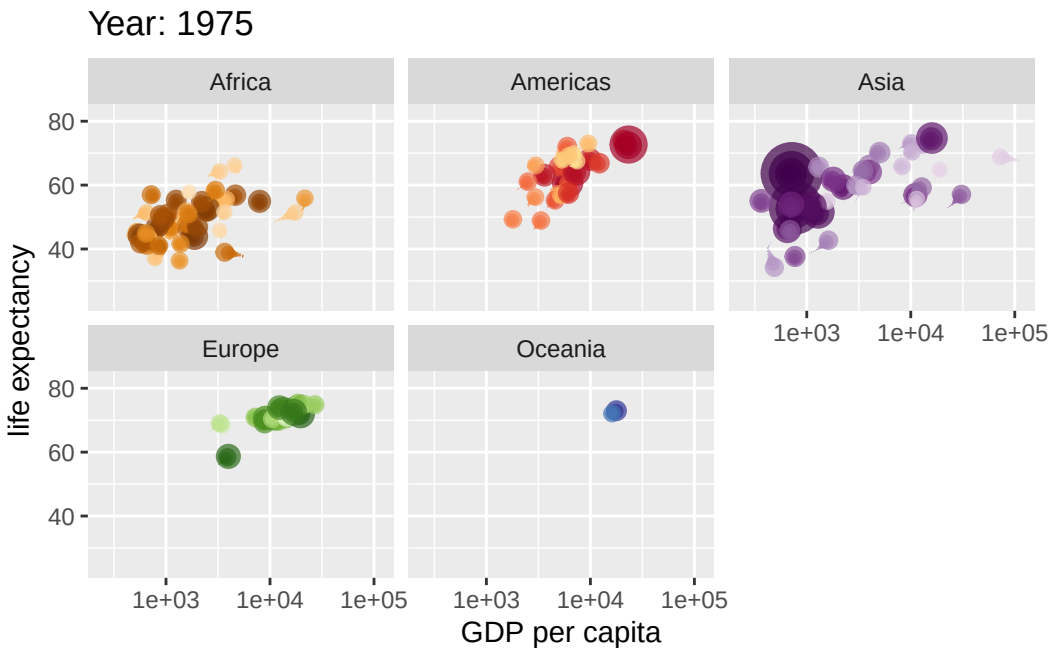
1e+05
GDP per capita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life expectancy
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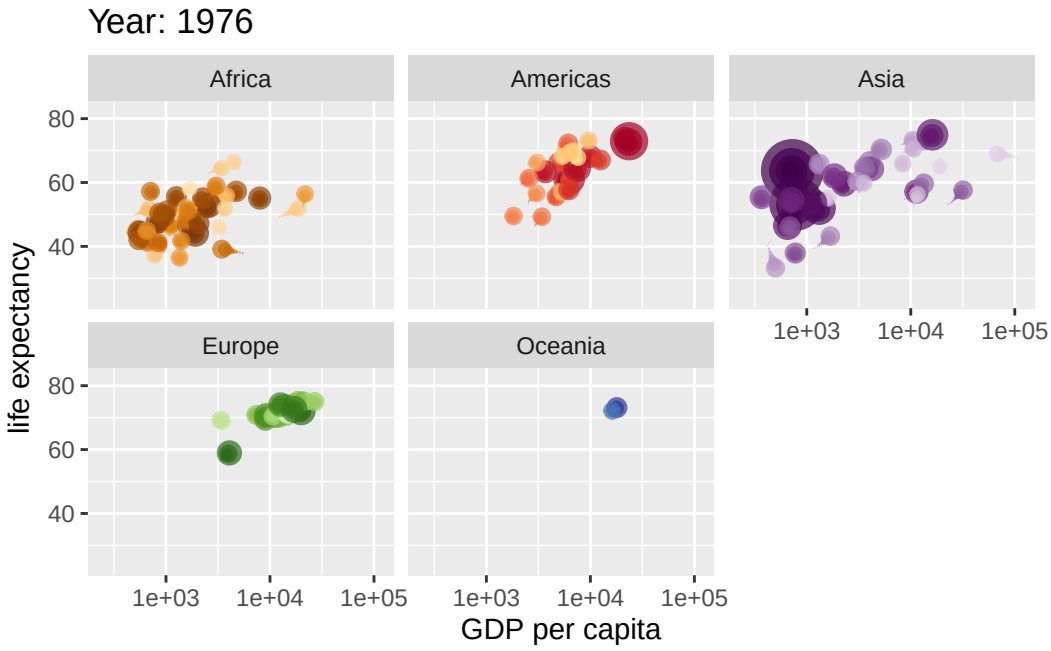
1e+05
GDP per capita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Oceania
life expectancy
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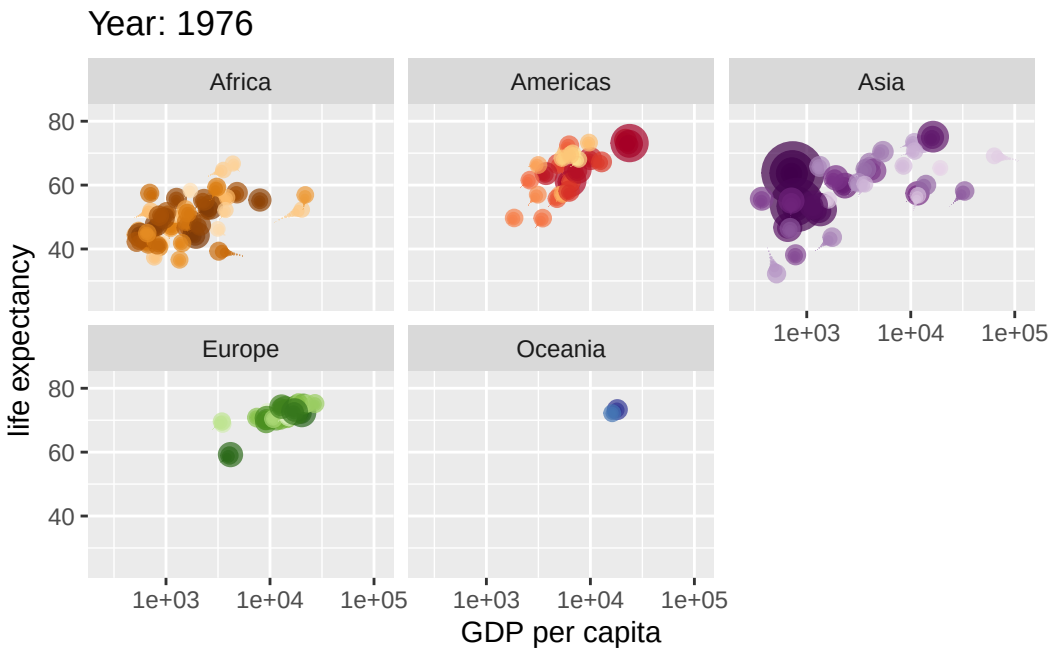
1e+05
GDP per capita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life expectancy
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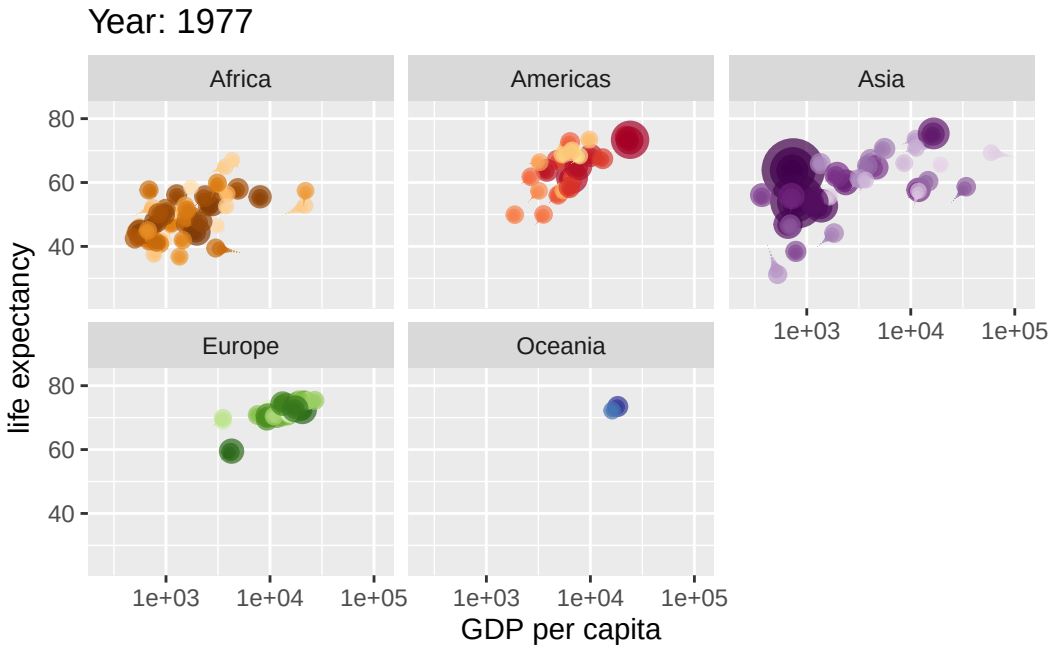
1e+05
GDP per capita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Europe
Oceania
life expectancy
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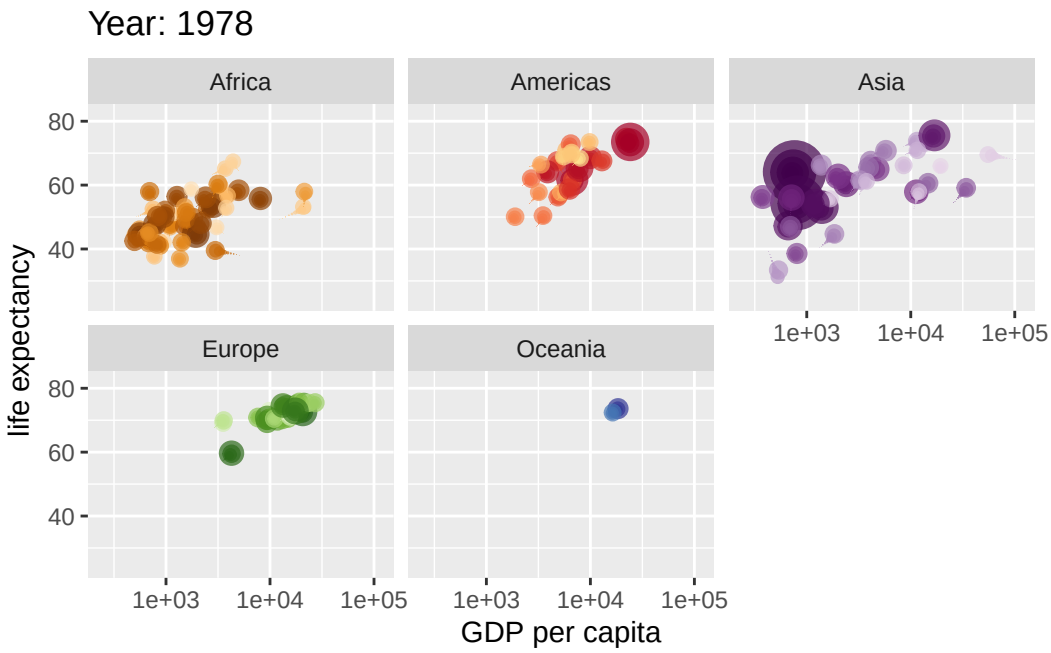
1e+03
1e+04
1e+05
GDP per capita


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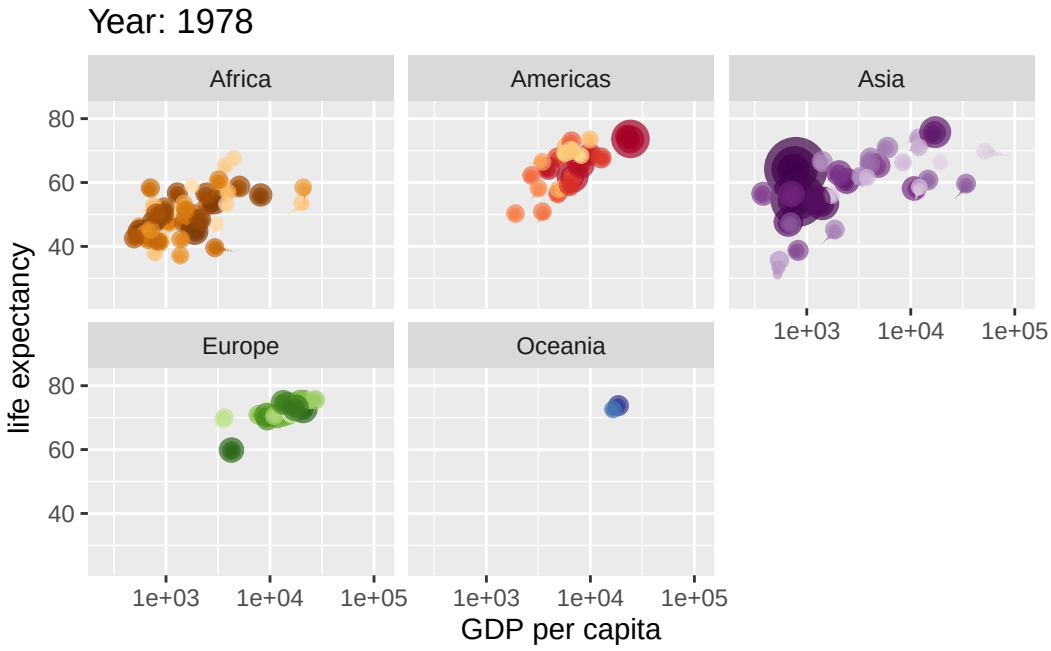
1e+03
1e+04
1e+05
GDP per capita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Africa
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Oceania
life expectancy
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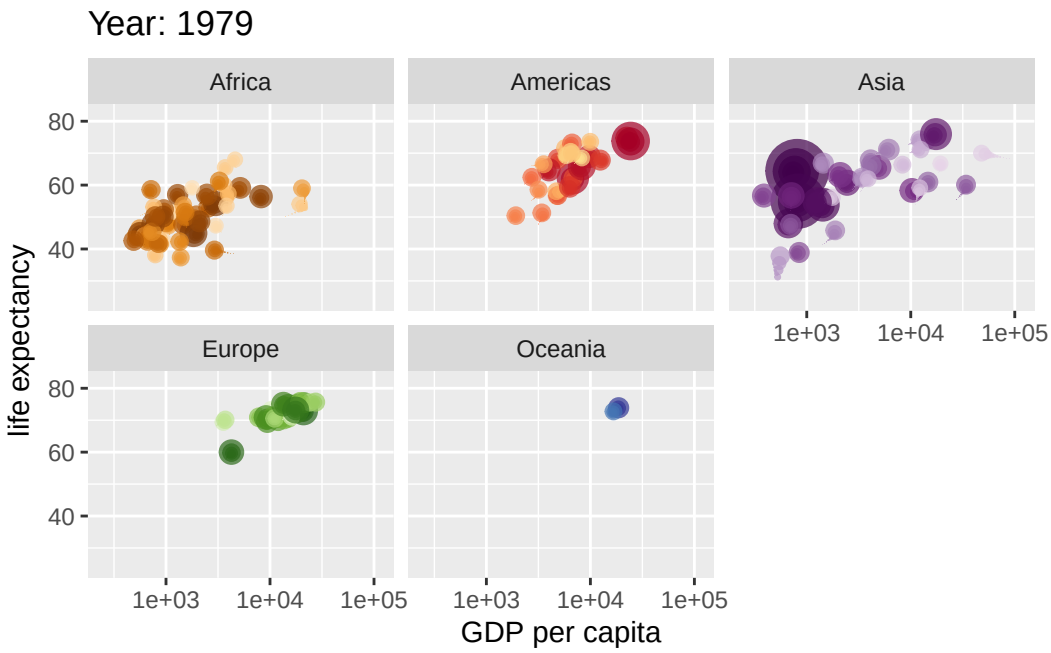
1e+03
1e+04
1e+05
GDP per capita


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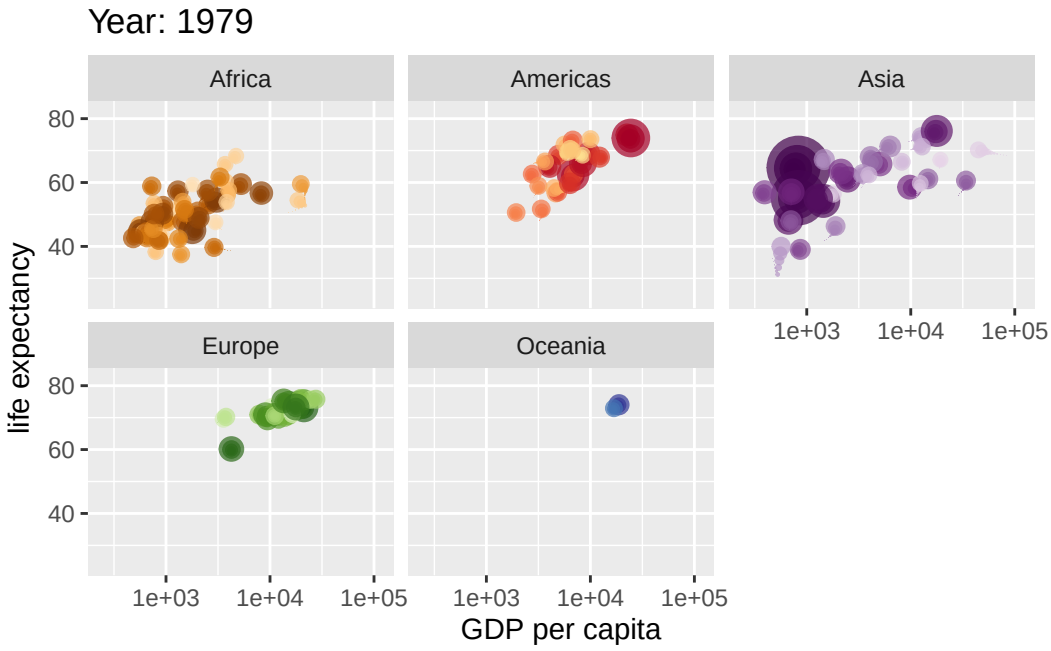
1e+03
1e+04
1e+05
GDP per capita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Africa
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Asia
Europe
Oceania
life expectancy
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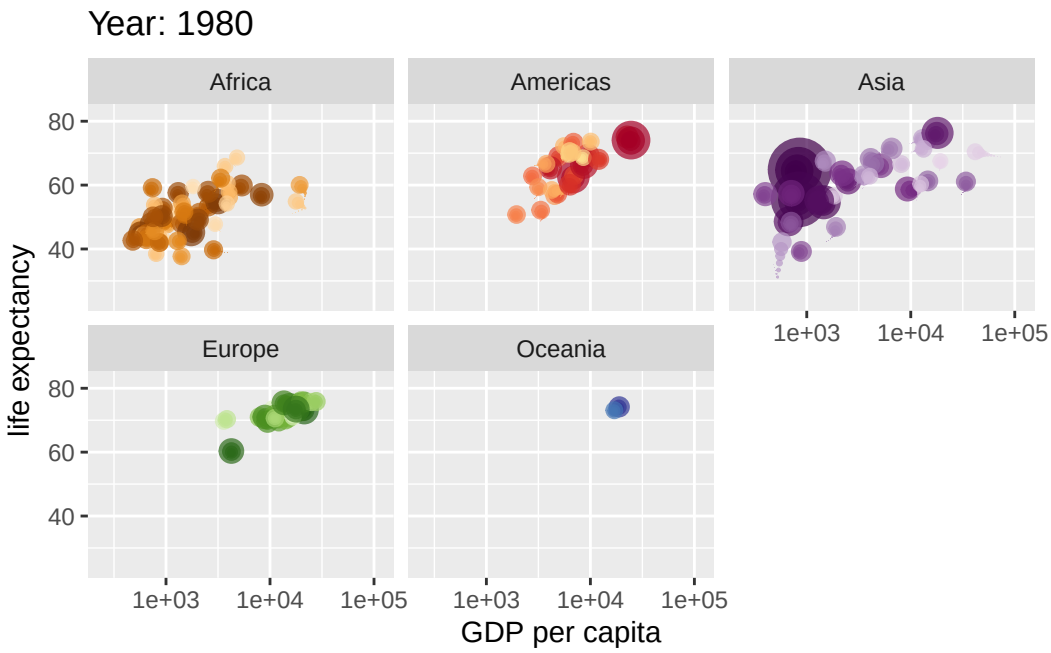
1e+03
1e+04
1e+05
GDP per capita


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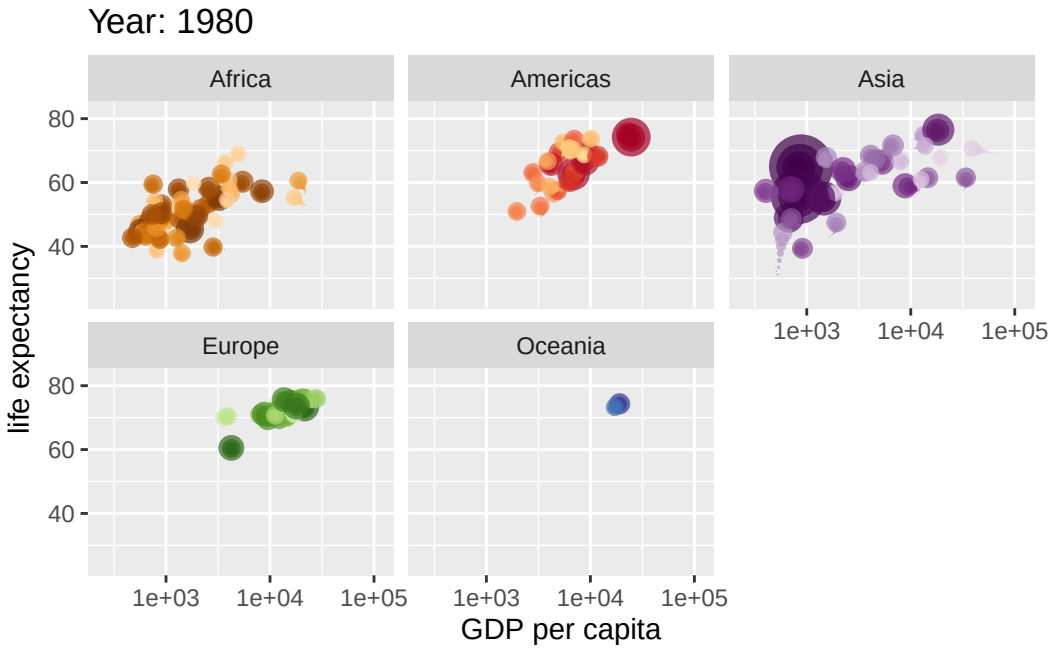
1e+03
1e+04
1e+05
GDP per capita


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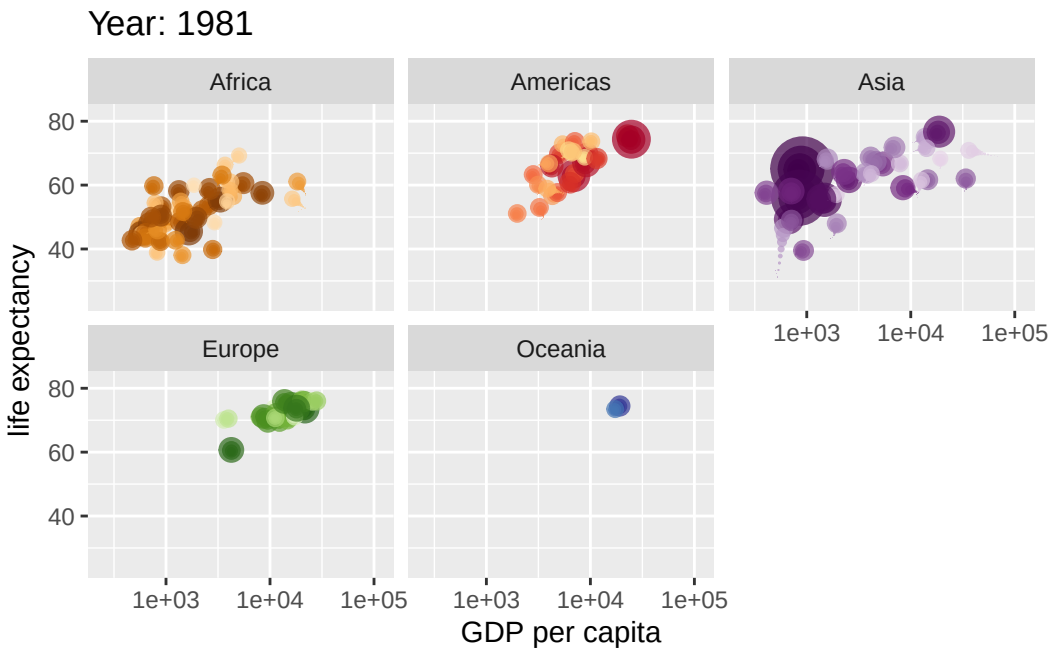
1e+03
1e+04
1e+05
GDP per capita


Year: 1981
Africa
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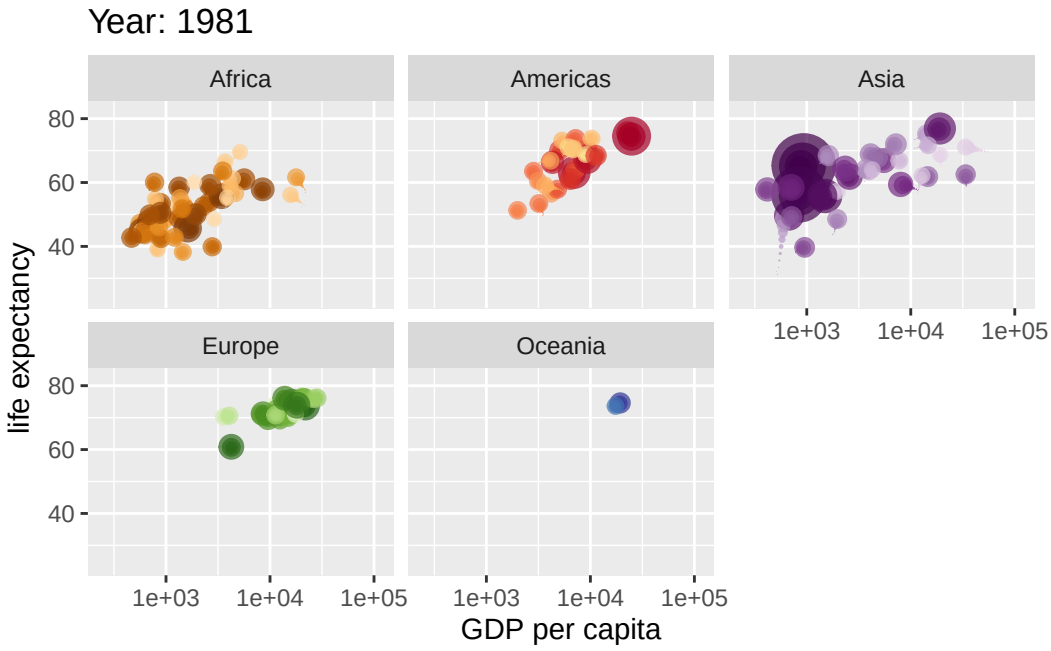
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1981
Africa
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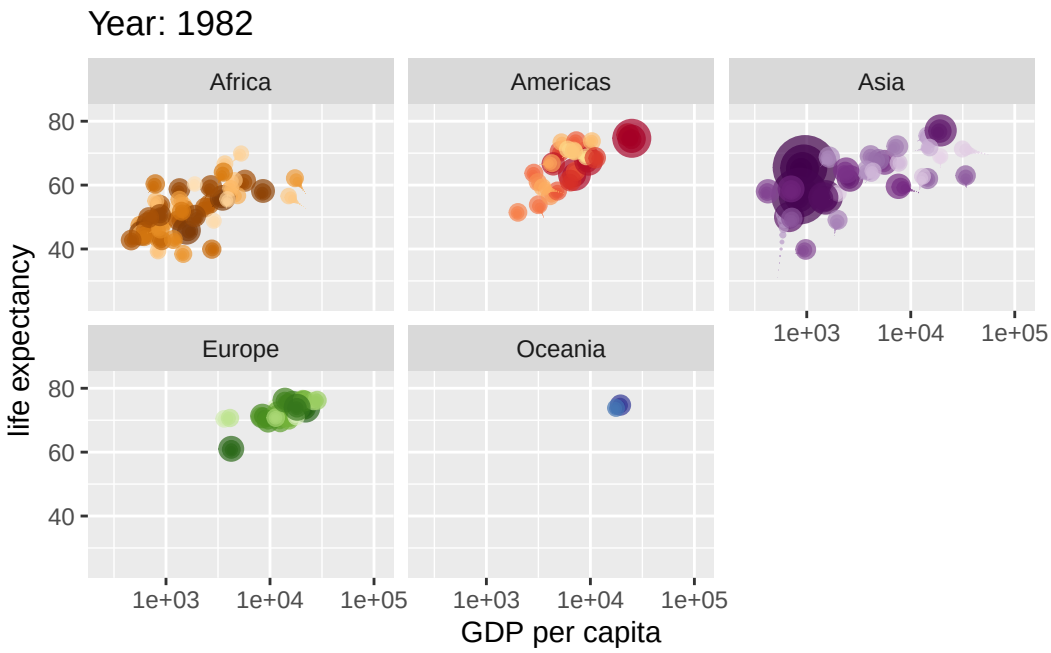
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita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Asia
Europe
Oceania
life expectancy
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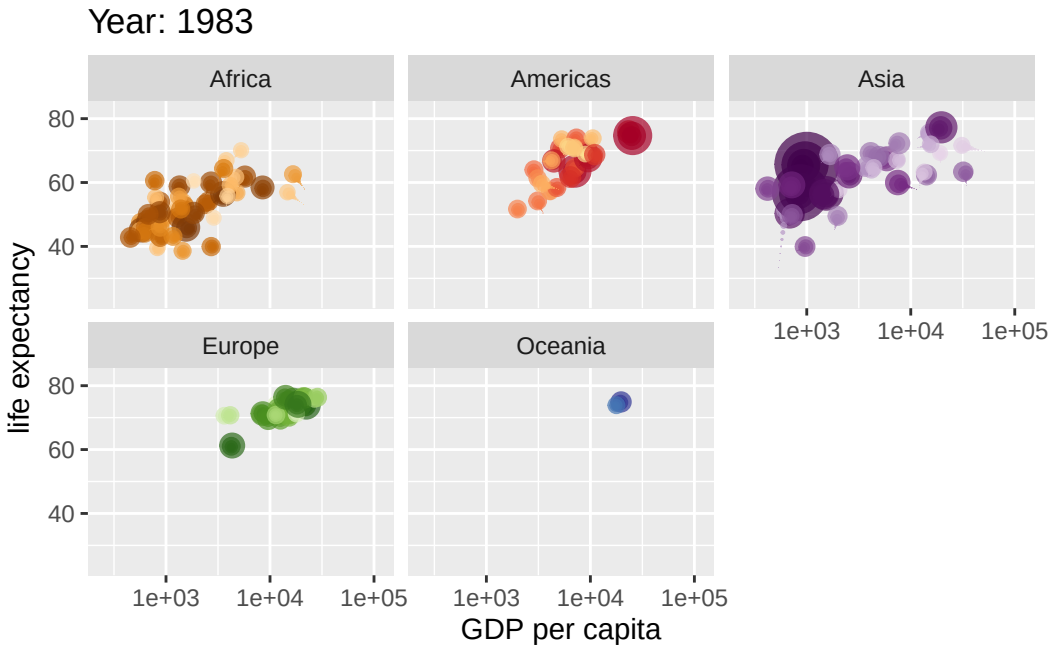
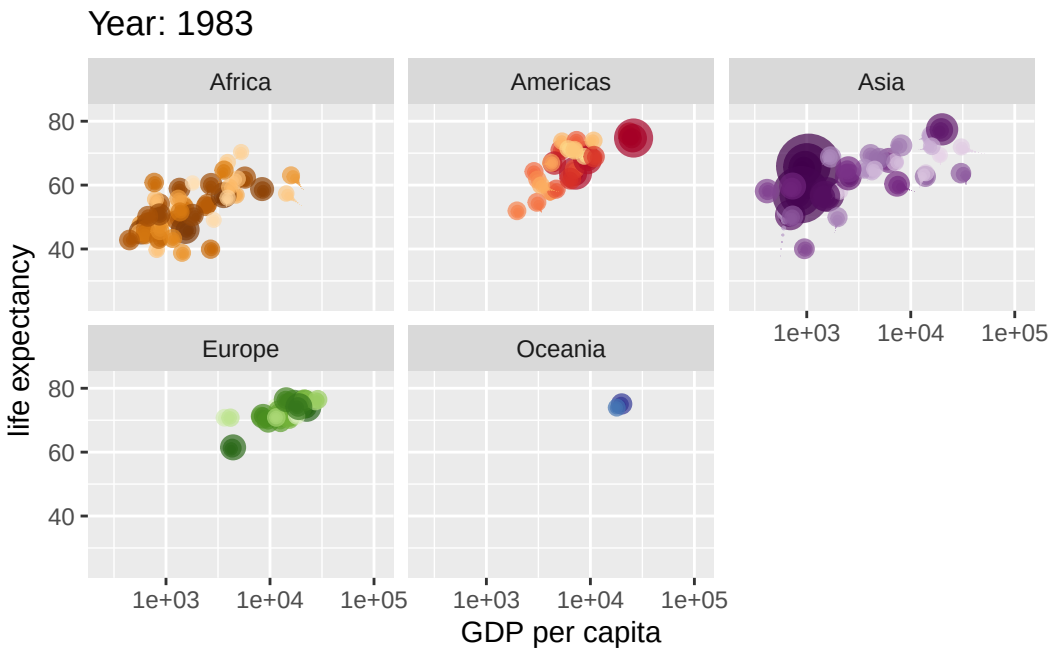
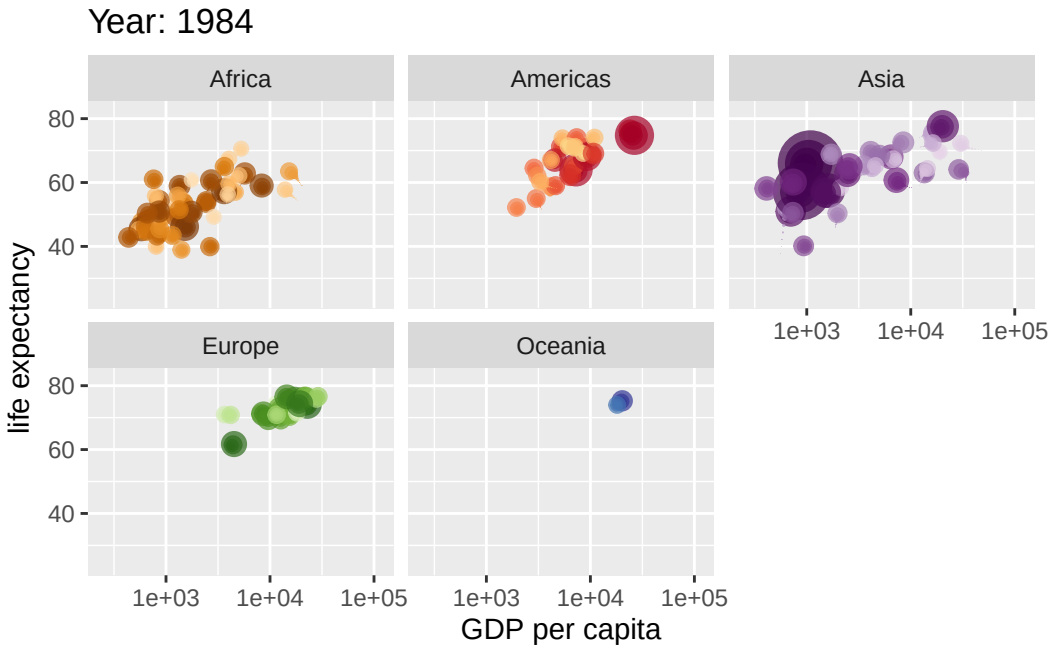
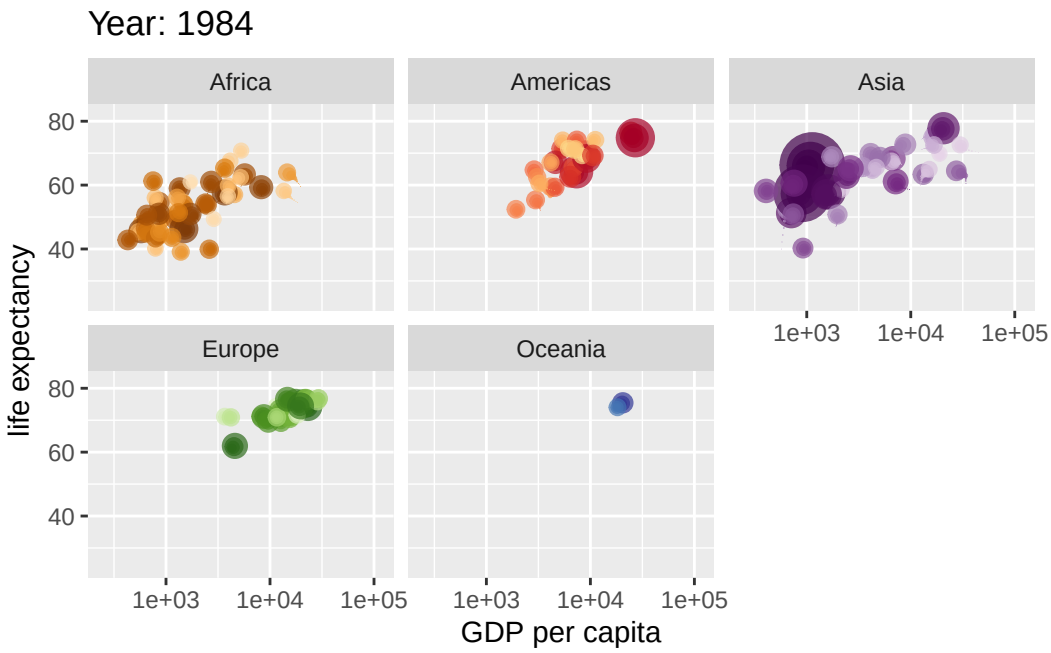
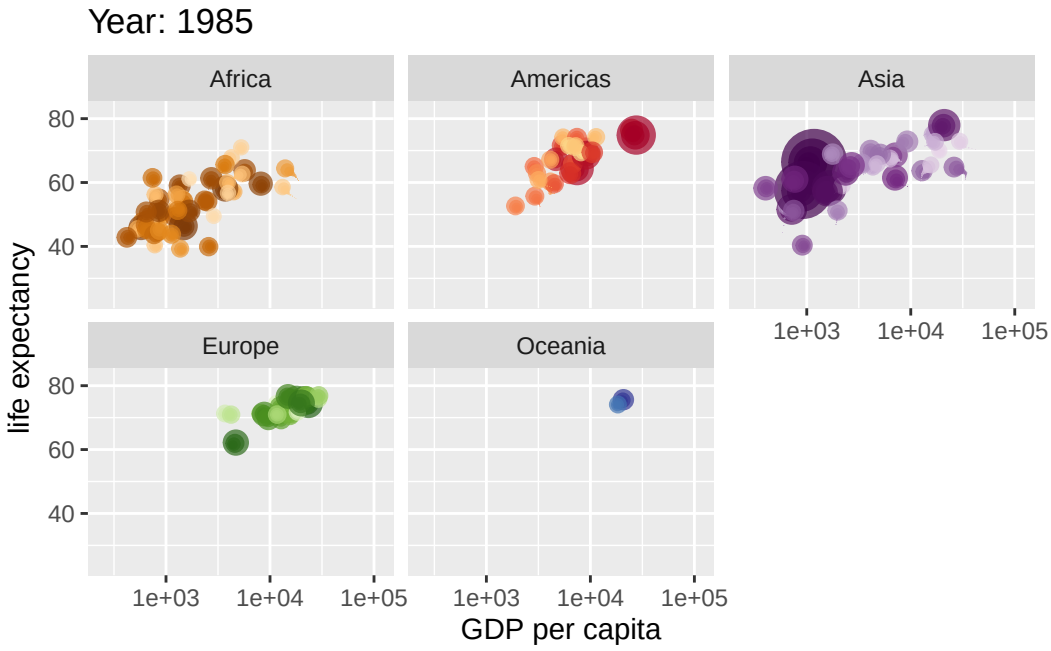
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1983
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1983
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1984
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1984
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita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Asia
Europe
Oceania
life expectancy
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60
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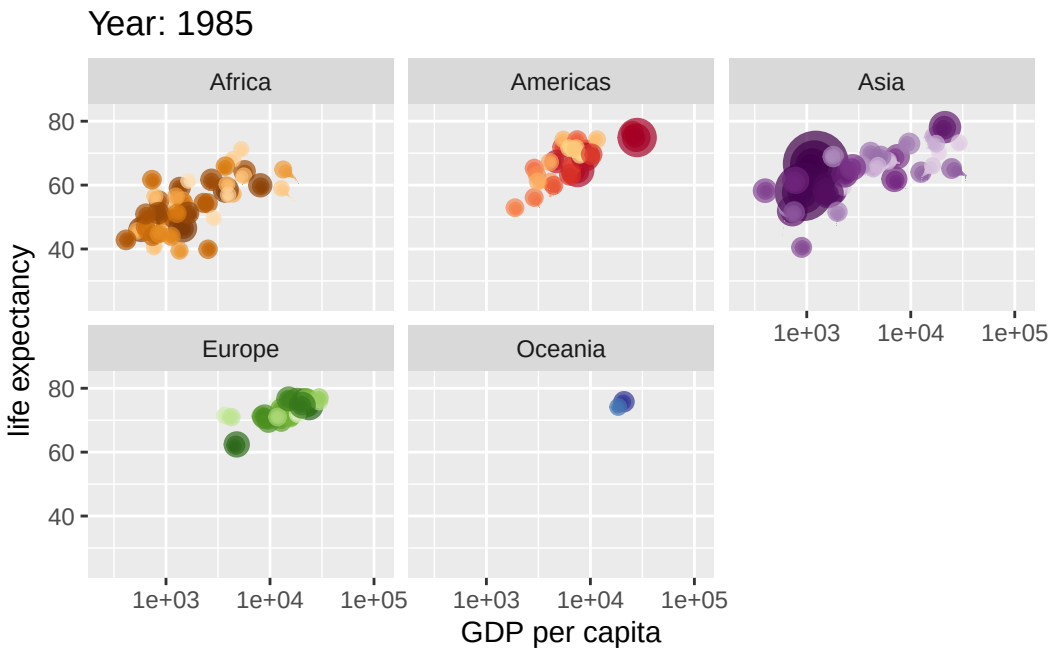
1e+03
1e+04
1e+05
GDP per capita


Year: 1985
Africa
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Europe
Oceania
life expectancy
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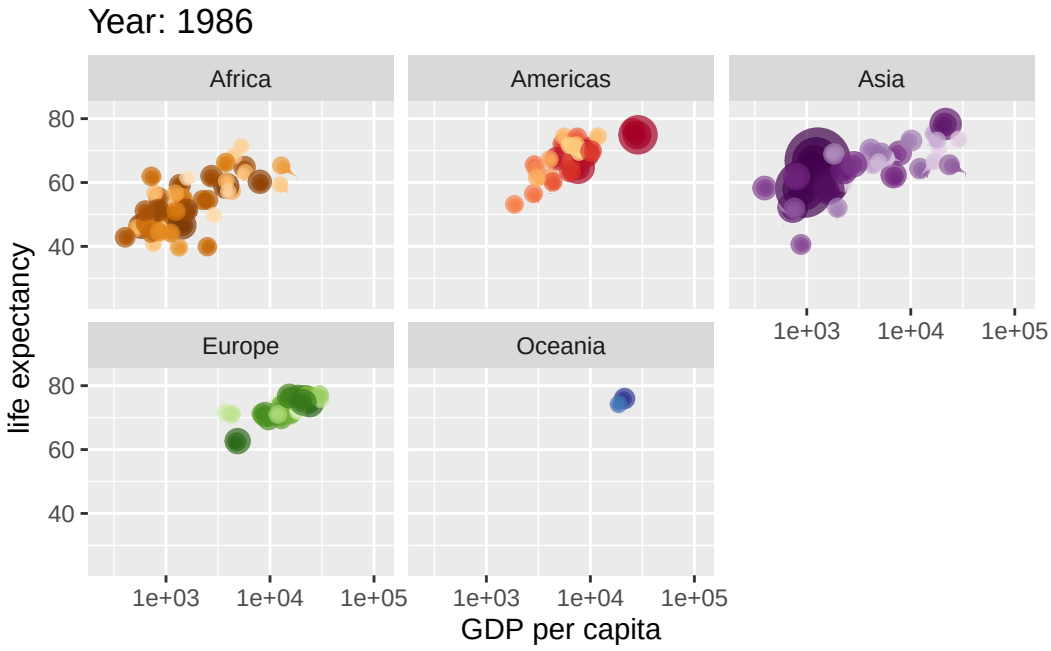
60
40
1e+03
1e+04
1e+05
GDP per capita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Europe
Oceania
life expectancy
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40
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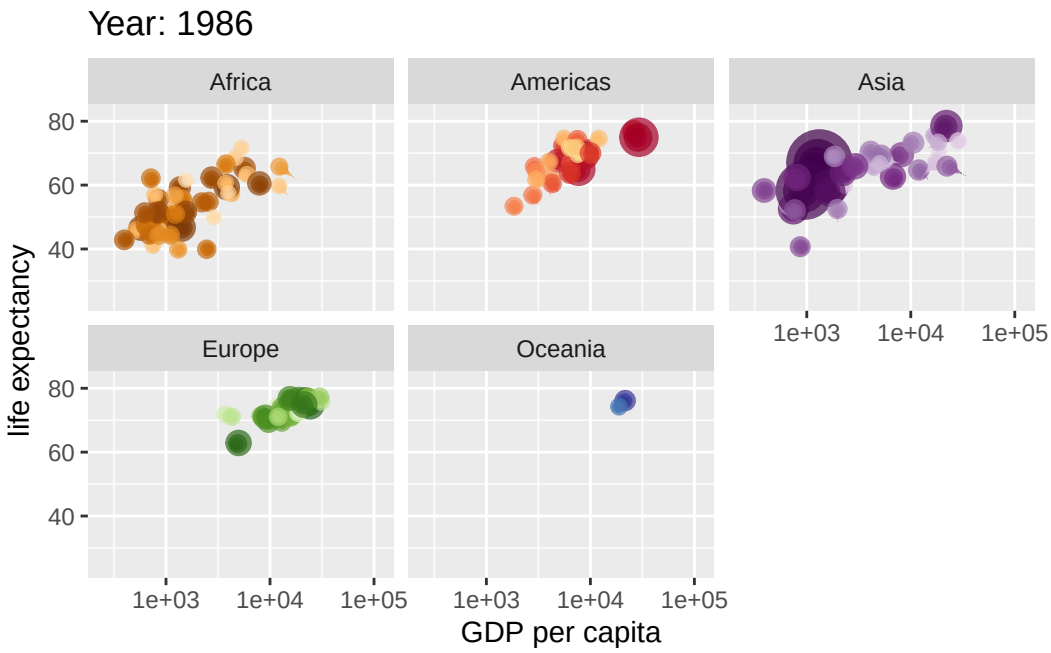
1e+05
GDP per capita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Africa
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Europe
Oceania
life expectancy
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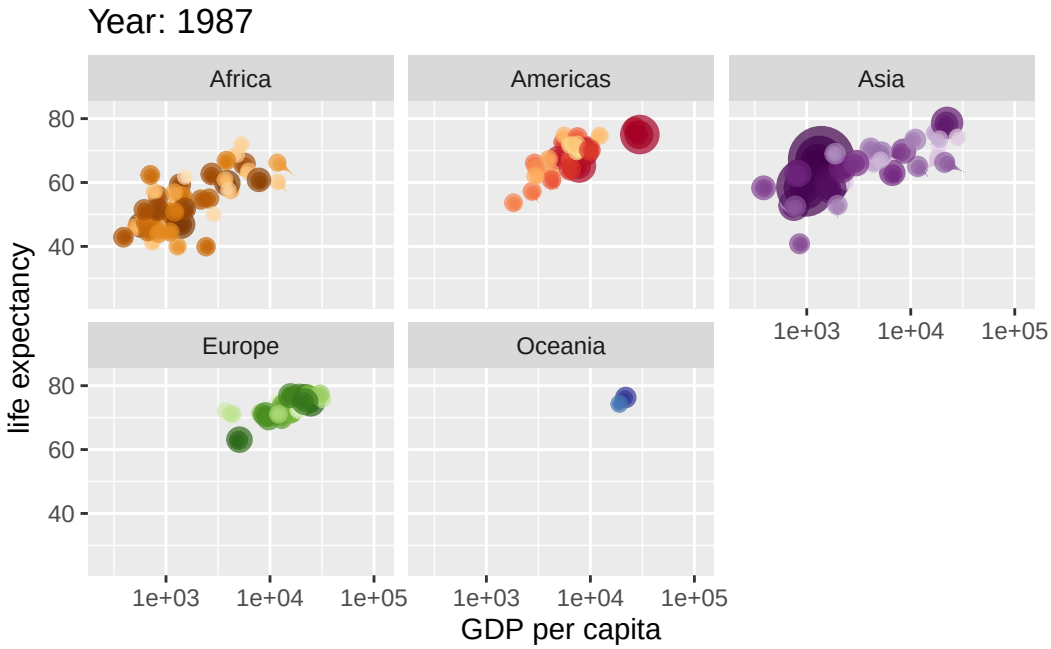
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1987
Africa
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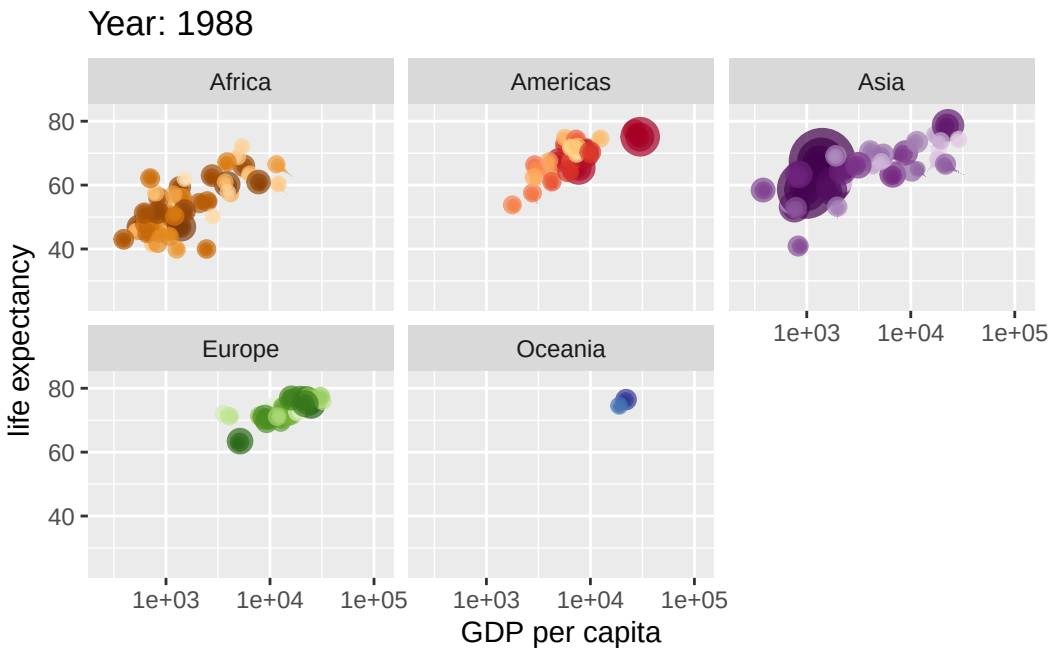
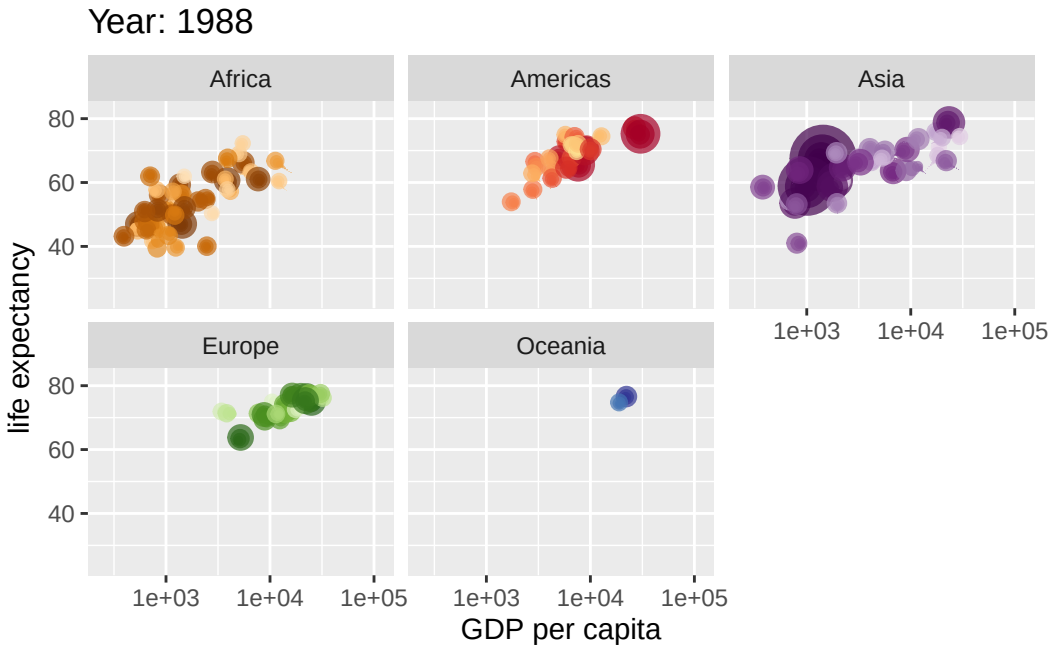
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1988
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1988
Africa
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Asia
Europe
Oceania
life expectancy
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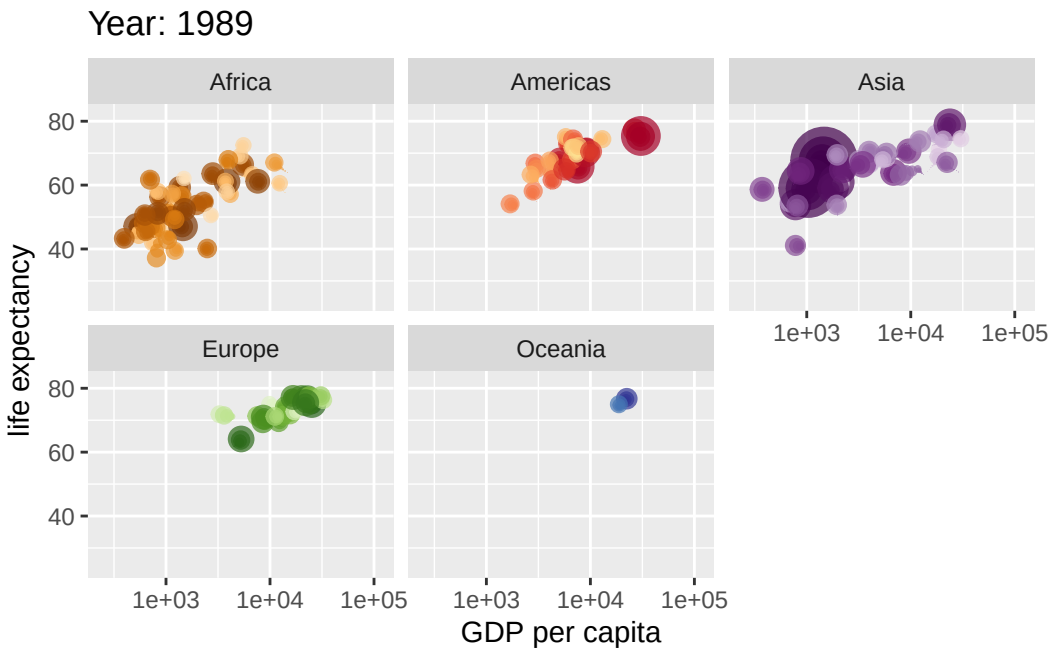
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1989
Africa
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Asia
Europe
Oceania
life expectancy
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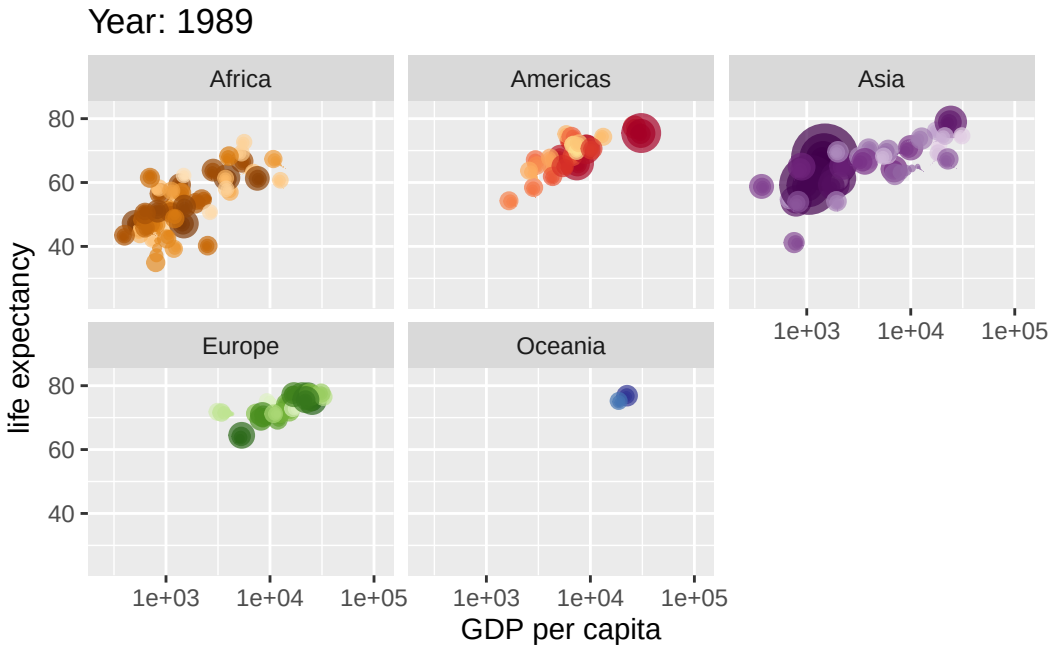
60
40
1e+03
1e+04
1e+05
GDP per capita


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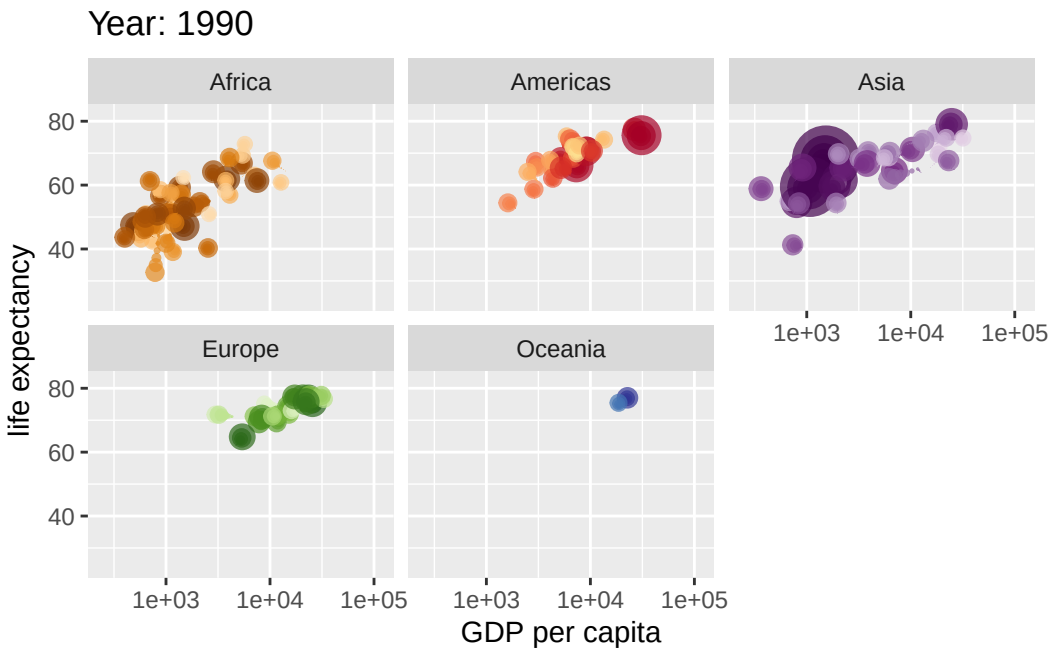
1e+03
1e+04
1e+05
GDP per capita


Year: 1990
Africa
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Asia
Europe
Oceania
life expectancy
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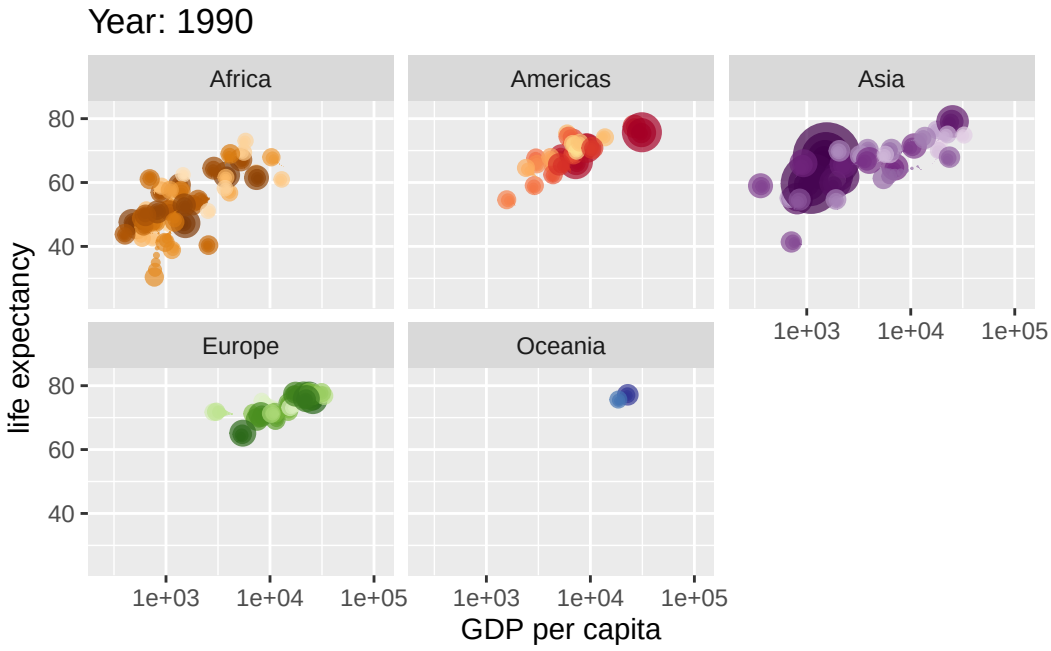
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1990
Africa
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Asia
Europe
Oceania
life expectancy
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60
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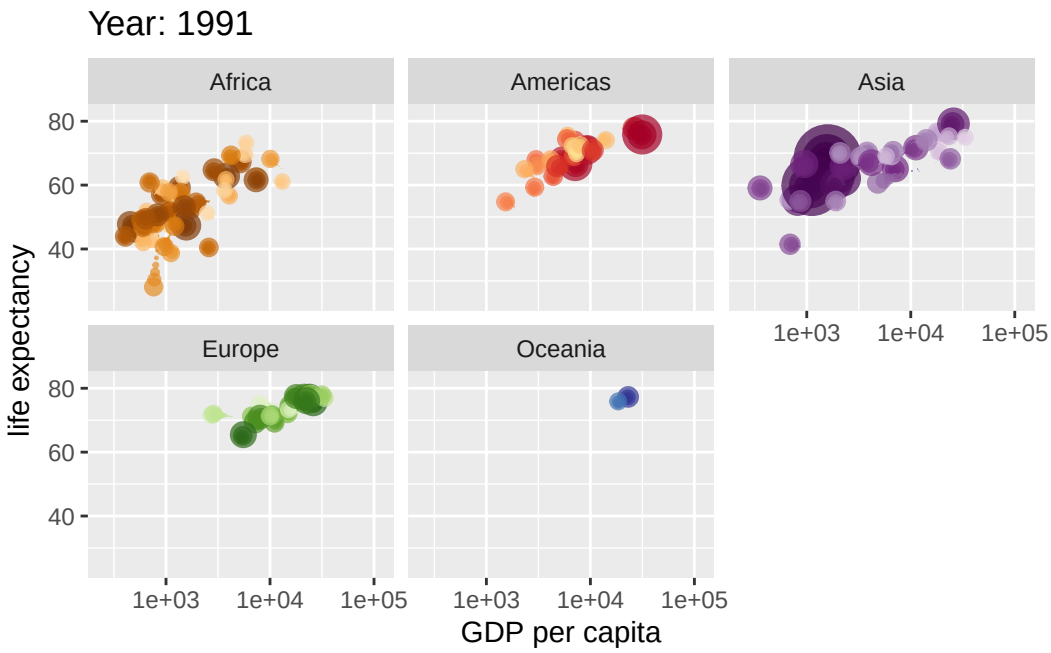
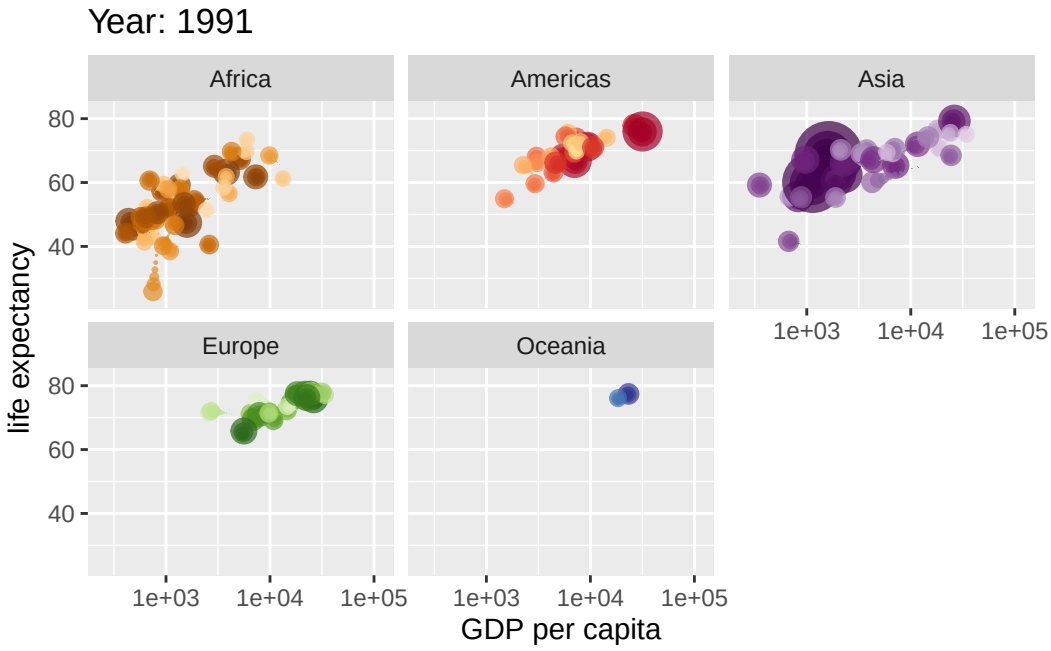
1e+03
1e+04
1e+05
GDP per capita


Year: 1991
Africa
Americas
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1991
Africa
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Asia
Europe
Oceania
life expectancy
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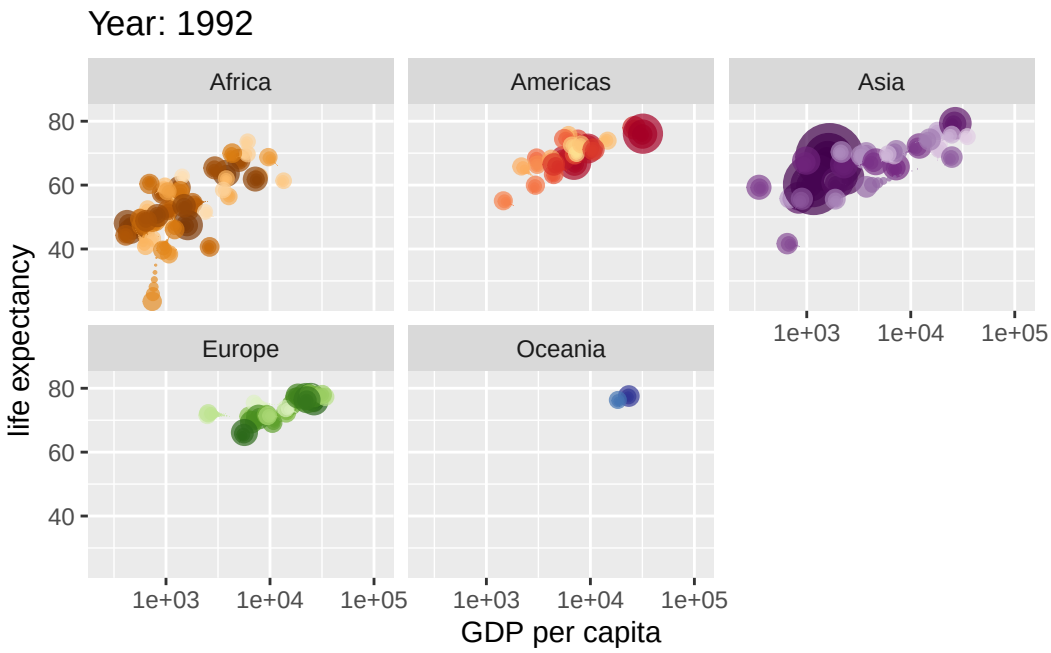
60
40
1e+03
1e+04
1e+05
GDP per capita


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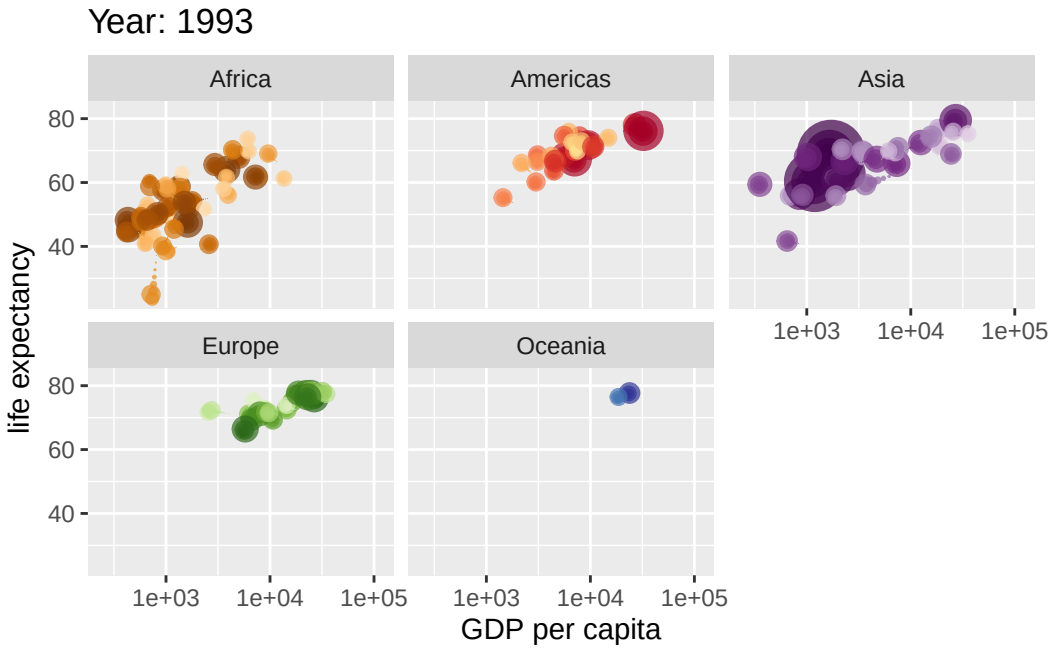
1e+03
1e+04
1e+05
GDP per capita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Africa
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Europe
Oceania
life expectancy
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60
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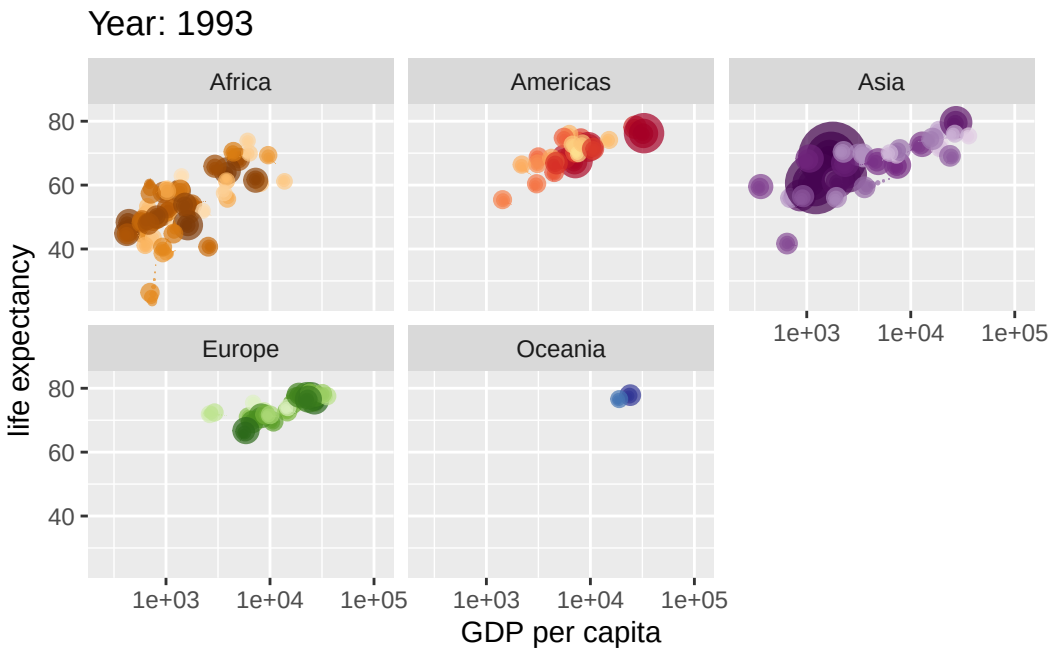
1e+03
1e+04
1e+05
GDP per capita


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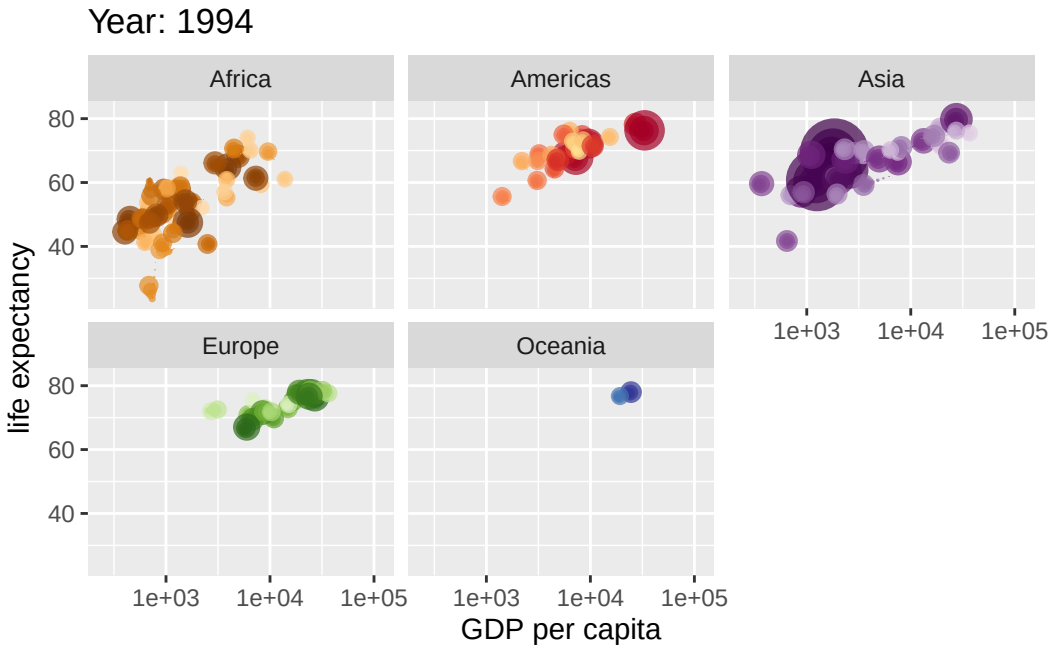
1e+03
1e+04
1e+05
GDP per capita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Africa
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Asia
Europe
Oceania
life expectancy
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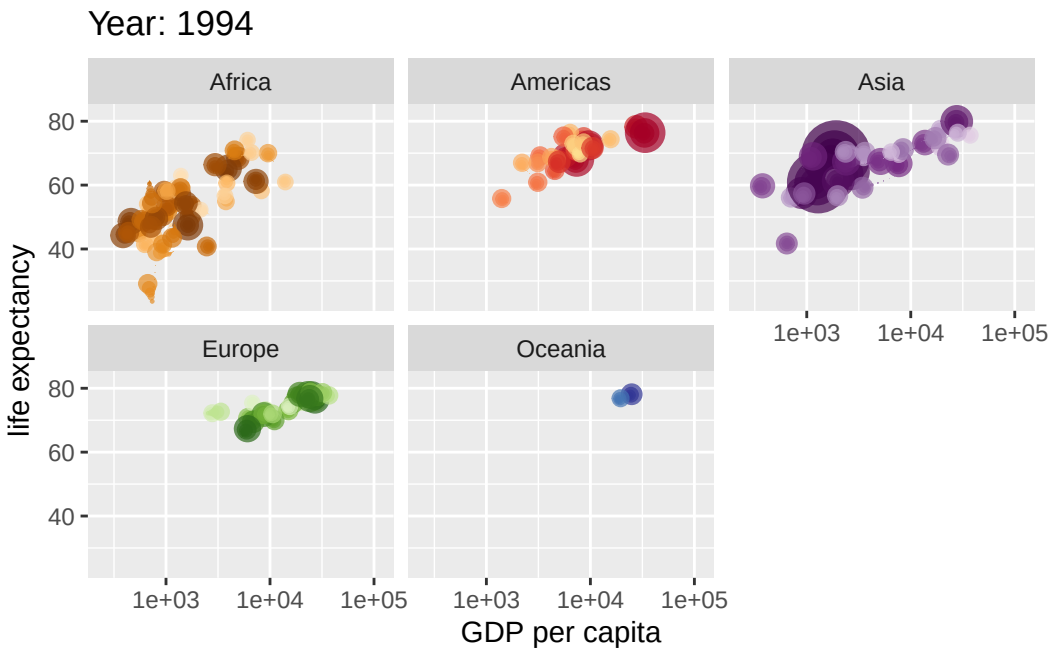
1e+03
1e+04
1e+05
GDP per capita


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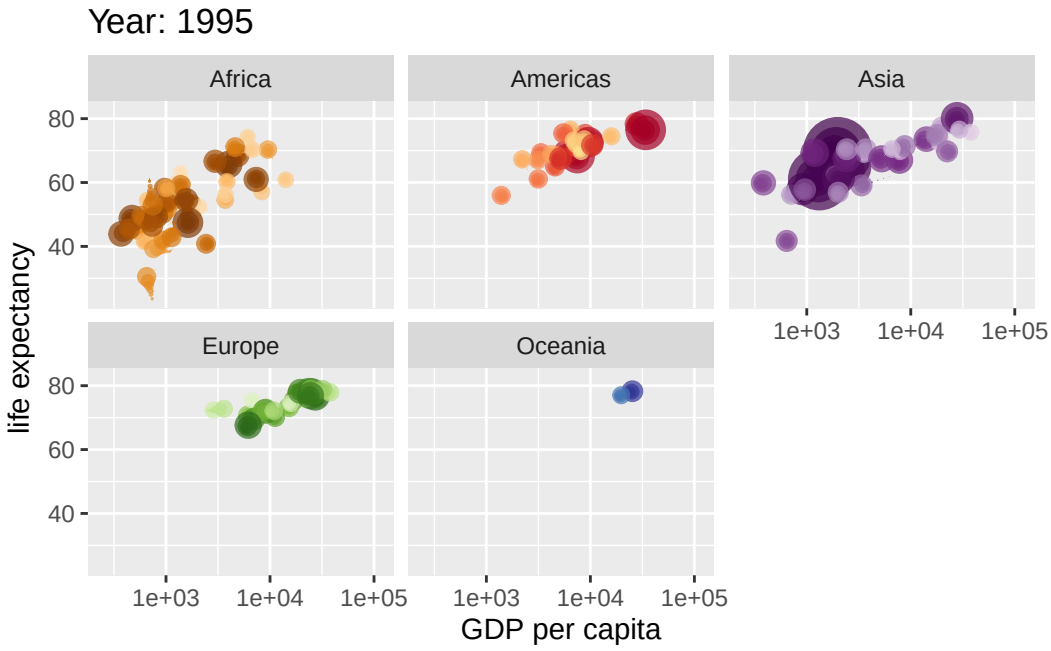
1e+03
1e+04
1e+05
GDP per capita


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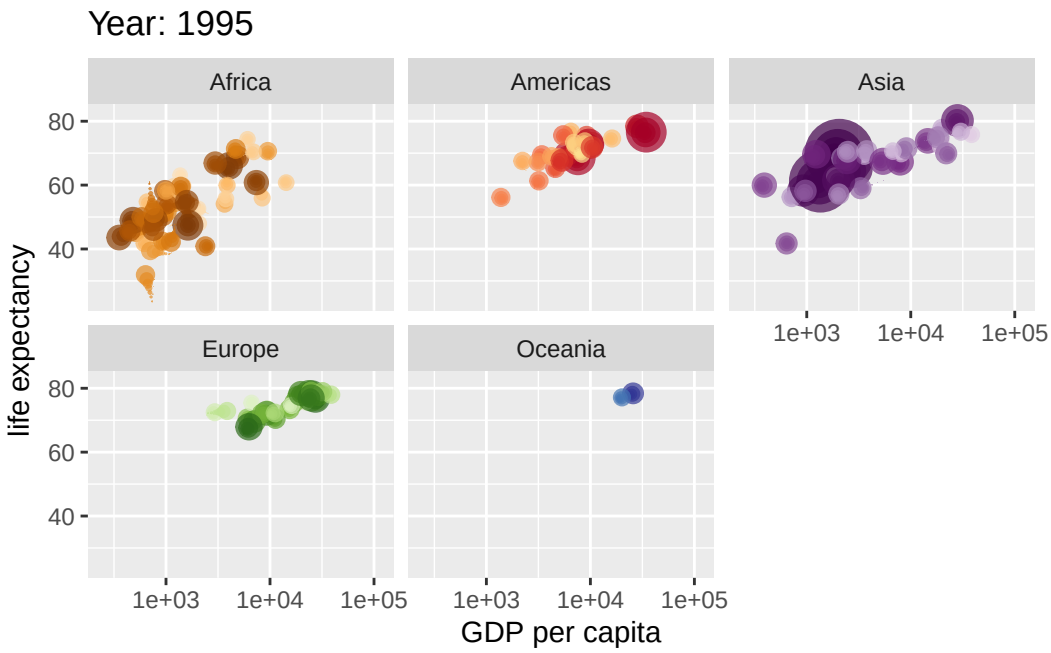
1e+03
1e+04
1e+05
GDP per capita


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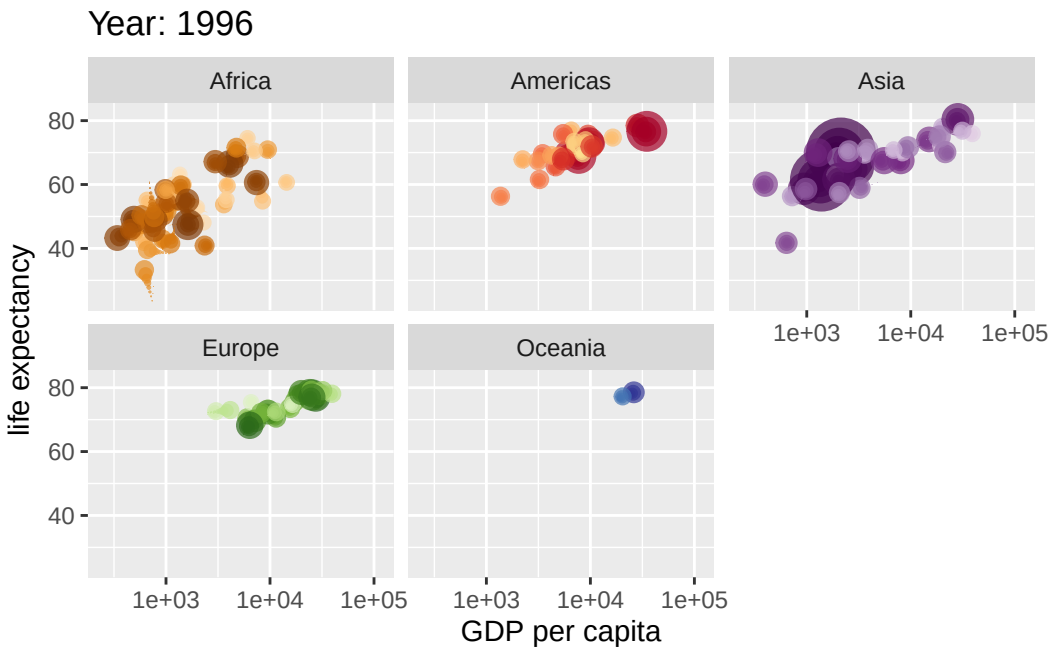
1e+03
1e+04
1e+05
GDP per capita


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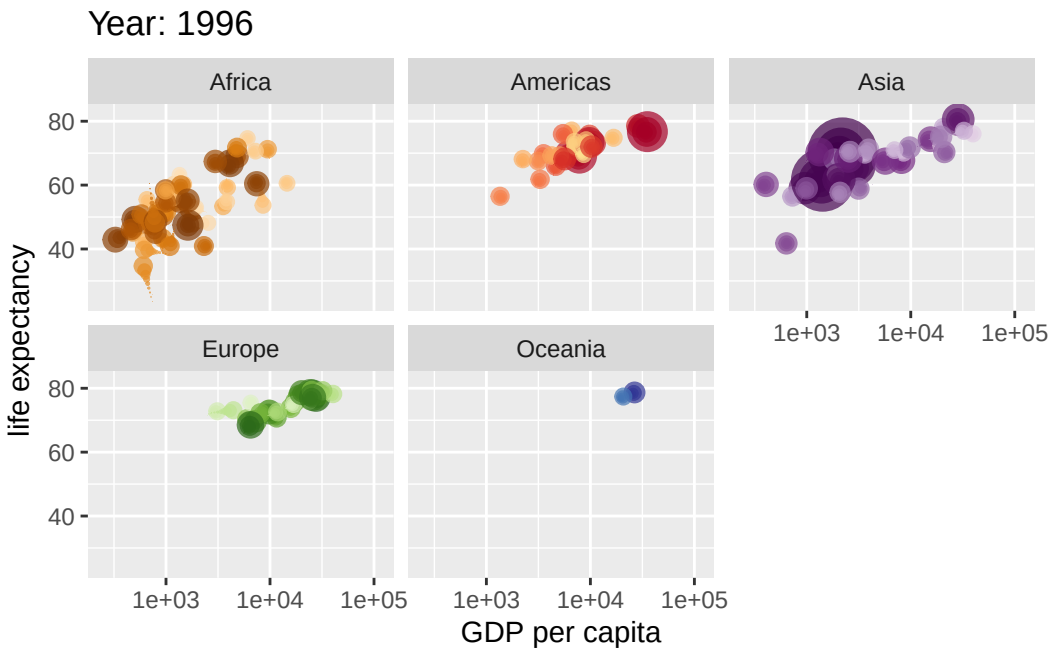
40
1e+03
1e+04
1e+05
GDP per capita


Year: 1996
Africa
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Europe
Oceania
life expectancy
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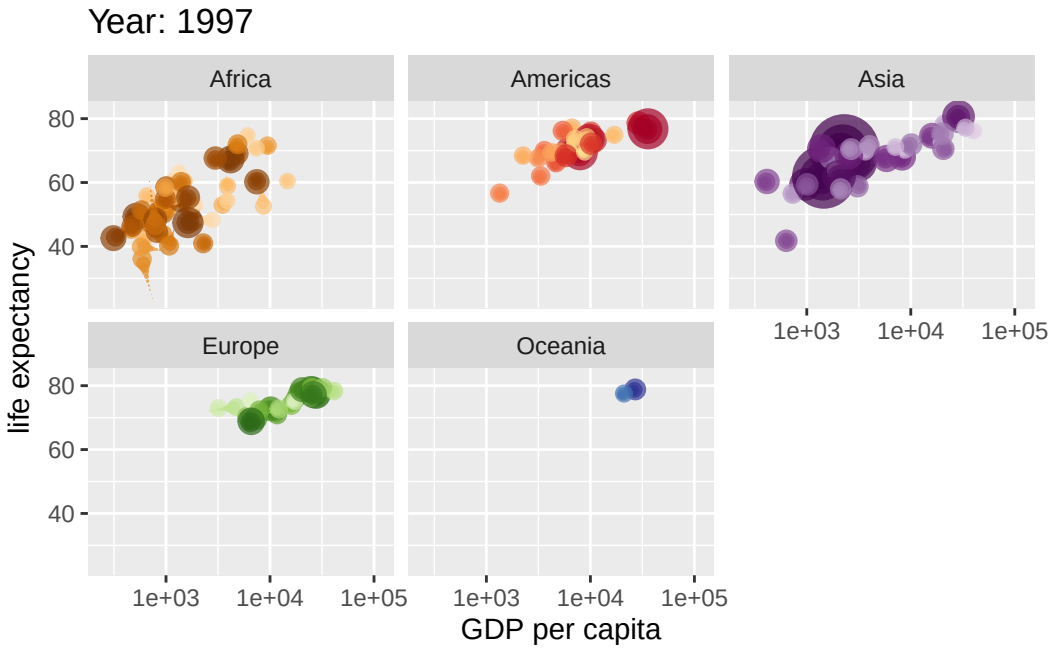
1e+04
1e+05
GDP per capita


Year: 1997
Africa
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Europe
Oceania
life expectancy
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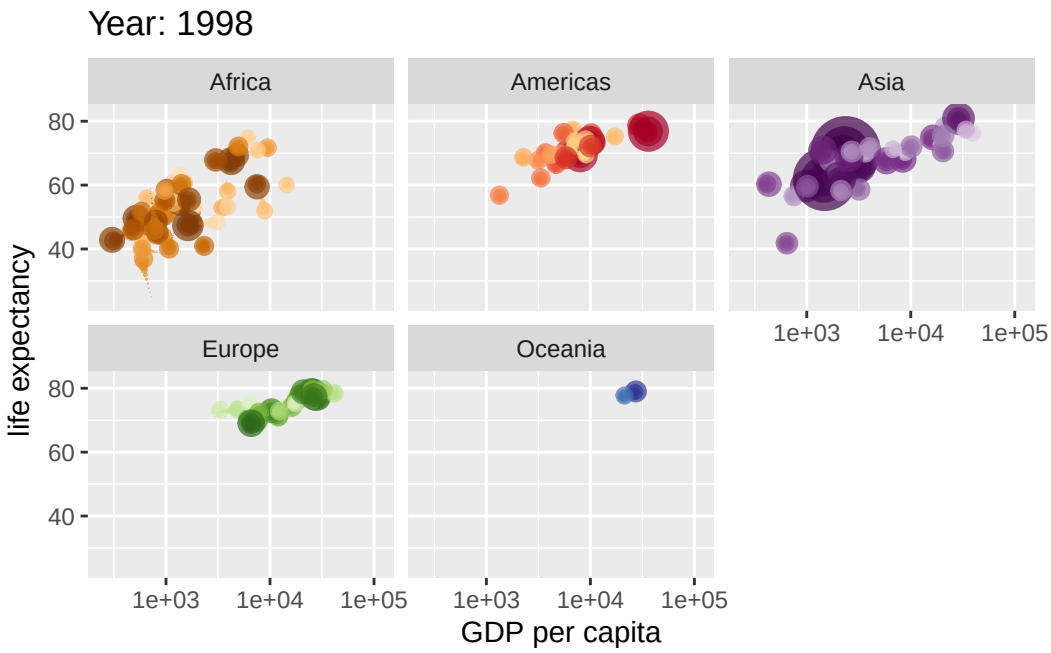
1e+03
1e+04
1e+05
GDP per capita


Year: 1998
Africa
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Oceania
life expectancy
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1e+03
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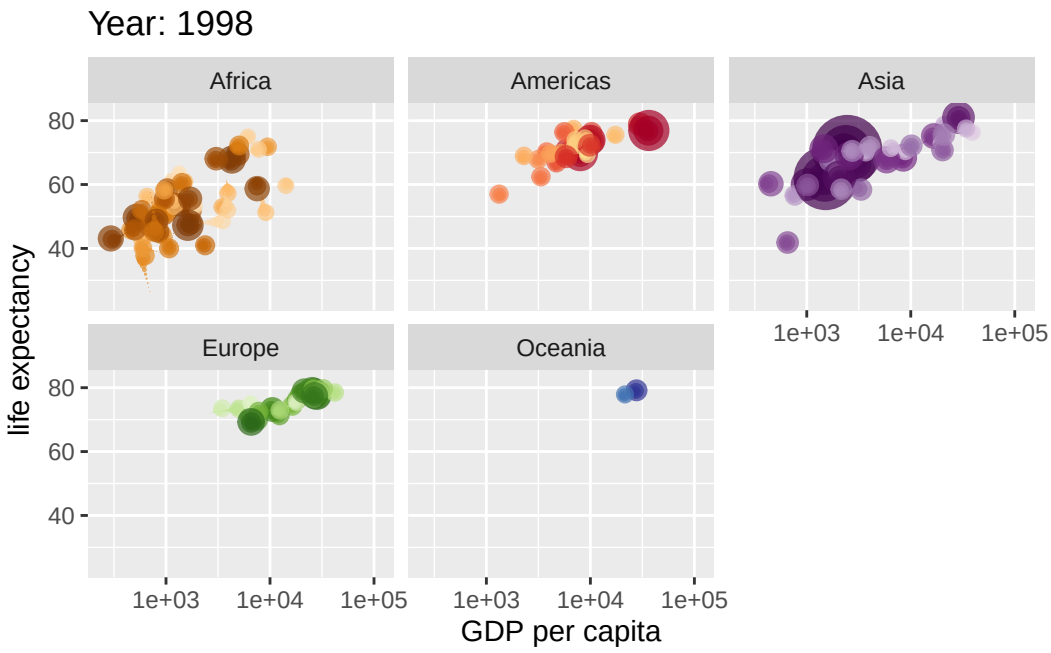
1e+05
GDP per capita


Year: 1998
Africa
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Europe
Oceania
life expectancy
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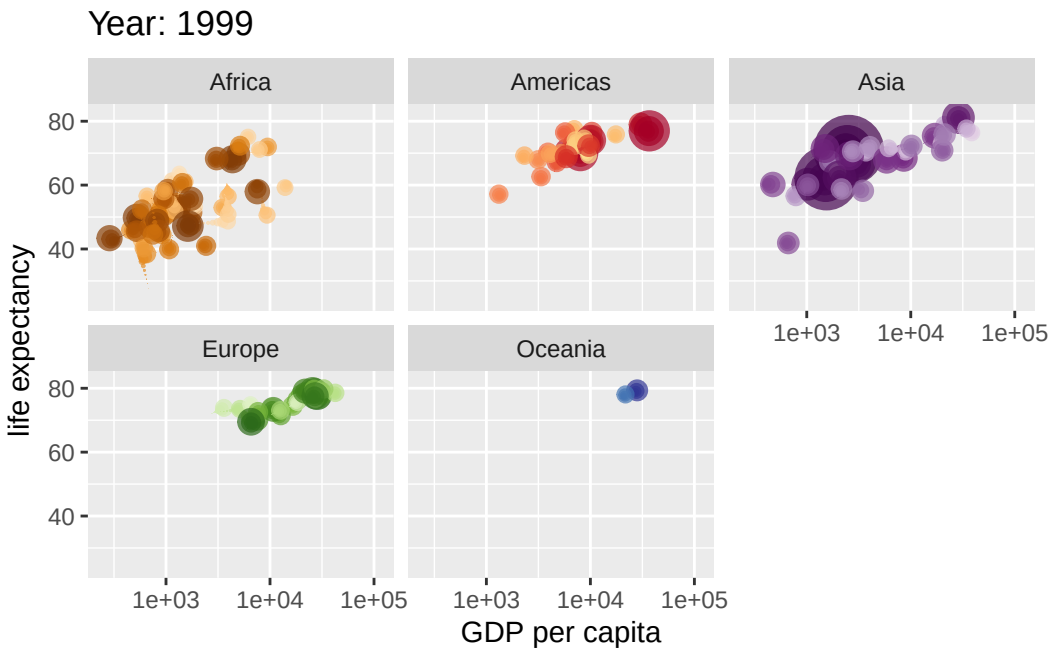
1e+03
1e+04
1e+05
GDP per capita


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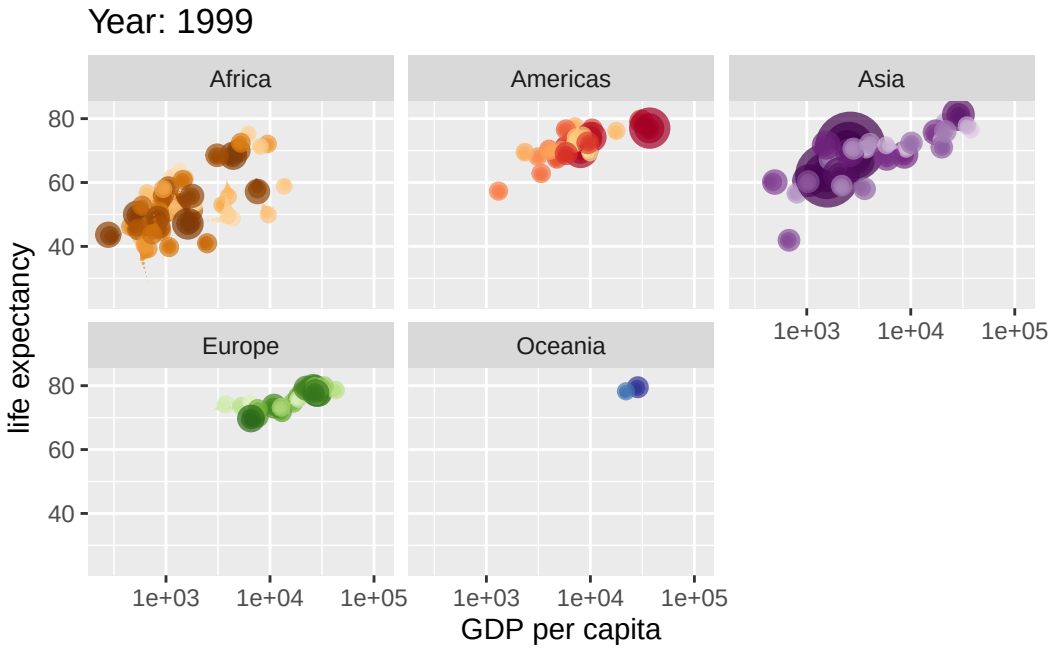
60
40
1e+03
1e+04
1e+05
GDP per capita


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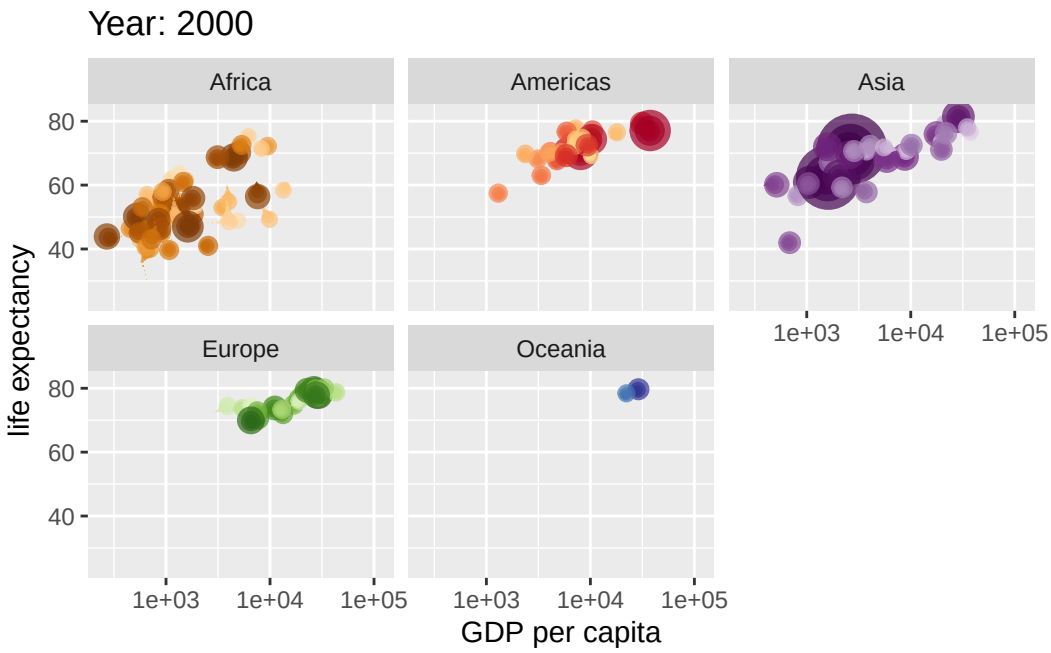
1e+03
1e+04
1e+05
GDP per capita


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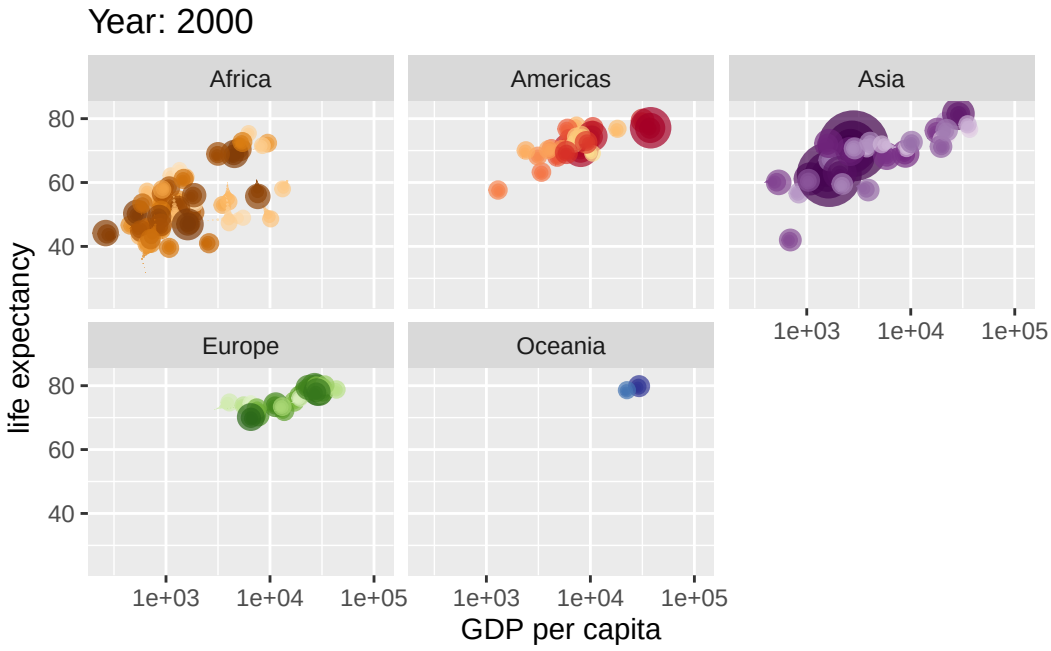
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


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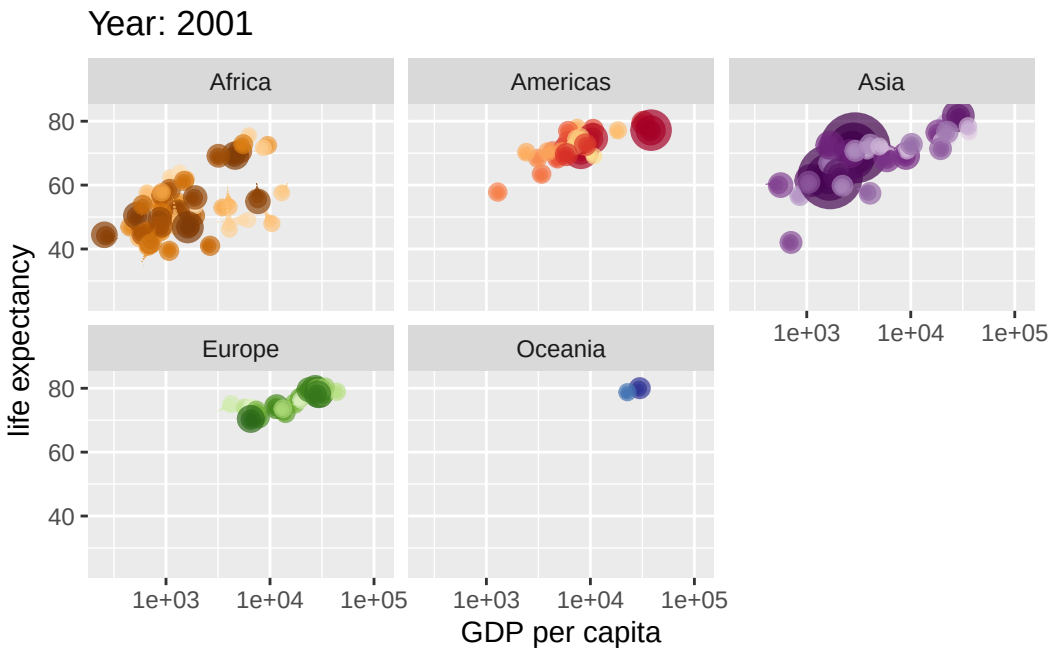
40
1e+03
1e+04
1e+05
GDP per capita


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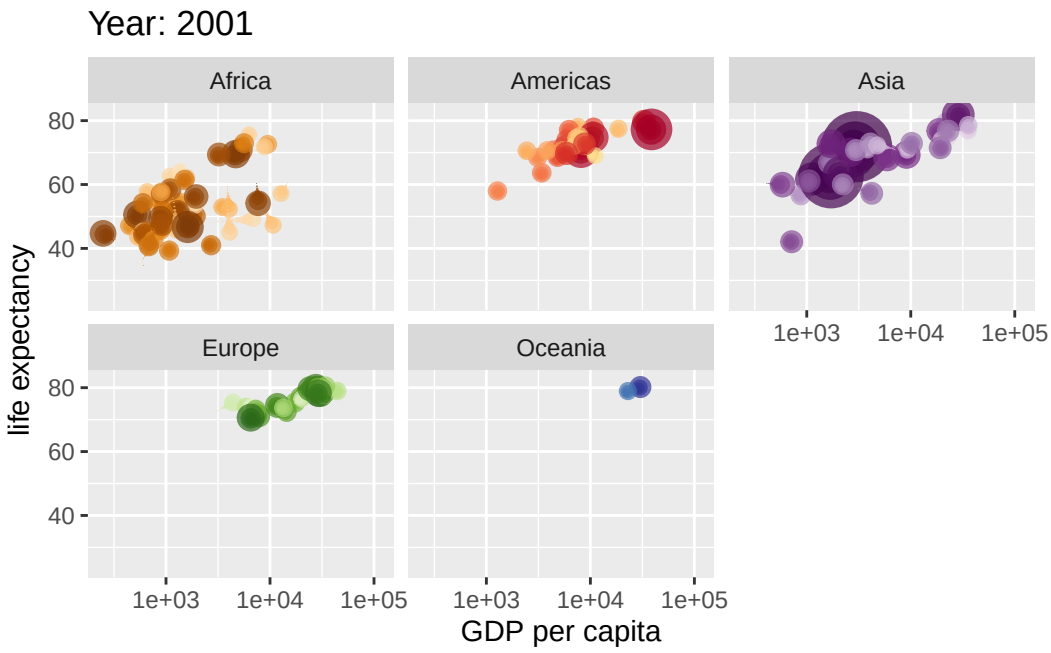
40
1e+03
1e+04
1e+05
GDP per capita


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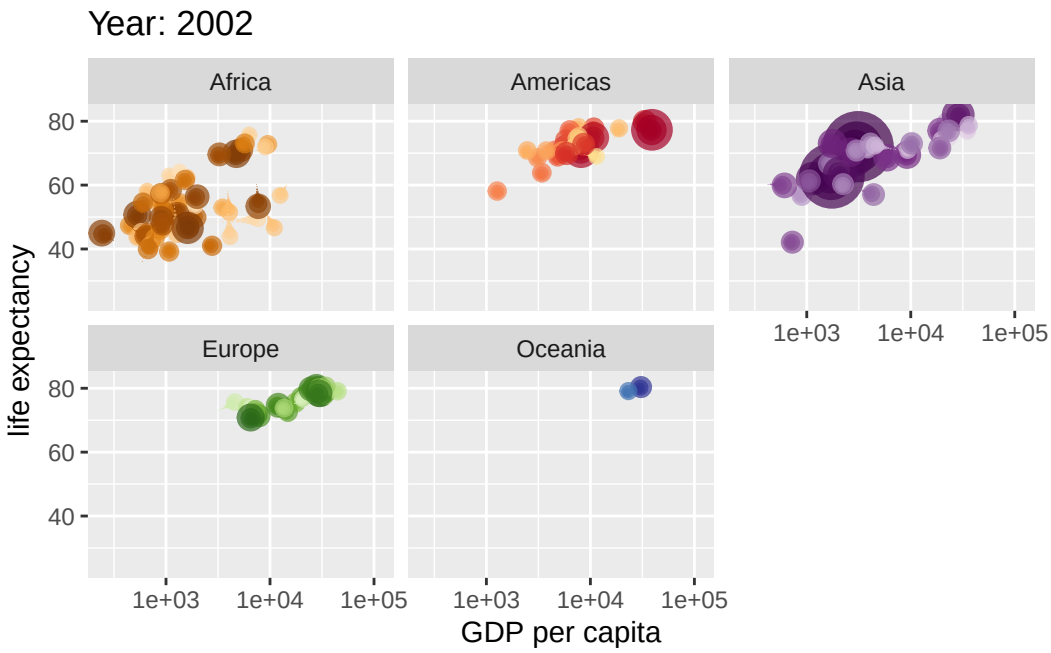
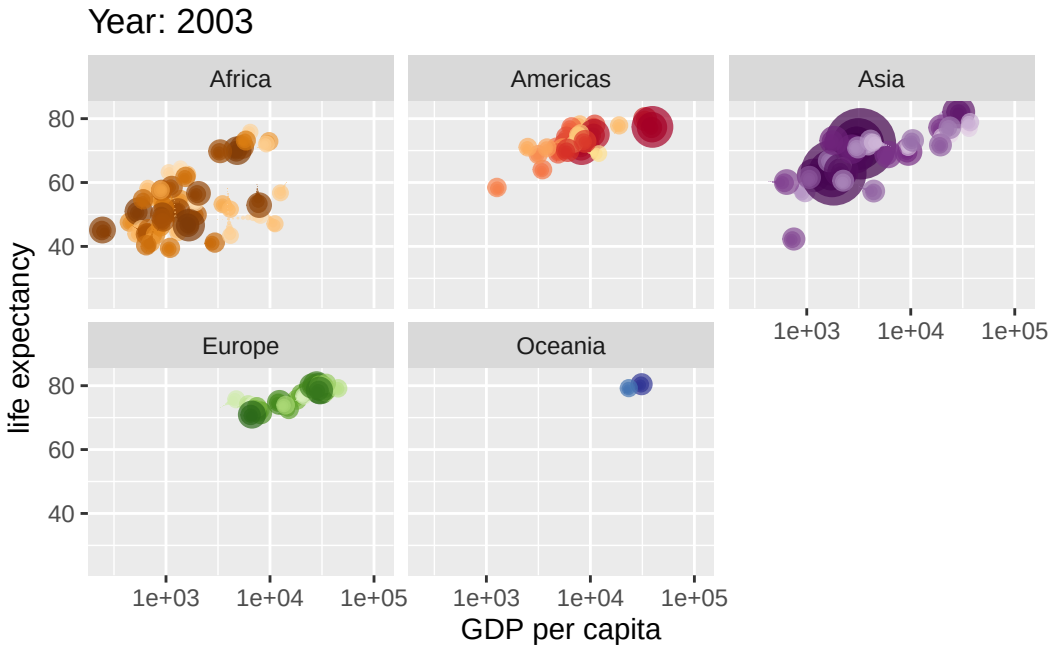
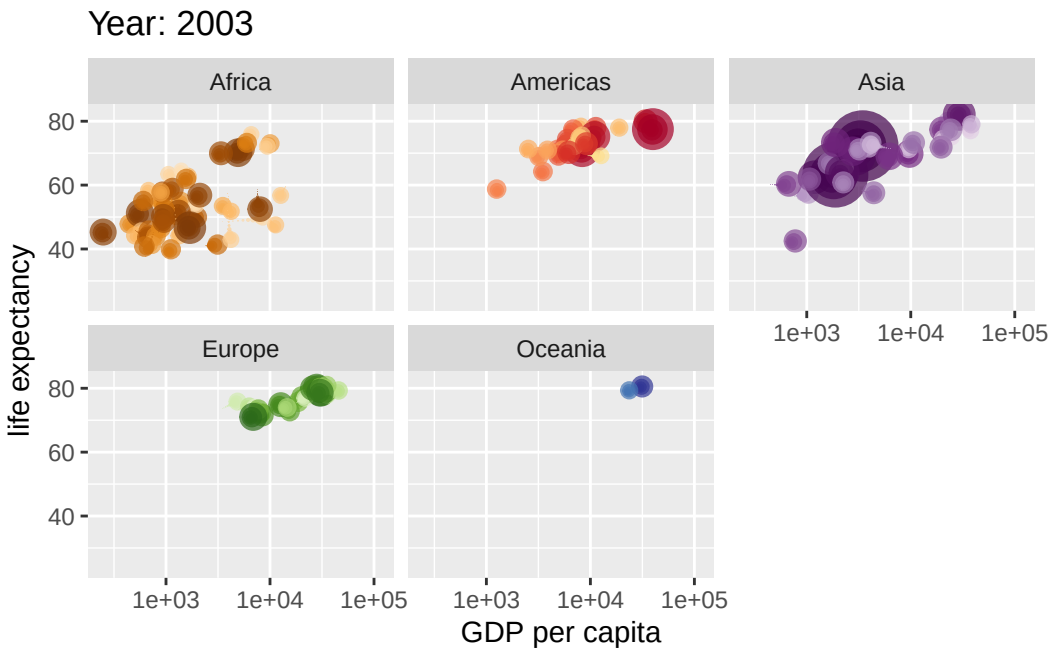
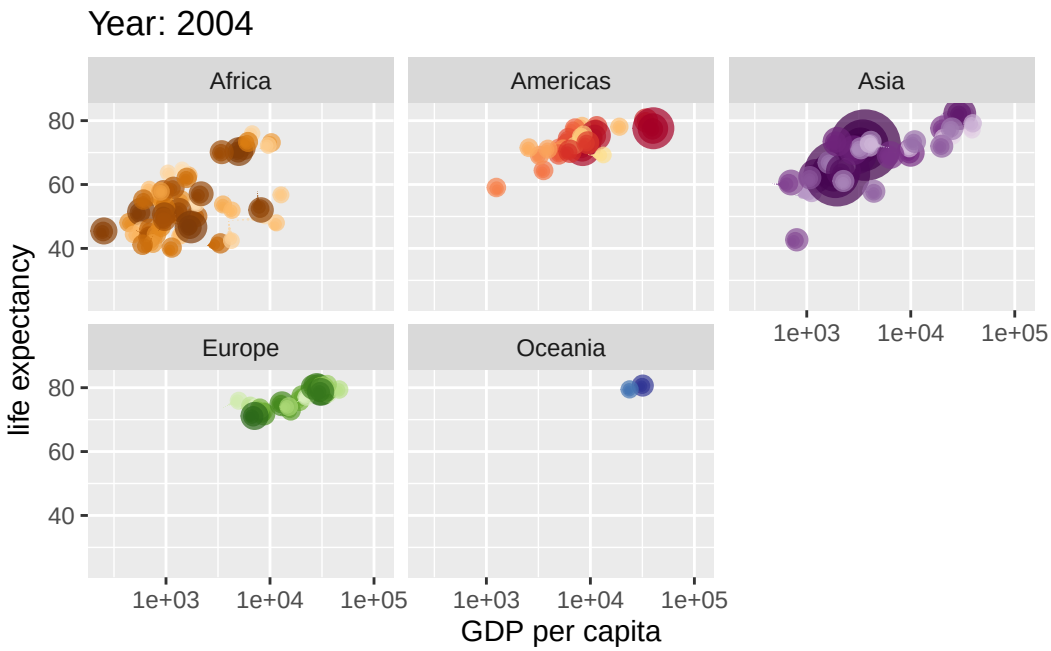
40
1e+03
1e+04
1e+05
GDP per capita


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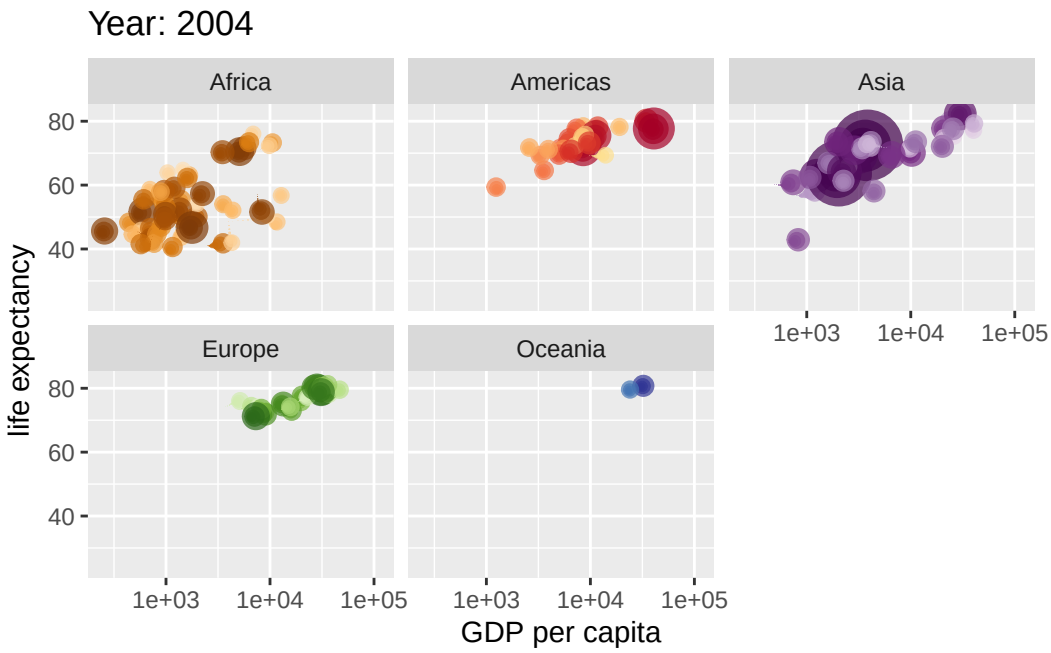
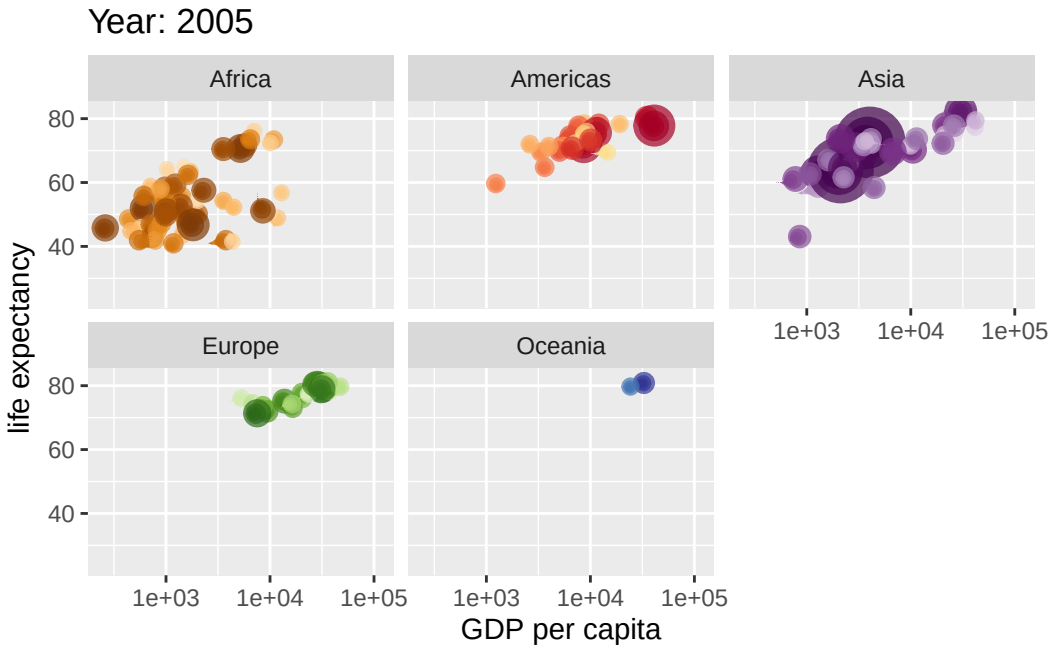
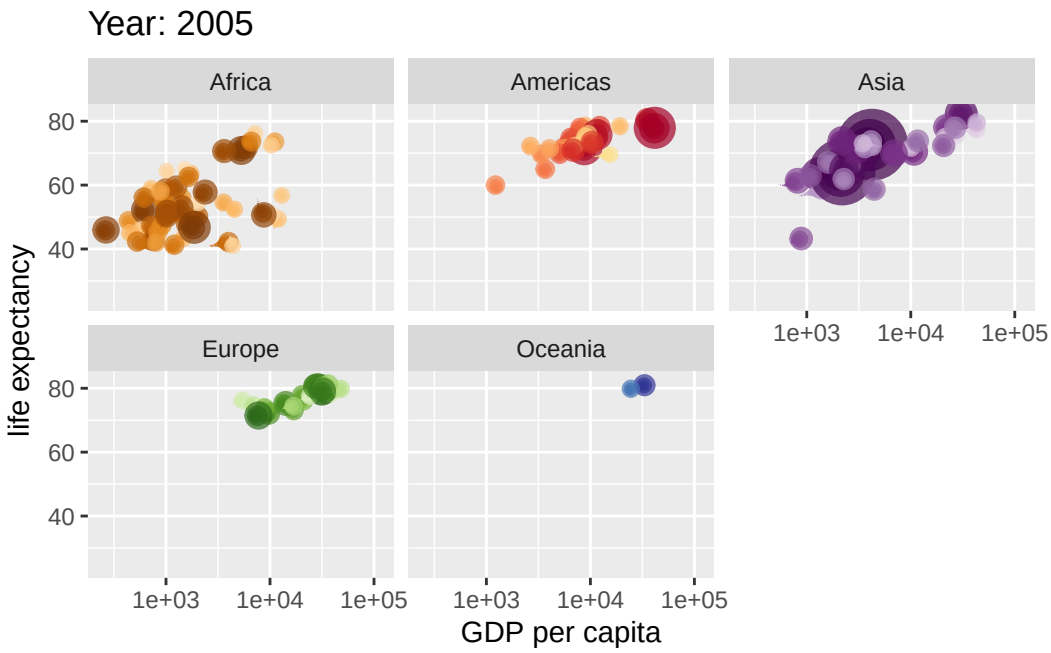
Asia
Europe
Oceania
life expectancy
80
60
40
1e+03
1e+04
1e+05
GDP per capita


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
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life expectancy
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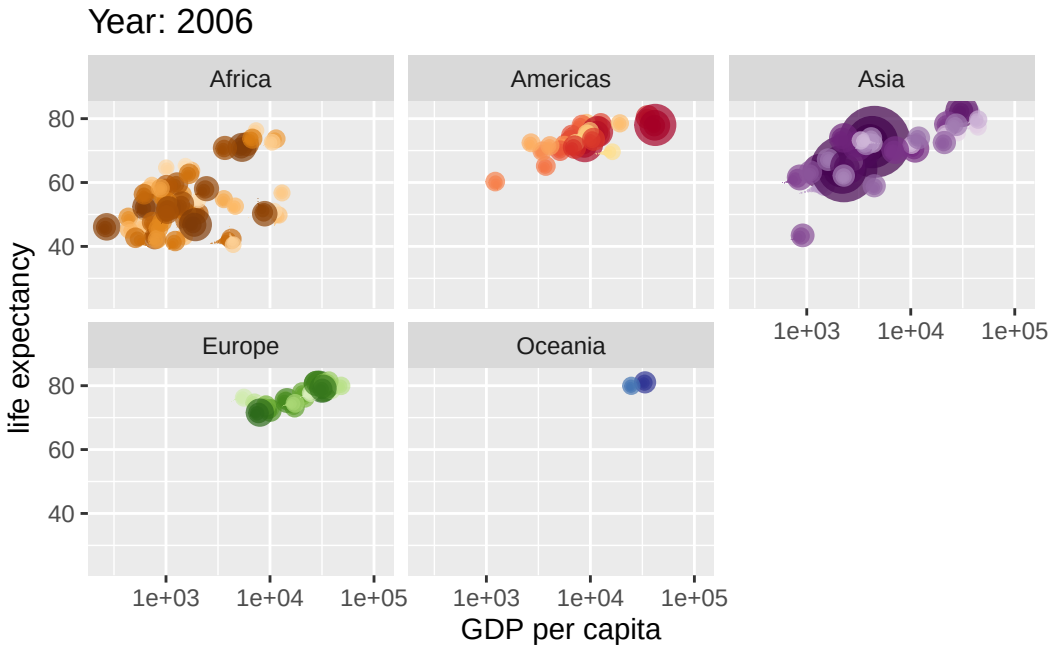
GDP per capita


Year: 2006
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