Making a plot

Data Visualisation mini-course

Gavin L. Simpson

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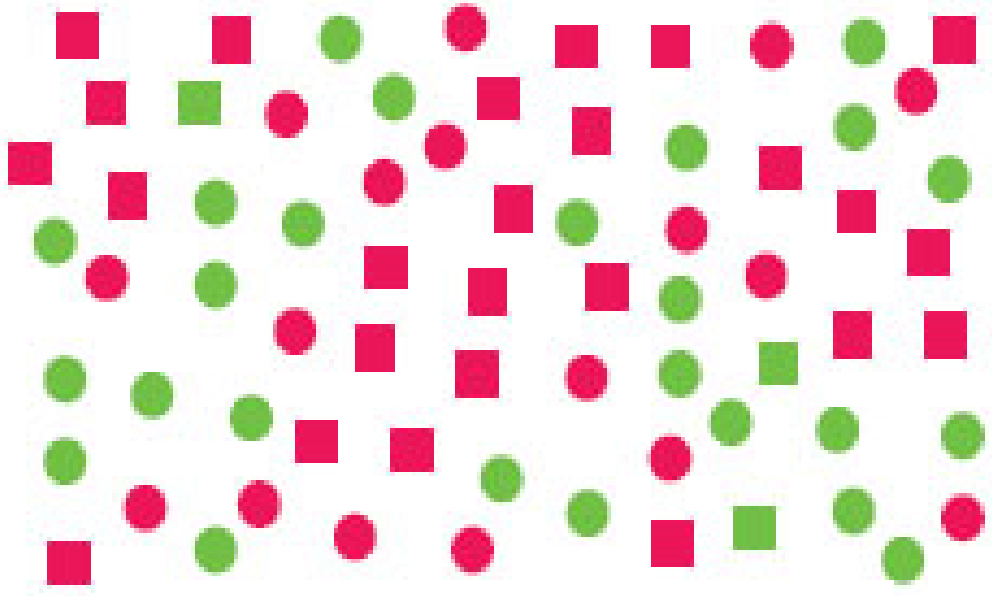
Pop

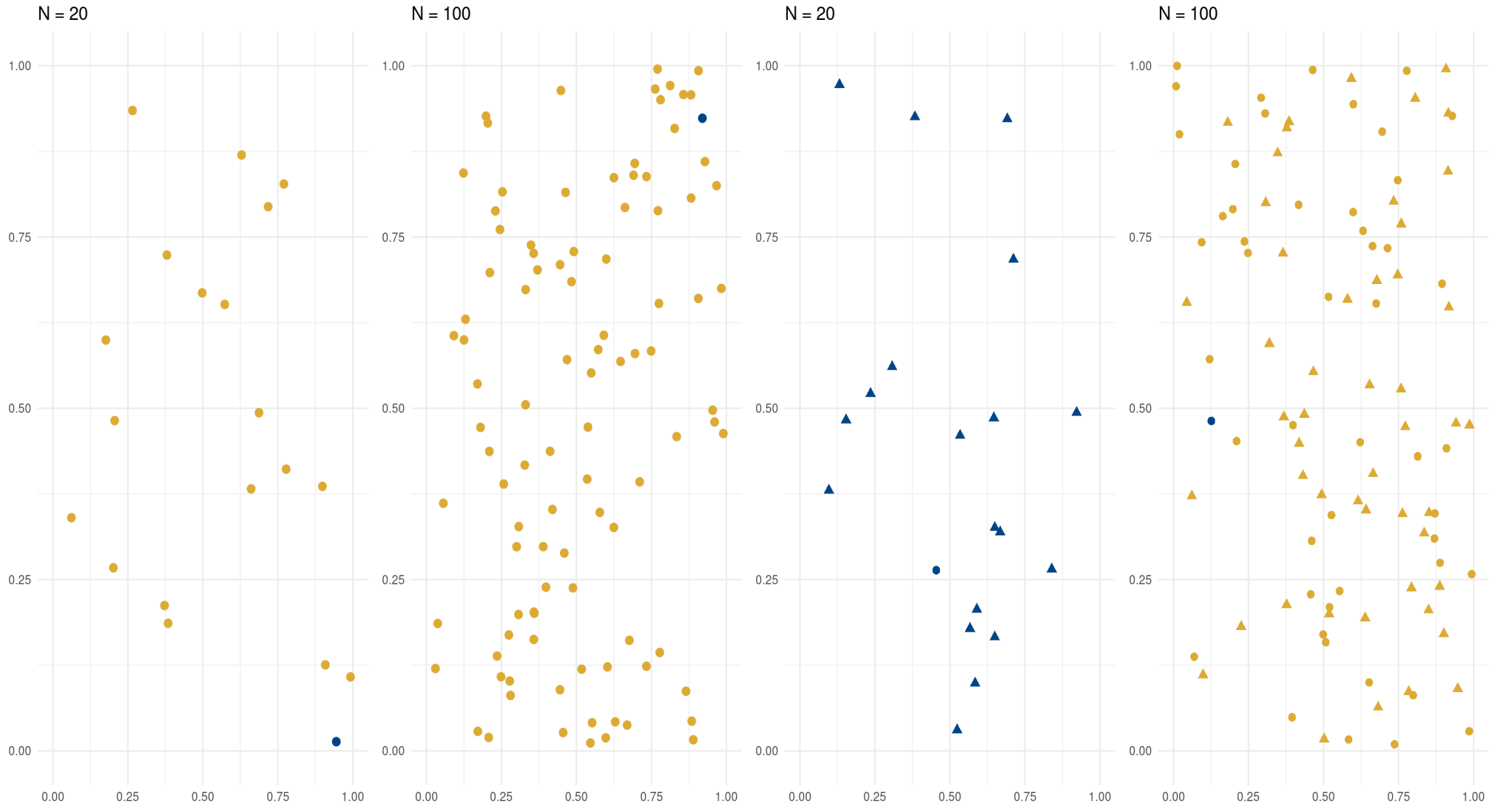
Cody Davis

Pop

Can you see the green squares?



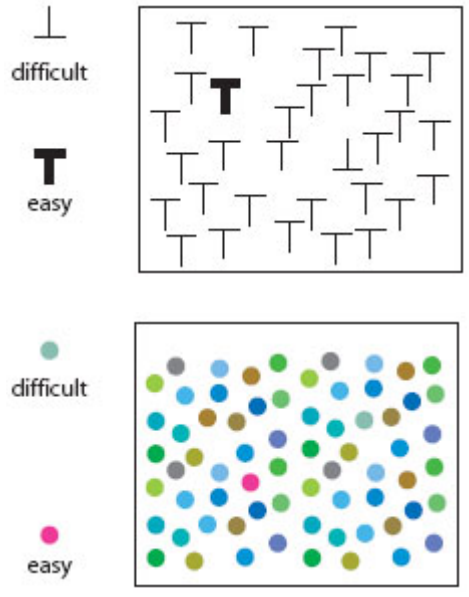
Pop

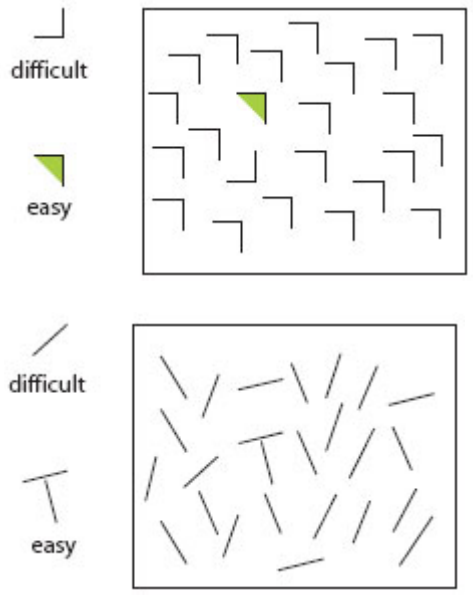


Preattentive pop-out

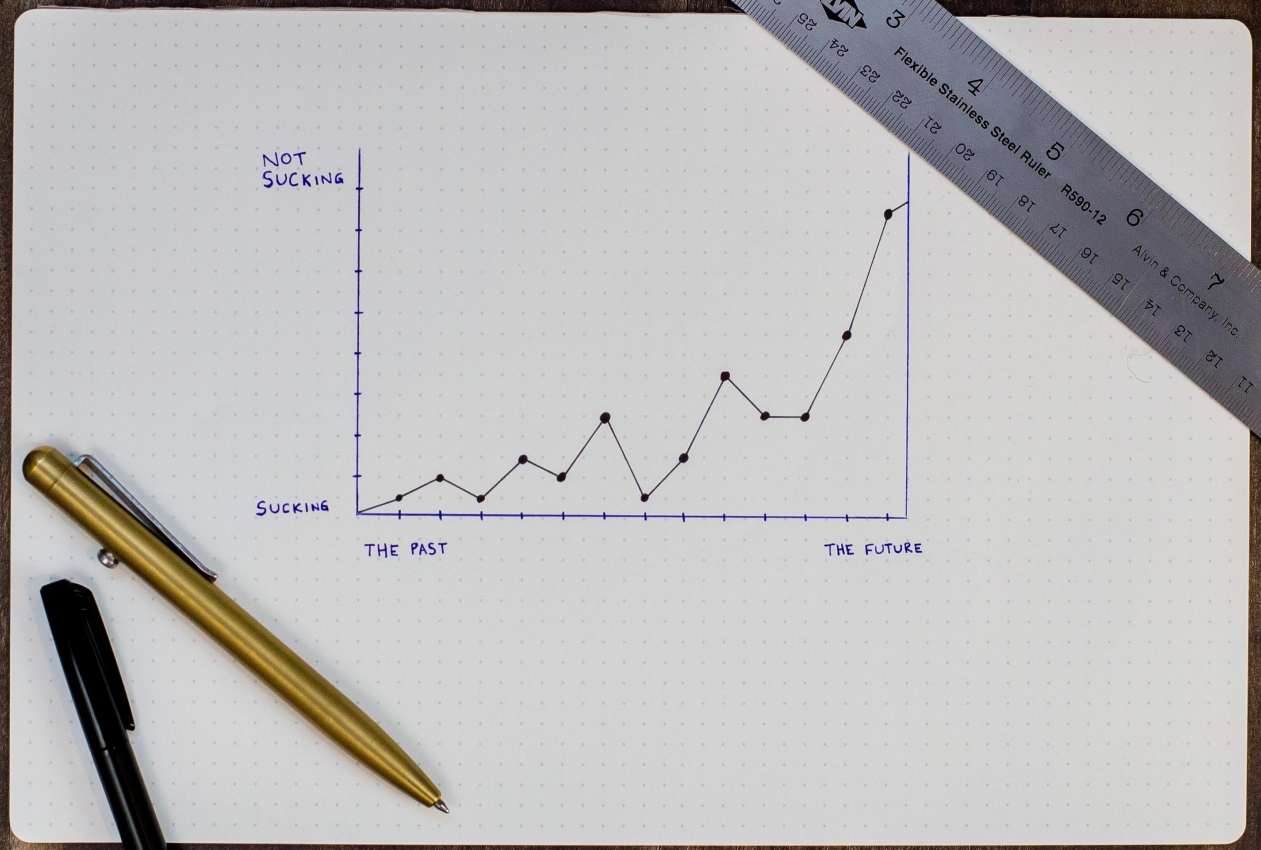
Some shapes, colours, angles more easy to spot

Can happen before (or almost before) before consciously looking at something





Making a plot



Isaac Smith

The anatomy of a plot

Visualisation involves representing data by lines, shapes, colours, etc.

Map data to visual channels — some channels more effective than others

ggplot provides a set of tools to

- map data to visual elements,
- specify the kind of plot, and
- control the fine details of the final plot

The anatomy of a *ggplot*

A *ggplot* comprises several main elements

1. Data
2. Aesthetic mappings
3. Geoms
4. Co-ordinates & scales
5. Labels & guides

ggplot()

Main function is `ggplot()`

- specify `data`, the data frame containing the data
- specify mappings of variables in `data` to *aesthetics* with `aes()`

Add *layers* to plot vis `+`

Geoms are the main layer-types we add to influence the plot

Geoms by default inherit the `data` and *aesthetics* from the `ggplot()` call

```
ggplot(data_frame, aes(x = var1, y = var2, colour = var3)) +
    geom_<type>(....) +
    geom_<type>(....)
```

Data

Two main ways in which data tend to be recorded

1. *wide*-format
2. *long*-format

In *long*-format:

- every column is a variable
- every row is an observation

In *wide*-format

- some variables are spread out over multiple columns

ggplot requires data in *long* form

Wide-format

```
## # A tibble: 142 x 13
##    country `1952` `1957` `1962` `1967` `1972` `1977` `1982` `1987` `1992`
##    <fct>    <dbl>  <dbl>  <dbl>  <dbl>  <dbl>  <dbl>  <dbl>  <dbl>  <dbl>
##  1 Afghan…   28.8   30.3   32.0   34.0   36.1   38.4   39.9   40.8   41.7
##  2 Albania   55.2   59.3   64.8   66.2   67.7   68.9   70.4   72     71.6
##  3 Algeria   43.1   45.7   48.3   51.4   54.5   58.0   61.4   65.8   67.7
##  4 Angola    30.0   32.0   34     36.0   37.9   39.5   39.9   39.9   40.6
##  5 Argent…   62.5   64.4   65.1   65.6   67.1   68.5   69.9   70.8   71.9
##  6 Austra…   69.1   70.3   70.9   71.1   71.9   73.5   74.7   76.3   77.6
##  7 Austria   66.8   67.5   69.5   70.1   70.6   72.2   73.2   74.9   76.0
##  8 Bahrain   50.9   53.8   56.9   59.9   63.3   65.6   69.1   70.8   72.6
##  9 Bangla…   37.5   39.3   41.2   43.5   45.3   46.9   50.0   52.8   56.0
## 10 Belgium   68     69.2   70.2   70.9   71.4   72.8   73.9   75.4   76.5
## # … with 132 more rows, and 3 more variables: `1997` <dbl>, `2002` <dbl>,
## #   `2007` <dbl>
```

Long-format

```
## # A tibble: 1,704 x 3
##    country      year lifeExp
##    <fct>       <int>   <dbl>
##  1 Afghanistan  1952    28.8
##  2 Afghanistan  1957    30.3
##  3 Afghanistan  1962    32.0
##  4 Afghanistan  1967    34.0
##  5 Afghanistan  1972    36.1
##  6 Afghanistan  1977    38.4
##  7 Afghanistan  1982    39.9
##  8 Afghanistan  1987    40.8
##  9 Afghanistan  1992    41.7
## 10 Afghanistan  1997    41.8
## # … with 1,694 more rows
```

Long-format

Data arranged in *key* and *value* pairs

`year` is the *key*

`lifeExp` is the *value*

```
## # A tibble: 5 x 3
##   country      year lifeExp
##   <fct>       <int>   <dbl>
## 1 Afghanistan  1952    28.8
## 2 Afghanistan  1957    30.3
## 3 Afghanistan  1962    32.0
## 4 Afghanistan  1967    34.0
## 5 Afghanistan  1972    36.1
```

Long-format

Can have multiple *key* and *value* columns

```
## # A tibble: 5 x 6
##   country     continent  year lifeExp      pop gdpPercap
##   <fct>       <fct>     <int>   <dbl>    <int>     <dbl>
## 1 Afghanistan Asia       1952    28.8  8425333      779.
## 2 Afghanistan Asia       1957    30.3  9240934      821.
## 3 Afghanistan Asia       1962    32.0 10267083      853.
## 4 Afghanistan Asia       1967    34.0 11537966      836.
## 5 Afghanistan Asia       1972    36.1 13079460      740.
```

RStudio tour

Jeffrey Buchbinder

gapminder data set

```
library('gapminder')                    # load package
gapminder                               # print data frame
```

```
## # A tibble: 1,704 x 6
##    country     continent  year lifeExp      pop gdpPercap
##    <fct>       <fct>     <int>   <dbl>    <int>     <dbl>
##  1 Afghanistan Asia       1952    28.8  8425333      779.
##  2 Afghanistan Asia       1957    30.3  9240934      821.
##  3 Afghanistan Asia       1962    32.0 10267083      853.
##  4 Afghanistan Asia       1967    34.0 11537966      836.
##  5 Afghanistan Asia       1972    36.1 13079460      740.
##  6 Afghanistan Asia       1977    38.4 14880372      786.
##  7 Afghanistan Asia       1982    39.9 12881816      978.
##  8 Afghanistan Asia       1987    40.8 13867957      852.
##  9 Afghanistan Asia       1992    41.7 16317921      649.
## 10 Afghanistan Asia       1997    41.8 22227415      635.
## # … with 1,694 more rows
```

Our first plot

Say we want to plot life expepctancy (`lifeExp`) against per capita GDP `gdpPercap`

```
p <- ggplot(data = gapminder)
```

We tell `ggplot()` *where* to look for variables, but haven't specified any mappings yet

Assigned the ouput of the `ggplot()` call to the object `p` (could call `p` anything)

`Alt + -`

or

`Option + -`

types the *assignment operator* `<-`

Our first plot

We specify mappings between variables and aesthetics via the `mapping` argument

Use the `aes()` function to specify the mappings

```
p <- ggplot(data = gapminder,
            mapping = aes(x = gdpPercap, y = lifeExp))
```

This sets up a mapping between our two variables and the `x` and `y` aesthetics

The `x` and `y` aesthetics are the x and y coordinates of the plot

Our first plot

We can draw the plot by `print()`ing the object `p`

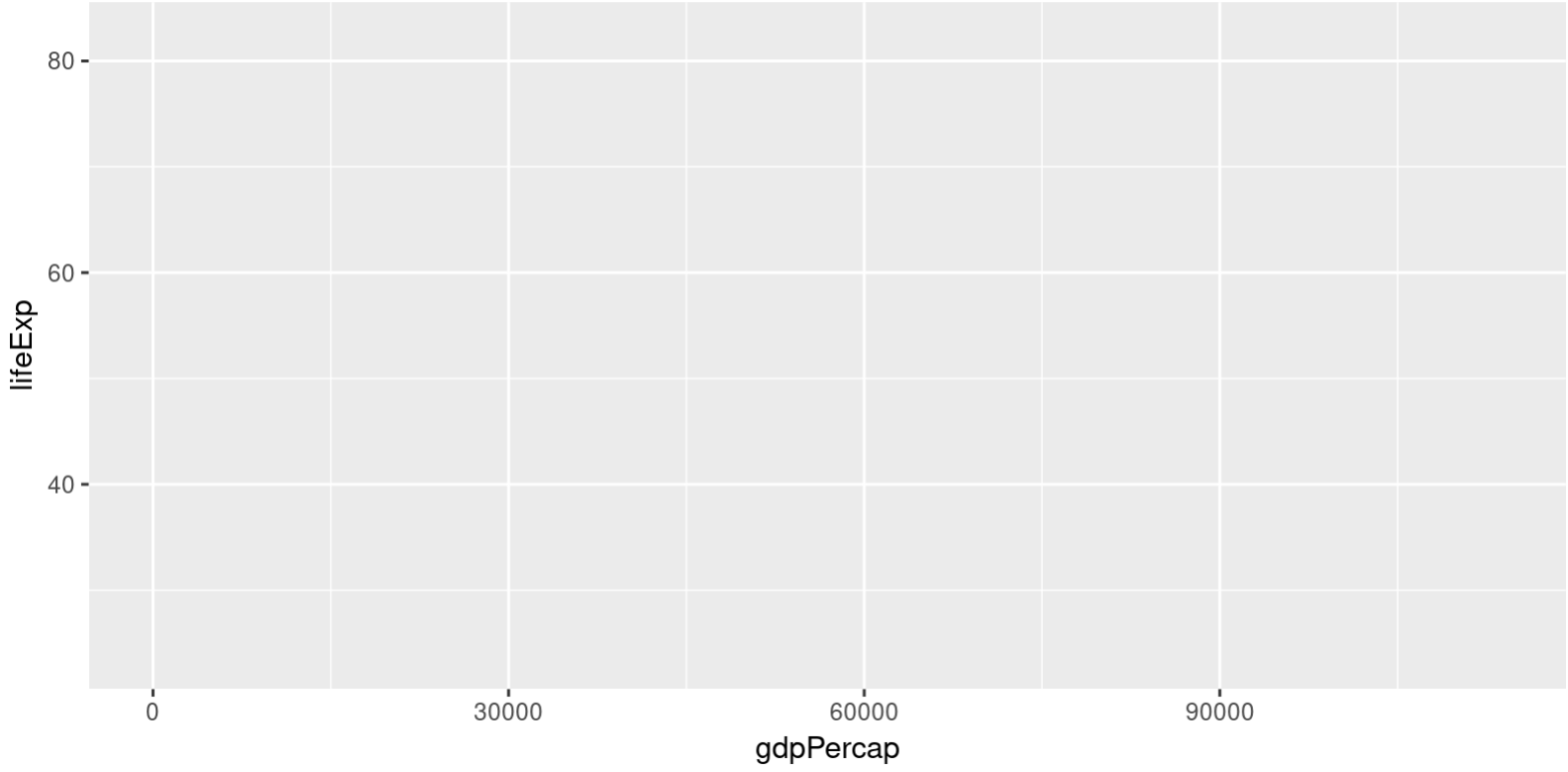
What do you think you'll get if you print `p`?

```
p
```

Our first plot

Only the *scale* for the x and y aesthetics is drawn

```
p
```



Adding a layer

Need to tell `ggplot()` *how* we want the data drawn

Need to choose a *geometric object* or *geom*

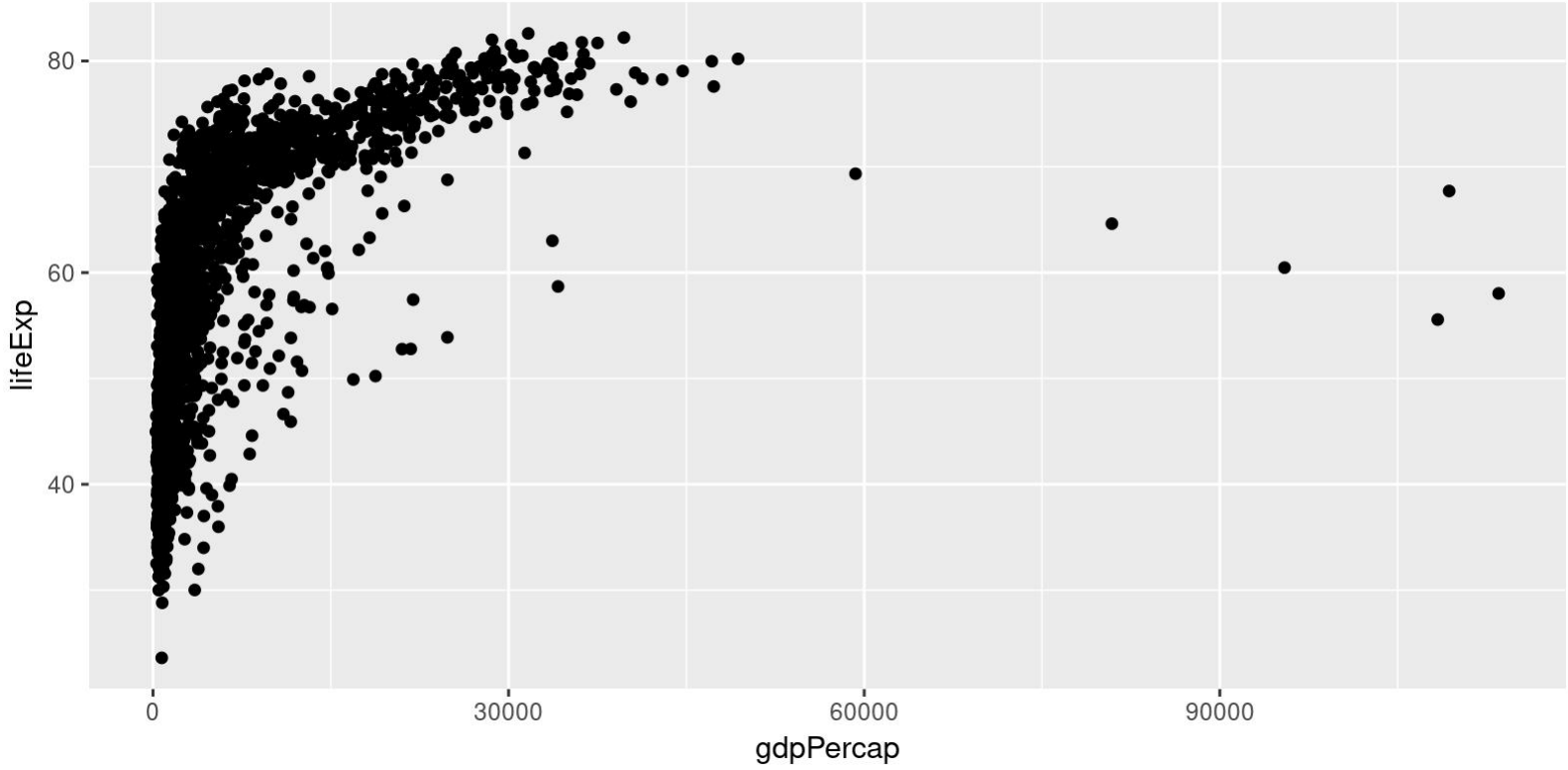
geoms are functions with names `geom_<type>()`

A *geom* adds a layer to an existing plot

For a scatterplot, we represent the x, y pairs via points `geom_point()`

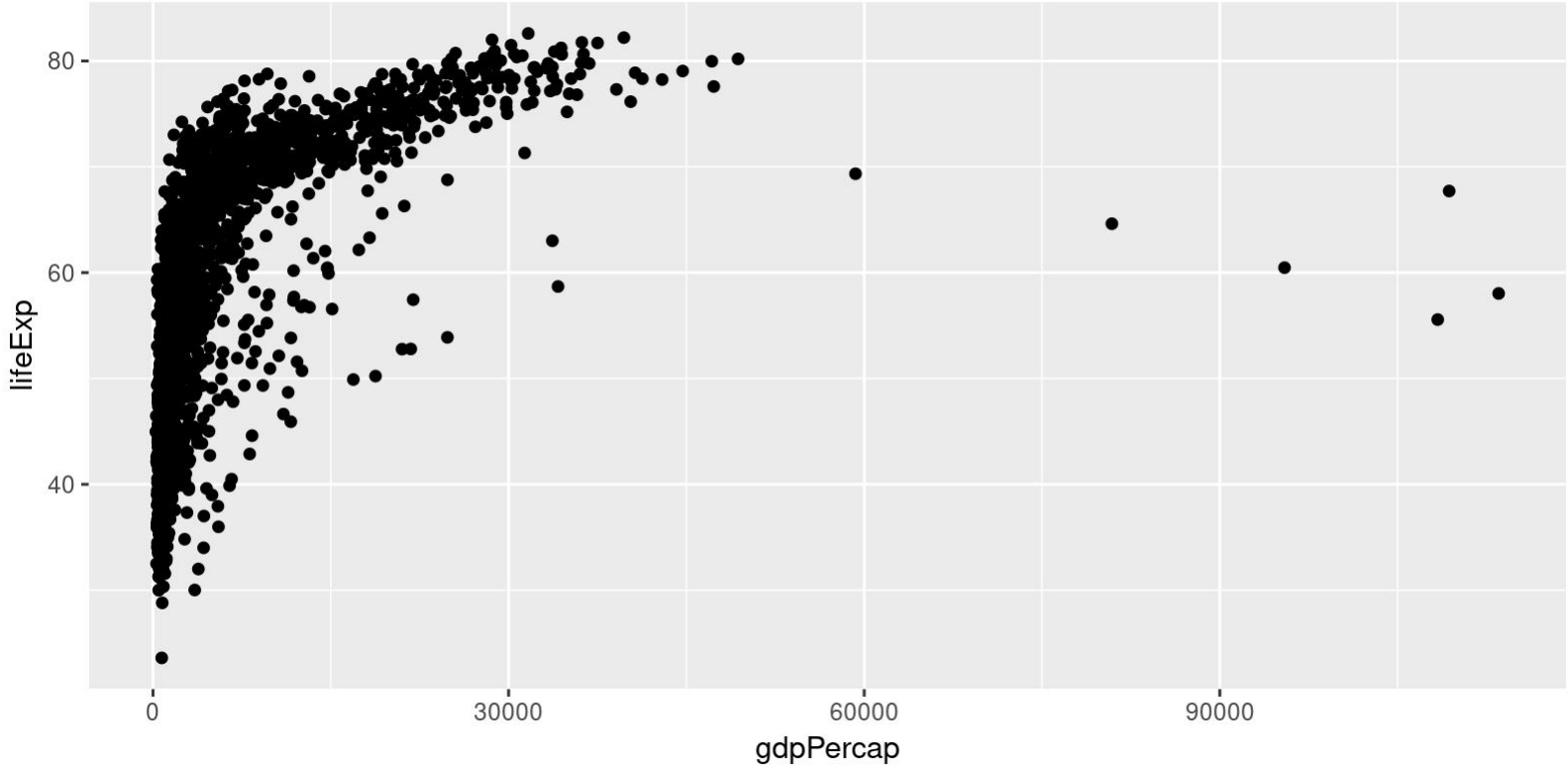
Adding a layer

```
p + geom_point()
```



Putting it all together

```
ggplot(data = gapminder,
       mapping = aes(x = gdpPercap, y = lifeExp)) +
    geom_point()
```



Your turn

Create a scatterplot of *population* and *per captia GDP*

Previously on...

- *ggplot* provides a set of tools to
  - map data to visual elements
  - specify the kind of plot
  - control fine details of the plot
- A *ggplot* comprises several elements
  1. Data — via the `data` argument
  2. Aesthetic mappings — via the `aes()` argument
  3. Geometric objects or *geoms*
  4. Coordinates & scales
  5. Labels & Guides
- Preparing data — **tidy** or **long** data not **wide**
- Created our first plot

Previously on...

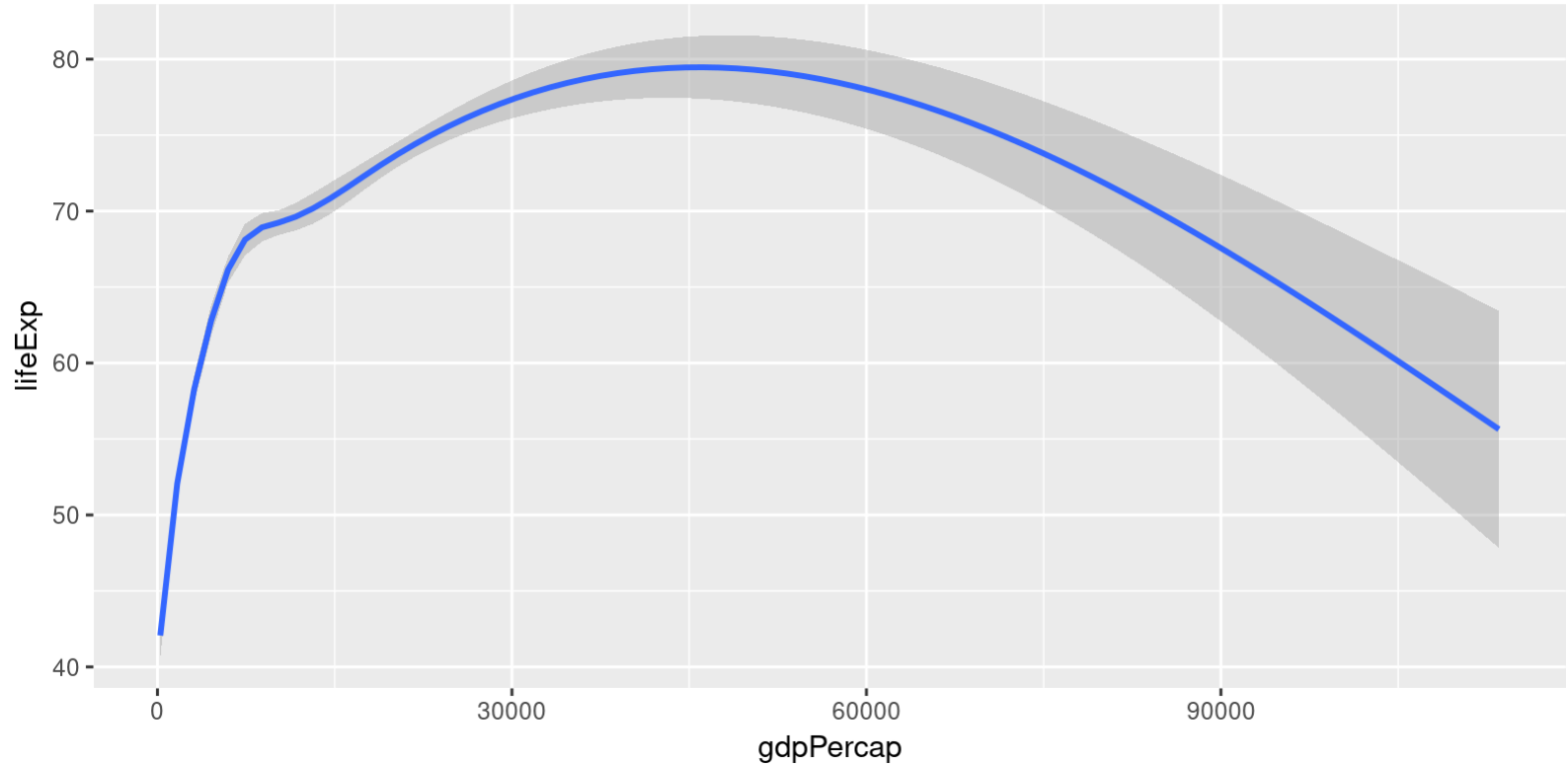
```
library('gapminder')
library('ggplot2')

p <- ggplot(data = gapminder,
            mapping = aes(x = gdpPercap, y = lifeExp))

p + geom_point()
```

```
ggplot(data = gapminder,
       mapping = aes(x = gdpPercap, y = lifeExp)) +
    geom_point()
```

geoms don't always draw the data

```
p  <- ggplot(data = gapminder, mapping = aes(x = gdpPercap, y = lifeExp))
p + geom_smooth()
```

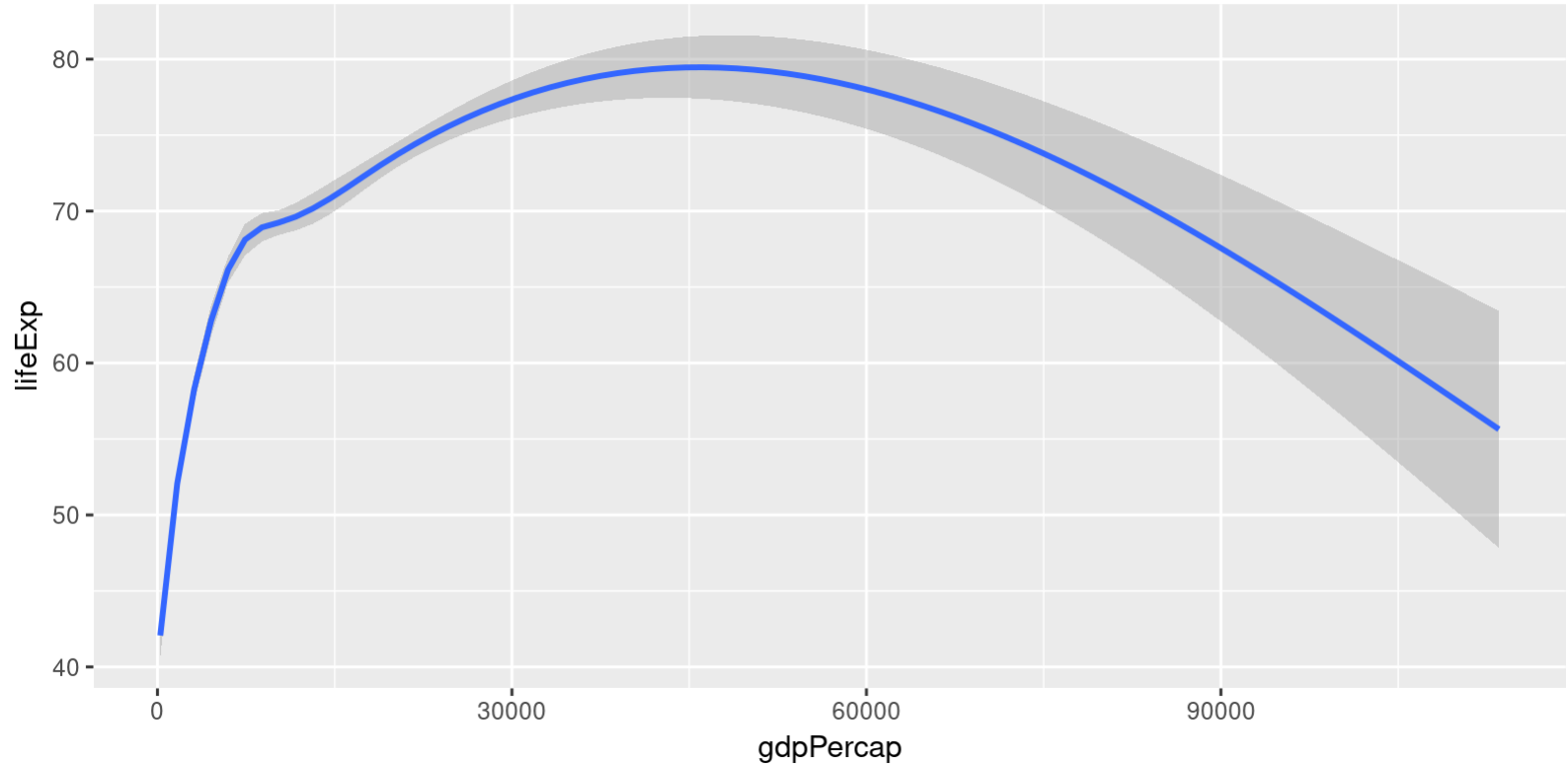
```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```



`geom_smooth()` adds a smooth via a GAM or LOESS

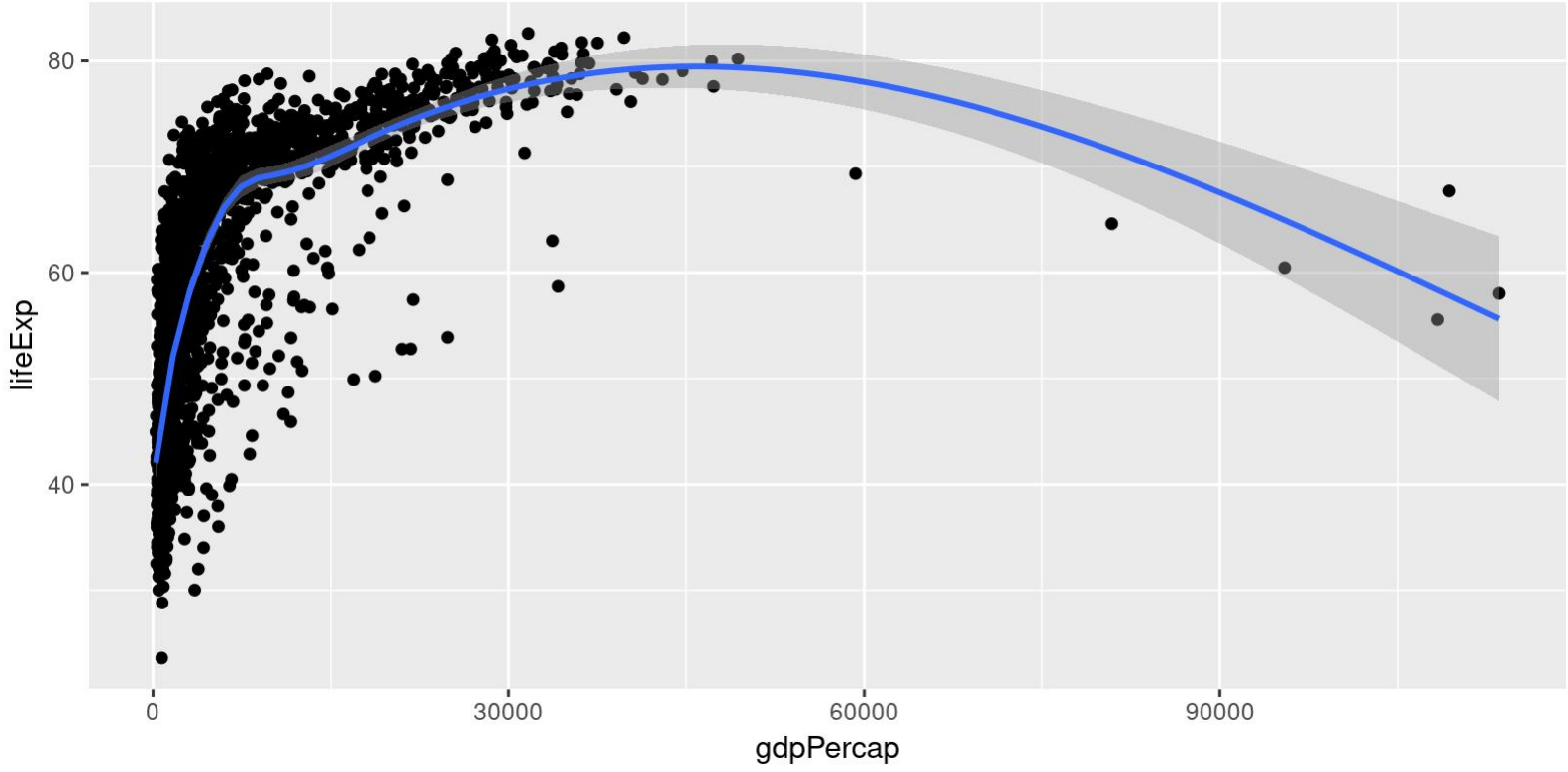
```
p  <- ggplot(data = gapminder, mapping = aes(x = gdpPercap, y = lifeExp))
p + geom_smooth()
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```



Plots with multiple layers

```
p  <- ggplot(data = gapminder, mapping = aes(x = gdpPercap, y = lifeExp))
p + geom_point() + geom_smooth()
```



Geoms inherit data and mappings

Didn't need to tell each geom what data or mappings to use

Information is *inherited* from the main `ggplot()` object

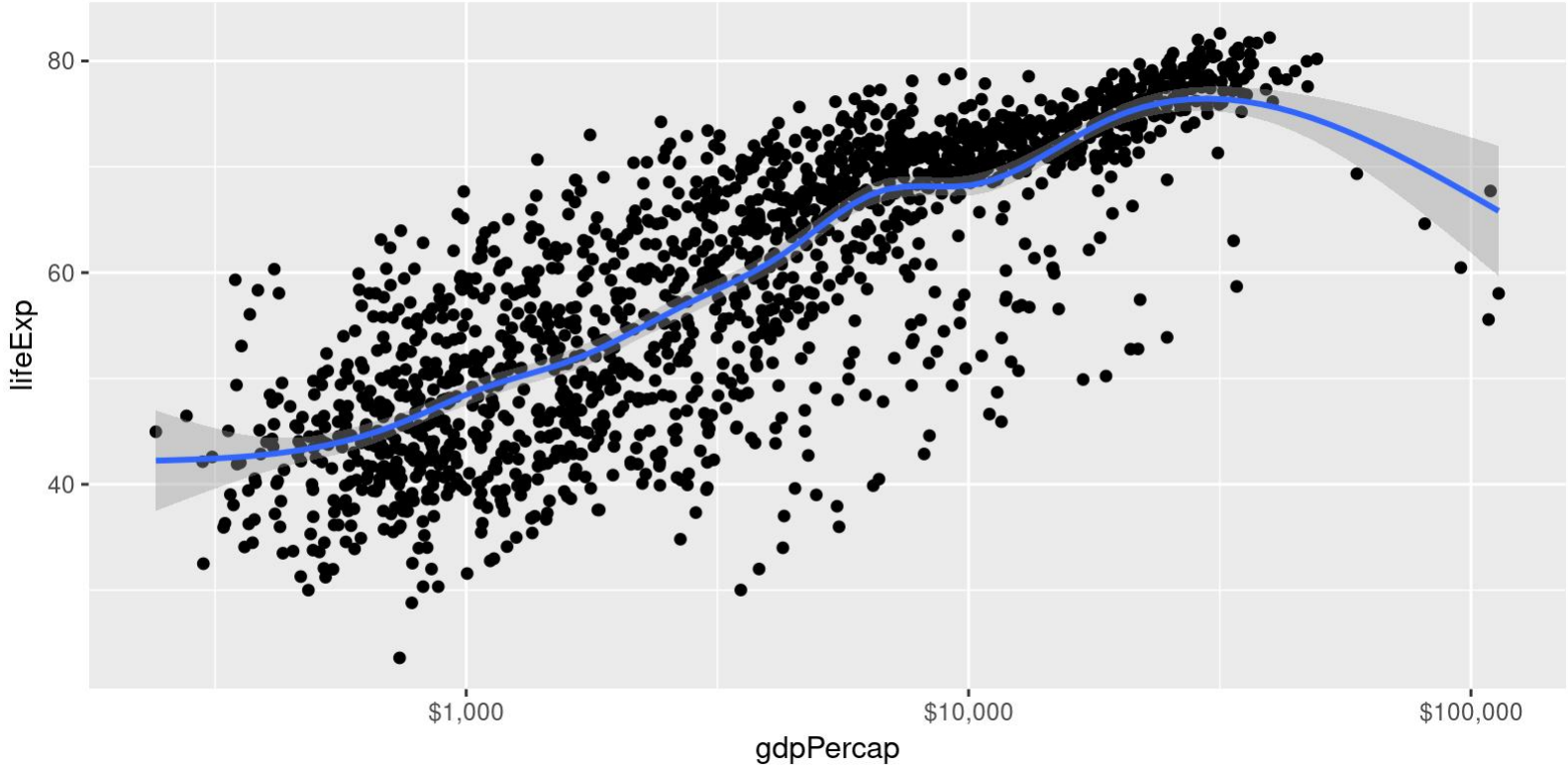
Can override this

```
p  <- ggplot(data = gapminder, mapping = aes(x = gdpPercap, y = lifeExp))
p + geom_point() + geom_smooth()
```

`scale_<aes>_<type>()` control scales

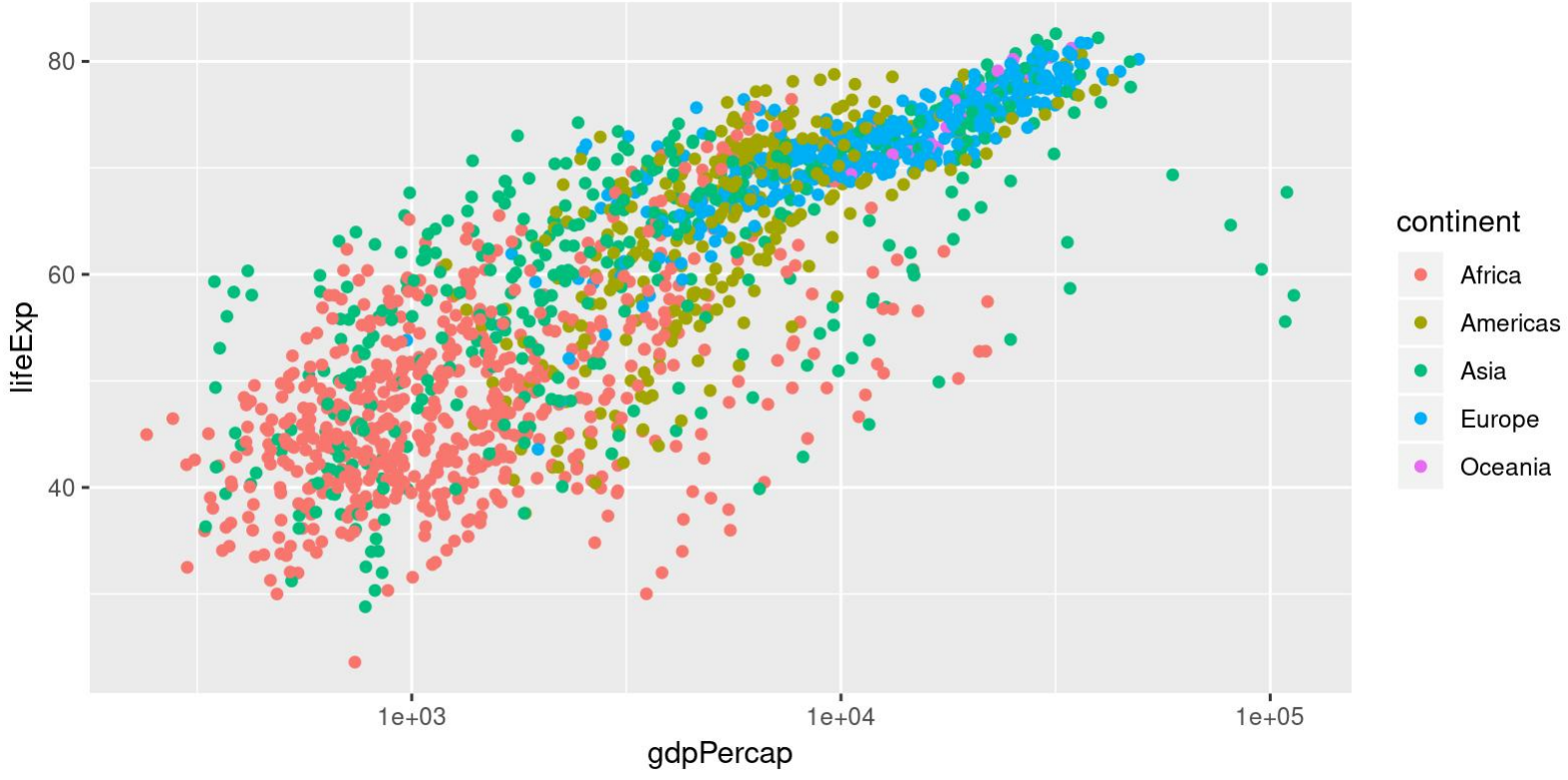
Tick labels modified via `labels` — convenient functions in *scales* package

```
p + geom_point() + geom_smooth() + scale_x_log10(labels = scales::dollar)
```



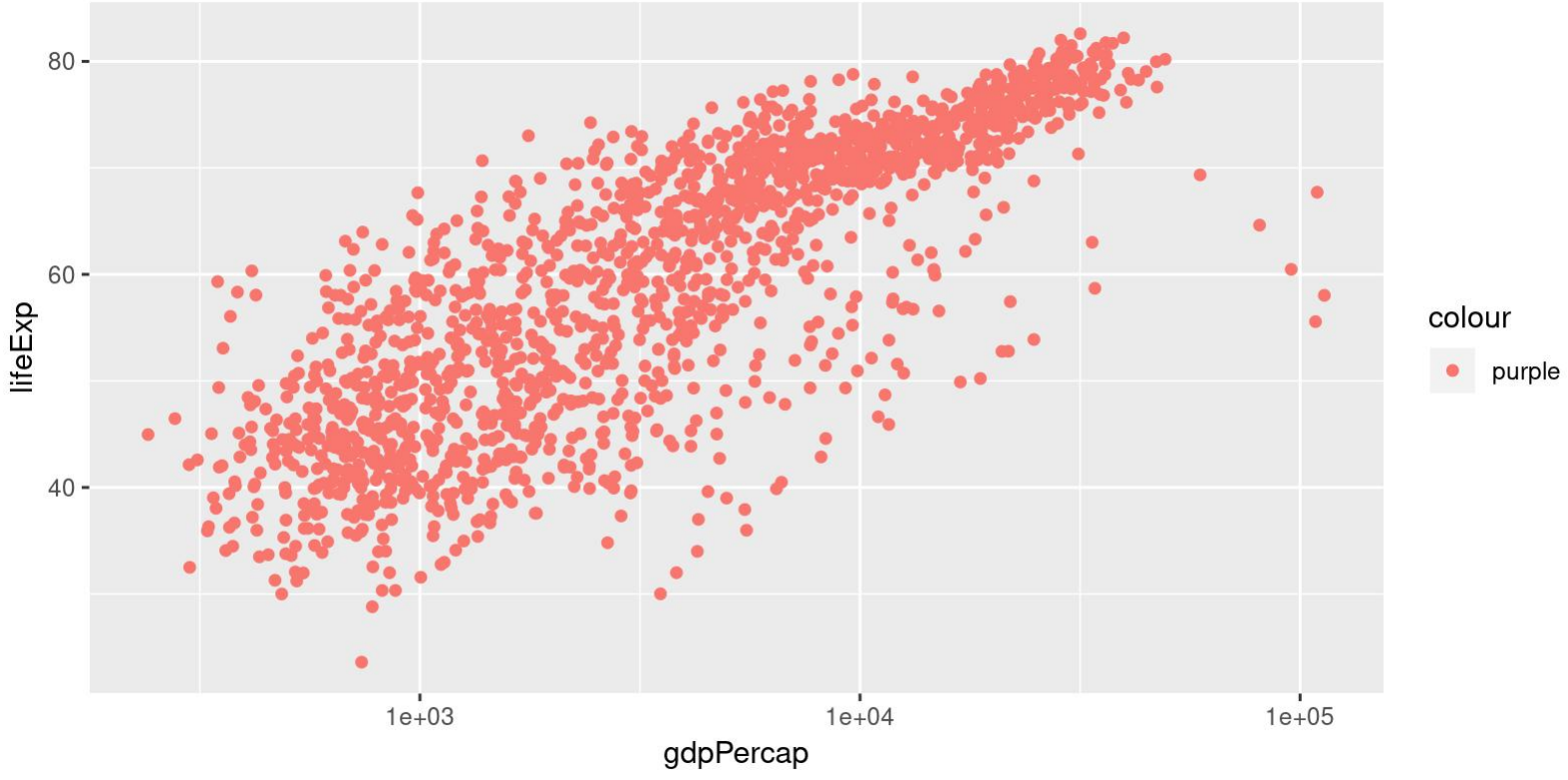
Mapping vs setting aesthetics

```
p  <- ggplot(data = gapminder,
             mapping = aes(x = gdpPercap, y = lifeExp, colour = continent))
p + geom_point() + scale_x_log10()
```



Setting aesthetics — the wrong way

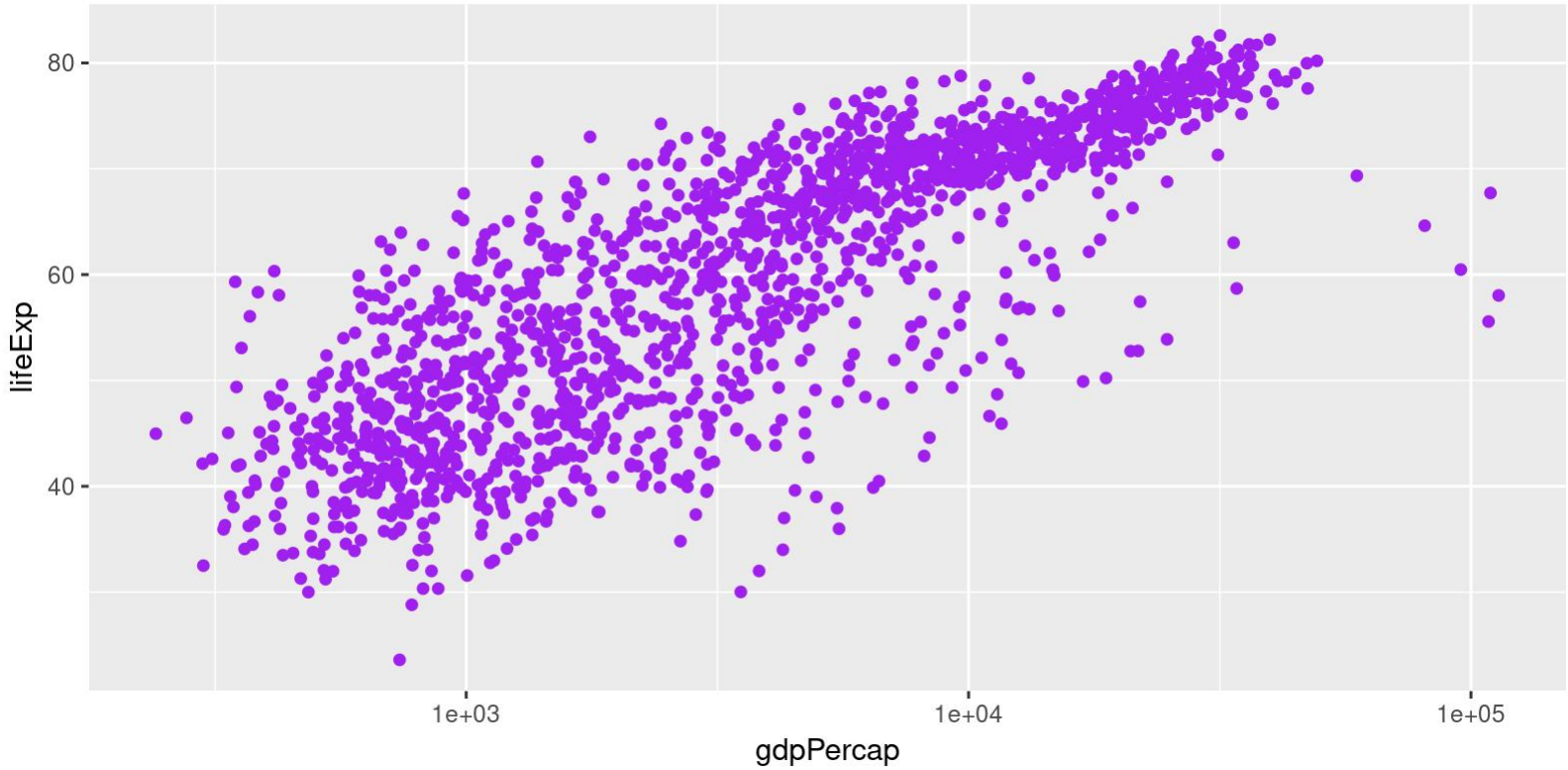
```
p  <- ggplot(data = gapminder,
             mapping = aes(x = gdpPercap, y = lifeExp, colour = "purple"))
p + geom_point() + scale_x_log10()
```



Setting aesthetics — the right way

Mappings are in `aes()`, settings go *outside* `aes()`

```
p  <- ggplot(data = gapminder, mapping = aes(x = gdpPercap, y = lifeExp))
p + geom_point(colour = "purple") + scale_x_log10()
```

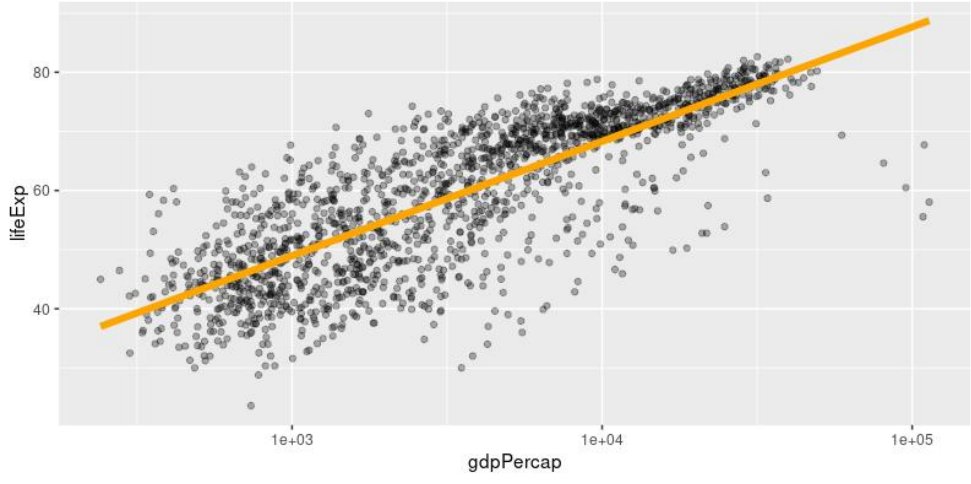


Setting aesthetics — the right way

Mappings are in `aes()`, settings go *outside* `aes()`

`alpha` controls transparency, `size` controls how big things are

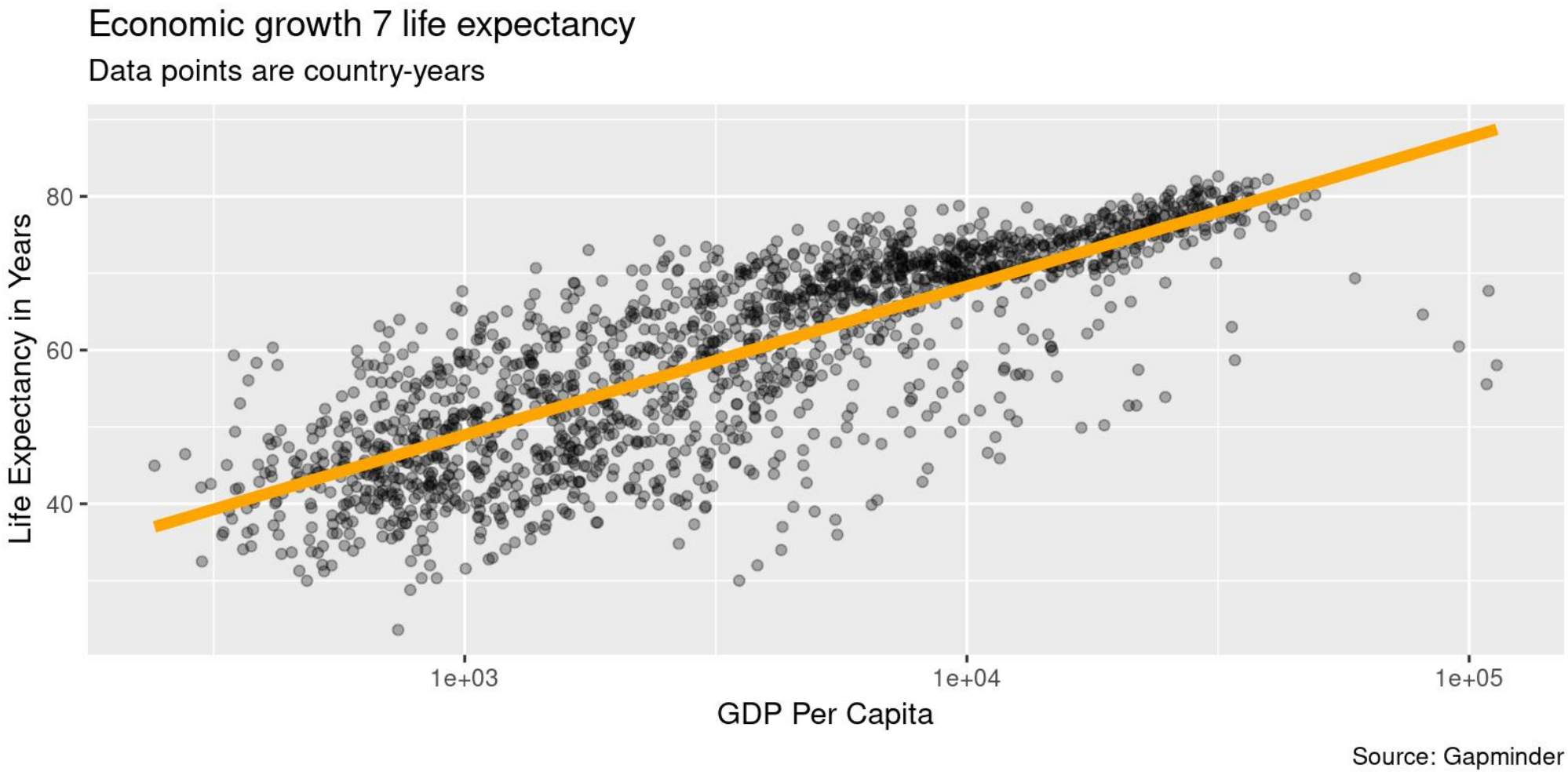
```
ggplot(gapminder,
       aes(x = gdpPercap,
           y = lifeExp)) +
    geom_point(alpha = 0.3) +
    geom_smooth(method = 'lm',
                colour = 'orange',
                se = FALSE, size = 2)
+
    scale_x_log10()
```



`labs()` — setting plot labels

```
ggplot(gapminder, aes(x = gdpPercap, y = lifeExp)) +
    geom_point(alpha = 0.3) +
    geom_smooth(method = 'lm', colour = 'orange', se = FALSE, size = 2) +
    scale_x_log10() +
    labs(x = 'GDP Per Capita',
         y = 'Life Expectancy in Years',
         title = 'Economic growth 7 life expectancy',
         subtitle = 'Data points are country-years',
         caption = 'Source: Gapminder')
```

`labs()` — setting plot labels



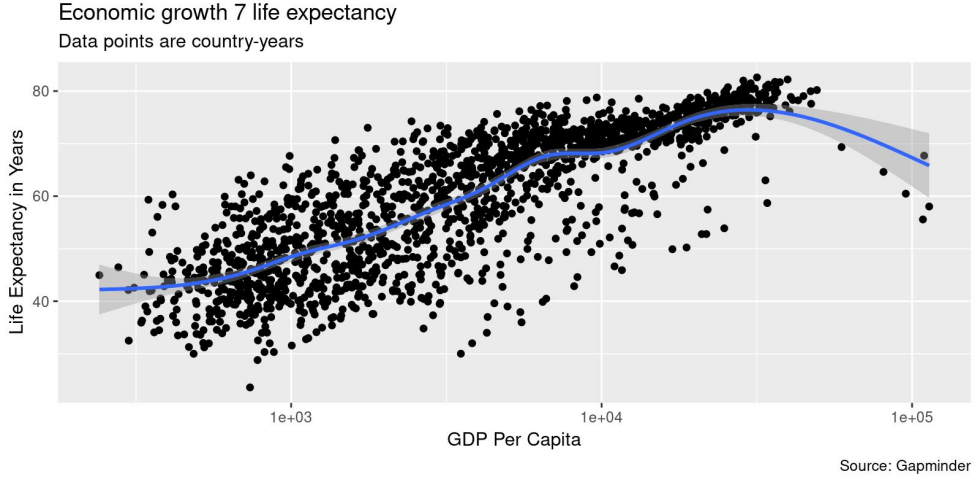
Reusing elements

You can save time and effort by reusing plot elements

```
my_labs <- labs(x = 'GDP Per Capita',
                y = 'Life Expectancy in Years',
                title = 'Economic growth 7 life expectancy',
                subtitle = 'Data points are country-years',
                caption = 'Source: Gapminder')
```

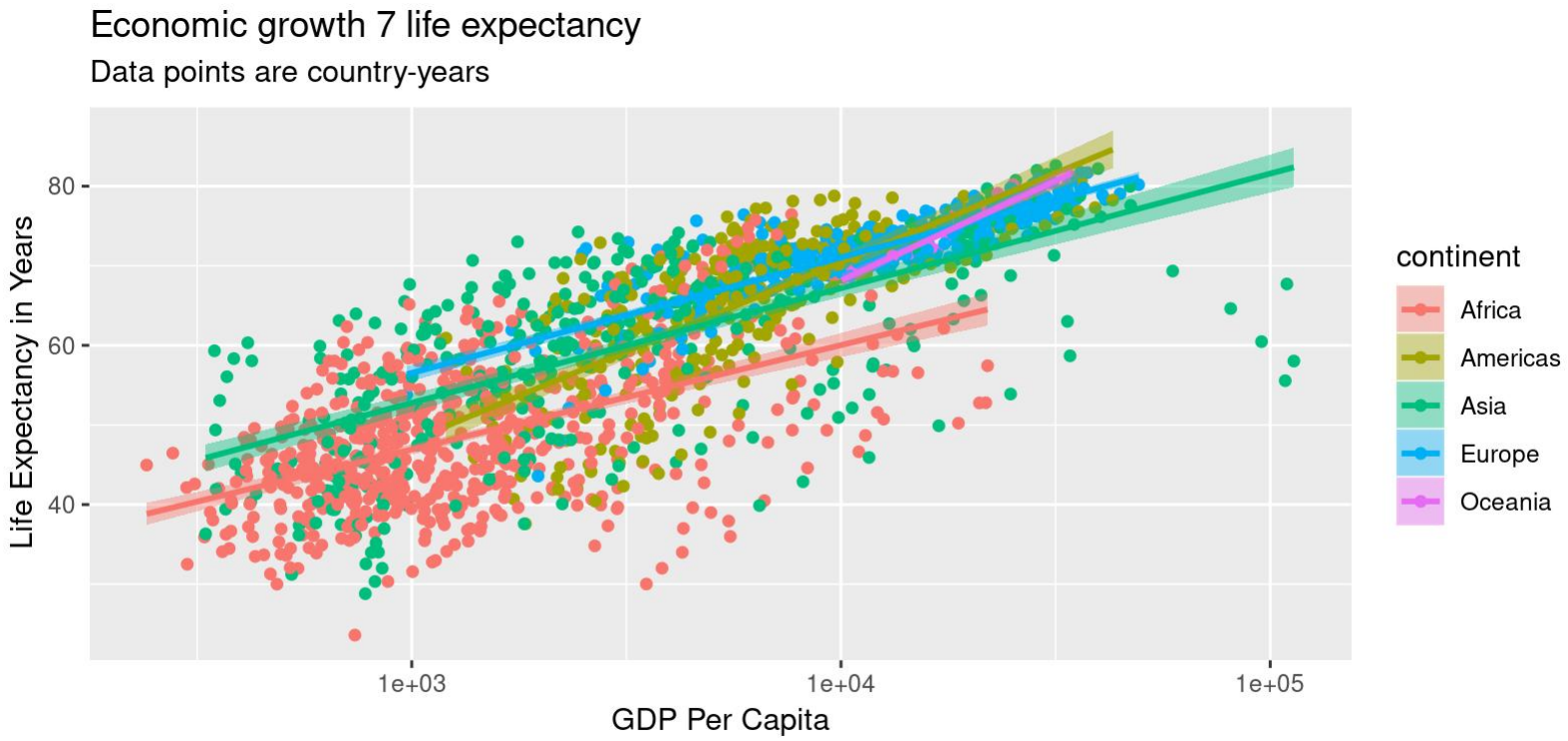
Then resuse

```
p + geom_point() + geom_smooth() +
    scale_x_log10() + my_labs
```



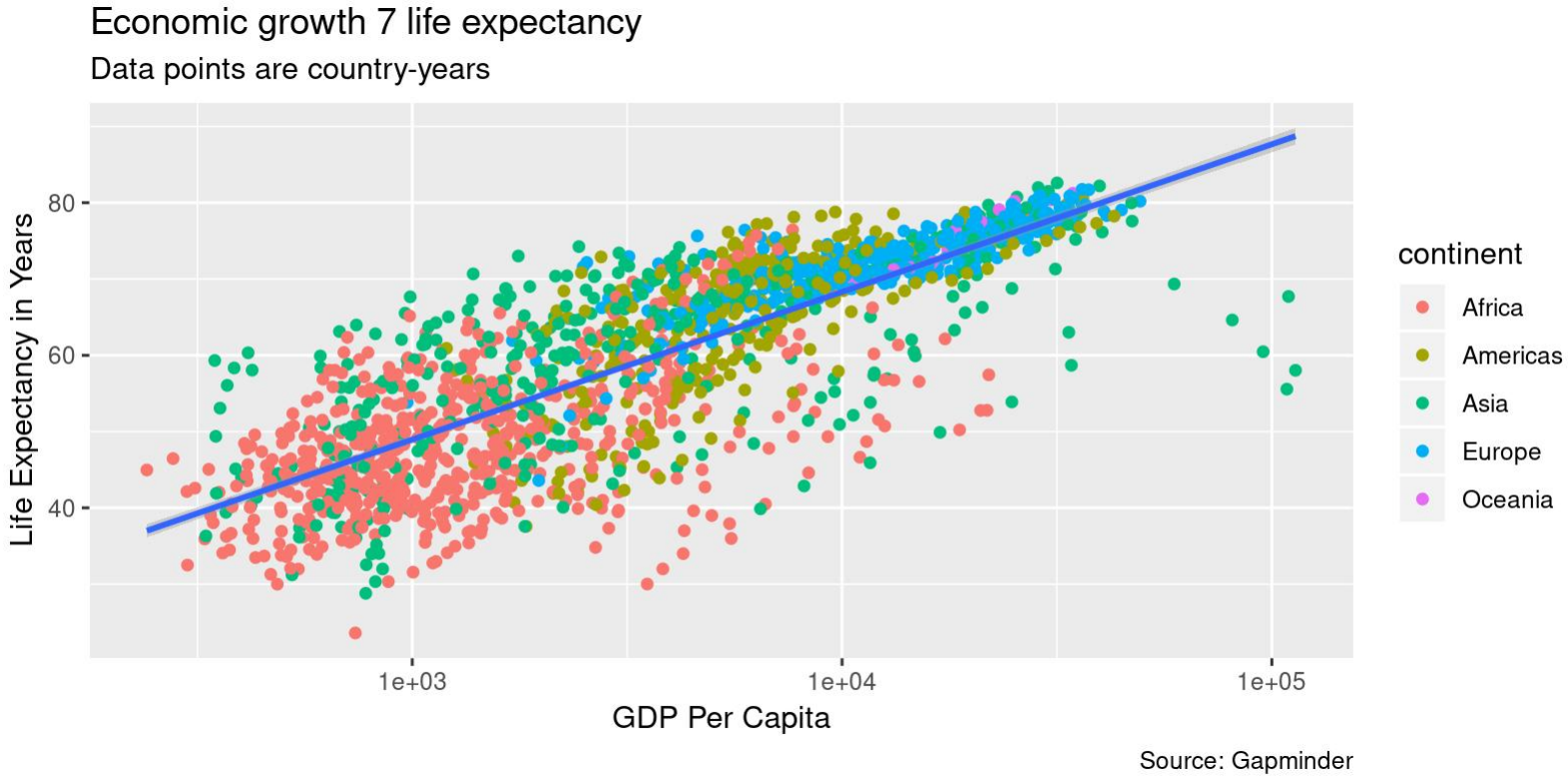
Matching aesthetics

```
ggplot(gapminder, aes(x = gdpPercap, y = lifeExp, colour = continent,
                      fill = continent)) +
    geom_point() + geom_smooth(method = 'gam') +
    scale_x_log10() + my_labs
```



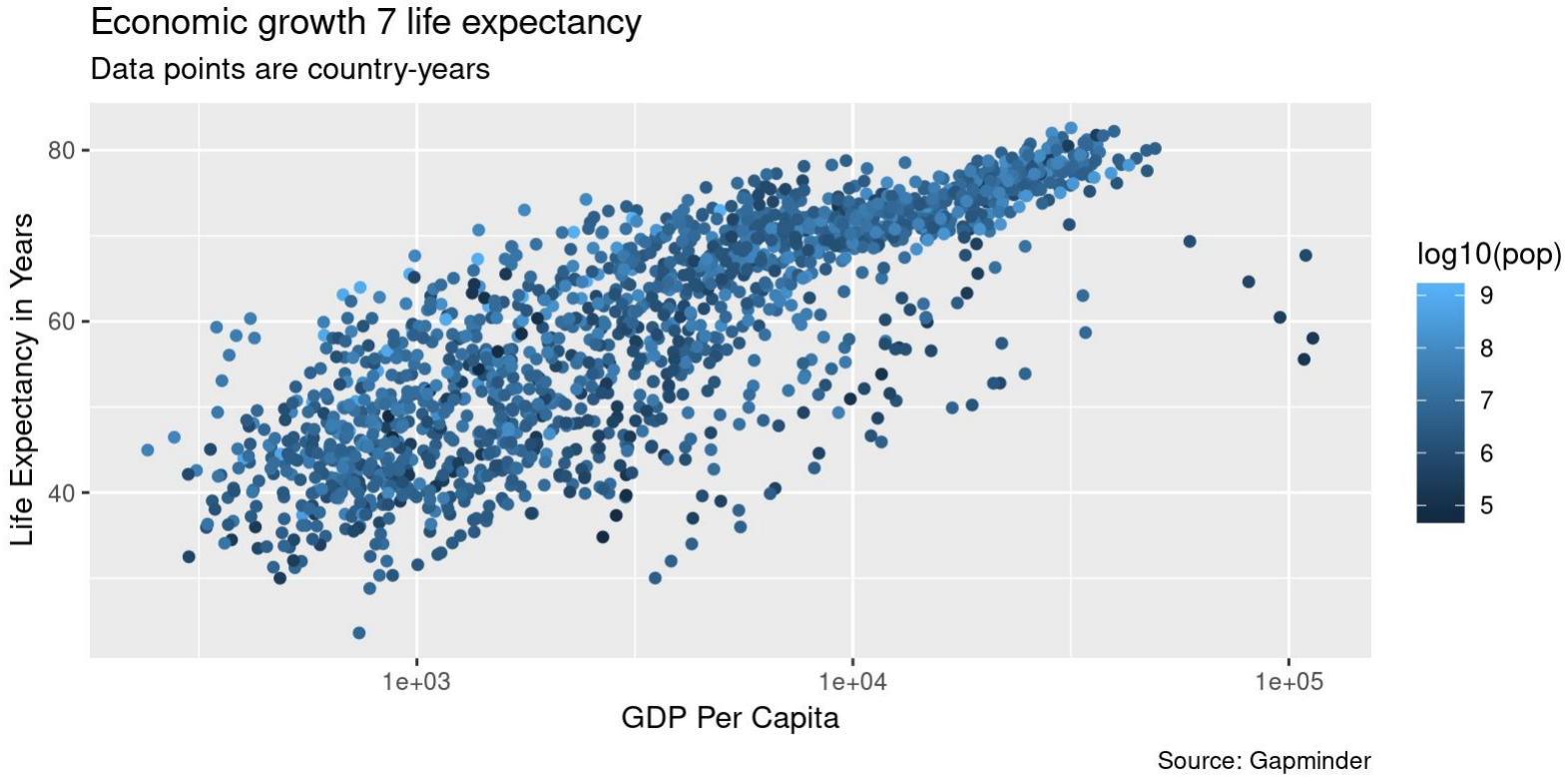
Mapping aesthetics per geom

```
ggplot(gapminder, aes(x = gdpPercap, y = lifeExp)) +
    geom_point(mapping = aes(colour = continent)) + geom_smooth(method = 'gam') +
    scale_x_log10() + my_labs
```



Mapping continuous variables

```
ggplot(gapminder, aes(x = gdpPercap, y = lifeExp)) +
    geom_point(mapping = aes(colour = log10(pop))) +
    scale_x_log10() + my_labs
```



`ggsave()` — Saving your work

Plots can be rendered to disk in a range of formats — PNG, PDF, ...

Type of file depends on the extension given in `filename`

`ggsave()` saves the last `ggplot` object plotted

```
ggplot(gapminder, aes(x = gdpPercap, y = lifeExp)) +
    geom_point(mapping = aes(colour = log10(pop))) +
    scale_x_log10() + my_labs
```

```
## save the last plot
ggsave('my-plot.png')
```

```
## Saving 7 x 7 in image
```

`ggsave()` — Saving your work

Plots can be rendered to disk in a range of formats — PNG, PDF, ...

Type of file depends on the extension given in `filename`

`ggsave()` saves a specific `ggplot` object if given on

```
my_plt <- ggplot(gapminder, aes(x = gdpPercap, y = lifeExp)) +
    geom_point(mapping = aes(colour = log10(pop))) +
    scale_x_log10() + my_labs

## save a specific plot object
ggsave('my-plot.pdf', plot = my_plt)
```

```
## Saving 7 x 7 in image
```

`ggsave()` — Specifying size

`ggsave()` always saves objects in inches & takes the size from the device if not specified

Can set `width` and `height` to numeric values and select the units via `units`

```
my_plt <- ggplot(gapminder, aes(x = gdpPercap, y = lifeExp)) +
    geom_point(mapping = aes(colour = log10(pop))) +
    scale_x_log10() + my_labs

## save a specific plot object
ggsave('my-plot-cm.pdf', plot = my_plt, height = 10, width= 20, units = 'cm')
```