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# Lesson notes | Lines, scales, and labels

Created by the GRAPH Courses team

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This document serves as an accompaniment for a lesson found on <https://thegraphcourses.org>.

The GRAPH Courses is a project of the Global Research and Analyses for Public Health (GRAPH) Network, a non-profit headquartered at the University of Geneva Global Health Institute, and supported by the World Health Organization (WHO) and other partners

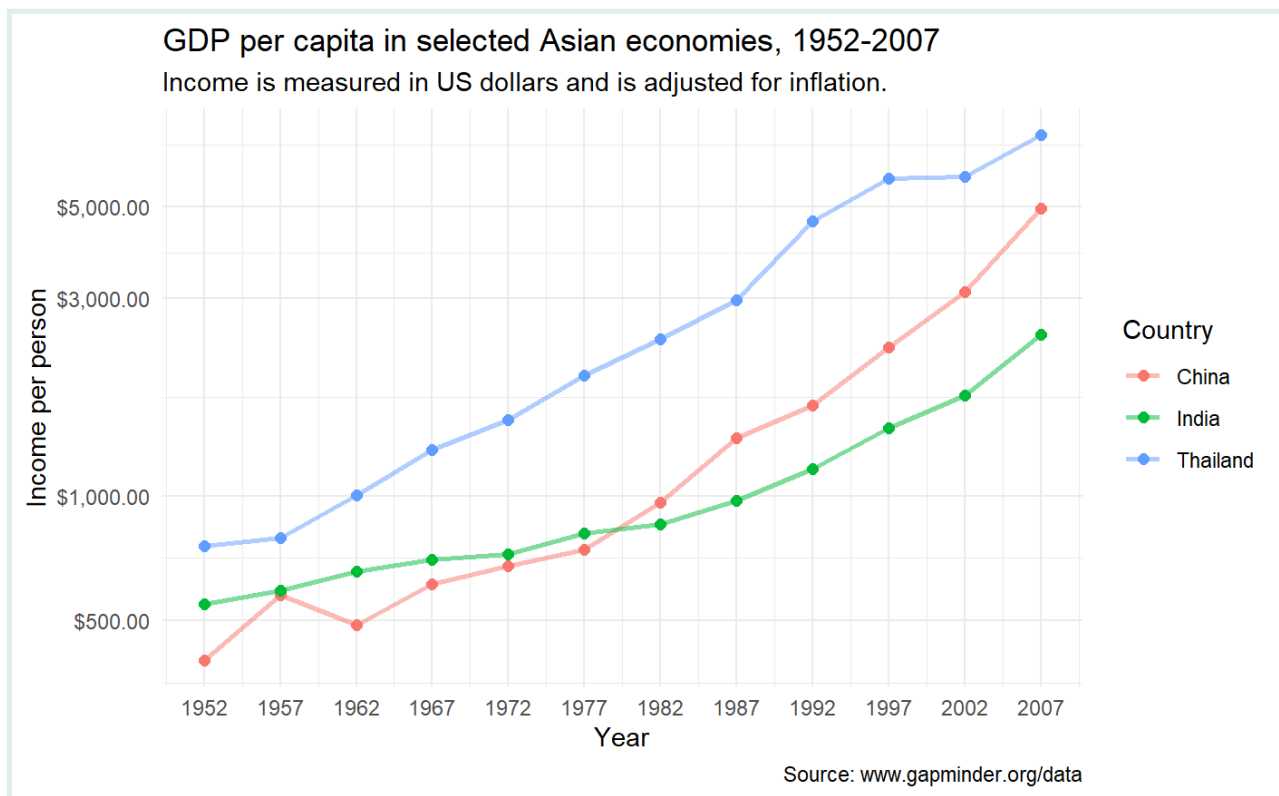


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## Learning Objectives

1. You can create **line graphs** to visualize relationships between two numerical variables with `geom_line()`.
2. You can **add points** to a line graph with `geom_point()`.
3. You can use aesthetics like `color`, `size`, `color`, and `linetype` to modify line graphs.
4. You can **manipulate axis scales** for continuous data with `scale_*_continuous()` and `scale_*_log10()`.
5. You can **add labels** to a plot such as a `title`, `subtitle`, or `caption` with the `labs()` function.



## Introduction

Line graphs are used to show **relationships** between two **numerical variables**, just like scatterplots. They are especially useful when the variable on the x-axis, also called the *explanatory* variable, is of a **sequential** nature. In other words, there is an inherent ordering to the variable.

The most common examples of line graphs have some notion of **time on the x-axis**: hours, days, weeks, years, etc. Since time is sequential, we connect consecutive observations of the variable on the y-axis with a line. Line graphs that have some notion of time on the x-axis are also called **time series plots**.

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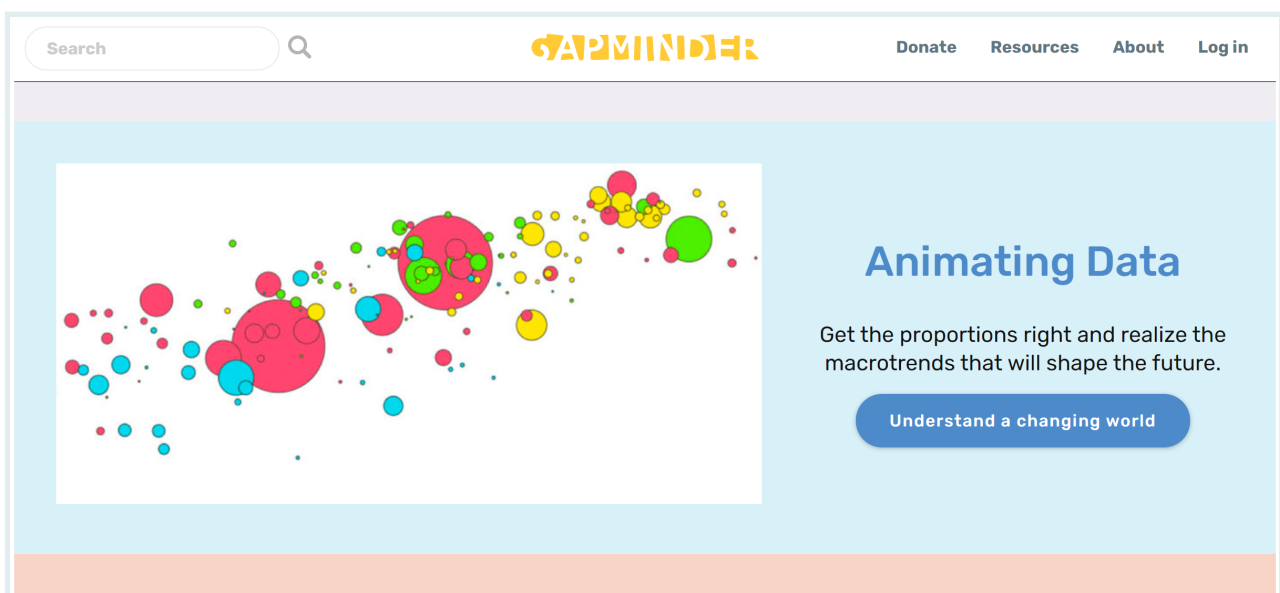
## Packages

```
# Load packages
pacman::p_load(tidyverse,
               gapminder,
               here)
```

---

## The gapminder data frame

In February 2006, a Swedish physician and data advocate named Hans Rosling gave a famous TED talk titled “The best stats you’ve ever seen” where he presented global economic, health, and development data compiled by the Gapminder Foundation.



We can access a clean subset of this data with the R package **{gapminder}**, which we just loaded.

```
# Load gapminder data frame from the gapminder package
data(gapminder, package="gapminder")

# Print dataframe
gapminder
```

Each row in this table corresponds to a country-year combination. For each row, we have 6 columns:

1. **country**: Country name

2. **continent**: Geographic region of the world
3. **year**: Calendar year
4. **lifeExp**: Average number of years a newborn child would live if current mortality patterns were to stay the same
5. **pop**: Total population
6. **gdpPercap**: Gross domestic product per person (inflation-adjusted US dollars)

The `str()` function can tell us more about these variables.

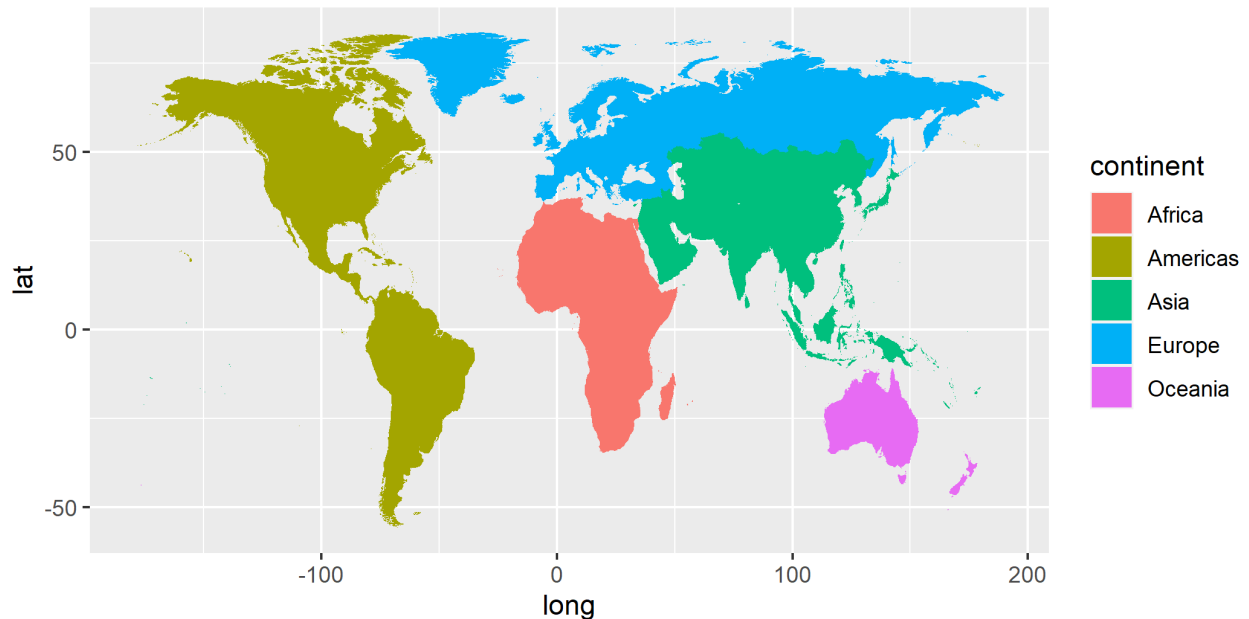
```
# Data structure
str(gapminder)

## tibble [1,704 × 6] (S3: tbl_df/tbl/data.frame)
##  $ country   : Factor w/ 142 levels "Afghanistan",...: 1 1 1 1 1 1 1 1 1 1
##  $ continent: Factor w/ 5 levels "Africa","Americas",...: 3 3 3 3 3 3 3 3 3 3
##  $ year      : int [1:1704] 1952 1957 1962 1967 1972 1977 1982 1987 1992
##  $ lifeExp   : num [1:1704] 28.8 30.3 32 34 36.1 ...
##  $ pop       : int [1:1704] 8425333 9240934 10267083 11537966 13079460
##  $ gdpPercap: num [1:1704] 779 821 853 836 740 ...
```

This version of the **gapminder** dataset contains information for **142 countries**, divided in to **5 continents**.

## Gapminder world regions

Five regions in the `continent` variable of `gapminder`



```
# Data summary
summary(gapminder)
```

```
##           country           continent           year           lifeExp           pop
gdpPercap
## Afghanistan: 12    Africa    :624    Min.      :1952    Min.      :23.60    Min.
:6.001e+04    Min.      : 241.2
## Albania      : 12    Americas:300    1st Qu.:1966    1st Qu.:48.20    1st
Qu.:2.794e+06    1st Qu.: 1202.1
## Algeria      : 12    Asia     :396    Median :1980    Median :60.71    Median
:7.024e+06    Median : 3531.8
## Angola       : 12    Europe   :360    Mean    :1980    Mean    :59.47    Mean
:2.960e+07    Mean    : 7215.3
## Argentina    : 12    Oceania  : 24    3rd Qu.:1993    3rd Qu.:70.85    3rd
Qu.:1.959e+07    3rd Qu.: 9325.5
## Australia    : 12                    Max.      :2007    Max.      :82.60    Max.
:1.319e+09    Max.      :113523.1
## (Other)      :1632
```

Data are recorded every 5 years from 1952 to 2007 (a total of 12 years).

Let's say we want to visualize the relationship between time (`year`) and life expectancy (`lifeExp`).

For now let's just focus on one country - United States. First, we need to create a new data frame with only the data from this country.

```
# Select US cases
gap_US <- dplyr::filter(gapminder,
                        country == "United States")

gap_US
```

#### REMINDER



The code above is covered in our course on Data Wrangling using the {dplyr} package. Data wrangling is the process of transforming and modifying existing data with the intent of making it more appropriate for analysis purposes. For example, this code segments used the `filter()` function to create a new data frame (`gap_US`) by choosing only a subset of rows of original `gapminder` data frame (only those that have “United States” in the `country` column).

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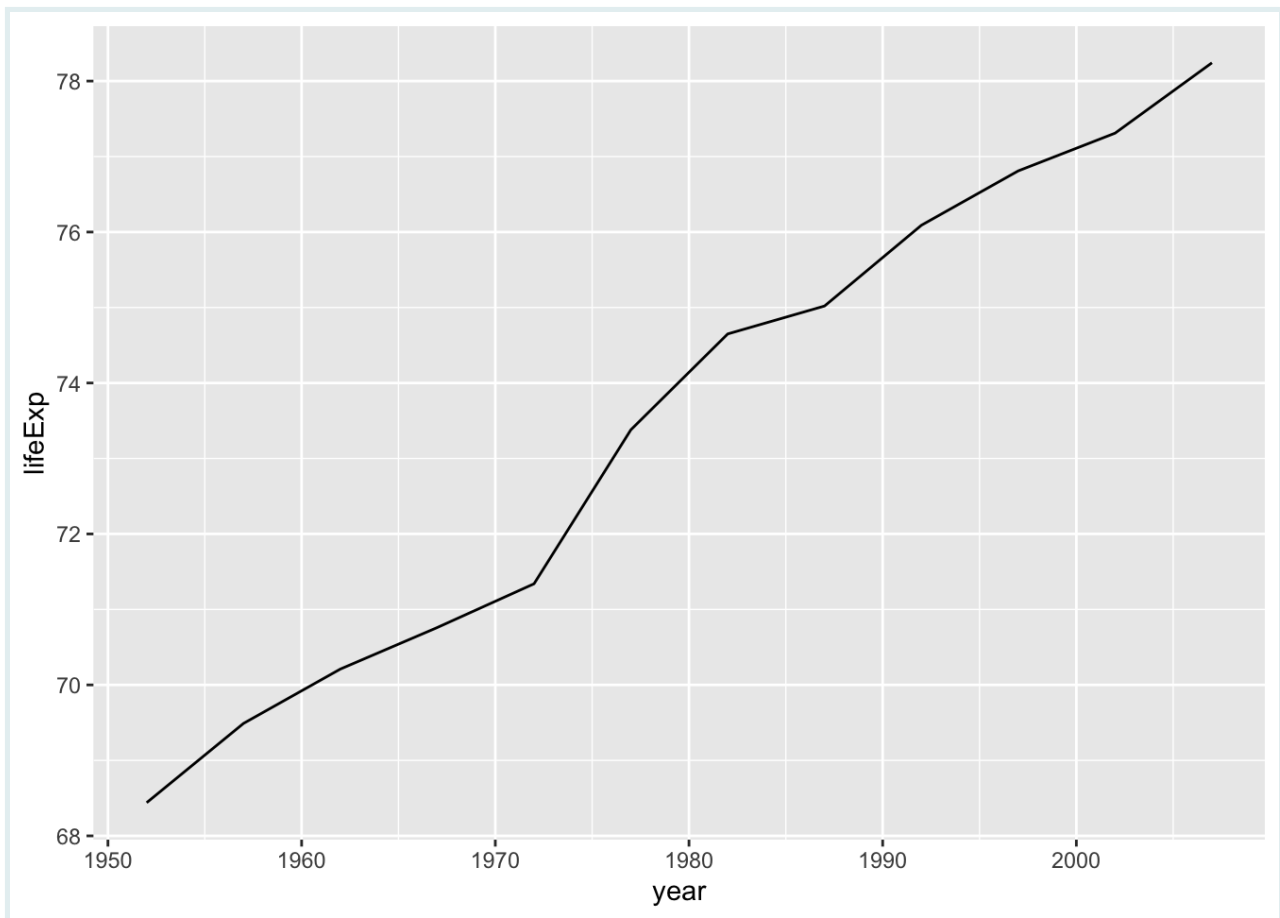
## Line graphs via `geom_line()`

Now we're ready to feed the `gap_US` data frame to `ggplot()`, mapping **time** in years on the horizontal x axis and **life expectancy** on the vertical y axis.

We can visualize this time series data by using `geom_line()` to create a line graph, instead of using `geom_point()` like we used previously to create scatterplots:

```
# Simple line graph
ggplot(data = gap_US,
       mapping = aes(x = year,
                     y = lifeExp)) +
  geom_line()
```





Much as with the `ggplot()` code that created the scatterplot of age and viral load with `geom_point()`, let's break down this code piece-by-piece in terms of the grammar of graphics:

Within the `ggplot()` function call, we specify two of the components of the grammar of graphics as arguments:

1. The data to be the `gap_US` data frame by setting `data = gap_US`.
2. The aesthetic mapping by setting `mapping = aes(x = year, y = lifeExp)`. Specifically, the variable `year` maps to the `x` position aesthetic, while the variable `lifeExp` maps to the `y` position aesthetic.

After telling R which data and aesthetic mappings we wanted to plot we then added the third essential component, the geometric object using the `+` sign. In this case, the geometric object was set to lines using `geom_line()`.

#### PRACTICE



Create a time series plot of the GDP per capita (`gdpPerCap`) recorded in the `gap_US` data frame by using `geom_line()` to create a line graph.

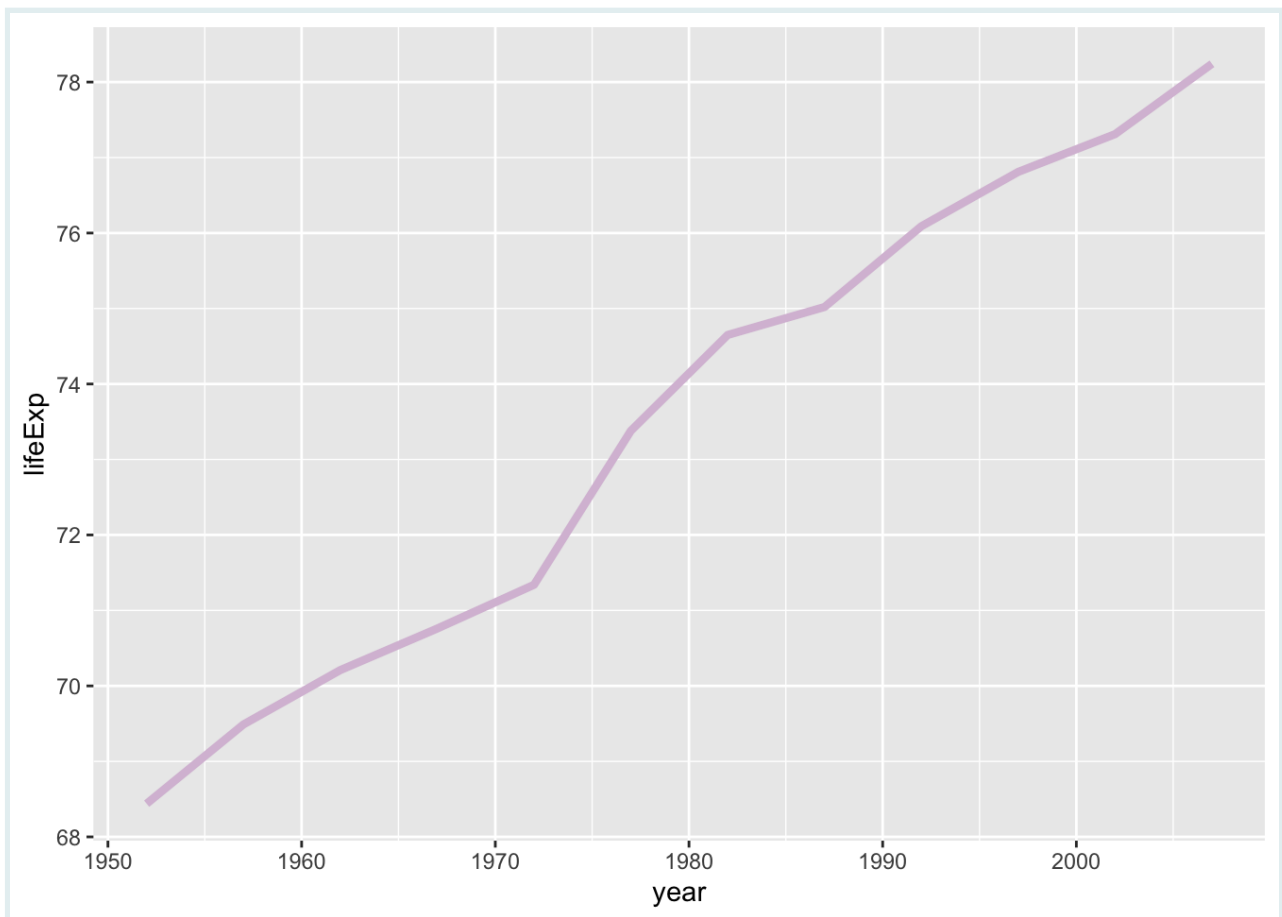
## Fixed aesthetics in `geom_line()`

The color, line width and line type of the line graph can be customized making use of `color`, `size` and `linetype` arguments, respectively.








We've changed the color and size of geoms in previous lessons.

Here we will add these as fixed aesthetics:

```
# enhanced line graph with color and size as fixed aesthetics
ggplot(data = gap_US,
       mapping = aes(x = year,
                     y = lifeExp)) +
  geom_line(color = "thistle",
           size = 1.5)
```

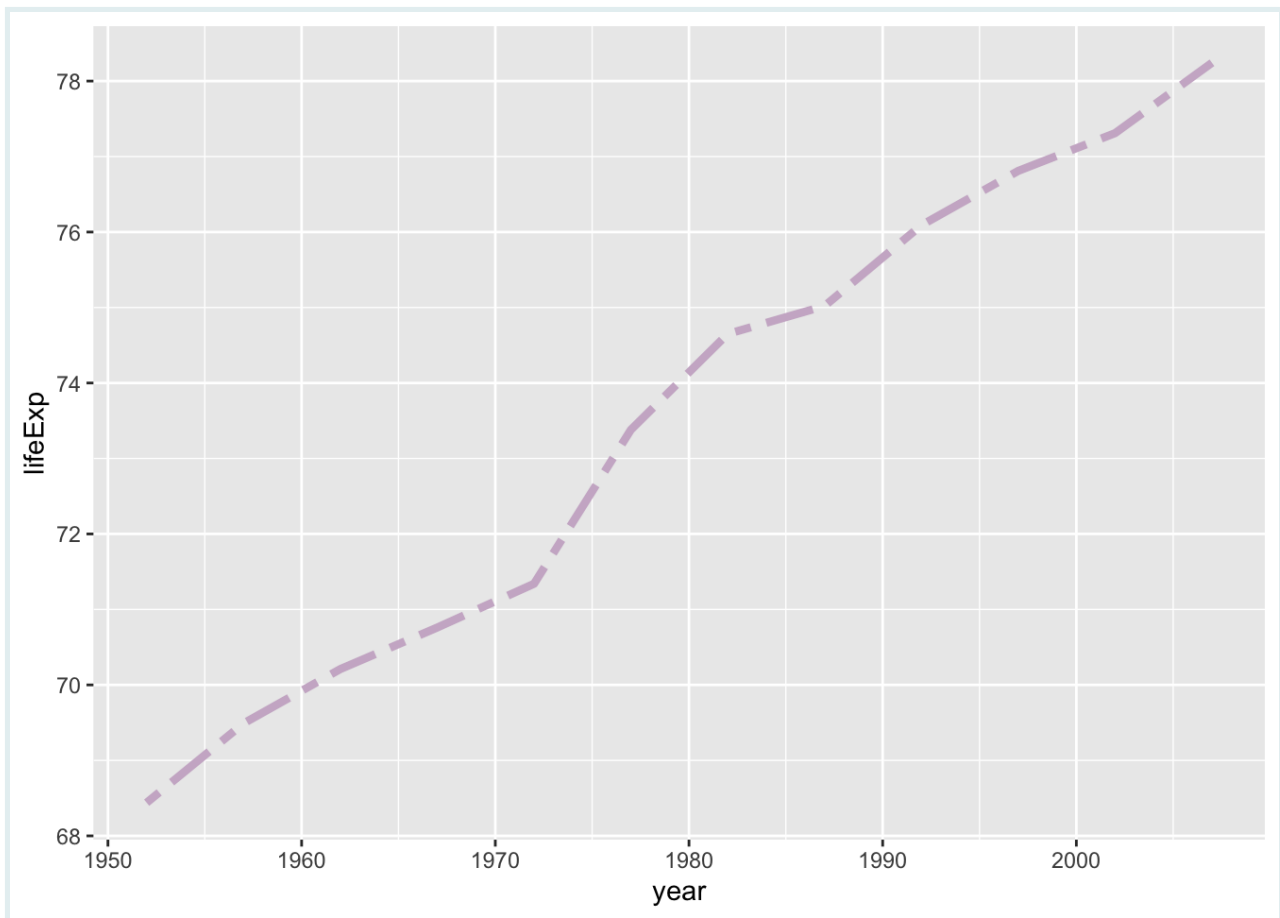


In this lesson we introduce a new fixed aesthetic that is specific to line graphs: `linetype` (or `lty` for short).

	lty = 0 or 'blank'
	lty = 1 or 'solid'
	lty = 2 or 'dashed'
	lty = 3 or 'dotted'
	lty = 4 or 'dotdash'
	lty = 5 or 'longdash'
	lty = 6 or 'twodash'

Line type can be specified using a name or with an integer. Valid line types can be set using a human readable character string: "blank", "solid", "dashed", "dotted", "dotdash", "longdash", and "twodash" are all understood by `linetype` or `lty`.

```
# Enhanced line graph with color, size, and line type as fixed aesthetics
ggplot(data = gap_US,
       mapping = aes(x = year,
                     y = lifeExp)) +
  geom_line(color = "thistle3",
            size = 1.5,
            linetype = "twodash")
```



In these line graphs, it can be hard to tell where exactly there data points are. In the next plot, we'll add points to make this clearer.

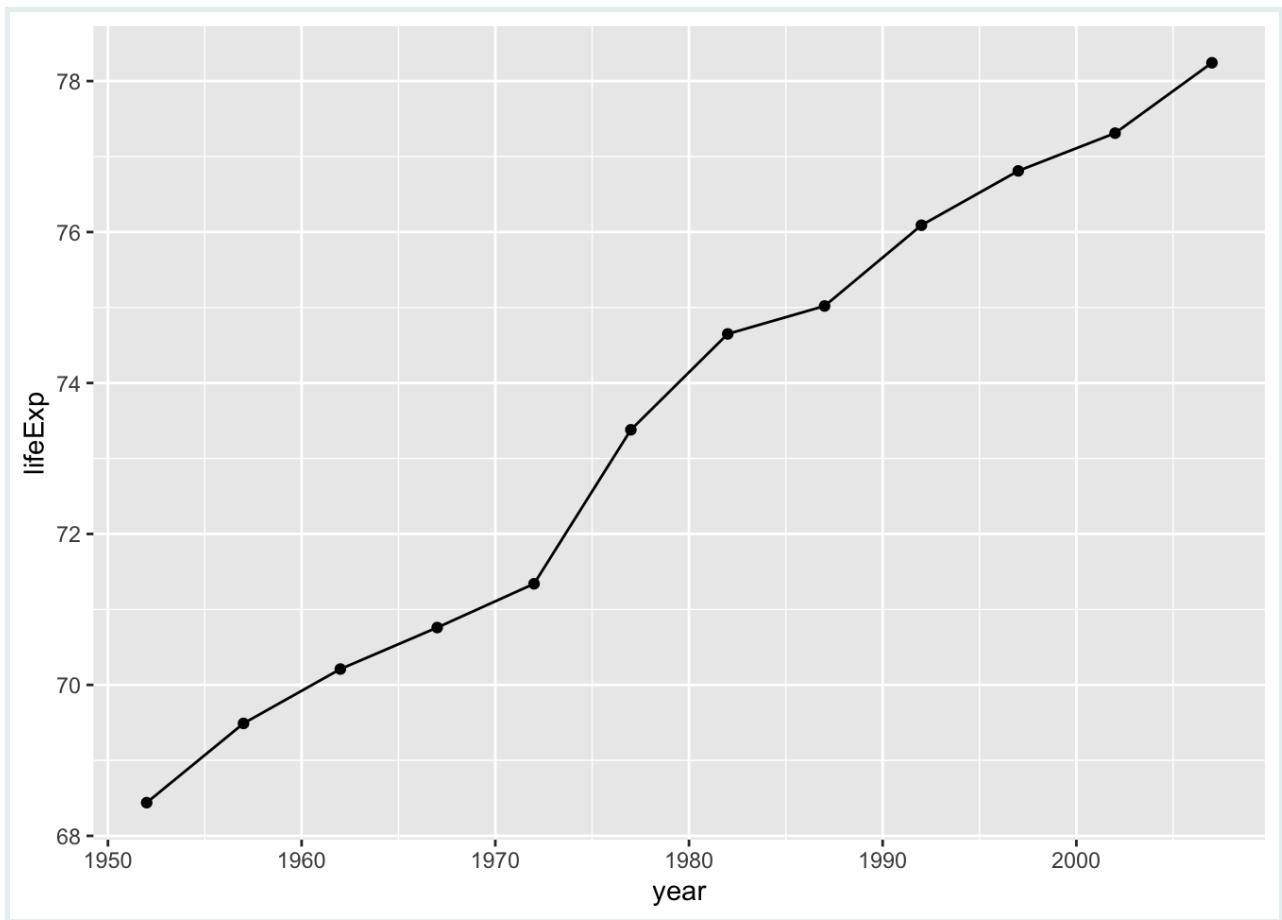
---

## Combining compatible geoms

As long as the geoms are compatible, we can layer them on top of one another to further customize a graph.

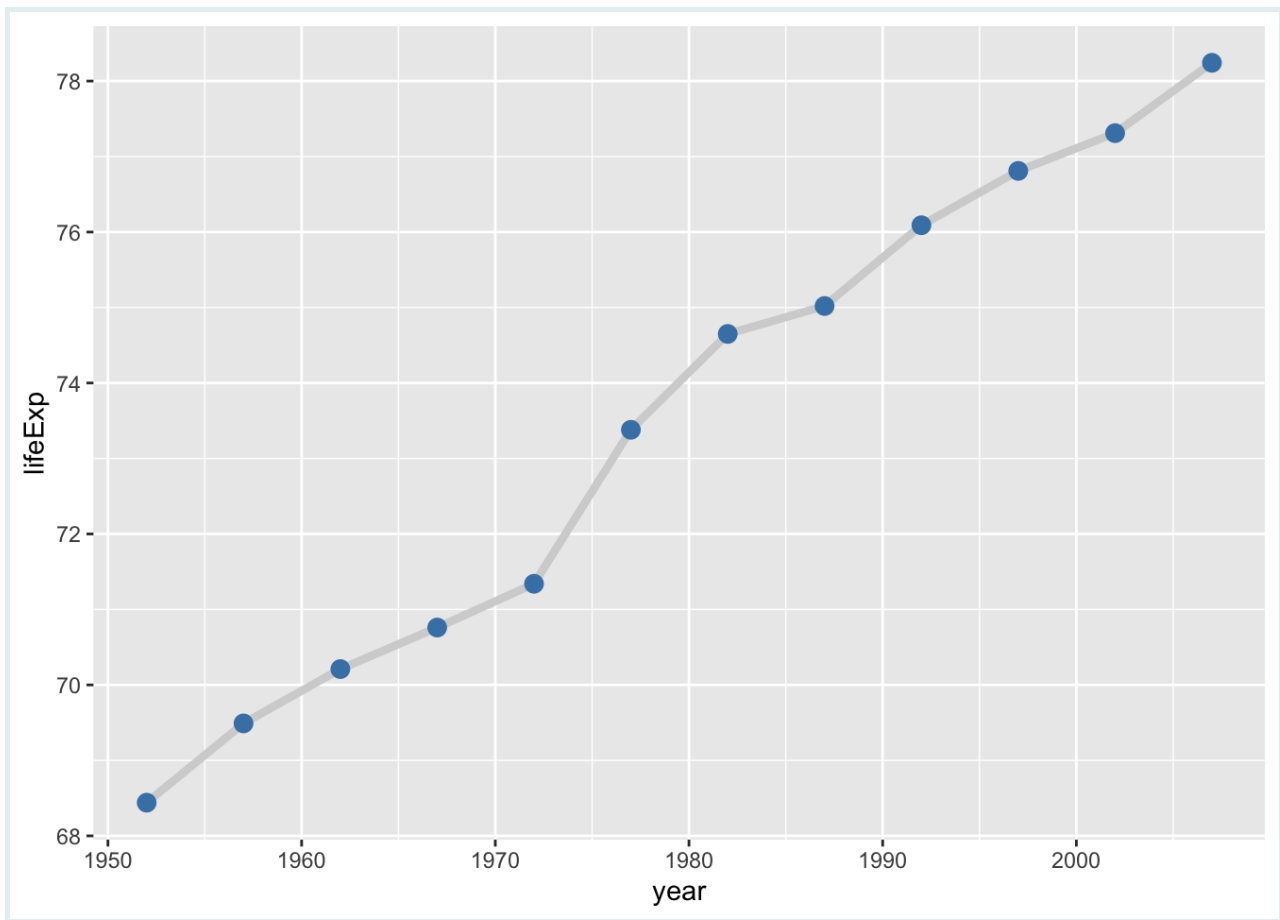
For example, we can add points to our line graph using the + sign to add a second `geom` layer with `geom_point()`:

```
# Simple line graph with points
ggplot(data = gap_US,
       mapping = aes(x = year,
                     y = lifeExp)) +
  geom_line() +
  geom_point()
```



We can create a more attractive plot by customizing the size and color of our geoms.

```
# Line graph with points and fixed aesthetics
ggplot(data = gap_US,
       mapping = aes(x = year,
                     y = lifeExp)) +
  geom_line(size = 1.5,
           color = "lightgrey") +
  geom_point(size = 3,
            color = "steelblue")
```



### PRACTICE



(in RMD)

Building on the code above, visualize the relationship between time and **GPD per capita** from the `gap_US` data frame.

Use both points and lines to represent the data.

Change the line type of the line and the color of the points to any valid values of your choice.

## Mapping data to multiple lines

In the previous section, we only looked at data from one country, but what if we want to plot data for multiple countries and compare?

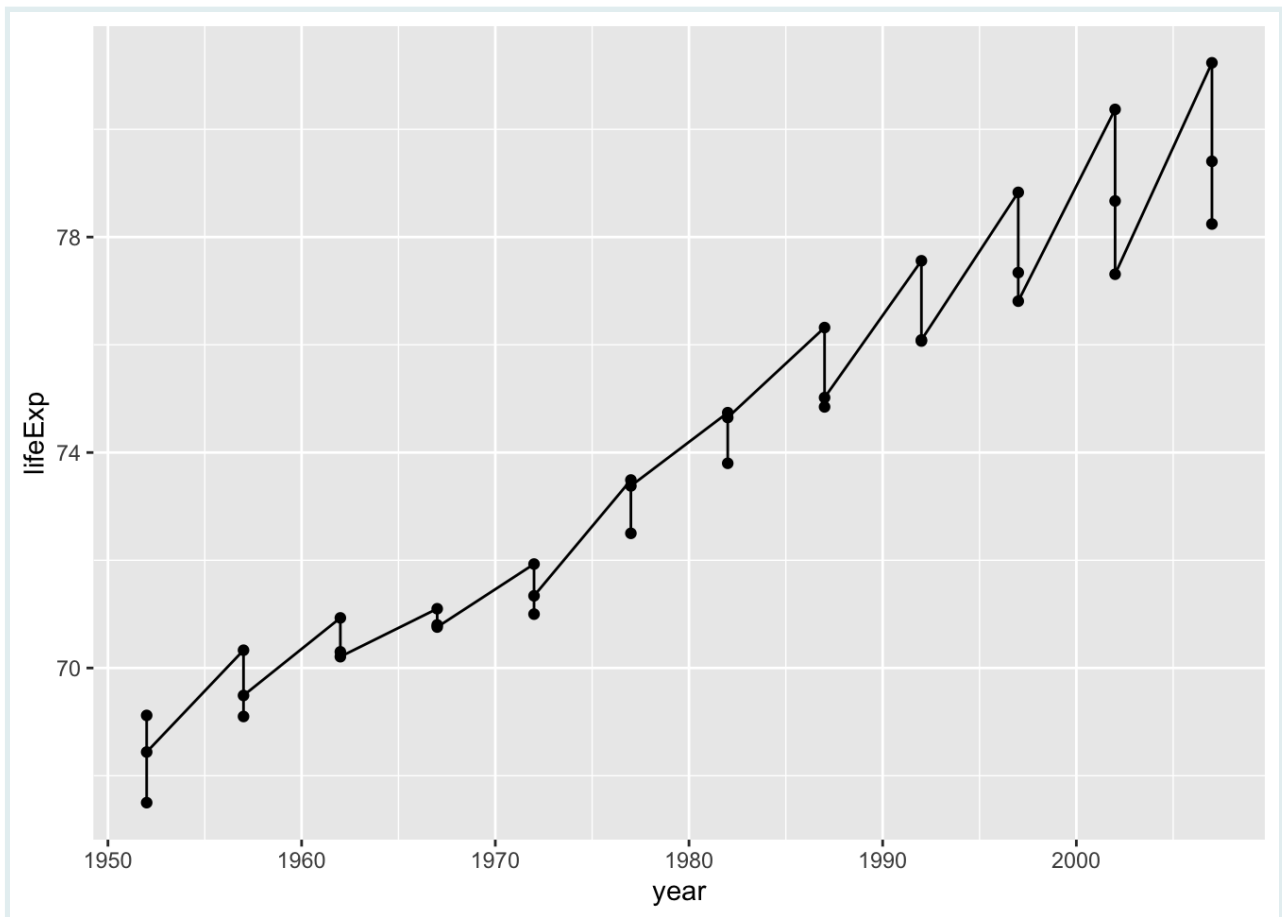
First let's add two more countries to our data subset:

```
# Create data subset for visualizing multiple categories
gap_mini <- filter(gapminder,
                   country %in% c("United States",
                                "Australia",
                                "Germany"))

gap_mini
```

If we simply enter it using the same code and change the data layer, the lines are not automatically separated by country:

```
# Line graph with no grouping aesthetic
ggplot(data = gap_mini,
       mapping = aes(y = lifeExp,
                     x = year)) +
  geom_line() +
  geom_point()
```

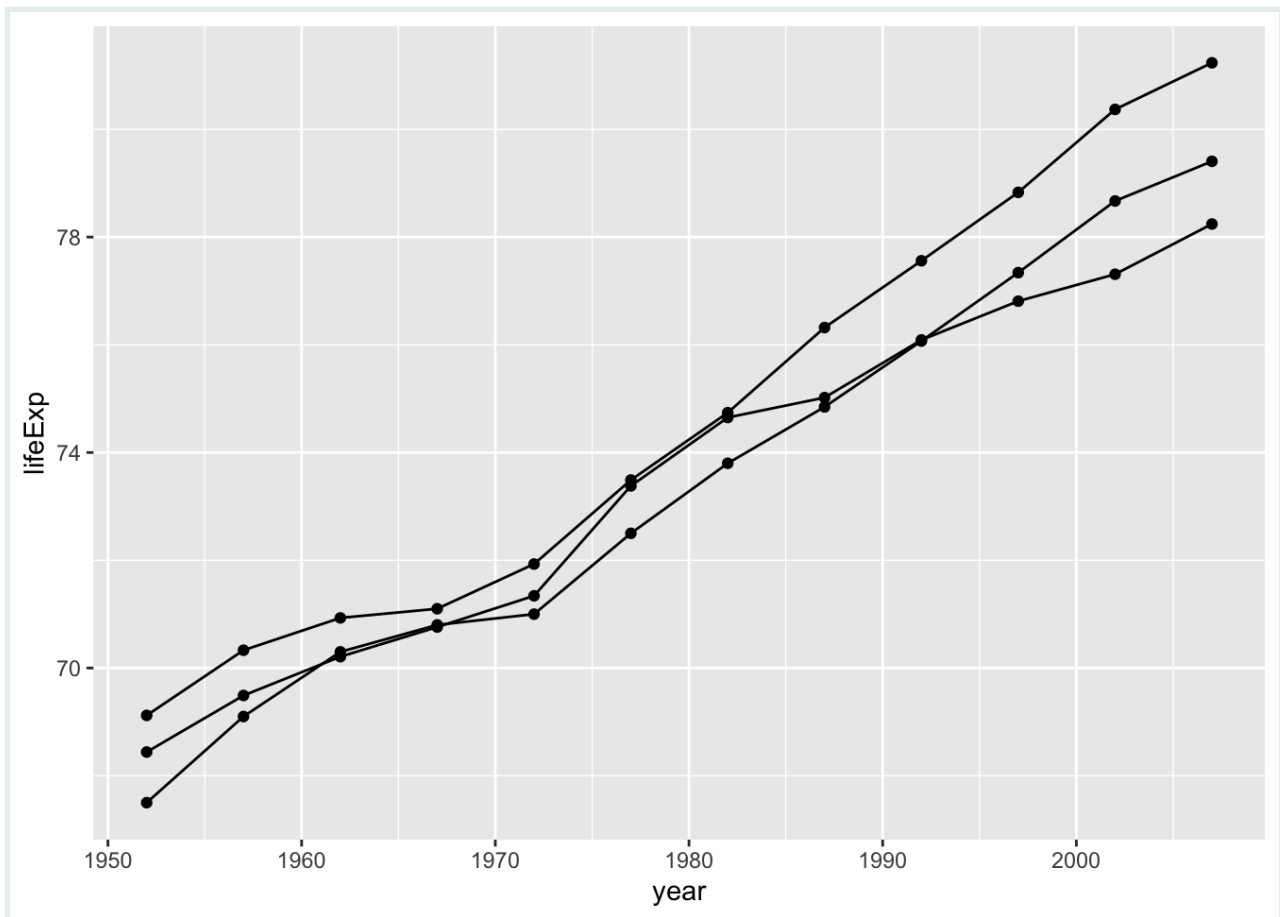


This is not a very helpful plot for comparing trends between groups.

To tell `ggplot()` to map the data from each country separately, we can use the `group` argument as an aesthetic mapping:

```
# Line graph with grouping by a categorical variable
ggplot(data = gap_mini,
       mapping = aes(y = lifeExp,
                     x = year,
                     group = country)) +

  geom_line() +
  geom_point()
```



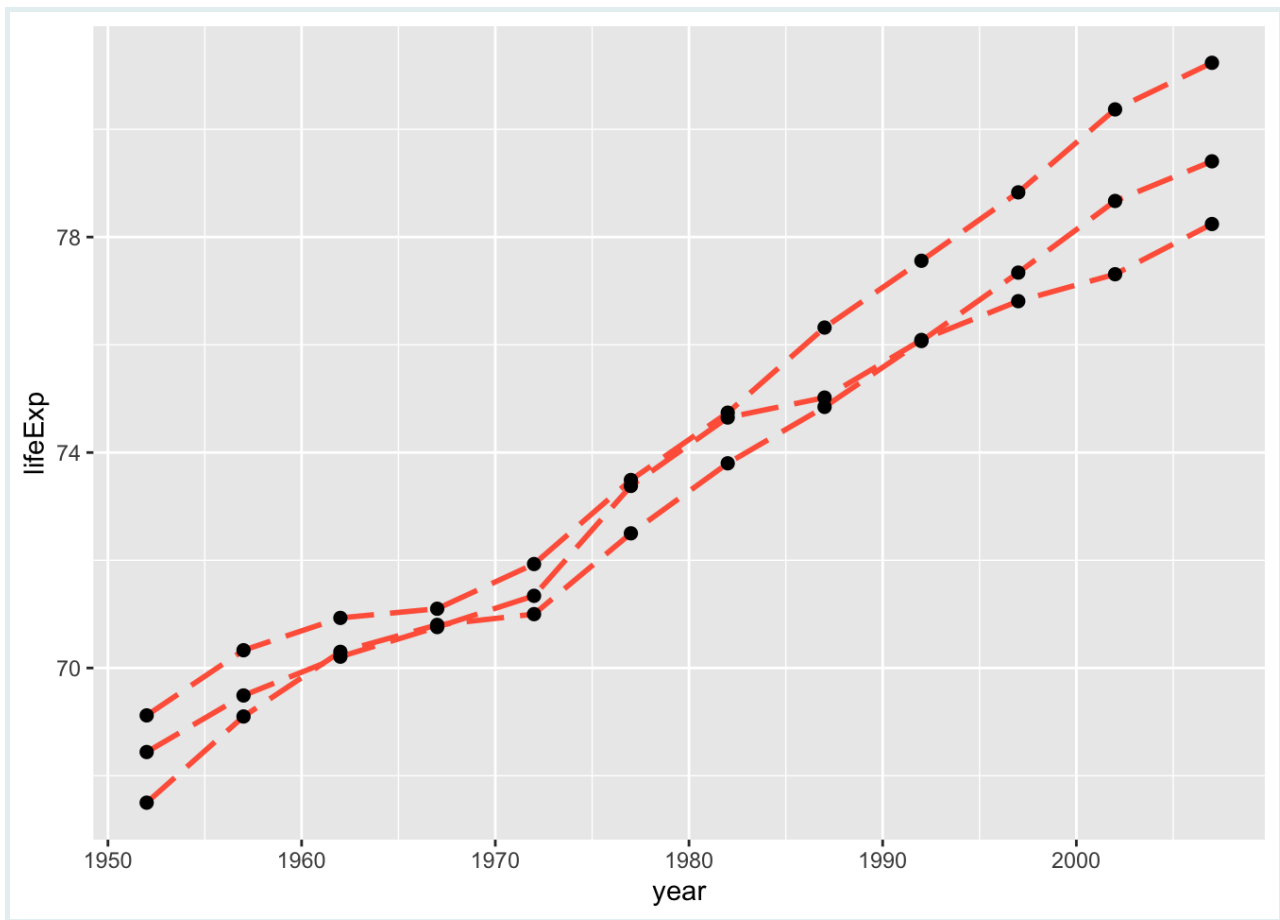
Now that the data is grouped by country, we have 3 separate lines - one for each level of the `country` variable.

We can also apply fixed aesthetics to the geometric layers.

```
# Applying fixed aesthetics to multiple lines
ggplot(data = gap_mini,
       mapping = aes(y = lifeExp,
                     x = year,
                     group = country)) +

  geom_line(linetype="longdash",      # set line type
           color="tomato",            # set line color
           size=1) +                  # set line size
  geom_point(size = 2)                # set point size
```

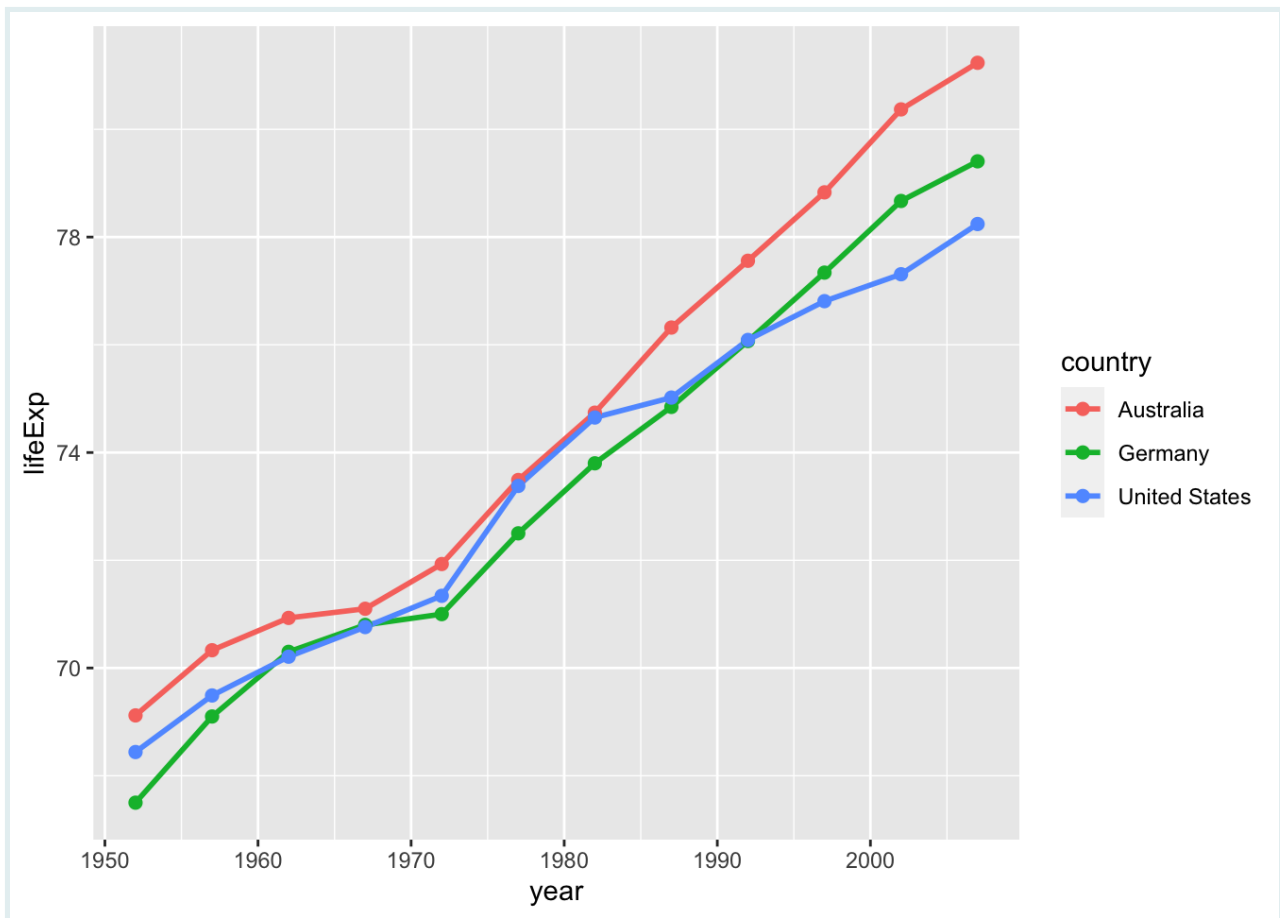




In the graphs above, line types, colors and sizes are the same for the three groups.

This doesn't tell us which is which though. We should add an aesthetic mapping that can help us identify which line belongs to which country, like color or line type.

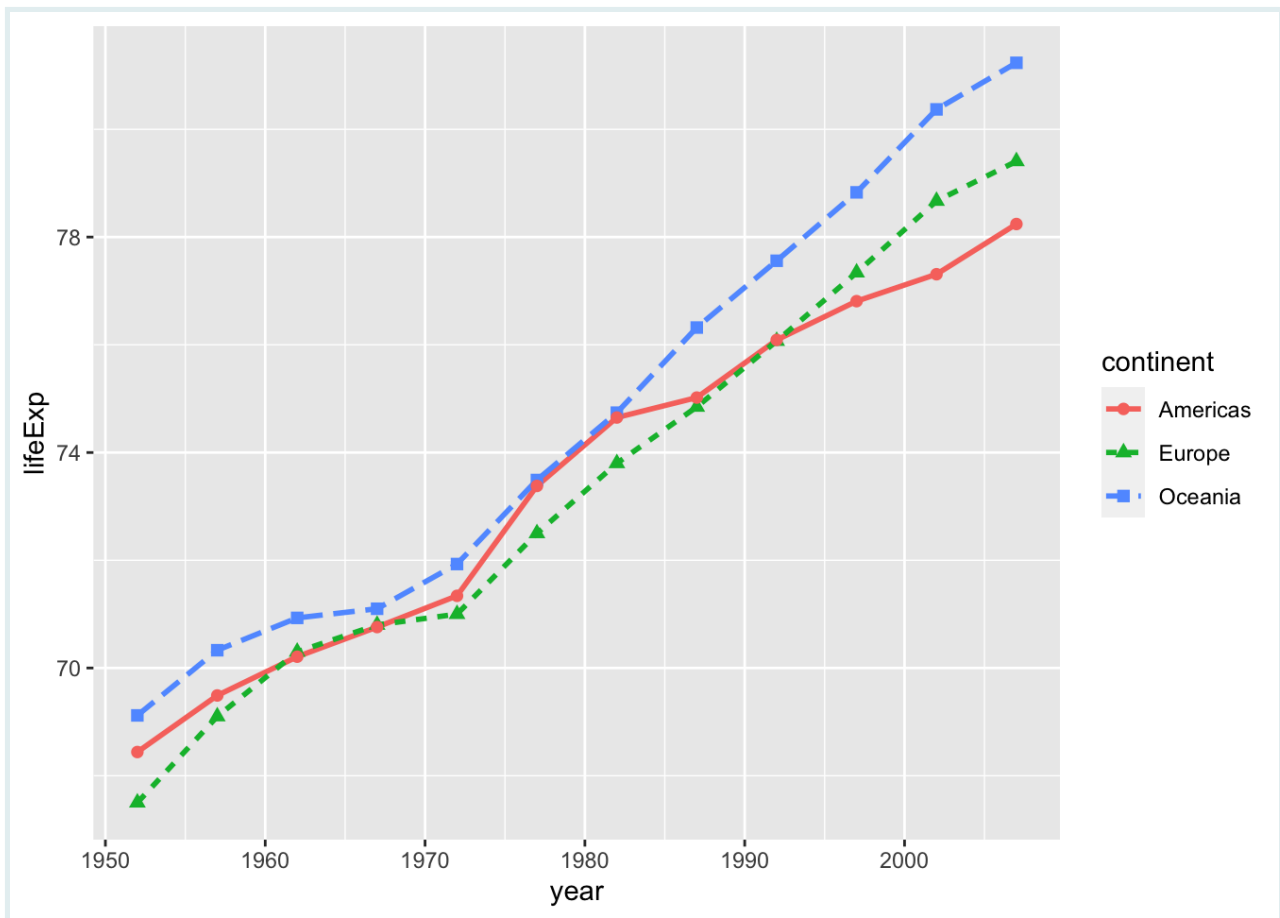
```
# Map country to color
ggplot(data = gap_mini,
       mapping = aes(y = lifeExp, x = year,
                     group = country,
                     color = country)) +
  geom_line(size = 1) +
  geom_point(size = 2)
```



Aesthetic mappings specified within `ggplot()` function call are passed down to subsequent layers.

Instead of grouping by `country`, we can also group by `continent`:

```
# Map continent to color, line type, and shape
ggplot(data = gap_mini,
       mapping = aes(x = year,
                     y = lifeExp,
                     color = continent,
                     lty = continent,
                     shape = continent)) +
  geom_line(size = 1) +
  geom_point(size = 2)
```



When given multiple mappings and geoms, {ggplot2} can discern which mappings apply to which geoms.

Here `color` was inherited by both points and lines, but `lty` was ignored by `geom_point()` and `shape` was ignored by `geom_line()`, since they don't apply.

## Challenge

Mappings can either go in the `ggplot()` function or in `geom_*()` layer.

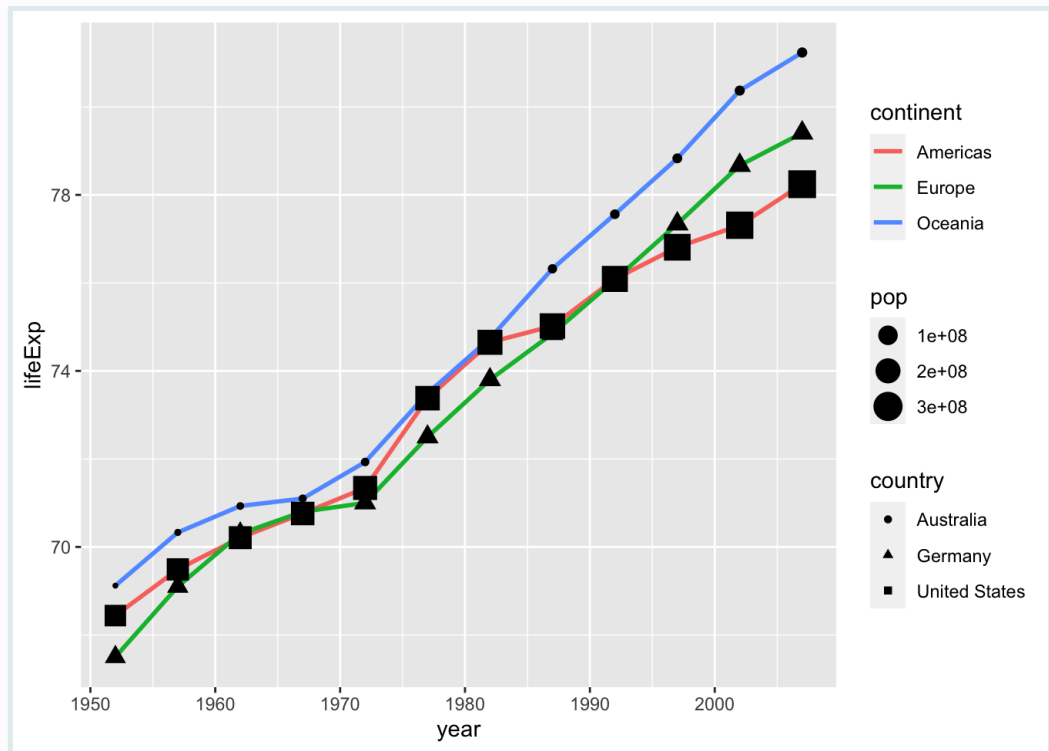
### CHALLENGE



For example, aesthetic mappings can go in `geom_line()` and will only be applied to that layer:

```
ggplot(data = gap_mini,
       mapping = aes(x = year,
                     y = lifeExp)) +
  geom_line(size = 1, mapping = aes(color = continent)) +
  geom_point(mapping = aes(shape = country,
                          size = pop))
```

### CHALLENGE

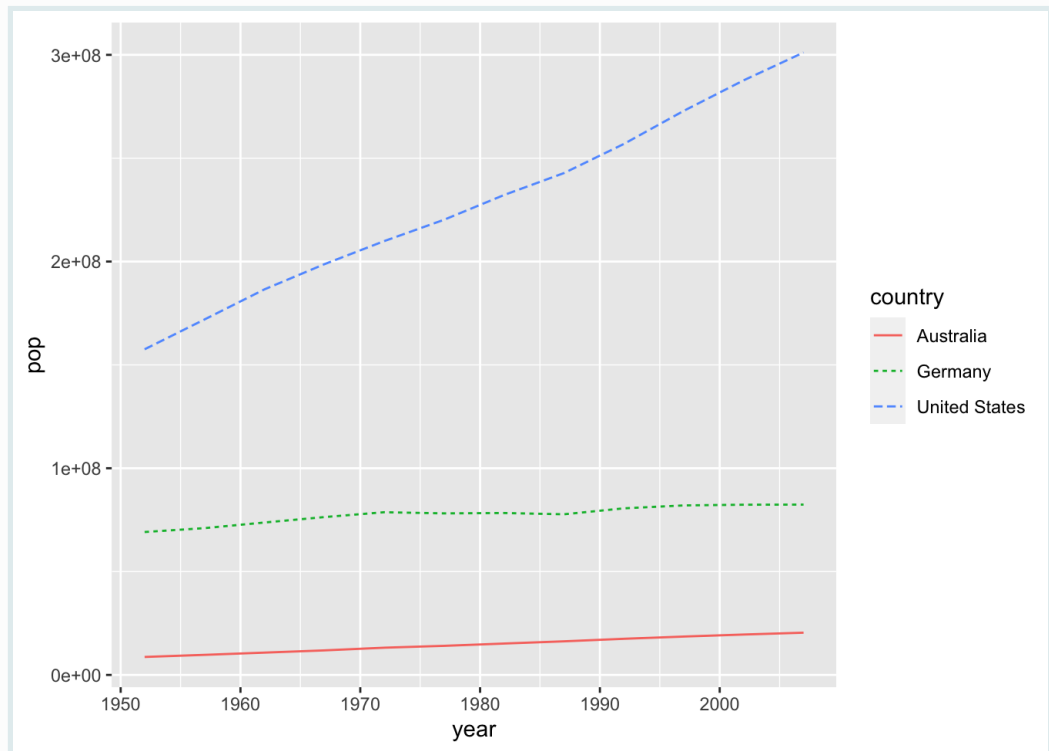


Try adding `mapping = aes()` in `geom_point()` and map `continent` to any valid aesthetic!

### PRACTICE



Using the `gap_mini` data frame, create a **population** growth chart with these aesthetic mappings:

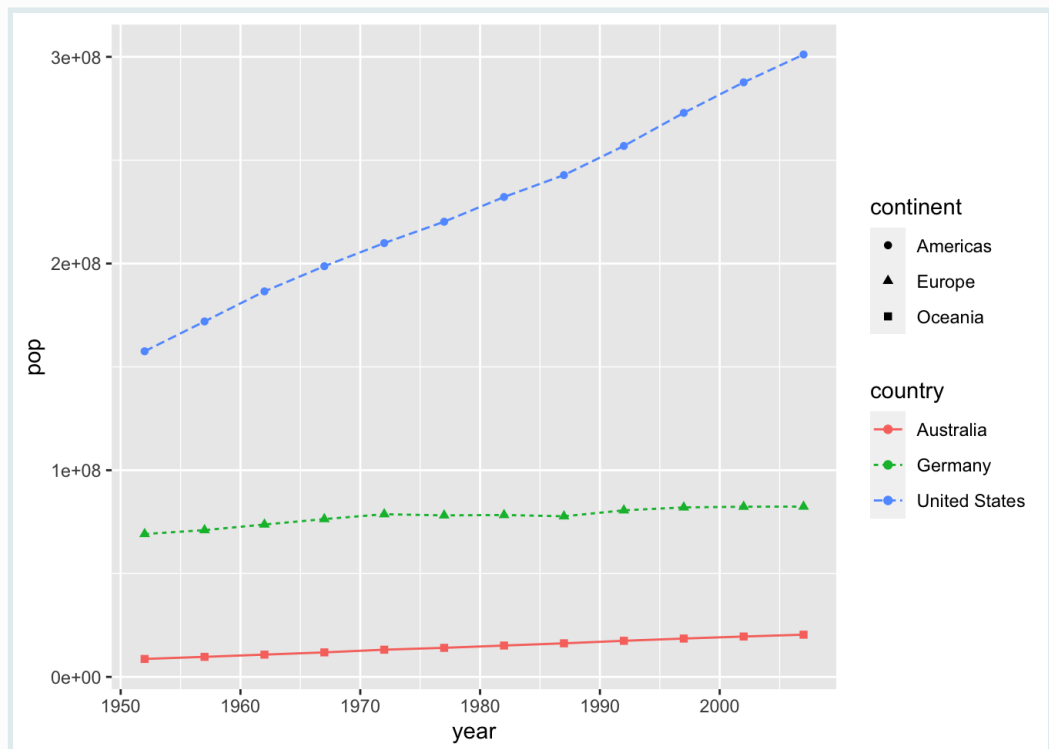


## PRACTICE



(in RMD)

Next, add a layer of points to the previous plot, and add the required aesthetic mappings to produce a plot that looks like this:

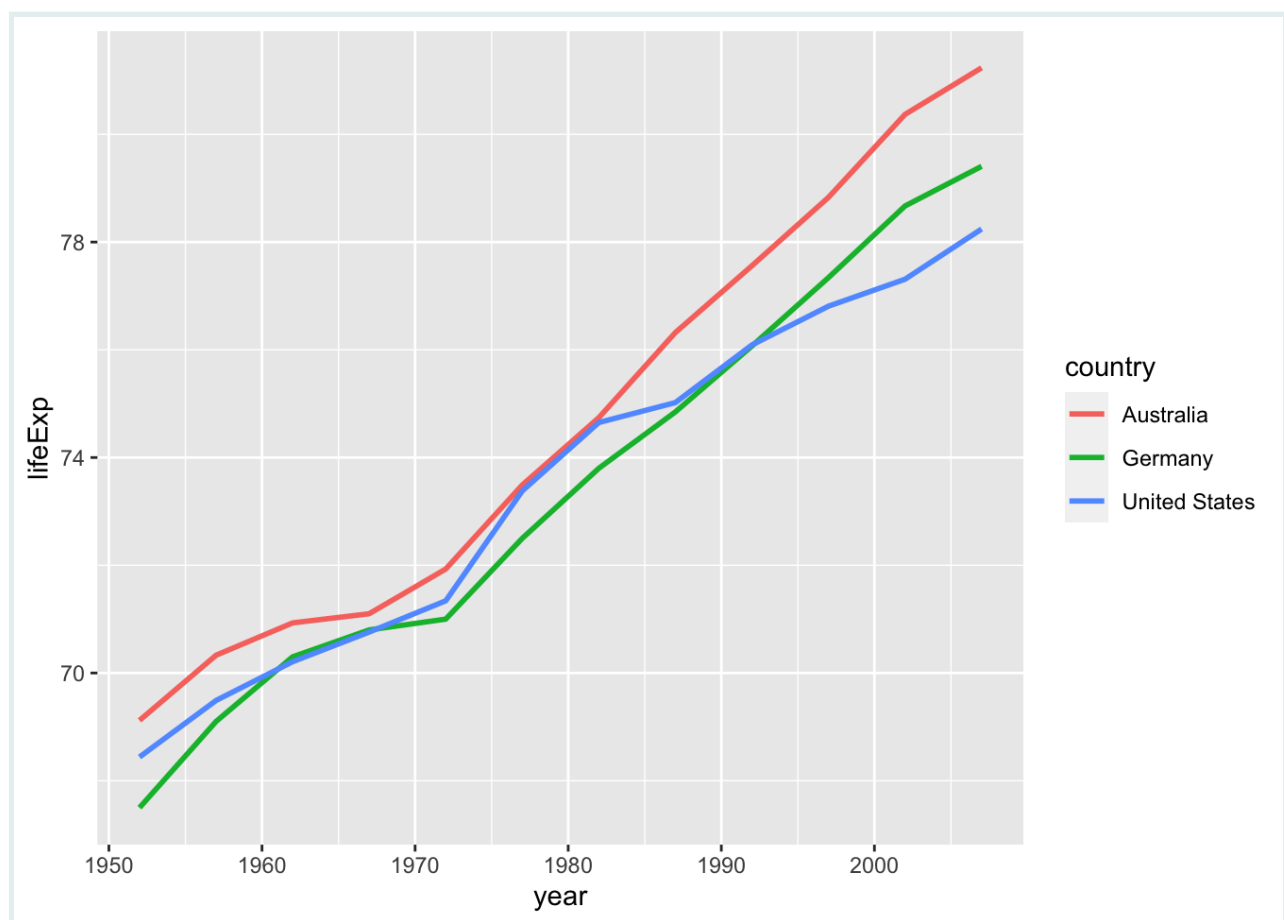


Don't worry about any fixed aesthetics, just make sure the mapping of data variables is the same.

## Modifying continuous x & y scales

{ggplot2} automatically scales variables to an aesthetic mapping according to type of variable it's given.

```
# Automatic scaling for x, y, and color
ggplot(data = gap_mini,
       mapping = aes(x = year,
                     y = lifeExp,
                     color = country)) +
  geom_line(size = 1)
```



In some cases the we might want to transform the axis scaling for better visualization. We can customize these scales with the `scale_*()` family of functions.

```
ggplot(data = <DATAFRAME>,
       mapping = aes(<VARS TO MAP>)) +
  <GEOM_FUNCTION> () +
  stat = <STAT>, position = <POSITION> ) +
  <COORDINATE_FUNCTION> +
  <FACET_FUNCTION> +
  <SCALE_FUNCTION> +
  <THEME_FUNCTION>
```

Required

Not required, sensible defaults supplied

**scale\_x\_continuous()** and **scale\_y\_continuous()** are the default scale functions for continuous x and y aesthetics.

## GENERAL PURPOSE SCALES

Use with most aesthetics

**scale\_\*\_continuous()** - map cont' values to visual ones

**scale\_\*\_discrete()** - map discrete values to visual ones

**scale\_\*\_identity()** - use data values **as** visual ones

**scale\_\*\_manual(values = c())** - map discrete values to manually chosen visual ones

```
scale_*_date(date_labels = "%m/%d"), date_breaks = "2 weeks") - treat data values as dates.
```

**scale\_\*\_datetime()** - treat data x values as date times. Use same arguments as scale\_x\_date(). See ?strptime for label formats.

## X & Y LOCATION SCALES

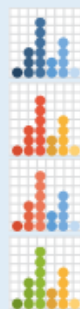
Use with x or y aesthetics (x shown here)

**scale\_x\_log10()** - Plot x on log10 scale

**scale\_x\_reverse()** - Reverse direction of x axis

**scale\_x\_sqrt()** - Plot x on square root scale

## COLOR AND FILL SCALES (CONTINUOUS)



```
o <- c + geom_dotplot(aes(fill = ..x..))
```

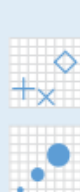
```
o + scale_fill_distiller(palette = "Blues")
```

```
o + scale_fill_gradient(low="red", high="yellow")
```

```
o + scale_fill_gradient2(low="red", high="blue",
mid = "white", midpoint = 25)
```

**o + scale\_fill\_gradientn(colours=topo.colors(6))**  
Also: rainbow(), heat.colors(), terrain.colors(),  
cm.colors(), RColorBrewer::brewer.pal()

## SHAPE AND SIZE SCALES



```
p <- e + geom_point(aes(shape = fl, size = cyl))
```

```
p + scale_shape() + scale_size()
```

```
p + scale_shape_manual(values = c(3:7))
```

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

**p + scale\_radius(range = c(1,6))**

```
p + scale_size_area(max_size = 6)
```

## Scale breaks

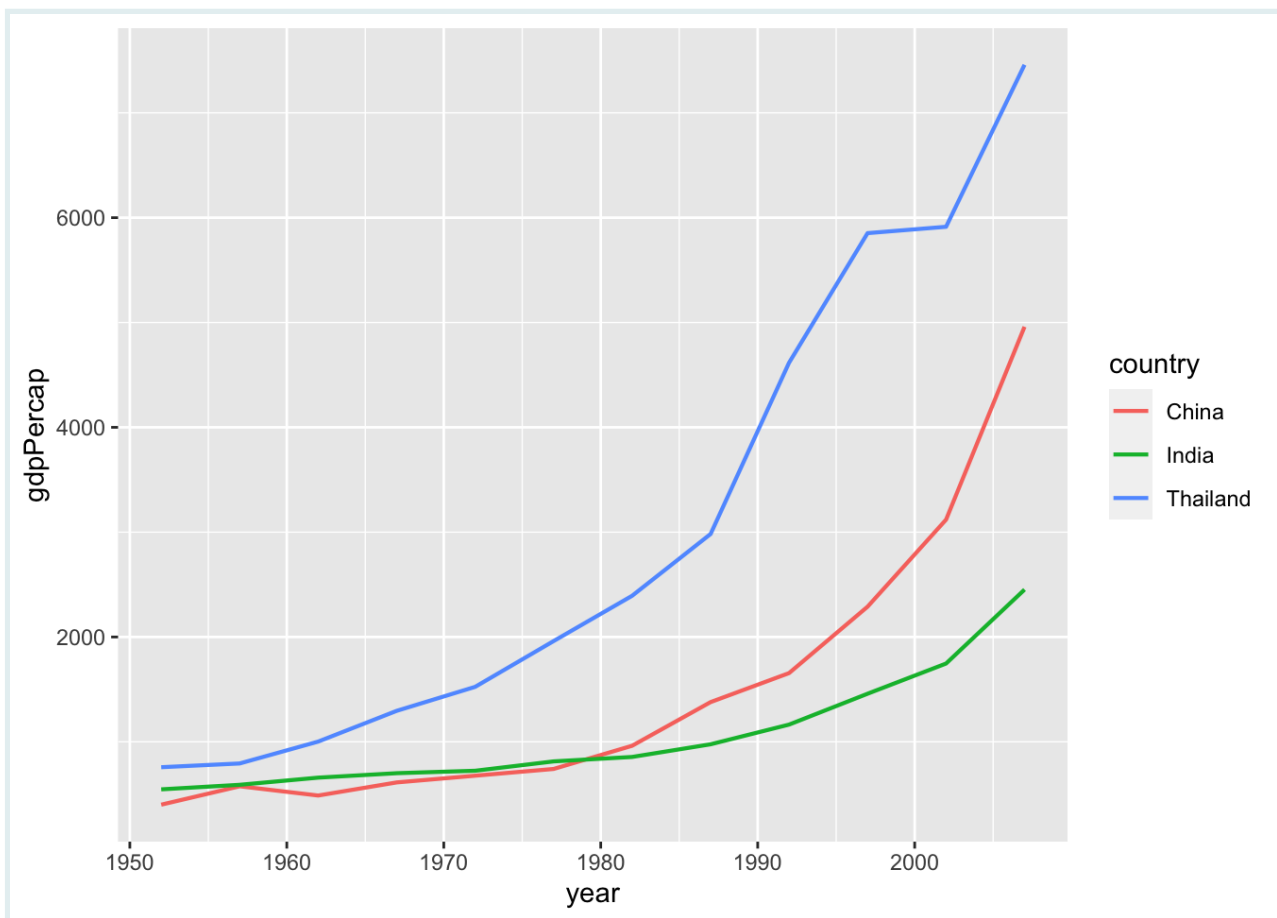
Let's create a new subset of countries from `gapminder`, and this time we will plot changes in GDP over time.

```
# Data subset to include India, China, and Thailand
gap_mini2 <- filter(gapminder,
```

```
"Thailand"))gap_mini2
```

Here we will change the y-axis mapping from `lifeExp` to `gdpPercap`:

```
ggplot(data = gap_mini2,  
       mapping = aes(x = year,  
                     y = gdpPercap,  
                     group = country,  
                     color = country)) +  
  geom_line(size = 0.75)
```



The x-axis labels for `year` in don't match up with the dataset.

```
gap_mini2$year %>% unique()
```

```
## [1] 1952 1957 1962 1967 1972 1977 1982 1987 1992 1997 2002 2007
```

We can specify exactly where to label the axis by providing a numeric vector.

```
# You can manually enter scale breaks (don't do this)
```



```
c(1952, 1957, 1962, 1967, 1972, 1977, 1982, 1987, 1992, 1997, 2002, 2007)
```

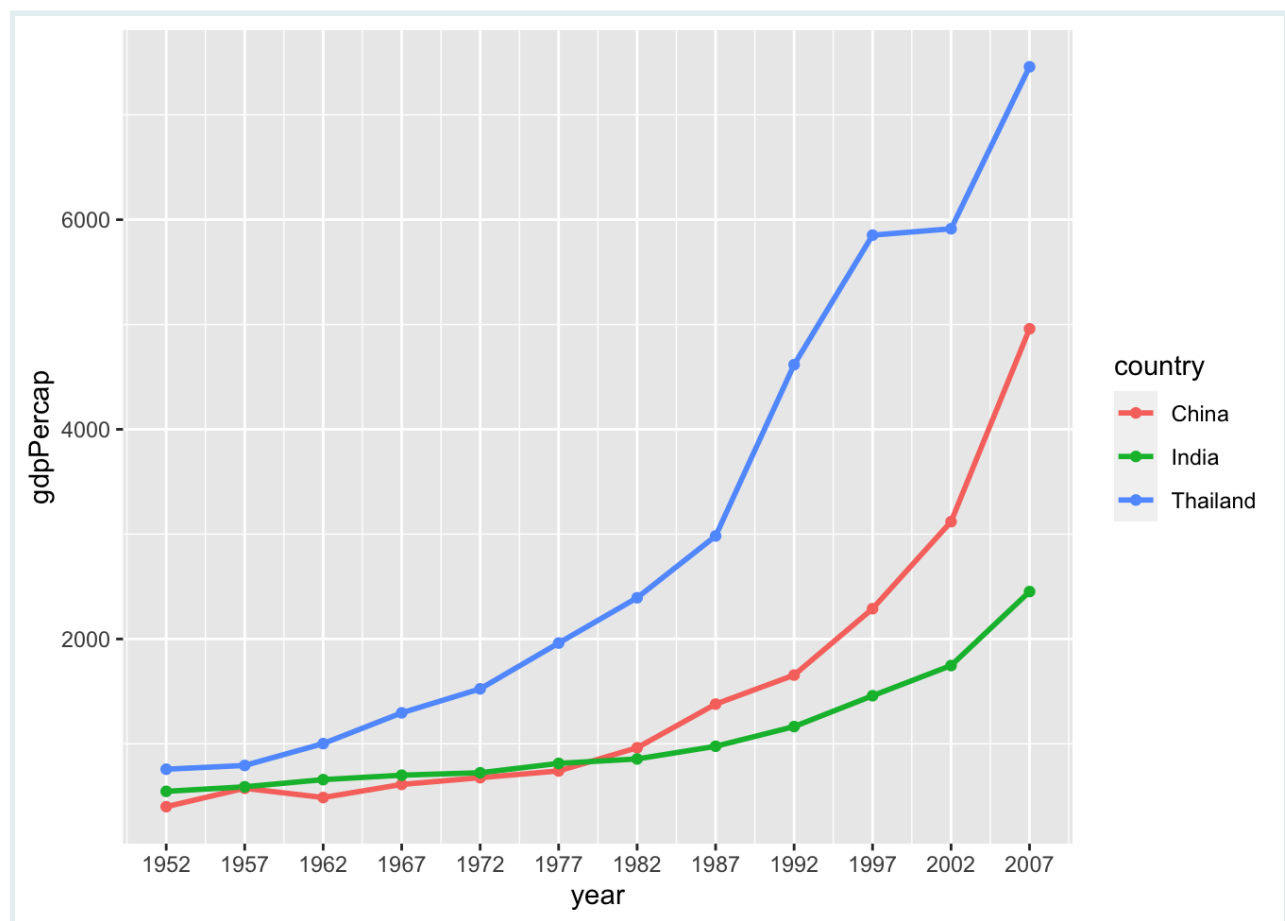
```
## [1] 1952 1957 1962 1967 1972 1977 1982 1987 1992 1997 2002 2007
```

```
# It's better to create the vector with seq()
seq(from = 1952, to = 2007, by = 5)
```

```
## [1] 1952 1957 1962 1967 1972 1977 1982 1987 1992 1997 2002 2007
```

Use `scale_x_continuous` to make the axis breaks match up with the dataset:

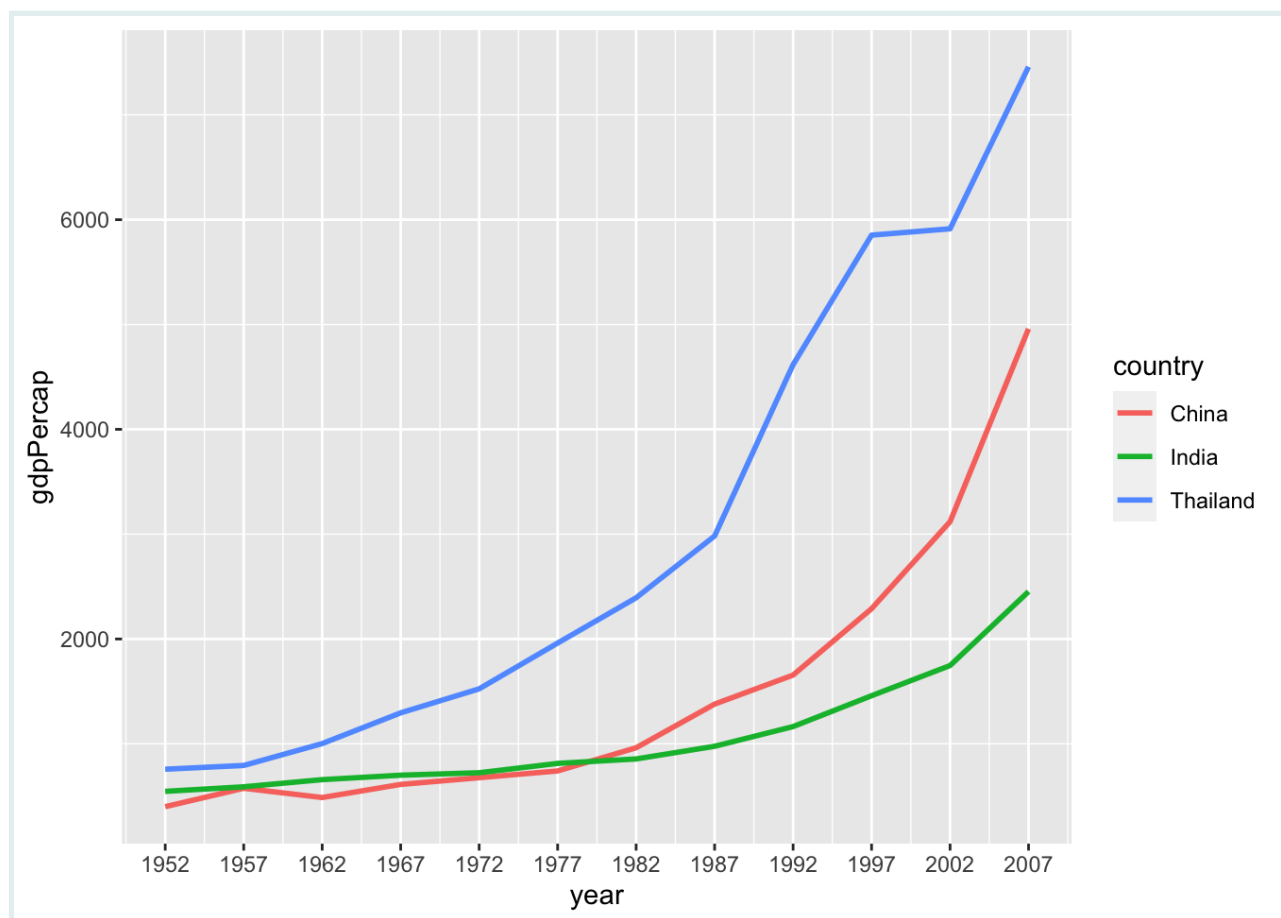
```
# Customize x-axis breaks with `scale_x_continuous(breaks = VECTOR)`
ggplot(data = gap_mini2,
       mapping = aes(x = year,
                     y = gdpPercap,
                     color = country)) +
  geom_line(size = 1) +
  scale_x_continuous(breaks = seq(from = 1952, to = 2007, by = 5)) +
  geom_point()
```



Store scale break values as an R object for easier reference:

```
# Store numeric vector to a named object
gap_years <- seq(from = 1952, to = 2007, by = 5)
```

```
# Replace seq() code with named vector
ggplot(data = gap_mini2,
       mapping = aes(x = year,
                     y = gdpPerCap,
                     color = country)) +
  geom_line(size = 1) +
  scale_x_continuous(breaks = gap_years)
```



#### PRACTICE

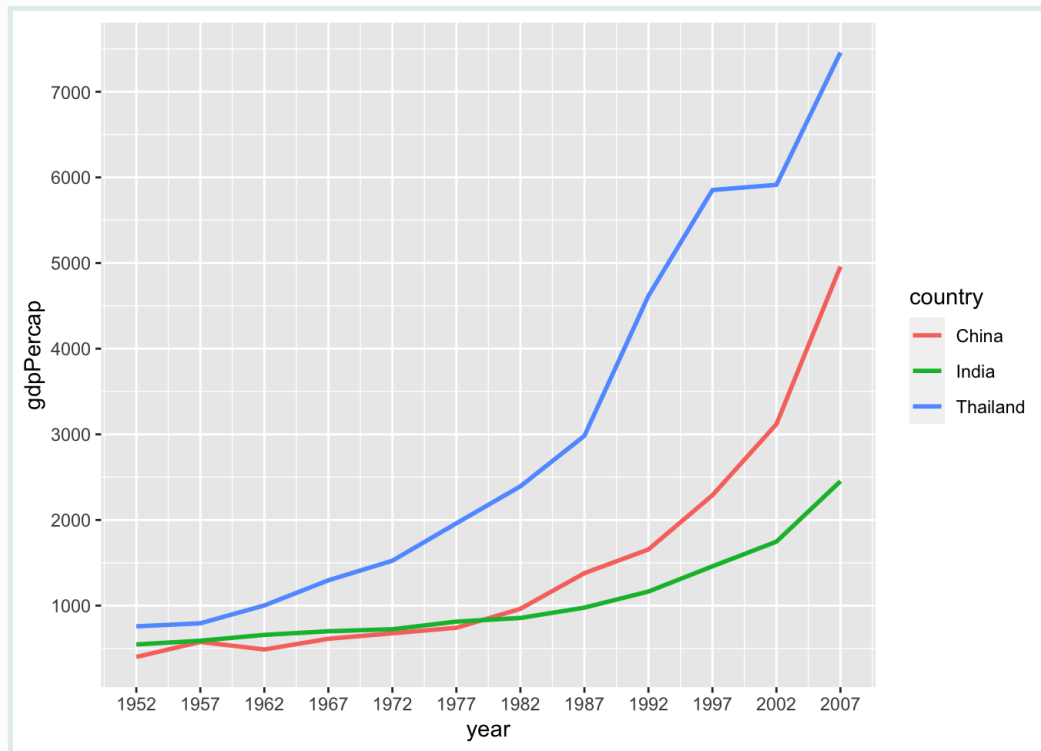


(in RMD)

We can customize scale breaks on a continuous **y**-axis values with `scale_y_continuous()`.

Copy the code from the last example, and add `scale_y_continuous()` to add the following y-axis breaks:

## PRACTICE



## Logarithmic scaling

In the last two mini sets, I chose three countries that had similar range of GDP or life expectancy for good scaling and readability so that we can make out these changes.

But if we add a country to the group that significantly differs, default scaling is not so great.

We'll look at an example plot where you may want to rescale the axes from linear to a log scale.

Let's add New Zealand to the previous set of countries and create `gap_mini3`:

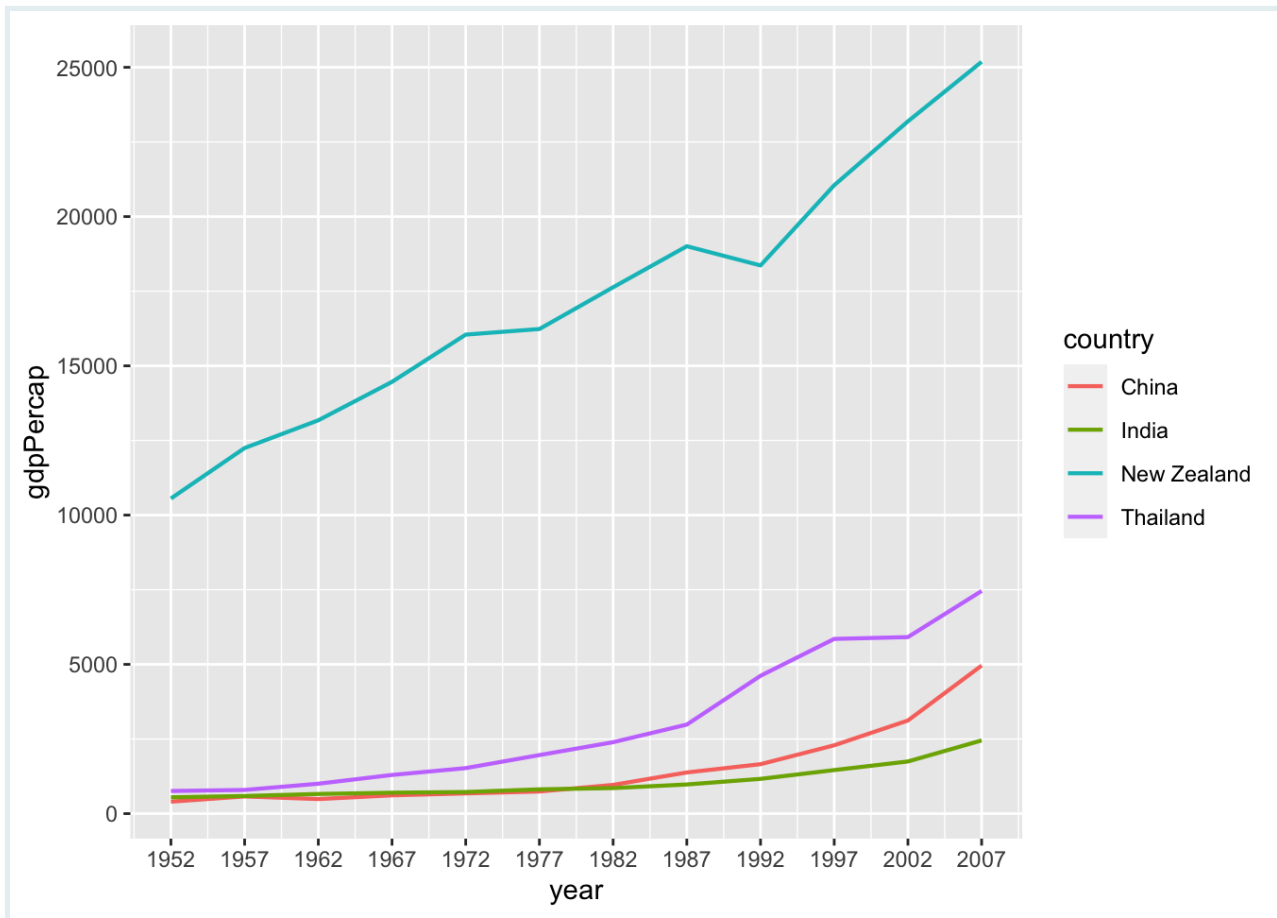
```
# Data subset to include India, China, Thailand, and New Zealand
gap_mini3 <- filter(gapminder,
  country %in% c("India",
    "China",
    "Thailand",
    "New Zealand"))

gap_mini3
```

Now we will recreate the plot of GDP over time with the new data subset:

```
ggplot(data = gap_mini3,
  mapping = aes(x = year,
    y = gdpPerCap,
```

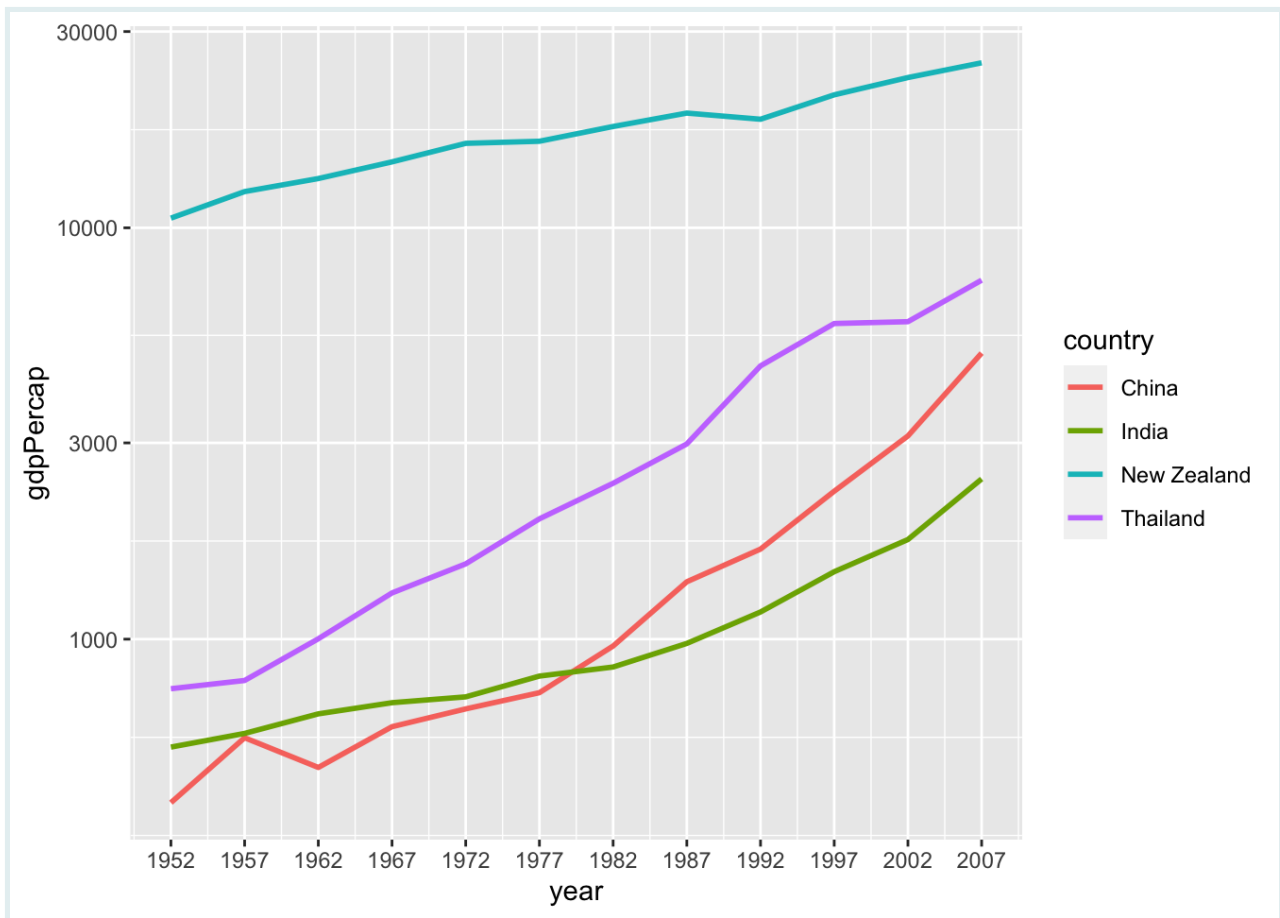
```
color = country)) + geom_line(size = 0.75) +
scale_x_continuous(breaks = gap_years)
```



The curves for India and China show an exponential increase in GDP per capita. However, the y-axis values for these two countries are much lower than that of New Zealand, so the lines are a bit squashed together. This makes the data hard to read. Additionally, the large empty area in the middle is not a great use of plot space.

We can address this by log-transforming the y-axis using `scale_y_log10()`, which log-scales the y-axis (as the name suggests). We will add this function as a new layer after a `+` sign, as usual:

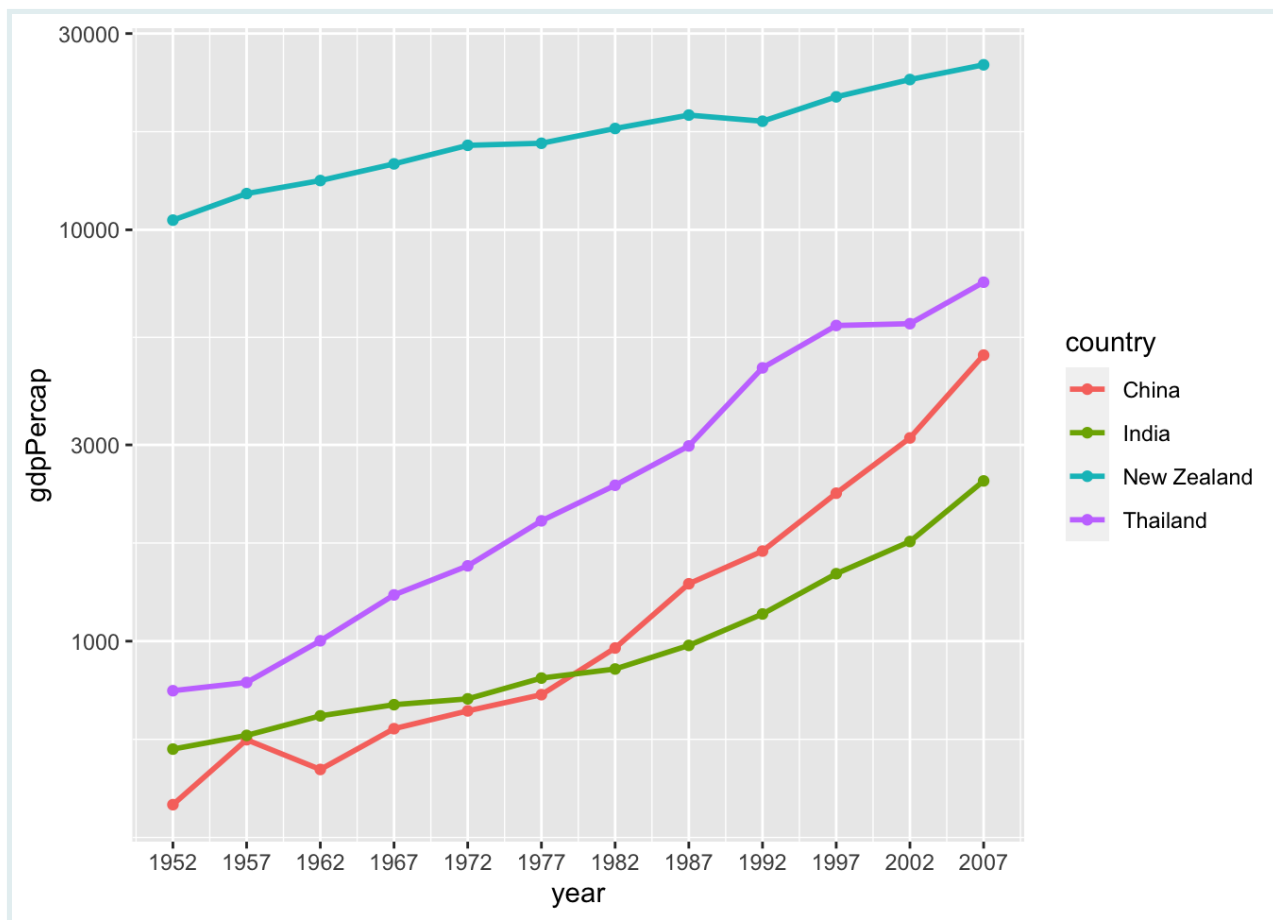
```
# Add scale_y_log10()
ggplot(data = gap_mini3,
       mapping = aes(x = year,
                     y = gdpPerCap,
                     color = country)) +
  geom_line(size = 1) +
  scale_x_continuous(breaks = gap_years) +
  scale_y_log10()
```



Now the y-axis values are rescaled, and the scale break labels tell us that it is nonlinear.

We can add a layer of points to make this clearer:

```
ggplot(data = gap_mini3,
       mapping = aes(x = year,
                     y = gdpPerCap,
                     color = country)) +
  geom_line(size = 1) +
  scale_x_continuous(breaks = gap_years) +
  scale_y_log10() +
  geom_point()
```



### PRACTICE



First subset `gapminder` to only the rows containing data for **Uganda**:

Now, use `gap_Uganda` to create a time series plot of population (`pop`) over time (`year`). Transform the y axis to a log scale, edit the scale breaks to `gap_years`, change the line color to `forestgreen` and the size to 1mm.

Next, we can change the text of the axis labels to be more descriptive, as well as add titles, subtitles, and other informative text to the plot.

## Labeling with `labs()`

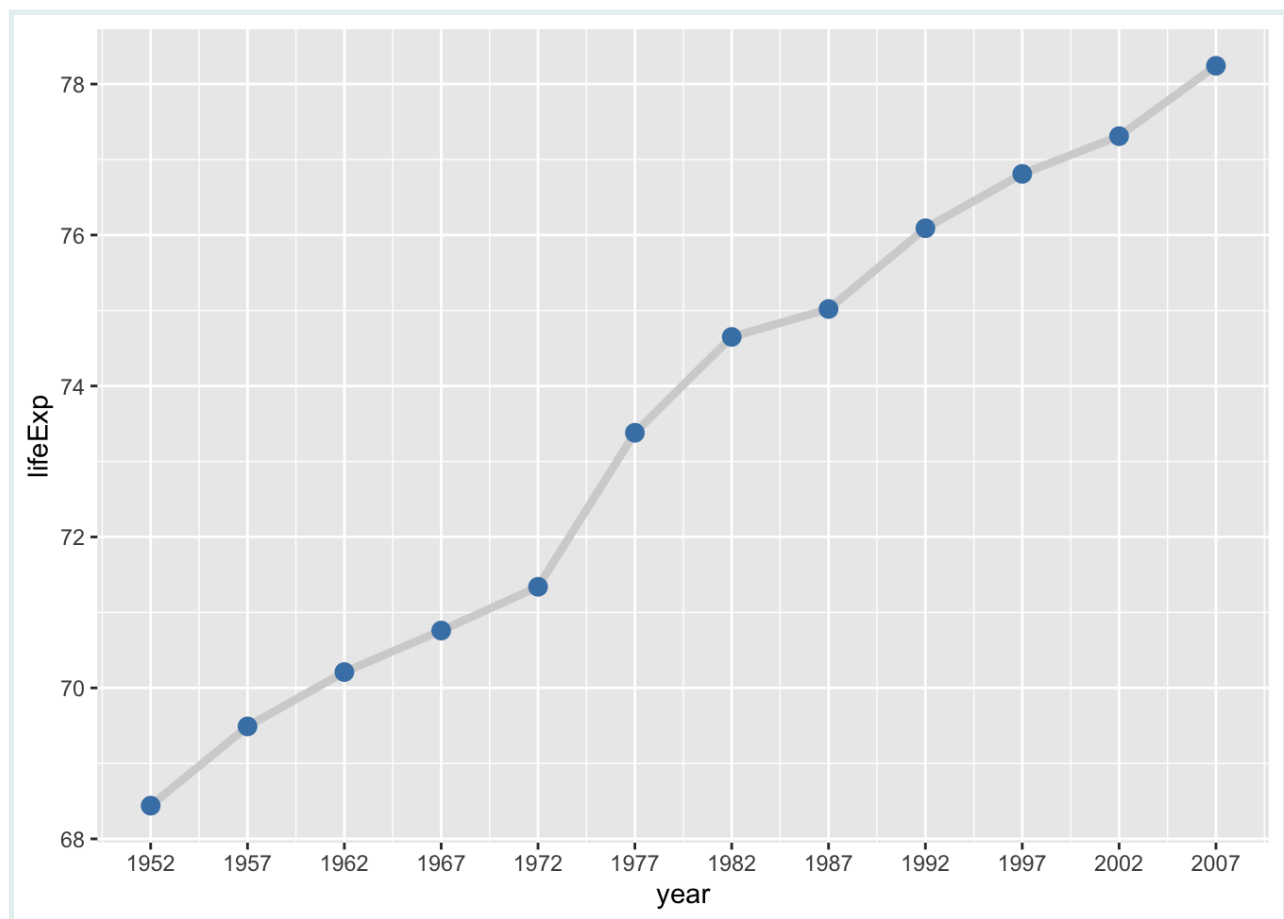
You can add labels to a plot with the `labs()` function. Arguments we can specify with the `labs()` function include:

- `title`: Change or add a title

- x: Rename x-axis
- y: Rename y-axis
- caption: Add caption below the graph

Let's start with this plot and start adding labels to it:

```
# Time series plot of life expectancy in the United States
ggplot(data = gap_US,
       mapping = aes(x = year,
                     y = lifeExp)) +
  geom_line(size = 1.5,
           color = "lightgrey") +
  geom_point(size = 3,
            color = "steelblue") +
  scale_x_continuous(breaks = gap_years)
```



We add the `labs()` to our code using a `+` sign.

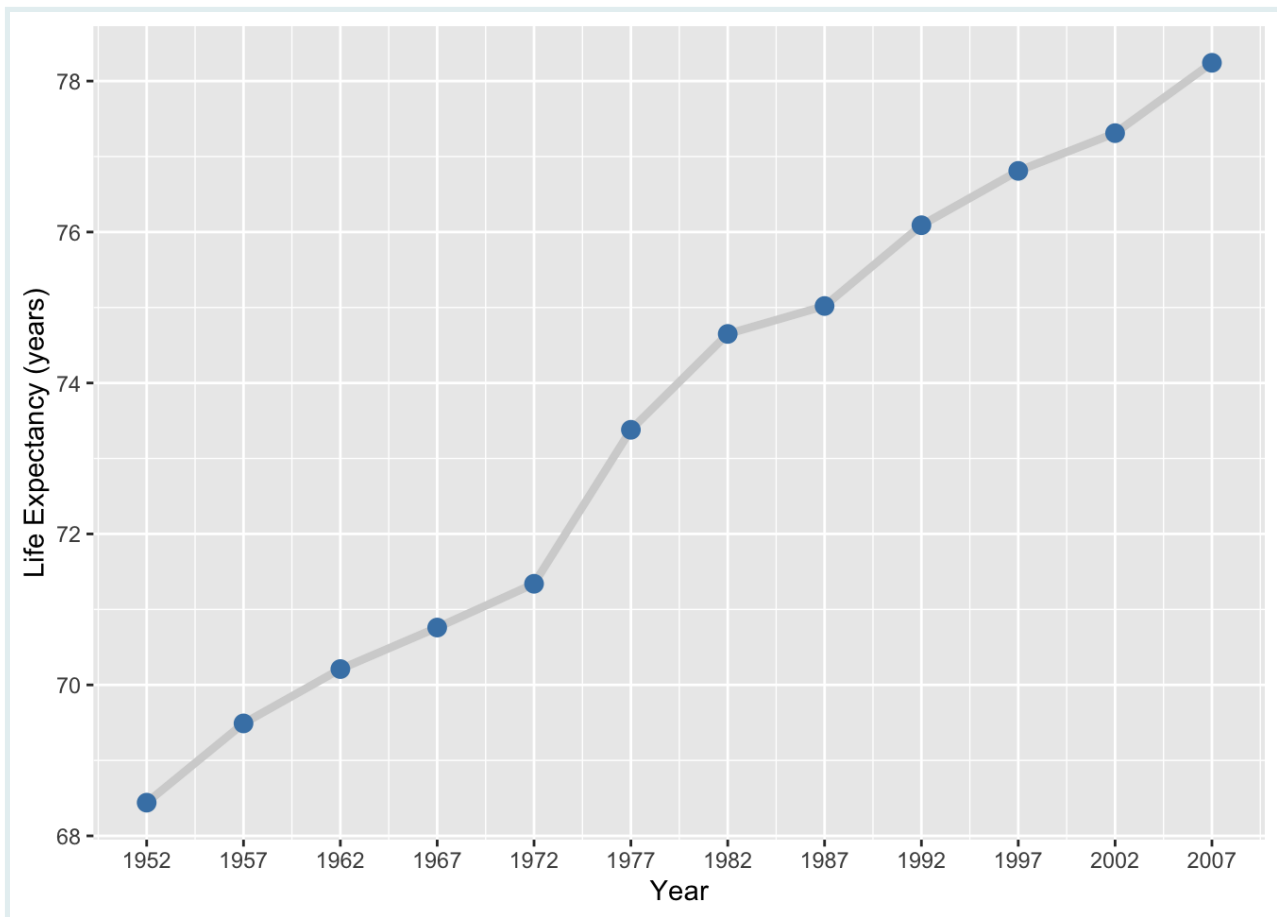
First we will add the `x` and `y` arguments to `labs()`, and change the axis titles from the default (variable name) to something more informative.

```
# Rename axis titles
ggplot(data = gap_US,
       mapping = aes(x = year,
```

```

    y = lifeExp)) + geom_line(size = 1.5,
    color = "lightgrey") + geom_point(size = 3,
    color = "steelblue") +
scale_x_continuous(breaks = gap_years) + labs(x = "Year",
    y = "Life Expectancy (years)")

```



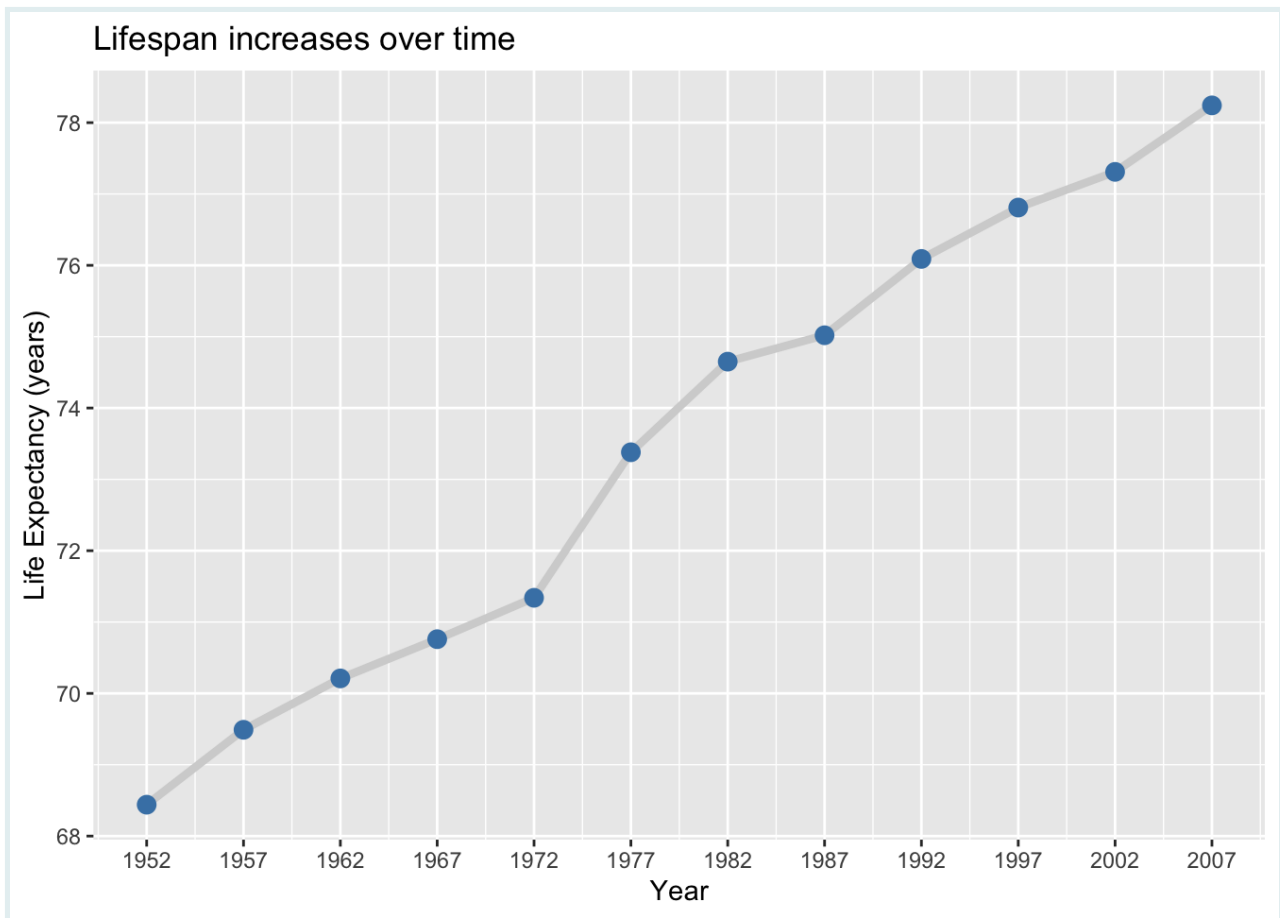
Next we supply a character string to the `title` argument to add large text above the plot.

```

# Add main title: "Lifespan increases over time"
ggplot(data = gap_US,
    mapping = aes(x = year,
    y = lifeExp)) +
geom_line(size = 1.5,
    color = "lightgrey") +
geom_point(size = 3,
    color = "steelblue") +
scale_x_continuous(breaks = gap_years) +
labs(x = "Year",
    y = "Life Expectancy (years)",
    title = "Lifespan increases over time")

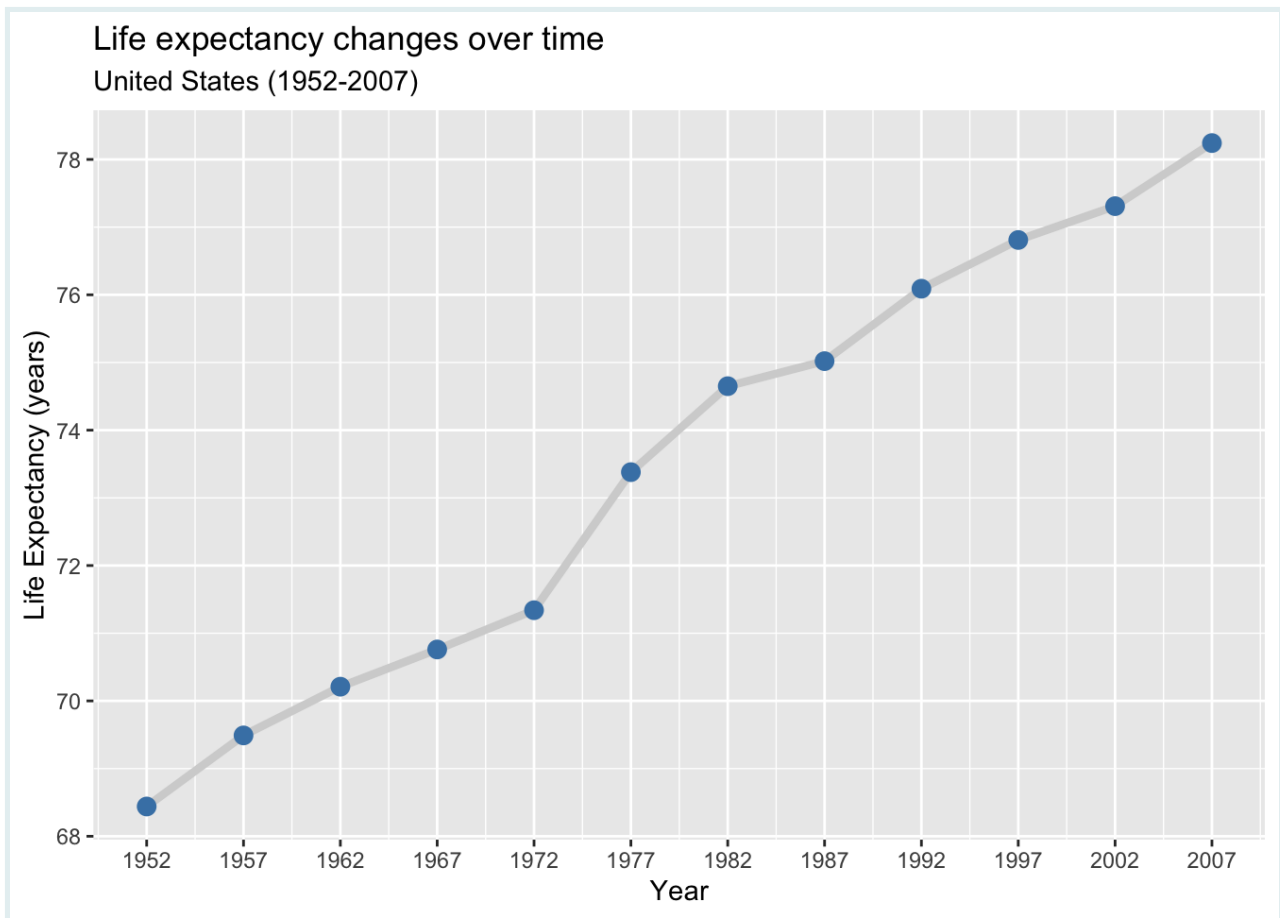
```





The subtitle argument adds smaller text below the main title.

```
# Add subtitle with location and time frame
ggplot(data = gap_US,
       mapping = aes(x = year,
                     y = lifeExp)) +
  geom_line(size = 1.5,
            color = "lightgrey") +
  geom_point(size = 3,
             color = "steelblue") +
  scale_x_continuous(breaks = gap_years) +
  labs(x = "Year",
       y = "Life Expectancy (years)",
       title = "Life expectancy changes over time",
       subtitle = "United States (1952-2007)")
```

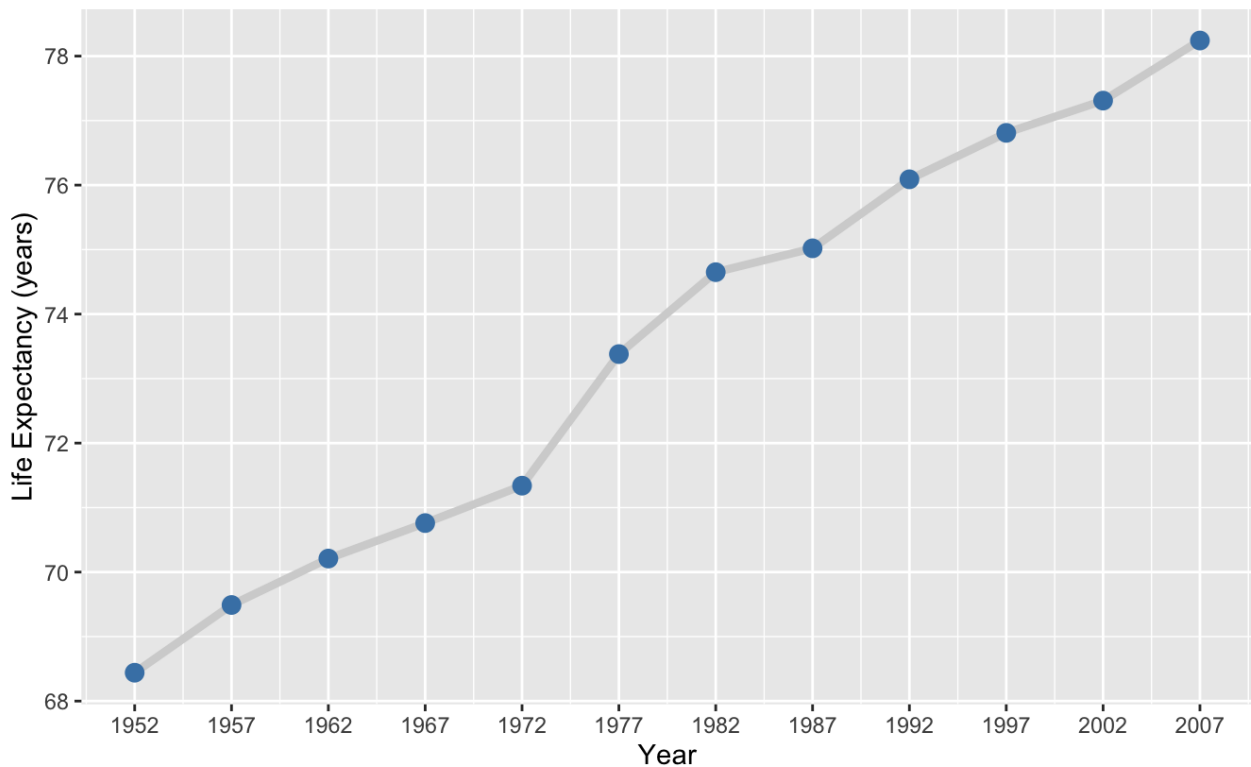


Finally, we can supply the caption argument to add small text to the bottom-right corner below the plot.

```
# Add caption with data source: "Source: www.gapminder.org/data"
ggplot(data = gap_US,
       mapping = aes(x = year,
                     y = lifeExp)) +
  geom_line(size = 1.5,
           color = "lightgrey") +
  geom_point(size = 3,
            color = "steelblue") +
  scale_x_continuous(breaks = gap_years) +
  labs(x = "Year",
       y = "Life Expectancy (years)",
       title = "Life expectancy changes over time",
       subtitle = "United States (1952-2007)",
       caption = "Source: http://www.gapminder.org/data/")
```

## Life expectancy changes over time

United States (1952-2007)



Source: <http://www.gapminder.org/data/>

When you use an aesthetic mapping (e.g., color, size), {ggplot2} automatically scales the given aesthetic to match the data and adds a legend.

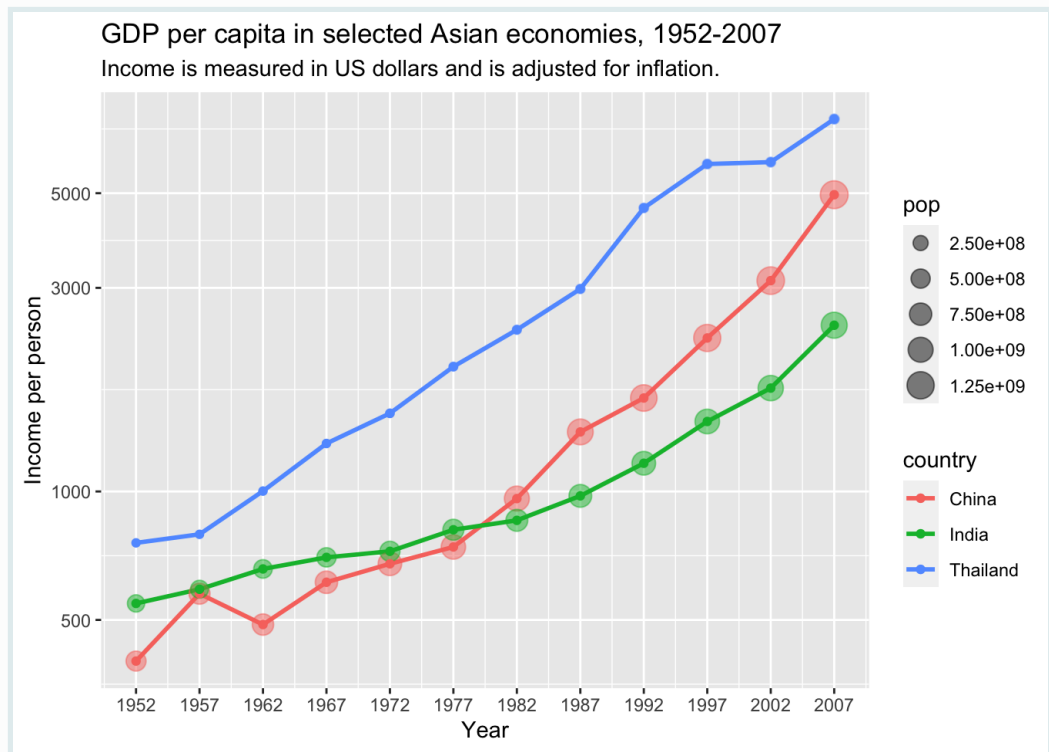
Here is an updated version of the `gap_mini3` plot we made before. We are changing the of points *and* lines by setting `aes(color = country)` in `ggplot()`. Then the size of *points* is scaled to the `pop` variable. See that `labs()` is used to change the title, subtitle, and axis labels.

### CHALLENGE



```
ggplot(data = gap_mini2,
       mapping = aes(x = year,
                     y = gdpPercap,
                     color = country)) +
  geom_line(size = 1) +
  geom_point(mapping = aes(size = pop),
            alpha = 0.5) +
  geom_point() +
  scale_x_continuous(breaks = gap_years) +
  scale_y_log10() +
  labs(x = "Year",
       y = "Income per person",
```

```
title = "GDP per capita in selected Asian economies,
1952-2007",
subtitle = "Income is measured in US dollars and is
adjusted for inflation.")
```



#### CHALLENGE



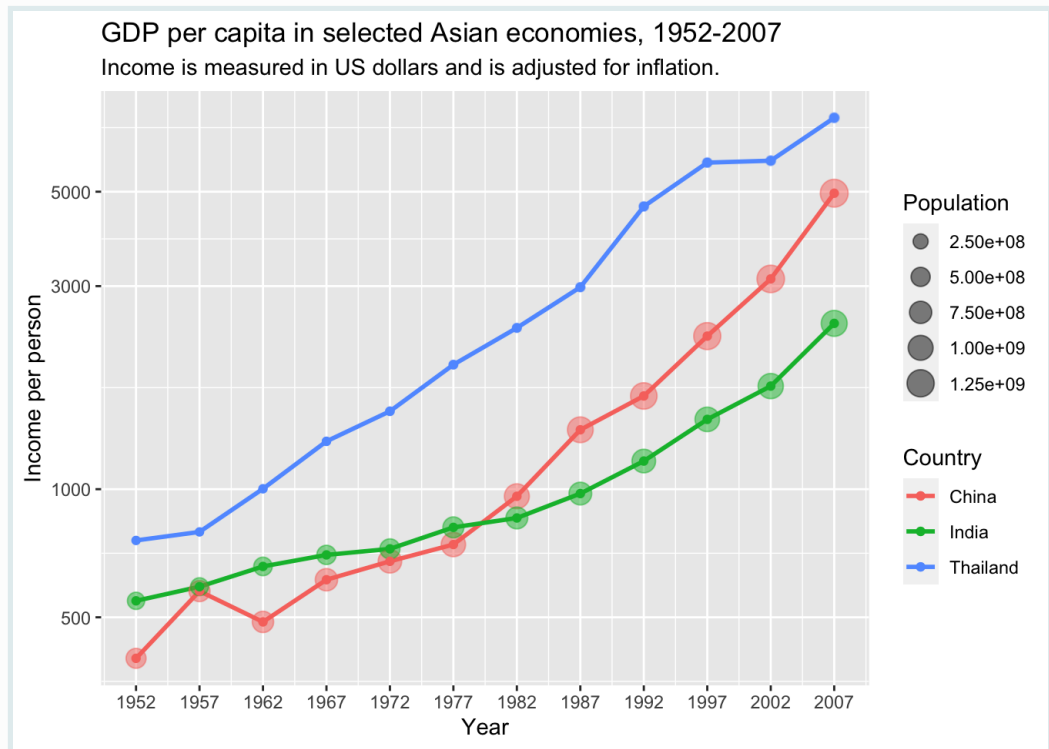
The default title of a legend or key is the name of the data variable it corresponds to. Here the color legend is titled `country`, and the size legend is titled `pop`.

We can also edit these in `labs()` by setting `AES_NAME = "CUSTOM_TITLE"`.

```
ggplot(data = gap_mini2,
       mapping = aes(x = year,
                     y = gdpPercap,
                     color = country)) +
  geom_line(size = 1) +
  geom_point(mapping = aes(size = pop),
             alpha = 0.5) +
  geom_point() +
  scale_x_continuous(breaks = gap_years) +
  scale_y_log10() +
  labs(x = "Year",
       y = "Income per person",
```

```
color = "Country", size = "Population")
```

### CHALLENGE



The same syntax can be used to edit legend titles for other aesthetic mappings. A common mistake is to use the variable name instead of the aesthetic name in `labs()`, so watch out for that!

Create a time series plot comparing the trends in GDP per capita from 1952-2007 for **three countries** in the `gapminder` data frame.

First, subset the data to three countries of your choice:

Use `my_gap_mini` to create a plot with the following attributes:

### PRACTICE



(in RMD)

- Add points to the line graph
- Color the lines and points by country
- Increase the width of lines to 1mm and the size of points to 2mm
- Make the lines 50% transparent

Finally, add the following labels to your plot:

#### PRACTICE



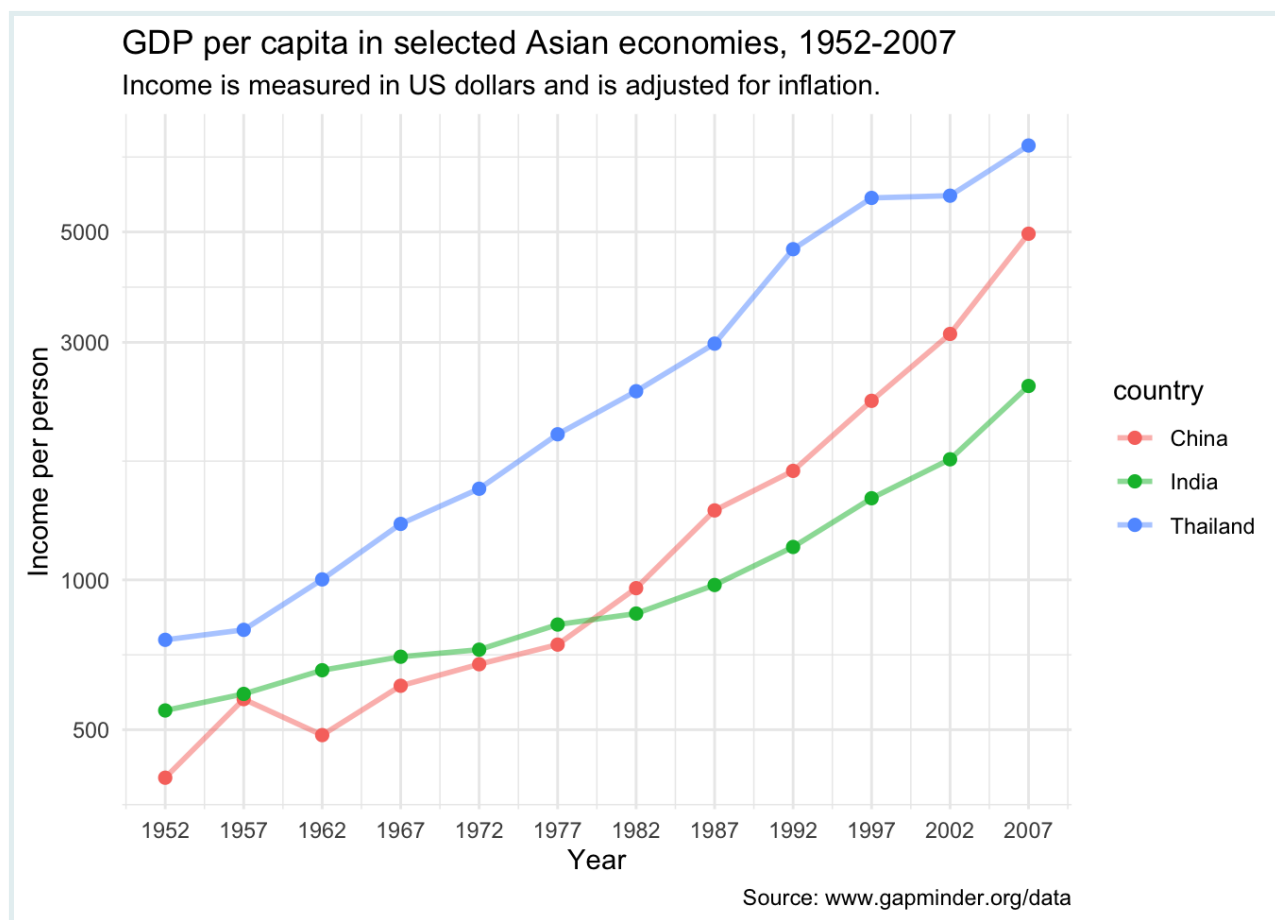
- Title: "Health & wealth of nations"
- Axis titles: "Longevity" and "Year"
- Capitalize legend title

(Note: subtitle requirement has been removed.)

## Preview: Themes

In the next lesson, you will learn how to use `theme` functions.

```
# Use theme_minimal()
ggplot(data = gap_mini2,
       mapping = aes(x = year,
                     y = gdpPercap,
                     color = country)) +
  geom_line(size = 1, alpha = 0.5) +
  geom_point(size = 2) +
  scale_x_continuous(breaks = gap_years) +
  scale_y_log10() +
  labs(x = "Year",
       y = "Income per person",
       title = "GDP per capita in selected Asian economies, 1952-2007",
       subtitle = "Income is measured in US dollars and is adjusted for
inflation.",
       caption = "Source: www.gapminder.org/data") +
  theme_minimal()
```



## Wrap up

Line graphs, just like scatterplots, display the relationship between two numerical variables. When one of the two variables represents time, a line graph can be a more effective method of displaying relationship. Therefore, it is preferred to use line graphs over scatterplots when the variable on the x-axis (i.e., the explanatory variable) has an inherent ordering, such as some notion of time, like the `year` variable of `gapminder`.

We can change scale breaks and transform scales to make plots easier to read, and label them to add more information.

Hope you found this lesson helpful!

## Contributors

The following team members contributed to this lesson:



## JOY VAZ

R Developer and Instructor, the GRAPH Network  
Loves doing science and teaching science

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## ADMIN TEAM

GRAPH Courses Administration Team

The GRAPH Courses team is building epidemiological training courses to enhance disease surveillance and data science for public health across the globe

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## References

Some material in this lesson was adapted from the following sources:

- Ismay, Chester, and Albert Y. Kim. 2022. *A ModernDive into R and the Tidyverse*. <https://moderndive.com/>.
- Kabacoff, Rob. 2020. *Data Visualization with R*. <https://rkabacoff.github.io/datavis/>.
- [https://www.rebeccabarter.com/blog/2017-11-17-ggplot2\\_tutorial/](https://www.rebeccabarter.com/blog/2017-11-17-ggplot2_tutorial/)

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