The R Workshop Book

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Table of contents

Preface

Welcome to *The R Workshop* Book by Rebecca L Barter.

This book was designed as a companion to two R workshops that I originally developed and taught at the University of Utah: "Introduction to R for Data Analysis", which I teach over 2 days, and "Advanced R for Data Analysis", which is just a 1 day workshop. So far, this book only contains the content for the first workshop, but keep an eye on this space as I'll be progressively releasing the advanced R workshop chapters.

This book, like the original workshops on which it is based, is designed to get you up and running using R for the analysis of tabular data (i.e., data that comes in a table) using the tidyverse, focusing on data manipulation and data visualization. Rather than teaching you everything there is to know about R, this book just teaches what you need to actually start doing data analysis within the modern "tidyverse" ecosystem.

My approach is a somewhat less fancy approach to teaching R than many of the existing modern R books out there, such as R for Data Science, which starts working with data and creating visualizations up front. These are great books, but I personally prefer to teach beginners in a more linear fashion, which takes a more step-by-step approach, starting with understanding how the programming language works and building up to fancy things like actually working with data. If you're looking to be inspired, *R for Data Science* is probably a better book for you. But if you're looking for a resource to give you the building blocks for learning R, starting with the absolute basics, then you're in the right place.

The R programming language is constantly evolving, and my goal is to keep this book up-to-date as new developments emerge.

Teaching from this book

You are absolutely welcome to teach from this book however you like, but I do request that you provide appropriate attribution.

Learn from me!

Feel free to reach out if you're interested in hiring me to teach custom versions of these workshops.

Inspiration attribution

The original inspiration for the first parts of this book came from Software Carpentry, which is where I first encountered the gapminder dataset that is used throughout (however, the materials you will find in this book bear little-to-no resemblance to any of the R Software Carpentry workshops.)

Errors, typos, and contributions

If you notice any errors or typos, feel free to let me know by filing an issue on the book's GitHub repository.

Get in touch

Feel free to email me at rlbarter at gmail dot com if you'd like to get in touch.

License

Part I

Getting Started

1 R, RStudio, and Quarto

1.1 What is R?

R is a "programming language" that once we can speak (write) it, we can use it to tell our computer to do things with our data. Just like learning a real language, learning a programming language involves learning an entirely new vocabulary along with the grammar rules that glues it all together. .

Many of you may be familiar with other software programs, like Excel, SAS, SPSS, STATA, or MATLAB. The main issues with these software programs, is that they are proprietary and they cost money.

R, however, is what is called an "*open source*" programming language. This means that it is completely *free*, and also that anyone can be an R developer. The result is that there are massive diverse communities of people who have come together to contribute to the R programming language, helping turn it into the powerful programming tool that it is today.

1.2 What is RStudio?

The *RStudio* "IDE", which is the computer application that most people use to write their R code (RStudio is to R code what a Word Doc is to text).

> **Positron**
>
> I should probably note here that Posit, the company behind RStudio, has recently developed a new application or "IDE" called *Positron* that will likely eventually supersede RStudio, but Positron still in "Beta" mode and, for now, my recommendation is to stick with RStudio. Rest assured, I'll update this page once I feel like Positron is ready for general use.

1.3 Downloading R and RStudio

If you will be using R "locally" (i.e., on your own computer, rather than in the cloud), then you will need to download R from the CRAN website (https://cran.rstudio.com/). While this will download an "R" application in which you can technically write R code, I recommend that you instead write your R code inside a separate desktop application called RStudio. You can download RStudio from the Posit website https://posit.co/downloads/.

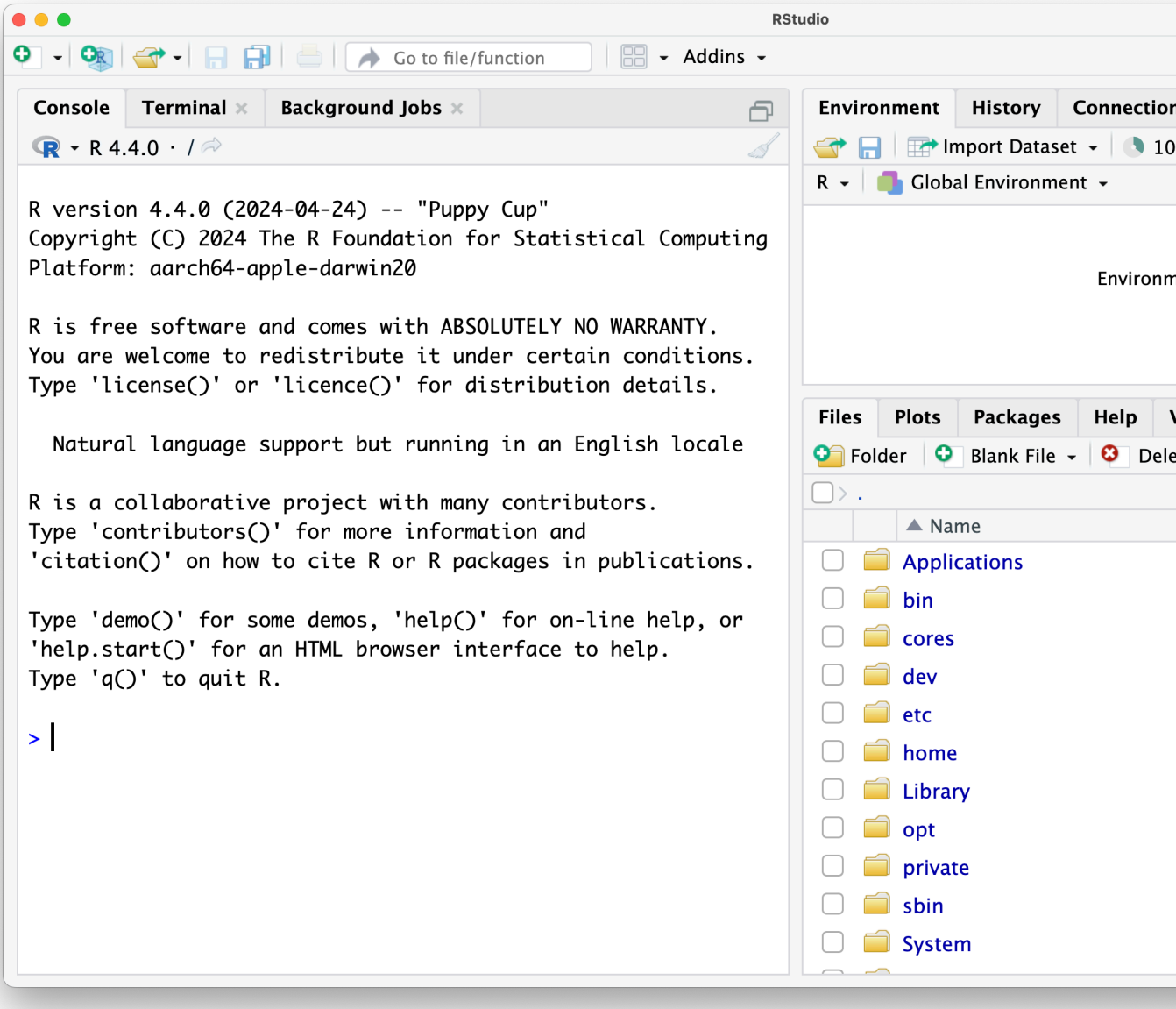
> Updating R and RStudio
>
> Even if you already have R and RStudio on your computer, I recommend that you re-download them to ensure that you have the latest versions.
> It is good practice to keep up to date with the latest versions in general–I recommend actively re-installing the latest new versions of R and RStudio at least every 6 months or so.

Alternatively, if you prefer not to (or cannot) download applications from the web onto your computer, you can use R and RStudio directly in your web browser with Posit cloud.

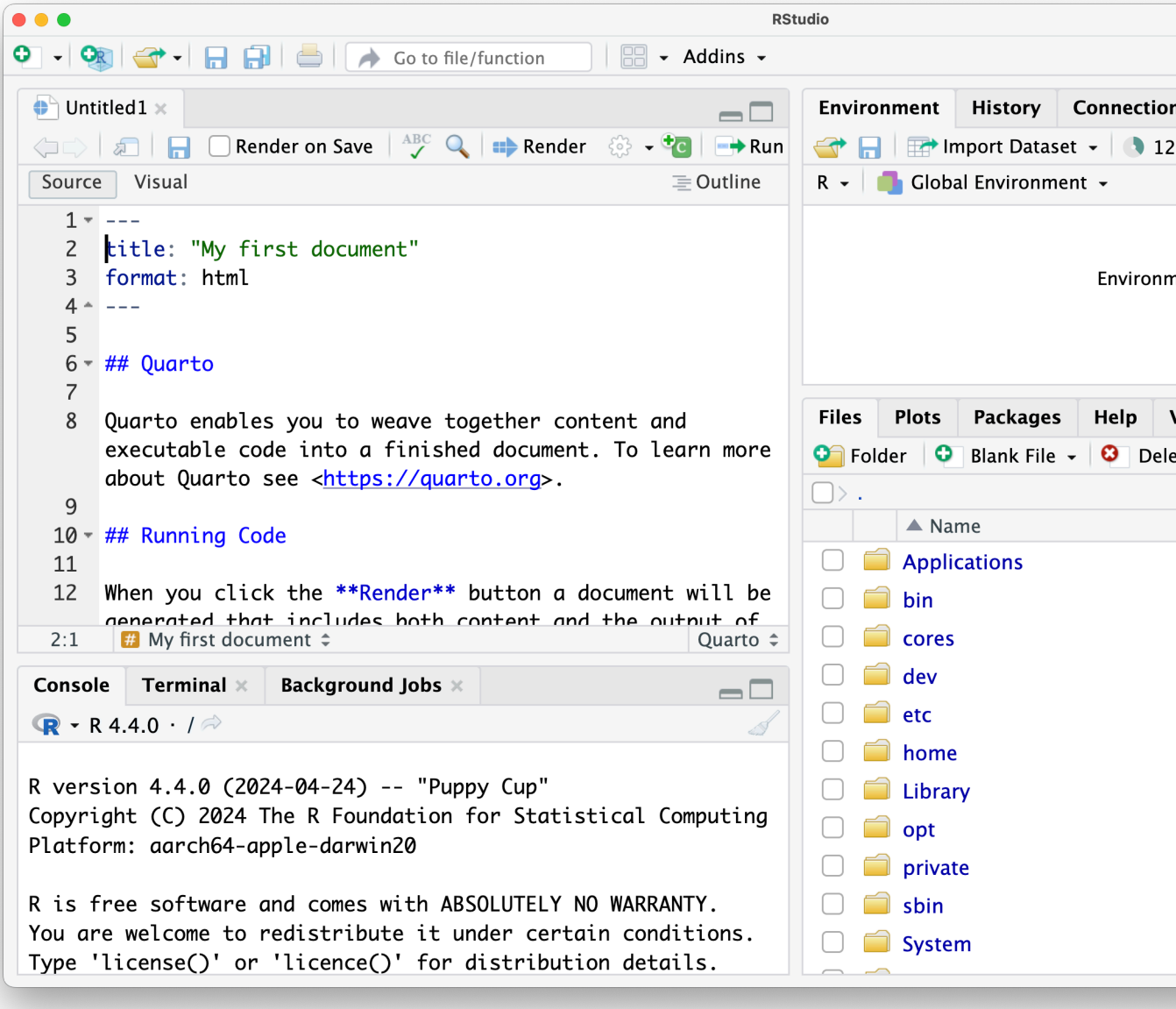
1.4 A tour of RStudio

Since we will be using R inside RStudio, let's start with a quick tour of RStudio.

Whether you're using RStudio "locally" on your own computer, or in the cloud, when you open RStudio, it should look something like this:



If you go ahead and select *File* > *New File* > *Quarto Document*, type "My first R" in the "Title" bar and your name in the "Author" bar, then your RStudio should look something like this:



Congratulations, you've just created your first R document! Technically, this is called a *quarto* document, but you can think of it like a Word document in which you are going to write both regular text and R code text to tell a data-driven story! We will talk about the contents of this document in a moment.

If you've used RStudio before, you might have re-arranged the four panels that you see in the image above, but your version should have the same general features as in the image above:

- A **document panel** (the top-left panel in the image), which is where the document that you're currently *writing* in lives.
- A **console panel** (The bottom-left panel in the image), which is where we can *run* the code that we write.
- An **environment panel** (the top-right panel in the image), which will show the "objects" that exist in your R environment. We haven't run any code yet, so this is empty.
- The **files panel** (which is also the **plot panel** and **viewer panel**), which shows the files in the current local "directory" (the folder on your computer). When you first open RStudio, this is typically your computer's home page.

Note that the size of each panel can be changed by dragging the border between two adjacent panels.

The most important panels at the moment are the *documents* and *console* panels on the left, so let's take a closer look at these.

1.5 Quarto documents

The top-left documents panel contains the document that you're currently working in. There are several types of documents that you could create in which you could write your R code, but I recommend using *quarto documents*.

> **Quarto versus R Markdown**
>
> If you're already familiar with *R Markdown*, *quarto* is just its modern successor and at first glance, quarto is pretty much the same as R Markdown, with minor syntactic differences. Don't worry, if you already have a bunch of old R Markdown documents, there isn't much to be gained by converting them to quarto files, but I'd recommend that any *new* files you create be quarto files rather than R Markdown. If you've never heard of R Markdown, feel free to forget I even mentioned it.

Quarto documents allow you to combine text and code, so that rather than having your R code be lonely on its own, your code (and its output) can instead live nestled in between narrative text that describes the analysis that you're conducting and summarizes the results you obtain.

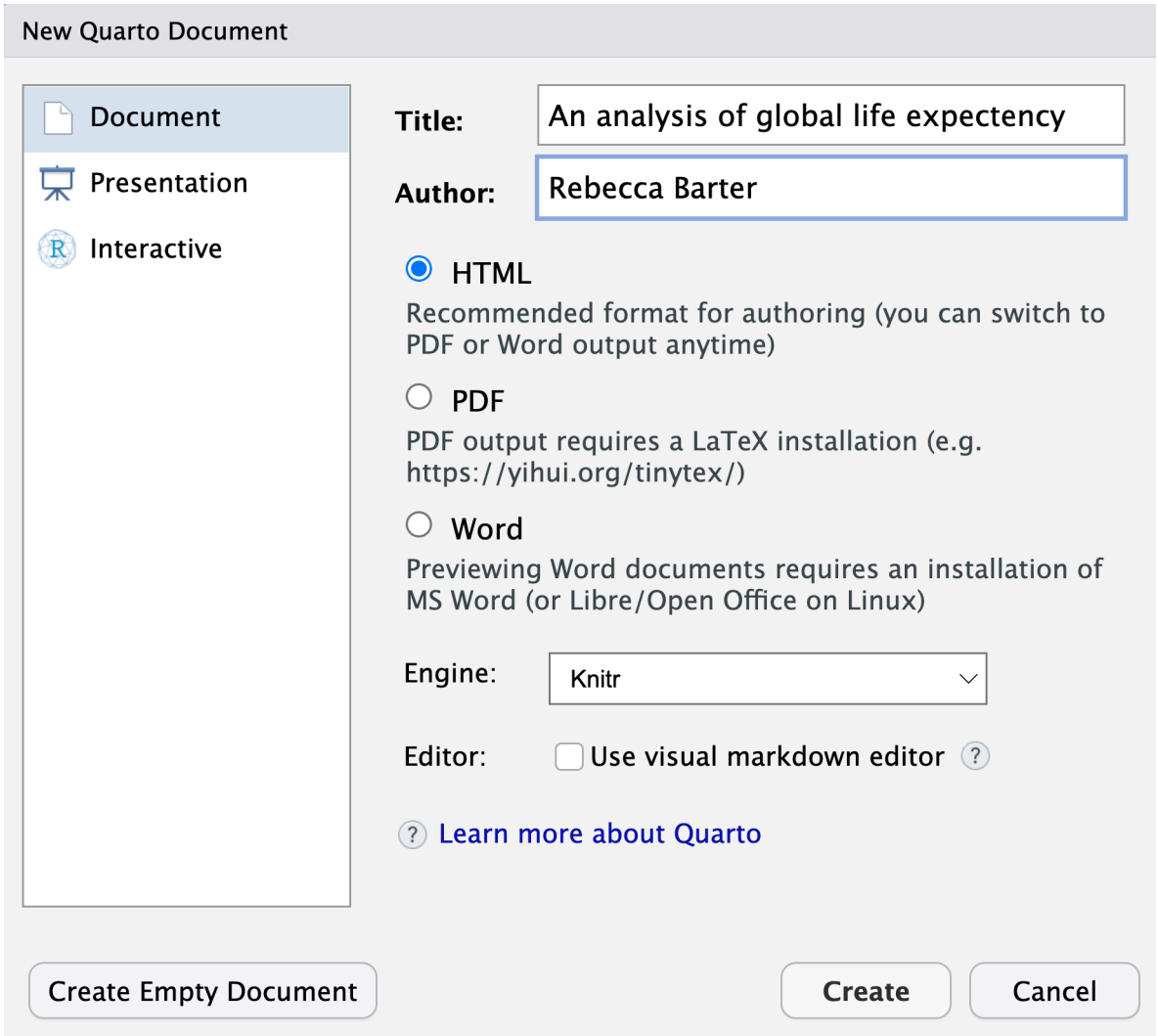
Quarto documents are mind-blowingly versatile, and while they are mostly used to create simple html or pdf documents, they can also be used to make websites (like mine) and books (like this one!)

Whenever I am conducting an analysis using R, I conduct my analysis in a quarto document. In fact, every chapter in this book is just a quarto document!

Since we want to practice *reproducible* data science, it is important that we keep detailed records of the code we wrote that led us to our data-driven answers. Quarto provides us with an easy way of doing that. Moreover, because you can surround your code with text narrative, it can be used to communicate your analysis and results to other people: quarto lets us feed two birds with one seed!

To start a new quarto document inside RStudio:

- Hit the "New file" icon, , in the top-left-hand corner of RStudio (or *File* > *New File* > *Quarto Document*) and select "Quarto document". The following window should pop up:



Then

- Choose a title (e.g., "An analysis of global life expectancy"), and make yourself the author.
- Hit the "*Create*" button to create your file.

This will open up a new quarto template document in the documents panel.

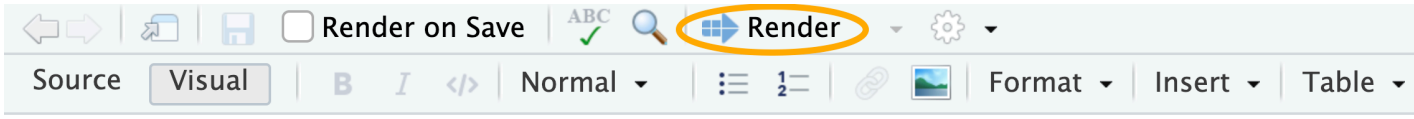
The template text in your new quarto document contains a very summary of how quarto documents work. Take a moment to read it.

The regular white-background text is just text like in a Word Document. The text at the top of the quarto document surrounded by dashes `---` is called the **YAML header**, provides several parameters and options for your quarto document, such as the title, the author, and the rendered output format (more on this in a moment).

The grey boxes with `{r}` are called "code chunks" and these are where we will write your R code.

1.5.1 Rendering quarto documents

Note the instructions in the template quarto document "*When you click the **Render** button a document will be generated that includes both content and the output of embedded code.*" Take the document's advice: click the "Render" button with a blue arrow, which is circled in orange below and save your document when prompted as "analysis.qmd" or something like that:




```
---
title: "An analysis of global life expectancy"
format: html
---
```

Quarto

Quarto enables you to weave together content and executable code into a finished d
learn more about Quarto see https://quarto.org.

Running Code

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

```{r}
1 + 1
```

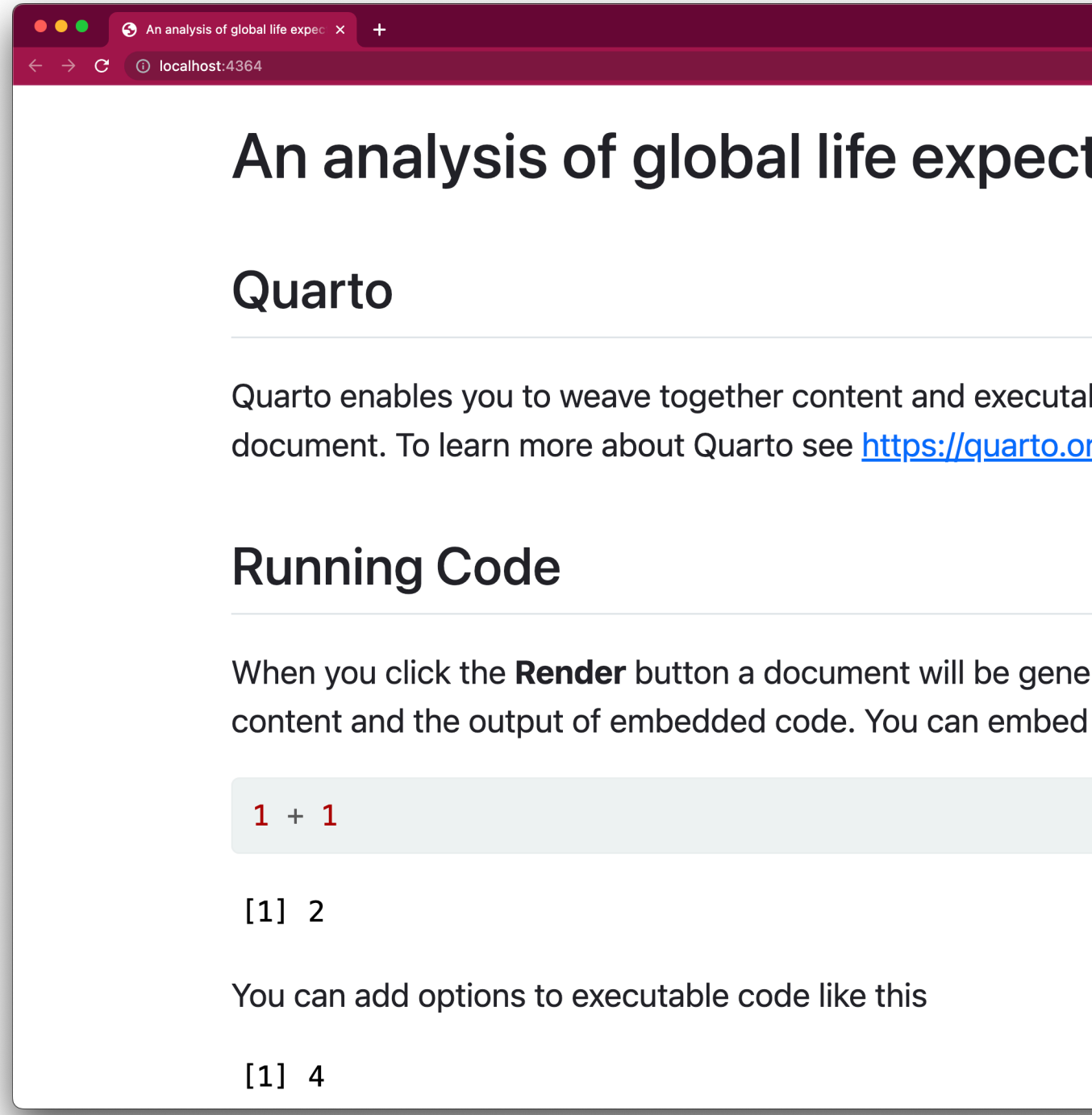
You can add options to executable code like this

```{r}
#| echo: false
2 * 2
```

The `echo: false` option disables the printing of code (only output is displayed).

(Top Level)

Hopefully, what happened when you hit “Render” is that some text appeared very quickly in your bottom-left “console” panel and your web browser opened up with a new (html) webpage with whatever title you provided that looks something like this:


An analysis of global life expec
localhost:4364
An analysis of global life expect
Quarto
Quarto enables you to weave together content and executal
document. To learn more about Quarto see https://quarto.or
Running Code
When you click the Render button a document will be gene
content and the output of embedded code. You can embed
1 + 1
[1] 2
You can add options to executable code like this
[1] 4

If you're using RStudio in the cloud (or you have different settings to me), you may have instead found that the window opened in the "Viewer" panel of your RStudio application. If no window opened anywhere, navigate to the location on your computer where you saved your quarto document ("analysis.qmd") and see if a new file "analysis.html" has appeared. If it has, open it in your web browser.

What happened when we hit the "Render" button? Hitting "Render" renders your *interactive* quarto (analysis.qmd) document as a *static* HTML (analysis.html) file. This is like saving your interactive word document file that you can edit as a static pdf file that you cannot edit.

Compare the original quarto (analysis.qmd) document in RStudio with the rendered page (analysis.html) in your web browser. What differences do you notice? Which one can you modify?

> Rendering quarto as PDF and Microsoft Word documents
>
> By default, quarto documents will be rendered as HTML files, but they can also be rendered to PDF and Microsoft Word files! You can do this by changing the `format: html` in the "*yaml*" text at the top of your quarto document (right underneath the "title" and "author" definitions) to `format: pdf` or `format: docx`, respectively.
> However, note that to render a quarto document to a PDF file, you will need to have an application called LaTeX installed on your computer (see the exercise below).
> If you switched to `format: pdf`, we recommend switching back to `format: html` for the rest of this lesson.

1.5.2 "Visual" mode versus "Source" mode

There are currently two modes that your *interactive* quarto document (i.e., the version in RStudio, not the rendered HTML document) can be in.

The "analysis.qmd" file in "visual mode" looks like this:


```yaml
---
title: "An analysis of global life expectancy"
format: html
---
```

Quarto

Quarto enables you to weave together content and executable code into a finished
learn more about Quarto see https://quarto.org.

Running Code

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

```r
{r}
1 + 1
```

You can add options to executable code like this

```r
{r}
#| echo: false
2 * 2
```

The `echo: false` option disables the printing of code (only output is displayed).

If your quarto document is in visual mode, it will be a lot more like a Word Document, where you will see boldface text, headings, italics, links, etc.

In this visual mode format, much of the underlying quarto syntax is hidden from you.

Alternatively, if you view this same "analysis.qmd" quarto document in "Source" mode, you will be looking at the underlying quarto (markdown) syntax. The "analysis.qmd" file in source mode looks like this:

Source Visual

```
1  ---
2  title: "An analysis of global life expectancy"
3  format: html
4  ---
5
6  ## Quarto
7
8  Quarto enables you to weave together content and executable code into
   about Quarto see <https://quarto.org>.
9
10 ## Running Code
11
12 When you click the **Render** button a document will be generated that
   output of embedded code. You can embed code like this:
13
14 ```{r}
15 1 + 1
16 ```
17
18 You can add options to executable code like this
19
20 ```{r}
21 #| echo: false
22 2 * 2
23 ```
24
25 The `echo: false` option disables the printing of code (only output is
26
```

Notice that there is no boldface text, or headings, etc. Instead there are raw text symbols to

represent these things. For instance, surrounding text by two asterisks (**) creates boldface text and preceding some text with pound symbols (##) creates headings (the more pound symbols used, the more lower-level the heading). This text syntax is called "Markdown" syntax.

Can you identify whether your quarto document is currently in source or visual mode?

You can toggle your quarto document between source and visual mode using the "Source" and "Visual" buttons in the top-left corner of your quarto document in RStudio.

Whether you prefer source or visual mode will come down to a personal preference. I personally prefer working with the source mode where I can see the underlying Markdown syntax that defines the text formatting and R code chunks, but I know many people who prefer the visual mode.

1.5.2.1 Markdown syntax

In case you're interested in learning a little bit more about Markdown syntax, switch your document over to the "Source" mode by hitting "Source" in the top left corner of your document.

Re-render your document by hitting the "Render" button, and based on the rendered static html page that will open in your web browser, let's try to make some sense of the Markdown syntax used in the original quarto (.qmd) document in RStudio.

Can you see what the `##` syntax is doing (if you can't see the `##` syntax in your quarto document in RStudio, ensure that you are viewing the quarto document using "Source" rather than "Visual" in the top-right corner of the document)? The pound symbols are **markdown** syntax for creating headers: `#` will create a top-level header (this is the same level as the overall document title), `##` will create a level-2 header, `###` will create a level-3 header, etc.

Notice that the word "**Render**" is shown in bold in the rendered html file. By looking at the .qmd file, can you figure out what the markdown syntax is for creating bold-face text?

To learn more about markdown syntax, see https://www.markdownguide.org/basic-syntax/.

If you want to play around with the Markdown formatting syntax, add some additional markdown features to your `analysis.qmd` file (E.g., a sub-section heading, some italics, or extra bold text), and re-render your quarto html output by hitting the "Render" button. Take note of how the changes you made were rendered in the static HTML version of your document.

1.6 Where to write your code

1.6.1 Writing R code in code chunks in a quarto document

I recommend that you write 99% of your R code in a quarto document, specifically, your R code should live in the grey boxes with `{r}`–these are called "**code chunks**".

Hopefully when you were comparing your interactive quarto document with the rendered HTML document, one difference that you noticed that the rendered document also showed the "output" of the two R code chunks, which contained the R code `1 + 1` and `2 + 2` (the *output* of these two code chunks were `2` and `4`, respectively.)

The image below shows how this interactive code chunk looks in the quarto document (in source mode):

````
```{r}
1 + 1
```
````

Which you can compare with the following image that shows how the static code chunk looks in the rendered HTML document:

```
1 + 1
```

```
[1] 2
```

When a quarto document is rendered into a HTML document, the code in each of the code chunks is compiled and the result or "output" (in this case the result is `2`) is printed underneath the chunk.

You can provide "options" to code chunks, which are specified with a point symbol followed by a vertical bar on the first line(s) of the quarto chunk `#|`, such as `#| echo: false`, which will tell quarto that it should hide the R code, but still show the output. So if I have this in my interactive quarto document in RStudio:

````
```{r}
#| echo: false
1 + 1
```
````

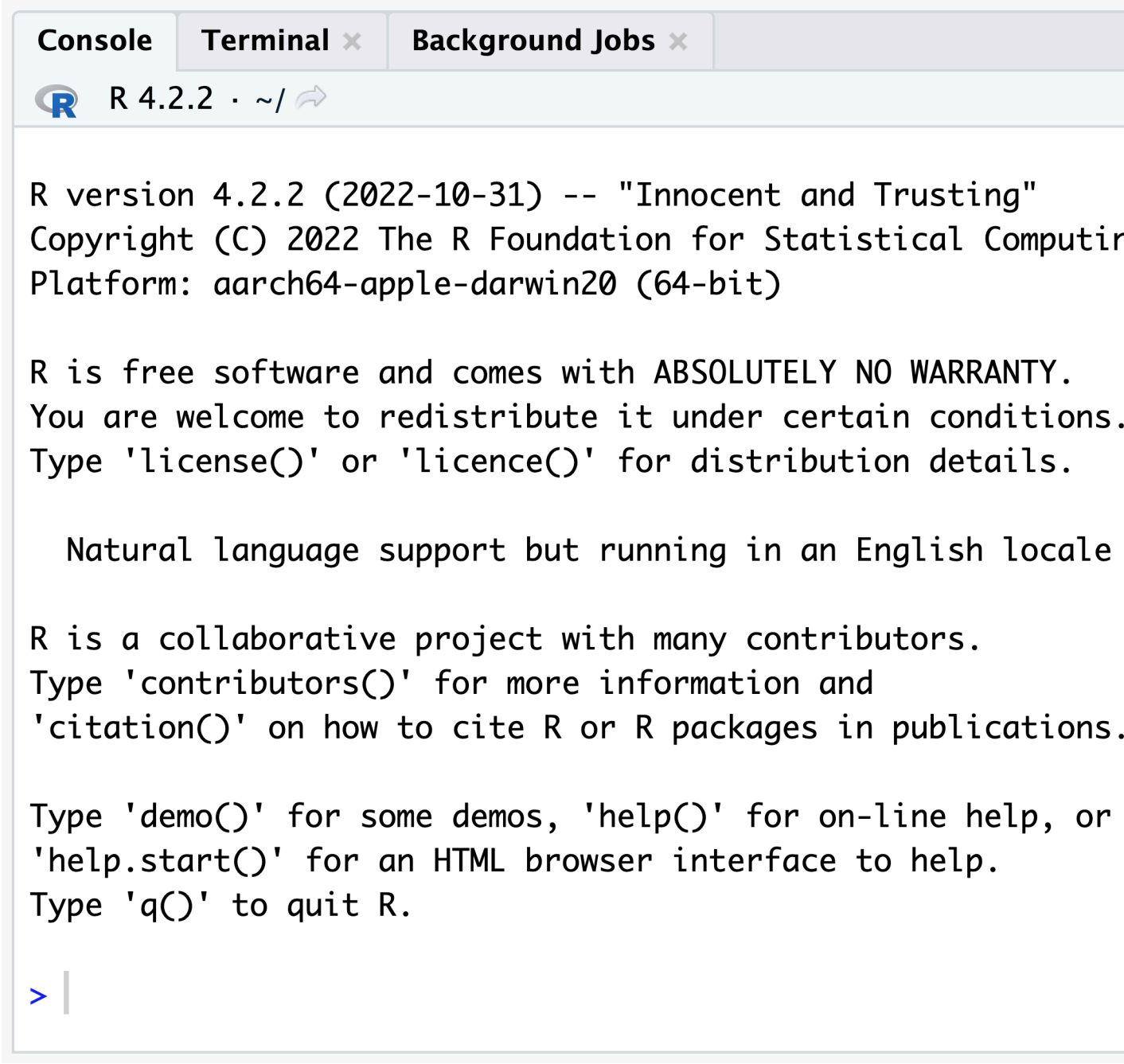
I will only see this in the rendered HTML document (i.e., the `1 + 1` code is hidden):

```
[1] 2
```

1.6.2 Writing and running R code in the console

Admittedly, it would be really annoying if every time you wanted to see the output of your code, you had to render the entire quarto document and look at the output in the HTML document. No one has that much patience.

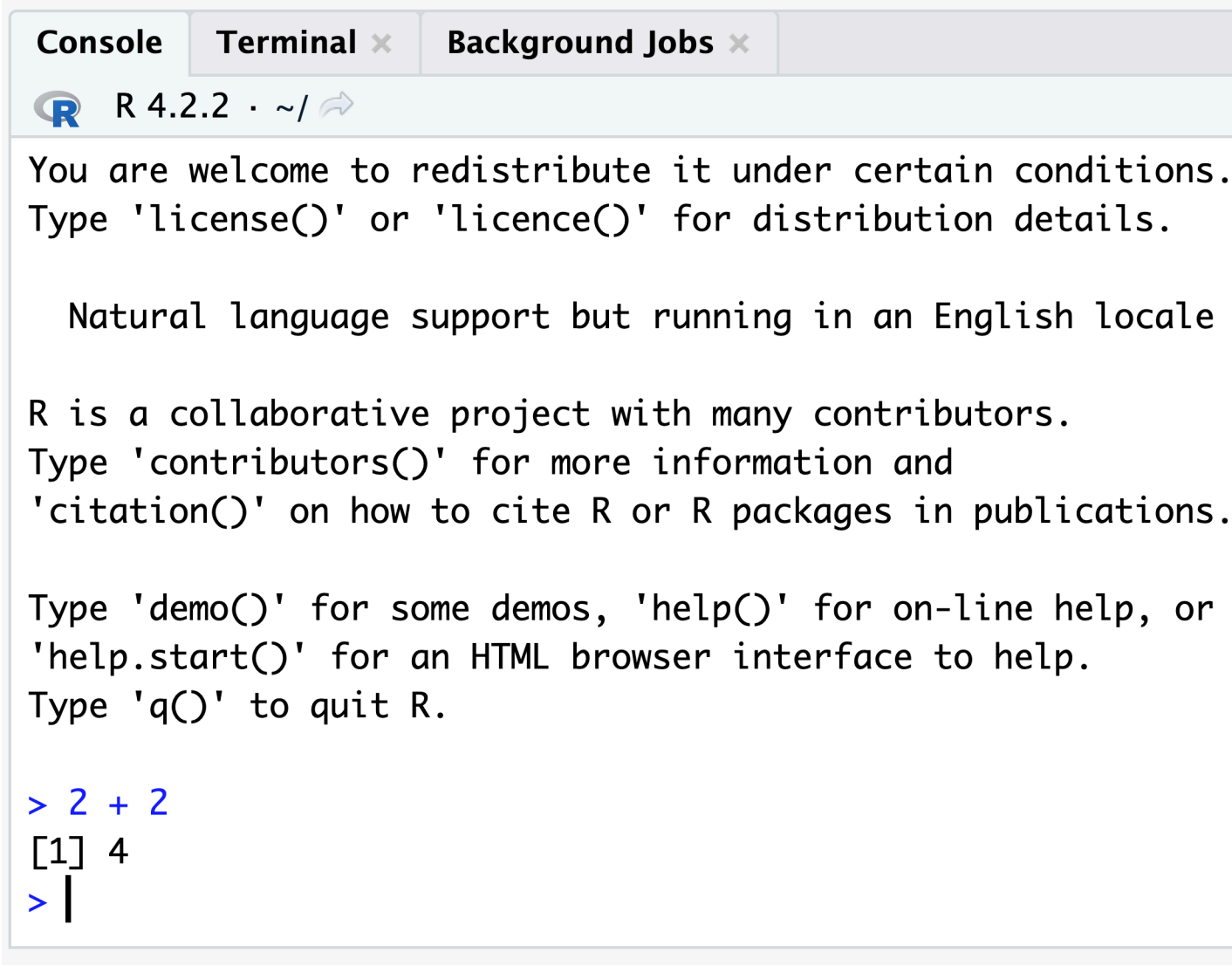
Fortunately, you can check the output of your code by running it in the console panel, which is usually directly underneath your quarto document.



If you click on the console panel (and scroll down to the bottom), you should see an arrow `>` with a blinking cursor `|` symbol. This means that the console is waiting for you to type your code.

In your console in RStudio, after the `>` symbol, type `2 + 2` and then hit return (Enter).

Your console should have produced the output/result of your code (4) underneath, and a new arrow > with a blinking cursor should have appeared underneath, indicating that R is ready for some more code like this:



So if you can just write your code directly in the console, why bother with the quarto document at all?

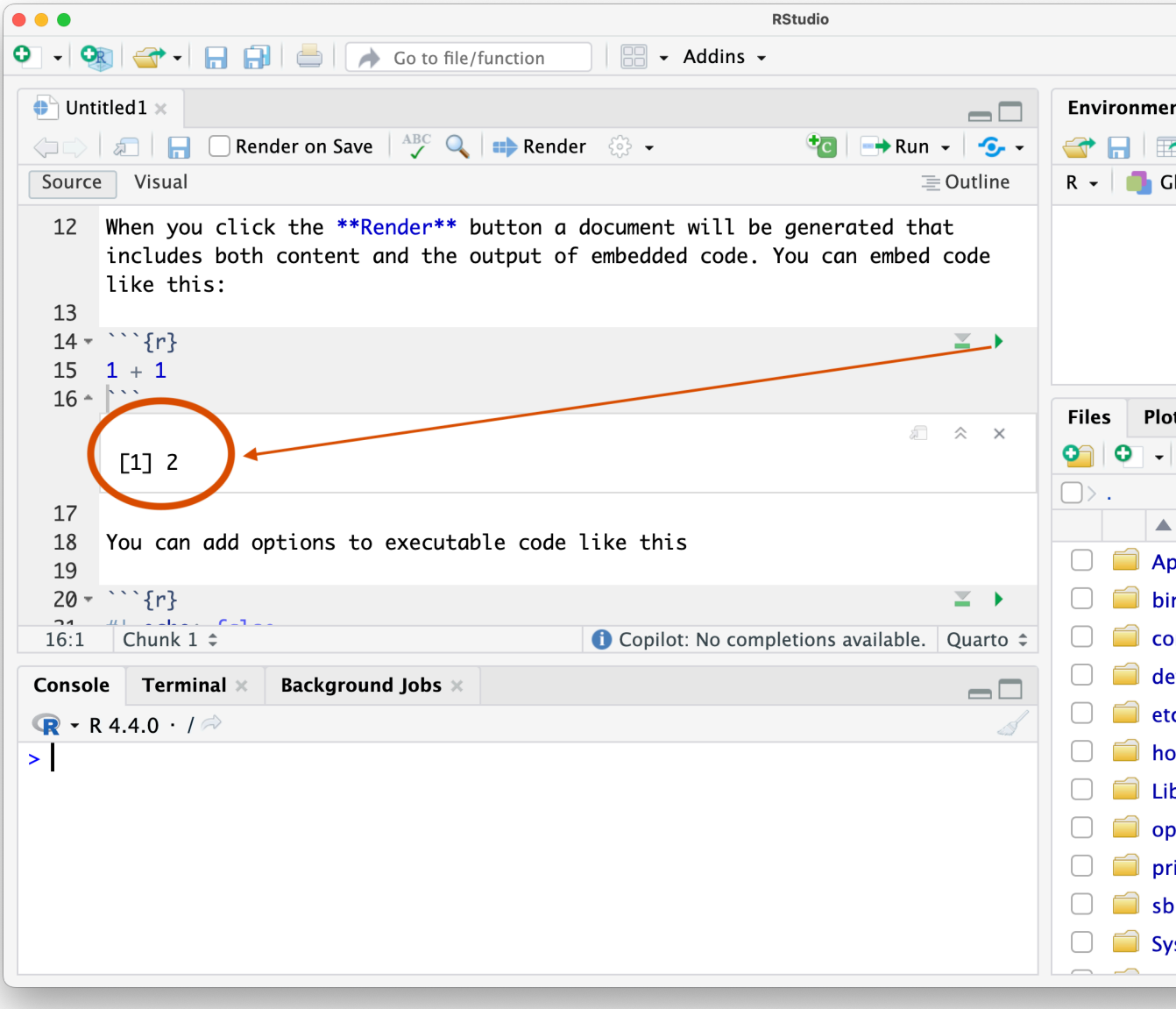
The problem with only ever writing your R code in the R console is that once you quit RStudio, there will be no record of the code that you ran.

1.6.3 Best practices: quarto vs the console

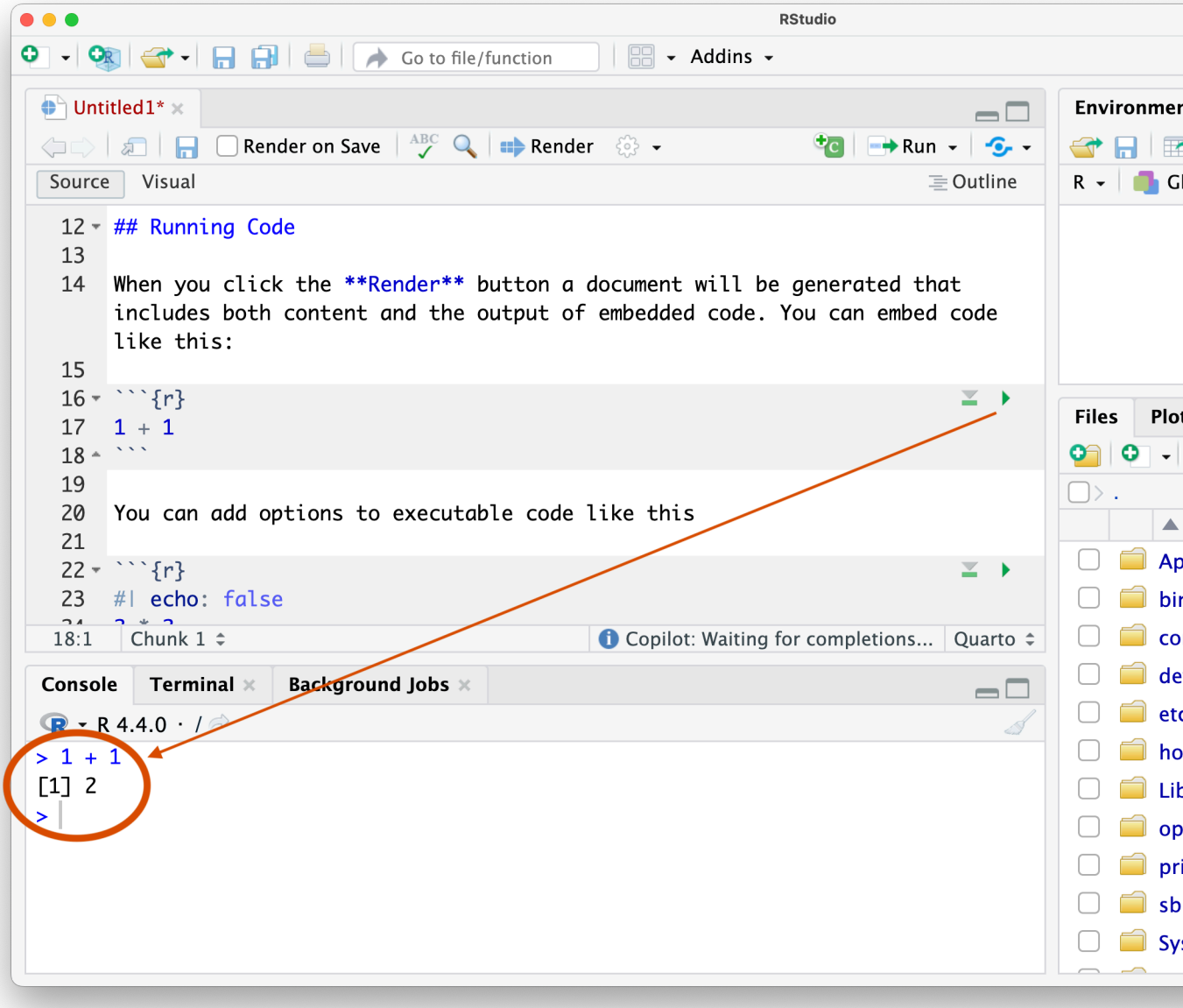
Best practices for writing and saving R code involves writing your code in R chunks within a quarto document, and then running that code in the console (and then later rendering your quarto document after you've written a bunch of code).

This might sound convoluted, but fortunately, you don't have to write your code in two places. Once you write some code in a code chunk in your quarto document, you will notice a green "play" (right arrow) button at the right end of the code chunk. If you hit that, you will see one of two things happen:

1. **Chunk output inline**: The output of your code will appear directly underneath your code chunk *inside* your interactive quarto document.

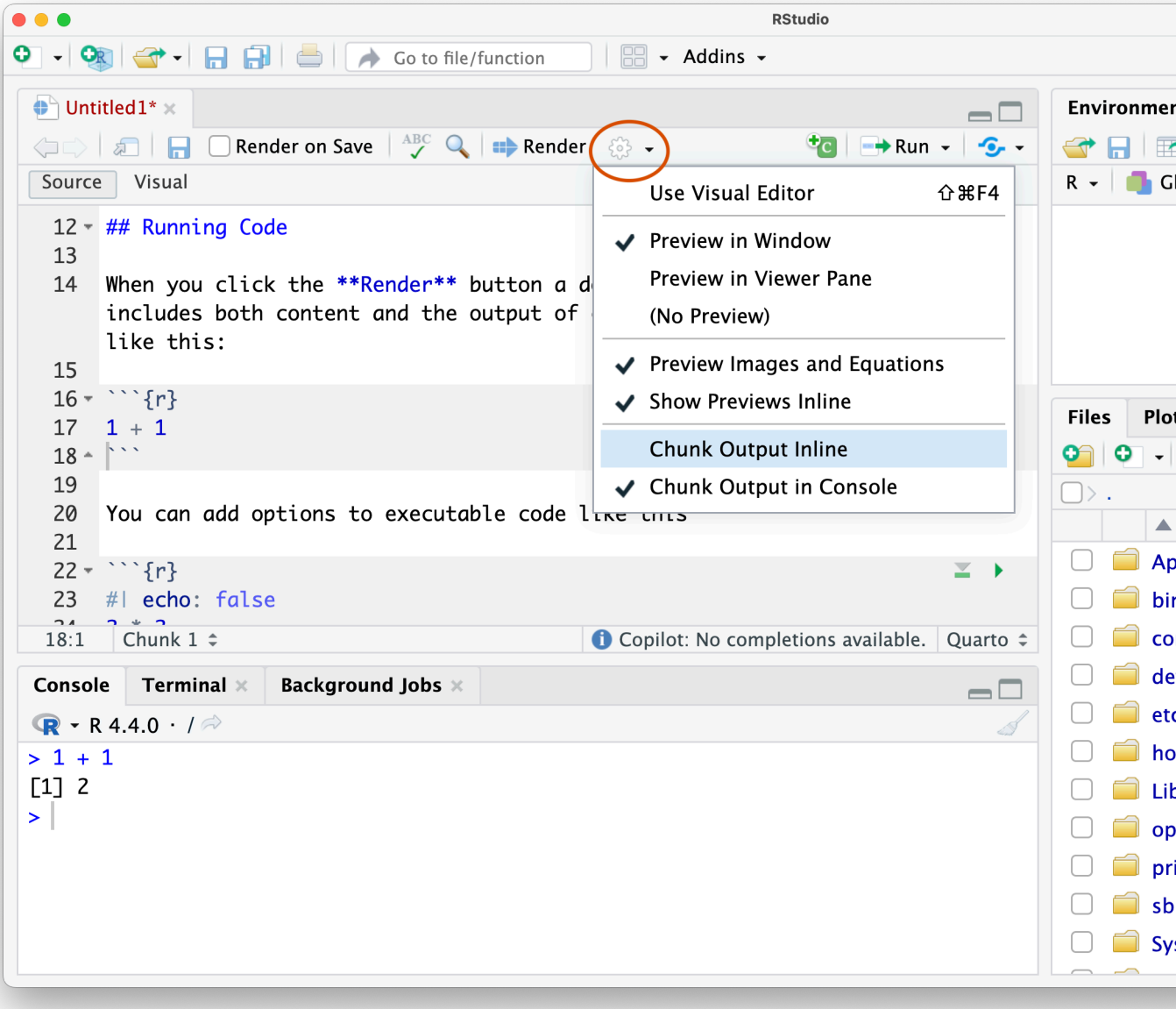


2. **Chunk output in console**: Your code be magically transported to the console, where it will be automatically run and the output will be shown *in the console*.



There is also a nice keyboard shortcut for running the line of code on which your cursor is: Command+Enter on a Mac or Ctrl+Enter on Windows and Linux.

You can change the settings for where your output appears by selecting the settings button (circled in the image below) and choosing "Chunk output inline" for the first option or "chunk output in console" for the second option.



I strongly prefer the second option of "chunk output in console", but R users are notoriously divided on where they like their output to appear (inline or in the console).

My suggestion is try both options for a few hours and see which one sparks joy.

Regardless of where your output appears (inline or in the console), I strongly suggest that you write all your code in a quarto document (rather than directly in the console). Writing your

code in a quarto document will save your code and results in a *reproducible* way AND help you to communicate your findings to other people.

1.6.4 Creating new code chunks in quarto

In a quarto document you can open a new R code chunk by writing three backticks followed by the letter "r" inside some curly parentheses and you need to "close" the code chunk with three backticks. Anything between these two lines (inside the grey box) is treated as R code, and anything outside these two lines is regular text.

````
```{r}


```
````

Since it's a pain to type all that every time you want to create a new code chunk, you can use one of two shortcuts to create a new code chunk:

1. Hit the "New Chunk" button, in RStudio, or
2. Use the Option+Command+i keyboard shortcut.

In your quarto document, create three new code chunks, one in each of the three ways described above. Conduct some basic mathematical calculations in each code chunk and run the code using any of the approaches described in the previous section (your output should appear either inline or in the console, depending on the settings). Then render your quarto document and look at the html output.

Add a chunk option to hide the code `#| echo: false` to one of your chunks (this echo: false chunk option must go on the first line of the chunk) and re-run your code (nothing should be different) and re-render your document and look at the output. What has changed?

> ⚠ Common issue: I can't find my rendered document
>
> If you can't find your rendered HTML document, find the location where you saved your quarto document and find the .html file with the same name. Open this file in your web browser – this is your rendered document. If it doesn't update, when you render your quarto document, there might be an error in your quarto document (check the "Background Jobs" tab in the console panel to see if there are any error messages).

Common issue: I can't run my code

R is very particular about the syntax for the code chunks. There must be no spaces in front of the backticks that define the code chunk and your chunk options that start with `#|` must be on the first line of the code chunk directly under the backticks and not have any spaces before it.
If your code shortcuts don't work, start super hard at your code chunk and see if there is anything wrong!

Part II

R Fundamentals

2 R Fundamentals

2.1 Doing math with R

Who needs a calculator, when you have R! I legitimately use R as a basic calculator all the time. And while R can do a lot more than just compute `1 + 1`, it's worth taking a moment to discuss basic mathematical operations of R.

Here are some helpful math symbols in R:

- Parentheses: `(`, `)`
- Exponents: `^` or `**`
- Multiply: `*`
- Divide: `/`
- Add: `+`
- Subtract: `-`

To follow along with the code examples that I provide in this chapter (and in this book in general), I recommend creating a new quarto document and practicing writing your own code in code chunks in your quarto document and running the code in the *console* by either pressing the green play/arrow button in the top right corner of the code chunks or using the Command+Return shortcut. Feel free to make some of your own notes in your quarto document outside. I recommend compiling/rendering your quarto document every now and then too!

Some basic mathematical computations you can compute in R include power calculations:

```
(3 + 5)^2
```

```
[1] 64
```

Division:

```
2 / 7
```

```
[1] 0.2857143
```

Note that R doesn't really care about spaces, so this is the same as

```
2/7
```

```
[1] 0.2857143
```

But my recommendation is to always place a single space around mathematical operators (i.e., `*`, `+`, `-`, etc, with the exception of the power operator `^`), so:

```
2 + 1
```

```
[1] 3
```

```
5 * 3
```

```
[1] 15
```

```
5^2
```

```
[1] 25
```

When writing code, even if the language itself doesn't require certain syntax like spaces, it is a good idea to choose a syntax *style* and stick with it.

You can place multiple computations in the same code chunk, like this:

````
```{r}
5 + 109
(4 + 2) * 4
```
````

When a code chunk contains multiple pieces of code, they will all be computed separately when you compile your document and the output will look like this:

```
5 + 109
```

```
[1] 114
```

```
(4 + 2) * 4
```

```
[1] 24
```

2.2 Code comments

When you have multiple pieces of code in a single code chunk (or even a single piece of code), it is recommended that you use code comments to explain what your code is doing. Since R treats everything inside a code chunk as code, if you want to write some text comments inside a code chunk, you can tell R that your text is not code by placing a `#` symbol at the beginning of your text like this:

```
# compute 4 times 5
4 * 5
```

```
[1] 20
```

R will ignore anything that follows a `#` symbol. So in the above code chunk, R will ignore the first line with the code comment "compute 4 times 5", and then it will compute the R code on the next line, `4 * 5`.

Code comments are really helpful for explaining what your code is doing. I usually reserve the text *outside* code chunks for more general discussion of my data, analysis, and results and I reserve code comments *inside* code chunks for explaining my code itself. Since I tend to forget the reasons behind certain decisions I made in my code, adding explanations in code comments helps me remember my motivations and intentions days, months, or even years later.

2.3 Scientific notation

When doing mathematical calculations in R, very quickly you are going to start encountering some very strange-looking output. For example, if I compute

```
1 / 70000
```

```
[1] 1.428571e-05
```

or

```
12^15
```

```
[1] 1.540702e+16
```

You can see that my output looks a little strange.

When a number is very big or very small, R gets lazy and decides that it doesn't want to print all of its digits. Rather than just making up random numbers, R is printing these numbers in scientific notation. `2e-05` means "0.00002", i.e., there is a 2 in the 5th decimal place. On the other hand, `2e+05` (with a `+` instead of `-`), corresponds to 200000, i.e., "2" with 5 0's after it.

> No commas allowed!
>
> Note that R doesn't allow for commas in numbers. If you want to write a large number, you have to remove the comma:
>
> ```
> # this is fine
> 70000
> ```
>
> ```
> [1] 70000
> ```
>
> ```
> # this is not fine -- note the "error" message
> 70,000
> ```
>
> ```
> Error: <text>:1:3: unexpected ','
> 1: 70,
>       ^
> ```

2.4 Mathematical functions

While being able to do addition, subtraction, and multiplication is super awesome, sometimes you will need to use more complex mathematical operations in your computations, such as the logarithm, exponential, and square root. Fortunately, there are **functions** in R that let you compute these operations.

A function is a piece of R code that is referenced using an alias or a name. A function typically takes an "argument", such as a number, and it does something to the argument, such as compute the logarithm, and then it returns the result.

To apply a function to a value, you write the name of the function (e.g., `log`), followed by some parentheses `()`, inside which you provide the argument or value that you want to apply the function to, as in: `log(2)`.

```
# compute the square root of 2
sqrt(2)
```

```
[1] 1.414214
```

```
# compute the log of 2
log(2)
```

```
[1] 0.6931472
```

```
# compute e^2
exp(2)
```

```
[1] 7.389056
```

2.5 Defining variables

One of the main features of coding in R is defining "objects" or "variables" (I use these terms interchangeably). Creating a variable essentially involves giving a value a name, allowing you to reference that value later. When we are ready to load some actual data, we will give that data a name by storing it in a variable.

Let's store the value `1` in a variable called `my_variable` using the **assignment operator**: `my_variable <- 1`. Think of the assignment operator `<-` as an arrow, pointing from the value on the right to the variable name on the left.

```
my_variable <- 1
```

Note that when you define a variable, no output is shown.

You can view the value of `my_variable` by writing it's name:

```
my_variable
```

```
[1] 1
```

You can think of `my_variable` as an alias for the value `1`. This means that anything that I could do to the value `1`, I can now do to `my_variable`, such as adding `2` to it:

```
my_variable + 2
```

```
[1] 3
```

> R is case-sensitive
>
> R is case-sensitive, which means that I must write my variable name exactly as it is written. For example, the following will yield an error:
>
> ```
> my_Variable
> ```
>
> ```
> Error in eval(expr, envir, enclos): object 'my_Variable' not found
> ```
>
> because the variable is called `my_variable`, not `my_Variable`.

> Defining variables using `=`
>
> Another way to define a variable is using "=".
> Below, I create `another_variable`, assign it the value `3`
>
> ```
> another_variable = 3
> another_variable
> ```
>
> ```
> [1] 3
> ```
>
> However, convention in the R community prefers the use of the `<-` assignment operator over the `=` assignment operator. So while `=` will work just fine, it is less common among seasoned R programmers.

Whenever we do a mathematical calculation using numeric values, we create a new numeric value, for example, the computation

```
1 + 1
```

```
[1] 2
```

creates the value `2`.

You can also assign the *output* of a mathematical calculation to a variable.

```
# assign the output of 1 + 1 to the variable one_plus_one
one_plus_one <- 1 + 1
one_plus_one
```

```
[1] 2
```

It is important to make the distinction that `one_plus_one` does not contain the mathematical *equation* `1 + 1`. Instead, it contains the numerical value, `2`, which is the *output* of the equation `1 + 1`.

`one_plus_one` doesn't remember that it was created by computing `1 + 1`, it just knows that the value it contains is `2`.

2.6 Exercise

Define a new object `prod` that contains the output of the product of 5 and 2. Print out `prod` by writing its name

2.7 Solution

```
prod <- 5 * 2
prod
```

```
[1] 10
```

2.7.1 Overwriting variables

Below I define `my_number` to be a variable containing the numeric value `5`.

```
my_number <- 5
```

Next, I define a new variable called `result` that contains the product of `my_number` and `7` and I print it out:

```
result <- my_number * 7
result
```

```
[1] 35
```

Here, `result` is defined based on the value of `my_number`.

What do you think would happen to `result` if I redefine `my_number` to now contain `8`?

```
# update the value of my_number to be 8
my_number <- 8
```

Do you think `result` will have changed? Try it yourself in RStudio or click the "Answer" tab below.

2.8 Question

What happens to `result`?

2.9 Answer

```
# define result using `my_number`
result <- my_number * 7
result
```

```
[1] 56
```

```
# modify my_number
my_number <- 8
```

Result does not change.

```
result
```

```
[1] 56
```

When we defined `result <- my_number * 7`, we assigned result to the *output* of `my_number * 7`, which is `56`.

Once it has been defined, `result` forgets all about `my_number`, it just remembers the value `56`.

This means that changing `my_number` *after* having defined `result` will have no effect on `result`. There is no link between the two variables, even though `result` was originally defined using `my_number`!

2.10 Exercise

Without running the code below, guess what the output/result will be:

```
value <- 1
computed_result <- value * 10 + 3^2
value <- value + 2
computed_result
```

2.11 Solution

Note that the first three lines of code all involve defining variables and so no output is shown when these are run. The final line of code will print out the value of `computed_result`.

The second line `computed_result <- value * 10 + 3^2` defines `computed_result` using `value`. Then the third line `value <- value + 2` updates value. Since `computed_result` is assigned to the *output* of `value * 10 + 3^2`, which is `19`, it doesn't care when `value` is subsequently updated, and so the `computed_result` is still just equal to `19`:

```
value <- 1
computed_result <- value * 10 + 3^2
value <- value + 2
computed_result
```

```
[1] 19
```

2.11.1 Variable names

While you can give your variables *almost* any name you like, there are a few rules that you need to follow.

While variable names can contain letters, numbers, underscores, and periods, the recommended convention specifies that variable names should contain purely **lowercase letters and numbers, with words separated by underscores**.

For example, `var_name` and `my_var` are considered "good" variable names, whereas `varName`, `VarName`, and `var.name` are not.

Note that variable names cannot *begin* with numbers or underscores. If you try to create variables whose names are illegal, you will get an error, such as:

```
1plus1 <- 1 + 1
```

```
Error: <text>:1:2: unexpected symbol
1: 1plus1
     ^
```

```
_var <- 1 + 1
```

```
Error: <text>:1:2: unexpected symbol
1: _var
     ^
```

2.12 Exercise

Which of the following are valid R variable names? Which ones are *good* variable names?

```
min_height
max.height
_age
MaxLength
min-length
2widths
```

2.13 Solution

- `min_height`: this is a **good** variable name
- `max.height`: this is a **valid** variable name, but not necessarily a "good" variable name (words should be separated with `_`, not `.`)
- `_age`: this is **not a valid** variable name (variable names cannot start with `_`)
- `MaxLength`: this is a **valid** variable name, but not necessarily a "good" variable name (words should be lowercase and separated with underscores)
- `min-length`: this is **not a valid** variable name (words should be separated with `_`, not the minus sign `-`)
- `2widths`: this is **not a valid** variable name (variable names cannot start with numbers)

3 Types

3.1 Common object types

So far, we have only worked with numbers in R. But there are many other kinds of values that you will encounter in your R journeys.

The main types of values that you'll encounter in R are:

- **Numeric**: numbers, e.g., `1`, `3.5`, `1e5` (which is scientific notation for 100,000)
- **Character**: free-form text values, e.g., `"California"`, `"John Doe"`, `"XJ1784"`
- **Logical** (Boolean): binary values corresponding to `TRUE` and `FALSE`

3.1.1 Numeric values

You can use the `class()` function to ask what type of object a value is. For example, the class of `9.6` is "numeric"

```
class(9.6)
```

```
[1] "numeric"
```

So is the class of `-5`

```
class(-5)
```

```
[1] "numeric"
```

and `1e7` (which is scientific notation for 10,000,000)

```
class(1e7)
```

```
[1] "numeric"
```

You can also use the `class()` function to ask the class of the value stored in a *variable*:

```
y <- 2 * 3 + 1
y
```

```
[1] 7
```

Identify the class of `y` (which contains the value `7`):

```
class(y)
```

```
[1] "numeric"
```

If your object has class `"numeric"`, you can do mathematical computations with it:

```
y + 2
```

```
[1] 9
```

```
y^3
```

```
[1] 343
```

3.2 Exercise

Identify the class (type) of the value `99.9`

3.3 Solution

```
class(99.9)
```

```
[1] "numeric"
```

3.3.1 Character values

Many datasets will contain text as well as numbers! In R, text has a "character" type.

The following contain examples of character type values:

```
"banana"
```

```
[1] "banana"
```

```
"I really like owls"
```

```
[1] "I really like owls"
```

And like numbers, you can save character type values in a variable:

```
char_var <- "my first character variable"
```

To view the contents of our character variable, you just type its name as usual:

```
char_var
```

```
[1] "my first character variable"
```

And I can ask what class it has using the class function:

```
class(char_var)
```

```
[1] "character"
```

What is the difference between a variable name and a character value? **Character values are always surrounded by quotes**, whereas variable names are not.

So if I try to type `banana` into my R console without the quotes, R will think I am referring to a variable name called `banana` and I will get a mildly rude error because I haven't defined any variables called `banana`:

```
banana
```

```
Error in eval(expr, envir, enclos): object 'banana' not found
```

The `object 'banana' not found` means that I've accidentally referred to a variable in my code (`banana`, in this case) that doesn't exist because I haven't defined it!

3.4 Question

What will be the class of the following variable that contains the value `"1"` with quotes (as opposed to `1` without quotes)?

```
var_one <- "1"
```

3.5 Solution

It's a character value

```
class(var_one)
```

```
[1] "character"
```

Note the quotes when I print out the variable:

```
var_one
```

```
[1] "1"
```

Does the answer to the question above surprise you? Remember, that whenever a value is surrounded by quotes, it is a character. It doesn't matter whether the value contains a number or not!

3.5.0.1 Mathematical computations with character values

What do you think will happen when you try to do mathematical operations with character (text) variables?

Let's define a character variable and try to add the number `1` to it:

```
# define a character variable
char <- "hello"
# try to add 1 to it
char + 1
```

```
Error in char + 1: non-numeric argument to binary operator
```

This `Error in char + 1 : non-numeric argument to binary operator` error will become very familiar to you in time. This error is a very unhelpful way that R tells us that we *cannot do mathematical operations with non-numeric (e.g., character) values*. Bummer.

So if we can't do math with character values, what's the point of them?

The purpose of character values is to store categorical and text information, which we will often use to do things like creating groups in our data (e.g., separating people according to the state in which they live).

3.5.1 Logical values

Next up are the "logical" ("Boolean") type values. These are fairly simple because there are only two of them: `TRUE` and `FALSE`.

```
TRUE
```

```
[1] TRUE
```

```
FALSE
```

```
[1] FALSE
```

For your logical value to be recognized as a logical value it must be in all caps. As if you're yelling (LIKE THIS). If you don't yell loud enough, R will complain. For instance, if I only yell the first letter, like this:

```
True
```

```
Error in eval(expr, envir, enclos): object 'True' not found
```

R says `Error: object 'True' not found`, which, if you were paying attention earlier, is code for "there is no *variable* named `True`. R is trying to find a variable called `True` and it's failing to do so which is unsurprising... because you haven't defined one! It doesn't know you're trying to use a logical `TRUE` value, because you didn't use all caps.

As with everything else, we can use `class()` to ask the class of logical values, and unsurprisingly, it tells us that the class of logical values are "logical":

```
class(TRUE)
```

```
[1] "logical"
```

```
class(FALSE)
```

```
[1] "logical"
```

```
logical_var <- TRUE
class(logical_var)
```

```
[1] "logical"
```

3.5.1.1 Mathematical computations with logical values

What do you think will happen when we try to do mathematical operations with logical values? Let's try:

```
# Try to subtract 3 from logical_var
logical_var - 3
```

```
[1] -2
```

```
# Try to add 0.2 to FALSE
FALSE + 0.2
```

```
[1] 0.2
```

Interestingly, it seems to work (unlike when we tried to do mathematical operations with character values)… But what is it doing?

If you could choose any numbers to convert `TRUE` and `FALSE` to, what would you choose? I would probably choose `TRUE` to be `1` and `FALSE` to be `0`. Fortunately for me, this is exactly what R does.

When they are involved in mathematical operations, logical values are converted to their numeric binary counterpart values of `0` (`FALSE`) and `1` (`TRUE`).

If you replaced `logical_var` (which contains `TRUE`) with `1` and `FALSE` with `0` in the code chunk above, does the output make sense now?

3.6 Exercise

Before you run the following code, predict which of the following four computations will work and what their output will be.

```
"TRUE" * 4
"banana" + "apple"
FALSE + 5
TRUE + "TRUE"
```

3.7 Solution

Only the third computation is valid.

The first computation doesn't work because `"TRUE"` is a character type (since it is surrounded by quotes) and you can't add characters and numbers.

```
"TRUE" * 4
```

```
Error in "TRUE" * 4: non-numeric argument to binary operator
```

The second computation doesn't work because you can't add character values to one another.

```
"banana" + "apple"
```

```
Error in "banana" + "apple": non-numeric argument to binary operator
```

This third computation does work because when used in a mathematical operation, the Boolean/logical value `FALSE` is treated as 0

```
FALSE + 5
```

```
[1] 5
```

The fourth computation doesn't work because `"TRUE"` is a character type (since it is surrounded by quotes) and you can't add characters to anything, including logical values.

```
TRUE + "TRUE"
```

```
Error in TRUE + "TRUE": non-numeric argument to binary operator
```

3.8 Type conversions

Let's define a numeric variable.

```
numeric_var <- 12.5
```

Let's try to convert the numeric object to a character type using the `as.character()` function. As you may have guessed, `as.character()` tries to convert whatever object given inside its parentheses (i.e., its "argument") to a character type.

```
# apply as.character() to numeric_var
as.character(numeric_var)
```

```
[1] "12.5"
```

Did it work? Notice that the 12.5 has some quotes around it now. That means that it's not a numeric value anymore. It's now a *text* (character) value that contains a number. This means that you can't do math with it.

But just to prove it to you, I'm going to try anyway (and unsurprisingly, I get an error):

```
as.character(numeric_var) * 5
```

```
Error in as.character(numeric_var) * 5: non-numeric argument to binary operator
```

To confirm that `as.character(numeric_var)` is indeed a character, I can apply the `class()` function to the character value created by `as.character(numeric_var)` by placing `as.character(numeric_var)` inside the `class()` parentheses:

```
class(as.character(numeric_var))
```

```
[1] "character"
```

This code is "nesting" the `class()` and `as.character()` functions.

Do you think that running the `as.character(numeric_var)` code has *modified* the original `numeric_var` object at all (i.e., does using `as.character()` on a variable actually convert that variable to a character type… or does it just print out the character type version of the variable)?

You can check by just outputting the `numeric_var` object by typing its name:

```
numeric_var
```

```
[1] 12.5
```

Notice there are no quotes, so it's still a numeric-type object. We can also confirm this using the class function:

```
class(numeric_var)
```

```
[1] "numeric"
```

If we wanted to update the `numeric_var` object so that it had a character type, we would need to "reassign" it to the output of `as.character(numeric_var)`. This would overwrite the old `numeric_var` and replace it with the new character version. I don't want to do this though, so I'm not going to run this code.

```
# To overwrite numeric_var with a character version, run:
numeric_var <- as.character(numeric_var)
numeric_var
```

```
[1] "12.5"
```

Just as there is an `as.character()` function, there is also an `as.numeric()` function (there's also an `as.logical()` function, but I don't think I've ever actually had used it)

Rather than bore you to bits by outlining all of the possible conversions you can do with `as.numeric()` and `as.character()`, you're going to do it for me. Use the `as.numeric()` and `as.character()` functions to fill in the following table (I've already filled in the first row for you):

`value`	Original type	`as.character(value)`	`as.numeric(value)`
`12.5`	numeric	`"12.5"`	`12.5`
`TRUE`	logical		
`FALSE`	logical		
`"howdy"`	character		
`"99"`	character		
`"1,200"`	character		

Pay close attention to which `value` entries have quotes and which values do not.

Did any of these results surprise you?

When you run `as.numeric("howdy")` or `as.numeric("1,200")`, you should get an `NA` value, which is a *missing value*, along with a warning:

```
as.numeric("howdy")
```

```
Warning: NAs introduced by coercion
```

```
[1] NA
```

Unlike an error, which means that your code did not actually run, when you get a *warning*, your code has run, but R is telling you it's not happy with you. When you get a warning, it's a good idea to take a pause and consider that perhaps your code may not have done what you expected.

The warning `NAs introduced by coercion` happens when you try to convert characters to numbers. **Characters cannot be converted to numbers**, unless the character contains a number without any additional characters, as you should have seen when filling in your table above.

This means that this works:

```
as.numeric("99")
```

```
[1] 99
```

But this does not:

```
as.numeric("1,200")
```

```
Warning: NAs introduced by coercion
```

```
[1] NA
```

`1,200` may look like a number, but the presence of the comma `,` means that R cannot parse the number inside the quotes. What is obvious to us is not always obvious to our computer overlords.

> Extracting numeric values from characters
>
> If you do want to convert a character containing a number, such as `"1,200"` to a numeric type, you can use the `parse_number()` function from the "readr" R library. You'll learn more about libraries in future chapters, so don't worry about running this code now–I just wanted to let you know that this exists!

```
# uncomment and run the next line of code to install the "readr" library:
# install.packages("readr")

library(readr)
parse_number("1,200")
```

```
[1] 1200
```

```
parse_number("I have 49 bananas")
```

```
[1] 49
```

3.9 `NA` values

Let's talk briefly about the `NA` value (missing values). They are everywhere. You will often find that once they make their way into your data in R, missing values have a way of permeating your existence.

A missing value, `NA`, is a special type of object. Like `TRUE` and `FALSE`, your `NA` must be in all caps (i.e., you must yell when you type it).

For example, this is the NA value:

```
NA
```

```
[1] NA
```

But R thinks that the lowercase version, `na`, is a variable (and R then complains when I type `na` because I haven't defined a variable called `na`):

```
na
```

```
Error in eval(expr, envir, enclos): object 'na' not found
```

`NA` values are annoying mostly because the result of any mathematical operation with an `NA` is always `NA`:

```
NA + 5
```

```
[1] NA
```

```
NA * 0
```

```
[1] NA
```

Armed with the knowledge that character values will be converted to `NA` when you apply `as.numeric()`, but numeric values can be converted to character values using `as.character()` just fine, try the following exercise.

3.10 Exercise

Without running the following pieces of code, which of the following pieces of code will work, and what do you think the output will be?

```
as.numeric("TRUE") + 3
```

```
as.character(TRUE + 12)
```

```
as.character(as.numeric("35"))
```

3.11 Solution

```
as.numeric("TRUE") + 3
```

```
Warning: NAs introduced by coercion
```

```
[1] NA
```

```
as.character(TRUE + 12)
```

```
[1] "13"
```

```
as.character(as.numeric("35"))
```

```
[1] "35"
```

3.12 Asking questions with logical operations

Let's go ahead and create two band-new numeric variables, `x` and `y`:

```
x <- 2
y <- 4
```

I'm now going to ask R some questions about `x` and `y`.

First question: *"Is x equal to 2?"*

```
x == 2
```

```
[1] TRUE
```

R answered "Yes!" But in R, "Yes!" is `TRUE`.

To ask a question of equality, we used two equals symbols `==`.

Next question: *"Is* ***x*** *less than or equal to 1?"*

```
x <= 1
```

```
[1] FALSE
```

Again, R came through with an answer (this time `FALSE`). To ask a question of "less than or equal to", we used a "less than" symbol `<` followed by an equals symbol `=`, giving me `<=`.

Although both `==` and `<=` kind of look like the assignment operators `=` and `<-`, they're not affiliated in any way.

`==` and `<=` are "question asking" operators, or "*logical operators*" if you want to sound fancy (they're called "logical operators" because they always result in a `TRUE` or `FALSE` logical result).

Before we asked if `x` was equal to `2` (`x == 2`), but we can also ask whether `x` is equal to `y`:

```
x == y
```

```
[1] FALSE
```

As well as "is `x` *not* equal to y" using the "not equal to" logical question operator of an exclamation point followed by an equals symbol `!=` (not equals):

```
x != y
```

```
[1] TRUE
```

In fact, for any logical question we ask, we can ask its *inverse* by placing the original question in parentheses and prefacing it with a `!`. So the following is another way to ask `x != y`:

```
!(x == y)
```

```
[1] TRUE
```

The parentheses are necessary to tell R that we want the inverse of the entire question `x == y` (not just of `x`).

Here are some more questions:

"Is `x` strictly greater than `y`?"

```
x > y
```

```
[1] FALSE
```

"Is `x` greater than or equal to `y`?"

```
x >= y
```

```
[1] FALSE
```

"Is x strictly less than y?"

```
x < y
```

```
[1] TRUE
```

It's almost like we're talking to R and it's *replying!* This is going to be really important later, since we will use these kinds of logical operations to filter to various subsets of our data based on logical conditions/questions.

4 Vectors

4.1 Defining a vector

While being able to store numbers and text in a variable, such as `x <- 12`, is super neat, the real power of variables is being able to store a wide variety of objects, including an entire dataset, model, or even a data visualization!

However, before we try to create an object containing an entire dataset, let's start with a variable that contains just a collection of values, such as might appear in a single column of a dataset.

The kind of object that contains a collection of values is called a **vector**. Let's create a vector that contains the ages of 5 people and store it in a variable called `age`:

```
age <- c(12, 19, 22, 35, 18)
```

Just like our variables in the previous chapters, we can look at the contents of `age` by typing its name:

```
age
```

```
[1] 12 19 22 35 18
```

But unlike our previous variables, `age` contains many values, and this is because `age` is a vector, which is defined by "concatenating" values together using the `c()` function.

Note that the `[1]` at the beginning of the output is just telling you that the first value is at index position/location 1 (i.e., that it is the *first* entry). If our vector is so long that its output spills onto multiple lines, such as the vector below, notice that the second line in the output has a different number inside the square parentheses. This is just telling you which index position the *first entry on the second* line has (and it may change based on the width of your window when the code was run).

```
long_age <- c(12, 19, 22, 35, 18, 44, 23, 56, 23, 12, 18, 19, 50, 60, 77, 54,
              34, 66, 34, 32, 19, 20, 21, 18, 19, 72, 27, 43, 63, 23, 12, 18,
              19, 50, 60, 77, 54)
long_age
```

```
 [1] 12 19 22 35 18 44 23 56 23 12 18 19 50 60 77 54 34 66 34 32 19 20 21 18 19
[26] 72 27 43 63 23 12 18 19 50 60 77 54
```

The `c()` function asks R to place all of the values provided inside the parentheses of `c()`, which are separated by commas, into a single vector object.

You might think that when we apply `class()` to our `age` vector object, it would return "vector". However, the *type* or *class* of a vector is actually just the *type* or *class* of the values it contains, which in this case, is "numeric"

```
class(age)
```

```
[1] "numeric"
```

This means that if we had created a vector of names, such as the one below:

```
names <- c("Dean", "Xiao", "Sara", "Ravi", "Maya")
names
```

```
[1] "Dean" "Xiao" "Sara" "Ravi" "Maya"
```

Then our `names` vector object will have class "character":

```
class(names)
```

```
[1] "character"
```

Vectors are great. Rather than having to carry around all of my individual numbers and words individually, I can put them all into a little vector "bag" and carry them around together.

However, vectors are a little bit particular. Let's try and create a vector that contains multiple different types of values, such as numbers and text:

```
multi_vec <- c(1, 9, "banana", 10, -1)
multi_vec
```

```
[1] "1"      "9"      "banana" "10"     "-1"
```

What class/type do you think this `multi_vec` vector will have? Take a close look at the values in the `multi_vec` output above. Notice the quotes around the numbers. Let's check the class of `multi_vec`:

```
class(multi_vec)
```

```
[1] "character"
```

Interesting. `multi_vec` is a character vector, despite the fact that most of the values used to create it were numbers.

This is because **vectors can only contain values of a single type**.

R will let you create a vector using values of multiple different types (such as numbers and characters), but in the actual vector object that is created, all of the values will be *converted* to the same type, in this example, that type was "character".

What do you think will happen if we try to create a vector with numeric and logical values (`TRUE`/`FALSE`) values? Below I try to combine some numbers with a `TRUE` and a `FALSE` into the same vector.

```
multi_vec2 <- c(1, 5, TRUE, FALSE, -9)
```

Notice how the output when I print the name of the object differs from the object I defined above:

```
multi_vec2
```

```
[1]  1  5  1  0 -9
```

What has happened here? Just like R converted my numbers to a character when a character value was present in the vector, here, R has converted my logical values (my `TRUE` and `FALSE` values) to numbers (corresponding to `1` and `0`, respectively).

How can you tell what type a vector will have when it is created using values of various different types? It turns out that there is a hierarchy of types:

Character > Numeric > Logical

This doesn't mean that characters are better than numerics and logicals, but rather this means that if a character value is present among the values that define the vector, then all values in the vector will be converted to the character type. If there are no characters being used to define the vector, but there are numeric values and logical values, then all of the values will be converted to the numeric type.

4.2 Exercise

Before you run the code below, predict what vector will be created from the code below. Consider the type hierarchy above.

```
vector_example <- c(TRUE, 4, "hello", FALSE, 0)
```

4.3 Solution

Since the vector definition includes a character value, all values in the resulting vector have a character type (notice the quotes)

```
vector_example <- c(TRUE, 4, "hello", FALSE, 0)
vector_example
```

```
[1] "TRUE"  "4"     "hello" "FALSE" "0"
```

```
class(vector_example)
```

```
[1] "character"
```

4.4 Working with vectors: vectorization

While it's super neat that we can collect all of our numbers and words in a single vector object (although no mixing of words and numbers), the actual cool thing about vectors is that it makes it really easy to do computations on all of our values at once.

If we define our `age` vector below:

```
age <- c(12, 18, 22, 21, 17)
```

Then we can demonstrate a really neat property of vectors: if I subtract `1` from the vector object `age`, R will subtract `1` from *every value in the vector* at once:

```
age - 1
```

```
[1] 11 17 21 20 16
```

Let's create an entirely new vector object, that I'm going to creatively call `age2`, which contains the original `age` vector multiplied by 2.

```
age2 <- age * 2
```

If we want to look at what values `age2` contains, we can print out its name, and lo and behold, all of the values in `age2` correspond to the original values in `age`, multiplied by 2:

```
age2
```

```
[1] 24 36 44 42 34
```

The fact that mathematical operations applied to a vector are applied separately to each individual value in the vector is called **vectorization**.

While this might not seem *that* cool to you. Trust me when I say that this 100% *is* cool. Imagine how tired your fingers would get if you had to subtract `1` from every individual value in a vector containing 1000 values. With vectorization, I just have to subtract `1` from the vector object itself, and I'm done.

So now that we have two age vectors, `age` and `age2`, which are both printed below:

```
age
```

```
[1] 12 18 22 21 17
```

```
age2
```

```
[1] 24 36 44 42 34
```

What do you think will happen if I try to add these two vectors together?

```
age2 + age
```

```
[1] 36 54 66 63 51
```

Because vectors are *vectorized*, the entries were added *element-wise*. This means that the first value in `age` was added to the first value in `age2`, and similarly for the second value, and so on.

Note that in the `age2 + age` computation above, I printed out the resulting vector, but I did not *save* this vector as an object. Having been computed, the `age2 + age` vector has now been lost to the ether. If I wanted to use this resulting vector for something, I would need to *save* it as a new variable (such as `age3 <- age2 + age`).

Since we can add vectors together, it follows that we can probably also subtract them from one another and multiply them by one another, and all of these operations will happen *element-wise*. For example, we can divide `age2` by `age`, and we will get a vector containing 5 2s, because each entry in `age2` is twice the corresponding entry in `age`:

```
age2 / age
```

```
[1] 2 2 2 2 2
```

In this example, both `age` and `age2` have the same *length*. That is, they have the same number of entries.

What do you think will happen if we try to do a computation with vectors of different lengths? Let's try to subtract a vector of length 2 (`c(1, 2)`) from `age`, which has length 5:

```
age - c(1, 2)
```

```
Warning in age - c(1, 2): longer object length is not a multiple of shorter
object length
```

```
[1] 11 16 21 19 16
```

Interestingly, it worked, but we got a warning message "*longer object length is not a multiple of shorter object length*". Take a look at the output of the code above. Can you figure out what R did here?

R is being very presumptuous. Without even bothering to ask me, it went ahead and repeated the values in the shorter vector, `c(1, 2)`, to match the length of the longer vector, `age`, i.e., until it gets to 5 values in total, so it is essentially doing this:

```
age - c(1, 2, 1, 2, 1)
```

```
[1] 11 16 21 19 16
```

Personally, I'd prefer if R gave me an error when I try to do mathematical operations with vectors of different lengths. But unfortunately for me, I didn't write the R programming language, I just use it.

To be fair, R did provide a *warning* that I was trying to do a computation with vectors of different lengths. But it's really easy to unintentionally ignore warnings.

If you ever see this warning, it probably means that you've made a mistake somewhere. I can guarantee that you almost never actually want to do mathematical operations with vectors of different lengths.

In summary, my advice is *don't ignore* the warning message "*longer object length is not a multiple of shorter object length*". Check your lengths and check your code output!

Speaking of "checking your lengths", it might be helpful if I told you how to do that! You can compute the length of a vector by applying the `length()` function to it:

```
length(age)
```

```
[1] 5
```

4.4.1 Vectorized logical operations

Do you remember when we asked questions about the values we stored in our variables/objects, like `x == 1`? Well, it turns out that we can ask the same questions of vectors! And, you guessed it, those questions will be asked *element-wise*.

Let's keep working with our `age` vector:

```
age
```

```
[1] 12 18 22 21 17
```

If we ask "which `age` entries are greater or equal to 18" using the code below:

```
age >= 18
```

```
[1] FALSE  TRUE  TRUE  TRUE FALSE
```

This question gets asked separately for every entry in `age`. The resulting logical vector above is `TRUE` for the `age` entries that are 18 or above, and is `FALSE` for the `age` entries that are less than 18.

Let's ask another question: "which `age` entries are equal to 17"?

```
age == 17
```

```
[1] FALSE FALSE FALSE FALSE  TRUE
```

It looks like only the last one is.

What about "which `age` entries are *not* equal to 21"?

```
age != 21
```

```
[1]  TRUE  TRUE  TRUE FALSE  TRUE
```

What if we want to ask which `age` entries are equal to *either* 17 or 18? The natural thing to try is:

```
age == c(17, 18)
```

```
Warning in age == c(17, 18): longer object length is not a multiple of shorter
object length
```

```
[1] FALSE  TRUE FALSE FALSE  TRUE
```

But notice our `longer object length is not a multiple of shorter object length` warning!

If we take a look at `age` again,

```
age
```

```
[1] 12 18 22 21 17
```

It looks like `age == c(17 18)` gave us the right answer (as in, we got `TRUE` for the second and fifth entries), but I never like to ignore a "*longer object length is not a multiple of shorter object length*" warning message.

Since the code `age == c(17, 18)` worked, it should probably also work if we switch the order of 18 and 17 in our question, right?

```
age == c(18, 17)
```

```
Warning in age == c(18, 17): longer object length is not a multiple of shorter
object length
```

```
[1] FALSE FALSE FALSE FALSE FALSE
```

This time we still get some output, along with our "longer object length is not a multiple of shorter object length" warning, but the answer is *wrong*. All of the entries in the output vector are `FALSE`.

This is because R is doing that pesky recycling thing again. This question is equivalent to:

```
age == c(18, 17, 18, 17, 18)
```

```
[1] FALSE FALSE FALSE FALSE FALSE
```

And the question is being asked element-wise (is the first entry equal to `18`? Is the second entry equal to `17`? Is the third entry equal to `18`?). The only reason we got the correct answer the first time is because we got lucky with our recycling.

The moral of the story is: *don't ignore* the warning message "*longer object length is not a multiple of shorter object length*". Check your lengths!

4.4.2 The `%in%` operator

Okay, so if `age == c(17, 18)` isn't how we ask the question of which `age` entries are equal to `17` or `18`, how *do* we ask that question?

We are going to use a new operator, `%in%`. To use `%in%`, just replace `==` in the question above, with `%in%`!

```
# use %in% to ask which entries in age are equal to 17 or 18
age %in% c(17, 18)
```

```
[1] FALSE  TRUE FALSE FALSE  TRUE
```

Et voila! This time it tells us that the second and fifth entries are equal to either 17 or 18, *and* we didn't get any warnings! Yay!

4.5 Summary functions for vectors

So I showed you earlier that you can use the `length()` function to compute the number of values in a vector, but this is just one of many functions you can use to summarize a vector.

For example, the `sum()` function can be used to add up all the entries in a (numeric) vector:

```
sum(age)
```

```
[1] 90
```

The `mean()` function computes the mean/average:

```
mean(age)
```

```
[1] 18
```

The `median()` function computes the median:

```
median(age)
```

```
[1] 18
```

The `var()` function computes the variance:

```
var(age)
```

```
[1] 15.5
```

The `sd()` function computes the standard deviation:

```
sd(age)
```

```
[1] 3.937004
```

The function `length()` tells you how many entries the vector contains:

```
length(age)
```

```
[1] 5
```

The `min()` function tells you the smallest value:

```
min(age)
```

```
[1] 12
```

And the `max` function tells you the biggest value:

```
max(age)
```

```
[1] 22
```

And we can combine some of the super fun logical stuff from above with `sum()` to compute even more interesting summaries.

First, note that when you apply `sum()` (or `mean()`) to a vector of *logical* values, it treats `FALSE` as `0` and `TRUE` as `1`. So when you apply `sum()` to a logical vector, it adds up the number of `TRUE` values:

```
# compute the number of TRUE values
sum(c(TRUE, FALSE, FALSE, TRUE))
```

```
[1] 2
```

So we can use this to do things like add up the number of values in `age` that are either 17 or 18:

```
sum(age %in% c(17, 18))
```

```
[1] 2
```

Or add the number of values in `age` that are strictly greater than 15:

```
sum(age > 15)
```

```
[1] 4
```

4.6 Exercise

Try to use the functions above to compute the *proportion* of people whose age is strictly greater than 15

4.7 Hint

Consider using the `sum()` function and the `length()` function.

4.8 Solution

```
sum(age > 15) / length(age)
```

```
[1] 0.8
```

4.9 Extracting information from vectors

We know how to put values into a vector (i.e., using `c()`), but how do we get them out again?

To extract values from a vector, you can type the name of the vector that you want to extract the values from, followed by some square parentheses `[]`, inside which you place the numeric location (index) of the value you want to extract.

Let's keep working with `age`:

```
age
```

```
[1] 12 18 22 21 17
```

To extract the first entry from `age`:

```
age[1]
```

```
[1] 12
```

To extract the fourth entry from `age`:

```
age[4]
```

```
[1] 21
```

If you want to extract the final entry in a vector and you don't immediately know its length, you can do something clever like this:

```
age[length(age)]
```

```
[1] 17
```

Why does this work? Remember that `length(age)` tells you how many values there are in `age` (i.e., 5), and so this is equivalent to `age[5]`, which will extract the final value from the `age` vector.

4.9.1 Removing a value from a vector

If I wanted to *extract* the first entry from `age`, I would write, `age[1]`. This is actually essentially creating a new vector that just consists of the first value in `age` (although I haven't saved this vector anywhere).

If I wanted to instead create a new vector that *removed* this first entry, I would write

```
# remove the first entry from age
age[-1]
```

```
[1] 18 22 21 17
```

So `age[1]` *extracts* the first entry from `age` and `age[-1]` *removes* the first entry from age.

Keep in mind that none of these operations so far have modified the original `age` object:

```
age
```

```
[1] 12 18 22 21 17
```

`age[1]` prints the result of extracting the first entry from `age`, but I am not saving this result, nor am I overwriting our `age` vector with this value. Remember that the output of your code is only saved when you assign the result of the computation to something using `<-`!

4.10 Exercise

Remove the fourth entry from `age`

```
age <- c(12, 18, 22, 21, 17)
```

4.11 Solution

```
age[-4]
```

```
[1] 12 18 22 17
```

4.11.1 Extracting/removing multiple entries from a vector

So far we have just extracted and removed a single entry from `age` at a time. But often, we want to be able to extract or remove multiple entries at once. That is, I want to provide multiple values inside my square parentheses `[ ]`, but they only accept one value!

Let's quickly remind ourselves of what `age` contains:

```
age
```

```
[1] 12 18 22 21 17
```

If I try to provide two values inside my `[ ]` parentheses, I get an error. For example, below, I try to extract both the first and third entries (`12` and `22`) from `age` at once by just providing two numbers inside the square parentheses:

```
age[1, 3]
```

```
Error in age[1, 3]: incorrect number of dimensions
```

But I got an error :(. The error `"incorrect number of dimensions"` is telling me that it only wants one object, not two inside the square parentheses!

So I need to provide two position values (1 and 3), but I can only provide one object inside. How could I create *one* object that contains *two* values? One object... two values... Hmmmmmmmm. Have you figured it out yet? Why don't you put the two values inside a *vector*! Wow! Neat idea!

Let's try and extract the first and third entries from `age` at once, by providing a vector `c(1, 3)` inside the square parentheses:

```
age[c(1, 3)]
```

```
[1] 12 22
```

It worked!

Maybe we can also remove the first and third entries by providing the negative of this vector:

```
age[-c(1, 3)]
```

```
[1] 18 21 17
```

That worked too! Vectors are great.

4.12 Definining integer sequences

What if you wanted to define a really long vector of sequential integers like:

```
my_long_vector <- c(101, 102, 103, 104, 105, 106, 107, 108, 109, 110,
                    111, 112, 113, 114, 115, 116, 117, 118, 119, 120,
                    121, 122, 123, 124, 125, 126, 127, 128, 129, 130,
                    131, 132, 133, 134, 135, 136, 137, 138, 139, 140,
                    141, 142, 143, 144, 145, 146, 147, 148, 149, 150,
                    151, 152, 153, 154, 155, 156, 157, 158, 159, 160,
                    161, 162, 163, 164, 165, 166, 167, 168, 169, 170,
                    171, 172, 173, 174, 175, 176, 177, 178, 179, 180,
                    181, 182, 183, 184, 185, 186, 187, 188, 189, 190,
                    191, 192, 193, 194, 195, 196, 197, 198, 199, 200)
```

```
my_long_vector
```

```
  [1] 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118
 [19] 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136
 [37] 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154
 [55] 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172
 [73] 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190
 [91] 191 192 193 194 195 196 197 198 199 200
```

Writing this out made my fingers really tired. And if you've learned anything about me so far, you'll know how much I hate it when my fingers get tired.

Fortunately, there's a better way. If I want to define a vector containing a sequence of consecutive integers like in `my_long_vector`, I can use the `:` syntax. For example, to create the vector `c(1, 2, 3, 4)`, I could write:

```
1:4
```

```
[1] 1 2 3 4
```

Note that I haven't saved this vector (I just wrote the code to create it and then the result was printed and subsequently lost to the ether), but I could if I wanted to. Below, I save the above vector in an object called `vector1to4`:

```
vector1to4 <- 1:4
```

And then I can access this vector by writing its name:

```
vector1to4
```

```
[1] 1 2 3 4
```

The syntax to create a sequential vector of integers is `start:stop`. So if `1:4` created the vector `c(1, 2, 3, 4)`, how might you create the long vector I saved in `my_long_vector` above? Well the starting value is 101 and the last (stop) value is 200, so maybe we can try `101:200`:

```
101:200
```

```
  [1] 101 102 103 104 105 106 107 108 109 110 111 112 113 114 115 116 117 118
 [19] 119 120 121 122 123 124 125 126 127 128 129 130 131 132 133 134 135 136
 [37] 137 138 139 140 141 142 143 144 145 146 147 148 149 150 151 152 153 154
 [55] 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172
 [73] 173 174 175 176 177 178 179 180 181 182 183 184 185 186 187 188 189 190
 [91] 191 192 193 194 195 196 197 198 199 200
```

Perfecto!

The cool thing about this is that we can use it to *extract* segments of a vector, for instance, to extract the first four entries of `age`, we could write

```
age[1:4]
```

```
[1] 12 18 22 21
```

4.13 Logical subsetting

Sometimes you might want to extract all the entries from a vector that satisfy a certain condition. To do that, you first need to understand how to use a logical vector to extract values.

If I provide a vector of `TRUE`s and `FALSE`s inside the square parentheses, R will extract all the values whose corresponding entry in the logical vector are `TRUE`.

For example, the following code will extract the first, fourth, and fifth entries:

```
age[c(TRUE, FALSE, FALSE, TRUE, TRUE)]
```

```
[1] 12 21 17
```

OK. So I would never actually write out such a vector, because I have a life, but remember when we asked logical questions of our vectors, such as, which entries in `age` are greater than or equal to 18?

```
age >= 18
```

```
[1] FALSE  TRUE  TRUE  TRUE FALSE
```

This creates a logical vector for us *and* the `TRUE` values correspond to the values in the vector for which the condition is true. Do you see where I'm going with this?

If you want to extract all of the values in a vector for which a logical condition is true, you can provide the logical condition inside the square parentheses of the vector!

The following code will extract the values in `age` that are all greater or equal to 18:

```
age[age >= 18]
```

```
[1] 18 22 21
```

This is great for simple conditions, but what about more complex conditions, such as ages that are at least 17 but less than 20? Unfortunately, the R code that would correspond to the mathematical syntax $17 \leq x \leq 20$ doesn't work in R:

```
17 <= age < 20
```

```
Error: <text>:1:11: unexpected '<'
1: 17 <= age <
              ^
```

Instead, we have to combine multiple conditions in R, using `|` if we want *either* condition to be true (the logical "OR") and `&` if we want *both* conditions to be true (the logical "AND").

The condition that the age is at least 17 but less than 20 is the combination of the two conditions `age >= 17` and `age < 20`, and we need both of these things to be true so we can write

```
# age at least 17 and less than 20
(age >= 17) & (age < 20)
```

```
[1] FALSE  TRUE FALSE FALSE  TRUE
```

Combining conditions with an `&` will only be `TRUE` if both conditions are `TRUE`.

Let's use this "AND" condition to *extract* all of the entries in `age` that are both greater or equal to 17 *and* less than 20.

```
age[(age >= 17) & (age < 20)]
```

```
[1] 18 17
```

On the other hand, combining conditions with an `|` "OR" operator will be `TRUE` if *either* `TRUE` (even if the other one is `FALSE`).

So for example, the ages that are *either* less than 16 *or* greater than 20 are the first, third, and fourth entries

```
(age < 16) | (age > 20)
```

```
[1]  TRUE FALSE  TRUE  TRUE FALSE
```

And we can use this `|` operator to *extract* all of the entries in `age` that are *either* less than 16 *or* greater than 20:

```
age[(age <= 16) | (age > 20)]
```

```
[1] 12 22 21
```

Sorry if your brain hurts.

Let's practice a little.

4.14 Exercise

Here is a new vector, `vec`.

```
vec <- c(4, 19, 2, 2, 3, 90, 55, 12)
```

Extract the entries that are less than 10

4.15 Solution

```
vec[vec < 10]
```

```
[1] 4 2 2 3
```

4.16 Exercise

Extract the entries of `vec` that are less than 25 but greater than 10

4.17 Solution

Since I need both `vec < 25` and `vec > 10` to be `TRUE`, this involves an `&` statement:

```
vec[(vec < 25) & (vec > 10)]
```

```
[1] 19 12
```

4.18 Exercise

Extract the entries of `vec` that are either less than 10 or equal to 55

4.19 Solution

Since I only need either `vec < 10` and `vec == 55` to be `TRUE`, this involves an `|` statement:

```
vec[(vec < 10) | (vec == 55)]
```

```
[1]  4  2  2  3 55
```

4.20 Named vectors

If we wanted each entry in `age` to have its own name, we could use the `names()` function.

Note that `names(age)` extracts an attribute of `age` (its names, which are currently nonexistent), and by assigning `names(age)` to something, we can update the names.

Below, we update the names of the entries in `age` to be "Dean", "Xiao", "Sara", "Ravi", and "Maya", respectively.

```
names(age) <- c("Dean", "Xiao", "Sara", "Ravi", "Maya")
```

Note that this *does* modify the `age` object directly (specifically, it modifies the *names* of age through assignment `<-`):

```
age
```

```
Dean Xiao Sara Ravi Maya
  12   18   22   21   17
```

While you can define a vector and then update its names later, you can alternatively create the names when you initially create the vector using the syntax below.

```
age <- c("Dean" = 12, "Xiao" = 18, "Sara" = 22, "Ravi" = 21, "Maya" = 17)
age
```

```
Dean Xiao Sara Ravi Maya
  12   18   22   21   17
```

Take a look at the output of this "named vector". How does it look different from the original unnamed `age` vector? The name for each entry appears above the value, and the `[1]` at the beginning of the vector that denotes the first entry is gone! I have no explanation for why this second thing happens.

The cool thing about named vectors is that you can extract an entry from a vector using its name. For example, if I just wanted Ravi's age, I could write:

```
age["Ravi"]
```

```
Ravi
  21
```

Note that the name of the entry must be a character string, i.e., I have to have quotes around `"Ravi"`.

I can also extract several entries from the vector using a vector of the names I want, just as I did with numbers representing the index positions I wanted to extract:

```
age[c("Maya", "Ravi")]
```

```
Maya Ravi
  17   21
```

4.21 Factors

Before moving on to actually working with data (yay!), I want to talk briefly about factors.

Factors are essentially vectors coupled with a set of allowed values. For example, you will often find states (e.g., US states CA, OR, NY, etc) stored as a factor since there are a pre-defined set of states.

As an example, let's create a character vector of 10 Australian states (where some states appear more than once–there are only 7 states total):

```
australia_states <- c("New South Wales", "New South Wales", "Queensland", "Tasmania", "ACT",
australia_states
```

```
 [1] "New South Wales"    "New South Wales"    "Queensland"
 [4] "Tasmania"           "ACT"                "South Australia"
 [7] "Western Australia"  "Northern Territory" "New South Wales"
[10] "Queensland"         "ACT"
```

And let's create a factor variable version of this vector using the `factor()` function:

```
australia_states_fct <- factor(australia_states)
australia_states_fct
```

```
 [1] New South Wales    New South Wales    Queensland         Tasmania
 [5] ACT                South Australia    Western Australia  Northern Territory
 [9] New South Wales    Queensland         ACT
7 Levels: ACT New South Wales Northern Territory ... Western Australia
```

What are two differences between the output of the character vector, `australia_states` and the factor `australia_states_fct`?

1. The factor entries are not surrounded by quotes
2. Underneath the factor output some text says `7 Levels: ACT New South Wales ... Western Australia` – these list the unique levels in the vector.

Remember that we couldn't convert a character vector to a numeric vector:

```
as.numeric(australia_states)
```

```
Warning: NAs introduced by coercion
```

```
 [1] NA NA NA NA NA NA NA NA NA NA NA
```

It turns out that we can convert a factor to a numeric vector:

```
as.numeric(australia_states_fct)
```

```
 [1] 2 2 4 6 1 5 7 3 2 4 1
```

But what is it doing? It replaces all instances of the first level, `ACT`, with `1`, all instances of the second level, `New South Wales`, with `2`, etc. This can be very handy, but also very dangerous.

To demonstrate why, let's create a factor containing numbers (factors are not just reserved for text!)

```
fct <- factor(c(5, 1, 1, 3, 6, 5, 5, 6, 1))
fct
```

```
[1] 5 1 1 3 6 5 5 6 1
Levels: 1 3 5 6
```

Notice that the factor *levels* are unique (i.e,. `1` only appears once in the levels, even though there are three `1`s in the factor itself)

If I try to convert the factor to a numeric variable, the numbers get all messed up:

```
as.numeric(fct)
```

```
[1] 3 1 1 2 4 3 3 4 1
```

What R is doing here is replacing the first level entry, `1`, with `1` (so the `1`s remain untouched), it is replacing the second level entry, `3`, with `2`, and replacing the third level entry, `5`, with `3`, and so on.

It's hard to give concrete advice about factors at this stage because they only really become relevant when you start doing fancy statistical modeling or creating sophisticated graphics using categorical data. For the most part, unless you are using a model that requires factor variables, your life will be slightly easier if you store your categorical/text information as character vectors and your numeric information as numeric vectors rather than factors. Once you get to the modeling stage, you'll see that 80% of the functions that require your categorical data to be a factor will automatically convert them to a factor for you anyway.

5 Data Frames

Let's imagine that you have an actual dataset containing a collection of columns ("variables" in data terminology) and rows ("observations" in data terminology). For example, maybe your dataset is:

Name	Age	Favorite Color
Dean	12	Blue
Xiao	18	Green
Sara	22	Red
Ravi	21	Purple
Maya	17	Blue

In this case, your dataset has three *"variables"* (name, age, and favorite color), and five *"observations"* for each of these variables (corresponding to the values for 5 unique people). You might even recognize this data from the previous chapter: the values in the "Age" column are the values from our `age` vector and the names correspond to the names that we gave our age vector, along with some extra "Favorite Color" information.

While we could define a separate vector variable in R for each column in our data, such as

```
# three vectors containing info on each person's name, age, and favorite color
name_vec <- c("Dean", "Xiao", "Sara", "Ravi", "Maya")
age_vec <- c(12, 18, 22, 21, 17)
color_vec <- c("blue", 'green', 'red', 'purple', 'blue')
```

Once we started analyzing this data, it would quickly become hard to keep track of which age corresponded to which name, and what their corresponding favorite color is since the variables are each stored in three separate objects. For example, if I look at the `color_vec` vector by typing its name:

```
color_vec
```

```
[1] "blue"   "green"  "red"    "purple" "blue"
```

It isn't clear whose color preference is whose.

It would be much nicer if we could create a *single* object containing all three of these variables such that the corresponding values are "aligned" in such a way that it is very clear that "Ravi" has age 21 and favorite color "purple".

Fortunately, the creators of R share our desires, so they let us store each of our vectors in an object called a "**data frame**".

If I already have the columns of my data stored as separate vectors, I can create a data frame using the `data.frame()` function as follows:

```
my_data <- data.frame(name = name_vec,
                      age = age_vec,
                      color = color_vec)
```

Where the name to the left of the `=` symbol in my `data.frame()` arguments defines the corresponding "column name" in my data frame.

Since `my_data` is an R object, I can view it by typing its name:

```
my_data
```

```
  name age  color
1 Dean  12   blue
2 Xiao  18  green
3 Sara  22    red
4 Ravi  21 purple
5 Maya  17   blue
```

Now our three variables are neatly arranged in rows and columns, where there is one row for each person and one column for each variable *and* this is all stored in a single variable/object called `my_data`.

The integer numbers 1, 2, 3, 4, and 5 shown along the left-hand side of the rows are not actually a part of the data object itself (notice that there is no "column name" printed above these integers). These numbers are just visual aids provided by the R console when you print a data frame object to make it a little bit easier to count the rows in the data.

If I ask R what kind of object `my_data` is, it tells me it's a "data.frame".

```
class(my_data)
```

```
[1] "data.frame"
```

And I can get a quick summary of what my data frame contains using the `str` function:

```
str(my_data)
```

```
'data.frame':   5 obs. of  3 variables:
 $ name : chr  "Dean" "Xiao" "Sara" "Ravi" ...
 $ age  : num  12 18 22 21 17
 $ color: chr  "blue" "green" "red" "purple" ...
```

In particular, the things that I find helpful in this summary are the number of "obs." (5) and "variables" (3), and the type/class of each variable shown after its name, which tells me that the `name` and `color` columns have a "chr" (character) type, and the `age` variable has a "num" (numeric) type.

Each column in a data frame can have a different type, but *each entry within a single column must be the same type* (because each column corresponds to a vector).

There are several techniques for extracting the vectors stored in a data frame. For instance, if I wanted to extract the `age` column, or specifically, the vector corresponding to the `age` column, I can write:

```
my_data$age
```

```
[1] 12 18 22 21 17
```

or

```
my_data['age']
```

```
  age
1  12
2  18
3  22
4  21
5  17
```

These two approaches both extracted the `age` column, but notice that the output of these two column extraction techniques look a little different.

Can you guess why? Hint: What type/class do you think each output object has? Look at its formatting. Learning to recognize what type each object has based on the way it looks is a really helpful skill.

The output of `my_data$age` *looks* is an ordinary vector. I can tell because the values are arranged horizontally, and there is a `[1]` at the beginning of the output. But this isn't the case for the output of `my_data['age']`. The output here looks more like our data frame output (but with only one column).

Indeed, if I ask R to tell me the class of each of these two objects that I have extracted, I learn that the `my_data$age` object has a "numeric" type (remember that a vector containing numeric values will have a "numeric" type!)

```
class(my_data$age)
```

```
[1] "numeric"
```

And I learn that the `my_data['age']` object has a "data.frame" type:

```
class(my_data['age'])
```

```
[1] "data.frame"
```

Since data frames and vectors have different behaviors, there will be some scenarios where you prefer your extracted column to be a vector, and others where you will prefer your extracted column to be a single-column data frame.

While I occasionally want to extract columns from my data as a vector using one of these techniques, I typically conduct my data analyses and modifications on the data frame object itself. You'll encounter some sophisticated techniques for working with data frames in the next chapter. But first, I want to show you how to load a dataset that you have saved on your computer into a data frame in R.

5.1 Loading data from external files

To create the `my_data` data frame object above, I first created the individual vectors, which I then used to define the columns of my data frame within the `data.frame()` function. Imagine if your data had hundreds of observations/values for each of hundreds of variables. No one wants to manually type their data into R.

More often than not, the data you want to analyze will already live in a file on your computer, such as a .csv file or an Excel spreadsheet. In this section, I will show you how to "load" data from such files into an R data frame.

5.1.1 Loading data from .csv data files

.csv files are one of the *simplest* data formats. "csv" stands for "comma separated value". In a .csv file:

- Columns are separated by commas
- New rows are created by starting a new line

The .csv version of our data above looks like this:

```
name, age, color
Dean, 12, blue
Xiao, 18, green
Sara,  22, red
Ravi, 21, purple
Maya, 17, blue
```

To load in a dataset (as a data frame) from a .csv file, we can use the `read.csv()` function. However, for R to be able to find your file you need to provide a "filepath" argument (as a character/text value) to your csv file.

The file path corresponds to the location where your file lives on your computer relative to where the current R file you are working in is saved. Ideally, you are working in a quarto document. If so, identify where on your computer you have saved your quarto document. If your csv data file lives in the same folder as your quarto document, then you will write

```
data <- read.csv("filename.csv")
```

where you replace `"filename.csv"` with the actual file name of your .csv file.

If your .csv data file lives in a `data/` subfolder, then you will write

```
data <- read.csv("data/filename.csv")
```

When you compile a quarto document (which will involve sequentially running all of the code in the code chunks), R automatically searches for any referenced files in the folder where the quarto document is saved.

However, if you run the code in the console, R might not automatically know to look for files in the same folder as your quarto document. To ensure R can locate your files, your console's working directory needs to match the folder containing your quarto document. The **working directory** is the folder where your R console looks for files to load (and where it saves any files you create).

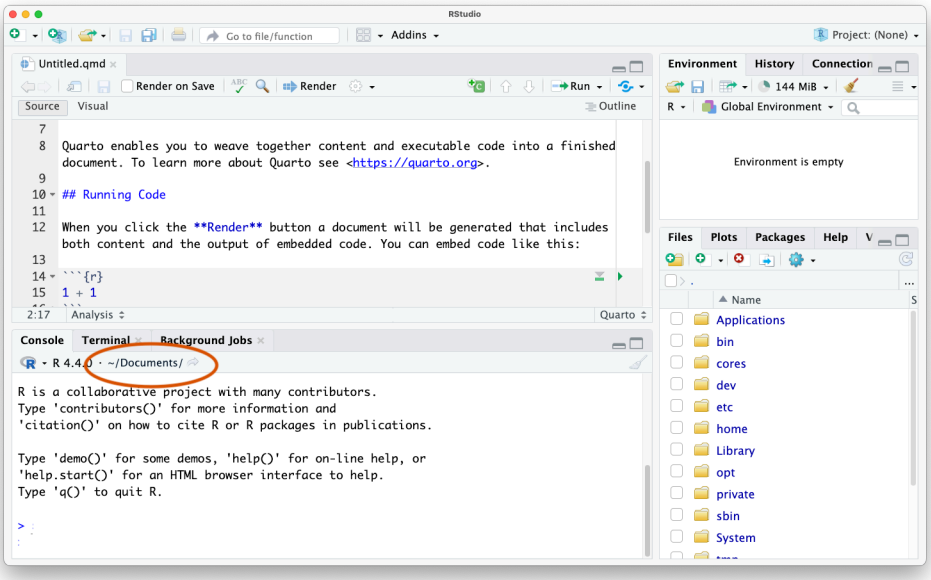
All file paths in code that is run in the console are relative to your console's current working directory, regardless of where your quarto document is saved.

If you open RStudio by directly opening a quarto document or an R script, the working directory is typically set to the folder containing that file. However, if you open your IDE without opening a specific file, the working directory is likely set to your computer's home folder.

If the console's working directory doesn't match the folder where your quarto document or R script is saved (the location of the code you're running), R won't be able to find your data files.

Identifying the console's current working directory

You can see your console's current working directory by looking at the top of the console. In the image below, the working directory is the "Documents" folder. If you just see ~, then your console's current working directory is your computer's home folder.

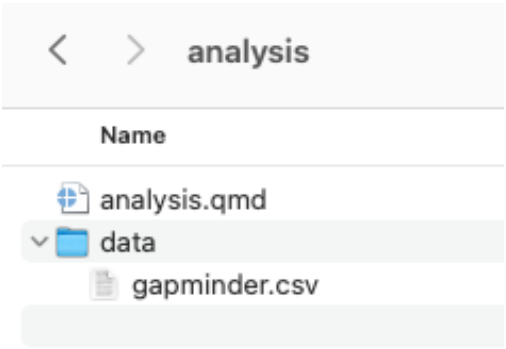


Changing your console's working directory

It is recommended that your working directory matches the location of the quarto document you are working in.
You can update your console's working directory to be the location of your current quarto document in RStudio by choosing "Session > Set Working Directory > To Source File Location".

Let's load an actual .csv file. If you are working in a quarto document or an R script on your computer, take note of where you saved it. Then download the following "data" folder containing the "gapminder" dataset and move the data folder to the same location as your current quarto document.

If you are working in a quarto document called "analysis.qmd" then your folder should have the following structure, in which the "data" folder lives in the same place as "analysis.qmd":



Then, assuming that your console's working directory matches the location of your quarto document on your computer, you should be able to run the code below to load in the gapminder.csv data file and save it as a data frame object called `gapminder`:

```
gapminder <- read.csv(file = "data/gapminder.csv")
```

If you get an error that says `"Warning message: In file(file, "rt") : cannot open file 'data/gapminder.csv': No such file or directory"`, this means that either you did not move the "data" folder containing "gapminder.csv" in the right place, or your console's working directory is incorrect!

Hopefully you figured out how to tell R to find and load your dataset! If your code above worked, you should then be able to take a look at the `gapminder` object by typing its name:

```
gapminder
```

```
      country continent year  lifeExp      pop   gdpPercap
1 Afghanistan      Asia 1952 28.80100  8425333    779.4453
2 Afghanistan      Asia 1957 30.33200  9240934    820.8530
3 Afghanistan      Asia 1962 31.99700 10267083    853.1007
4 Afghanistan      Asia 1967 34.02000 11537966    836.1971
5 Afghanistan      Asia 1972 36.08800 13079460    739.9811
6 Afghanistan      Asia 1977 38.43800 14880372    786.1134
```

7	Afghanistan	Asia	1982	39.85400	12881816	978.0114
8	Afghanistan	Asia	1987	40.82200	13867957	852.3959
9	Afghanistan	Asia	1992	41.67400	16317921	649.3414
10	Afghanistan	Asia	1997	41.76300	22227415	635.3414
11	Afghanistan	Asia	2002	42.12900	25268405	726.7341
12	Afghanistan	Asia	2007	43.82800	31889923	974.5803
13	Albania	Europe	1952	55.23000	1282697	1601.0561
14	Albania	Europe	1957	59.28000	1476505	1942.2842
15	Albania	Europe	1962	64.82000	1728137	2312.8890
16	Albania	Europe	1967	66.22000	1984060	2760.1969
17	Albania	Europe	1972	67.69000	2263554	3313.4222
18	Albania	Europe	1977	68.93000	2509048	3533.0039
19	Albania	Europe	1982	70.42000	2780097	3630.8807
20	Albania	Europe	1987	72.00000	3075321	3738.9327
21	Albania	Europe	1992	71.58100	3326498	2497.4379
22	Albania	Europe	1997	72.95000	3428038	3193.0546
23	Albania	Europe	2002	75.65100	3508512	4604.2117
24	Albania	Europe	2007	76.42300	3600523	5937.0295
25	Algeria	Africa	1952	43.07700	9279525	2449.0082
26	Algeria	Africa	1957	45.68500	10270856	3013.9760
27	Algeria	Africa	1962	48.30300	11000948	2550.8169
28	Algeria	Africa	1967	51.40700	12760499	3246.9918
29	Algeria	Africa	1972	54.51800	14760787	4182.6638
30	Algeria	Africa	1977	58.01400	17152804	4910.4168
31	Algeria	Africa	1982	61.36800	20033753	5745.1602
32	Algeria	Africa	1987	65.79900	23254956	5681.3585
33	Algeria	Africa	1992	67.74400	26298373	5023.2166
34	Algeria	Africa	1997	69.15200	29072015	4797.2951
35	Algeria	Africa	2002	70.99400	31287142	5288.0404
36	Algeria	Africa	2007	72.30100	33333216	6223.3675
37	Angola	Africa	1952	30.01500	4232095	3520.6103
38	Angola	Africa	1957	31.99900	4561361	3827.9405
39	Angola	Africa	1962	34.00000	4826015	4269.2767
40	Angola	Africa	1967	35.98500	5247469	5522.7764
41	Angola	Africa	1972	37.92800	5894858	5473.2880
42	Angola	Africa	1977	39.48300	6162675	3008.6474
43	Angola	Africa	1982	39.94200	7016384	2756.9537
44	Angola	Africa	1987	39.90600	7874230	2430.2083
45	Angola	Africa	1992	40.64700	8735988	2627.8457
46	Angola	Africa	1997	40.96300	9875024	2277.1409
47	Angola	Africa	2002	41.00300	10866106	2773.2873
48	Angola	Africa	2007	42.73100	12420476	4797.2313
49	Argentina	Americas	1952	62.48500	17876956	5911.3151

50	Argentina	Americas	1957	64.39900	19610538	6856.8562
51	Argentina	Americas	1962	65.14200	21283783	7133.1660
52	Argentina	Americas	1967	65.63400	22934225	8052.9530
53	Argentina	Americas	1972	67.06500	24779799	9443.0385
54	Argentina	Americas	1977	68.48100	26983828	10079.0267
55	Argentina	Americas	1982	69.94200	29341374	8997.8974
56	Argentina	Americas	1987	70.77400	31620918	9139.6714
57	Argentina	Americas	1992	71.86800	33958947	9308.4187
58	Argentina	Americas	1997	73.27500	36203463	10967.2820
59	Argentina	Americas	2002	74.34000	38331121	8797.6407
60	Argentina	Americas	2007	75.32000	40301927	12779.3796
61	Australia	Oceania	1952	69.12000	8691212	10039.5956
62	Australia	Oceania	1957	70.33000	9712569	10949.6496
63	Australia	Oceania	1962	70.93000	10794968	12217.2269
64	Australia	Oceania	1967	71.10000	11872264	14526.1246
65	Australia	Oceania	1972	71.93000	13177000	16788.6295
66	Australia	Oceania	1977	73.49000	14074100	18334.1975
67	Australia	Oceania	1982	74.74000	15184200	19477.0093
68	Australia	Oceania	1987	76.32000	16257249	21888.8890
69	Australia	Oceania	1992	77.56000	17481977	23424.7668
70	Australia	Oceania	1997	78.83000	18565243	26997.9366
71	Australia	Oceania	2002	80.37000	19546792	30687.7547
72	Australia	Oceania	2007	81.23500	20434176	34435.3674
73	Austria	Europe	1952	66.80000	6927772	6137.0765
74	Austria	Europe	1957	67.48000	6965860	8842.5980
75	Austria	Europe	1962	69.54000	7129864	10750.7211
76	Austria	Europe	1967	70.14000	7376998	12834.6024
77	Austria	Europe	1972	70.63000	7544201	16661.6256
78	Austria	Europe	1977	72.17000	7568430	19749.4223
79	Austria	Europe	1982	73.18000	7574613	21597.0836
80	Austria	Europe	1987	74.94000	7578903	23687.8261
81	Austria	Europe	1992	76.04000	7914969	27042.0187
82	Austria	Europe	1997	77.51000	8069876	29095.9207
83	Austria	Europe	2002	78.98000	8148312	32417.6077
84	Austria	Europe	2007	79.82900	8199783	36126.4927
85	Bahrain	Asia	1952	50.93900	120447	9867.0848
86	Bahrain	Asia	1957	53.83200	138655	11635.7995
87	Bahrain	Asia	1962	56.92300	171863	12753.2751
88	Bahrain	Asia	1967	59.92300	202182	14804.6727
89	Bahrain	Asia	1972	63.30000	230800	18268.6584
90	Bahrain	Asia	1977	65.59300	297410	19340.1020
91	Bahrain	Asia	1982	69.05200	377967	19211.1473
92	Bahrain	Asia	1987	70.75000	454612	18524.0241

93	Bahrain	Asia	1992	72.60100	529491	19035.5792
94	Bahrain	Asia	1997	73.92500	598561	20292.0168
95	Bahrain	Asia	2002	74.79500	656397	23403.5593
96	Bahrain	Asia	2007	75.63500	708573	29796.0483
97	Bangladesh	Asia	1952	37.48400	46886859	684.2442
98	Bangladesh	Asia	1957	39.34800	51365468	661.6375
99	Bangladesh	Asia	1962	41.21600	56839289	686.3416
100	Bangladesh	Asia	1967	43.45300	62821884	721.1861
101	Bangladesh	Asia	1972	45.25200	70759295	630.2336
102	Bangladesh	Asia	1977	46.92300	80428306	659.8772
103	Bangladesh	Asia	1982	50.00900	93074406	676.9819
104	Bangladesh	Asia	1987	52.81900	103764241	751.9794
105	Bangladesh	Asia	1992	56.01800	113704579	837.8102
106	Bangladesh	Asia	1997	59.41200	123315288	972.7700
107	Bangladesh	Asia	2002	62.01300	135656790	1136.3904
108	Bangladesh	Asia	2007	64.06200	150448339	1391.2538
109	Belgium	Europe	1952	68.00000	8730405	8343.1051
110	Belgium	Europe	1957	69.24000	8989111	9714.9606
111	Belgium	Europe	1962	70.25000	9218400	10991.2068
112	Belgium	Europe	1967	70.94000	9556500	13149.0412
113	Belgium	Europe	1972	71.44000	9709100	16672.1436
114	Belgium	Europe	1977	72.80000	9821800	19117.9745
115	Belgium	Europe	1982	73.93000	9856303	20979.8459
116	Belgium	Europe	1987	75.35000	9870200	22525.5631
117	Belgium	Europe	1992	76.46000	10045622	25575.5707
118	Belgium	Europe	1997	77.53000	10199787	27561.1966
119	Belgium	Europe	2002	78.32000	10311970	30485.8838
120	Belgium	Europe	2007	79.44100	10392226	33692.6051
121	Benin	Africa	1952	38.22300	1738315	1062.7522
122	Benin	Africa	1957	40.35800	1925173	959.6011
123	Benin	Africa	1962	42.61800	2151895	949.4991
124	Benin	Africa	1967	44.88500	2427334	1035.8314
125	Benin	Africa	1972	47.01400	2761407	1085.7969
126	Benin	Africa	1977	49.19000	3168267	1029.1613
127	Benin	Africa	1982	50.90400	3641603	1277.8976
128	Benin	Africa	1987	52.33700	4243788	1225.8560
129	Benin	Africa	1992	53.91900	4981671	1191.2077
130	Benin	Africa	1997	54.77700	6066080	1232.9753
131	Benin	Africa	2002	54.40600	7026113	1372.8779
132	Benin	Africa	2007	56.72800	8078314	1441.2849
133	Bolivia	Americas	1952	40.41400	2883315	2677.3263
134	Bolivia	Americas	1957	41.89000	3211738	2127.6863
135	Bolivia	Americas	1962	43.42800	3593918	2180.9725

136	Bolivia	Americas	1967	45.03200	4040665	2586.8861
137	Bolivia	Americas	1972	46.71400	4565872	2980.3313
138	Bolivia	Americas	1977	50.02300	5079716	3548.0978
139	Bolivia	Americas	1982	53.85900	5642224	3156.5105
140	Bolivia	Americas	1987	57.25100	6156369	2753.6915
141	Bolivia	Americas	1992	59.95700	6893451	2961.6997
142	Bolivia	Americas	1997	62.05000	7693188	3326.1432
143	Bolivia	Americas	2002	63.88300	8445134	3413.2627
144	Bolivia	Americas	2007	65.55400	9119152	3822.1371
145	Bosnia and Herzegovina	Europe	1952	53.82000	2791000	973.5332
146	Bosnia and Herzegovina	Europe	1957	58.45000	3076000	1353.9892
147	Bosnia and Herzegovina	Europe	1962	61.93000	3349000	1709.6837
148	Bosnia and Herzegovina	Europe	1967	64.79000	3585000	2172.3524
149	Bosnia and Herzegovina	Europe	1972	67.45000	3819000	2860.1698
150	Bosnia and Herzegovina	Europe	1977	69.86000	4086000	3528.4813
151	Bosnia and Herzegovina	Europe	1982	70.69000	4172693	4126.6132
152	Bosnia and Herzegovina	Europe	1987	71.14000	4338977	4314.1148
153	Bosnia and Herzegovina	Europe	1992	72.17800	4256013	2546.7814
154	Bosnia and Herzegovina	Europe	1997	73.24400	3607000	4766.3559
155	Bosnia and Herzegovina	Europe	2002	74.09000	4165416	6018.9752
156	Bosnia and Herzegovina	Europe	2007	74.85200	4552198	7446.2988
157	Botswana	Africa	1952	47.62200	442308	851.2411
158	Botswana	Africa	1957	49.61800	474639	918.2325
159	Botswana	Africa	1962	51.52000	512764	983.6540
160	Botswana	Africa	1967	53.29800	553541	1214.7093
161	Botswana	Africa	1972	56.02400	619351	2263.6111
162	Botswana	Africa	1977	59.31900	781472	3214.8578
163	Botswana	Africa	1982	61.48400	970347	4551.1421
164	Botswana	Africa	1987	63.62200	1151184	6205.8839
165	Botswana	Africa	1992	62.74500	1342614	7954.1116
166	Botswana	Africa	1997	52.55600	1536536	8647.1423
167	Botswana	Africa	2002	46.63400	1630347	11003.6051
168	Botswana	Africa	2007	50.72800	1639131	12569.8518
169	Brazil	Americas	1952	50.91700	56602560	2108.9444
170	Brazil	Americas	1957	53.28500	65551171	2487.3660
171	Brazil	Americas	1962	55.66500	76039390	3336.5858
172	Brazil	Americas	1967	57.63200	88049823	3429.8644
173	Brazil	Americas	1972	59.50400	100840058	4985.7115
174	Brazil	Americas	1977	61.48900	114313951	6660.1187
175	Brazil	Americas	1982	63.33600	128962939	7030.8359
176	Brazil	Americas	1987	65.20500	142938076	7807.0958
177	Brazil	Americas	1992	67.05700	155975974	6950.2830
178	Brazil	Americas	1997	69.38800	168546719	7957.9808

179	Brazil	Americas	2002	71.00600	179914212	8131.2128
180	Brazil	Americas	2007	72.39000	190010647	9065.8008
181	Bulgaria	Europe	1952	59.60000	7274900	2444.2866
182	Bulgaria	Europe	1957	66.61000	7651254	3008.6707
183	Bulgaria	Europe	1962	69.51000	8012946	4254.3378
184	Bulgaria	Europe	1967	70.42000	8310226	5577.0028
185	Bulgaria	Europe	1972	70.90000	8576200	6597.4944
186	Bulgaria	Europe	1977	70.81000	8797022	7612.2404
187	Bulgaria	Europe	1982	71.08000	8892098	8224.1916
188	Bulgaria	Europe	1987	71.34000	8971958	8239.8548
189	Bulgaria	Europe	1992	71.19000	8658506	6302.6234
190	Bulgaria	Europe	1997	70.32000	8066057	5970.3888
191	Bulgaria	Europe	2002	72.14000	7661799	7696.7777
192	Bulgaria	Europe	2007	73.00500	7322858	10680.7928
193	Burkina Faso	Africa	1952	31.97500	4469979	543.2552
194	Burkina Faso	Africa	1957	34.90600	4713416	617.1835
195	Burkina Faso	Africa	1962	37.81400	4919632	722.5120
196	Burkina Faso	Africa	1967	40.69700	5127935	794.8266
197	Burkina Faso	Africa	1972	43.59100	5433886	854.7360
198	Burkina Faso	Africa	1977	46.13700	5889574	743.3870
199	Burkina Faso	Africa	1982	48.12200	6634596	807.1986
200	Burkina Faso	Africa	1987	49.55700	7586551	912.0631
201	Burkina Faso	Africa	1992	50.26000	8878303	931.7528
202	Burkina Faso	Africa	1997	50.32400	10352843	946.2950
203	Burkina Faso	Africa	2002	50.65000	12251209	1037.6452
204	Burkina Faso	Africa	2007	52.29500	14326203	1217.0330
205	Burundi	Africa	1952	39.03100	2445618	339.2965
206	Burundi	Africa	1957	40.53300	2667518	379.5646
207	Burundi	Africa	1962	42.04500	2961915	355.2032
208	Burundi	Africa	1967	43.54800	3330989	412.9775
209	Burundi	Africa	1972	44.05700	3529983	464.0995
210	Burundi	Africa	1977	45.91000	3834415	556.1033
211	Burundi	Africa	1982	47.47100	4580410	559.6032
212	Burundi	Africa	1987	48.21100	5126023	621.8188
213	Burundi	Africa	1992	44.73600	5809236	631.6999
214	Burundi	Africa	1997	45.32600	6121610	463.1151
215	Burundi	Africa	2002	47.36000	7021078	446.4035
216	Burundi	Africa	2007	49.58000	8390505	430.0707
217	Cambodia	Asia	1952	39.41700	4693836	368.4693
218	Cambodia	Asia	1957	41.36600	5322536	434.0383
219	Cambodia	Asia	1962	43.41500	6083619	496.9136
220	Cambodia	Asia	1967	45.41500	6960067	523.4323
221	Cambodia	Asia	1972	40.31700	7450606	421.6240

222		Cambodia	Asia	1977	31.22000	6978607	524.9722
223		Cambodia	Asia	1982	50.95700	7272485	624.4755
224		Cambodia	Asia	1987	53.91400	8371791	683.8956
225		Cambodia	Asia	1992	55.80300	10150094	682.3032
226		Cambodia	Asia	1997	56.53400	11782962	734.2852
227		Cambodia	Asia	2002	56.75200	12926707	896.2260
228		Cambodia	Asia	2007	59.72300	14131858	1713.7787
229		Cameroon	Africa	1952	38.52300	5009067	1172.6677
230		Cameroon	Africa	1957	40.42800	5359923	1313.0481
231		Cameroon	Africa	1962	42.64300	5793633	1399.6074
232		Cameroon	Africa	1967	44.79900	6335506	1508.4531
233		Cameroon	Africa	1972	47.04900	7021028	1684.1465
234		Cameroon	Africa	1977	49.35500	7959865	1783.4329
235		Cameroon	Africa	1982	52.96100	9250831	2367.9833
236		Cameroon	Africa	1987	54.98500	10780667	2602.6642
237		Cameroon	Africa	1992	54.31400	12467171	1793.1633
238		Cameroon	Africa	1997	52.19900	14195809	1694.3375
239		Cameroon	Africa	2002	49.85600	15929988	1934.0114
240		Cameroon	Africa	2007	50.43000	17696293	2042.0952
241		Canada	Americas	1952	68.75000	14785584	11367.1611
242		Canada	Americas	1957	69.96000	17010154	12489.9501
243		Canada	Americas	1962	71.30000	18985849	13462.4855
244		Canada	Americas	1967	72.13000	20819767	16076.5880
245		Canada	Americas	1972	72.88000	22284500	18970.5709
246		Canada	Americas	1977	74.21000	23796400	22090.8831
247		Canada	Americas	1982	75.76000	25201900	22898.7921
248		Canada	Americas	1987	76.86000	26549700	26626.5150
249		Canada	Americas	1992	77.95000	28523502	26342.8843
250		Canada	Americas	1997	78.61000	30305843	28954.9259
251		Canada	Americas	2002	79.77000	31902268	33328.9651
252		Canada	Americas	2007	80.65300	33390141	36319.2350
253	Central African Republic		Africa	1952	35.46300	1291695	1071.3107
254	Central African Republic		Africa	1957	37.46400	1392284	1190.8443
255	Central African Republic		Africa	1962	39.47500	1523478	1193.0688
256	Central African Republic		Africa	1967	41.47800	1733638	1136.0566
257	Central African Republic		Africa	1972	43.45700	1927260	1070.0133
258	Central African Republic		Africa	1977	46.77500	2167533	1109.3743
259	Central African Republic		Africa	1982	48.29500	2476971	956.7530
260	Central African Republic		Africa	1987	50.48500	2840009	844.8764
261	Central African Republic		Africa	1992	49.39600	3265124	747.9055
262	Central African Republic		Africa	1997	46.06600	3696513	740.5063
263	Central African Republic		Africa	2002	43.30800	4048013	738.6906
264	Central African Republic		Africa	2007	44.74100	4369038	706.0165

265	Chad	Africa	1952	38.09200	2682462	1178.6659
266	Chad	Africa	1957	39.88100	2894855	1308.4956
267	Chad	Africa	1962	41.71600	3150417	1389.8176
268	Chad	Africa	1967	43.60100	3495967	1196.8106
269	Chad	Africa	1972	45.56900	3899068	1104.1040
270	Chad	Africa	1977	47.38300	4388260	1133.9850
271	Chad	Africa	1982	49.51700	4875118	797.9081
272	Chad	Africa	1987	51.05100	5498955	952.3861
273	Chad	Africa	1992	51.72400	6429417	1058.0643
274	Chad	Africa	1997	51.57300	7562011	1004.9614
275	Chad	Africa	2002	50.52500	8835739	1156.1819
276	Chad	Africa	2007	50.65100	10238807	1704.0637
277	Chile	Americas	1952	54.74500	6377619	3939.9788
278	Chile	Americas	1957	56.07400	7048426	4315.6227
279	Chile	Americas	1962	57.92400	7961258	4519.0943
280	Chile	Americas	1967	60.52300	8858908	5106.6543
281	Chile	Americas	1972	63.44100	9717524	5494.0244
282	Chile	Americas	1977	67.05200	10599793	4756.7638
283	Chile	Americas	1982	70.56500	11487112	5095.6657
284	Chile	Americas	1987	72.49200	12463354	5547.0638
285	Chile	Americas	1992	74.12600	13572994	7596.1260
286	Chile	Americas	1997	75.81600	14599929	10118.0532
287	Chile	Americas	2002	77.86000	15497046	10778.7838
288	Chile	Americas	2007	78.55300	16284741	13171.6388
289	China	Asia	1952	44.00000	556263527	400.4486
290	China	Asia	1957	50.54896	637408000	575.9870
291	China	Asia	1962	44.50136	665770000	487.6740
292	China	Asia	1967	58.38112	754550000	612.7057
293	China	Asia	1972	63.11888	862030000	676.9001
294	China	Asia	1977	63.96736	943455000	741.2375
295	China	Asia	1982	65.52500	1000281000	962.4214
296	China	Asia	1987	67.27400	1084035000	1378.9040
297	China	Asia	1992	68.69000	1164970000	1655.7842
298	China	Asia	1997	70.42600	1230075000	2289.2341
299	China	Asia	2002	72.02800	1280400000	3119.2809
300	China	Asia	2007	72.96100	1318683096	4959.1149
301	Colombia	Americas	1952	50.64300	12350771	2144.1151
302	Colombia	Americas	1957	55.11800	14485993	2323.8056
303	Colombia	Americas	1962	57.86300	17009885	2492.3511
304	Colombia	Americas	1967	59.96300	19764027	2678.7298
305	Colombia	Americas	1972	61.62300	22542890	3264.6600
306	Colombia	Americas	1977	63.83700	25094412	3815.8079
307	Colombia	Americas	1982	66.65300	27764644	4397.5757

308	Colombia	Americas	1987	67.76800	30964245	4903.2191
309	Colombia	Americas	1992	68.42100	34202721	5444.6486
310	Colombia	Americas	1997	70.31300	37657830	6117.3617
311	Colombia	Americas	2002	71.68200	41008227	5755.2600
312	Colombia	Americas	2007	72.88900	44227550	7006.5804
313	Comoros	Africa	1952	40.71500	153936	1102.9909
314	Comoros	Africa	1957	42.46000	170928	1211.1485
315	Comoros	Africa	1962	44.46700	191689	1406.6483
316	Comoros	Africa	1967	46.47200	217378	1876.0296
317	Comoros	Africa	1972	48.94400	250027	1937.5777
318	Comoros	Africa	1977	50.93900	304739	1172.6030
319	Comoros	Africa	1982	52.93300	348643	1267.1001
320	Comoros	Africa	1987	54.92600	395114	1315.9808
321	Comoros	Africa	1992	57.93900	454429	1246.9074
322	Comoros	Africa	1997	60.66000	527982	1173.6182
323	Comoros	Africa	2002	62.97400	614382	1075.8116
324	Comoros	Africa	2007	65.15200	710960	986.1479
325	Congo, Dem. Rep.	Africa	1952	39.14300	14100005	780.5423
326	Congo, Dem. Rep.	Africa	1957	40.65200	15577932	905.8602
327	Congo, Dem. Rep.	Africa	1962	42.12200	17486434	896.3146
328	Congo, Dem. Rep.	Africa	1967	44.05600	19941073	861.5932
329	Congo, Dem. Rep.	Africa	1972	45.98900	23007669	904.8961
330	Congo, Dem. Rep.	Africa	1977	47.80400	26480870	795.7573
331	Congo, Dem. Rep.	Africa	1982	47.78400	30646495	673.7478
332	Congo, Dem. Rep.	Africa	1987	47.41200	35481645	672.7748
333	Congo, Dem. Rep.	Africa	1992	45.54800	41672143	457.7192
334	Congo, Dem. Rep.	Africa	1997	42.58700	47798986	312.1884
335	Congo, Dem. Rep.	Africa	2002	44.96600	55379852	241.1659
336	Congo, Dem. Rep.	Africa	2007	46.46200	64606759	277.5519
337	Congo, Rep.	Africa	1952	42.11100	854885	2125.6214
338	Congo, Rep.	Africa	1957	45.05300	940458	2315.0566
339	Congo, Rep.	Africa	1962	48.43500	1047924	2464.7832
340	Congo, Rep.	Africa	1967	52.04000	1179760	2677.9396
341	Congo, Rep.	Africa	1972	54.90700	1340458	3213.1527
342	Congo, Rep.	Africa	1977	55.62500	1536769	3259.1790
343	Congo, Rep.	Africa	1982	56.69500	1774735	4879.5075
344	Congo, Rep.	Africa	1987	57.47000	2064095	4201.1949
345	Congo, Rep.	Africa	1992	56.43300	2409073	4016.2395
346	Congo, Rep.	Africa	1997	52.96200	2800947	3484.1644
347	Congo, Rep.	Africa	2002	52.97000	3328795	3484.0620
348	Congo, Rep.	Africa	2007	55.32200	3800610	3632.5578
349	Costa Rica	Americas	1952	57.20600	926317	2627.0095
350	Costa Rica	Americas	1957	60.02600	1112300	2990.0108

351	Costa Rica	Americas	1962	62.84200	1345187	3460.9370
352	Costa Rica	Americas	1967	65.42400	1588717	4161.7278
353	Costa Rica	Americas	1972	67.84900	1834796	5118.1469
354	Costa Rica	Americas	1977	70.75000	2108457	5926.8770
355	Costa Rica	Americas	1982	73.45000	2424367	5262.7348
356	Costa Rica	Americas	1987	74.75200	2799811	5629.9153
357	Costa Rica	Americas	1992	75.71300	3173216	6160.4163
358	Costa Rica	Americas	1997	77.26000	3518107	6677.0453
359	Costa Rica	Americas	2002	78.12300	3834934	7723.4472
360	Costa Rica	Americas	2007	78.78200	4133884	9645.0614
361	Cote d'Ivoire	Africa	1952	40.47700	2977019	1388.5947
362	Cote d'Ivoire	Africa	1957	42.46900	3300000	1500.8959
363	Cote d'Ivoire	Africa	1962	44.93000	3832408	1728.8694
364	Cote d'Ivoire	Africa	1967	47.35000	4744870	2052.0505
365	Cote d'Ivoire	Africa	1972	49.80100	6071696	2378.2011
366	Cote d'Ivoire	Africa	1977	52.37400	7459574	2517.7365
367	Cote d'Ivoire	Africa	1982	53.98300	9025951	2602.7102
368	Cote d'Ivoire	Africa	1987	54.65500	10761098	2156.9561
369	Cote d'Ivoire	Africa	1992	52.04400	12772596	1648.0738
370	Cote d'Ivoire	Africa	1997	47.99100	14625967	1786.2654
371	Cote d'Ivoire	Africa	2002	46.83200	16252726	1648.8008
372	Cote d'Ivoire	Africa	2007	48.32800	18013409	1544.7501
373	Croatia	Europe	1952	61.21000	3882229	3119.2365
374	Croatia	Europe	1957	64.77000	3991242	4338.2316
375	Croatia	Europe	1962	67.13000	4076557	5477.8900
376	Croatia	Europe	1967	68.50000	4174366	6960.2979
377	Croatia	Europe	1972	69.61000	4225310	9164.0901
378	Croatia	Europe	1977	70.64000	4318673	11305.3852
379	Croatia	Europe	1982	70.46000	4413368	13221.8218
380	Croatia	Europe	1987	71.52000	4484310	13822.5839
381	Croatia	Europe	1992	72.52700	4494013	8447.7949
382	Croatia	Europe	1997	73.68000	4444595	9875.6045
383	Croatia	Europe	2002	74.87600	4481020	11628.3890
384	Croatia	Europe	2007	75.74800	4493312	14619.2227
385	Cuba	Americas	1952	59.42100	6007797	5586.5388
386	Cuba	Americas	1957	62.32500	6640752	6092.1744
387	Cuba	Americas	1962	65.24600	7254373	5180.7559
388	Cuba	Americas	1967	68.29000	8139332	5690.2680
389	Cuba	Americas	1972	70.72300	8831348	5305.4453
390	Cuba	Americas	1977	72.64900	9537988	6380.4950
391	Cuba	Americas	1982	73.71700	9789224	7316.9181
392	Cuba	Americas	1987	74.17400	10239839	7532.9248
393	Cuba	Americas	1992	74.41400	10723260	5592.8440

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394                    Cuba  Americas 1997 76.15100   10983007   5431.9904
395                    Cuba  Americas 2002 77.15800   11226999   6340.6467
396                    Cuba  Americas 2007 78.27300   11416987   8948.1029
397          Czech Republic    Europe 1952 66.87000    9125183   6876.1403
398          Czech Republic    Europe 1957 69.03000    9513758   8256.3439
399          Czech Republic    Europe 1962 69.90000    9620282  10136.8671
400          Czech Republic    Europe 1967 70.38000    9835109  11399.4449
401          Czech Republic    Europe 1972 70.29000    9862158  13108.4536
402          Czech Republic    Europe 1977 70.71000   10161915  14800.1606
403          Czech Republic    Europe 1982 70.96000   10303704  15377.2285
404          Czech Republic    Europe 1987 71.58000   10311597  16310.4434
405          Czech Republic    Europe 1992 72.40000   10315702  14297.0212
406          Czech Republic    Europe 1997 74.01000   10300707  16048.5142
407          Czech Republic    Europe 2002 75.51000   10256295  17596.2102
408          Czech Republic    Europe 2007 76.48600   10228744  22833.3085
409                 Denmark    Europe 1952 70.78000    4334000   9692.3852
410                 Denmark    Europe 1957 71.81000    4487831  11099.6593
411                 Denmark    Europe 1962 72.35000    4646899  13583.3135
412                 Denmark    Europe 1967 72.96000    4838800  15937.2112
413                 Denmark    Europe 1972 73.47000    4991596  18866.2072
414                 Denmark    Europe 1977 74.69000    5088419  20422.9015
415                 Denmark    Europe 1982 74.63000    5117810  21688.0405
416                 Denmark    Europe 1987 74.80000    5127024  25116.1758
417                 Denmark    Europe 1992 75.33000    5171393  26406.7399
418                 Denmark    Europe 1997 76.11000    5283663  29804.3457
419                 Denmark    Europe 2002 77.18000    5374693  32166.5001
420                 Denmark    Europe 2007 78.33200    5468120  35278.4187
421                Djibouti    Africa 1952 34.81200      63149   2669.5295
422                Djibouti    Africa 1957 37.32800      71851   2864.9691
423                Djibouti    Africa 1962 39.69300      89898   3020.9893
424                Djibouti    Africa 1967 42.07400     127617   3020.0505
425                Djibouti    Africa 1972 44.36600     178848   3694.2124
426                Djibouti    Africa 1977 46.51900     228694   3081.7610
427                Djibouti    Africa 1982 48.81200     305991   2879.4681
428                Djibouti    Africa 1987 50.04000     311025   2880.1026
429                Djibouti    Africa 1992 51.60400     384156   2377.1562
430                Djibouti    Africa 1997 53.15700     417908   1895.0170
431                Djibouti    Africa 2002 53.37300     447416   1908.2609
432                Djibouti    Africa 2007 54.79100     496374   2082.4816
433  Dominican Republic  Americas 1952 45.92800    2491346   1397.7171
434  Dominican Republic  Americas 1957 49.82800    2923186   1544.4030
435  Dominican Republic  Americas 1962 53.45900    3453434   1662.1374
436  Dominican Republic  Americas 1967 56.75100    4049146   1653.7230
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437	Dominican Republic	Americas	1972	59.63100	4671329	2189.8745
438	Dominican Republic	Americas	1977	61.78800	5302800	2681.9889
439	Dominican Republic	Americas	1982	63.72700	5968349	2861.0924
440	Dominican Republic	Americas	1987	66.04600	6655297	2899.8422
441	Dominican Republic	Americas	1992	68.45700	7351181	3044.2142
442	Dominican Republic	Americas	1997	69.95700	7992357	3614.1013
443	Dominican Republic	Americas	2002	70.84700	8650322	4563.8082
444	Dominican Republic	Americas	2007	72.23500	9319622	6025.3748
445	Ecuador	Americas	1952	48.35700	3548753	3522.1107
446	Ecuador	Americas	1957	51.35600	4058385	3780.5467
447	Ecuador	Americas	1962	54.64000	4681707	4086.1141
448	Ecuador	Americas	1967	56.67800	5432424	4579.0742
449	Ecuador	Americas	1972	58.79600	6298651	5280.9947
450	Ecuador	Americas	1977	61.31000	7278866	6679.6233
451	Ecuador	Americas	1982	64.34200	8365850	7213.7913
452	Ecuador	Americas	1987	67.23100	9545158	6481.7770
453	Ecuador	Americas	1992	69.61300	10748394	7103.7026
454	Ecuador	Americas	1997	72.31200	11911819	7429.4559
455	Ecuador	Americas	2002	74.17300	12921234	5773.0445
456	Ecuador	Americas	2007	74.99400	13755680	6873.2623
457	Egypt	Africa	1952	41.89300	22223309	1418.8224
458	Egypt	Africa	1957	44.44400	25009741	1458.9153
459	Egypt	Africa	1962	46.99200	28173309	1693.3359
460	Egypt	Africa	1967	49.29300	31681188	1814.8807
461	Egypt	Africa	1972	51.13700	34807417	2024.0081
462	Egypt	Africa	1977	53.31900	38783863	2785.4936
463	Egypt	Africa	1982	56.00600	45681811	3503.7296
464	Egypt	Africa	1987	59.79700	52799062	3885.4607
465	Egypt	Africa	1992	63.67400	59402198	3794.7552
466	Egypt	Africa	1997	67.21700	66134291	4173.1818
467	Egypt	Africa	2002	69.80600	73312559	4754.6044
468	Egypt	Africa	2007	71.33800	80264543	5581.1810
469	El Salvador	Americas	1952	45.26200	2042865	3048.3029
470	El Salvador	Americas	1957	48.57000	2355805	3421.5232
471	El Salvador	Americas	1962	52.30700	2747687	3776.8036
472	El Salvador	Americas	1967	55.85500	3232927	4358.5954
473	El Salvador	Americas	1972	58.20700	3790903	4520.2460
474	El Salvador	Americas	1977	56.69600	4282586	5138.9224
475	El Salvador	Americas	1982	56.60400	4474873	4098.3442
476	El Salvador	Americas	1987	63.15400	4842194	4140.4421
477	El Salvador	Americas	1992	66.79800	5274649	4444.2317
478	El Salvador	Americas	1997	69.53500	5783439	5154.8255
479	El Salvador	Americas	2002	70.73400	6353681	5351.5687

480	El Salvador	Americas	2007	71.87800	6939688	5728.3535
481	Equatorial Guinea	Africa	1952	34.48200	216964	375.6431
482	Equatorial Guinea	Africa	1957	35.98300	232922	426.0964
483	Equatorial Guinea	Africa	1962	37.48500	249220	582.8420
484	Equatorial Guinea	Africa	1967	38.98700	259864	915.5960
485	Equatorial Guinea	Africa	1972	40.51600	277603	672.4123
486	Equatorial Guinea	Africa	1977	42.02400	192675	958.5668
487	Equatorial Guinea	Africa	1982	43.66200	285483	927.8253
488	Equatorial Guinea	Africa	1987	45.66400	341244	966.8968
489	Equatorial Guinea	Africa	1992	47.54500	387838	1132.0550
490	Equatorial Guinea	Africa	1997	48.24500	439971	2814.4808
491	Equatorial Guinea	Africa	2002	49.34800	495627	7703.4959
492	Equatorial Guinea	Africa	2007	51.57900	551201	12154.0897
493	Eritrea	Africa	1952	35.92800	1438760	328.9406
494	Eritrea	Africa	1957	38.04700	1542611	344.1619
495	Eritrea	Africa	1962	40.15800	1666618	380.9958
496	Eritrea	Africa	1967	42.18900	1820319	468.7950
497	Eritrea	Africa	1972	44.14200	2260187	514.3242
498	Eritrea	Africa	1977	44.53500	2512642	505.7538
499	Eritrea	Africa	1982	43.89000	2637297	524.8758
500	Eritrea	Africa	1987	46.45300	2915959	521.1341
501	Eritrea	Africa	1992	49.99100	3668440	582.8585
502	Eritrea	Africa	1997	53.37800	4058319	913.4708
503	Eritrea	Africa	2002	55.24000	4414865	765.3500
504	Eritrea	Africa	2007	58.04000	4906585	641.3695
505	Ethiopia	Africa	1952	34.07800	20860941	362.1463
506	Ethiopia	Africa	1957	36.66700	22815614	378.9042
507	Ethiopia	Africa	1962	40.05900	25145372	419.4564
508	Ethiopia	Africa	1967	42.11500	27860297	516.1186
509	Ethiopia	Africa	1972	43.51500	30770372	566.2439
510	Ethiopia	Africa	1977	44.51000	34617799	556.8084
511	Ethiopia	Africa	1982	44.91600	38111756	577.8607
512	Ethiopia	Africa	1987	46.68400	42999530	573.7413
513	Ethiopia	Africa	1992	48.09100	52088559	421.3535
514	Ethiopia	Africa	1997	49.40200	59861301	515.8894
515	Ethiopia	Africa	2002	50.72500	67946797	530.0535
516	Ethiopia	Africa	2007	52.94700	76511887	690.8056
517	Finland	Europe	1952	66.55000	4090500	6424.5191
518	Finland	Europe	1957	67.49000	4324000	7545.4154
519	Finland	Europe	1962	68.75000	4491443	9371.8426
520	Finland	Europe	1967	69.83000	4605744	10921.6363
521	Finland	Europe	1972	70.87000	4639657	14358.8759
522	Finland	Europe	1977	72.52000	4738902	15605.4228

523	Finland	Europe	1982	74.55000	4826933	18533.1576
524	Finland	Europe	1987	74.83000	4931729	21141.0122
525	Finland	Europe	1992	75.70000	5041039	20647.1650
526	Finland	Europe	1997	77.13000	5134406	23723.9502
527	Finland	Europe	2002	78.37000	5193039	28204.5906
528	Finland	Europe	2007	79.31300	5238460	33207.0844
529	France	Europe	1952	67.41000	42459667	7029.8093
530	France	Europe	1957	68.93000	44310863	8662.8349
531	France	Europe	1962	70.51000	47124000	10560.4855
532	France	Europe	1967	71.55000	49569000	12999.9177
533	France	Europe	1972	72.38000	51732000	16107.1917
534	France	Europe	1977	73.83000	53165019	18292.6351
535	France	Europe	1982	74.89000	54433565	20293.8975
536	France	Europe	1987	76.34000	55630100	22066.4421
537	France	Europe	1992	77.46000	57374179	24703.7961
538	France	Europe	1997	78.64000	58623428	25889.7849
539	France	Europe	2002	79.59000	59925035	28926.0323
540	France	Europe	2007	80.65700	61083916	30470.0167
541	Gabon	Africa	1952	37.00300	420702	4293.4765
542	Gabon	Africa	1957	38.99900	434904	4976.1981
543	Gabon	Africa	1962	40.48900	455661	6631.4592
544	Gabon	Africa	1967	44.59800	489004	8358.7620
545	Gabon	Africa	1972	48.69000	537977	11401.9484
546	Gabon	Africa	1977	52.79000	706367	21745.5733
547	Gabon	Africa	1982	56.56400	753874	15113.3619
548	Gabon	Africa	1987	60.19000	880397	11864.4084
549	Gabon	Africa	1992	61.36600	985739	13522.1575
550	Gabon	Africa	1997	60.46100	1126189	14722.8419
551	Gabon	Africa	2002	56.76100	1299304	12521.7139
552	Gabon	Africa	2007	56.73500	1454867	13206.4845
553	Gambia	Africa	1952	30.00000	284320	485.2307
554	Gambia	Africa	1957	32.06500	323150	520.9267
555	Gambia	Africa	1962	33.89600	374020	599.6503
556	Gambia	Africa	1967	35.85700	439593	734.7829
557	Gambia	Africa	1972	38.30800	517101	756.0868
558	Gambia	Africa	1977	41.84200	608274	884.7553
559	Gambia	Africa	1982	45.58000	715523	835.8096
560	Gambia	Africa	1987	49.26500	848406	611.6589
561	Gambia	Africa	1992	52.64400	1025384	665.6244
562	Gambia	Africa	1997	55.86100	1235767	653.7302
563	Gambia	Africa	2002	58.04100	1457766	660.5856
564	Gambia	Africa	2007	59.44800	1688359	752.7497
565	Germany	Europe	1952	67.50000	69145952	7144.1144

566	Germany	Europe	1957	69.10000	71019069	10187.8267
567	Germany	Europe	1962	70.30000	73739117	12902.4629
568	Germany	Europe	1967	70.80000	76368453	14745.6256
569	Germany	Europe	1972	71.00000	78717088	18016.1803
570	Germany	Europe	1977	72.50000	78160773	20512.9212
571	Germany	Europe	1982	73.80000	78335266	22031.5327
572	Germany	Europe	1987	74.84700	77718298	24639.1857
573	Germany	Europe	1992	76.07000	80597764	26505.3032
574	Germany	Europe	1997	77.34000	82011073	27788.8842
575	Germany	Europe	2002	78.67000	82350671	30035.8020
576	Germany	Europe	2007	79.40600	82400996	32170.3744
577	Ghana	Africa	1952	43.14900	5581001	911.2989
578	Ghana	Africa	1957	44.77900	6391288	1043.5615
579	Ghana	Africa	1962	46.45200	7355248	1190.0411
580	Ghana	Africa	1967	48.07200	8490213	1125.6972
581	Ghana	Africa	1972	49.87500	9354120	1178.2237
582	Ghana	Africa	1977	51.75600	10538093	993.2240
583	Ghana	Africa	1982	53.74400	11400338	876.0326
584	Ghana	Africa	1987	55.72900	14168101	847.0061
585	Ghana	Africa	1992	57.50100	16278738	925.0602
586	Ghana	Africa	1997	58.55600	18418288	1005.2458
587	Ghana	Africa	2002	58.45300	20550751	1111.9846
588	Ghana	Africa	2007	60.02200	22873338	1327.6089
589	Greece	Europe	1952	65.86000	7733250	3530.6901
590	Greece	Europe	1957	67.86000	8096218	4916.2999
591	Greece	Europe	1962	69.51000	8448233	6017.1907
592	Greece	Europe	1967	71.00000	8716441	8513.0970
593	Greece	Europe	1972	72.34000	8888628	12724.8296
594	Greece	Europe	1977	73.68000	9308479	14195.5243
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596	Greece	Europe	1987	76.67000	9974490	16120.5284
597	Greece	Europe	1992	77.03000	10325429	17541.4963
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599	Greece	Europe	2002	78.25600	10603863	22514.2548
600	Greece	Europe	2007	79.48300	10706290	27538.4119
601	Guatemala	Americas	1952	42.02300	3146381	2428.2378
602	Guatemala	Americas	1957	44.14200	3640876	2617.1560
603	Guatemala	Americas	1962	46.95400	4208858	2750.3644
604	Guatemala	Americas	1967	50.01600	4690773	3242.5311
605	Guatemala	Americas	1972	53.73800	5149581	4031.4083
606	Guatemala	Americas	1977	56.02900	5703430	4879.9927
607	Guatemala	Americas	1982	58.13700	6395630	4820.4948
608	Guatemala	Americas	1987	60.78200	7326406	4246.4860

609	Guatemala	Americas	1992	63.37300	8486949	4439.4508
610	Guatemala	Americas	1997	66.32200	9803875	4684.3138
611	Guatemala	Americas	2002	68.97800	11178650	4858.3475
612	Guatemala	Americas	2007	70.25900	12572928	5186.0500
613	Guinea	Africa	1952	33.60900	2664249	510.1965
614	Guinea	Africa	1957	34.55800	2876726	576.2670
615	Guinea	Africa	1962	35.75300	3140003	686.3737
616	Guinea	Africa	1967	37.19700	3451418	708.7595
617	Guinea	Africa	1972	38.84200	3811387	741.6662
618	Guinea	Africa	1977	40.76200	4227026	874.6859
619	Guinea	Africa	1982	42.89100	4710497	857.2504
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622	Guinea	Africa	1997	51.45500	8048834	869.4498
623	Guinea	Africa	2002	53.67600	8807818	945.5836
624	Guinea	Africa	2007	56.00700	9947814	942.6542
625	Guinea-Bissau	Africa	1952	32.50000	580653	299.8503
626	Guinea-Bissau	Africa	1957	33.48900	601095	431.7905
627	Guinea-Bissau	Africa	1962	34.48800	627820	522.0344
628	Guinea-Bissau	Africa	1967	35.49200	601287	715.5806
629	Guinea-Bissau	Africa	1972	36.48600	625361	820.2246
630	Guinea-Bissau	Africa	1977	37.46500	745228	764.7260
631	Guinea-Bissau	Africa	1982	39.32700	825987	838.1240
632	Guinea-Bissau	Africa	1987	41.24500	927524	736.4154
633	Guinea-Bissau	Africa	1992	43.26600	1050938	745.5399
634	Guinea-Bissau	Africa	1997	44.87300	1193708	796.6645
635	Guinea-Bissau	Africa	2002	45.50400	1332459	575.7047
636	Guinea-Bissau	Africa	2007	46.38800	1472041	579.2317
637	Haiti	Americas	1952	37.57900	3201488	1840.3669
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643	Haiti	Americas	1982	51.46100	5198399	2011.1595
644	Haiti	Americas	1987	53.63600	5756203	1823.0160
645	Haiti	Americas	1992	55.08900	6326682	1456.3095
646	Haiti	Americas	1997	56.67100	6913545	1341.7269
647	Haiti	Americas	2002	58.13700	7607651	1270.3649
648	Haiti	Americas	2007	60.91600	8502814	1201.6372
649	Honduras	Americas	1952	41.91200	1517453	2194.9262
650	Honduras	Americas	1957	44.66500	1770390	2220.4877
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655                Honduras  Americas 1982 60.90900    3669448   3121.7608
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660                Honduras  Americas 2007 70.19800    7483763   3548.3308
661         Hong Kong, China      Asia 1952 60.96000    2125900   3054.4212
662         Hong Kong, China      Asia 1957 64.75000    2736300   3629.0765
663         Hong Kong, China      Asia 1962 67.65000    3305200   4692.6483
664         Hong Kong, China      Asia 1967 70.00000    3722800   6197.9628
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667         Hong Kong, China      Asia 1982 75.45000    5264500  14560.5305
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669         Hong Kong, China      Asia 1992 77.60100    5829696  24757.6030
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673                 Hungary    Europe 1952 64.03000    9504000   5263.6738
674                 Hungary    Europe 1957 66.41000    9839000   6040.1800
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692                 Iceland    Europe 1987 77.23000     244676  26923.2063
693                 Iceland    Europe 1992 78.77000     259012  25144.3920
694                 Iceland    Europe 1997 78.95000     271192  28061.0997
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696	Iceland	Europe	2007	81.75700	301931	36180.7892
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698	India	Asia	1957	40.24900	409000000	590.0620
699	India	Asia	1962	43.60500	454000000	658.3472
700	India	Asia	1967	47.19300	506000000	700.7706
701	India	Asia	1972	50.65100	567000000	724.0325
702	India	Asia	1977	54.20800	634000000	813.3373
703	India	Asia	1982	56.59600	708000000	855.7235
704	India	Asia	1987	58.55300	788000000	976.5127
705	India	Asia	1992	60.22300	872000000	1164.4068
706	India	Asia	1997	61.76500	959000000	1458.8174
707	India	Asia	2002	62.87900	1034172547	1746.7695
708	India	Asia	2007	64.69800	1110396331	2452.2104
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710	Indonesia	Asia	1957	39.91800	90124000	858.9003
711	Indonesia	Asia	1962	42.51800	99028000	849.2898
712	Indonesia	Asia	1967	45.96400	109343000	762.4318
713	Indonesia	Asia	1972	49.20300	121282000	1111.1079
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721	Iran	Asia	1952	44.86900	17272000	3035.3260
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724	Iran	Asia	1967	52.46900	26538000	5906.7318
725	Iran	Asia	1972	55.23400	30614000	9613.8186
726	Iran	Asia	1977	57.70200	35480679	11888.5951
727	Iran	Asia	1982	59.62000	43072751	7608.3346
728	Iran	Asia	1987	63.04000	51889696	6642.8814
729	Iran	Asia	1992	65.74200	60397973	7235.6532
730	Iran	Asia	1997	68.04200	63327987	8263.5903
731	Iran	Asia	2002	69.45100	66907826	9240.7620
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733	Iraq	Asia	1952	45.32000	5441766	4129.7661
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735	Iraq	Asia	1962	51.45700	7240260	8341.7378
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738	Iraq	Asia	1977	60.41300	11882916	14688.2351
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744	Iraq	Asia	2007	59.54500	27499638	4471.0619
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747	Ireland	Europe	1962	70.29000	2830000	6631.5973
748	Ireland	Europe	1967	71.08000	2900100	7655.5690
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755	Ireland	Europe	2002	77.78300	3879155	34077.0494
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757	Israel	Asia	1952	65.39000	1620914	4086.5221
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765	Israel	Asia	1992	76.93000	4936550	18051.5225
766	Israel	Asia	1997	78.26900	5531387	20896.6092
767	Israel	Asia	2002	79.69600	6029529	21905.5951
768	Israel	Asia	2007	80.74500	6426679	25523.2771
769	Italy	Europe	1952	65.94000	47666000	4931.4042
770	Italy	Europe	1957	67.81000	49182000	6248.6562
771	Italy	Europe	1962	69.24000	50843200	8243.5823
772	Italy	Europe	1967	71.06000	52667100	10022.4013
773	Italy	Europe	1972	72.19000	54365564	12269.2738
774	Italy	Europe	1977	73.48000	56059245	14255.9847
775	Italy	Europe	1982	74.98000	56535636	16537.4835
776	Italy	Europe	1987	76.42000	56729703	19207.2348
777	Italy	Europe	1992	77.44000	56840847	22013.6449
778	Italy	Europe	1997	78.82000	57479469	24675.0245
779	Italy	Europe	2002	80.24000	57926999	27968.0982
780	Italy	Europe	2007	80.54600	58147733	28569.7197

781	Jamaica	Americas	1952	58.53000	1426095	2898.5309
782	Jamaica	Americas	1957	62.61000	1535090	4756.5258
783	Jamaica	Americas	1962	65.61000	1665128	5246.1075
784	Jamaica	Americas	1967	67.51000	1861096	6124.7035
785	Jamaica	Americas	1972	69.00000	1997616	7433.8893
786	Jamaica	Americas	1977	70.11000	2156814	6650.1956
787	Jamaica	Americas	1982	71.21000	2298309	6068.0513
788	Jamaica	Americas	1987	71.77000	2326606	6351.2375
789	Jamaica	Americas	1992	71.76600	2378618	7404.9237
790	Jamaica	Americas	1997	72.26200	2531311	7121.9247
791	Jamaica	Americas	2002	72.04700	2664659	6994.7749
792	Jamaica	Americas	2007	72.56700	2780132	7320.8803
793	Japan	Asia	1952	63.03000	86459025	3216.9563
794	Japan	Asia	1957	65.50000	91563009	4317.6944
795	Japan	Asia	1962	68.73000	95831757	6576.6495
796	Japan	Asia	1967	71.43000	100825279	9847.7886
797	Japan	Asia	1972	73.42000	107188273	14778.7864
798	Japan	Asia	1977	75.38000	113872473	16610.3770
799	Japan	Asia	1982	77.11000	118454974	19384.1057
800	Japan	Asia	1987	78.67000	122091325	22375.9419
801	Japan	Asia	1992	79.36000	124329269	26824.8951
802	Japan	Asia	1997	80.69000	125956499	28816.5850
803	Japan	Asia	2002	82.00000	127065841	28604.5919
804	Japan	Asia	2007	82.60300	127467972	31656.0681
805	Jordan	Asia	1952	43.15800	607914	1546.9078
806	Jordan	Asia	1957	45.66900	746559	1886.0806
807	Jordan	Asia	1962	48.12600	933559	2348.0092
808	Jordan	Asia	1967	51.62900	1255058	2741.7963
809	Jordan	Asia	1972	56.52800	1613551	2110.8563
810	Jordan	Asia	1977	61.13400	1937652	2852.3516
811	Jordan	Asia	1982	63.73900	2347031	4161.4160
812	Jordan	Asia	1987	65.86900	2820042	4448.6799
813	Jordan	Asia	1992	68.01500	3867409	3431.5936
814	Jordan	Asia	1997	69.77200	4526235	3645.3796
815	Jordan	Asia	2002	71.26300	5307470	3844.9172
816	Jordan	Asia	2007	72.53500	6053193	4519.4612
817	Kenya	Africa	1952	42.27000	6464046	853.5409
818	Kenya	Africa	1957	44.68600	7454779	944.4383
819	Kenya	Africa	1962	47.94900	8678557	896.9664
820	Kenya	Africa	1967	50.65400	10191512	1056.7365
821	Kenya	Africa	1972	53.55900	12044785	1222.3600
822	Kenya	Africa	1977	56.15500	14500404	1267.6132
823	Kenya	Africa	1982	58.76600	17661452	1348.2258

824	Kenya	Africa	1987	59.33900	21198082	1361.9369
825	Kenya	Africa	1992	59.28500	25020539	1341.9217
826	Kenya	Africa	1997	54.40700	28263827	1360.4850
827	Kenya	Africa	2002	50.99200	31386842	1287.5147
828	Kenya	Africa	2007	54.11000	35610177	1463.2493
829	Korea, Dem. Rep.	Asia	1952	50.05600	8865488	1088.2778
830	Korea, Dem. Rep.	Asia	1957	54.08100	9411381	1571.1347
831	Korea, Dem. Rep.	Asia	1962	56.65600	10917494	1621.6936
832	Korea, Dem. Rep.	Asia	1967	59.94200	12617009	2143.5406
833	Korea, Dem. Rep.	Asia	1972	63.98300	14781241	3701.6215
834	Korea, Dem. Rep.	Asia	1977	67.15900	16325320	4106.3012
835	Korea, Dem. Rep.	Asia	1982	69.10000	17647518	4106.5253
836	Korea, Dem. Rep.	Asia	1987	70.64700	19067554	4106.4923
837	Korea, Dem. Rep.	Asia	1992	69.97800	20711375	3726.0635
838	Korea, Dem. Rep.	Asia	1997	67.72700	21585105	1690.7568
839	Korea, Dem. Rep.	Asia	2002	66.66200	22215365	1646.7582
840	Korea, Dem. Rep.	Asia	2007	67.29700	23301725	1593.0655
841	Korea, Rep.	Asia	1952	47.45300	20947571	1030.5922
842	Korea, Rep.	Asia	1957	52.68100	22611552	1487.5935
843	Korea, Rep.	Asia	1962	55.29200	26420307	1536.3444
844	Korea, Rep.	Asia	1967	57.71600	30131000	2029.2281
845	Korea, Rep.	Asia	1972	62.61200	33505000	3030.8767
846	Korea, Rep.	Asia	1977	64.76600	36436000	4657.2210
847	Korea, Rep.	Asia	1982	67.12300	39326000	5622.9425
848	Korea, Rep.	Asia	1987	69.81000	41622000	8533.0888
849	Korea, Rep.	Asia	1992	72.24400	43805450	12104.2787
850	Korea, Rep.	Asia	1997	74.64700	46173816	15993.5280
851	Korea, Rep.	Asia	2002	77.04500	47969150	19233.9882
852	Korea, Rep.	Asia	2007	78.62300	49044790	23348.1397
853	Kuwait	Asia	1952	55.56500	160000	108382.3529
854	Kuwait	Asia	1957	58.03300	212846	113523.1329
855	Kuwait	Asia	1962	60.47000	358266	95458.1118
856	Kuwait	Asia	1967	64.62400	575003	80894.8833
857	Kuwait	Asia	1972	67.71200	841934	109347.8670
858	Kuwait	Asia	1977	69.34300	1140357	59265.4771
859	Kuwait	Asia	1982	71.30900	1497494	31354.0357
860	Kuwait	Asia	1987	74.17400	1891487	28118.4300
861	Kuwait	Asia	1992	75.19000	1418095	34932.9196
862	Kuwait	Asia	1997	76.15600	1765345	40300.6200
863	Kuwait	Asia	2002	76.90400	2111561	35110.1057
864	Kuwait	Asia	2007	77.58800	2505559	47306.9898
865	Lebanon	Asia	1952	55.92800	1439529	4834.8041
866	Lebanon	Asia	1957	59.48900	1647412	6089.7869

867	Lebanon	Asia	1962	62.09400	1886848	5714.5606
868	Lebanon	Asia	1967	63.87000	2186894	6006.9830
869	Lebanon	Asia	1972	65.42100	2680018	7486.3843
870	Lebanon	Asia	1977	66.09900	3115787	8659.6968
871	Lebanon	Asia	1982	66.98300	3086876	7640.5195
872	Lebanon	Asia	1987	67.92600	3089353	5377.0913
873	Lebanon	Asia	1992	69.29200	3219994	6890.8069
874	Lebanon	Asia	1997	70.26500	3430388	8754.9639
875	Lebanon	Asia	2002	71.02800	3677780	9313.9388
876	Lebanon	Asia	2007	71.99300	3921278	10461.0587
877	Lesotho	Africa	1952	42.13800	748747	298.8462
878	Lesotho	Africa	1957	45.04700	813338	335.9971
879	Lesotho	Africa	1962	47.74700	893143	411.8006
880	Lesotho	Africa	1967	48.49200	996380	498.6390
881	Lesotho	Africa	1972	49.76700	1116779	496.5816
882	Lesotho	Africa	1977	52.20800	1251524	745.3695
883	Lesotho	Africa	1982	55.07800	1411807	797.2631
884	Lesotho	Africa	1987	57.18000	1599200	773.9932
885	Lesotho	Africa	1992	59.68500	1803195	977.4863
886	Lesotho	Africa	1997	55.55800	1982823	1186.1480
887	Lesotho	Africa	2002	44.59300	2046772	1275.1846
888	Lesotho	Africa	2007	42.59200	2012649	1569.3314
889	Liberia	Africa	1952	38.48000	863308	575.5730
890	Liberia	Africa	1957	39.48600	975950	620.9700
891	Liberia	Africa	1962	40.50200	1112796	634.1952
892	Liberia	Africa	1967	41.53600	1279406	713.6036
893	Liberia	Africa	1972	42.61400	1482628	803.0055
894	Liberia	Africa	1977	43.76400	1703617	640.3224
895	Liberia	Africa	1982	44.85200	1956875	572.1996
896	Liberia	Africa	1987	46.02700	2269414	506.1139
897	Liberia	Africa	1992	40.80200	1912974	636.6229
898	Liberia	Africa	1997	42.22100	2200725	609.1740
899	Liberia	Africa	2002	43.75300	2814651	531.4824
900	Liberia	Africa	2007	45.67800	3193942	414.5073
901	Libya	Africa	1952	42.72300	1019729	2387.5481
902	Libya	Africa	1957	45.28900	1201578	3448.2844
903	Libya	Africa	1962	47.80800	1441863	6757.0308
904	Libya	Africa	1967	50.22700	1759224	18772.7517
905	Libya	Africa	1972	52.77300	2183877	21011.4972
906	Libya	Africa	1977	57.44200	2721783	21951.2118
907	Libya	Africa	1982	62.15500	3344074	17364.2754
908	Libya	Africa	1987	66.23400	3799845	11770.5898
909	Libya	Africa	1992	68.75500	4364501	9640.1385

910	Libya	Africa	1997	71.55500	4759670	9467.4461
911	Libya	Africa	2002	72.73700	5368585	9534.6775
912	Libya	Africa	2007	73.95200	6036914	12057.4993
913	Madagascar	Africa	1952	36.68100	4762912	1443.0117
914	Madagascar	Africa	1957	38.86500	5181679	1589.2027
915	Madagascar	Africa	1962	40.84800	5703324	1643.3871
916	Madagascar	Africa	1967	42.88100	6334556	1634.0473
917	Madagascar	Africa	1972	44.85100	7082430	1748.5630
918	Madagascar	Africa	1977	46.88100	8007166	1544.2286
919	Madagascar	Africa	1982	48.96900	9171477	1302.8787
920	Madagascar	Africa	1987	49.35000	10568642	1155.4419
921	Madagascar	Africa	1992	52.21400	12210395	1040.6762
922	Madagascar	Africa	1997	54.97800	14165114	986.2959
923	Madagascar	Africa	2002	57.28600	16473477	894.6371
924	Madagascar	Africa	2007	59.44300	19167654	1044.7701
925	Malawi	Africa	1952	36.25600	2917802	369.1651
926	Malawi	Africa	1957	37.20700	3221238	416.3698
927	Malawi	Africa	1962	38.41000	3628608	427.9011
928	Malawi	Africa	1967	39.48700	4147252	495.5148
929	Malawi	Africa	1972	41.76600	4730997	584.6220
930	Malawi	Africa	1977	43.76700	5637246	663.2237
931	Malawi	Africa	1982	45.64200	6502825	632.8039
932	Malawi	Africa	1987	47.45700	7824747	635.5174
933	Malawi	Africa	1992	49.42000	10014249	563.2000
934	Malawi	Africa	1997	47.49500	10419991	692.2758
935	Malawi	Africa	2002	45.00900	11824495	665.4231
936	Malawi	Africa	2007	48.30300	13327079	759.3499
937	Malaysia	Asia	1952	48.46300	6748378	1831.1329
938	Malaysia	Asia	1957	52.10200	7739235	1810.0670
939	Malaysia	Asia	1962	55.73700	8906385	2036.8849
940	Malaysia	Asia	1967	59.37100	10154878	2277.7424
941	Malaysia	Asia	1972	63.01000	11441462	2849.0948
942	Malaysia	Asia	1977	65.25600	12845381	3827.9216
943	Malaysia	Asia	1982	68.00000	14441916	4920.3560
944	Malaysia	Asia	1987	69.50000	16331785	5249.8027
945	Malaysia	Asia	1992	70.69300	18319502	7277.9128
946	Malaysia	Asia	1997	71.93800	20476091	10132.9096
947	Malaysia	Asia	2002	73.04400	22662365	10206.9779
948	Malaysia	Asia	2007	74.24100	24821286	12451.6558
949	Mali	Africa	1952	33.68500	3838168	452.3370
950	Mali	Africa	1957	35.30700	4241884	490.3822
951	Mali	Africa	1962	36.93600	4690372	496.1743
952	Mali	Africa	1967	38.48700	5212416	545.0099

953	Mali	Africa	1972	39.97700	5828158	581.3689
954	Mali	Africa	1977	41.71400	6491649	686.3953
955	Mali	Africa	1982	43.91600	6998256	618.0141
956	Mali	Africa	1987	46.36400	7634008	684.1716
957	Mali	Africa	1992	48.38800	8416215	739.0144
958	Mali	Africa	1997	49.90300	9384984	790.2580
959	Mali	Africa	2002	51.81800	10580176	951.4098
960	Mali	Africa	2007	54.46700	12031795	1042.5816
961	Mauritania	Africa	1952	40.54300	1022556	743.1159
962	Mauritania	Africa	1957	42.33800	1076852	846.1203
963	Mauritania	Africa	1962	44.24800	1146757	1055.8960
964	Mauritania	Africa	1967	46.28900	1230542	1421.1452
965	Mauritania	Africa	1972	48.43700	1332786	1586.8518
966	Mauritania	Africa	1977	50.85200	1456688	1497.4922
967	Mauritania	Africa	1982	53.59900	1622136	1481.1502
968	Mauritania	Africa	1987	56.14500	1841240	1421.6036
969	Mauritania	Africa	1992	58.33300	2119465	1361.3698
970	Mauritania	Africa	1997	60.43000	2444741	1483.1361
971	Mauritania	Africa	2002	62.24700	2828858	1579.0195
972	Mauritania	Africa	2007	64.16400	3270065	1803.1515
973	Mauritius	Africa	1952	50.98600	516556	1967.9557
974	Mauritius	Africa	1957	58.08900	609816	2034.0380
975	Mauritius	Africa	1962	60.24600	701016	2529.0675
976	Mauritius	Africa	1967	61.55700	789309	2475.3876
977	Mauritius	Africa	1972	62.94400	851334	2575.4842
978	Mauritius	Africa	1977	64.93000	913025	3710.9830
979	Mauritius	Africa	1982	66.71100	992040	3688.0377
980	Mauritius	Africa	1987	68.74000	1042663	4783.5869
981	Mauritius	Africa	1992	69.74500	1096202	6058.2538
982	Mauritius	Africa	1997	70.73600	1149818	7425.7053
983	Mauritius	Africa	2002	71.95400	1200206	9021.8159
984	Mauritius	Africa	2007	72.80100	1250882	10956.9911
985	Mexico	Americas	1952	50.78900	30144317	3478.1255
986	Mexico	Americas	1957	55.19000	35015548	4131.5466
987	Mexico	Americas	1962	58.29900	41121485	4581.6094
988	Mexico	Americas	1967	60.11000	47995559	5754.7339
989	Mexico	Americas	1972	62.36100	55984294	6809.4067
990	Mexico	Americas	1977	65.03200	63759976	7674.9291
991	Mexico	Americas	1982	67.40500	71640904	9611.1475
992	Mexico	Americas	1987	69.49800	80122492	8688.1560
993	Mexico	Americas	1992	71.45500	88111030	9472.3843
994	Mexico	Americas	1997	73.67000	95895146	9767.2975
995	Mexico	Americas	2002	74.90200	102479927	10742.4405

996	Mexico	Americas	2007	76.19500	108700891	11977.5750
997	Mongolia	Asia	1952	42.24400	800663	786.5669
998	Mongolia	Asia	1957	45.24800	882134	912.6626
999	Mongolia	Asia	1962	48.25100	1010280	1056.3540
1000	Mongolia	Asia	1967	51.25300	1149500	1226.0411
1001	Mongolia	Asia	1972	53.75400	1320500	1421.7420
1002	Mongolia	Asia	1977	55.49100	1528000	1647.5117
1003	Mongolia	Asia	1982	57.48900	1756032	2000.6031
1004	Mongolia	Asia	1987	60.22200	2015133	2338.0083
1005	Mongolia	Asia	1992	61.27100	2312802	1785.4020
1006	Mongolia	Asia	1997	63.62500	2494803	1902.2521
1007	Mongolia	Asia	2002	65.03300	2674234	2140.7393
1008	Mongolia	Asia	2007	66.80300	2874127	3095.7723
1009	Montenegro	Europe	1952	59.16400	413834	2647.5856
1010	Montenegro	Europe	1957	61.44800	442829	3682.2599
1011	Montenegro	Europe	1962	63.72800	474528	4649.5938
1012	Montenegro	Europe	1967	67.17800	501035	5907.8509
1013	Montenegro	Europe	1972	70.63600	527678	7778.4140
1014	Montenegro	Europe	1977	73.06600	560073	9595.9299
1015	Montenegro	Europe	1982	74.10100	562548	11222.5876
1016	Montenegro	Europe	1987	74.86500	569473	11732.5102
1017	Montenegro	Europe	1992	75.43500	621621	7003.3390
1018	Montenegro	Europe	1997	75.44500	692651	6465.6133
1019	Montenegro	Europe	2002	73.98100	720230	6557.1943
1020	Montenegro	Europe	2007	74.54300	684736	9253.8961
1021	Morocco	Africa	1952	42.87300	9939217	1688.2036
1022	Morocco	Africa	1957	45.42300	11406350	1642.0023
1023	Morocco	Africa	1962	47.92400	13056604	1566.3535
1024	Morocco	Africa	1967	50.33500	14770296	1711.0448
1025	Morocco	Africa	1972	52.86200	16660670	1930.1950
1026	Morocco	Africa	1977	55.73000	18396941	2370.6200
1027	Morocco	Africa	1982	59.65000	20198730	2702.6204
1028	Morocco	Africa	1987	62.67700	22987397	2755.0470
1029	Morocco	Africa	1992	65.39300	25798239	2948.0473
1030	Morocco	Africa	1997	67.66000	28529501	2982.1019
1031	Morocco	Africa	2002	69.61500	31167783	3258.4956
1032	Morocco	Africa	2007	71.16400	33757175	3820.1752
1033	Mozambique	Africa	1952	31.28600	6446316	468.5260
1034	Mozambique	Africa	1957	33.77900	7038035	495.5868
1035	Mozambique	Africa	1962	36.16100	7788944	556.6864
1036	Mozambique	Africa	1967	38.11300	8680909	566.6692
1037	Mozambique	Africa	1972	40.32800	9809596	724.9178
1038	Mozambique	Africa	1977	42.49500	11127868	502.3197

1039	Mozambique	Africa	1982	42.79500	12587223	462.2114
1040	Mozambique	Africa	1987	42.86100	12891952	389.8762
1041	Mozambique	Africa	1992	44.28400	13160731	410.8968
1042	Mozambique	Africa	1997	46.34400	16603334	472.3461
1043	Mozambique	Africa	2002	44.02600	18473780	633.6179
1044	Mozambique	Africa	2007	42.08200	19951656	823.6856
1045	Myanmar	Asia	1952	36.31900	20092996	331.0000
1046	Myanmar	Asia	1957	41.90500	21731844	350.0000
1047	Myanmar	Asia	1962	45.10800	23634436	388.0000
1048	Myanmar	Asia	1967	49.37900	25870271	349.0000
1049	Myanmar	Asia	1972	53.07000	28466390	357.0000
1050	Myanmar	Asia	1977	56.05900	31528087	371.0000
1051	Myanmar	Asia	1982	58.05600	34680442	424.0000
1052	Myanmar	Asia	1987	58.33900	38028578	385.0000
1053	Myanmar	Asia	1992	59.32000	40546538	347.0000
1054	Myanmar	Asia	1997	60.32800	43247867	415.0000
1055	Myanmar	Asia	2002	59.90800	45598081	611.0000
1056	Myanmar	Asia	2007	62.06900	47761980	944.0000
1057	Namibia	Africa	1952	41.72500	485831	2423.7804
1058	Namibia	Africa	1957	45.22600	548080	2621.4481
1059	Namibia	Africa	1962	48.38600	621392	3173.2156
1060	Namibia	Africa	1967	51.15900	706640	3793.6948
1061	Namibia	Africa	1972	53.86700	821782	3746.0809
1062	Namibia	Africa	1977	56.43700	977026	3876.4860
1063	Namibia	Africa	1982	58.96800	1099010	4191.1005
1064	Namibia	Africa	1987	60.83500	1278184	3693.7313
1065	Namibia	Africa	1992	61.99900	1554253	3804.5380
1066	Namibia	Africa	1997	58.90900	1774766	3899.5243
1067	Namibia	Africa	2002	51.47900	1972153	4072.3248
1068	Namibia	Africa	2007	52.90600	2055080	4811.0604
1069	Nepal	Asia	1952	36.15700	9182536	545.8657
1070	Nepal	Asia	1957	37.68600	9682338	597.9364
1071	Nepal	Asia	1962	39.39300	10332057	652.3969
1072	Nepal	Asia	1967	41.47200	11261690	676.4422
1073	Nepal	Asia	1972	43.97100	12412593	674.7881
1074	Nepal	Asia	1977	46.74800	13933198	694.1124
1075	Nepal	Asia	1982	49.59400	15796314	718.3731
1076	Nepal	Asia	1987	52.53700	17917180	775.6325
1077	Nepal	Asia	1992	55.72700	20326209	897.7404
1078	Nepal	Asia	1997	59.42600	23001113	1010.8921
1079	Nepal	Asia	2002	61.34000	25873917	1057.2063
1080	Nepal	Asia	2007	63.78500	28901790	1091.3598
1081	Netherlands	Europe	1952	72.13000	10381988	8941.5719

1082	Netherlands	Europe	1957	72.99000	11026383	11276.1934
1083	Netherlands	Europe	1962	73.23000	11805689	12790.8496
1084	Netherlands	Europe	1967	73.82000	12596822	15363.2514
1085	Netherlands	Europe	1972	73.75000	13329874	18794.7457
1086	Netherlands	Europe	1977	75.24000	13852989	21209.0592
1087	Netherlands	Europe	1982	76.05000	14310401	21399.4605
1088	Netherlands	Europe	1987	76.83000	14665278	23651.3236
1089	Netherlands	Europe	1992	77.42000	15174244	26790.9496
1090	Netherlands	Europe	1997	78.03000	15604464	30246.1306
1091	Netherlands	Europe	2002	78.53000	16122830	33724.7578
1092	Netherlands	Europe	2007	79.76200	16570613	36797.9333
1093	New Zealand	Oceania	1952	69.39000	1994794	10556.5757
1094	New Zealand	Oceania	1957	70.26000	2229407	12247.3953
1095	New Zealand	Oceania	1962	71.24000	2488550	13175.6780
1096	New Zealand	Oceania	1967	71.52000	2728150	14463.9189
1097	New Zealand	Oceania	1972	71.89000	2929100	16046.0373
1098	New Zealand	Oceania	1977	72.22000	3164900	16233.7177
1099	New Zealand	Oceania	1982	73.84000	3210650	17632.4104
1100	New Zealand	Oceania	1987	74.32000	3317166	19007.1913
1101	New Zealand	Oceania	1992	76.33000	3437674	18363.3249
1102	New Zealand	Oceania	1997	77.55000	3676187	21050.4138
1103	New Zealand	Oceania	2002	79.11000	3908037	23189.8014
1104	New Zealand	Oceania	2007	80.20400	4115771	25185.0091
1105	Nicaragua	Americas	1952	42.31400	1165790	3112.3639
1106	Nicaragua	Americas	1957	45.43200	1358828	3457.4159
1107	Nicaragua	Americas	1962	48.63200	1590597	3634.3644
1108	Nicaragua	Americas	1967	51.88400	1865490	4643.3935
1109	Nicaragua	Americas	1972	55.15100	2182908	4688.5933
1110	Nicaragua	Americas	1977	57.47000	2554598	5486.3711
1111	Nicaragua	Americas	1982	59.29800	2979423	3470.3382
1112	Nicaragua	Americas	1987	62.00800	3344353	2955.9844
1113	Nicaragua	Americas	1992	65.84300	4017939	2170.1517
1114	Nicaragua	Americas	1997	68.42600	4609572	2253.0230
1115	Nicaragua	Americas	2002	70.83600	5146848	2474.5488
1116	Nicaragua	Americas	2007	72.89900	5675356	2749.3210
1117	Niger	Africa	1952	37.44400	3379468	761.8794
1118	Niger	Africa	1957	38.59800	3692184	835.5234
1119	Niger	Africa	1962	39.48700	4076008	997.7661
1120	Niger	Africa	1967	40.11800	4534062	1054.3849
1121	Niger	Africa	1972	40.54600	5060262	954.2092
1122	Niger	Africa	1977	41.29100	5682086	808.8971
1123	Niger	Africa	1982	42.59800	6437188	909.7221
1124	Niger	Africa	1987	44.55500	7332638	668.3000

1125	Niger	Africa	1992	47.39100	8392818	581.1827
1126	Niger	Africa	1997	51.31300	9666252	580.3052
1127	Niger	Africa	2002	54.49600	11140655	601.0745
1128	Niger	Africa	2007	56.86700	12894865	619.6769
1129	Nigeria	Africa	1952	36.32400	33119096	1077.2819
1130	Nigeria	Africa	1957	37.80200	37173340	1100.5926
1131	Nigeria	Africa	1962	39.36000	41871351	1150.9275
1132	Nigeria	Africa	1967	41.04000	47287752	1014.5141
1133	Nigeria	Africa	1972	42.82100	53740085	1698.3888
1134	Nigeria	Africa	1977	44.51400	62209173	1981.9518
1135	Nigeria	Africa	1982	45.82600	73039376	1576.9738
1136	Nigeria	Africa	1987	46.88600	81551520	1385.0296
1137	Nigeria	Africa	1992	47.47200	93364244	1619.8482
1138	Nigeria	Africa	1997	47.46400	106207839	1624.9413
1139	Nigeria	Africa	2002	46.60800	119901274	1615.2864
1140	Nigeria	Africa	2007	46.85900	135031164	2013.9773
1141	Norway	Europe	1952	72.67000	3327728	10095.4217
1142	Norway	Europe	1957	73.44000	3491938	11653.9730
1143	Norway	Europe	1962	73.47000	3638919	13450.4015
1144	Norway	Europe	1967	74.08000	3786019	16361.8765
1145	Norway	Europe	1972	74.34000	3933004	18965.0555
1146	Norway	Europe	1977	75.37000	4043205	23311.3494
1147	Norway	Europe	1982	75.97000	4114787	26298.6353
1148	Norway	Europe	1987	75.89000	4186147	31540.9748
1149	Norway	Europe	1992	77.32000	4286357	33965.6611
1150	Norway	Europe	1997	78.32000	4405672	41283.1643
1151	Norway	Europe	2002	79.05000	4535591	44683.9753
1152	Norway	Europe	2007	80.19600	4627926	49357.1902
1153	Oman	Asia	1952	37.57800	507833	1828.2303
1154	Oman	Asia	1957	40.08000	561977	2242.7466
1155	Oman	Asia	1962	43.16500	628164	2924.6381
1156	Oman	Asia	1967	46.98800	714775	4720.9427
1157	Oman	Asia	1972	52.14300	829050	10618.0385
1158	Oman	Asia	1977	57.36700	1004533	11848.3439
1159	Oman	Asia	1982	62.72800	1301048	12954.7910
1160	Oman	Asia	1987	67.73400	1593882	18115.2231
1161	Oman	Asia	1992	71.19700	1915208	18616.7069
1162	Oman	Asia	1997	72.49900	2283635	19702.0558
1163	Oman	Asia	2002	74.19300	2713462	19774.8369
1164	Oman	Asia	2007	75.64000	3204897	22316.1929
1165	Pakistan	Asia	1952	43.43600	41346560	684.5971
1166	Pakistan	Asia	1957	45.55700	46679944	747.0835
1167	Pakistan	Asia	1962	47.67000	53100671	803.3427

1168	Pakistan	Asia	1967	49.80000	60641899	942.4083
1169	Pakistan	Asia	1972	51.92900	69325921	1049.9390
1170	Pakistan	Asia	1977	54.04300	78152686	1175.9212
1171	Pakistan	Asia	1982	56.15800	91462088	1443.4298
1172	Pakistan	Asia	1987	58.24500	105186881	1704.6866
1173	Pakistan	Asia	1992	60.83800	120065004	1971.8295
1174	Pakistan	Asia	1997	61.81800	135564834	2049.3505
1175	Pakistan	Asia	2002	63.61000	153403524	2092.7124
1176	Pakistan	Asia	2007	65.48300	169270617	2605.9476
1177	Panama	Americas	1952	55.19100	940080	2480.3803
1178	Panama	Americas	1957	59.20100	1063506	2961.8009
1179	Panama	Americas	1962	61.81700	1215725	3536.5403
1180	Panama	Americas	1967	64.07100	1405486	4421.0091
1181	Panama	Americas	1972	66.21600	1616384	5364.2497
1182	Panama	Americas	1977	68.68100	1839782	5351.9121
1183	Panama	Americas	1982	70.47200	2036305	7009.6016
1184	Panama	Americas	1987	71.52300	2253639	7034.7792
1185	Panama	Americas	1992	72.46200	2484997	6618.7431
1186	Panama	Americas	1997	73.73800	2734531	7113.6923
1187	Panama	Americas	2002	74.71200	2990875	7356.0319
1188	Panama	Americas	2007	75.53700	3242173	9809.1856
1189	Paraguay	Americas	1952	62.64900	1555876	1952.3087
1190	Paraguay	Americas	1957	63.19600	1770902	2046.1547
1191	Paraguay	Americas	1962	64.36100	2009813	2148.0271
1192	Paraguay	Americas	1967	64.95100	2287985	2299.3763
1193	Paraguay	Americas	1972	65.81500	2614104	2523.3380
1194	Paraguay	Americas	1977	66.35300	2984494	3248.3733
1195	Paraguay	Americas	1982	66.87400	3366439	4258.5036
1196	Paraguay	Americas	1987	67.37800	3886512	3998.8757
1197	Paraguay	Americas	1992	68.22500	4483945	4196.4111
1198	Paraguay	Americas	1997	69.40000	5154123	4247.4003
1199	Paraguay	Americas	2002	70.75500	5884491	3783.6742
1200	Paraguay	Americas	2007	71.75200	6667147	4172.8385
1201	Peru	Americas	1952	43.90200	8025700	3758.5234
1202	Peru	Americas	1957	46.26300	9146100	4245.2567
1203	Peru	Americas	1962	49.09600	10516500	4957.0380
1204	Peru	Americas	1967	51.44500	12132200	5788.0933
1205	Peru	Americas	1972	55.44800	13954700	5937.8273
1206	Peru	Americas	1977	58.44700	15990099	6281.2909
1207	Peru	Americas	1982	61.40600	18125129	6434.5018
1208	Peru	Americas	1987	64.13400	20195924	6360.9434
1209	Peru	Americas	1992	66.45800	22430449	4446.3809
1210	Peru	Americas	1997	68.38600	24748122	5838.3477

1211	Peru	Americas	2002	69.90600	26769436	5909.0201
1212	Peru	Americas	2007	71.42100	28674757	7408.9056
1213	Philippines	Asia	1952	47.75200	22438691	1272.8810
1214	Philippines	Asia	1957	51.33400	26072194	1547.9448
1215	Philippines	Asia	1962	54.75700	30325264	1649.5522
1216	Philippines	Asia	1967	56.39300	35356600	1814.1274
1217	Philippines	Asia	1972	58.06500	40850141	1989.3741
1218	Philippines	Asia	1977	60.06000	46850962	2373.2043
1219	Philippines	Asia	1982	62.08200	53456774	2603.2738
1220	Philippines	Asia	1987	64.15100	60017788	2189.6350
1221	Philippines	Asia	1992	66.45800	67185766	2279.3240
1222	Philippines	Asia	1997	68.56400	75012988	2536.5349
1223	Philippines	Asia	2002	70.30300	82995088	2650.9211
1224	Philippines	Asia	2007	71.68800	91077287	3190.4810
1225	Poland	Europe	1952	61.31000	25730551	4029.3297
1226	Poland	Europe	1957	65.77000	28235346	4734.2530
1227	Poland	Europe	1962	67.64000	30329617	5338.7521
1228	Poland	Europe	1967	69.61000	31785378	6557.1528
1229	Poland	Europe	1972	70.85000	33039545	8006.5070
1230	Poland	Europe	1977	70.67000	34621254	9508.1415
1231	Poland	Europe	1982	71.32000	36227381	8451.5310
1232	Poland	Europe	1987	70.98000	37740710	9082.3512
1233	Poland	Europe	1992	70.99000	38370697	7738.8812
1234	Poland	Europe	1997	72.75000	38654957	10159.5837
1235	Poland	Europe	2002	74.67000	38625976	12002.2391
1236	Poland	Europe	2007	75.56300	38518241	15389.9247
1237	Portugal	Europe	1952	59.82000	8526050	3068.3199
1238	Portugal	Europe	1957	61.51000	8817650	3774.5717
1239	Portugal	Europe	1962	64.39000	9019800	4727.9549
1240	Portugal	Europe	1967	66.60000	9103000	6361.5180
1241	Portugal	Europe	1972	69.26000	8970450	9022.2474
1242	Portugal	Europe	1977	70.41000	9662600	10172.4857
1243	Portugal	Europe	1982	72.77000	9859650	11753.8429
1244	Portugal	Europe	1987	74.06000	9915289	13039.3088
1245	Portugal	Europe	1992	74.86000	9927680	16207.2666
1246	Portugal	Europe	1997	75.97000	10156415	17641.0316
1247	Portugal	Europe	2002	77.29000	10433867	19970.9079
1248	Portugal	Europe	2007	78.09800	10642836	20509.6478
1249	Puerto Rico	Americas	1952	64.28000	2227000	3081.9598
1250	Puerto Rico	Americas	1957	68.54000	2260000	3907.1562
1251	Puerto Rico	Americas	1962	69.62000	2448046	5108.3446
1252	Puerto Rico	Americas	1967	71.10000	2648961	6929.2777
1253	Puerto Rico	Americas	1972	72.16000	2847132	9123.0417

1254	Puerto Rico	Americas	1977	73.44000	3080828	9770.5249
1255	Puerto Rico	Americas	1982	73.75000	3279001	10330.9891
1256	Puerto Rico	Americas	1987	74.63000	3444468	12281.3419
1257	Puerto Rico	Americas	1992	73.91100	3585176	14641.5871
1258	Puerto Rico	Americas	1997	74.91700	3759430	16999.4333
1259	Puerto Rico	Americas	2002	77.77800	3859606	18855.6062
1260	Puerto Rico	Americas	2007	78.74600	3942491	19328.7090
1261	Reunion	Africa	1952	52.72400	257700	2718.8853
1262	Reunion	Africa	1957	55.09000	308700	2769.4518
1263	Reunion	Africa	1962	57.66600	358900	3173.7233
1264	Reunion	Africa	1967	60.54200	414024	4021.1757
1265	Reunion	Africa	1972	64.27400	461633	5047.6586
1266	Reunion	Africa	1977	67.06400	492095	4319.8041
1267	Reunion	Africa	1982	69.88500	517810	5267.2194
1268	Reunion	Africa	1987	71.91300	562035	5303.3775
1269	Reunion	Africa	1992	73.61500	622191	6101.2558
1270	Reunion	Africa	1997	74.77200	684810	6071.9414
1271	Reunion	Africa	2002	75.74400	743981	6316.1652
1272	Reunion	Africa	2007	76.44200	798094	7670.1226
1273	Romania	Europe	1952	61.05000	16630000	3144.6132
1274	Romania	Europe	1957	64.10000	17829327	3943.3702
1275	Romania	Europe	1962	66.80000	18680721	4734.9976
1276	Romania	Europe	1967	66.80000	19284814	6470.8665
1277	Romania	Europe	1972	69.21000	20662648	8011.4144
1278	Romania	Europe	1977	69.46000	21658597	9356.3972
1279	Romania	Europe	1982	69.66000	22356726	9605.3141
1280	Romania	Europe	1987	69.53000	22686371	9696.2733
1281	Romania	Europe	1992	69.36000	22797027	6598.4099
1282	Romania	Europe	1997	69.72000	22562458	7346.5476
1283	Romania	Europe	2002	71.32200	22404337	7885.3601
1284	Romania	Europe	2007	72.47600	22276056	10808.4756
1285	Rwanda	Africa	1952	40.00000	2534927	493.3239
1286	Rwanda	Africa	1957	41.50000	2822082	540.2894
1287	Rwanda	Africa	1962	43.00000	3051242	597.4731
1288	Rwanda	Africa	1967	44.10000	3451079	510.9637
1289	Rwanda	Africa	1972	44.60000	3992121	590.5807
1290	Rwanda	Africa	1977	45.00000	4657072	670.0806
1291	Rwanda	Africa	1982	46.21800	5507565	881.5706
1292	Rwanda	Africa	1987	44.02000	6349365	847.9912
1293	Rwanda	Africa	1992	23.59900	7290203	737.0686
1294	Rwanda	Africa	1997	36.08700	7212583	589.9445
1295	Rwanda	Africa	2002	43.41300	7852401	785.6538
1296	Rwanda	Africa	2007	46.24200	8860588	863.0885

1297	Sao Tome and Principe	Africa	1952	46.47100	60011	879.5836
1298	Sao Tome and Principe	Africa	1957	48.94500	61325	860.7369
1299	Sao Tome and Principe	Africa	1962	51.89300	65345	1071.5511
1300	Sao Tome and Principe	Africa	1967	54.42500	70787	1384.8406
1301	Sao Tome and Principe	Africa	1972	56.48000	76595	1532.9853
1302	Sao Tome and Principe	Africa	1977	58.55000	86796	1737.5617
1303	Sao Tome and Principe	Africa	1982	60.35100	98593	1890.2181
1304	Sao Tome and Principe	Africa	1987	61.72800	110812	1516.5255
1305	Sao Tome and Principe	Africa	1992	62.74200	125911	1428.7778
1306	Sao Tome and Principe	Africa	1997	63.30600	145608	1339.0760
1307	Sao Tome and Principe	Africa	2002	64.33700	170372	1353.0924
1308	Sao Tome and Principe	Africa	2007	65.52800	199579	1598.4351
1309	Saudi Arabia	Asia	1952	39.87500	4005677	6459.5548
1310	Saudi Arabia	Asia	1957	42.86800	4419650	8157.5912
1311	Saudi Arabia	Asia	1962	45.91400	4943029	11626.4197
1312	Saudi Arabia	Asia	1967	49.90100	5618198	16903.0489
1313	Saudi Arabia	Asia	1972	53.88600	6472756	24837.4287
1314	Saudi Arabia	Asia	1977	58.69000	8128505	34167.7626
1315	Saudi Arabia	Asia	1982	63.01200	11254672	33693.1753
1316	Saudi Arabia	Asia	1987	66.29500	14619745	21198.2614
1317	Saudi Arabia	Asia	1992	68.76800	16945857	24841.6178
1318	Saudi Arabia	Asia	1997	70.53300	21229759	20586.6902
1319	Saudi Arabia	Asia	2002	71.62600	24501530	19014.5412
1320	Saudi Arabia	Asia	2007	72.77700	27601038	21654.8319
1321	Senegal	Africa	1952	37.27800	2755589	1450.3570
1322	Senegal	Africa	1957	39.32900	3054547	1567.6530
1323	Senegal	Africa	1962	41.45400	3430243	1654.9887
1324	Senegal	Africa	1967	43.56300	3965841	1612.4046
1325	Senegal	Africa	1972	45.81500	4588696	1597.7121
1326	Senegal	Africa	1977	48.87900	5260855	1561.7691
1327	Senegal	Africa	1982	52.37900	6147783	1518.4800
1328	Senegal	Africa	1987	55.76900	7171347	1441.7207
1329	Senegal	Africa	1992	58.19600	8307920	1367.8994
1330	Senegal	Africa	1997	60.18700	9535314	1392.3683
1331	Senegal	Africa	2002	61.60000	10870037	1519.6353
1332	Senegal	Africa	2007	63.06200	12267493	1712.4721
1333	Serbia	Europe	1952	57.99600	6860147	3581.4594
1334	Serbia	Europe	1957	61.68500	7271135	4981.0909
1335	Serbia	Europe	1962	64.53100	7616060	6289.6292
1336	Serbia	Europe	1967	66.91400	7971222	7991.7071
1337	Serbia	Europe	1972	68.70000	8313288	10522.0675
1338	Serbia	Europe	1977	70.30000	8686367	12980.6696
1339	Serbia	Europe	1982	70.16200	9032824	15181.0927

1340	Serbia	Europe	1987	71.21800	9230783	15870.8785
1341	Serbia	Europe	1992	71.65900	9826397	9325.0682
1342	Serbia	Europe	1997	72.23200	10336594	7914.3203
1343	Serbia	Europe	2002	73.21300	10111559	7236.0753
1344	Serbia	Europe	2007	74.00200	10150265	9786.5347
1345	Sierra Leone	Africa	1952	30.33100	2143249	879.7877
1346	Sierra Leone	Africa	1957	31.57000	2295678	1004.4844
1347	Sierra Leone	Africa	1962	32.76700	2467895	1116.6399
1348	Sierra Leone	Africa	1967	34.11300	2662190	1206.0435
1349	Sierra Leone	Africa	1972	35.40000	2879013	1353.7598
1350	Sierra Leone	Africa	1977	36.78800	3140897	1348.2852
1351	Sierra Leone	Africa	1982	38.44500	3464522	1465.0108
1352	Sierra Leone	Africa	1987	40.00600	3868905	1294.4478
1353	Sierra Leone	Africa	1992	38.33300	4260884	1068.6963
1354	Sierra Leone	Africa	1997	39.89700	4578212	574.6482
1355	Sierra Leone	Africa	2002	41.01200	5359092	699.4897
1356	Sierra Leone	Africa	2007	42.56800	6144562	862.5408
1357	Singapore	Asia	1952	60.39600	1127000	2315.1382
1358	Singapore	Asia	1957	63.17900	1445929	2843.1044
1359	Singapore	Asia	1962	65.79800	1750200	3674.7356
1360	Singapore	Asia	1967	67.94600	1977600	4977.4185
1361	Singapore	Asia	1972	69.52100	2152400	8597.7562
1362	Singapore	Asia	1977	70.79500	2325300	11210.0895
1363	Singapore	Asia	1982	71.76000	2651869	15169.1611
1364	Singapore	Asia	1987	73.56000	2794552	18861.5308
1365	Singapore	Asia	1992	75.78800	3235865	24769.8912
1366	Singapore	Asia	1997	77.15800	3802309	33519.4766
1367	Singapore	Asia	2002	78.77000	4197776	36023.1054
1368	Singapore	Asia	2007	79.97200	4553009	47143.1796
1369	Slovak Republic	Europe	1952	64.36000	3558137	5074.6591
1370	Slovak Republic	Europe	1957	67.45000	3844277	6093.2630
1371	Slovak Republic	Europe	1962	70.33000	4237384	7481.1076
1372	Slovak Republic	Europe	1967	70.98000	4442238	8412.9024
1373	Slovak Republic	Europe	1972	70.35000	4593433	9674.1676
1374	Slovak Republic	Europe	1977	70.45000	4827803	10922.6640
1375	Slovak Republic	Europe	1982	70.80000	5048043	11348.5459
1376	Slovak Republic	Europe	1987	71.08000	5199318	12037.2676
1377	Slovak Republic	Europe	1992	71.38000	5302888	9498.4677
1378	Slovak Republic	Europe	1997	72.71000	5383010	12126.2306
1379	Slovak Republic	Europe	2002	73.80000	5410052	13638.7784
1380	Slovak Republic	Europe	2007	74.66300	5447502	18678.3144
1381	Slovenia	Europe	1952	65.57000	1489518	4215.0417
1382	Slovenia	Europe	1957	67.85000	1533070	5862.2766

1383		Slovenia	Europe	1962	69.15000	1582962	7402.3034
1384		Slovenia	Europe	1967	69.18000	1646912	9405.4894
1385		Slovenia	Europe	1972	69.82000	1694510	12383.4862
1386		Slovenia	Europe	1977	70.97000	1746919	15277.0302
1387		Slovenia	Europe	1982	71.06300	1861252	17866.7218
1388		Slovenia	Europe	1987	72.25000	1945870	18678.5349
1389		Slovenia	Europe	1992	73.64000	1999210	14214.7168
1390		Slovenia	Europe	1997	75.13000	2011612	17161.1073
1391		Slovenia	Europe	2002	76.66000	2011497	20660.0194
1392		Slovenia	Europe	2007	77.92600	2009245	25768.2576
1393		Somalia	Africa	1952	32.97800	2526994	1135.7498
1394		Somalia	Africa	1957	34.97700	2780415	1258.1474
1395		Somalia	Africa	1962	36.98100	3080153	1369.4883
1396		Somalia	Africa	1967	38.97700	3428839	1284.7332
1397		Somalia	Africa	1972	40.97300	3840161	1254.5761
1398		Somalia	Africa	1977	41.97400	4353666	1450.9925
1399		Somalia	Africa	1982	42.95500	5828892	1176.8070
1400		Somalia	Africa	1987	44.50100	6921858	1093.2450
1401		Somalia	Africa	1992	39.65800	6099799	926.9603
1402		Somalia	Africa	1997	43.79500	6633514	930.5964
1403		Somalia	Africa	2002	45.93600	7753310	882.0818
1404		Somalia	Africa	2007	48.15900	9118773	926.1411
1405	South	Africa	Africa	1952	45.00900	14264935	4725.2955
1406	South	Africa	Africa	1957	47.98500	16151549	5487.1042
1407	South	Africa	Africa	1962	49.95100	18356657	5768.7297
1408	South	Africa	Africa	1967	51.92700	20997321	7114.4780
1409	South	Africa	Africa	1972	53.69600	23935810	7765.9626
1410	South	Africa	Africa	1977	55.52700	27129932	8028.6514
1411	South	Africa	Africa	1982	58.16100	31140029	8568.2662
1412	South	Africa	Africa	1987	60.83400	35933379	7825.8234
1413	South	Africa	Africa	1992	61.88800	39964159	7225.0693
1414	South	Africa	Africa	1997	60.23600	42835005	7479.1882
1415	South	Africa	Africa	2002	53.36500	44433622	7710.9464
1416	South	Africa	Africa	2007	49.33900	43997828	9269.6578
1417		Spain	Europe	1952	64.94000	28549870	3834.0347
1418		Spain	Europe	1957	66.66000	29841614	4564.8024
1419		Spain	Europe	1962	69.69000	31158061	5693.8439
1420		Spain	Europe	1967	71.44000	32850275	7993.5123
1421		Spain	Europe	1972	73.06000	34513161	10638.7513
1422		Spain	Europe	1977	74.39000	36439000	13236.9212
1423		Spain	Europe	1982	76.30000	37983310	13926.1700
1424		Spain	Europe	1987	76.90000	38880702	15764.9831
1425		Spain	Europe	1992	77.57000	39549438	18603.0645

1426	Spain	Europe	1997	78.77000	39855442	20445.2990
1427	Spain	Europe	2002	79.78000	40152517	24835.4717
1428	Spain	Europe	2007	80.94100	40448191	28821.0637
1429	Sri Lanka	Asia	1952	57.59300	7982342	1083.5320
1430	Sri Lanka	Asia	1957	61.45600	9128546	1072.5466
1431	Sri Lanka	Asia	1962	62.19200	10421936	1074.4720
1432	Sri Lanka	Asia	1967	64.26600	11737396	1135.5143
1433	Sri Lanka	Asia	1972	65.04200	13016733	1213.3955
1434	Sri Lanka	Asia	1977	65.94900	14116836	1348.7757
1435	Sri Lanka	Asia	1982	68.75700	15410151	1648.0798
1436	Sri Lanka	Asia	1987	69.01100	16495304	1876.7668
1437	Sri Lanka	Asia	1992	70.37900	17587060	2153.7392
1438	Sri Lanka	Asia	1997	70.45700	18698655	2664.4773
1439	Sri Lanka	Asia	2002	70.81500	19576783	3015.3788
1440	Sri Lanka	Asia	2007	72.39600	20378239	3970.0954
1441	Sudan	Africa	1952	38.63500	8504667	1615.9911
1442	Sudan	Africa	1957	39.62400	9753392	1770.3371
1443	Sudan	Africa	1962	40.87000	11183227	1959.5938
1444	Sudan	Africa	1967	42.85800	12716129	1687.9976
1445	Sudan	Africa	1972	45.08300	14597019	1659.6528
1446	Sudan	Africa	1977	47.80000	17104986	2202.9884
1447	Sudan	Africa	1982	50.33800	20367053	1895.5441
1448	Sudan	Africa	1987	51.74400	24725960	1507.8192
1449	Sudan	Africa	1992	53.55600	28227588	1492.1970
1450	Sudan	Africa	1997	55.37300	32160729	1632.2108
1451	Sudan	Africa	2002	56.36900	37090298	1993.3983
1452	Sudan	Africa	2007	58.55600	42292929	2602.3950
1453	Swaziland	Africa	1952	41.40700	290243	1148.3766
1454	Swaziland	Africa	1957	43.42400	326741	1244.7084
1455	Swaziland	Africa	1962	44.99200	370006	1856.1821
1456	Swaziland	Africa	1967	46.63300	420690	2613.1017
1457	Swaziland	Africa	1972	49.55200	480105	3364.8366
1458	Swaziland	Africa	1977	52.53700	551425	3781.4106
1459	Swaziland	Africa	1982	55.56100	649901	3895.3840
1460	Swaziland	Africa	1987	57.67800	779348	3984.8398
1461	Swaziland	Africa	1992	58.47400	962344	3553.0224
1462	Swaziland	Africa	1997	54.28900	1054486	3876.7685
1463	Swaziland	Africa	2002	43.86900	1130269	4128.1169
1464	Swaziland	Africa	2007	39.61300	1133066	4513.4806
1465	Sweden	Europe	1952	71.86000	7124673	8527.8447
1466	Sweden	Europe	1957	72.49000	7363802	9911.8782
1467	Sweden	Europe	1962	73.37000	7561588	12329.4419
1468	Sweden	Europe	1967	74.16000	7867931	15258.2970

1469	Sweden	Europe	1972	74.72000	8122293	17832.0246
1470	Sweden	Europe	1977	75.44000	8251648	18855.7252
1471	Sweden	Europe	1982	76.42000	8325260	20667.3812
1472	Sweden	Europe	1987	77.19000	8421403	23586.9293
1473	Sweden	Europe	1992	78.16000	8718867	23880.0168
1474	Sweden	Europe	1997	79.39000	8897619	25266.5950
1475	Sweden	Europe	2002	80.04000	8954175	29341.6309
1476	Sweden	Europe	2007	80.88400	9031088	33859.7484
1477	Switzerland	Europe	1952	69.62000	4815000	14734.2327
1478	Switzerland	Europe	1957	70.56000	5126000	17909.4897
1479	Switzerland	Europe	1962	71.32000	5666000	20431.0927
1480	Switzerland	Europe	1967	72.77000	6063000	22966.1443
1481	Switzerland	Europe	1972	73.78000	6401400	27195.1130
1482	Switzerland	Europe	1977	75.39000	6316424	26982.2905
1483	Switzerland	Europe	1982	76.21000	6468126	28397.7151
1484	Switzerland	Europe	1987	77.41000	6649942	30281.7046
1485	Switzerland	Europe	1992	78.03000	6995447	31871.5303
1486	Switzerland	Europe	1997	79.37000	7193761	32135.3230
1487	Switzerland	Europe	2002	80.62000	7361757	34480.9577
1488	Switzerland	Europe	2007	81.70100	7554661	37506.4191
1489	Syria	Asia	1952	45.88300	3661549	1643.4854
1490	Syria	Asia	1957	48.28400	4149908	2117.2349
1491	Syria	Asia	1962	50.30500	4834621	2193.0371
1492	Syria	Asia	1967	53.65500	5680812	1881.9236
1493	Syria	Asia	1972	57.29600	6701172	2571.4230
1494	Syria	Asia	1977	61.19500	7932503	3195.4846
1495	Syria	Asia	1982	64.59000	9410494	3761.8377
1496	Syria	Asia	1987	66.97400	11242847	3116.7743
1497	Syria	Asia	1992	69.24900	13219062	3340.5428
1498	Syria	Asia	1997	71.52700	15081016	4014.2390
1499	Syria	Asia	2002	73.05300	17155814	4090.9253
1500	Syria	Asia	2007	74.14300	19314747	4184.5481
1501	Taiwan	Asia	1952	58.50000	8550362	1206.9479
1502	Taiwan	Asia	1957	62.40000	10164215	1507.8613
1503	Taiwan	Asia	1962	65.20000	11918938	1822.8790
1504	Taiwan	Asia	1967	67.50000	13648692	2643.8587
1505	Taiwan	Asia	1972	69.39000	15226039	4062.5239
1506	Taiwan	Asia	1977	70.59000	16785196	5596.5198
1507	Taiwan	Asia	1982	72.16000	18501390	7426.3548
1508	Taiwan	Asia	1987	73.40000	19757799	11054.5618
1509	Taiwan	Asia	1992	74.26000	20686918	15215.6579
1510	Taiwan	Asia	1997	75.25000	21628605	20206.8210
1511	Taiwan	Asia	2002	76.99000	22454239	23235.4233

1512	Taiwan	Asia	2007	78.40000	23174294	28718.2768
1513	Tanzania	Africa	1952	41.21500	8322925	716.6501
1514	Tanzania	Africa	1957	42.97400	9452826	698.5356
1515	Tanzania	Africa	1962	44.24600	10863958	722.0038
1516	Tanzania	Africa	1967	45.75700	12607312	848.2187
1517	Tanzania	Africa	1972	47.62000	14706593	915.9851
1518	Tanzania	Africa	1977	49.91900	17129565	962.4923
1519	Tanzania	Africa	1982	50.60800	19844382	874.2426
1520	Tanzania	Africa	1987	51.53500	23040630	831.8221
1521	Tanzania	Africa	1992	50.44000	26605473	825.6825
1522	Tanzania	Africa	1997	48.46600	30686889	789.1862
1523	Tanzania	Africa	2002	49.65100	34593779	899.0742
1524	Tanzania	Africa	2007	52.51700	38139640	1107.4822
1525	Thailand	Asia	1952	50.84800	21289402	757.7974
1526	Thailand	Asia	1957	53.63000	25041917	793.5774
1527	Thailand	Asia	1962	56.06100	29263397	1002.1992
1528	Thailand	Asia	1967	58.28500	34024249	1295.4607
1529	Thailand	Asia	1972	60.40500	39276153	1524.3589
1530	Thailand	Asia	1977	62.49400	44148285	1961.2246
1531	Thailand	Asia	1982	64.59700	48827160	2393.2198
1532	Thailand	Asia	1987	66.08400	52910342	2982.6538
1533	Thailand	Asia	1992	67.29800	56667095	4616.8965
1534	Thailand	Asia	1997	67.52100	60216677	5852.6255
1535	Thailand	Asia	2002	68.56400	62806748	5913.1875
1536	Thailand	Asia	2007	70.61600	65068149	7458.3963
1537	Togo	Africa	1952	38.59600	1219113	859.8087
1538	Togo	Africa	1957	41.20800	1357445	925.9083
1539	Togo	Africa	1962	43.92200	1528098	1067.5348
1540	Togo	Africa	1967	46.76900	1735550	1477.5968
1541	Togo	Africa	1972	49.75900	2056351	1649.6602
1542	Togo	Africa	1977	52.88700	2308582	1532.7770
1543	Togo	Africa	1982	55.47100	2644765	1344.5780
1544	Togo	Africa	1987	56.94100	3154264	1202.2014
1545	Togo	Africa	1992	58.06100	3747553	1034.2989
1546	Togo	Africa	1997	58.39000	4320890	982.2869
1547	Togo	Africa	2002	57.56100	4977378	886.2206
1548	Togo	Africa	2007	58.42000	5701579	882.9699
1549	Trinidad and Tobago	Americas	1952	59.10000	662850	3023.2719
1550	Trinidad and Tobago	Americas	1957	61.80000	764900	4100.3934
1551	Trinidad and Tobago	Americas	1962	64.90000	887498	4997.5240
1552	Trinidad and Tobago	Americas	1967	65.40000	960155	5621.3685
1553	Trinidad and Tobago	Americas	1972	65.90000	975199	6619.5514
1554	Trinidad and Tobago	Americas	1977	68.30000	1039009	7899.5542

1555	Trinidad and Tobago	Americas	1982	68.83200	1116479	9119.5286
1556	Trinidad and Tobago	Americas	1987	69.58200	1191336	7388.5978
1557	Trinidad and Tobago	Americas	1992	69.86200	1183669	7370.9909
1558	Trinidad and Tobago	Americas	1997	69.46500	1138101	8792.5731
1559	Trinidad and Tobago	Americas	2002	68.97600	1101832	11460.6002
1560	Trinidad and Tobago	Americas	2007	69.81900	1056608	18008.5092
1561	Tunisia	Africa	1952	44.60000	3647735	1468.4756
1562	Tunisia	Africa	1957	47.10000	3950849	1395.2325
1563	Tunisia	Africa	1962	49.57900	4286552	1660.3032
1564	Tunisia	Africa	1967	52.05300	4786986	1932.3602
1565	Tunisia	Africa	1972	55.60200	5303507	2753.2860
1566	Tunisia	Africa	1977	59.83700	6005061	3120.8768
1567	Tunisia	Africa	1982	64.04800	6734098	3560.2332
1568	Tunisia	Africa	1987	66.89400	7724976	3810.4193
1569	Tunisia	Africa	1992	70.00100	8523077	4332.7202
1570	Tunisia	Africa	1997	71.97300	9231669	4876.7986
1571	Tunisia	Africa	2002	73.04200	9770575	5722.8957
1572	Tunisia	Africa	2007	73.92300	10276158	7092.9230
1573	Turkey	Europe	1952	43.58500	22235677	1969.1010
1574	Turkey	Europe	1957	48.07900	25670939	2218.7543
1575	Turkey	Europe	1962	52.09800	29788695	2322.8699
1576	Turkey	Europe	1967	54.33600	33411317	2826.3564
1577	Turkey	Europe	1972	57.00500	37492953	3450.6964
1578	Turkey	Europe	1977	59.50700	42404033	4269.1223
1579	Turkey	Europe	1982	61.03600	47328791	4241.3563
1580	Turkey	Europe	1987	63.10800	52881328	5089.0437
1581	Turkey	Europe	1992	66.14600	58179144	5678.3483
1582	Turkey	Europe	1997	68.83500	63047647	6601.4299
1583	Turkey	Europe	2002	70.84500	67308928	6508.0857
1584	Turkey	Europe	2007	71.77700	71158647	8458.2764
1585	Uganda	Africa	1952	39.97800	5824797	734.7535
1586	Uganda	Africa	1957	42.57100	6675501	774.3711
1587	Uganda	Africa	1962	45.34400	7688797	767.2717
1588	Uganda	Africa	1967	48.05100	8900294	908.9185
1589	Uganda	Africa	1972	51.01600	10190285	950.7359
1590	Uganda	Africa	1977	50.35000	11457758	843.7331
1591	Uganda	Africa	1982	49.84900	12939400	682.2662
1592	Uganda	Africa	1987	51.50900	15283050	617.7244
1593	Uganda	Africa	1992	48.82500	18252190	644.1708
1594	Uganda	Africa	1997	44.57800	21210254	816.5591
1595	Uganda	Africa	2002	47.81300	24739869	927.7210
1596	Uganda	Africa	2007	51.54200	29170398	1056.3801
1597	United Kingdom	Europe	1952	69.18000	50430000	9979.5085

1598	United Kingdom	Europe	1957	70.42000	51430000	11283.1779
1599	United Kingdom	Europe	1962	70.76000	53292000	12477.1771
1600	United Kingdom	Europe	1967	71.36000	54959000	14142.8509
1601	United Kingdom	Europe	1972	72.01000	56079000	15895.1164
1602	United Kingdom	Europe	1977	72.76000	56179000	17428.7485
1603	United Kingdom	Europe	1982	74.04000	56339704	18232.4245
1604	United Kingdom	Europe	1987	75.00700	56981620	21664.7877
1605	United Kingdom	Europe	1992	76.42000	57866349	22705.0925
1606	United Kingdom	Europe	1997	77.21800	58808266	26074.5314
1607	United Kingdom	Europe	2002	78.47100	59912431	29478.9992
1608	United Kingdom	Europe	2007	79.42500	60776238	33203.2613
1609	United States	Americas	1952	68.44000	157553000	13990.4821
1610	United States	Americas	1957	69.49000	171984000	14847.1271
1611	United States	Americas	1962	70.21000	186538000	16173.1459
1612	United States	Americas	1967	70.76000	198712000	19530.3656
1613	United States	Americas	1972	71.34000	209896000	21806.0359
1614	United States	Americas	1977	73.38000	220239000	24072.6321
1615	United States	Americas	1982	74.65000	232187835	25009.5591
1616	United States	Americas	1987	75.02000	242803533	29884.3504
1617	United States	Americas	1992	76.09000	256894189	32003.9322
1618	United States	Americas	1997	76.81000	272911760	35767.4330
1619	United States	Americas	2002	77.31000	287675526	39097.0995
1620	United States	Americas	2007	78.24200	301139947	42951.6531
1621	Uruguay	Americas	1952	66.07100	2252965	5716.7667
1622	Uruguay	Americas	1957	67.04400	2424959	6150.7730
1623	Uruguay	Americas	1962	68.25300	2598466	5603.3577
1624	Uruguay	Americas	1967	68.46800	2748579	5444.6196
1625	Uruguay	Americas	1972	68.67300	2829526	5703.4089
1626	Uruguay	Americas	1977	69.48100	2873520	6504.3397
1627	Uruguay	Americas	1982	70.80500	2953997	6920.2231
1628	Uruguay	Americas	1987	71.91800	3045153	7452.3990
1629	Uruguay	Americas	1992	72.75200	3149262	8137.0048
1630	Uruguay	Americas	1997	74.22300	3262838	9230.2407
1631	Uruguay	Americas	2002	75.30700	3363085	7727.0020
1632	Uruguay	Americas	2007	76.38400	3447496	10611.4630
1633	Venezuela	Americas	1952	55.08800	5439568	7689.7998
1634	Venezuela	Americas	1957	57.90700	6702668	9802.4665
1635	Venezuela	Americas	1962	60.77000	8143375	8422.9742
1636	Venezuela	Americas	1967	63.47900	9709552	9541.4742
1637	Venezuela	Americas	1972	65.71200	11515649	10505.2597
1638	Venezuela	Americas	1977	67.45600	13503563	13143.9510
1639	Venezuela	Americas	1982	68.55700	15620766	11152.4101
1640	Venezuela	Americas	1987	70.19000	17910182	9883.5846

1641		Venezuela	Americas	1992	71.15000	20265563	10733.9263
1642		Venezuela	Americas	1997	72.14600	22374398	10165.4952
1643		Venezuela	Americas	2002	72.76600	24287670	8605.0478
1644		Venezuela	Americas	2007	73.74700	26084662	11415.8057
1645		Vietnam	Asia	1952	40.41200	26246839	605.0665
1646		Vietnam	Asia	1957	42.88700	28998543	676.2854
1647		Vietnam	Asia	1962	45.36300	33796140	772.0492
1648		Vietnam	Asia	1967	47.83800	39463910	637.1233
1649		Vietnam	Asia	1972	50.25400	44655014	699.5016
1650		Vietnam	Asia	1977	55.76400	50533506	713.5371
1651		Vietnam	Asia	1982	58.81600	56142181	707.2358
1652		Vietnam	Asia	1987	62.82000	62826491	820.7994
1653		Vietnam	Asia	1992	67.66200	69940728	989.0231
1654		Vietnam	Asia	1997	70.67200	76048996	1385.8968
1655		Vietnam	Asia	2002	73.01700	80908147	1764.4567
1656		Vietnam	Asia	2007	74.24900	85262356	2441.5764
1657	West	Bank and Gaza	Asia	1952	43.16000	1030585	1515.5923
1658	West	Bank and Gaza	Asia	1957	45.67100	1070439	1827.0677
1659	West	Bank and Gaza	Asia	1962	48.12700	1133134	2198.9563
1660	West	Bank and Gaza	Asia	1967	51.63100	1142636	2649.7150
1661	West	Bank and Gaza	Asia	1972	56.53200	1089572	3133.4093
1662	West	Bank and Gaza	Asia	1977	60.76500	1261091	3682.8315
1663	West	Bank and Gaza	Asia	1982	64.40600	1425876	4336.0321
1664	West	Bank and Gaza	Asia	1987	67.04600	1691210	5107.1974
1665	West	Bank and Gaza	Asia	1992	69.71800	2104779	6017.6548
1666	West	Bank and Gaza	Asia	1997	71.09600	2826046	7110.6676
1667	West	Bank and Gaza	Asia	2002	72.37000	3389578	4515.4876
1668	West	Bank and Gaza	Asia	2007	73.42200	4018332	3025.3498
1669		Yemen, Rep.	Asia	1952	32.54800	4963829	781.7176
1670		Yemen, Rep.	Asia	1957	33.97000	5498090	804.8305
1671		Yemen, Rep.	Asia	1962	35.18000	6120081	825.6232
1672		Yemen, Rep.	Asia	1967	36.98400	6740785	862.4421
1673		Yemen, Rep.	Asia	1972	39.84800	7407075	1265.0470
1674		Yemen, Rep.	Asia	1977	44.17500	8403990	1829.7652
1675		Yemen, Rep.	Asia	1982	49.11300	9657618	1977.5570
1676		Yemen, Rep.	Asia	1987	52.92200	11219340	1971.7415
1677		Yemen, Rep.	Asia	1992	55.59900	13367997	1879.4967
1678		Yemen, Rep.	Asia	1997	58.02000	15826497	2117.4845
1679		Yemen, Rep.	Asia	2002	60.30800	18701257	2234.8208
1680		Yemen, Rep.	Asia	2007	62.69800	22211743	2280.7699
1681		Zambia	Africa	1952	42.03800	2672000	1147.3888
1682		Zambia	Africa	1957	44.07700	3016000	1311.9568
1683		Zambia	Africa	1962	46.02300	3421000	1452.7258

```
1684                  Zambia    Africa 1967 47.76800    3900000   1777.0773
1685                  Zambia    Africa 1972 50.10700    4506497   1773.4983
1686                  Zambia    Africa 1977 51.38600    5216550   1588.6883
1687                  Zambia    Africa 1982 51.82100    6100407   1408.6786
1688                  Zambia    Africa 1987 50.82100    7272406   1213.3151
1689                  Zambia    Africa 1992 46.10000    8381163   1210.8846
1690                  Zambia    Africa 1997 40.23800    9417789   1071.3538
1691                  Zambia    Africa 2002 39.19300   10595811   1071.6139
1692                  Zambia    Africa 2007 42.38400   11746035   1271.2116
1693                Zimbabwe    Africa 1952 48.45100    3080907    406.8841
1694                Zimbabwe    Africa 1957 50.46900    3646340    518.7643
1695                Zimbabwe    Africa 1962 52.35800    4277736    527.2722
1696                Zimbabwe    Africa 1967 53.99500    4995432    569.7951
1697                Zimbabwe    Africa 1972 55.63500    5861135    799.3622
1698                Zimbabwe    Africa 1977 57.67400    6642107    685.5877
1699                Zimbabwe    Africa 1982 60.36300    7636524    788.8550
1700                Zimbabwe    Africa 1987 62.35100    9216418    706.1573
1701                Zimbabwe    Africa 1992 60.37700   10704340    693.4208
1702                Zimbabwe    Africa 1997 46.80900   11404948    792.4500
1703                Zimbabwe    Africa 2002 39.98900   11926563    672.0386
1704                Zimbabwe    Africa 2007 43.48700   12311143    469.7093
```

This prints out A LOT of data (I've contained the output in a nice scrolly box, but if you did this in a standard quarto document or in your console, the entire thing will be printed out, sans scrolly box). In general, you want to avoid printing your entire dataset in your R console or rendered quarto document.

Instead, try printing just the first few (6, to be exact) rows using the `head()` function:

```
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
```

Now that we are starting to get a handle on our gapminder data frame, let's talk about the information it contains. The gapminder dataset contains information on life expectancy,

population, and GDP per capita for 142 countries every 5 years between 1952 to 2007. Each country has 12 rows in the data, one for each year.

If you want to learn more about the gapminder dataset, head on over to the gapminder website.

5.2 Attributes of a data frame

Often I find it helpful to print out just the column names of a data frame using the `colnames()` function:

```
colnames(gapminder)
```

```
[1] "country"   "continent" "year"      "lifeExp"   "pop"       "gdpPercap"
```

We can also ask things like how many rows our data frame has using the `nrow()` function:

```
nrow(gapminder)
```

```
[1] 1704
```

We can ask how many columns our data frame has using the `ncol()` function:

```
ncol(gapminder)
```

```
[1] 6
```

Or we can ask both how many rows and how many columns our data frame has at the same time using the `dim()` function:

```
dim(gapminder)
```

```
[1] 1704    6
```

We can use our trusty `str()` function from earlier to take a sneak peek at the "structure" of our data:

```
str(gapminder)
```

```
'data.frame':   1704 obs. of  6 variables:
 $ country  : chr  "Afghanistan" "Afghanistan" "Afghanistan" "Afghanistan" ...
 $ continent: chr  "Asia" "Asia" "Asia" "Asia" ...
 $ year     : int  1952 1957 1962 1967 1972 1977 1982 1987 1992 1997 ...
 $ lifeExp  : num  28.8 30.3 32 34 36.1 ...
 $ pop      : int  8425333 9240934 10267083 11537966 13079460 14880372 12881816 13867957 163
 $ gdpPercap: num  779 821 853 836 740 ...
```

And we can use the `summary()` function to get some statistical summaries (like the minimum, median, mean, maximum, and the quartiles) of each of the numeric columns in our data frame (this summary is fairly useless for character/categorical columns though):

```
# use summary() to look at a summary of gapminder
summary(gapminder)
```

```
   country           continent              year         lifeExp     
 Length:1704        Length:1704        Min.   :1952   Min.   :23.60  
 Class :character   Class :character   1st Qu.:1966   1st Qu.:48.20  
 Mode  :character   Mode  :character   Median :1980   Median :60.71  
                                       Mean   :1980   Mean   :59.47  
                                       3rd Qu.:1993   3rd Qu.:70.85  
                                       Max.   :2007   Max.   :82.60  
      pop              gdpPercap       
 Min.   :6.001e+04   Min.   :   241.2  
 1st Qu.:2.794e+06   1st Qu.:  1202.1  
 Median :7.024e+06   Median :  3531.8  
 Mean   :2.960e+07   Mean   :  7215.3  
 3rd Qu.:1.959e+07   3rd Qu.:  9325.5  
 Max.   :1.319e+09   Max.   :113523.1  
```

5.3 Exercise

Your turn: download the following world happiness dataset. Load the `whr_2023.csv` file into R, saving it as a variable called `world_happiness`.

Then print out the first 6 rows, the column names, create a summary of the data, and report its dimension.

5.4 Solution

Loading the data

```
world_happiness <- read.csv("data/whr_2023.csv")
```

Printing the first 6 rows:

```
head(world_happiness)
```

```
  country_name year life_ladder log_GDP_per_capita social_support
1  Afghanistan 2005          NA                 NA             NA
2  Afghanistan 2006          NA                 NA             NA
3  Afghanistan 2007          NA                 NA             NA
4  Afghanistan 2008       3.724              7.350          0.451
5  Afghanistan 2009       4.402              7.509          0.552
6  Afghanistan 2010       4.758              7.614          0.539
  healthy_life_expectancy_at_birth freedom_to_make_life_choices generosity
1                               NA                           NA         NA
2                               NA                           NA         NA
3                               NA                           NA         NA
4                             50.5                        0.718      0.168
5                             50.8                        0.679      0.191
6                             51.1                        0.600      0.121
  perceptions_of_corruption positive_affect negative_affect
1                        NA              NA              NA
2                        NA              NA              NA
3                        NA              NA              NA
4                     0.882           0.414           0.258
5                     0.850           0.481           0.237
6                     0.707           0.517           0.275
```

And looking at several features of the data:

```
str(world_happiness)
```

```
'data.frame':   2970 obs. of  11 variables:
 $ country_name                    : chr  "Afghanistan" "Afghanistan" "Afghanistan" "Afghanis
 $ year                            : int  2005 2006 2007 2008 2009 2010 2011 2012 2013 2014
 $ life_ladder                     : num  NA NA NA 3.72 4.4 ...
```

```
 $ log_GDP_per_capita              : num  NA NA NA 7.35 7.51 ...
 $ social_support                  : num  NA NA NA 0.451 0.552 0.539 0.521 0.521 0.484 0.526
 $ healthy_life_expectancy_at_birth: num  NA NA NA 50.5 50.8 51.1 51.4 51.7 52 52.3 ...
 $ freedom_to_make_life_choices    : num  NA NA NA 0.718 0.679 0.6 0.496 0.531 0.578 0.509 .
 $ generosity                      : num  NA NA NA 0.168 0.191 0.121 0.164 0.238 0.063 0.106
 $ perceptions_of_corruption       : num  NA NA NA 0.882 0.85 0.707 0.731 0.776 0.823 0.871
 $ positive_affect                 : num  NA NA NA 0.414 0.481 0.517 0.48 0.614 0.547 0.492
 $ negative_affect                 : num  NA NA NA 0.258 0.237 0.275 0.267 0.268 0.273 0.375
```

```
summary(world_happiness)
```

```
 country_name            year       life_ladder    log_GDP_per_capita
 Length:2970        Min.   :2005   Min.   :1.281   Min.   : 5.527
 Class :character   1st Qu.:2009   1st Qu.:4.647   1st Qu.: 8.500
 Mode  :character   Median :2014   Median :5.432   Median : 9.499
                    Mean   :2014   Mean   :5.479   Mean   : 9.390
                    3rd Qu.:2018   3rd Qu.:6.309   3rd Qu.:10.373
                    Max.   :2022   Max.   :8.019   Max.   :11.664
                                   NA's   :771     NA's   :791
 social_support   healthy_life_expectancy_at_birth freedom_to_make_life_choices
 Min.   :0.2280   Min.   : 6.72                    Min.   :0.2580
 1st Qu.:0.7470   1st Qu.:59.12                    1st Qu.:0.6562
 Median :0.8360   Median :65.05                    Median :0.7700
 Mean   :0.8107   Mean   :63.29                    Mean   :0.7478
 3rd Qu.:0.9050   3rd Qu.:68.50                    3rd Qu.:0.8590
 Max.   :0.9870   Max.   :74.47                    Max.   :0.9850
 NA's   :784      NA's   :825                      NA's   :804
   generosity      perceptions_of_corruption positive_affect  negative_affect
 Min.   :-0.3380   Min.   :0.0350            Min.   :0.1790   Min.   :0.0830
 1st Qu.:-0.1120   1st Qu.:0.6880            1st Qu.:0.5720   1st Qu.:0.2080
 Median :-0.0230   Median :0.8000            Median :0.6630   Median :0.2610
 Mean   : 0.0001   Mean   :0.7452            Mean   :0.6521   Mean   :0.2715
 3rd Qu.: 0.0920   3rd Qu.:0.8690            3rd Qu.:0.7380   3rd Qu.:0.3230
 Max.   : 0.7030   Max.   :0.9830            Max.   :0.8840   Max.   :0.7050
 NA's   :844       NA's   :887               NA's   :795      NA's   :787
```

```
dim(world_happiness)
```

```
[1] 2970   11
```

5.5 Loading data from Excel, SPSS, Stata, and SAS files

Loading data from Excel, SPSS, Stata, and files is almost as easy as loading data from .csv files, except that you will need to install some add-on packages to do so. Specifically, to load Excel files, you will need to install the "readxl" package, and to load SPSS, Stata, or SAS files, you'll need to install the "haven" package.

You'll learn about installing and loading packages in the next chapter. Click here to learn more about loading data from Excel files and click here to learn more about loading data from SPSS, Stata, and SAS files.

Part III

The Tidyverse

6 Data Frames in the Tidyverse

R is an open source programming language, which means that anyone can extend it by creating their own R functions. When someone creates a collection of related R functions, they typically bundle them into what is called a "package" or a "library" (I use these terms interchangeably), which can then be downloaded and used by other people.

I don't think it's an exaggeration to say that you probably wouldn't be learning R today were it not for one particular package called the "tidyverse" (so named because it helps you create and work with "tidy" data). The tidyverse is actually a collection of several important R packages, including one called "dplyr" and another one called "ggplot2" (this chapter will introduce dplyr and you'll get to know ggplot2 in the next chapter).

Although the tidyverse was originally created by Hadley Wickham, it has since grown to include contributions from hundreds of brilliant R developers. Together, they have revolutionized the way we use R for the better. The tidyverse and its impacts are a true testament to the power of the open source community.

6.1 Installing and Loading R packages

R packages are collections of "add-on" R functions that you can "load" into your R session to provide additional functionality.

To use functions from a package, you need to do two things:

1. Install the package on your computer. **You only need to do this once.**
2. Load your package into your current R session. **You need to do this every time you start a new R session (i.e., every time you open up RStudio).**

I like to think of *installing* an R package like installing a new application onto your computer. You only ever need to install the application once (unless you're updating it), but you need to open it every time you want to use it (in this analogy, loading a library is like "opening" your application).

6.1.1 Installing an R package

So to get started with dplyr, ggplot2, and the other tidyverse packages, we need to *install* them. But to make our lives easier, we can simultaneously install all the tidyverse packages (ggplot2, dplyr, reshape, purrr, readr, and many others) by just installing the "tidyverse" package itself.

To install the "tidyverse" package (or any other package), write the following code *directly into your console* (I do *not* recommend saving this code in a quarto document or R script, because once you've run this code, you don't need to run it again):

```
# write this code directly into the console:
install.packages("tidyverse")
```

Note that you need to be connected to the internet to install a package (since it's like downloading an application from the internet.)

6.1.2 Loading an R package

Once you've installed it, every time you want to *use* an installed R package in a new R session, you need to *"load"* it using the library() function.

```
library(tidyverse)
```

```
-- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
v dplyr     1.1.4     v readr     2.1.5
v forcats   1.0.0     v stringr   1.5.1
v ggplot2   3.5.1     v tibble    3.2.1
v lubridate 1.9.3     v tidyr     1.3.1
v purrr     1.0.2
-- Conflicts ------------------------------------------ tidyverse_conflicts() --
x dplyr::filter() masks stats::filter()
x dplyr::lag()    masks stats::lag()
i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to beco
```

Since you need to run this every time you open RStudio, you should include this code in the first chunk of your quarto document or R script.

When you load libraries into R, you'll often see a lot of message "output" (what I like to call "chatter"). This output (such as that printed below the `library(tidyverse)` chunk above) is completely normal. But if you're loading a library in a quarto document, you might want to hide the message output in the resulting rendered document. To do that, you can use the chunk option `#| message: false`, as in:

```
```{r}
#| message: false
library(dplyr)
```
```

Then the library loading "chatter" will be hidden from the rendered HTML document.

6.2 Tibbles and the `read_csv()` function

In the last chapter, we used a "base R" function (`read.csv()`) to load our gapminder dataset. The term "*base R*" refers to functions that are always available in R and do not require you to load any additional libraries.

While it's perfectly fine to continue to use this `read.csv()` function, I recommend instead using a slightly different function that has an underscore instead of a period in its name: `read_csv()`. This function does pretty much the same thing as `read.csv()` but it is part of the tidyverse and is a little bit more efficient and user-friendly than `read.csv()`.

Let's use `read_csv()` (the tidyverse version of `read.csv()`) to load the gapminder dataset:

```
gapminder <- read_csv("data/gapminder.csv")
```

```
Rows: 1704 Columns: 6
-- Column specification --------------------------------------------------------
Delimiter: ","
chr (2): country, continent
dbl (4): year, lifeExp, pop, gdpPercap

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

This function also tends to print out some "chatter" message text, which I can hide from my rendered quarto output by providing the `#| message: false` chunk option at the top of the relevant code chunk.

If you ran this in your own console and you got an error saying "*Error in read_csv("data/gapminder.csv") : could not find function "read_csv"*", make sure you have installed the tidyverse *and have run the code* ***`library(tidyverse)`*** *in your console*! R can only find the `read_csv()` function if you have loaded the tidyverse!

Now let's take a look at `gapminder` (*without using* ***`head()`***)

```
gapminder
```

```
# A tibble: 1,704 x 6
   country     continent  year lifeExp      pop gdpPercap
   <chr>       <chr>     <dbl>   <dbl>    <dbl>     <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.
# i 1,694 more rows
```

Do you notice any differences between this version of `gapminder` (that has been loaded using the tidyverse `read_csv()`) and the version from the previous chapter (that was loaded using the base R `read.csv()` function)?

To make your life easier, here is the version of `gapminder` that we loaded with the base R `read.csv()` function:

```
gapminder_base_r <- read.csv("data/gapminder.csv")
gapminder_base_r
```

```
                    country continent year  lifeExp        pop   gdpPercap
1               Afghanistan      Asia 1952 28.80100    8425333    779.4453
2               Afghanistan      Asia 1957 30.33200    9240934    820.8530
3               Afghanistan      Asia 1962 31.99700   10267083    853.1007
4               Afghanistan      Asia 1967 34.02000   11537966    836.1971
5               Afghanistan      Asia 1972 36.08800   13079460    739.9811
6               Afghanistan      Asia 1977 38.43800   14880372    786.1134
7               Afghanistan      Asia 1982 39.85400   12881816    978.0114
8               Afghanistan      Asia 1987 40.82200   13867957    852.3959
9               Afghanistan      Asia 1992 41.67400   16317921    649.3414
10              Afghanistan      Asia 1997 41.76300   22227415    635.3414
11              Afghanistan      Asia 2002 42.12900   25268405    726.7341
12              Afghanistan      Asia 2007 43.82800   31889923    974.5803
13                  Albania    Europe 1952 55.23000    1282697   1601.0561
```

14	Albania	Europe	1957	59.28000	1476505	1942.2842
15	Albania	Europe	1962	64.82000	1728137	2312.8890
16	Albania	Europe	1967	66.22000	1984060	2760.1969
17	Albania	Europe	1972	67.69000	2263554	3313.4222
18	Albania	Europe	1977	68.93000	2509048	3533.0039
19	Albania	Europe	1982	70.42000	2780097	3630.8807
20	Albania	Europe	1987	72.00000	3075321	3738.9327
21	Albania	Europe	1992	71.58100	3326498	2497.4379
22	Albania	Europe	1997	72.95000	3428038	3193.0546
23	Albania	Europe	2002	75.65100	3508512	4604.2117
24	Albania	Europe	2007	76.42300	3600523	5937.0295
25	Algeria	Africa	1952	43.07700	9279525	2449.0082
26	Algeria	Africa	1957	45.68500	10270856	3013.9760
27	Algeria	Africa	1962	48.30300	11000948	2550.8169
28	Algeria	Africa	1967	51.40700	12760499	3246.9918
29	Algeria	Africa	1972	54.51800	14760787	4182.6638
30	Algeria	Africa	1977	58.01400	17152804	4910.4168
31	Algeria	Africa	1982	61.36800	20033753	5745.1602
32	Algeria	Africa	1987	65.79900	23254956	5681.3585
33	Algeria	Africa	1992	67.74400	26298373	5023.2166
34	Algeria	Africa	1997	69.15200	29072015	4797.2951
35	Algeria	Africa	2002	70.99400	31287142	5288.0404
36	Algeria	Africa	2007	72.30100	33333216	6223.3675
37	Angola	Africa	1952	30.01500	4232095	3520.6103
38	Angola	Africa	1957	31.99900	4561361	3827.9405
39	Angola	Africa	1962	34.00000	4826015	4269.2767
40	Angola	Africa	1967	35.98500	5247469	5522.7764
41	Angola	Africa	1972	37.92800	5894858	5473.2880
42	Angola	Africa	1977	39.48300	6162675	3008.6474
43	Angola	Africa	1982	39.94200	7016384	2756.9537
44	Angola	Africa	1987	39.90600	7874230	2430.2083
45	Angola	Africa	1992	40.64700	8735988	2627.8457
46	Angola	Africa	1997	40.96300	9875024	2277.1409
47	Angola	Africa	2002	41.00300	10866106	2773.2873
48	Angola	Africa	2007	42.73100	12420476	4797.2313
49	Argentina	Americas	1952	62.48500	17876956	5911.3151
50	Argentina	Americas	1957	64.39900	19610538	6856.8562
51	Argentina	Americas	1962	65.14200	21283783	7133.1660
52	Argentina	Americas	1967	65.63400	22934225	8052.9530
53	Argentina	Americas	1972	67.06500	24779799	9443.0385
54	Argentina	Americas	1977	68.48100	26983828	10079.0267
55	Argentina	Americas	1982	69.94200	29341374	8997.8974
56	Argentina	Americas	1987	70.77400	31620918	9139.6714

57	Argentina	Americas	1992	71.86800	33958947	9308.4187
58	Argentina	Americas	1997	73.27500	36203463	10967.2820
59	Argentina	Americas	2002	74.34000	38331121	8797.6407
60	Argentina	Americas	2007	75.32000	40301927	12779.3796
61	Australia	Oceania	1952	69.12000	8691212	10039.5956
62	Australia	Oceania	1957	70.33000	9712569	10949.6496
63	Australia	Oceania	1962	70.93000	10794968	12217.2269
64	Australia	Oceania	1967	71.10000	11872264	14526.1246
65	Australia	Oceania	1972	71.93000	13177000	16788.6295
66	Australia	Oceania	1977	73.49000	14074100	18334.1975
67	Australia	Oceania	1982	74.74000	15184200	19477.0093
68	Australia	Oceania	1987	76.32000	16257249	21888.8890
69	Australia	Oceania	1992	77.56000	17481977	23424.7668
70	Australia	Oceania	1997	78.83000	18565243	26997.9366
71	Australia	Oceania	2002	80.37000	19546792	30687.7547
72	Australia	Oceania	2007	81.23500	20434176	34435.3674
73	Austria	Europe	1952	66.80000	6927772	6137.0765
74	Austria	Europe	1957	67.48000	6965860	8842.5980
75	Austria	Europe	1962	69.54000	7129864	10750.7211
76	Austria	Europe	1967	70.14000	7376998	12834.6024
77	Austria	Europe	1972	70.63000	7544201	16661.6256
78	Austria	Europe	1977	72.17000	7568430	19749.4223
79	Austria	Europe	1982	73.18000	7574613	21597.0836
80	Austria	Europe	1987	74.94000	7578903	23687.8261
81	Austria	Europe	1992	76.04000	7914969	27042.0187
82	Austria	Europe	1997	77.51000	8069876	29095.9207
83	Austria	Europe	2002	78.98000	8148312	32417.6077
84	Austria	Europe	2007	79.82900	8199783	36126.4927
85	Bahrain	Asia	1952	50.93900	120447	9867.0848
86	Bahrain	Asia	1957	53.83200	138655	11635.7995
87	Bahrain	Asia	1962	56.92300	171863	12753.2751
88	Bahrain	Asia	1967	59.92300	202182	14804.6727
89	Bahrain	Asia	1972	63.30000	230800	18268.6584
90	Bahrain	Asia	1977	65.59300	297410	19340.1020
91	Bahrain	Asia	1982	69.05200	377967	19211.1473
92	Bahrain	Asia	1987	70.75000	454612	18524.0241
93	Bahrain	Asia	1992	72.60100	529491	19035.5792
94	Bahrain	Asia	1997	73.92500	598561	20292.0168
95	Bahrain	Asia	2002	74.79500	656397	23403.5593
96	Bahrain	Asia	2007	75.63500	708573	29796.0483
97	Bangladesh	Asia	1952	37.48400	46886859	684.2442
98	Bangladesh	Asia	1957	39.34800	51365468	661.6375
99	Bangladesh	Asia	1962	41.21600	56839289	686.3416

100	Bangladesh	Asia	1967	43.45300	62821884	721.1861
101	Bangladesh	Asia	1972	45.25200	70759295	630.2336
102	Bangladesh	Asia	1977	46.92300	80428306	659.8772
103	Bangladesh	Asia	1982	50.00900	93074406	676.9819
104	Bangladesh	Asia	1987	52.81900	103764241	751.9794
105	Bangladesh	Asia	1992	56.01800	113704579	837.8102
106	Bangladesh	Asia	1997	59.41200	123315288	972.7700
107	Bangladesh	Asia	2002	62.01300	135656790	1136.3904
108	Bangladesh	Asia	2007	64.06200	150448339	1391.2538
109	Belgium	Europe	1952	68.00000	8730405	8343.1051
110	Belgium	Europe	1957	69.24000	8989111	9714.9606
111	Belgium	Europe	1962	70.25000	9218400	10991.2068
112	Belgium	Europe	1967	70.94000	9556500	13149.0412
113	Belgium	Europe	1972	71.44000	9709100	16672.1436
114	Belgium	Europe	1977	72.80000	9821800	19117.9745
115	Belgium	Europe	1982	73.93000	9856303	20979.8459
116	Belgium	Europe	1987	75.35000	9870200	22525.5631
117	Belgium	Europe	1992	76.46000	10045622	25575.5707
118	Belgium	Europe	1997	77.53000	10199787	27561.1966
119	Belgium	Europe	2002	78.32000	10311970	30485.8838
120	Belgium	Europe	2007	79.44100	10392226	33692.6051
121	Benin	Africa	1952	38.22300	1738315	1062.7522
122	Benin	Africa	1957	40.35800	1925173	959.6011
123	Benin	Africa	1962	42.61800	2151895	949.4991
124	Benin	Africa	1967	44.88500	2427334	1035.8314
125	Benin	Africa	1972	47.01400	2761407	1085.7969
126	Benin	Africa	1977	49.19000	3168267	1029.1613
127	Benin	Africa	1982	50.90400	3641603	1277.8976
128	Benin	Africa	1987	52.33700	4243788	1225.8560
129	Benin	Africa	1992	53.91900	4981671	1191.2077
130	Benin	Africa	1997	54.77700	6066080	1232.9753
131	Benin	Africa	2002	54.40600	7026113	1372.8779
132	Benin	Africa	2007	56.72800	8078314	1441.2849
133	Bolivia	Americas	1952	40.41400	2883315	2677.3263
134	Bolivia	Americas	1957	41.89000	3211738	2127.6863
135	Bolivia	Americas	1962	43.42800	3593918	2180.9725
136	Bolivia	Americas	1967	45.03200	4040665	2586.8861
137	Bolivia	Americas	1972	46.71400	4565872	2980.3313
138	Bolivia	Americas	1977	50.02300	5079716	3548.0978
139	Bolivia	Americas	1982	53.85900	5642224	3156.5105
140	Bolivia	Americas	1987	57.25100	6156369	2753.6915
141	Bolivia	Americas	1992	59.95700	6893451	2961.6997
142	Bolivia	Americas	1997	62.05000	7693188	3326.1432

143	Bolivia	Americas	2002	63.88300	8445134	3413.2627
144	Bolivia	Americas	2007	65.55400	9119152	3822.1371
145	Bosnia and Herzegovina	Europe	1952	53.82000	2791000	973.5332
146	Bosnia and Herzegovina	Europe	1957	58.45000	3076000	1353.9892
147	Bosnia and Herzegovina	Europe	1962	61.93000	3349000	1709.6837
148	Bosnia and Herzegovina	Europe	1967	64.79000	3585000	2172.3524
149	Bosnia and Herzegovina	Europe	1972	67.45000	3819000	2860.1698
150	Bosnia and Herzegovina	Europe	1977	69.86000	4086000	3528.4813
151	Bosnia and Herzegovina	Europe	1982	70.69000	4172693	4126.6132
152	Bosnia and Herzegovina	Europe	1987	71.14000	4338977	4314.1148
153	Bosnia and Herzegovina	Europe	1992	72.17800	4256013	2546.7814
154	Bosnia and Herzegovina	Europe	1997	73.24400	3607000	4766.3559
155	Bosnia and Herzegovina	Europe	2002	74.09000	4165416	6018.9752
156	Bosnia and Herzegovina	Europe	2007	74.85200	4552198	7446.2988
157	Botswana	Africa	1952	47.62200	442308	851.2411
158	Botswana	Africa	1957	49.61800	474639	918.2325
159	Botswana	Africa	1962	51.52000	512764	983.6540
160	Botswana	Africa	1967	53.29800	553541	1214.7093
161	Botswana	Africa	1972	56.02400	619351	2263.6111
162	Botswana	Africa	1977	59.31900	781472	3214.8578
163	Botswana	Africa	1982	61.48400	970347	4551.1421
164	Botswana	Africa	1987	63.62200	1151184	6205.8839
165	Botswana	Africa	1992	62.74500	1342614	7954.1116
166	Botswana	Africa	1997	52.55600	1536536	8647.1423
167	Botswana	Africa	2002	46.63400	1630347	11003.6051
168	Botswana	Africa	2007	50.72800	1639131	12569.8518
169	Brazil	Americas	1952	50.91700	56602560	2108.9444
170	Brazil	Americas	1957	53.28500	65551171	2487.3660
171	Brazil	Americas	1962	55.66500	76039390	3336.5858
172	Brazil	Americas	1967	57.63200	88049823	3429.8644
173	Brazil	Americas	1972	59.50400	100840058	4985.7115
174	Brazil	Americas	1977	61.48900	114313951	6660.1187
175	Brazil	Americas	1982	63.33600	128962939	7030.8359
176	Brazil	Americas	1987	65.20500	142938076	7807.0958
177	Brazil	Americas	1992	67.05700	155975974	6950.2830
178	Brazil	Americas	1997	69.38800	168546719	7957.9808
179	Brazil	Americas	2002	71.00600	179914212	8131.2128
180	Brazil	Americas	2007	72.39000	190010647	9065.8008
181	Bulgaria	Europe	1952	59.60000	7274900	2444.2866
182	Bulgaria	Europe	1957	66.61000	7651254	3008.6707
183	Bulgaria	Europe	1962	69.51000	8012946	4254.3378
184	Bulgaria	Europe	1967	70.42000	8310226	5577.0028
185	Bulgaria	Europe	1972	70.90000	8576200	6597.4944

186	Bulgaria	Europe	1977	70.81000	8797022	7612.2404
187	Bulgaria	Europe	1982	71.08000	8892098	8224.1916
188	Bulgaria	Europe	1987	71.34000	8971958	8239.8548
189	Bulgaria	Europe	1992	71.19000	8658506	6302.6234
190	Bulgaria	Europe	1997	70.32000	8066057	5970.3888
191	Bulgaria	Europe	2002	72.14000	7661799	7696.7777
192	Bulgaria	Europe	2007	73.00500	7322858	10680.7928
193	Burkina Faso	Africa	1952	31.97500	4469979	543.2552
194	Burkina Faso	Africa	1957	34.90600	4713416	617.1835
195	Burkina Faso	Africa	1962	37.81400	4919632	722.5120
196	Burkina Faso	Africa	1967	40.69700	5127935	794.8266
197	Burkina Faso	Africa	1972	43.59100	5433886	854.7360
198	Burkina Faso	Africa	1977	46.13700	5889574	743.3870
199	Burkina Faso	Africa	1982	48.12200	6634596	807.1986
200	Burkina Faso	Africa	1987	49.55700	7586551	912.0631
201	Burkina Faso	Africa	1992	50.26000	8878303	931.7528
202	Burkina Faso	Africa	1997	50.32400	10352843	946.2950
203	Burkina Faso	Africa	2002	50.65000	12251209	1037.6452
204	Burkina Faso	Africa	2007	52.29500	14326203	1217.0330
205	Burundi	Africa	1952	39.03100	2445618	339.2965
206	Burundi	Africa	1957	40.53300	2667518	379.5646
207	Burundi	Africa	1962	42.04500	2961915	355.2032
208	Burundi	Africa	1967	43.54800	3330989	412.9775
209	Burundi	Africa	1972	44.05700	3529983	464.0995
210	Burundi	Africa	1977	45.91000	3834415	556.1033
211	Burundi	Africa	1982	47.47100	4580410	559.6032
212	Burundi	Africa	1987	48.21100	5126023	621.8188
213	Burundi	Africa	1992	44.73600	5809236	631.6999
214	Burundi	Africa	1997	45.32600	6121610	463.1151
215	Burundi	Africa	2002	47.36000	7021078	446.4035
216	Burundi	Africa	2007	49.58000	8390505	430.0707
217	Cambodia	Asia	1952	39.41700	4693836	368.4693
218	Cambodia	Asia	1957	41.36600	5322536	434.0383
219	Cambodia	Asia	1962	43.41500	6083619	496.9136
220	Cambodia	Asia	1967	45.41500	6960067	523.4323
221	Cambodia	Asia	1972	40.31700	7450606	421.6240
222	Cambodia	Asia	1977	31.22000	6978607	524.9722
223	Cambodia	Asia	1982	50.95700	7272485	624.4755
224	Cambodia	Asia	1987	53.91400	8371791	683.8956
225	Cambodia	Asia	1992	55.80300	10150094	682.3032
226	Cambodia	Asia	1997	56.53400	11782962	734.2852
227	Cambodia	Asia	2002	56.75200	12926707	896.2260
228	Cambodia	Asia	2007	59.72300	14131858	1713.7787

229		Cameroon	Africa	1952	38.52300	5009067	1172.6677
230		Cameroon	Africa	1957	40.42800	5359923	1313.0481
231		Cameroon	Africa	1962	42.64300	5793633	1399.6074
232		Cameroon	Africa	1967	44.79900	6335506	1508.4531
233		Cameroon	Africa	1972	47.04900	7021028	1684.1465
234		Cameroon	Africa	1977	49.35500	7959865	1783.4329
235		Cameroon	Africa	1982	52.96100	9250831	2367.9833
236		Cameroon	Africa	1987	54.98500	10780667	2602.6642
237		Cameroon	Africa	1992	54.31400	12467171	1793.1633
238		Cameroon	Africa	1997	52.19900	14195809	1694.3375
239		Cameroon	Africa	2002	49.85600	15929988	1934.0114
240		Cameroon	Africa	2007	50.43000	17696293	2042.0952
241		Canada	Americas	1952	68.75000	14785584	11367.1611
242		Canada	Americas	1957	69.96000	17010154	12489.9501
243		Canada	Americas	1962	71.30000	18985849	13462.4855
244		Canada	Americas	1967	72.13000	20819767	16076.5880
245		Canada	Americas	1972	72.88000	22284500	18970.5709
246		Canada	Americas	1977	74.21000	23796400	22090.8831
247		Canada	Americas	1982	75.76000	25201900	22898.7921
248		Canada	Americas	1987	76.86000	26549700	26626.5150
249		Canada	Americas	1992	77.95000	28523502	26342.8843
250		Canada	Americas	1997	78.61000	30305843	28954.9259
251		Canada	Americas	2002	79.77000	31902268	33328.9651
252		Canada	Americas	2007	80.65300	33390141	36319.2350
253	Central African	Republic	Africa	1952	35.46300	1291695	1071.3107
254	Central African	Republic	Africa	1957	37.46400	1392284	1190.8443
255	Central African	Republic	Africa	1962	39.47500	1523478	1193.0688
256	Central African	Republic	Africa	1967	41.47800	1733638	1136.0566
257	Central African	Republic	Africa	1972	43.45700	1927260	1070.0133
258	Central African	Republic	Africa	1977	46.77500	2167533	1109.3743
259	Central African	Republic	Africa	1982	48.29500	2476971	956.7530
260	Central African	Republic	Africa	1987	50.48500	2840009	844.8764
261	Central African	Republic	Africa	1992	49.39600	3265124	747.9055
262	Central African	Republic	Africa	1997	46.06600	3696513	740.5063
263	Central African	Republic	Africa	2002	43.30800	4048013	738.6906
264	Central African	Republic	Africa	2007	44.74100	4369038	706.0165
265		Chad	Africa	1952	38.09200	2682462	1178.6659
266		Chad	Africa	1957	39.88100	2894855	1308.4956
267		Chad	Africa	1962	41.71600	3150417	1389.8176
268		Chad	Africa	1967	43.60100	3495967	1196.8106
269		Chad	Africa	1972	45.56900	3899068	1104.1040
270		Chad	Africa	1977	47.38300	4388260	1133.9850
271		Chad	Africa	1982	49.51700	4875118	797.9081

272	Chad	Africa	1987	51.05100	5498955	952.3861
273	Chad	Africa	1992	51.72400	6429417	1058.0643
274	Chad	Africa	1997	51.57300	7562011	1004.9614
275	Chad	Africa	2002	50.52500	8835739	1156.1819
276	Chad	Africa	2007	50.65100	10238807	1704.0637
277	Chile	Americas	1952	54.74500	6377619	3939.9788
278	Chile	Americas	1957	56.07400	7048426	4315.6227
279	Chile	Americas	1962	57.92400	7961258	4519.0943
280	Chile	Americas	1967	60.52300	8858908	5106.6543
281	Chile	Americas	1972	63.44100	9717524	5494.0244
282	Chile	Americas	1977	67.05200	10599793	4756.7638
283	Chile	Americas	1982	70.56500	11487112	5095.6657
284	Chile	Americas	1987	72.49200	12463354	5547.0638
285	Chile	Americas	1992	74.12600	13572994	7596.1260
286	Chile	Americas	1997	75.81600	14599929	10118.0532
287	Chile	Americas	2002	77.86000	15497046	10778.7838
288	Chile	Americas	2007	78.55300	16284741	13171.6388
289	China	Asia	1952	44.00000	556263527	400.4486
290	China	Asia	1957	50.54896	637408000	575.9870
291	China	Asia	1962	44.50136	665770000	487.6740
292	China	Asia	1967	58.38112	754550000	612.7057
293	China	Asia	1972	63.11888	862030000	676.9001
294	China	Asia	1977	63.96736	943455000	741.2375
295	China	Asia	1982	65.52500	1000281000	962.4214
296	China	Asia	1987	67.27400	1084035000	1378.9040
297	China	Asia	1992	68.69000	1164970000	1655.7842
298	China	Asia	1997	70.42600	1230075000	2289.2341
299	China	Asia	2002	72.02800	1280400000	3119.2809
300	China	Asia	2007	72.96100	1318683096	4959.1149
301	Colombia	Americas	1952	50.64300	12350771	2144.1151
302	Colombia	Americas	1957	55.11800	14485993	2323.8056
303	Colombia	Americas	1962	57.86300	17009885	2492.3511
304	Colombia	Americas	1967	59.96300	19764027	2678.7298
305	Colombia	Americas	1972	61.62300	22542890	3264.6600
306	Colombia	Americas	1977	63.83700	25094412	3815.8079
307	Colombia	Americas	1982	66.65300	27764644	4397.5757
308	Colombia	Americas	1987	67.76800	30964245	4903.2191
309	Colombia	Americas	1992	68.42100	34202721	5444.6486
310	Colombia	Americas	1997	70.31300	37657830	6117.3617
311	Colombia	Americas	2002	71.68200	41008227	5755.2600
312	Colombia	Americas	2007	72.88900	44227550	7006.5804
313	Comoros	Africa	1952	40.71500	153936	1102.9909
314	Comoros	Africa	1957	42.46000	170928	1211.1485

315	Comoros	Africa	1962	44.46700	191689	1406.6483
316	Comoros	Africa	1967	46.47200	217378	1876.0296
317	Comoros	Africa	1972	48.94400	250027	1937.5777
318	Comoros	Africa	1977	50.93900	304739	1172.6030
319	Comoros	Africa	1982	52.93300	348643	1267.1001
320	Comoros	Africa	1987	54.92600	395114	1315.9808
321	Comoros	Africa	1992	57.93900	454429	1246.9074
322	Comoros	Africa	1997	60.66000	527982	1173.6182
323	Comoros	Africa	2002	62.97400	614382	1075.8116
324	Comoros	Africa	2007	65.15200	710960	986.1479
325	Congo, Dem. Rep.	Africa	1952	39.14300	14100005	780.5423
326	Congo, Dem. Rep.	Africa	1957	40.65200	15577932	905.8602
327	Congo, Dem. Rep.	Africa	1962	42.12200	17486434	896.3146
328	Congo, Dem. Rep.	Africa	1967	44.05600	19941073	861.5932
329	Congo, Dem. Rep.	Africa	1972	45.98900	23007669	904.8961
330	Congo, Dem. Rep.	Africa	1977	47.80400	26480870	795.7573
331	Congo, Dem. Rep.	Africa	1982	47.78400	30646495	673.7478
332	Congo, Dem. Rep.	Africa	1987	47.41200	35481645	672.7748
333	Congo, Dem. Rep.	Africa	1992	45.54800	41672143	457.7192
334	Congo, Dem. Rep.	Africa	1997	42.58700	47798986	312.1884
335	Congo, Dem. Rep.	Africa	2002	44.96600	55379852	241.1659
336	Congo, Dem. Rep.	Africa	2007	46.46200	64606759	277.5519
337	Congo, Rep.	Africa	1952	42.11100	854885	2125.6214
338	Congo, Rep.	Africa	1957	45.05300	940458	2315.0566
339	Congo, Rep.	Africa	1962	48.43500	1047924	2464.7832
340	Congo, Rep.	Africa	1967	52.04000	1179760	2677.9396
341	Congo, Rep.	Africa	1972	54.90700	1340458	3213.1527
342	Congo, Rep.	Africa	1977	55.62500	1536769	3259.1790
343	Congo, Rep.	Africa	1982	56.69500	1774735	4879.5075
344	Congo, Rep.	Africa	1987	57.47000	2064095	4201.1949
345	Congo, Rep.	Africa	1992	56.43300	2409073	4016.2395
346	Congo, Rep.	Africa	1997	52.96200	2800947	3484.1644
347	Congo, Rep.	Africa	2002	52.97000	3328795	3484.0620
348	Congo, Rep.	Africa	2007	55.32200	3800610	3632.5578
349	Costa Rica	Americas	1952	57.20600	926317	2627.0095
350	Costa Rica	Americas	1957	60.02600	1112300	2990.0108
351	Costa Rica	Americas	1962	62.84200	1345187	3460.9370
352	Costa Rica	Americas	1967	65.42400	1588717	4161.7278
353	Costa Rica	Americas	1972	67.84900	1834796	5118.1469
354	Costa Rica	Americas	1977	70.75000	2108457	5926.8770
355	Costa Rica	Americas	1982	73.45000	2424367	5262.7348
356	Costa Rica	Americas	1987	74.75200	2799811	5629.9153
357	Costa Rica	Americas	1992	75.71300	3173216	6160.4163

358	Costa Rica	Americas	1997	77.26000	3518107	6677.0453
359	Costa Rica	Americas	2002	78.12300	3834934	7723.4472
360	Costa Rica	Americas	2007	78.78200	4133884	9645.0614
361	Cote d'Ivoire	Africa	1952	40.47700	2977019	1388.5947
362	Cote d'Ivoire	Africa	1957	42.46900	3300000	1500.8959
363	Cote d'Ivoire	Africa	1962	44.93000	3832408	1728.8694
364	Cote d'Ivoire	Africa	1967	47.35000	4744870	2052.0505
365	Cote d'Ivoire	Africa	1972	49.80100	6071696	2378.2011
366	Cote d'Ivoire	Africa	1977	52.37400	7459574	2517.7365
367	Cote d'Ivoire	Africa	1982	53.98300	9025951	2602.7102
368	Cote d'Ivoire	Africa	1987	54.65500	10761098	2156.9561
369	Cote d'Ivoire	Africa	1992	52.04400	12772596	1648.0738
370	Cote d'Ivoire	Africa	1997	47.99100	14625967	1786.2654
371	Cote d'Ivoire	Africa	2002	46.83200	16252726	1648.8008
372	Cote d'Ivoire	Africa	2007	48.32800	18013409	1544.7501
373	Croatia	Europe	1952	61.21000	3882229	3119.2365
374	Croatia	Europe	1957	64.77000	3991242	4338.2316
375	Croatia	Europe	1962	67.13000	4076557	5477.8900
376	Croatia	Europe	1967	68.50000	4174366	6960.2979
377	Croatia	Europe	1972	69.61000	4225310	9164.0901
378	Croatia	Europe	1977	70.64000	4318673	11305.3852
379	Croatia	Europe	1982	70.46000	4413368	13221.8218
380	Croatia	Europe	1987	71.52000	4484310	13822.5839
381	Croatia	Europe	1992	72.52700	4494013	8447.7949
382	Croatia	Europe	1997	73.68000	4444595	9875.6045
383	Croatia	Europe	2002	74.87600	4481020	11628.3890
384	Croatia	Europe	2007	75.74800	4493312	14619.2227
385	Cuba	Americas	1952	59.42100	6007797	5586.5388
386	Cuba	Americas	1957	62.32500	6640752	6092.1744
387	Cuba	Americas	1962	65.24600	7254373	5180.7559
388	Cuba	Americas	1967	68.29000	8139332	5690.2680
389	Cuba	Americas	1972	70.72300	8831348	5305.4453
390	Cuba	Americas	1977	72.64900	9537988	6380.4950
391	Cuba	Americas	1982	73.71700	9789224	7316.9181
392	Cuba	Americas	1987	74.17400	10239839	7532.9248
393	Cuba	Americas	1992	74.41400	10723260	5592.8440
394	Cuba	Americas	1997	76.15100	10983007	5431.9904
395	Cuba	Americas	2002	77.15800	11226999	6340.6467
396	Cuba	Americas	2007	78.27300	11416987	8948.1029
397	Czech Republic	Europe	1952	66.87000	9125183	6876.1403
398	Czech Republic	Europe	1957	69.03000	9513758	8256.3439
399	Czech Republic	Europe	1962	69.90000	9620282	10136.8671
400	Czech Republic	Europe	1967	70.38000	9835109	11399.4449

401	Czech Republic	Europe	1972	70.29000	9862158	13108.4536
402	Czech Republic	Europe	1977	70.71000	10161915	14800.1606
403	Czech Republic	Europe	1982	70.96000	10303704	15377.2285
404	Czech Republic	Europe	1987	71.58000	10311597	16310.4434
405	Czech Republic	Europe	1992	72.40000	10315702	14297.0212
406	Czech Republic	Europe	1997	74.01000	10300707	16048.5142
407	Czech Republic	Europe	2002	75.51000	10256295	17596.2102
408	Czech Republic	Europe	2007	76.48600	10228744	22833.3085
409	Denmark	Europe	1952	70.78000	4334000	9692.3852
410	Denmark	Europe	1957	71.81000	4487831	11099.6593
411	Denmark	Europe	1962	72.35000	4646899	13583.3135
412	Denmark	Europe	1967	72.96000	4838800	15937.2112
413	Denmark	Europe	1972	73.47000	4991596	18866.2072
414	Denmark	Europe	1977	74.69000	5088419	20422.9015
415	Denmark	Europe	1982	74.63000	5117810	21688.0405
416	Denmark	Europe	1987	74.80000	5127024	25116.1758
417	Denmark	Europe	1992	75.33000	5171393	26406.7399
418	Denmark	Europe	1997	76.11000	5283663	29804.3457
419	Denmark	Europe	2002	77.18000	5374693	32166.5001
420	Denmark	Europe	2007	78.33200	5468120	35278.4187
421	Djibouti	Africa	1952	34.81200	63149	2669.5295
422	Djibouti	Africa	1957	37.32800	71851	2864.9691
423	Djibouti	Africa	1962	39.69300	89898	3020.9893
424	Djibouti	Africa	1967	42.07400	127617	3020.0505
425	Djibouti	Africa	1972	44.36600	178848	3694.2124
426	Djibouti	Africa	1977	46.51900	228694	3081.7610
427	Djibouti	Africa	1982	48.81200	305991	2879.4681
428	Djibouti	Africa	1987	50.04000	311025	2880.1026
429	Djibouti	Africa	1992	51.60400	384156	2377.1562
430	Djibouti	Africa	1997	53.15700	417908	1895.0170
431	Djibouti	Africa	2002	53.37300	447416	1908.2609
432	Djibouti	Africa	2007	54.79100	496374	2082.4816
433	Dominican Republic	Americas	1952	45.92800	2491346	1397.7171
434	Dominican Republic	Americas	1957	49.82800	2923186	1544.4030
435	Dominican Republic	Americas	1962	53.45900	3453434	1662.1374
436	Dominican Republic	Americas	1967	56.75100	4049146	1653.7230
437	Dominican Republic	Americas	1972	59.63100	4671329	2189.8745
438	Dominican Republic	Americas	1977	61.78800	5302800	2681.9889
439	Dominican Republic	Americas	1982	63.72700	5968349	2861.0924
440	Dominican Republic	Americas	1987	66.04600	6655297	2899.8422
441	Dominican Republic	Americas	1992	68.45700	7351181	3044.2142
442	Dominican Republic	Americas	1997	69.95700	7992357	3614.1013
443	Dominican Republic	Americas	2002	70.84700	8650322	4563.8082

444	Dominican Republic	Americas	2007	72.23500	9319622	6025.3748
445	Ecuador	Americas	1952	48.35700	3548753	3522.1107
446	Ecuador	Americas	1957	51.35600	4058385	3780.5467
447	Ecuador	Americas	1962	54.64000	4681707	4086.1141
448	Ecuador	Americas	1967	56.67800	5432424	4579.0742
449	Ecuador	Americas	1972	58.79600	6298651	5280.9947
450	Ecuador	Americas	1977	61.31000	7278866	6679.6233
451	Ecuador	Americas	1982	64.34200	8365850	7213.7913
452	Ecuador	Americas	1987	67.23100	9545158	6481.7770
453	Ecuador	Americas	1992	69.61300	10748394	7103.7026
454	Ecuador	Americas	1997	72.31200	11911819	7429.4559
455	Ecuador	Americas	2002	74.17300	12921234	5773.0445
456	Ecuador	Americas	2007	74.99400	13755680	6873.2623
457	Egypt	Africa	1952	41.89300	22223309	1418.8224
458	Egypt	Africa	1957	44.44400	25009741	1458.9153
459	Egypt	Africa	1962	46.99200	28173309	1693.3359
460	Egypt	Africa	1967	49.29300	31681188	1814.8807
461	Egypt	Africa	1972	51.13700	34807417	2024.0081
462	Egypt	Africa	1977	53.31900	38783863	2785.4936
463	Egypt	Africa	1982	56.00600	45681811	3503.7296
464	Egypt	Africa	1987	59.79700	52799062	3885.4607
465	Egypt	Africa	1992	63.67400	59402198	3794.7552
466	Egypt	Africa	1997	67.21700	66134291	4173.1818
467	Egypt	Africa	2002	69.80600	73312559	4754.6044
468	Egypt	Africa	2007	71.33800	80264543	5581.1810
469	El Salvador	Americas	1952	45.26200	2042865	3048.3029
470	El Salvador	Americas	1957	48.57000	2355805	3421.5232
471	El Salvador	Americas	1962	52.30700	2747687	3776.8036
472	El Salvador	Americas	1967	55.85500	3232927	4358.5954
473	El Salvador	Americas	1972	58.20700	3790903	4520.2460
474	El Salvador	Americas	1977	56.69600	4282586	5138.9224
475	El Salvador	Americas	1982	56.60400	4474873	4098.3442
476	El Salvador	Americas	1987	63.15400	4842194	4140.4421
477	El Salvador	Americas	1992	66.79800	5274649	4444.2317
478	El Salvador	Americas	1997	69.53500	5783439	5154.8255
479	El Salvador	Americas	2002	70.73400	6353681	5351.5687
480	El Salvador	Americas	2007	71.87800	6939688	5728.3535
481	Equatorial Guinea	Africa	1952	34.48200	216964	375.6431
482	Equatorial Guinea	Africa	1957	35.98300	232922	426.0964
483	Equatorial Guinea	Africa	1962	37.48500	249220	582.8420
484	Equatorial Guinea	Africa	1967	38.98700	259864	915.5960
485	Equatorial Guinea	Africa	1972	40.51600	277603	672.4123
486	Equatorial Guinea	Africa	1977	42.02400	192675	958.5668

487	Equatorial Guinea	Africa	1982	43.66200	285483	927.8253
488	Equatorial Guinea	Africa	1987	45.66400	341244	966.8968
489	Equatorial Guinea	Africa	1992	47.54500	387838	1132.0550
490	Equatorial Guinea	Africa	1997	48.24500	439971	2814.4808
491	Equatorial Guinea	Africa	2002	49.34800	495627	7703.4959
492	Equatorial Guinea	Africa	2007	51.57900	551201	12154.0897
493	Eritrea	Africa	1952	35.92800	1438760	328.9406
494	Eritrea	Africa	1957	38.04700	1542611	344.1619
495	Eritrea	Africa	1962	40.15800	1666618	380.9958
496	Eritrea	Africa	1967	42.18900	1820319	468.7950
497	Eritrea	Africa	1972	44.14200	2260187	514.3242
498	Eritrea	Africa	1977	44.53500	2512642	505.7538
499	Eritrea	Africa	1982	43.89000	2637297	524.8758
500	Eritrea	Africa	1987	46.45300	2915959	521.1341
501	Eritrea	Africa	1992	49.99100	3668440	582.8585
502	Eritrea	Africa	1997	53.37800	4058319	913.4708
503	Eritrea	Africa	2002	55.24000	4414865	765.3500
504	Eritrea	Africa	2007	58.04000	4906585	641.3695
505	Ethiopia	Africa	1952	34.07800	20860941	362.1463
506	Ethiopia	Africa	1957	36.66700	22815614	378.9042
507	Ethiopia	Africa	1962	40.05900	25145372	419.4564
508	Ethiopia	Africa	1967	42.11500	27860297	516.1186
509	Ethiopia	Africa	1972	43.51500	30770372	566.2439
510	Ethiopia	Africa	1977	44.51000	34617799	556.8084
511	Ethiopia	Africa	1982	44.91600	38111756	577.8607
512	Ethiopia	Africa	1987	46.68400	42999530	573.7413
513	Ethiopia	Africa	1992	48.09100	52088559	421.3535
514	Ethiopia	Africa	1997	49.40200	59861301	515.8894
515	Ethiopia	Africa	2002	50.72500	67946797	530.0535
516	Ethiopia	Africa	2007	52.94700	76511887	690.8056
517	Finland	Europe	1952	66.55000	4090500	6424.5191
518	Finland	Europe	1957	67.49000	4324000	7545.4154
519	Finland	Europe	1962	68.75000	4491443	9371.8426
520	Finland	Europe	1967	69.83000	4605744	10921.6363
521	Finland	Europe	1972	70.87000	4639657	14358.8759
522	Finland	Europe	1977	72.52000	4738902	15605.4228
523	Finland	Europe	1982	74.55000	4826933	18533.1576
524	Finland	Europe	1987	74.83000	4931729	21141.0122
525	Finland	Europe	1992	75.70000	5041039	20647.1650
526	Finland	Europe	1997	77.13000	5134406	23723.9502
527	Finland	Europe	2002	78.37000	5193039	28204.5906
528	Finland	Europe	2007	79.31300	5238460	33207.0844
529	France	Europe	1952	67.41000	42459667	7029.8093

530	France	Europe	1957	68.93000	44310863	8662.8349
531	France	Europe	1962	70.51000	47124000	10560.4855
532	France	Europe	1967	71.55000	49569000	12999.9177
533	France	Europe	1972	72.38000	51732000	16107.1917
534	France	Europe	1977	73.83000	53165019	18292.6351
535	France	Europe	1982	74.89000	54433565	20293.8975
536	France	Europe	1987	76.34000	55630100	22066.4421
537	France	Europe	1992	77.46000	57374179	24703.7961
538	France	Europe	1997	78.64000	58623428	25889.7849
539	France	Europe	2002	79.59000	59925035	28926.0323
540	France	Europe	2007	80.65700	61083916	30470.0167
541	Gabon	Africa	1952	37.00300	420702	4293.4765
542	Gabon	Africa	1957	38.99900	434904	4976.1981
543	Gabon	Africa	1962	40.48900	455661	6631.4592
544	Gabon	Africa	1967	44.59800	489004	8358.7620
545	Gabon	Africa	1972	48.69000	537977	11401.9484
546	Gabon	Africa	1977	52.79000	706367	21745.5733
547	Gabon	Africa	1982	56.56400	753874	15113.3619
548	Gabon	Africa	1987	60.19000	880397	11864.4084
549	Gabon	Africa	1992	61.36600	985739	13522.1575
550	Gabon	Africa	1997	60.46100	1126189	14722.8419
551	Gabon	Africa	2002	56.76100	1299304	12521.7139
552	Gabon	Africa	2007	56.73500	1454867	13206.4845
553	Gambia	Africa	1952	30.00000	284320	485.2307
554	Gambia	Africa	1957	32.06500	323150	520.9267
555	Gambia	Africa	1962	33.89600	374020	599.6503
556	Gambia	Africa	1967	35.85700	439593	734.7829
557	Gambia	Africa	1972	38.30800	517101	756.0868
558	Gambia	Africa	1977	41.84200	608274	884.7553
559	Gambia	Africa	1982	45.58000	715523	835.8096
560	Gambia	Africa	1987	49.26500	848406	611.6589
561	Gambia	Africa	1992	52.64400	1025384	665.6244
562	Gambia	Africa	1997	55.86100	1235767	653.7302
563	Gambia	Africa	2002	58.04100	1457766	660.5856
564	Gambia	Africa	2007	59.44800	1688359	752.7497
565	Germany	Europe	1952	67.50000	69145952	7144.1144
566	Germany	Europe	1957	69.10000	71019069	10187.8267
567	Germany	Europe	1962	70.30000	73739117	12902.4629
568	Germany	Europe	1967	70.80000	76368453	14745.6256
569	Germany	Europe	1972	71.00000	78717088	18016.1803
570	Germany	Europe	1977	72.50000	78160773	20512.9212
571	Germany	Europe	1982	73.80000	78335266	22031.5327
572	Germany	Europe	1987	74.84700	77718298	24639.1857

573	Germany	Europe	1992	76.07000	80597764	26505.3032
574	Germany	Europe	1997	77.34000	82011073	27788.8842
575	Germany	Europe	2002	78.67000	82350671	30035.8020
576	Germany	Europe	2007	79.40600	82400996	32170.3744
577	Ghana	Africa	1952	43.14900	5581001	911.2989
578	Ghana	Africa	1957	44.77900	6391288	1043.5615
579	Ghana	Africa	1962	46.45200	7355248	1190.0411
580	Ghana	Africa	1967	48.07200	8490213	1125.6972
581	Ghana	Africa	1972	49.87500	9354120	1178.2237
582	Ghana	Africa	1977	51.75600	10538093	993.2240
583	Ghana	Africa	1982	53.74400	11400338	876.0326
584	Ghana	Africa	1987	55.72900	14168101	847.0061
585	Ghana	Africa	1992	57.50100	16278738	925.0602
586	Ghana	Africa	1997	58.55600	18418288	1005.2458
587	Ghana	Africa	2002	58.45300	20550751	1111.9846
588	Ghana	Africa	2007	60.02200	22873338	1327.6089
589	Greece	Europe	1952	65.86000	7733250	3530.6901
590	Greece	Europe	1957	67.86000	8096218	4916.2999
591	Greece	Europe	1962	69.51000	8448233	6017.1907
592	Greece	Europe	1967	71.00000	8716441	8513.0970
593	Greece	Europe	1972	72.34000	8888628	12724.8296
594	Greece	Europe	1977	73.68000	9308479	14195.5243
595	Greece	Europe	1982	75.24000	9786480	15268.4209
596	Greece	Europe	1987	76.67000	9974490	16120.5284
597	Greece	Europe	1992	77.03000	10325429	17541.4963
598	Greece	Europe	1997	77.86900	10502372	18747.6981
599	Greece	Europe	2002	78.25600	10603863	22514.2548
600	Greece	Europe	2007	79.48300	10706290	27538.4119
601	Guatemala	Americas	1952	42.02300	3146381	2428.2378
602	Guatemala	Americas	1957	44.14200	3640876	2617.1560
603	Guatemala	Americas	1962	46.95400	4208858	2750.3644
604	Guatemala	Americas	1967	50.01600	4690773	3242.5311
605	Guatemala	Americas	1972	53.73800	5149581	4031.4083
606	Guatemala	Americas	1977	56.02900	5703430	4879.9927
607	Guatemala	Americas	1982	58.13700	6395630	4820.4948
608	Guatemala	Americas	1987	60.78200	7326406	4246.4860
609	Guatemala	Americas	1992	63.37300	8486949	4439.4508
610	Guatemala	Americas	1997	66.32200	9803875	4684.3138
611	Guatemala	Americas	2002	68.97800	11178650	4858.3475
612	Guatemala	Americas	2007	70.25900	12572928	5186.0500
613	Guinea	Africa	1952	33.60900	2664249	510.1965
614	Guinea	Africa	1957	34.55800	2876726	576.2670
615	Guinea	Africa	1962	35.75300	3140003	686.3737

616	Guinea	Africa	1967	37.19700	3451418	708.7595
617	Guinea	Africa	1972	38.84200	3811387	741.6662
618	Guinea	Africa	1977	40.76200	4227026	874.6859
619	Guinea	Africa	1982	42.89100	4710497	857.2504
620	Guinea	Africa	1987	45.55200	5650262	805.5725
621	Guinea	Africa	1992	48.57600	6990574	794.3484
622	Guinea	Africa	1997	51.45500	8048834	869.4498
623	Guinea	Africa	2002	53.67600	8807818	945.5836
624	Guinea	Africa	2007	56.00700	9947814	942.6542
625	Guinea-Bissau	Africa	1952	32.50000	580653	299.8503
626	Guinea-Bissau	Africa	1957	33.48900	601095	431.7905
627	Guinea-Bissau	Africa	1962	34.48800	627820	522.0344
628	Guinea-Bissau	Africa	1967	35.49200	601287	715.5806
629	Guinea-Bissau	Africa	1972	36.48600	625361	820.2246
630	Guinea-Bissau	Africa	1977	37.46500	745228	764.7260
631	Guinea-Bissau	Africa	1982	39.32700	825987	838.1240
632	Guinea-Bissau	Africa	1987	41.24500	927524	736.4154
633	Guinea-Bissau	Africa	1992	43.26600	1050938	745.5399
634	Guinea-Bissau	Africa	1997	44.87300	1193708	796.6645
635	Guinea-Bissau	Africa	2002	45.50400	1332459	575.7047
636	Guinea-Bissau	Africa	2007	46.38800	1472041	579.2317
637	Haiti	Americas	1952	37.57900	3201488	1840.3669
638	Haiti	Americas	1957	40.69600	3507701	1726.8879
639	Haiti	Americas	1962	43.59000	3880130	1796.5890
640	Haiti	Americas	1967	46.24300	4318137	1452.0577
641	Haiti	Americas	1972	48.04200	4698301	1654.4569
642	Haiti	Americas	1977	49.92300	4908554	1874.2989
643	Haiti	Americas	1982	51.46100	5198399	2011.1595
644	Haiti	Americas	1987	53.63600	5756203	1823.0160
645	Haiti	Americas	1992	55.08900	6326682	1456.3095
646	Haiti	Americas	1997	56.67100	6913545	1341.7269
647	Haiti	Americas	2002	58.13700	7607651	1270.3649
648	Haiti	Americas	2007	60.91600	8502814	1201.6372
649	Honduras	Americas	1952	41.91200	1517453	2194.9262
650	Honduras	Americas	1957	44.66500	1770390	2220.4877
651	Honduras	Americas	1962	48.04100	2090162	2291.1568
652	Honduras	Americas	1967	50.92400	2500689	2538.2694
653	Honduras	Americas	1972	53.88400	2965146	2529.8423
654	Honduras	Americas	1977	57.40200	3055235	3203.2081
655	Honduras	Americas	1982	60.90900	3669448	3121.7608
656	Honduras	Americas	1987	64.49200	4372203	3023.0967
657	Honduras	Americas	1992	66.39900	5077347	3081.6946
658	Honduras	Americas	1997	67.65900	5867957	3160.4549

659	Honduras	Americas	2002	68.56500	6677328	3099.7287
660	Honduras	Americas	2007	70.19800	7483763	3548.3308
661	Hong Kong, China	Asia	1952	60.96000	2125900	3054.4212
662	Hong Kong, China	Asia	1957	64.75000	2736300	3629.0765
663	Hong Kong, China	Asia	1962	67.65000	3305200	4692.6483
664	Hong Kong, China	Asia	1967	70.00000	3722800	6197.9628
665	Hong Kong, China	Asia	1972	72.00000	4115700	8315.9281
666	Hong Kong, China	Asia	1977	73.60000	4583700	11186.1413
667	Hong Kong, China	Asia	1982	75.45000	5264500	14560.5305
668	Hong Kong, China	Asia	1987	76.20000	5584510	20038.4727
669	Hong Kong, China	Asia	1992	77.60100	5829696	24757.6030
670	Hong Kong, China	Asia	1997	80.00000	6495918	28377.6322
671	Hong Kong, China	Asia	2002	81.49500	6762476	30209.0152
672	Hong Kong, China	Asia	2007	82.20800	6980412	39724.9787
673	Hungary	Europe	1952	64.03000	9504000	5263.6738
674	Hungary	Europe	1957	66.41000	9839000	6040.1800
675	Hungary	Europe	1962	67.96000	10063000	7550.3599
676	Hungary	Europe	1967	69.50000	10223422	9326.6447
677	Hungary	Europe	1972	69.76000	10394091	10168.6561
678	Hungary	Europe	1977	69.95000	10637171	11674.8374
679	Hungary	Europe	1982	69.39000	10705535	12545.9907
680	Hungary	Europe	1987	69.58000	10612740	12986.4800
681	Hungary	Europe	1992	69.17000	10348684	10535.6285
682	Hungary	Europe	1997	71.04000	10244684	11712.7768
683	Hungary	Europe	2002	72.59000	10083313	14843.9356
684	Hungary	Europe	2007	73.33800	9956108	18008.9444
685	Iceland	Europe	1952	72.49000	147962	7267.6884
686	Iceland	Europe	1957	73.47000	165110	9244.0014
687	Iceland	Europe	1962	73.68000	182053	10350.1591
688	Iceland	Europe	1967	73.73000	198676	13319.8957
689	Iceland	Europe	1972	74.46000	209275	15798.0636
690	Iceland	Europe	1977	76.11000	221823	19654.9625
691	Iceland	Europe	1982	76.99000	233997	23269.6075
692	Iceland	Europe	1987	77.23000	244676	26923.2063
693	Iceland	Europe	1992	78.77000	259012	25144.3920
694	Iceland	Europe	1997	78.95000	271192	28061.0997
695	Iceland	Europe	2002	80.50000	288030	31163.2020
696	Iceland	Europe	2007	81.75700	301931	36180.7892
697	India	Asia	1952	37.37300	372000000	546.5657
698	India	Asia	1957	40.24900	409000000	590.0620
699	India	Asia	1962	43.60500	454000000	658.3472
700	India	Asia	1967	47.19300	506000000	700.7706
701	India	Asia	1972	50.65100	567000000	724.0325

702	India	Asia	1977	54.20800	634000000	813.3373
703	India	Asia	1982	56.59600	708000000	855.7235
704	India	Asia	1987	58.55300	788000000	976.5127
705	India	Asia	1992	60.22300	872000000	1164.4068
706	India	Asia	1997	61.76500	959000000	1458.8174
707	India	Asia	2002	62.87900	1034172547	1746.7695
708	India	Asia	2007	64.69800	1110396331	2452.2104
709	Indonesia	Asia	1952	37.46800	82052000	749.6817
710	Indonesia	Asia	1957	39.91800	90124000	858.9003
711	Indonesia	Asia	1962	42.51800	99028000	849.2898
712	Indonesia	Asia	1967	45.96400	109343000	762.4318
713	Indonesia	Asia	1972	49.20300	121282000	1111.1079
714	Indonesia	Asia	1977	52.70200	136725000	1382.7021
715	Indonesia	Asia	1982	56.15900	153343000	1516.8730
716	Indonesia	Asia	1987	60.13700	169276000	1748.3570
717	Indonesia	Asia	1992	62.68100	184816000	2383.1409
718	Indonesia	Asia	1997	66.04100	199278000	3119.3356
719	Indonesia	Asia	2002	68.58800	211060000	2873.9129
720	Indonesia	Asia	2007	70.65000	223547000	3540.6516
721	Iran	Asia	1952	44.86900	17272000	3035.3260
722	Iran	Asia	1957	47.18100	19792000	3290.2576
723	Iran	Asia	1962	49.32500	22874000	4187.3298
724	Iran	Asia	1967	52.46900	26538000	5906.7318
725	Iran	Asia	1972	55.23400	30614000	9613.8186
726	Iran	Asia	1977	57.70200	35480679	11888.5951
727	Iran	Asia	1982	59.62000	43072751	7608.3346
728	Iran	Asia	1987	63.04000	51889696	6642.8814
729	Iran	Asia	1992	65.74200	60397973	7235.6532
730	Iran	Asia	1997	68.04200	63327987	8263.5903
731	Iran	Asia	2002	69.45100	66907826	9240.7620
732	Iran	Asia	2007	70.96400	69453570	11605.7145
733	Iraq	Asia	1952	45.32000	5441766	4129.7661
734	Iraq	Asia	1957	48.43700	6248643	6229.3336
735	Iraq	Asia	1962	51.45700	7240260	8341.7378
736	Iraq	Asia	1967	54.45900	8519282	8931.4598
737	Iraq	Asia	1972	56.95000	10061506	9576.0376
738	Iraq	Asia	1977	60.41300	11882916	14688.2351
739	Iraq	Asia	1982	62.03800	14173318	14517.9071
740	Iraq	Asia	1987	65.04400	16543189	11643.5727
741	Iraq	Asia	1992	59.46100	17861905	3745.6407
742	Iraq	Asia	1997	58.81100	20775703	3076.2398
743	Iraq	Asia	2002	57.04600	24001816	4390.7173
744	Iraq	Asia	2007	59.54500	27499638	4471.0619

745	Ireland	Europe	1952	66.91000	2952156	5210.2803
746	Ireland	Europe	1957	68.90000	2878220	5599.0779
747	Ireland	Europe	1962	70.29000	2830000	6631.5973
748	Ireland	Europe	1967	71.08000	2900100	7655.5690
749	Ireland	Europe	1972	71.28000	3024400	9530.7729
750	Ireland	Europe	1977	72.03000	3271900	11150.9811
751	Ireland	Europe	1982	73.10000	3480000	12618.3214
752	Ireland	Europe	1987	74.36000	3539900	13872.8665
753	Ireland	Europe	1992	75.46700	3557761	17558.8155
754	Ireland	Europe	1997	76.12200	3667233	24521.9471
755	Ireland	Europe	2002	77.78300	3879155	34077.0494
756	Ireland	Europe	2007	78.88500	4109086	40675.9964
757	Israel	Asia	1952	65.39000	1620914	4086.5221
758	Israel	Asia	1957	67.84000	1944401	5385.2785
759	Israel	Asia	1962	69.39000	2310904	7105.6307
760	Israel	Asia	1967	70.75000	2693585	8393.7414
761	Israel	Asia	1972	71.63000	3095893	12786.9322
762	Israel	Asia	1977	73.06000	3495918	13306.6192
763	Israel	Asia	1982	74.45000	3858421	15367.0292
764	Israel	Asia	1987	75.60000	4203148	17122.4799
765	Israel	Asia	1992	76.93000	4936550	18051.5225
766	Israel	Asia	1997	78.26900	5531387	20896.6092
767	Israel	Asia	2002	79.69600	6029529	21905.5951
768	Israel	Asia	2007	80.74500	6426679	25523.2771
769	Italy	Europe	1952	65.94000	47666000	4931.4042
770	Italy	Europe	1957	67.81000	49182000	6248.6562
771	Italy	Europe	1962	69.24000	50843200	8243.5823
772	Italy	Europe	1967	71.06000	52667100	10022.4013
773	Italy	Europe	1972	72.19000	54365564	12269.2738
774	Italy	Europe	1977	73.48000	56059245	14255.9847
775	Italy	Europe	1982	74.98000	56535636	16537.4835
776	Italy	Europe	1987	76.42000	56729703	19207.2348
777	Italy	Europe	1992	77.44000	56840847	22013.6449
778	Italy	Europe	1997	78.82000	57479469	24675.0245
779	Italy	Europe	2002	80.24000	57926999	27968.0982
780	Italy	Europe	2007	80.54600	58147733	28569.7197
781	Jamaica	Americas	1952	58.53000	1426095	2898.5309
782	Jamaica	Americas	1957	62.61000	1535090	4756.5258
783	Jamaica	Americas	1962	65.61000	1665128	5246.1075
784	Jamaica	Americas	1967	67.51000	1861096	6124.7035
785	Jamaica	Americas	1972	69.00000	1997616	7433.8893
786	Jamaica	Americas	1977	70.11000	2156814	6650.1956
787	Jamaica	Americas	1982	71.21000	2298309	6068.0513

788	Jamaica	Americas	1987	71.77000	2326606	6351.2375
789	Jamaica	Americas	1992	71.76600	2378618	7404.9237
790	Jamaica	Americas	1997	72.26200	2531311	7121.9247
791	Jamaica	Americas	2002	72.04700	2664659	6994.7749
792	Jamaica	Americas	2007	72.56700	2780132	7320.8803
793	Japan	Asia	1952	63.03000	86459025	3216.9563
794	Japan	Asia	1957	65.50000	91563009	4317.6944
795	Japan	Asia	1962	68.73000	95831757	6576.6495
796	Japan	Asia	1967	71.43000	100825279	9847.7886
797	Japan	Asia	1972	73.42000	107188273	14778.7864
798	Japan	Asia	1977	75.38000	113872473	16610.3770
799	Japan	Asia	1982	77.11000	118454974	19384.1057
800	Japan	Asia	1987	78.67000	122091325	22375.9419
801	Japan	Asia	1992	79.36000	124329269	26824.8951
802	Japan	Asia	1997	80.69000	125956499	28816.5850
803	Japan	Asia	2002	82.00000	127065841	28604.5919
804	Japan	Asia	2007	82.60300	127467972	31656.0681
805	Jordan	Asia	1952	43.15800	607914	1546.9078
806	Jordan	Asia	1957	45.66900	746559	1886.0806
807	Jordan	Asia	1962	48.12600	933559	2348.0092
808	Jordan	Asia	1967	51.62900	1255058	2741.7963
809	Jordan	Asia	1972	56.52800	1613551	2110.8563
810	Jordan	Asia	1977	61.13400	1937652	2852.3516
811	Jordan	Asia	1982	63.73900	2347031	4161.4160
812	Jordan	Asia	1987	65.86900	2820042	4448.6799
813	Jordan	Asia	1992	68.01500	3867409	3431.5936
814	Jordan	Asia	1997	69.77200	4526235	3645.3796
815	Jordan	Asia	2002	71.26300	5307470	3844.9172
816	Jordan	Asia	2007	72.53500	6053193	4519.4612
817	Kenya	Africa	1952	42.27000	6464046	853.5409
818	Kenya	Africa	1957	44.68600	7454779	944.4383
819	Kenya	Africa	1962	47.94900	8678557	896.9664
820	Kenya	Africa	1967	50.65400	10191512	1056.7365
821	Kenya	Africa	1972	53.55900	12044785	1222.3600
822	Kenya	Africa	1977	56.15500	14500404	1267.6132
823	Kenya	Africa	1982	58.76600	17661452	1348.2258
824	Kenya	Africa	1987	59.33900	21198082	1361.9369
825	Kenya	Africa	1992	59.28500	25020539	1341.9217
826	Kenya	Africa	1997	54.40700	28263827	1360.4850
827	Kenya	Africa	2002	50.99200	31386842	1287.5147
828	Kenya	Africa	2007	54.11000	35610177	1463.2493
829	Korea, Dem. Rep.	Asia	1952	50.05600	8865488	1088.2778
830	Korea, Dem. Rep.	Asia	1957	54.08100	9411381	1571.1347

831	Korea, Dem. Rep.	Asia	1962	56.65600	10917494	1621.6936
832	Korea, Dem. Rep.	Asia	1967	59.94200	12617009	2143.5406
833	Korea, Dem. Rep.	Asia	1972	63.98300	14781241	3701.6215
834	Korea, Dem. Rep.	Asia	1977	67.15900	16325320	4106.3012
835	Korea, Dem. Rep.	Asia	1982	69.10000	17647518	4106.5253
836	Korea, Dem. Rep.	Asia	1987	70.64700	19067554	4106.4923
837	Korea, Dem. Rep.	Asia	1992	69.97800	20711375	3726.0635
838	Korea, Dem. Rep.	Asia	1997	67.72700	21585105	1690.7568
839	Korea, Dem. Rep.	Asia	2002	66.66200	22215365	1646.7582
840	Korea, Dem. Rep.	Asia	2007	67.29700	23301725	1593.0655
841	Korea, Rep.	Asia	1952	47.45300	20947571	1030.5922
842	Korea, Rep.	Asia	1957	52.68100	22611552	1487.5935
843	Korea, Rep.	Asia	1962	55.29200	26420307	1536.3444
844	Korea, Rep.	Asia	1967	57.71600	30131000	2029.2281
845	Korea, Rep.	Asia	1972	62.61200	33505000	3030.8767
846	Korea, Rep.	Asia	1977	64.76600	36436000	4657.2210
847	Korea, Rep.	Asia	1982	67.12300	39326000	5622.9425
848	Korea, Rep.	Asia	1987	69.81000	41622000	8533.0888
849	Korea, Rep.	Asia	1992	72.24400	43805450	12104.2787
850	Korea, Rep.	Asia	1997	74.64700	46173816	15993.5280
851	Korea, Rep.	Asia	2002	77.04500	47969150	19233.9882
852	Korea, Rep.	Asia	2007	78.62300	49044790	23348.1397
853	Kuwait	Asia	1952	55.56500	160000	108382.3529
854	Kuwait	Asia	1957	58.03300	212846	113523.1329
855	Kuwait	Asia	1962	60.47000	358266	95458.1118
856	Kuwait	Asia	1967	64.62400	575003	80894.8833
857	Kuwait	Asia	1972	67.71200	841934	109347.8670
858	Kuwait	Asia	1977	69.34300	1140357	59265.4771
859	Kuwait	Asia	1982	71.30900	1497494	31354.0357
860	Kuwait	Asia	1987	74.17400	1891487	28118.4300
861	Kuwait	Asia	1992	75.19000	1418095	34932.9196
862	Kuwait	Asia	1997	76.15600	1765345	40300.6200
863	Kuwait	Asia	2002	76.90400	2111561	35110.1057
864	Kuwait	Asia	2007	77.58800	2505559	47306.9898
865	Lebanon	Asia	1952	55.92800	1439529	4834.8041
866	Lebanon	Asia	1957	59.48900	1647412	6089.7869
867	Lebanon	Asia	1962	62.09400	1886848	5714.5606
868	Lebanon	Asia	1967	63.87000	2186894	6006.9830
869	Lebanon	Asia	1972	65.42100	2680018	7486.3843
870	Lebanon	Asia	1977	66.09900	3115787	8659.6968
871	Lebanon	Asia	1982	66.98300	3086876	7640.5195
872	Lebanon	Asia	1987	67.92600	3089353	5377.0913
873	Lebanon	Asia	1992	69.29200	3219994	6890.8069

874	Lebanon	Asia	1997	70.26500	3430388	8754.9639
875	Lebanon	Asia	2002	71.02800	3677780	9313.9388
876	Lebanon	Asia	2007	71.99300	3921278	10461.0587
877	Lesotho	Africa	1952	42.13800	748747	298.8462
878	Lesotho	Africa	1957	45.04700	813338	335.9971
879	Lesotho	Africa	1962	47.74700	893143	411.8006
880	Lesotho	Africa	1967	48.49200	996380	498.6390
881	Lesotho	Africa	1972	49.76700	1116779	496.5816
882	Lesotho	Africa	1977	52.20800	1251524	745.3695
883	Lesotho	Africa	1982	55.07800	1411807	797.2631
884	Lesotho	Africa	1987	57.18000	1599200	773.9932
885	Lesotho	Africa	1992	59.68500	1803195	977.4863
886	Lesotho	Africa	1997	55.55800	1982823	1186.1480
887	Lesotho	Africa	2002	44.59300	2046772	1275.1846
888	Lesotho	Africa	2007	42.59200	2012649	1569.3314
889	Liberia	Africa	1952	38.48000	863308	575.5730
890	Liberia	Africa	1957	39.48600	975950	620.9700
891	Liberia	Africa	1962	40.50200	1112796	634.1952
892	Liberia	Africa	1967	41.53600	1279406	713.6036
893	Liberia	Africa	1972	42.61400	1482628	803.0055
894	Liberia	Africa	1977	43.76400	1703617	640.3224
895	Liberia	Africa	1982	44.85200	1956875	572.1996
896	Liberia	Africa	1987	46.02700	2269414	506.1139
897	Liberia	Africa	1992	40.80200	1912974	636.6229
898	Liberia	Africa	1997	42.22100	2200725	609.1740
899	Liberia	Africa	2002	43.75300	2814651	531.4824
900	Liberia	Africa	2007	45.67800	3193942	414.5073
901	Libya	Africa	1952	42.72300	1019729	2387.5481
902	Libya	Africa	1957	45.28900	1201578	3448.2844
903	Libya	Africa	1962	47.80800	1441863	6757.0308
904	Libya	Africa	1967	50.22700	1759224	18772.7517
905	Libya	Africa	1972	52.77300	2183877	21011.4972
906	Libya	Africa	1977	57.44200	2721783	21951.2118
907	Libya	Africa	1982	62.15500	3344074	17364.2754
908	Libya	Africa	1987	66.23400	3799845	11770.5898
909	Libya	Africa	1992	68.75500	4364501	9640.1385
910	Libya	Africa	1997	71.55500	4759670	9467.4461
911	Libya	Africa	2002	72.73700	5368585	9534.6775
912	Libya	Africa	2007	73.95200	6036914	12057.4993
913	Madagascar	Africa	1952	36.68100	4762912	1443.0117
914	Madagascar	Africa	1957	38.86500	5181679	1589.2027
915	Madagascar	Africa	1962	40.84800	5703324	1643.3871
916	Madagascar	Africa	1967	42.88100	6334556	1634.0473

917	Madagascar	Africa	1972	44.85100	7082430	1748.5630
918	Madagascar	Africa	1977	46.88100	8007166	1544.2286
919	Madagascar	Africa	1982	48.96900	9171477	1302.8787
920	Madagascar	Africa	1987	49.35000	10568642	1155.4419
921	Madagascar	Africa	1992	52.21400	12210395	1040.6762
922	Madagascar	Africa	1997	54.97800	14165114	986.2959
923	Madagascar	Africa	2002	57.28600	16473477	894.6371
924	Madagascar	Africa	2007	59.44300	19167654	1044.7701
925	Malawi	Africa	1952	36.25600	2917802	369.1651
926	Malawi	Africa	1957	37.20700	3221238	416.3698
927	Malawi	Africa	1962	38.41000	3628608	427.9011
928	Malawi	Africa	1967	39.48700	4147252	495.5148
929	Malawi	Africa	1972	41.76600	4730997	584.6220
930	Malawi	Africa	1977	43.76700	5637246	663.2237
931	Malawi	Africa	1982	45.64200	6502825	632.8039
932	Malawi	Africa	1987	47.45700	7824747	635.5174
933	Malawi	Africa	1992	49.42000	10014249	563.2000
934	Malawi	Africa	1997	47.49500	10419991	692.2758
935	Malawi	Africa	2002	45.00900	11824495	665.4231
936	Malawi	Africa	2007	48.30300	13327079	759.3499
937	Malaysia	Asia	1952	48.46300	6748378	1831.1329
938	Malaysia	Asia	1957	52.10200	7739235	1810.0670
939	Malaysia	Asia	1962	55.73700	8906385	2036.8849
940	Malaysia	Asia	1967	59.37100	10154878	2277.7424
941	Malaysia	Asia	1972	63.01000	11441462	2849.0948
942	Malaysia	Asia	1977	65.25600	12845381	3827.9216
943	Malaysia	Asia	1982	68.00000	14441916	4920.3560
944	Malaysia	Asia	1987	69.50000	16331785	5249.8027
945	Malaysia	Asia	1992	70.69300	18319502	7277.9128
946	Malaysia	Asia	1997	71.93800	20476091	10132.9096
947	Malaysia	Asia	2002	73.04400	22662365	10206.9779
948	Malaysia	Asia	2007	74.24100	24821286	12451.6558
949	Mali	Africa	1952	33.68500	3838168	452.3370
950	Mali	Africa	1957	35.30700	4241884	490.3822
951	Mali	Africa	1962	36.93600	4690372	496.1743
952	Mali	Africa	1967	38.48700	5212416	545.0099
953	Mali	Africa	1972	39.97700	5828158	581.3689
954	Mali	Africa	1977	41.71400	6491649	686.3953
955	Mali	Africa	1982	43.91600	6998256	618.0141
956	Mali	Africa	1987	46.36400	7634008	684.1716
957	Mali	Africa	1992	48.38800	8416215	739.0144
958	Mali	Africa	1997	49.90300	9384984	790.2580
959	Mali	Africa	2002	51.81800	10580176	951.4098

960	Mali	Africa	2007	54.46700	12031795	1042.5816
961	Mauritania	Africa	1952	40.54300	1022556	743.1159
962	Mauritania	Africa	1957	42.33800	1076852	846.1203
963	Mauritania	Africa	1962	44.24800	1146757	1055.8960
964	Mauritania	Africa	1967	46.28900	1230542	1421.1452
965	Mauritania	Africa	1972	48.43700	1332786	1586.8518
966	Mauritania	Africa	1977	50.85200	1456688	1497.4922
967	Mauritania	Africa	1982	53.59900	1622136	1481.1502
968	Mauritania	Africa	1987	56.14500	1841240	1421.6036
969	Mauritania	Africa	1992	58.33300	2119465	1361.3698
970	Mauritania	Africa	1997	60.43000	2444741	1483.1361
971	Mauritania	Africa	2002	62.24700	2828858	1579.0195
972	Mauritania	Africa	2007	64.16400	3270065	1803.1515
973	Mauritius	Africa	1952	50.98600	516556	1967.9557
974	Mauritius	Africa	1957	58.08900	609816	2034.0380
975	Mauritius	Africa	1962	60.24600	701016	2529.0675
976	Mauritius	Africa	1967	61.55700	789309	2475.3876
977	Mauritius	Africa	1972	62.94400	851334	2575.4842
978	Mauritius	Africa	1977	64.93000	913025	3710.9830
979	Mauritius	Africa	1982	66.71100	992040	3688.0377
980	Mauritius	Africa	1987	68.74000	1042663	4783.5869
981	Mauritius	Africa	1992	69.74500	1096202	6058.2538
982	Mauritius	Africa	1997	70.73600	1149818	7425.7053
983	Mauritius	Africa	2002	71.95400	1200206	9021.8159
984	Mauritius	Africa	2007	72.80100	1250882	10956.9911
985	Mexico	Americas	1952	50.78900	30144317	3478.1255
986	Mexico	Americas	1957	55.19000	35015548	4131.5466
987	Mexico	Americas	1962	58.29900	41121485	4581.6094
988	Mexico	Americas	1967	60.11000	47995559	5754.7339
989	Mexico	Americas	1972	62.36100	55984294	6809.4067
990	Mexico	Americas	1977	65.03200	63759976	7674.9291
991	Mexico	Americas	1982	67.40500	71640904	9611.1475
992	Mexico	Americas	1987	69.49800	80122492	8688.1560
993	Mexico	Americas	1992	71.45500	88111030	9472.3843
994	Mexico	Americas	1997	73.67000	95895146	9767.2975
995	Mexico	Americas	2002	74.90200	102479927	10742.4405
996	Mexico	Americas	2007	76.19500	108700891	11977.5750
997	Mongolia	Asia	1952	42.24400	800663	786.5669
998	Mongolia	Asia	1957	45.24800	882134	912.6626
999	Mongolia	Asia	1962	48.25100	1010280	1056.3540
1000	Mongolia	Asia	1967	51.25300	1149500	1226.0411
1001	Mongolia	Asia	1972	53.75400	1320500	1421.7420
1002	Mongolia	Asia	1977	55.49100	1528000	1647.5117

1003	Mongolia	Asia	1982	57.48900	1756032	2000.6031
1004	Mongolia	Asia	1987	60.22200	2015133	2338.0083
1005	Mongolia	Asia	1992	61.27100	2312802	1785.4020
1006	Mongolia	Asia	1997	63.62500	2494803	1902.2521
1007	Mongolia	Asia	2002	65.03300	2674234	2140.7393
1008	Mongolia	Asia	2007	66.80300	2874127	3095.7723
1009	Montenegro	Europe	1952	59.16400	413834	2647.5856
1010	Montenegro	Europe	1957	61.44800	442829	3682.2599
1011	Montenegro	Europe	1962	63.72800	474528	4649.5938
1012	Montenegro	Europe	1967	67.17800	501035	5907.8509
1013	Montenegro	Europe	1972	70.63600	527678	7778.4140
1014	Montenegro	Europe	1977	73.06600	560073	9595.9299
1015	Montenegro	Europe	1982	74.10100	562548	11222.5876
1016	Montenegro	Europe	1987	74.86500	569473	11732.5102
1017	Montenegro	Europe	1992	75.43500	621621	7003.3390
1018	Montenegro	Europe	1997	75.44500	692651	6465.6133
1019	Montenegro	Europe	2002	73.98100	720230	6557.1943
1020	Montenegro	Europe	2007	74.54300	684736	9253.8961
1021	Morocco	Africa	1952	42.87300	9939217	1688.2036
1022	Morocco	Africa	1957	45.42300	11406350	1642.0023
1023	Morocco	Africa	1962	47.92400	13056604	1566.3535
1024	Morocco	Africa	1967	50.33500	14770296	1711.0448
1025	Morocco	Africa	1972	52.86200	16660670	1930.1950
1026	Morocco	Africa	1977	55.73000	18396941	2370.6200
1027	Morocco	Africa	1982	59.65000	20198730	2702.6204
1028	Morocco	Africa	1987	62.67700	22987397	2755.0470
1029	Morocco	Africa	1992	65.39300	25798239	2948.0473
1030	Morocco	Africa	1997	67.66000	28529501	2982.1019
1031	Morocco	Africa	2002	69.61500	31167783	3258.4956
1032	Morocco	Africa	2007	71.16400	33757175	3820.1752
1033	Mozambique	Africa	1952	31.28600	6446316	468.5260
1034	Mozambique	Africa	1957	33.77900	7038035	495.5868
1035	Mozambique	Africa	1962	36.16100	7788944	556.6864
1036	Mozambique	Africa	1967	38.11300	8680909	566.6692
1037	Mozambique	Africa	1972	40.32800	9809596	724.9178
1038	Mozambique	Africa	1977	42.49500	11127868	502.3197
1039	Mozambique	Africa	1982	42.79500	12587223	462.2114
1040	Mozambique	Africa	1987	42.86100	12891952	389.8762
1041	Mozambique	Africa	1992	44.28400	13160731	410.8968
1042	Mozambique	Africa	1997	46.34400	16603334	472.3461
1043	Mozambique	Africa	2002	44.02600	18473780	633.6179
1044	Mozambique	Africa	2007	42.08200	19951656	823.6856
1045	Myanmar	Asia	1952	36.31900	20092996	331.0000

1046	Myanmar	Asia	1957	41.90500	21731844	350.0000
1047	Myanmar	Asia	1962	45.10800	23634436	388.0000
1048	Myanmar	Asia	1967	49.37900	25870271	349.0000
1049	Myanmar	Asia	1972	53.07000	28466390	357.0000
1050	Myanmar	Asia	1977	56.05900	31528087	371.0000
1051	Myanmar	Asia	1982	58.05600	34680442	424.0000
1052	Myanmar	Asia	1987	58.33900	38028578	385.0000
1053	Myanmar	Asia	1992	59.32000	40546538	347.0000
1054	Myanmar	Asia	1997	60.32800	43247867	415.0000
1055	Myanmar	Asia	2002	59.90800	45598081	611.0000
1056	Myanmar	Asia	2007	62.06900	47761980	944.0000
1057	Namibia	Africa	1952	41.72500	485831	2423.7804
1058	Namibia	Africa	1957	45.22600	548080	2621.4481
1059	Namibia	Africa	1962	48.38600	621392	3173.2156
1060	Namibia	Africa	1967	51.15900	706640	3793.6948
1061	Namibia	Africa	1972	53.86700	821782	3746.0809
1062	Namibia	Africa	1977	56.43700	977026	3876.4860
1063	Namibia	Africa	1982	58.96800	1099010	4191.1005
1064	Namibia	Africa	1987	60.83500	1278184	3693.7313
1065	Namibia	Africa	1992	61.99900	1554253	3804.5380
1066	Namibia	Africa	1997	58.90900	1774766	3899.5243
1067	Namibia	Africa	2002	51.47900	1972153	4072.3248
1068	Namibia	Africa	2007	52.90600	2055080	4811.0604
1069	Nepal	Asia	1952	36.15700	9182536	545.8657
1070	Nepal	Asia	1957	37.68600	9682338	597.9364
1071	Nepal	Asia	1962	39.39300	10332057	652.3969
1072	Nepal	Asia	1967	41.47200	11261690	676.4422
1073	Nepal	Asia	1972	43.97100	12412593	674.7881
1074	Nepal	Asia	1977	46.74800	13933198	694.1124
1075	Nepal	Asia	1982	49.59400	15796314	718.3731
1076	Nepal	Asia	1987	52.53700	17917180	775.6325
1077	Nepal	Asia	1992	55.72700	20326209	897.7404
1078	Nepal	Asia	1997	59.42600	23001113	1010.8921
1079	Nepal	Asia	2002	61.34000	25873917	1057.2063
1080	Nepal	Asia	2007	63.78500	28901790	1091.3598
1081	Netherlands	Europe	1952	72.13000	10381988	8941.5719
1082	Netherlands	Europe	1957	72.99000	11026383	11276.1934
1083	Netherlands	Europe	1962	73.23000	11805689	12790.8496
1084	Netherlands	Europe	1967	73.82000	12596822	15363.2514
1085	Netherlands	Europe	1972	73.75000	13329874	18794.7457
1086	Netherlands	Europe	1977	75.24000	13852989	21209.0592
1087	Netherlands	Europe	1982	76.05000	14310401	21399.4605
1088	Netherlands	Europe	1987	76.83000	14665278	23651.3236

1089	Netherlands	Europe	1992	77.42000	15174244	26790.9496
1090	Netherlands	Europe	1997	78.03000	15604464	30246.1306
1091	Netherlands	Europe	2002	78.53000	16122830	33724.7578
1092	Netherlands	Europe	2007	79.76200	16570613	36797.9333
1093	New Zealand	Oceania	1952	69.39000	1994794	10556.5757
1094	New Zealand	Oceania	1957	70.26000	2229407	12247.3953
1095	New Zealand	Oceania	1962	71.24000	2488550	13175.6780
1096	New Zealand	Oceania	1967	71.52000	2728150	14463.9189
1097	New Zealand	Oceania	1972	71.89000	2929100	16046.0373
1098	New Zealand	Oceania	1977	72.22000	3164900	16233.7177
1099	New Zealand	Oceania	1982	73.84000	3210650	17632.4104
1100	New Zealand	Oceania	1987	74.32000	3317166	19007.1913
1101	New Zealand	Oceania	1992	76.33000	3437674	18363.3249
1102	New Zealand	Oceania	1997	77.55000	3676187	21050.4138
1103	New Zealand	Oceania	2002	79.11000	3908037	23189.8014
1104	New Zealand	Oceania	2007	80.20400	4115771	25185.0091
1105	Nicaragua	Americas	1952	42.31400	1165790	3112.3639
1106	Nicaragua	Americas	1957	45.43200	1358828	3457.4159
1107	Nicaragua	Americas	1962	48.63200	1590597	3634.3644
1108	Nicaragua	Americas	1967	51.88400	1865490	4643.3935
1109	Nicaragua	Americas	1972	55.15100	2182908	4688.5933
1110	Nicaragua	Americas	1977	57.47000	2554598	5486.3711
1111	Nicaragua	Americas	1982	59.29800	2979423	3470.3382
1112	Nicaragua	Americas	1987	62.00800	3344353	2955.9844
1113	Nicaragua	Americas	1992	65.84300	4017939	2170.1517
1114	Nicaragua	Americas	1997	68.42600	4609572	2253.0230
1115	Nicaragua	Americas	2002	70.83600	5146848	2474.5488
1116	Nicaragua	Americas	2007	72.89900	5675356	2749.3210
1117	Niger	Africa	1952	37.44400	3379468	761.8794
1118	Niger	Africa	1957	38.59800	3692184	835.5234
1119	Niger	Africa	1962	39.48700	4076008	997.7661
1120	Niger	Africa	1967	40.11800	4534062	1054.3849
1121	Niger	Africa	1972	40.54600	5060262	954.2092
1122	Niger	Africa	1977	41.29100	5682086	808.8971
1123	Niger	Africa	1982	42.59800	6437188	909.7221
1124	Niger	Africa	1987	44.55500	7332638	668.3000
1125	Niger	Africa	1992	47.39100	8392818	581.1827
1126	Niger	Africa	1997	51.31300	9666252	580.3052
1127	Niger	Africa	2002	54.49600	11140655	601.0745
1128	Niger	Africa	2007	56.86700	12894865	619.6769
1129	Nigeria	Africa	1952	36.32400	33119096	1077.2819
1130	Nigeria	Africa	1957	37.80200	37173340	1100.5926
1131	Nigeria	Africa	1962	39.36000	41871351	1150.9275

1132	Nigeria	Africa	1967	41.04000	47287752	1014.5141
1133	Nigeria	Africa	1972	42.82100	53740085	1698.3888
1134	Nigeria	Africa	1977	44.51400	62209173	1981.9518
1135	Nigeria	Africa	1982	45.82600	73039376	1576.9738
1136	Nigeria	Africa	1987	46.88600	81551520	1385.0296
1137	Nigeria	Africa	1992	47.47200	93364244	1619.8482
1138	Nigeria	Africa	1997	47.46400	106207839	1624.9413
1139	Nigeria	Africa	2002	46.60800	119901274	1615.2864
1140	Nigeria	Africa	2007	46.85900	135031164	2013.9773
1141	Norway	Europe	1952	72.67000	3327728	10095.4217
1142	Norway	Europe	1957	73.44000	3491938	11653.9730
1143	Norway	Europe	1962	73.47000	3638919	13450.4015
1144	Norway	Europe	1967	74.08000	3786019	16361.8765
1145	Norway	Europe	1972	74.34000	3933004	18965.0555
1146	Norway	Europe	1977	75.37000	4043205	23311.3494
1147	Norway	Europe	1982	75.97000	4114787	26298.6353
1148	Norway	Europe	1987	75.89000	4186147	31540.9748
1149	Norway	Europe	1992	77.32000	4286357	33965.6611
1150	Norway	Europe	1997	78.32000	4405672	41283.1643
1151	Norway	Europe	2002	79.05000	4535591	44683.9753
1152	Norway	Europe	2007	80.19600	4627926	49357.1902
1153	Oman	Asia	1952	37.57800	507833	1828.2303
1154	Oman	Asia	1957	40.08000	561977	2242.7466
1155	Oman	Asia	1962	43.16500	628164	2924.6381
1156	Oman	Asia	1967	46.98800	714775	4720.9427
1157	Oman	Asia	1972	52.14300	829050	10618.0385
1158	Oman	Asia	1977	57.36700	1004533	11848.3439
1159	Oman	Asia	1982	62.72800	1301048	12954.7910
1160	Oman	Asia	1987	67.73400	1593882	18115.2231
1161	Oman	Asia	1992	71.19700	1915208	18616.7069
1162	Oman	Asia	1997	72.49900	2283635	19702.0558
1163	Oman	Asia	2002	74.19300	2713462	19774.8369
1164	Oman	Asia	2007	75.64000	3204897	22316.1929
1165	Pakistan	Asia	1952	43.43600	41346560	684.5971
1166	Pakistan	Asia	1957	45.55700	46679944	747.0835
1167	Pakistan	Asia	1962	47.67000	53100671	803.3427
1168	Pakistan	Asia	1967	49.80000	60641899	942.4083
1169	Pakistan	Asia	1972	51.92900	69325921	1049.9390
1170	Pakistan	Asia	1977	54.04300	78152686	1175.9212
1171	Pakistan	Asia	1982	56.15800	91462088	1443.4298
1172	Pakistan	Asia	1987	58.24500	105186881	1704.6866
1173	Pakistan	Asia	1992	60.83800	120065004	1971.8295
1174	Pakistan	Asia	1997	61.81800	135564834	2049.3505

1175	Pakistan	Asia	2002	63.61000	153403524	2092.7124
1176	Pakistan	Asia	2007	65.48300	169270617	2605.9476
1177	Panama	Americas	1952	55.19100	940080	2480.3803
1178	Panama	Americas	1957	59.20100	1063506	2961.8009
1179	Panama	Americas	1962	61.81700	1215725	3536.5403
1180	Panama	Americas	1967	64.07100	1405486	4421.0091
1181	Panama	Americas	1972	66.21600	1616384	5364.2497
1182	Panama	Americas	1977	68.68100	1839782	5351.9121
1183	Panama	Americas	1982	70.47200	2036305	7009.6016
1184	Panama	Americas	1987	71.52300	2253639	7034.7792
1185	Panama	Americas	1992	72.46200	2484997	6618.7431
1186	Panama	Americas	1997	73.73800	2734531	7113.6923
1187	Panama	Americas	2002	74.71200	2990875	7356.0319
1188	Panama	Americas	2007	75.53700	3242173	9809.1856
1189	Paraguay	Americas	1952	62.64900	1555876	1952.3087
1190	Paraguay	Americas	1957	63.19600	1770902	2046.1547
1191	Paraguay	Americas	1962	64.36100	2009813	2148.0271
1192	Paraguay	Americas	1967	64.95100	2287985	2299.3763
1193	Paraguay	Americas	1972	65.81500	2614104	2523.3380
1194	Paraguay	Americas	1977	66.35300	2984494	3248.3733
1195	Paraguay	Americas	1982	66.87400	3366439	4258.5036
1196	Paraguay	Americas	1987	67.37800	3886512	3998.8757
1197	Paraguay	Americas	1992	68.22500	4483945	4196.4111
1198	Paraguay	Americas	1997	69.40000	5154123	4247.4003
1199	Paraguay	Americas	2002	70.75500	5884491	3783.6742
1200	Paraguay	Americas	2007	71.75200	6667147	4172.8385
1201	Peru	Americas	1952	43.90200	8025700	3758.5234
1202	Peru	Americas	1957	46.26300	9146100	4245.2567
1203	Peru	Americas	1962	49.09600	10516500	4957.0380
1204	Peru	Americas	1967	51.44500	12132200	5788.0933
1205	Peru	Americas	1972	55.44800	13954700	5937.8273
1206	Peru	Americas	1977	58.44700	15990099	6281.2909
1207	Peru	Americas	1982	61.40600	18125129	6434.5018
1208	Peru	Americas	1987	64.13400	20195924	6360.9434
1209	Peru	Americas	1992	66.45800	22430449	4446.3809
1210	Peru	Americas	1997	68.38600	24748122	5838.3477
1211	Peru	Americas	2002	69.90600	26769436	5909.0201
1212	Peru	Americas	2007	71.42100	28674757	7408.9056
1213	Philippines	Asia	1952	47.75200	22438691	1272.8810
1214	Philippines	Asia	1957	51.33400	26072194	1547.9448
1215	Philippines	Asia	1962	54.75700	30325264	1649.5522
1216	Philippines	Asia	1967	56.39300	35356600	1814.1274
1217	Philippines	Asia	1972	58.06500	40850141	1989.3741

1218	Philippines	Asia	1977	60.06000	46850962	2373.2043
1219	Philippines	Asia	1982	62.08200	53456774	2603.2738
1220	Philippines	Asia	1987	64.15100	60017788	2189.6350
1221	Philippines	Asia	1992	66.45800	67185766	2279.3240
1222	Philippines	Asia	1997	68.56400	75012988	2536.5349
1223	Philippines	Asia	2002	70.30300	82995088	2650.9211
1224	Philippines	Asia	2007	71.68800	91077287	3190.4810
1225	Poland	Europe	1952	61.31000	25730551	4029.3297
1226	Poland	Europe	1957	65.77000	28235346	4734.2530
1227	Poland	Europe	1962	67.64000	30329617	5338.7521
1228	Poland	Europe	1967	69.61000	31785378	6557.1528
1229	Poland	Europe	1972	70.85000	33039545	8006.5070
1230	Poland	Europe	1977	70.67000	34621254	9508.1415
1231	Poland	Europe	1982	71.32000	36227381	8451.5310
1232	Poland	Europe	1987	70.98000	37740710	9082.3512
1233	Poland	Europe	1992	70.99000	38370697	7738.8812
1234	Poland	Europe	1997	72.75000	38654957	10159.5837
1235	Poland	Europe	2002	74.67000	38625976	12002.2391
1236	Poland	Europe	2007	75.56300	38518241	15389.9247
1237	Portugal	Europe	1952	59.82000	8526050	3068.3199
1238	Portugal	Europe	1957	61.51000	8817650	3774.5717
1239	Portugal	Europe	1962	64.39000	9019800	4727.9549
1240	Portugal	Europe	1967	66.60000	9103000	6361.5180
1241	Portugal	Europe	1972	69.26000	8970450	9022.2474
1242	Portugal	Europe	1977	70.41000	9662600	10172.4857
1243	Portugal	Europe	1982	72.77000	9859650	11753.8429
1244	Portugal	Europe	1987	74.06000	9915289	13039.3088
1245	Portugal	Europe	1992	74.86000	9927680	16207.2666
1246	Portugal	Europe	1997	75.97000	10156415	17641.0316
1247	Portugal	Europe	2002	77.29000	10433867	19970.9079
1248	Portugal	Europe	2007	78.09800	10642836	20509.6478
1249	Puerto Rico	Americas	1952	64.28000	2227000	3081.9598
1250	Puerto Rico	Americas	1957	68.54000	2260000	3907.1562
1251	Puerto Rico	Americas	1962	69.62000	2448046	5108.3446
1252	Puerto Rico	Americas	1967	71.10000	2648961	6929.2777
1253	Puerto Rico	Americas	1972	72.16000	2847132	9123.0417
1254	Puerto Rico	Americas	1977	73.44000	3080828	9770.5249
1255	Puerto Rico	Americas	1982	73.75000	3279001	10330.9891
1256	Puerto Rico	Americas	1987	74.63000	3444468	12281.3419
1257	Puerto Rico	Americas	1992	73.91100	3585176	14641.5871
1258	Puerto Rico	Americas	1997	74.91700	3759430	16999.4333
1259	Puerto Rico	Americas	2002	77.77800	3859606	18855.6062
1260	Puerto Rico	Americas	2007	78.74600	3942491	19328.7090

1261	Reunion	Africa	1952	52.72400	257700	2718.8853
1262	Reunion	Africa	1957	55.09000	308700	2769.4518
1263	Reunion	Africa	1962	57.66600	358900	3173.7233
1264	Reunion	Africa	1967	60.54200	414024	4021.1757
1265	Reunion	Africa	1972	64.27400	461633	5047.6586
1266	Reunion	Africa	1977	67.06400	492095	4319.8041
1267	Reunion	Africa	1982	69.88500	517810	5267.2194
1268	Reunion	Africa	1987	71.91300	562035	5303.3775
1269	Reunion	Africa	1992	73.61500	622191	6101.2558
1270	Reunion	Africa	1997	74.77200	684810	6071.9414
1271	Reunion	Africa	2002	75.74400	743981	6316.1652
1272	Reunion	Africa	2007	76.44200	798094	7670.1226
1273	Romania	Europe	1952	61.05000	16630000	3144.6132
1274	Romania	Europe	1957	64.10000	17829327	3943.3702
1275	Romania	Europe	1962	66.80000	18680721	4734.9976
1276	Romania	Europe	1967	66.80000	19284814	6470.8665
1277	Romania	Europe	1972	69.21000	20662648	8011.4144
1278	Romania	Europe	1977	69.46000	21658597	9356.3972
1279	Romania	Europe	1982	69.66000	22356726	9605.3141
1280	Romania	Europe	1987	69.53000	22686371	9696.2733
1281	Romania	Europe	1992	69.36000	22797027	6598.4099
1282	Romania	Europe	1997	69.72000	22562458	7346.5476
1283	Romania	Europe	2002	71.32200	22404337	7885.3601
1284	Romania	Europe	2007	72.47600	22276056	10808.4756
1285	Rwanda	Africa	1952	40.00000	2534927	493.3239
1286	Rwanda	Africa	1957	41.50000	2822082	540.2894
1287	Rwanda	Africa	1962	43.00000	3051242	597.4731
1288	Rwanda	Africa	1967	44.10000	3451079	510.9637
1289	Rwanda	Africa	1972	44.60000	3992121	590.5807
1290	Rwanda	Africa	1977	45.00000	4657072	670.0806
1291	Rwanda	Africa	1982	46.21800	5507565	881.5706
1292	Rwanda	Africa	1987	44.02000	6349365	847.9912
1293	Rwanda	Africa	1992	23.59900	7290203	737.0686
1294	Rwanda	Africa	1997	36.08700	7212583	589.9445
1295	Rwanda	Africa	2002	43.41300	7852401	785.6538
1296	Rwanda	Africa	2007	46.24200	8860588	863.0885
1297	Sao Tome and Principe	Africa	1952	46.47100	60011	879.5836
1298	Sao Tome and Principe	Africa	1957	48.94500	61325	860.7369
1299	Sao Tome and Principe	Africa	1962	51.89300	65345	1071.5511
1300	Sao Tome and Principe	Africa	1967	54.42500	70787	1384.8406
1301	Sao Tome and Principe	Africa	1972	56.48000	76595	1532.9853
1302	Sao Tome and Principe	Africa	1977	58.55000	86796	1737.5617
1303	Sao Tome and Principe	Africa	1982	60.35100	98593	1890.2181

1304	Sao Tome and Principe	Africa	1987	61.72800	110812	1516.5255
1305	Sao Tome and Principe	Africa	1992	62.74200	125911	1428.7778
1306	Sao Tome and Principe	Africa	1997	63.30600	145608	1339.0760
1307	Sao Tome and Principe	Africa	2002	64.33700	170372	1353.0924
1308	Sao Tome and Principe	Africa	2007	65.52800	199579	1598.4351
1309	Saudi Arabia	Asia	1952	39.87500	4005677	6459.5548
1310	Saudi Arabia	Asia	1957	42.86800	4419650	8157.5912
1311	Saudi Arabia	Asia	1962	45.91400	4943029	11626.4197
1312	Saudi Arabia	Asia	1967	49.90100	5618198	16903.0489
1313	Saudi Arabia	Asia	1972	53.88600	6472756	24837.4287
1314	Saudi Arabia	Asia	1977	58.69000	8128505	34167.7626
1315	Saudi Arabia	Asia	1982	63.01200	11254672	33693.1753
1316	Saudi Arabia	Asia	1987	66.29500	14619745	21198.2614
1317	Saudi Arabia	Asia	1992	68.76800	16945857	24841.6178
1318	Saudi Arabia	Asia	1997	70.53300	21229759	20586.6902
1319	Saudi Arabia	Asia	2002	71.62600	24501530	19014.5412
1320	Saudi Arabia	Asia	2007	72.77700	27601038	21654.8319
1321	Senegal	Africa	1952	37.27800	2755589	1450.3570
1322	Senegal	Africa	1957	39.32900	3054547	1567.6530
1323	Senegal	Africa	1962	41.45400	3430243	1654.9887
1324	Senegal	Africa	1967	43.56300	3965841	1612.4046
1325	Senegal	Africa	1972	45.81500	4588696	1597.7121
1326	Senegal	Africa	1977	48.87900	5260855	1561.7691
1327	Senegal	Africa	1982	52.37900	6147783	1518.4800
1328	Senegal	Africa	1987	55.76900	7171347	1441.7207
1329	Senegal	Africa	1992	58.19600	8307920	1367.8994
1330	Senegal	Africa	1997	60.18700	9535314	1392.3683
1331	Senegal	Africa	2002	61.60000	10870037	1519.6353
1332	Senegal	Africa	2007	63.06200	12267493	1712.4721
1333	Serbia	Europe	1952	57.99600	6860147	3581.4594
1334	Serbia	Europe	1957	61.68500	7271135	4981.0909
1335	Serbia	Europe	1962	64.53100	7616060	6289.6292
1336	Serbia	Europe	1967	66.91400	7971222	7991.7071
1337	Serbia	Europe	1972	68.70000	8313288	10522.0675
1338	Serbia	Europe	1977	70.30000	8686367	12980.6696
1339	Serbia	Europe	1982	70.16200	9032824	15181.0927
1340	Serbia	Europe	1987	71.21800	9230783	15870.8785
1341	Serbia	Europe	1992	71.65900	9826397	9325.0682
1342	Serbia	Europe	1997	72.23200	10336594	7914.3203
1343	Serbia	Europe	2002	73.21300	10111559	7236.0753
1344	Serbia	Europe	2007	74.00200	10150265	9786.5347
1345	Sierra Leone	Africa	1952	30.33100	2143249	879.7877
1346	Sierra Leone	Africa	1957	31.57000	2295678	1004.4844

1347	Sierra Leone	Africa	1962	32.76700	2467895	1116.6399
1348	Sierra Leone	Africa	1967	34.11300	2662190	1206.0435
1349	Sierra Leone	Africa	1972	35.40000	2879013	1353.7598
1350	Sierra Leone	Africa	1977	36.78800	3140897	1348.2852
1351	Sierra Leone	Africa	1982	38.44500	3464522	1465.0108
1352	Sierra Leone	Africa	1987	40.00600	3868905	1294.4478
1353	Sierra Leone	Africa	1992	38.33300	4260884	1068.6963
1354	Sierra Leone	Africa	1997	39.89700	4578212	574.6482
1355	Sierra Leone	Africa	2002	41.01200	5359092	699.4897
1356	Sierra Leone	Africa	2007	42.56800	6144562	862.5408
1357	Singapore	Asia	1952	60.39600	1127000	2315.1382
1358	Singapore	Asia	1957	63.17900	1445929	2843.1044
1359	Singapore	Asia	1962	65.79800	1750200	3674.7356
1360	Singapore	Asia	1967	67.94600	1977600	4977.4185
1361	Singapore	Asia	1972	69.52100	2152400	8597.7562
1362	Singapore	Asia	1977	70.79500	2325300	11210.0895
1363	Singapore	Asia	1982	71.76000	2651869	15169.1611
1364	Singapore	Asia	1987	73.56000	2794552	18861.5308
1365	Singapore	Asia	1992	75.78800	3235865	24769.8912
1366	Singapore	Asia	1997	77.15800	3802309	33519.4766
1367	Singapore	Asia	2002	78.77000	4197776	36023.1054
1368	Singapore	Asia	2007	79.97200	4553009	47143.1796
1369	Slovak Republic	Europe	1952	64.36000	3558137	5074.6591
1370	Slovak Republic	Europe	1957	67.45000	3844277	6093.2630
1371	Slovak Republic	Europe	1962	70.33000	4237384	7481.1076
1372	Slovak Republic	Europe	1967	70.98000	4442238	8412.9024
1373	Slovak Republic	Europe	1972	70.35000	4593433	9674.1676
1374	Slovak Republic	Europe	1977	70.45000	4827803	10922.6640
1375	Slovak Republic	Europe	1982	70.80000	5048043	11348.5459
1376	Slovak Republic	Europe	1987	71.08000	5199318	12037.2676
1377	Slovak Republic	Europe	1992	71.38000	5302888	9498.4677
1378	Slovak Republic	Europe	1997	72.71000	5383010	12126.2306
1379	Slovak Republic	Europe	2002	73.80000	5410052	13638.7784
1380	Slovak Republic	Europe	2007	74.66300	5447502	18678.3144
1381	Slovenia	Europe	1952	65.57000	1489518	4215.0417
1382	Slovenia	Europe	1957	67.85000	1533070	5862.2766
1383	Slovenia	Europe	1962	69.15000	1582962	7402.3034
1384	Slovenia	Europe	1967	69.18000	1646912	9405.4894
1385	Slovenia	Europe	1972	69.82000	1694510	12383.4862
1386	Slovenia	Europe	1977	70.97000	1746919	15277.0302
1387	Slovenia	Europe	1982	71.06300	1861252	17866.7218
1388	Slovenia	Europe	1987	72.25000	1945870	18678.5349
1389	Slovenia	Europe	1992	73.64000	1999210	14214.7168

1390	Slovenia	Europe	1997	75.13000	2011612	17161.1073
1391	Slovenia	Europe	2002	76.66000	2011497	20660.0194
1392	Slovenia	Europe	2007	77.92600	2009245	25768.2576
1393	Somalia	Africa	1952	32.97800	2526994	1135.7498
1394	Somalia	Africa	1957	34.97700	2780415	1258.1474
1395	Somalia	Africa	1962	36.98100	3080153	1369.4883
1396	Somalia	Africa	1967	38.97700	3428839	1284.7332
1397	Somalia	Africa	1972	40.97300	3840161	1254.5761
1398	Somalia	Africa	1977	41.97400	4353666	1450.9925
1399	Somalia	Africa	1982	42.95500	5828892	1176.8070
1400	Somalia	Africa	1987	44.50100	6921858	1093.2450
1401	Somalia	Africa	1992	39.65800	6099799	926.9603
1402	Somalia	Africa	1997	43.79500	6633514	930.5964
1403	Somalia	Africa	2002	45.93600	7753310	882.0818
1404	Somalia	Africa	2007	48.15900	9118773	926.1411
1405	South Africa	Africa	1952	45.00900	14264935	4725.2955
1406	South Africa	Africa	1957	47.98500	16151549	5487.1042
1407	South Africa	Africa	1962	49.95100	18356657	5768.7297
1408	South Africa	Africa	1967	51.92700	20997321	7114.4780
1409	South Africa	Africa	1972	53.69600	23935810	7765.9626
1410	South Africa	Africa	1977	55.52700	27129932	8028.6514
1411	South Africa	Africa	1982	58.16100	31140029	8568.2662
1412	South Africa	Africa	1987	60.83400	35933379	7825.8234
1413	South Africa	Africa	1992	61.88800	39964159	7225.0693
1414	South Africa	Africa	1997	60.23600	42835005	7479.1882
1415	South Africa	Africa	2002	53.36500	44433622	7710.9464
1416	South Africa	Africa	2007	49.33900	43997828	9269.6578
1417	Spain	Europe	1952	64.94000	28549870	3834.0347
1418	Spain	Europe	1957	66.66000	29841614	4564.8024
1419	Spain	Europe	1962	69.69000	31158061	5693.8439
1420	Spain	Europe	1967	71.44000	32850275	7993.5123
1421	Spain	Europe	1972	73.06000	34513161	10638.7513
1422	Spain	Europe	1977	74.39000	36439000	13236.9212
1423	Spain	Europe	1982	76.30000	37983310	13926.1700
1424	Spain	Europe	1987	76.90000	38880702	15764.9831
1425	Spain	Europe	1992	77.57000	39549438	18603.0645
1426	Spain	Europe	1997	78.77000	39855442	20445.2990
1427	Spain	Europe	2002	79.78000	40152517	24835.4717
1428	Spain	Europe	2007	80.94100	40448191	28821.0637
1429	Sri Lanka	Asia	1952	57.59300	7982342	1083.5320
1430	Sri Lanka	Asia	1957	61.45600	9128546	1072.5466
1431	Sri Lanka	Asia	1962	62.19200	10421936	1074.4720
1432	Sri Lanka	Asia	1967	64.26600	11737396	1135.5143

1433	Sri Lanka	Asia	1972	65.04200	13016733	1213.3955
1434	Sri Lanka	Asia	1977	65.94900	14116836	1348.7757
1435	Sri Lanka	Asia	1982	68.75700	15410151	1648.0798
1436	Sri Lanka	Asia	1987	69.01100	16495304	1876.7668
1437	Sri Lanka	Asia	1992	70.37900	17587060	2153.7392
1438	Sri Lanka	Asia	1997	70.45700	18698655	2664.4773
1439	Sri Lanka	Asia	2002	70.81500	19576783	3015.3788
1440	Sri Lanka	Asia	2007	72.39600	20378239	3970.0954
1441	Sudan	Africa	1952	38.63500	8504667	1615.9911
1442	Sudan	Africa	1957	39.62400	9753392	1770.3371
1443	Sudan	Africa	1962	40.87000	11183227	1959.5938
1444	Sudan	Africa	1967	42.85800	12716129	1687.9976
1445	Sudan	Africa	1972	45.08300	14597019	1659.6528
1446	Sudan	Africa	1977	47.80000	17104986	2202.9884
1447	Sudan	Africa	1982	50.33800	20367053	1895.5441
1448	Sudan	Africa	1987	51.74400	24725960	1507.8192
1449	Sudan	Africa	1992	53.55600	28227588	1492.1970
1450	Sudan	Africa	1997	55.37300	32160729	1632.2108
1451	Sudan	Africa	2002	56.36900	37090298	1993.3983
1452	Sudan	Africa	2007	58.55600	42292929	2602.3950
1453	Swaziland	Africa	1952	41.40700	290243	1148.3766
1454	Swaziland	Africa	1957	43.42400	326741	1244.7084
1455	Swaziland	Africa	1962	44.99200	370006	1856.1821
1456	Swaziland	Africa	1967	46.63300	420690	2613.1017
1457	Swaziland	Africa	1972	49.55200	480105	3364.8366
1458	Swaziland	Africa	1977	52.53700	551425	3781.4106
1459	Swaziland	Africa	1982	55.56100	649901	3895.3840
1460	Swaziland	Africa	1987	57.67800	779348	3984.8398
1461	Swaziland	Africa	1992	58.47400	962344	3553.0224
1462	Swaziland	Africa	1997	54.28900	1054486	3876.7685
1463	Swaziland	Africa	2002	43.86900	1130269	4128.1169
1464	Swaziland	Africa	2007	39.61300	1133066	4513.4806
1465	Sweden	Europe	1952	71.86000	7124673	8527.8447
1466	Sweden	Europe	1957	72.49000	7363802	9911.8782
1467	Sweden	Europe	1962	73.37000	7561588	12329.4419
1468	Sweden	Europe	1967	74.16000	7867931	15258.2970
1469	Sweden	Europe	1972	74.72000	8122293	17832.0246
1470	Sweden	Europe	1977	75.44000	8251648	18855.7252
1471	Sweden	Europe	1982	76.42000	8325260	20667.3812
1472	Sweden	Europe	1987	77.19000	8421403	23586.9293
1473	Sweden	Europe	1992	78.16000	8718867	23880.0168
1474	Sweden	Europe	1997	79.39000	8897619	25266.5950
1475	Sweden	Europe	2002	80.04000	8954175	29341.6309

1476	Sweden	Europe	2007	80.88400	9031088	33859.7484
1477	Switzerland	Europe	1952	69.62000	4815000	14734.2327
1478	Switzerland	Europe	1957	70.56000	5126000	17909.4897
1479	Switzerland	Europe	1962	71.32000	5666000	20431.0927
1480	Switzerland	Europe	1967	72.77000	6063000	22966.1443
1481	Switzerland	Europe	1972	73.78000	6401400	27195.1130
1482	Switzerland	Europe	1977	75.39000	6316424	26982.2905
1483	Switzerland	Europe	1982	76.21000	6468126	28397.7151
1484	Switzerland	Europe	1987	77.41000	6649942	30281.7046
1485	Switzerland	Europe	1992	78.03000	6995447	31871.5303
1486	Switzerland	Europe	1997	79.37000	7193761	32135.3230
1487	Switzerland	Europe	2002	80.62000	7361757	34480.9577
1488	Switzerland	Europe	2007	81.70100	7554661	37506.4191
1489	Syria	Asia	1952	45.88300	3661549	1643.4854
1490	Syria	Asia	1957	48.28400	4149908	2117.2349
1491	Syria	Asia	1962	50.30500	4834621	2193.0371
1492	Syria	Asia	1967	53.65500	5680812	1881.9236
1493	Syria	Asia	1972	57.29600	6701172	2571.4230
1494	Syria	Asia	1977	61.19500	7932503	3195.4846
1495	Syria	Asia	1982	64.59000	9410494	3761.8377
1496	Syria	Asia	1987	66.97400	11242847	3116.7743
1497	Syria	Asia	1992	69.24900	13219062	3340.5428
1498	Syria	Asia	1997	71.52700	15081016	4014.2390
1499	Syria	Asia	2002	73.05300	17155814	4090.9253
1500	Syria	Asia	2007	74.14300	19314747	4184.5481
1501	Taiwan	Asia	1952	58.50000	8550362	1206.9479
1502	Taiwan	Asia	1957	62.40000	10164215	1507.8613
1503	Taiwan	Asia	1962	65.20000	11918938	1822.8790
1504	Taiwan	Asia	1967	67.50000	13648692	2643.8587
1505	Taiwan	Asia	1972	69.39000	15226039	4062.5239
1506	Taiwan	Asia	1977	70.59000	16785196	5596.5198
1507	Taiwan	Asia	1982	72.16000	18501390	7426.3548
1508	Taiwan	Asia	1987	73.40000	19757799	11054.5618
1509	Taiwan	Asia	1992	74.26000	20686918	15215.6579
1510	Taiwan	Asia	1997	75.25000	21628605	20206.8210
1511	Taiwan	Asia	2002	76.99000	22454239	23235.4233
1512	Taiwan	Asia	2007	78.40000	23174294	28718.2768
1513	Tanzania	Africa	1952	41.21500	8322925	716.6501
1514	Tanzania	Africa	1957	42.97400	9452826	698.5356
1515	Tanzania	Africa	1962	44.24600	10863958	722.0038
1516	Tanzania	Africa	1967	45.75700	12607312	848.2187
1517	Tanzania	Africa	1972	47.62000	14706593	915.9851
1518	Tanzania	Africa	1977	49.91900	17129565	962.4923

1519	Tanzania	Africa	1982	50.60800	19844382	874.2426
1520	Tanzania	Africa	1987	51.53500	23040630	831.8221
1521	Tanzania	Africa	1992	50.44000	26605473	825.6825
1522	Tanzania	Africa	1997	48.46600	30686889	789.1862
1523	Tanzania	Africa	2002	49.65100	34593779	899.0742
1524	Tanzania	Africa	2007	52.51700	38139640	1107.4822
1525	Thailand	Asia	1952	50.84800	21289402	757.7974
1526	Thailand	Asia	1957	53.63000	25041917	793.5774
1527	Thailand	Asia	1962	56.06100	29263397	1002.1992
1528	Thailand	Asia	1967	58.28500	34024249	1295.4607
1529	Thailand	Asia	1972	60.40500	39276153	1524.3589
1530	Thailand	Asia	1977	62.49400	44148285	1961.2246
1531	Thailand	Asia	1982	64.59700	48827160	2393.2198
1532	Thailand	Asia	1987	66.08400	52910342	2982.6538
1533	Thailand	Asia	1992	67.29800	56667095	4616.8965
1534	Thailand	Asia	1997	67.52100	60216677	5852.6255
1535	Thailand	Asia	2002	68.56400	62806748	5913.1875
1536	Thailand	Asia	2007	70.61600	65068149	7458.3963
1537	Togo	Africa	1952	38.59600	1219113	859.8087
1538	Togo	Africa	1957	41.20800	1357445	925.9083
1539	Togo	Africa	1962	43.92200	1528098	1067.5348
1540	Togo	Africa	1967	46.76900	1735550	1477.5968
1541	Togo	Africa	1972	49.75900	2056351	1649.6602
1542	Togo	Africa	1977	52.88700	2308582	1532.7770
1543	Togo	Africa	1982	55.47100	2644765	1344.5780
1544	Togo	Africa	1987	56.94100	3154264	1202.2014
1545	Togo	Africa	1992	58.06100	3747553	1034.2989
1546	Togo	Africa	1997	58.39000	4320890	982.2869
1547	Togo	Africa	2002	57.56100	4977378	886.2206
1548	Togo	Africa	2007	58.42000	5701579	882.9699
1549	Trinidad and Tobago	Americas	1952	59.10000	662850	3023.2719
1550	Trinidad and Tobago	Americas	1957	61.80000	764900	4100.3934
1551	Trinidad and Tobago	Americas	1962	64.90000	887498	4997.5240
1552	Trinidad and Tobago	Americas	1967	65.40000	960155	5621.3685
1553	Trinidad and Tobago	Americas	1972	65.90000	975199	6619.5514
1554	Trinidad and Tobago	Americas	1977	68.30000	1039009	7899.5542
1555	Trinidad and Tobago	Americas	1982	68.83200	1116479	9119.5286
1556	Trinidad and Tobago	Americas	1987	69.58200	1191336	7388.5978
1557	Trinidad and Tobago	Americas	1992	69.86200	1183669	7370.9909
1558	Trinidad and Tobago	Americas	1997	69.46500	1138101	8792.5731
1559	Trinidad and Tobago	Americas	2002	68.97600	1101832	11460.6002
1560	Trinidad and Tobago	Americas	2007	69.81900	1056608	18008.5092
1561	Tunisia	Africa	1952	44.60000	3647735	1468.4756

1562	Tunisia	Africa	1957	47.10000	3950849	1395.2325
1563	Tunisia	Africa	1962	49.57900	4286552	1660.3032
1564	Tunisia	Africa	1967	52.05300	4786986	1932.3602
1565	Tunisia	Africa	1972	55.60200	5303507	2753.2860
1566	Tunisia	Africa	1977	59.83700	6005061	3120.8768
1567	Tunisia	Africa	1982	64.04800	6734098	3560.2332
1568	Tunisia	Africa	1987	66.89400	7724976	3810.4193
1569	Tunisia	Africa	1992	70.00100	8523077	4332.7202
1570	Tunisia	Africa	1997	71.97300	9231669	4876.7986
1571	Tunisia	Africa	2002	73.04200	9770575	5722.8957
1572	Tunisia	Africa	2007	73.92300	10276158	7092.9230
1573	Turkey	Europe	1952	43.58500	22235677	1969.1010
1574	Turkey	Europe	1957	48.07900	25670939	2218.7543
1575	Turkey	Europe	1962	52.09800	29788695	2322.8699
1576	Turkey	Europe	1967	54.33600	33411317	2826.3564
1577	Turkey	Europe	1972	57.00500	37492953	3450.6964
1578	Turkey	Europe	1977	59.50700	42404033	4269.1223
1579	Turkey	Europe	1982	61.03600	47328791	4241.3563
1580	Turkey	Europe	1987	63.10800	52881328	5089.0437
1581	Turkey	Europe	1992	66.14600	58179144	5678.3483
1582	Turkey	Europe	1997	68.83500	63047647	6601.4299
1583	Turkey	Europe	2002	70.84500	67308928	6508.0857
1584	Turkey	Europe	2007	71.77700	71158647	8458.2764
1585	Uganda	Africa	1952	39.97800	5824797	734.7535
1586	Uganda	Africa	1957	42.57100	6675501	774.3711
1587	Uganda	Africa	1962	45.34400	7688797	767.2717
1588	Uganda	Africa	1967	48.05100	8900294	908.9185
1589	Uganda	Africa	1972	51.01600	10190285	950.7359
1590	Uganda	Africa	1977	50.35000	11457758	843.7331
1591	Uganda	Africa	1982	49.84900	12939400	682.2662
1592	Uganda	Africa	1987	51.50900	15283050	617.7244
1593	Uganda	Africa	1992	48.82500	18252190	644.1708
1594	Uganda	Africa	1997	44.57800	21210254	816.5591
1595	Uganda	Africa	2002	47.81300	24739869	927.7210
1596	Uganda	Africa	2007	51.54200	29170398	1056.3801
1597	United Kingdom	Europe	1952	69.18000	50430000	9979.5085
1598	United Kingdom	Europe	1957	70.42000	51430000	11283.1779
1599	United Kingdom	Europe	1962	70.76000	53292000	12477.1771
1600	United Kingdom	Europe	1967	71.36000	54959000	14142.8509
1601	United Kingdom	Europe	1972	72.01000	56079000	15895.1164
1602	United Kingdom	Europe	1977	72.76000	56179000	17428.7485
1603	United Kingdom	Europe	1982	74.04000	56339704	18232.4245
1604	United Kingdom	Europe	1987	75.00700	56981620	21664.7877

1605	United Kingdom	Europe	1992	76.42000	57866349	22705.0925
1606	United Kingdom	Europe	1997	77.21800	58808266	26074.5314
1607	United Kingdom	Europe	2002	78.47100	59912431	29478.9992
1608	United Kingdom	Europe	2007	79.42500	60776238	33203.2613
1609	United States	Americas	1952	68.44000	157553000	13990.4821
1610	United States	Americas	1957	69.49000	171984000	14847.1271
1611	United States	Americas	1962	70.21000	186538000	16173.1459
1612	United States	Americas	1967	70.76000	198712000	19530.3656
1613	United States	Americas	1972	71.34000	209896000	21806.0359
1614	United States	Americas	1977	73.38000	220239000	24072.6321
1615	United States	Americas	1982	74.65000	232187835	25009.5591
1616	United States	Americas	1987	75.02000	242803533	29884.3504
1617	United States	Americas	1992	76.09000	256894189	32003.9322
1618	United States	Americas	1997	76.81000	272911760	35767.4330
1619	United States	Americas	2002	77.31000	287675526	39097.0995
1620	United States	Americas	2007	78.24200	301139947	42951.6531
1621	Uruguay	Americas	1952	66.07100	2252965	5716.7667
1622	Uruguay	Americas	1957	67.04400	2424959	6150.7730
1623	Uruguay	Americas	1962	68.25300	2598466	5603.3577
1624	Uruguay	Americas	1967	68.46800	2748579	5444.6196
1625	Uruguay	Americas	1972	68.67300	2829526	5703.4089
1626	Uruguay	Americas	1977	69.48100	2873520	6504.3397
1627	Uruguay	Americas	1982	70.80500	2953997	6920.2231
1628	Uruguay	Americas	1987	71.91800	3045153	7452.3990
1629	Uruguay	Americas	1992	72.75200	3149262	8137.0048
1630	Uruguay	Americas	1997	74.22300	3262838	9230.2407
1631	Uruguay	Americas	2002	75.30700	3363085	7727.0020
1632	Uruguay	Americas	2007	76.38400	3447496	10611.4630
1633	Venezuela	Americas	1952	55.08800	5439568	7689.7998
1634	Venezuela	Americas	1957	57.90700	6702668	9802.4665
1635	Venezuela	Americas	1962	60.77000	8143375	8422.9742
1636	Venezuela	Americas	1967	63.47900	9709552	9541.4742
1637	Venezuela	Americas	1972	65.71200	11515649	10505.2597
1638	Venezuela	Americas	1977	67.45600	13503563	13143.9510
1639	Venezuela	Americas	1982	68.55700	15620766	11152.4101
1640	Venezuela	Americas	1987	70.19000	17910182	9883.5846
1641	Venezuela	Americas	1992	71.15000	20265563	10733.9263
1642	Venezuela	Americas	1997	72.14600	22374398	10165.4952
1643	Venezuela	Americas	2002	72.76600	24287670	8605.0478
1644	Venezuela	Americas	2007	73.74700	26084662	11415.8057
1645	Vietnam	Asia	1952	40.41200	26246839	605.0665
1646	Vietnam	Asia	1957	42.88700	28998543	676.2854
1647	Vietnam	Asia	1962	45.36300	33796140	772.0492

1648	Vietnam	Asia	1967	47.83800	39463910	637.1233
1649	Vietnam	Asia	1972	50.25400	44655014	699.5016
1650	Vietnam	Asia	1977	55.76400	50533506	713.5371
1651	Vietnam	Asia	1982	58.81600	56142181	707.2358
1652	Vietnam	Asia	1987	62.82000	62826491	820.7994
1653	Vietnam	Asia	1992	67.66200	69940728	989.0231
1654	Vietnam	Asia	1997	70.67200	76048996	1385.8968
1655	Vietnam	Asia	2002	73.01700	80908147	1764.4567
1656	Vietnam	Asia	2007	74.24900	85262356	2441.5764
1657	West Bank and Gaza	Asia	1952	43.16000	1030585	1515.5923
1658	West Bank and Gaza	Asia	1957	45.67100	1070439	1827.0677
1659	West Bank and Gaza	Asia	1962	48.12700	1133134	2198.9563
1660	West Bank and Gaza	Asia	1967	51.63100	1142636	2649.7150
1661	West Bank and Gaza	Asia	1972	56.53200	1089572	3133.4093
1662	West Bank and Gaza	Asia	1977	60.76500	1261091	3682.8315
1663	West Bank and Gaza	Asia	1982	64.40600	1425876	4336.0321
1664	West Bank and Gaza	Asia	1987	67.04600	1691210	5107.1974
1665	West Bank and Gaza	Asia	1992	69.71800	2104779	6017.6548
1666	West Bank and Gaza	Asia	1997	71.09600	2826046	7110.6676
1667	West Bank and Gaza	Asia	2002	72.37000	3389578	4515.4876
1668	West Bank and Gaza	Asia	2007	73.42200	4018332	3025.3498
1669	Yemen, Rep.	Asia	1952	32.54800	4963829	781.7176
1670	Yemen, Rep.	Asia	1957	33.97000	5498090	804.8305
1671	Yemen, Rep.	Asia	1962	35.18000	6120081	825.6232
1672	Yemen, Rep.	Asia	1967	36.98400	6740785	862.4421
1673	Yemen, Rep.	Asia	1972	39.84800	7407075	1265.0470
1674	Yemen, Rep.	Asia	1977	44.17500	8403990	1829.7652
1675	Yemen, Rep.	Asia	1982	49.11300	9657618	1977.5570
1676	Yemen, Rep.	Asia	1987	52.92200	11219340	1971.7415
1677	Yemen, Rep.	Asia	1992	55.59900	13367997	1879.4967
1678	Yemen, Rep.	Asia	1997	58.02000	15826497	2117.4845
1679	Yemen, Rep.	Asia	2002	60.30800	18701257	2234.8208
1680	Yemen, Rep.	Asia	2007	62.69800	22211743	2280.7699
1681	Zambia	Africa	1952	42.03800	2672000	1147.3888
1682	Zambia	Africa	1957	44.07700	3016000	1311.9568
1683	Zambia	Africa	1962	46.02300	3421000	1452.7258
1684	Zambia	Africa	1967	47.76800	3900000	1777.0773
1685	Zambia	Africa	1972	50.10700	4506497	1773.4983
1686	Zambia	Africa	1977	51.38600	5216550	1588.6883
1687	Zambia	Africa	1982	51.82100	6100407	1408.6786
1688	Zambia	Africa	1987	50.82100	7272406	1213.3151
1689	Zambia	Africa	1992	46.10000	8381163	1210.8846
1690	Zambia	Africa	1997	40.23800	9417789	1071.3538

```
1691                Zambia    Africa 2002 39.19300   10595811   1071.6139
1692                Zambia    Africa 2007 42.38400   11746035   1271.2116
1693              Zimbabwe    Africa 1952 48.45100    3080907    406.8841
1694              Zimbabwe    Africa 1957 50.46900    3646340    518.7643
1695              Zimbabwe    Africa 1962 52.35800    4277736    527.2722
1696              Zimbabwe    Africa 1967 53.99500    4995432    569.7951
1697              Zimbabwe    Africa 1972 55.63500    5861135    799.3622
1698              Zimbabwe    Africa 1977 57.67400    6642107    685.5877
1699              Zimbabwe    Africa 1982 60.36300    7636524    788.8550
1700              Zimbabwe    Africa 1987 62.35100    9216418    706.1573
1701              Zimbabwe    Africa 1992 60.37700   10704340    693.4208
1702              Zimbabwe    Africa 1997 46.80900   11404948    792.4500
1703              Zimbabwe    Africa 2002 39.98900   11926563    672.0386
1704              Zimbabwe    Africa 2007 43.48700   12311143    469.7093
```

Here are the main differences:

1. The version loaded using the base R `read.csv()` function prints out the first 1000 rows (though I've kindly put them all in a nice scrolly box for you), whereas the version loaded using the tidyverse `read_csv()` function only prints out the first 10 rows (and it also only displays the first few columns whenever your dataset contains a large number of columns).
2. The version loaded using the tidyverse `read_csv()` function will also show you what *type/class* each columns has. Look underneath the column names of the tidyverse `read_csv()` version of `gapminder` above. See the `<chr>` and `<dbl>` symbols? These mean "character" and "double" ("double" means "numeric with decimals"), respectively.
3. The tidyverse `read_csv()` version prints out some information at the top that says `# A tibble: 1,704 × 6`, which tells us that our data frame has 1,704 rows and 6 columns.

What's a "tibble"? It turns out that `read_csv()` doesn't actually load your data in as a data frame. It loads your data in as a *"tibble"*. While tibbles have some fancy features, for our purposes, you can just think of a tibble as a data frame that looks slightly different when printed. Note that I will usually use the term "data frame" even if the object is technically a tibble.

6.3 The dplyr library

So we've now loaded the tidyverse library and we've loaded our gapminder data using `read_csv()`. The code we've written so far in this chapter is essentially just:

```
library(tidyverse)
gapminder <- read_csv("data/gapminder.csv")
```

When we loaded the "tidyverse" library, this also loaded the "dplyr" library (along with several others.)

The dplyr library is probably the most important library in the tidyverse. It contains a bunch of functions that allow you to work with data frames like extract columns, modify columns, and filter based on conditions.

The main dplyr functions to master are:

- `select()`: extract columns from your data frame
- `filter()`: filter to rows of your data frame based on a condition
- `mutate()`: add columns or modify columns in your data frame
- `summarize()`: aggregate information in your columns
- `group_by()`: perform an operation separately for each value of a categorical column

The rest of this chapter will guide you through using these functions step by step, showing not only how they work individually but also how to combine them. Once you're comfortable with these functions, you'll be ready to tackle a variety of data analysis tasks.

6.4 Select() for extacting columns

We can use the `select()` function to extract specific named columns from our data frame.

- The *first argument* of `select()` is always the data frame on which you are operating.
- All of the *remaining arguments* of `select()` are the names of the columns that you want to keep.

Note that the column names do *not* have quotes around them. This is something that makes dplyr (and tidyverse) functions special.

So if we want to use `select()` to extract just the `country`, `year`, and `lifeExp` columns from our `gapminder` data frame, the first argument will be the name of our data frame object, `gapminder`, and the subsequent arguments will be the names of the columns we want to extract:

```
select(gapminder, country, year, lifeExp)
```

```
# A tibble: 1,704 x 3
   country      year lifeExp
   <chr>       <dbl>   <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
# i 1,694 more rows
```

Note that I haven't *modified* the original `gapminder` data frame object here. If I print `gapminder`, it still has all of the original columns:

```
gapminder
```

```
# A tibble: 1,704 x 6
   country     continent  year lifeExp      pop gdpPercap
   <chr>       <chr>     <dbl>   <dbl>    <dbl>     <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.
# i 1,694 more rows
```

Instead, I have created a *new* data frame with just the `country`, `year`, and `lifeExp` columns, and I've just printed it out.

If I wanted to *use* this `country`, `year`, and `lifeExp` subsetted data frame, I would need to save it as a new variable/object using the `<-` assignment operator:

```
gapminder_subset <- select(gapminder, country, year, lifeExp)
```

And I could then work with this new data frame by referencing `gapminder_subset` in my code:

```
gapminder_subset
```

```
# A tibble: 1,704 x 3
   country      year lifeExp
   <chr>       <dbl>   <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
# i 1,694 more rows
```

In this chapter, however, I will typically print the output of various data frame operations without saving the resulting data frame output as new objects. This is because I just want to show what the result will be. I don't necessarily need to use the resulting data frames for anything (so there is no point in saving them as new objects).

6.4.1 Removing columns with `select()`

You can remove columns by using a minus sign in front of the column name. For example, the following code will return the `gapminder` data frame *without* the `continent`, `year`, and `pop` columns:

```
select(gapminder, -continent, -year, -pop)
```

```
# A tibble: 1,704 x 3
   country     lifeExp gdpPercap
   <chr>         <dbl>     <dbl>
 1 Afghanistan    28.8      779.
```

```
 2 Afghanistan    30.3      821.
 3 Afghanistan    32.0      853.
 4 Afghanistan    34.0      836.
 5 Afghanistan    36.1      740.
 6 Afghanistan    38.4      786.
 7 Afghanistan    39.9      978.
 8 Afghanistan    40.8      852.
 9 Afghanistan    41.7      649.
10 Afghanistan    41.8      635.
# i 1,694 more rows
```

6.4.2 Renaming columns with `select()`

`select()` can also help you rename columns. If you provide a named argument for your columns as `new_name = old_name`, the resulting column in the output data frame will be renamed to whatever you provide as `new_name`. For example, the following code will return the `gapminder` data frame with the `country`, `year`, `lifeExp`, and `gdpPercap` columns, except the `lifeExp` column will be renamed to `life_exp` and the `gdpPercap` column renamed to `gdp_per_cap`:

```
select(gapminder, country, year, life_exp = lifeExp, gdp_per_cap = gdpPercap)
```

```
# A tibble: 1,704 x 4
   country      year life_exp gdp_per_cap
   <chr>       <dbl>    <dbl>       <dbl>
 1 Afghanistan  1952     28.8        779.
 2 Afghanistan  1957     30.3        821.
 3 Afghanistan  1962     32.0        853.
 4 Afghanistan  1967     34.0        836.
 5 Afghanistan  1972     36.1        740.
 6 Afghanistan  1977     38.4        786.
 7 Afghanistan  1982     39.9        978.
 8 Afghanistan  1987     40.8        852.
 9 Afghanistan  1992     41.7        649.
10 Afghanistan  1997     41.8        635.
# i 1,694 more rows
```

6.4.3 Renaming columns with `rename()`

However, since `select()` will only return the columns included in its arguments. If you want to rename a column without also having to list all the other columns you want in your output

data frame, you can use the `rename()` function instead.

For example, the following code will return *all columns* in the `gapminder` data frame, with the `lifeExp` column renamed to `life_exp` and the `gdpPercap` column renamed to `gdp_per_cap`:

```
rename(gapminder, life_exp = lifeExp, gdp_per_cap = gdpPercap)
```

```
# A tibble: 1,704 x 6
   country     continent  year life_exp      pop gdp_per_cap
   <chr>       <chr>     <dbl>    <dbl>    <dbl>       <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.
# i 1,694 more rows
```

6.5 Question

What would happen if I replaced `rename()` in the code above with `select()`? As in:

```
select(gapminder, life_exp = lifeExp, gdp_per_cap = gdpPercap)
```

6.6 Answer

The resulting data frame output would *only* include the `life_exp` and `gdp_per_cap` columns!

```
select(gapminder, life_exp = lifeExp, gdp_per_cap = gdpPercap)
```

```
# A tibble: 1,704 x 2
   life_exp gdp_per_cap
      <dbl>       <dbl>
 1     28.8        779.
```

```
 2     30.3        821.
 3     32.0        853.
 4     34.0        836.
 5     36.1        740.
 6     38.4        786.
 7     39.9        978.
 8     40.8        852.
 9     41.7        649.
10     41.8        635.
# i 1,694 more rows
```

6.7 The pipe |> (formerly known as %>%)

Before introducing our next dplyr function, I want to introduce you to an operator called the **pipe**. The pipe is literally (in my very biased opinion) the best coding invention ever.

The pipe, `|>`, allows us to read our code as if it is a sentence. For example, if I wanted to turn the following sentence "*I take my backpack and then I put books in it and then put it on my back*" using the pipe, I would write `backpack |> put_books_in() |> put_on_back()`. I always think of the pipe operator `|>` as the word "and then" in a sentence.

Take a look at the following code:

```
gapminder |> select(country, year, lifeExp)
```

```
# A tibble: 1,704 x 3
   country      year lifeExp
   <chr>       <dbl>   <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
# i 1,694 more rows
```

I read this code in my head as "*take the gapminder data frame and then select the country, year, and lifeExp columns*":

The pipe syntax is: `object |> function()`. The way it works is that the object to the left of the pipe (`object`) is placed into the *first argument* of the function to the right of the pipe (`function()`).

This means that the following two pieces of code are equivalent:

```
# apply head() to gapminder directly
head(gapminder)
```

```
# A tibble: 6 x 6
  country     continent  year lifeExp      pop gdpPercap
  <chr>       <chr>     <dbl>   <dbl>    <dbl>     <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.
```

```
# apply head() to gapminder using the pipe
gapminder |> head()
```

```
# A tibble: 6 x 6
  country     continent  year lifeExp      pop gdpPercap
  <chr>       <chr>     <dbl>   <dbl>    <dbl>     <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.
```

The second version with the pipe takes the `gapminder` data frame (which is to the left of the pipe) and places it into the (first) argument of the `head()` function on the right of the pipe. The pipe always has an object (like a data frame) on its left and a function on its right.

Here is another example of two pieces of equivalent code, first, without the pipe:

```
# without the pipe
select(gapminder, year, pop)
```

```
# A tibble: 1,704 x 2
    year      pop
   <dbl>    <dbl>
 1  1952  8425333
 2  1957  9240934
 3  1962 10267083
 4  1967 11537966
 5  1972 13079460
 6  1977 14880372
 7  1982 12881816
 8  1987 13867957
 9  1992 16317921
10  1997 22227415
# i 1,694 more rows
```

Second, with the pipe ("take the `gapminder` data frame *and then* select the `year` and `pop` columns"):

```
# with the pipe
gapminder |> select(year, pop)
```

```
# A tibble: 1,704 x 2
    year      pop
   <dbl>    <dbl>
 1  1952  8425333
 2  1957  9240934
 3  1962 10267083
 4  1967 11537966
 5  1972 13079460
 6  1977 14880372
 7  1982 12881816
 8  1987 13867957
 9  1992 16317921
10  1997 22227415
# i 1,694 more rows
```

Remember that the pipe places the object on the left of the pipe into the *first* argument of the function on the right of the pipe. The `select()` function, however, takes many arguments. If the function to the right of the pipe `|>` takes more than one argument, then the remaining arguments are just included inside the parentheses of the function on the right of the pipe.

The "new" pipe `|>` versus the "old" pipe `%>%`

The pipe `|>` is now a part of the "base R" programming language. Previously, you needed to load the "magrittr", "dplyr", or "tidyverse" libraries to access the pipe and it had a different symbol: `%>%`.
The two pipes behave very similarly. The main difference I noticed when I switched was that the old pipe didn't require parentheses for functions that didn't have any additional arguments, e.g., you could write `df %>% head`. But the new pipe requires the empty parentheses after the function, as in: `df |> head()`.
The old pipe `%>%` still works, but my recommendation is that you use the newer "native" pipe syntax: `|>`.

6.8 Filtering rows using filter()

Our next dplyr function, `filter()`, lets you filter to specific rows based on a logical condition.

Imagine that we just want to look at the rows in the `gapminder` data frame whose `country` value is `"Australia"`. Then we can write:

```
filter(gapminder, country == "Australia")
```

```
# A tibble: 12 x 6
   country   continent  year lifeExp      pop gdpPercap
   <chr>     <chr>     <dbl>   <dbl>    <dbl>     <dbl>
 1 Australia Oceania    1952    69.1  8691212    10040.
 2 Australia Oceania    1957    70.3  9712569    10950.
 3 Australia Oceania    1962    70.9 10794968    12217.
 4 Australia Oceania    1967    71.1 11872264    14526.
 5 Australia Oceania    1972    71.9 13177000    16789.
 6 Australia Oceania    1977    73.5 14074100    18334.
 7 Australia Oceania    1982    74.7 15184200    19477.
 8 Australia Oceania    1987    76.3 16257249    21889.
 9 Australia Oceania    1992    77.6 17481977    23425.
10 Australia Oceania    1997    78.8 18565243    26998.
11 Australia Oceania    2002    80.4 19546792    30688.
12 Australia Oceania    2007    81.2 20434176    34435.
```

Where:

- The first argument of `filter()` is the data frame (`gapminder`) that you want to operate on.
- The second argument of `filter()` is the *logical condition* involving the column of the data frame that you want to use to filter (`country == "Australia"`).

`filter()` will return all rows for which the provided condition is `TRUE`. Note that in our condition, we do *not* need quotes around the column name, `country`, but we *do* need quotes around the value, `"Australia"`. Remember that when asking a logical question of equality, we need to use two equal signs `==`.

Now that we have met our trusty pipe, we can rewrite this `filter()` code as:

```
gapminder |> filter(country == "Australia")
```

```
# A tibble: 12 x 6
   country   continent  year lifeExp      pop gdpPercap
   <chr>     <chr>     <dbl>   <dbl>    <dbl>     <dbl>
 1 Australia Oceania    1952    69.1  8691212    10040.
 2 Australia Oceania    1957    70.3  9712569    10950.
 3 Australia Oceania    1962    70.9 10794968    12217.
 4 Australia Oceania    1967    71.1 11872264    14526.
 5 Australia Oceania    1972    71.9 13177000    16789.
 6 Australia Oceania    1977    73.5 14074100    18334.
 7 Australia Oceania    1982    74.7 15184200    19477.
 8 Australia Oceania    1987    76.3 16257249    21889.
 9 Australia Oceania    1992    77.6 17481977    23425.
10 Australia Oceania    1997    78.8 18565243    26998.
11 Australia Oceania    2002    80.4 19546792    30688.
12 Australia Oceania    2007    81.2 20434176    34435.
```

Remember that the pipe, `|>`, places the object on the left-hand side (`gapminder`) into the first argument of the function (`filter()`) on the right-hand side.

6.8.1 Multiple filtering conditions

You can provide multiple conditions to `filter()` as separate arguments. Given multiple conditions, `filter()` returns the rows for which *all* of the provided conditions are `TRUE`.

For example, the following code will filter the `gapminder` data frame to the rows where both `country == "Australia"` AND `year > 1990` are `TRUE`.

```
gapminder |> filter(country == "Australia", year > 1990)
```

```
# A tibble: 4 x 6
  country   continent  year lifeExp      pop gdpPercap
  <chr>     <chr>     <dbl>   <dbl>    <dbl>     <dbl>
1 Australia Oceania    1992    77.6 17481977    23425.
2 Australia Oceania    1997    78.8 18565243    26998.
3 Australia Oceania    2002    80.4 19546792    30688.
4 Australia Oceania    2007    81.2 20434176    34435.
```

Take note of when we do and when we do not need quotes. We never need quotes when referencing a column name from our data frame inside a dplyr function, nor do we need quotes for numeric values, such as `1990`. We do, however, need quotes when referencing a *character* value, such as `"Australia"`.

You can read this code (`gapminder |> filter(country == "Australia", year > 1990)`) as "take the gapminder data frame *and then* filter to the rows where the country is Australia and the year is greater than 1990".

To start to get a sense of why the pipe is so useful, let's use it to combine some sequential `filter()` and `select()` operations:

- Filter to the rows where the `continent` column is `"Africa"` and the `year` column is `1992`.
- Select just the `country` and `lifeExp` columns (renaming `lifeExp` to `life_exp`).

```
gapminder |>
  filter(continent == "Africa", year == 1992) |>
  select(country, life_exp = lifeExp)
```

```
# A tibble: 52 x 2
   country                  life_exp
   <chr>                       <dbl>
 1 Algeria                      67.7
 2 Angola                       40.6
 3 Benin                        53.9
 4 Botswana                     62.7
 5 Burkina Faso                 50.3
 6 Burundi                      44.7
 7 Cameroon                     54.3
 8 Central African Republic     49.4
```

```
 9 Chad                          51.7
10 Comoros                       57.9
# i 42 more rows
```

Note that I like to start a new line *after* each pipe `|>` to make the code more readable.

How would you read the code above as a sentence? I read it as "take the gapminder dataset *and then* filter to just the rows where the `continent` column is equal to `"Africa"` and the `year` column is equal to `1992` *and then* select just the `country` and `lifeExp` columns, renaming `lifeExp` to be `life_exp`".

Since the output of just the first filtered part of the above code, `gapminder |> filter(continent == "Africa", year == 1992)`, is a data frame itself, when I add another pipe `|>` after this first operation, I am piping the resulting filtered data frame into the subsequent `select()` function.

If I wanted to try to write this code *without* the pipe, I would have to do it in a few steps like this:

```
gapminder_africa_1992 <- filter(gapminder, continent == "Africa", year == 1992)
select(gapminder_africa_1992, country, life_exp = lifeExp)
```

```
# A tibble: 52 x 2
   country                  life_exp
   <chr>                       <dbl>
 1 Algeria                      67.7
 2 Angola                       40.6
 3 Benin                        53.9
 4 Botswana                     62.7
 5 Burkina Faso                 50.3
 6 Burundi                      44.7
 7 Cameroon                     54.3
 8 Central African Republic     49.4
 9 Chad                         51.7
10 Comoros                      57.9
# i 42 more rows
```

This code does the same thing, but without the pipe, I am forced to define an intermediate object, `gapminder_africa_1992` (or do some disgusting nested function stuff), which feels inferior to the pipe-based approach. The pipe allows me to do all this in a single, more readable, and more efficient operation.

6.8.2 The order of operations

It turns out that the order of operations when conducting dplyr operations can be fairly important.

For example, if I swap the order of `select()` and `filter()` in the code above, I will get an error:

```
# swap the filter and select steps above
gapminder |>
  select(country, life_exp = lifeExp) |>
  filter(continent == "Africa", year == 1992)
```

```
Error in `filter()`:
i In argument: `continent == "Africa"`.
Caused by error:
! object 'continent' not found
```

Why do you think this happens? Take a look at the error message for a hint. R is telling us that there is no `continent` column. What data frame is being piped into the `filter()` function?

Let's run just the first two lines of code to find out:

```
gapminder |>
  select(country, life_exp = lifeExp)
```

```
# A tibble: 1,704 x 2
   country     life_exp
   <chr>          <dbl>
 1 Afghanistan     28.8
 2 Afghanistan     30.3
 3 Afghanistan     32.0
 4 Afghanistan     34.0
 5 Afghanistan     36.1
 6 Afghanistan     38.4
 7 Afghanistan     39.9
 8 Afghanistan     40.8
 9 Afghanistan     41.7
10 Afghanistan     41.8
# i 1,694 more rows
```

This is the data frame that is being piped into `filter()`. Does it contain a `continent` column? No, it does not! So the `filter()` function is trying to filter this two-column data frame to just the rows for which it's `continent` column is equal to `"Africa"`, but this two-column data frame doesn't contain a `continent` column!

The following two pieces of code are therefore *not* equivalent:

```
gapminder |>
  filter(continent == "Africa", year == 1992) |>
  select(country, life_exp = lifeExp)
```

```
gapminder |>
  select(country, life_exp = lifeExp) |>
  filter(continent == "Africa", year == 1992)
```

6.8.3 Filtering using "OR" conditions

How would you filter to the rows where country corresponds to "Australia" and "Italy"? You might imagine that you can provide these two conditions separated by a comma, as in:

```
gapminder |> filter(country == "Australia", country == "Italy")
```

```
# A tibble: 0 x 6
# i 6 variables: country <chr>, continent <chr>, year <dbl>, lifeExp <dbl>,
#   pop <dbl>, gdpPercap <dbl>
```

However, this has returned an *empty* data frame with 0 rows. Why has this happened?

Remember that whenever you provide two conditions to `filter()` with a comma, R filters to the rows where *both* conditions are true. That is, a comma corresponds to an "AND" condition.

`filter(country == "Australia", country == "Italy")` means "filter to the rows where `country == "Australia"` AND `country == "Italy"` are both true. However, there are no rows where `country` is simultaneously equal to `"Australia"` and `"Italy"`. It is only ever equal to one or the other.

Although I phrased my desire as "filter to the rows where `country` corresponds to Australia **and** Italy", I really meant, "filter to the rows `country` corresponds to Australia **or** Italy".

Can you remember how to ask an "OR" question? You use the vertical bar `|`. So to provide an "OR" condition, I could provide my two conditions separated by a vertical bar, `(condition 1) | (condition 2)`, which will return all rows where *either* condition 1 *or* condition 2 are satisfied:

```
gapminder |>
  filter((country == "Australia") | (country == "Italy"))
```

```
# A tibble: 24 x 6
   country   continent  year lifeExp      pop gdpPercap
   <chr>     <chr>     <dbl>   <dbl>    <dbl>     <dbl>
 1 Australia Oceania    1952    69.1  8691212    10040.
 2 Australia Oceania    1957    70.3  9712569    10950.
 3 Australia Oceania    1962    70.9 10794968    12217.
 4 Australia Oceania    1967    71.1 11872264    14526.
 5 Australia Oceania    1972    71.9 13177000    16789.
 6 Australia Oceania    1977    73.5 14074100    18334.
 7 Australia Oceania    1982    74.7 15184200    19477.
 8 Australia Oceania    1987    76.3 16257249    21889.
 9 Australia Oceania    1992    77.6 17481977    23425.
10 Australia Oceania    1997    78.8 18565243    26998.
# i 14 more rows
```

Here R is trying to be helpful by only printing the first 10 rows. I can tell it to print all 24 by piping my data frame into a `print()` function:

```
gapminder |>
  filter((country == "Australia") | (country == "Italy")) |>
  print(n = 24)
```

```
# A tibble: 24 x 6
   country   continent  year lifeExp      pop gdpPercap
   <chr>     <chr>     <dbl>   <dbl>    <dbl>     <dbl>
 1 Australia Oceania    1952    69.1  8691212    10040.
 2 Australia Oceania    1957    70.3  9712569    10950.
 3 Australia Oceania    1962    70.9 10794968    12217.
 4 Australia Oceania    1967    71.1 11872264    14526.
 5 Australia Oceania    1972    71.9 13177000    16789.
 6 Australia Oceania    1977    73.5 14074100    18334.
 7 Australia Oceania    1982    74.7 15184200    19477.
 8 Australia Oceania    1987    76.3 16257249    21889.
 9 Australia Oceania    1992    77.6 17481977    23425.
10 Australia Oceania    1997    78.8 18565243    26998.
11 Australia Oceania    2002    80.4 19546792    30688.
12 Australia Oceania    2007    81.2 20434176    34435.
13 Italy     Europe     1952    65.9 47666000     4931.
```

```
14 Italy     Europe     1957    67.8 49182000     6249.
15 Italy     Europe     1962    69.2 50843200     8244.
16 Italy     Europe     1967    71.1 52667100    10022.
17 Italy     Europe     1972    72.2 54365564    12269.
18 Italy     Europe     1977    73.5 56059245    14256.
19 Italy     Europe     1982    75.0 56535636    16537.
20 Italy     Europe     1987    76.4 56729703    19207.
21 Italy     Europe     1992    77.4 56840847    22014.
22 Italy     Europe     1997    78.8 57479469    24675.
23 Italy     Europe     2002    80.2 57926999    27968.
24 Italy     Europe     2007    80.5 58147733    28570.
```

If both conditions involve the same variable (in this case, `country`), you can instead use the `%in%` operator! Remember that you can ask which values in a vector are also in some other vector, such as asking which values in the vector `c(1, 5, 2, 2, 1, 6)` are equal to `1` or `2` (i.e., are in the vector `c(1, 2)`) by writing:

```
c(1, 5, 2, 2, 1, 6) %in% c(1, 2)
```

```
[1]  TRUE FALSE  TRUE  TRUE  TRUE FALSE
```

We can use this same `%in%`operator to ask which entries of the `country` column are equal to `"Australia"` or `"Italy"`:

```
gapminder |>
  filter(country %in% c("Australia", "Italy")) |>
  print(n = 24)
```

```
# A tibble: 24 x 6
   country   continent  year lifeExp      pop gdpPercap
   <chr>     <chr>     <dbl>   <dbl>    <dbl>     <dbl>
 1 Australia Oceania    1952    69.1  8691212    10040.
 2 Australia Oceania    1957    70.3  9712569    10950.
 3 Australia Oceania    1962    70.9 10794968    12217.
 4 Australia Oceania    1967    71.1 11872264    14526.
 5 Australia Oceania    1972    71.9 13177000    16789.
 6 Australia Oceania    1977    73.5 14074100    18334.
 7 Australia Oceania    1982    74.7 15184200    19477.
 8 Australia Oceania    1987    76.3 16257249    21889.
 9 Australia Oceania    1992    77.6 17481977    23425.
10 Australia Oceania    1997    78.8 18565243    26998.
```

```
11 Australia Oceania    2002    80.4 19546792    30688.
12 Australia Oceania    2007    81.2 20434176    34435.
13 Italy     Europe     1952    65.9 47666000     4931.
14 Italy     Europe     1957    67.8 49182000     6249.
15 Italy     Europe     1962    69.2 50843200     8244.
16 Italy     Europe     1967    71.1 52667100    10022.
17 Italy     Europe     1972    72.2 54365564    12269.
18 Italy     Europe     1977    73.5 56059245    14256.
19 Italy     Europe     1982    75.0 56535636    16537.
20 Italy     Europe     1987    76.4 56729703    19207.
21 Italy     Europe     1992    77.4 56840847    22014.
22 Italy     Europe     1997    78.8 57479469    24675.
23 Italy     Europe     2002    80.2 57926999    27968.
24 Italy     Europe     2007    80.5 58147733    28570.
```

6.9 Exercise

Filter `gapminder` to all countries on the `"Oceania"` continent for just the years 1987 and 1992 and select just the `country`, `year`, and `gdpPercap` columns (and rename `gdpPercap` to be `gdp_per_cap`).

Save the output in an object called `gapminder_oceania`, and print `gapminder_oceania` to the console.

6.10 Solution

```
gapminder_oceania <- gapminder |>
  filter(continent == "Oceania", year %in% c(1987, 1992)) |>
  select(country, year, gdp_per_cap = gdpPercap)
gapminder_oceania
```

```
# A tibble: 4 x 3
  country      year gdp_per_cap
  <chr>       <dbl>       <dbl>
1 Australia    1987      21889.
2 Australia    1992      23425.
3 New Zealand  1987      19007.
4 New Zealand  1992      18363.
```

6.11 Adding and modifying columns using mutate()

Next, let's learn how to add and modify columns in our data frame using `mutate()`.

If I wanted to add a new column to my data, called `gdp`, which is the product of the `pop` and `gdpPercap` columns, I can do that using `mutate()`.

```
gapminder |> mutate(gdp = pop * gdpPercap)
```

```
# A tibble: 1,704 x 7
   country     continent  year lifeExp      pop gdpPercap          gdp
   <chr>       <chr>     <dbl>   <dbl>    <dbl>     <dbl>        <dbl>
 1 Afghanistan Asia       1952    28.8  8425333      779.  6567086330.
 2 Afghanistan Asia       1957    30.3  9240934      821.  7585448670.
 3 Afghanistan Asia       1962    32.0 10267083      853.  8758855797.
 4 Afghanistan Asia       1967    34.0 11537966      836.  9648014150.
 5 Afghanistan Asia       1972    36.1 13079460      740.  9678553274.
 6 Afghanistan Asia       1977    38.4 14880372      786. 11697659231.
 7 Afghanistan Asia       1982    39.9 12881816      978. 12598563401.
 8 Afghanistan Asia       1987    40.8 13867957      852. 11820990309.
 9 Afghanistan Asia       1992    41.7 16317921      649. 10595901589.
10 Afghanistan Asia       1997    41.8 22227415      635. 14121995875.
# i 1,694 more rows
```

Here, `gdp`, is the name of my new column, and `pop` and `gdpPercap` are existing columns in my data frame, so I don't need to use quotes.

Remember that the code above hasn't actually modified `gapminder`. To modify `gapminder` I would need to *reassign* `gapminder` to the mutated dataframe: `gaminder <- gapminder |> mutate(gdp = pop * gdpPercap)`.

What this code has done is it has created a brand new column, `gdp`, and placed it at the end of my data frame (and printed out the resulting data frame without saving it as a new variable). In this case, each value in the `gdp` column contains product of the corresponding values in the `pop` and `gdpPercap` columns.

As another example, if we wanted to create a new column that contained the population in millions, i.e., `pop` divided by 1 million, we could do that using:

```
gapminder |> mutate(pop_mil = pop / 1e6)
```

```
# A tibble: 1,704 x 7
   country     continent  year lifeExp      pop gdpPercap pop_mil
   <chr>       <chr>     <dbl>   <dbl>    <dbl>     <dbl>   <dbl>
 1 Afghanistan Asia       1952    28.8  8425333      779.    8.43
 2 Afghanistan Asia       1957    30.3  9240934      821.    9.24
 3 Afghanistan Asia       1962    32.0 10267083      853.   10.3
 4 Afghanistan Asia       1967    34.0 11537966      836.   11.5
 5 Afghanistan Asia       1972    36.1 13079460      740.   13.1
 6 Afghanistan Asia       1977    38.4 14880372      786.   14.9
 7 Afghanistan Asia       1982    39.9 12881816      978.   12.9
 8 Afghanistan Asia       1987    40.8 13867957      852.   13.9
 9 Afghanistan Asia       1992    41.7 16317921      649.   16.3
10 Afghanistan Asia       1997    41.8 22227415      635.   22.2
# i 1,694 more rows
```

Note that `1e6` is scientific notation for `1000000` (i.e., `1` followed by 6 `0`s).

While `mutate()` is often used to create *new* columns, it can also be used to *modify existing* columns. For example, the code below will modify the existing `lifeExp` column by rounding it to the nearest integer.

```
gapminder |> mutate(lifeExp = round(lifeExp))
```

```
# A tibble: 1,704 x 6
   country     continent  year lifeExp      pop gdpPercap
   <chr>       <chr>     <dbl>   <dbl>    <dbl>     <dbl>
 1 Afghanistan Asia       1952      29  8425333      779.
 2 Afghanistan Asia       1957      30  9240934      821.
 3 Afghanistan Asia       1962      32 10267083      853.
 4 Afghanistan Asia       1967      34 11537966      836.
 5 Afghanistan Asia       1972      36 13079460      740.
 6 Afghanistan Asia       1977      38 14880372      786.
 7 Afghanistan Asia       1982      40 12881816      978.
 8 Afghanistan Asia       1987      41 13867957      852.
 9 Afghanistan Asia       1992      42 16317921      649.
10 Afghanistan Asia       1997      42 22227415      635.
# i 1,694 more rows
```

Note that no new columns have been added to the end of our `gapminder` output. The data frame contains the exact same columns as the original `gapminder` object, except the `lifeExp` column is now a rounded integer!

6.12 Exercise

Create the following data frame (there is a new `log_pop` column, and the `gdpPercap` column has been rounded to the nearest integer):

```
# A tibble: 1,704 x 7
   country     continent  year lifeExp      pop gdpPercap log_pop
   <chr>       <chr>     <dbl>   <dbl>    <dbl>     <dbl>   <dbl>
 1 Afghanistan Asia       1952    28.8  8425333       779    15.9
 2 Afghanistan Asia       1957    30.3  9240934       821    16.0
 3 Afghanistan Asia       1962    32.0 10267083       853    16.1
 4 Afghanistan Asia       1967    34.0 11537966       836    16.3
 5 Afghanistan Asia       1972    36.1 13079460       740    16.4
 6 Afghanistan Asia       1977    38.4 14880372       786    16.5
 7 Afghanistan Asia       1982    39.9 12881816       978    16.4
 8 Afghanistan Asia       1987    40.8 13867957       852    16.4
 9 Afghanistan Asia       1992    41.7 16317921       649    16.6
10 Afghanistan Asia       1997    41.8 22227415       635    16.9
# i 1,694 more rows
```

6.13 Solution

```
gapminder |>
  mutate(log_pop = log(pop), gdpPercap = round(gdpPercap))
```

```
# A tibble: 1,704 x 7
   country     continent  year lifeExp      pop gdpPercap log_pop
   <chr>       <chr>     <dbl>   <dbl>    <dbl>     <dbl>   <dbl>
 1 Afghanistan Asia       1952    28.8  8425333       779    15.9
 2 Afghanistan Asia       1957    30.3  9240934       821    16.0
 3 Afghanistan Asia       1962    32.0 10267083       853    16.1
 4 Afghanistan Asia       1967    34.0 11537966       836    16.3
 5 Afghanistan Asia       1972    36.1 13079460       740    16.4
 6 Afghanistan Asia       1977    38.4 14880372       786    16.5
 7 Afghanistan Asia       1982    39.9 12881816       978    16.4
 8 Afghanistan Asia       1987    40.8 13867957       852    16.4
 9 Afghanistan Asia       1992    41.7 16317921       649    16.6
10 Afghanistan Asia       1997    41.8 22227415       635    16.9
# i 1,694 more rows
```

6.14 Summarizing data frames using summarize()

The functions that we have discussed do far in this chapter (`select()`, `filter()` and `mutate()`) are all functions that can be used to modify your data frame.

In this section, we will introduce `summarize()`, which can be used to–you guessed it–*summarize* your data frame.

As an example, let's summarize our data frame by computing the mean `lifeExp` value across all rows in the dataset:

```
gapminder |> summarize(mean(lifeExp))
```

```
# A tibble: 1 x 1
  `mean(lifeExp)`
            <dbl>
1            59.5
```

You can read this as: "take the `gapminder` dataset *and then* summarize it by computing `mean(lifeExp)`, i.e., the mean of the `lifeExp` column".

However, like all of the other functions we have used in this chapter, the output of `summarize()` function is itself a data frame (albeit with just a single row and column). But notice that the name of the column in our summary data frame is just the function that was computed, `mean(lifeExp)`. Wouldn't it be nice if we could give this column a nicer name? Fortunately, this is super easy to do by providing a name for our summary operation inside the summary() function:

```
gapminder |> summarize(mean_life_exp = mean(lifeExp))
```

```
# A tibble: 1 x 1
  mean_life_exp
          <dbl>
1          59.5
```

In this version, our one-row-one-column data frame has the column name `mean_life_exp`, instead of `mean(lifeExp)`.

It's also super easy to compute multiple summaries at once using our trusty comma:

```
gapminder |>
  summarize(mean_life_exp = mean(lifeExp),
            max_population = max(pop))
```

```
# A tibble: 1 x 2
  mean_life_exp max_population
          <dbl>          <dbl>
1          59.5     1318683096
```

You don't have to put each summary computation on a new line as I did here, but it makes it a bit easier to read (e.g., compared with `summarize(mean_life_exp = mean(lifeExp), max_population = max(pop))`).

6.15 Grouped operations with group_by()

Computing a `summary()` operation across all of the rows at once is nice and all, but I'll forgive you if you're sitting there thinking "Ok Rebecca, I know you love the tidyverse, and you want to pipe everything into everything else, but honestly it's just easier to use base R notation to do this, like:"

```
mean(gapminder$lifeExp)
```

```
[1] 59.47444
```

And my response to you would be: yeah. It is. But just wait. The next thing I'm going to show you will blow your mind.

What if I asked you to compute the average life expectancy again, but to do it separately *for each continent*.

While you could precede your `summarize()` operation with a `filter()` operation separately for each continent like this:

```
gapminder |> filter(continent == "Asia") |> summarize(mean(lifeExp))
```

```
# A tibble: 1 x 1
  `mean(lifeExp)`
            <dbl>
1            60.1
```

```
gapminder |> filter(continent == "Americas") |> summarize(mean(lifeExp))
```

```
# A tibble: 1 x 1
  `mean(lifeExp)`
            <dbl>
1            64.7
```

```
gapminder |> filter(continent == "Africa") |> summarize(mean(lifeExp))
```

```
# A tibble: 1 x 1
  `mean(lifeExp)`
            <dbl>
1            48.9
```

```
gapminder |> filter(continent == "Europe") |> summarize(mean(lifeExp))
```

```
# A tibble: 1 x 1
  `mean(lifeExp)`
            <dbl>
1            71.9
```

```
gapminder |> filter(continent == "Oceania") |> summarize(mean(lifeExp))
```

```
# A tibble: 1 x 1
  `mean(lifeExp)`
            <dbl>
1            74.3
```

Or even use a "for" loop (if you so desired...), it turns out that there is a better way!

The true value of the `summarize()` function lies in its friendship with the `group_by()` function. The following code concisely computes the average `lifeExp` separately for each `continent` by "grouping" the `gapminder` data frame by `continent` (using `group_by()`) *before* summarizing.

```
gapminder |>
  group_by(continent) |>
  summarize(mean_life_exp = mean(lifeExp))
```

```
# A tibble: 5 x 2
  continent mean_life_exp
  <chr>             <dbl>
1 Africa             48.9
2 Americas           64.7
3 Asia               60.1
4 Europe             71.9
5 Oceania            74.3
```

You can think about this as if `group_by()` is creating a separate data frame for each `continent` value and then it is computing the `summarize()` operation *separately* for each continent data frame, and it is then combining the summary output into a two-column data frame, where the first column contains the respective `continent` value, and the second column contains the result of the `summary()` operation for that particular continent.

Now that's rad as heck!

6.16 Exercise

Use group_by() and summarize() to compute the standard deviation of the `gdpPercap` column separately for each country.

Your output should look like this:

```
# A tibble: 142 x 2
   country     sd_gdp
   <chr>        <dbl>
 1 Afghanistan   978.
 2 Albania      5937.
 3 Algeria      6223.
 4 Angola       5523.
 5 Argentina   12779.
 6 Australia   34435.
 7 Austria     36126.
 8 Bahrain     29796.
 9 Bangladesh   1391.
10 Belgium     33693.
# i 132 more rows
```

6.17 Solution

```
gapminder |>
  group_by(country) |>
  summarize(sd_gdp = max(gdpPercap))
```

```
# A tibble: 142 x 2
   country     sd_gdp
   <chr>        <dbl>
 1 Afghanistan   978.
 2 Albania      5937.
 3 Algeria      6223.
 4 Angola       5523.
 5 Argentina   12779.
 6 Australia   34435.
 7 Austria     36126.
 8 Bahrain     29796.
 9 Bangladesh   1391.
10 Belgium     33693.
# i 132 more rows
```

6.17.1 Grouping by multiple columns simultaneously

Just in case you weren't already impressed enough by the `group_by()`/`summarize()` duo, you can also do more sophisticated grouping operations, such as computing the average `lifeExp` for each continent-year *combination* by grouping by both `continent` and `year`:

```
# compute the average life expectancy for each continent-year combination
gapminder |>
  group_by(continent, year) |>
  summarize(mean_life_exp = mean(lifeExp))
```

```
`summarise()` has grouped output by 'continent'. You can override using the
`.groups` argument.
```

```
# A tibble: 60 x 3
# Groups:   continent [5]
   continent  year mean_life_exp
   <chr>     <dbl>         <dbl>
 1 Africa     1952          39.1
```

```
 2 Africa     1957          41.3
 3 Africa     1962          43.3
 4 Africa     1967          45.3
 5 Africa     1972          47.5
 6 Africa     1977          49.6
 7 Africa     1982          51.6
 8 Africa     1987          53.3
 9 Africa     1992          53.6
10 Africa     1997          53.6
# i 50 more rows
```

With `filter()`, `mutate()`, `group_by()`, and `summarize()` up your sleeve, there is almost no summarization of your data you can't do!

6.18 Exercise

Compute the mean and standard deviation of the GDP (the product of `pop` and `gdpPercap`) separately for each continent and year after the year 2000. Your output should look like this:

```
# A tibble: 10 x 3
# Groups:   continent [5]
   continent  year   `mean(gdp)`
   <chr>     <dbl>         <dbl>
 1 Africa     2002  35303511424.
 2 Africa     2007  45778570846.
 3 Americas   2002 661248623419.
 4 Americas   2007 776723426068.
 5 Asia       2002 458042336179.
 6 Asia       2007 627513635079.
 7 Europe     2002 436448815097.
 8 Europe     2007 493183311052.
 9 Oceania    2002 345236880176.
10 Oceania    2007 403657044512.
```

6.19 Hint

My suggested order of operations is

```
gapminder |>
  filter() |>
  mutate() |>
  group_by() |>
  summarize()
```

6.20 Solution

```
gapminder |>
  filter(year > 2000) |>
  mutate(gdp = pop * gdpPercap) |>
  group_by(continent, year) |>
  summarize(mean(gdp))
```

```
`summarise()` has grouped output by 'continent'. You can override using the
`.groups` argument.

# A tibble: 10 x 3
# Groups:   continent [5]
   continent  year   `mean(gdp)`
   <chr>     <dbl>         <dbl>
 1 Africa     2002  35303511424.
 2 Africa     2007  45778570846.
 3 Americas   2002 661248623419.
 4 Americas   2007 776723426068.
 5 Asia       2002 458042336179.
 6 Asia       2007 627513635079.
 7 Europe     2002 436448815097.
 8 Europe     2007 493183311052.
 9 Oceania    2002 345236880176.
10 Oceania    2007 403657044512.
```

6.20.1 Grouped mutates

Although `group_by()` is most often used with `summarize()`, this doesn't mean that it can *only* be used with `summarize()`!

Below, I group by `continent` and then conduct a `mutate()` to add a new column `max_life_exp`, containing the maximum life expectancy for the corresponding country. This time, I save the resulting data frame in a new variable called `gapminder_new`:

```r
gapminder_new <- gapminder |>
  group_by(country) |>
  mutate(max_life_exp = max(lifeExp))
# print the first 30 rows of gapminder
print(gapminder_new, n = 30)
```

```
# A tibble: 1,704 x 7
# Groups:   country [142]
   country     continent  year lifeExp      pop gdpPercap max_life_exp
   <chr>       <chr>     <dbl>   <dbl>    <dbl>     <dbl>        <dbl>
 1 Afghanistan Asia       1952    28.8  8425333      779.         43.8
 2 Afghanistan Asia       1957    30.3  9240934      821.         43.8
 3 Afghanistan Asia       1962    32.0 10267083      853.         43.8
 4 Afghanistan Asia       1967    34.0 11537966      836.         43.8
 5 Afghanistan Asia       1972    36.1 13079460      740.         43.8
 6 Afghanistan Asia       1977    38.4 14880372      786.         43.8
 7 Afghanistan Asia       1982    39.9 12881816      978.         43.8
 8 Afghanistan Asia       1987    40.8 13867957      852.         43.8
 9 Afghanistan Asia       1992    41.7 16317921      649.         43.8
10 Afghanistan Asia       1997    41.8 22227415      635.         43.8
11 Afghanistan Asia       2002    42.1 25268405      727.         43.8
12 Afghanistan Asia       2007    43.8 31889923      975.         43.8
13 Albania     Europe     1952    55.2  1282697     1601.         76.4
14 Albania     Europe     1957    59.3  1476505     1942.         76.4
15 Albania     Europe     1962    64.8  1728137     2313.         76.4
16 Albania     Europe     1967    66.2  1984060     2760.         76.4
17 Albania     Europe     1972    67.7  2263554     3313.         76.4
18 Albania     Europe     1977    68.9  2509048     3533.         76.4
19 Albania     Europe     1982    70.4  2780097     3631.         76.4
20 Albania     Europe     1987    72    3075321     3739.         76.4
21 Albania     Europe     1992    71.6  3326498     2497.         76.4
22 Albania     Europe     1997    73.0  3428038     3193.         76.4
23 Albania     Europe     2002    75.7  3508512     4604.         76.4
24 Albania     Europe     2007    76.4  3600523     5937.         76.4
25 Algeria     Africa     1952    43.1  9279525     2449.         72.3
26 Algeria     Africa     1957    45.7 10270856     3014.         72.3
27 Algeria     Africa     1962    48.3 11000948     2551.         72.3
28 Algeria     Africa     1967    51.4 12760499     3247.         72.3
29 Algeria     Africa     1972    54.5 14760787     4183.         72.3
30 Algeria     Africa     1977    58.0 17152804     4910.         72.3
# i 1,674 more rows
```

Take a close look at the new `max_life_exp` column that I've tacked onto the end of my data frame. Notice that it contains a single value for each country corresponding to the average `lifeExp` value computed using just the rows for that country.

6.20.2 Don't forget to `ungroup()`

So we've got our `gapminder_new` object that contains our `max_life_exp` column which contains the maximum life expectancy value where the average is computed just using the corresponding country's rows.

If I then wanted to conduct a subsequent summarize operation on this `gapminder_new` object, such as computing the mean of this new `max_life_exp` value, with the goal of computing this average *over all rows in the data* (i.e., I should get a single value), I might write the following code:

```
gapminder_new |> summarize(mean(max_life_exp))
```

```
# A tibble: 142 x 2
   country     `mean(max_life_exp)`
   <chr>                      <dbl>
 1 Afghanistan                 43.8
 2 Albania                     76.4
 3 Algeria                     72.3
 4 Angola                      42.7
 5 Argentina                   75.3
 6 Australia                   81.2
 7 Austria                     79.8
 8 Bahrain                     75.6
 9 Bangladesh                  64.1
10 Belgium                     79.4
# i 132 more rows
```

Is there anything surprising about the output here? The `summary()` operation is still *grouped by country*, even though I didn't conduct another `group_by(country)` operation before my `summarize()` operation!

This is because `gapminder_new` is not technically a simple data frame… it is a *grouped* data frame. Notice the text at the top of the output:

```
gapminder_new
```

```
# A tibble: 1,704 x 7
# Groups:   country [142]
   country     continent  year lifeExp      pop gdpPercap max_life_exp
   <chr>       <chr>     <dbl>   <dbl>    <dbl>     <dbl>        <dbl>
 1 Afghanistan Asia       1952    28.8  8425333      779.         43.8
 2 Afghanistan Asia       1957    30.3  9240934      821.         43.8
 3 Afghanistan Asia       1962    32.0 10267083      853.         43.8
 4 Afghanistan Asia       1967    34.0 11537966      836.         43.8
 5 Afghanistan Asia       1972    36.1 13079460      740.         43.8
 6 Afghanistan Asia       1977    38.4 14880372      786.         43.8
 7 Afghanistan Asia       1982    39.9 12881816      978.         43.8
 8 Afghanistan Asia       1987    40.8 13867957      852.         43.8
 9 Afghanistan Asia       1992    41.7 16317921      649.         43.8
10 Afghanistan Asia       1997    41.8 22227415      635.         43.8
# i 1,694 more rows
```

It says `# Groups:  country [142]`, which tells me that `gapminder_new` is *grouped* by the country column (and there are 142 groups). This means that any subsequent operations that I conduct on `gapminder_new` will also be grouped (by `country`).

If you are going to continue working with a data frame that was created using a `group_by()` operation, it is important to remember to `ungroup()`, unless you also want your subsequent operations to be grouped:

```
gapminder_new |>
  ungroup() |>
  summarize(mean(max_life_exp))
```

```
# A tibble: 1 x 1
  `mean(max_life_exp)`
                 <dbl>
1                 68.0
```

I could write all of this code without defining my intermediate `gapminder_new` object as follows:

```
gapminder |>
  group_by(country) |>
  mutate(max_life_exp = max(lifeExp)) |>
  ungroup() |>
  summarize(mean(max_life_exp))
```

```
# A tibble: 1 x 1
  `mean(max_life_exp)`
                 <dbl>
1                 68.0
```

But if I forgot the `ungroup()` operation (the second-last line above), I get:

```
gapminder |>
  group_by(country) |>
  mutate(max_life_exp = max(lifeExp)) |>
  summarize(mean(max_life_exp))
```

```
# A tibble: 142 x 2
   country     `mean(max_life_exp)`
   <chr>                      <dbl>
 1 Afghanistan                 43.8
 2 Albania                     76.4
 3 Algeria                     72.3
 4 Angola                      42.7
 5 Argentina                   75.3
 6 Australia                   81.2
 7 Austria                     79.8
 8 Bahrain                     75.6
 9 Bangladesh                  64.1
10 Belgium                     79.4
# i 132 more rows
```

6.20.3 Grouped filtering

You can also conduct grouped filtering, which will apply your filter condition separately for each group. The most common scenario in which I find myself doing this is when I want to do something like filtering to the row in each group with the maximum value in one of the columns, such as filtering to the rows with the highest `lifeExp` separately *within each continent*:

```
gapminder |>
  group_by(continent) |>
  filter(lifeExp == max(lifeExp))
```

```
# A tibble: 5 x 6
# Groups:   continent [5]
```

```
  country   continent  year lifeExp       pop gdpPercap
  <chr>     <chr>     <dbl>   <dbl>     <dbl>     <dbl>
1 Australia Oceania    2007    81.2  20434176    34435.
2 Canada    Americas   2007    80.7  33390141    36319.
3 Iceland   Europe     2007    81.8    301931    36181.
4 Japan     Asia       2007    82.6 127467972    31656.
5 Reunion   Africa     2007    76.4    798094     7670.
```

6.21 Count

Another really useful function is `count()`, which is used to summarize categorical (character/factor) variables.

`count()` creates a two-column data frame, where the first column displays the unique values of the provided column from the original data frame, and the second column, `n`, contains the number of times that each unique value appears:

```
gapminder |>
  count(continent)
```

```
# A tibble: 5 x 2
  continent     n
  <chr>     <int>
1 Africa      624
2 Americas    300
3 Asia        396
4 Europe      360
5 Oceania      24
```

This shows that the `"Africa"` continent value appears in the data 624 times, the `"Americas"` continent value appears 300 times, and so on.

6.22 Arrange

The final function I will show you in this chapter is `arrange()`, which lets you arrange the rows of your data frame in ascending or descending order of the values in a specific column. By default, `arrange()` will arrange the rows in ascending order of the values in the provided column.

The following code will rearrange all of the rows so that the row with the smallest `lifeExp` value will be at the top and the row with the largest `lifeExp` value will be at the bottom:

```
gapminder |>
  arrange(lifeExp)
```

```
# A tibble: 1,704 x 6
   country      continent  year lifeExp     pop gdpPercap
   <chr>        <chr>     <dbl>   <dbl>   <dbl>     <dbl>
 1 Rwanda       Africa     1992    23.6 7290203      737.
 2 Afghanistan  Asia       1952    28.8 8425333      779.
 3 Gambia       Africa     1952    30    284320      485.
 4 Angola       Africa     1952    30.0 4232095     3521.
 5 Sierra Leone Africa     1952    30.3 2143249      880.
 6 Afghanistan  Asia       1957    30.3 9240934      821.
 7 Cambodia     Asia       1977    31.2 6978607      525.
 8 Mozambique   Africa     1952    31.3 6446316      469.
 9 Sierra Leone Africa     1957    31.6 2295678     1004.
10 Burkina Faso Africa     1952    32.0 4469979      543.
# i 1,694 more rows
```

For some reason, the way that you specify that the rows should be arranged in *descending* order instead is to wrap the variable name in the `desc()` function. The following code will arrange the `gapminder` rows so that the row with the largest `lifeExp` value will be at the top and the row with the smallest `lifeExp` value will be at the bottom:

```
gapminder |>
  arrange(desc(lifeExp))
```

```
# A tibble: 1,704 x 6
   country          continent  year lifeExp       pop gdpPercap
   <chr>            <chr>     <dbl>   <dbl>     <dbl>     <dbl>
 1 Japan            Asia       2007    82.6 127467972    31656.
 2 Hong Kong, China Asia       2007    82.2   6980412    39725.
 3 Japan            Asia       2002    82   127065841    28605.
 4 Iceland          Europe     2007    81.8    301931    36181.
 5 Switzerland      Europe     2007    81.7   7554661    37506.
 6 Hong Kong, China Asia       2002    81.5   6762476    30209.
 7 Australia        Oceania    2007    81.2  20434176    34435.
 8 Spain            Europe     2007    80.9  40448191    28821.
 9 Sweden           Europe     2007    80.9   9031088    33860.
10 Israel           Asia       2007    80.7   6426679    25523.
# i 1,694 more rows
```

Technically, you could also arrange by the negative of the column to arrange in descending order, but I usually use the `desc()` approach.

```
gapminder |>
  arrange(-lifeExp)
```

```
# A tibble: 1,704 x 6
   country          continent  year lifeExp       pop gdpPercap
   <chr>            <chr>     <dbl>   <dbl>     <dbl>     <dbl>
 1 Japan            Asia       2007    82.6 127467972    31656.
 2 Hong Kong, China Asia       2007    82.2   6980412    39725.
 3 Japan            Asia       2002    82   127065841    28605.
 4 Iceland          Europe     2007    81.8    301931    36181.
 5 Switzerland      Europe     2007    81.7   7554661    37506.
 6 Hong Kong, China Asia       2002    81.5   6762476    30209.
 7 Australia        Oceania    2007    81.2  20434176    34435.
 8 Spain            Europe     2007    80.9  40448191    28821.
 9 Sweden           Europe     2007    80.9   9031088    33860.
10 Israel           Asia       2007    80.7   6426679    25523.
# i 1,694 more rows
```

Here are a bunch of challenging exercises for you to test your dplyr skills. These are intentionally hard!

6.23 Exercise

Compute the *median* `lifeExp` and maximum `pop` values for each country, and then arrange the countries in descending order of their maximum `pop` value.

6.24 Solution

```
gapminder |>
  group_by(country) |>
  summarize(median_life_exp = median(lifeExp),
            max_pop = max(pop)) |>
  arrange(desc(max_pop))
```

```
# A tibble: 142 x 3
   country       median_life_exp    max_pop
   <chr>                   <dbl>      <dbl>
 1 China                    64.7 1318683096
 2 India                    55.4 1110396331
 3 United States            74.0  301139947
 4 Indonesia                54.4  223547000
 5 Brazil                   62.4  190010647
 6 Pakistan                 55.1  169270617
 7 Bangladesh               48.5  150448339
 8 Nigeria                  45.2  135031164
 9 Japan                    76.2  127467972
10 Mexico                   66.2  108700891
# i 132 more rows
```

6.25 Exercise

Identify the 5 countries with the highest *average* life expectancy.

6.26 Solution

```
gapminder |>
  group_by(country) |>
  summarize(mean_life_exp = mean(lifeExp)) |>
  ungroup() |>
  arrange(desc(mean_life_exp)) |>
  head(5)
```

```
# A tibble: 5 x 2
  country     mean_life_exp
  <chr>               <dbl>
1 Iceland              76.5
2 Sweden               76.2
3 Norway               75.8
4 Netherlands          75.6
5 Switzerland          75.6
```

6.27 Exercise

What are the three most populous countries on the “Asia” continent?

6.28 Solution

```
gapminder |>
  filter(continent == "Asia") |>
  group_by(country) |>
  summarize(max_pop = max(pop)) |>
  ungroup() |>
  arrange(desc(max_pop)) |>
  head(3)
```

```
# A tibble: 3 x 2
  country      max_pop
  <chr>          <dbl>
1 China     1318683096
2 India     1110396331
3 Indonesia  223547000
```

6.29 Exercise

Identify the country with the highest total GDP for each continent.

6.30 Hint

Apply a `filter()` after a `group_by()` – this will apply the filtering separately for each group.

6.31 Solution

These are the countries with the highest total GDP for each continent:

```r
gapminder |>
  mutate(gdp = gdpPercap * pop) |>
  group_by(continent) |>
  filter(gdp == max(gdp)) |>
  select(country, continent, gdp)
```

```
# A tibble: 5 x 3
# Groups:   continent [5]
  country       continent     gdp
  <chr>         <chr>       <dbl>
1 Australia     Oceania   7.04e11
2 China         Asia      6.54e12
3 Egypt         Africa    4.48e11
4 Germany       Europe    2.65e12
5 United States Americas  1.29e13
```

6.32 Exercise

Compute the average GDP per capita for each continent based only on countries with `gdpPercap` greater than 20,000.

6.33 Solution

```r
gapminder |>
  filter(gdpPercap > 20000) |>
  group_by(continent) |>
  summarize(mean(gdpPercap))
```

```
# A tibble: 5 x 2
  continent `mean(gdpPercap)`
  <chr>                 <dbl>
1 Africa               21569.
2 Americas             29810.
3 Asia                 37442.
4 Europe               27639.
5 Oceania              25857.
```

7 Visualization with ggplot2

Now that we have learned how to manipulate our data, it's time to learn how to visualize it!

The "one tool to rule them all" for data visualization in R is the ggplot2 library, originally created by Hadley Wickham. Ggplot2's "layered grammar of graphics" equips us with a grammar for data visualization that is similar to the grammar we learned for data manipulation, which used the pipe to add dplyr operations together.

The "*gg*" in "*ggplot2*" stands for "*grammar of graphics*" and the "*2*" stands for "*2*" (as in, this is the second iteration of the ggplot library that Hadley Wickham created, the first being lost to the ether.)

In this chapter, we're going to continue working with the gapminder dataset, and since this is a new quarto document, to do that, we need to load it again:

```
library(tidyverse)
gapminder <- read_csv("data/gapminder.csv")
gapminder
```

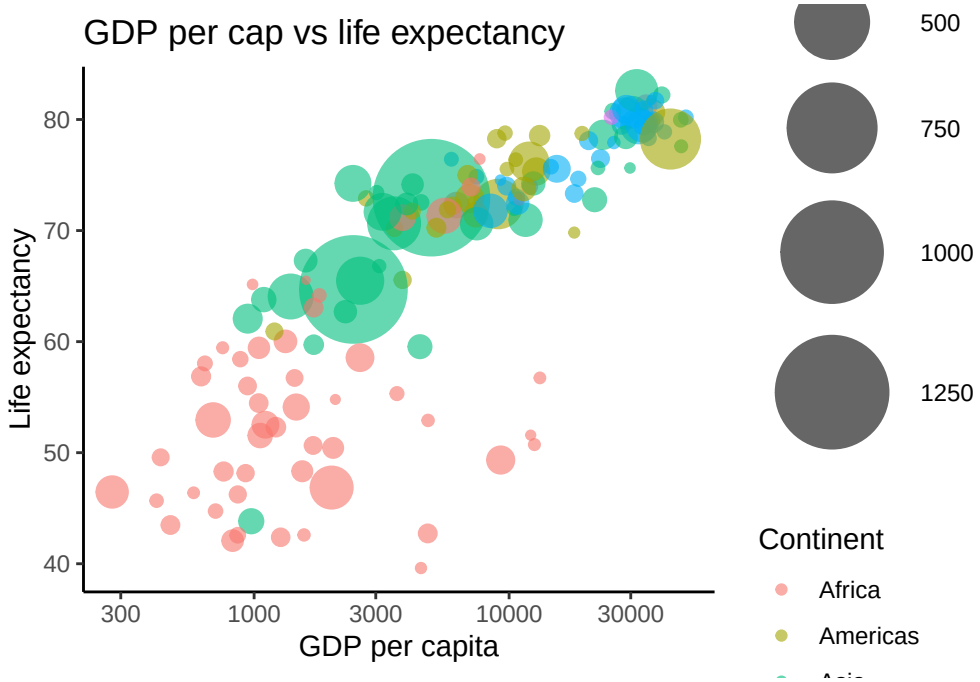
```
# A tibble: 1,704 x 6
   country     continent  year lifeExp      pop gdpPercap
   <chr>       <chr>     <dbl>   <dbl>    <dbl>     <dbl>
 1 Afghanistan Asia       1952    28.8  8425333      779.
 2 Afghanistan Asia       1957    30.3  9240934      821.
 3 Afghanistan Asia       1962    32.0 10267083      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.
# i 1,694 more rows
```

Note that I also loaded the tidyverse library again–it turns out that ggplot2, like the dplyr package from the previous chapter, is one of the core tidyverse packages. This means that

rather than loading ggplot2 independently (`library(ggplot2)`), I typically just load the tidyverse library instead (`library(tidyverse)`), which will simultaneously load both the ggplot2 library and the dplyr library (along with a few others).

Our goal in this chapter is to learn how to write the code to create publication-ready data visualizations (as well as quick-and-dirty non-publication-ready visualizations–but those are less impressive). For example, with just a few lines of ggplot2 code, you can create this figure (click the "code" button to see the code):

```
gapminder |>
  filter(year == 2007) |>
  ggplot() +
  geom_point(aes(x = gdpPercap,
                 y = lifeExp,
                 color = continent,
                 size = pop / 1000000),
             alpha = 0.6) +
  scale_x_log10() +
  scale_size_continuous(range = c(1, 20)) +
  labs(x = "GDP per capita",
       y = "Life expectancy",
       title = "GDP per cap vs life expectancy",
       size = "Population (millions)",
       color = "Continent") +
  theme_classic()
```



By the end of this chapter, you will be able to create a version of this plot yourself! However, it is worth noting what this chapter *won't* cover, which is the actual principles for creating effective data visualizations that tell a compelling story, and deciding *which* data visualizations to use to answer your specific question (or how to come up with good questions, for that matter). While I'd love to cover these things here, at the end of the day, this is an R book, which teaches you how to do practical things in R.

Fortunately, there are many resources that *do* teach these things, such as Storytelling with Data by Cole Nussbaumer Knaflic, which is a favorite of mine (and a great resource for learning how to produce effective graphics in general) and even the chapter on data visualization of my book with Bin Yu, Veridical Data Science.

7.1 The layered grammar of graphics

To create a ggplot figure, you start by creating an empty ggplot2 "canvas" using the `ggplot()` function. Our "canvas" here is the following grey box:

```
ggplot()
```

The first thing I need to do is to tell ggplot which dataset object (a data frame/tibble) to use to create my plot, and I do that by providing the name of my data object as the argument of `ggplot()`:

```
ggplot(gapminder)
```

Nothing has changed on our canvas, but now, when we add some "layers" to our plot, ggplot now knows where to look for the variables that I will refer to.

To *add* a layer to my plot, I literally use the plus symbol, `+`. The name of the layer that creates a scatterplot is `geom_point()` (because a scatterplot is made up of a collection of "points").

I can add my points layer like this:

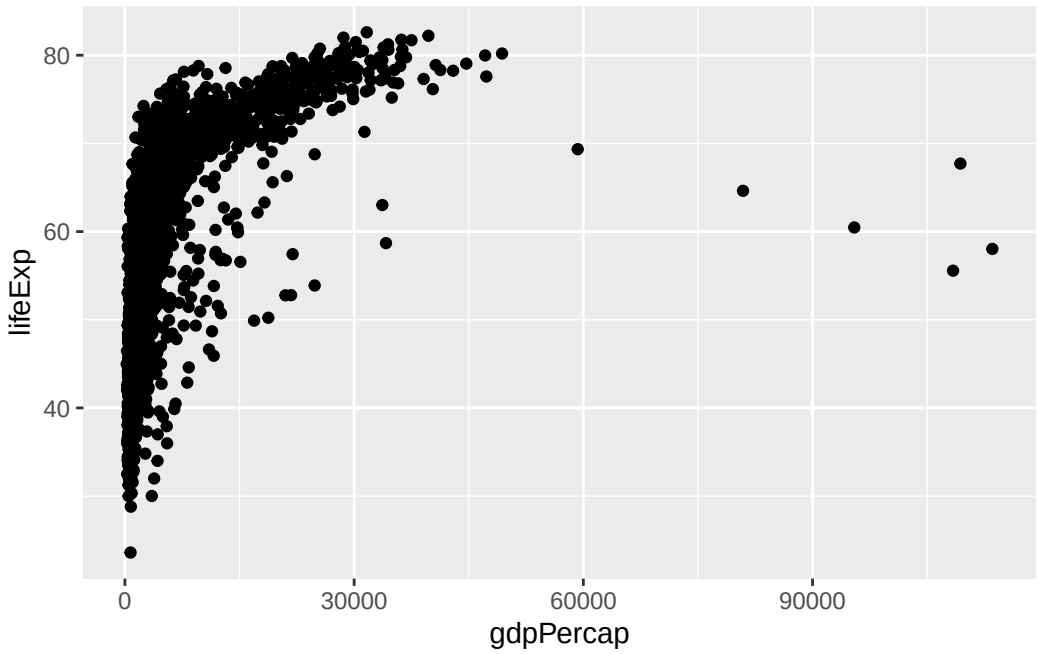
```
ggplot(gapminder) + geom_point()
```

```
Error in `geom_point()`:
! Problem while setting up geom.
i Error occurred in the 1st layer.
Caused by error in `compute_geom_1()`:
! `geom_point()` requires the following missing aesthetics: x and y.
```

But I got an error because I haven't told ggplot which columns/variables in my data I want to use to define my scatterplot. Specifically, I need to tell it which columns should define the x- and y-coordinates of my scatterplot points.

I do that by providing an "aesthetics", `aes()`, function as the argument of my points layer, in which I specify which column defines the x-coordinate (`x = gdpPercap`) and which column defines the y-coordinate (`y = lifeExp`).

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



Now we have our scatterplot, and ggplot has even very kindly provided x- and y-axis names!

Note the error that I get if I forget to place my `x` and `y` coordinates inside the `aes()` function, like this:

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

```
Error in eval(expr, envir, enclos): object 'gdpPercap' not found
```

Unfortunately, ggplot can only find your data frame columns (such as `gdpPercap`) when they are referenced inside the `aes()` function.

I like to think of the aesthetics function `aes()` as a secret code that tells ggplot that the objects I'm referring to are columns of my data frame.

A common mistake to make is to use a pipe `|>` instead of a `+` to add layers to your ggplot, like this:

```
ggplot(gapminder) |>
  geom_point(aes(x = gdpPercap, y = lifeExp))
```

```
Error in `geom_point()`:
! `mapping` must be created by `aes()`.
i Did you use `%>%` or `|>` instead of `+`?
```

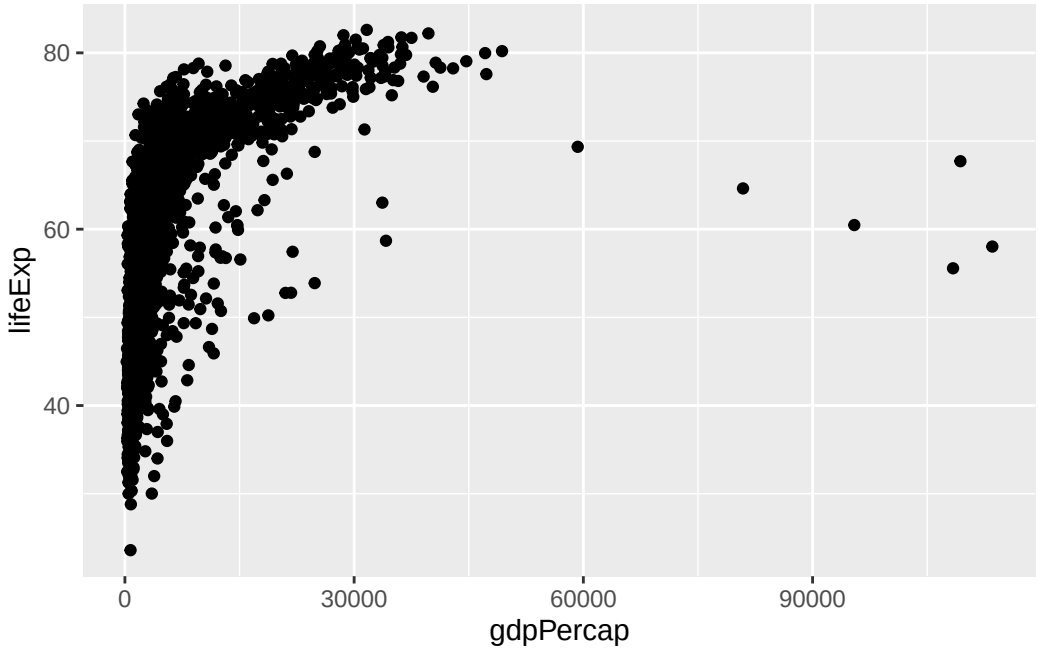
Fortunately, the error is quite helpful here–it says "*Did you use* `%>%` *or* `|>` *instead of* `+`*?*" This is hinting that the pipe on the first line of my code should have been a `+`.

If you remember that the pipe works by taking the object on its left-hand-side and placing it into the first argument of the function on its right-hand-side, then it kind of makes sense that the pipe doesn't work for creating layered ggplot objects.

The code `ggplot(gapminder) |> geom_point(aes(x = gdpPercap, y = lifeExp))` would be equivalent to `geom_point(ggplot(gapminder), aes(x = gdpPercap, y = lifeExp))`, but the `geom_point()` function doesn't want a `ggplot()` object as its first argument, it wants an `aes()` object!

Although I can't use the pipe `|>` to create my layered ggplot2 figure, the `ggplot()` function itself wants our data object (`gapminder`, in this case) as its first argument, so I *can* pipe my *data* into my `ggplot()` function like this:

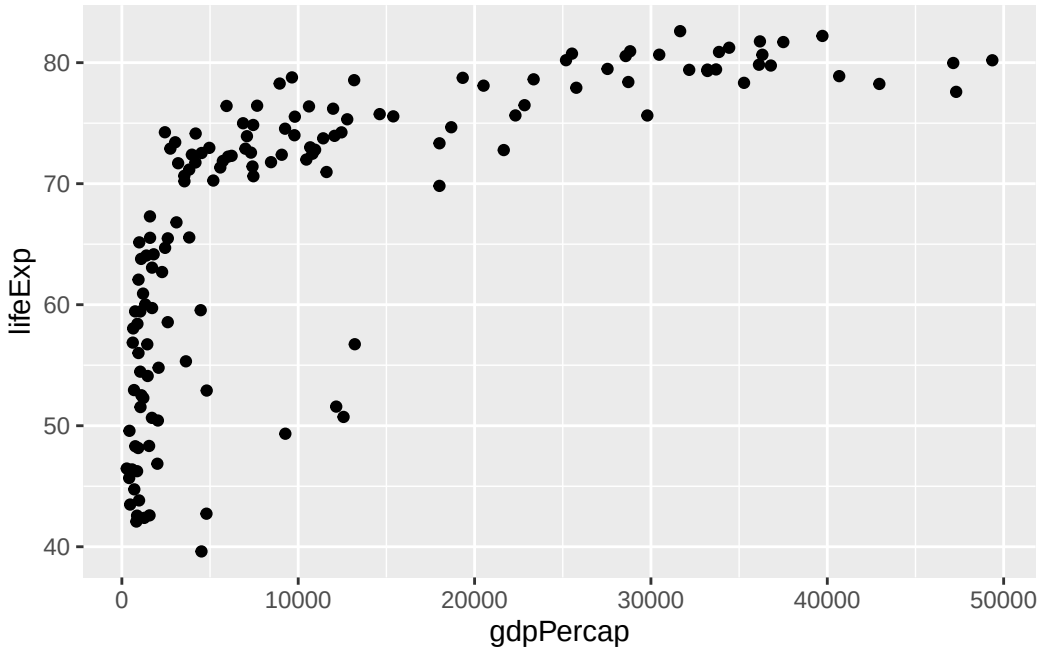
```
gapminder |>
  ggplot() +
  geom_point(aes(x = gdpPercap, y = lifeExp))
```



Why might I want to do this? I actually do this a lot, usually because I often want to make temporary minor modifications to my data before plotting it (but I don't necessarily want to create a new intermediate object).

For example, if I want to recreate the scatterplot above just for the year 2007, I could conduct a filter step and then pipe the resulting filtered data frame object into `ggplot()`:

```
gapminder |>
  filter(year == 2007) |>
  ggplot() +
  geom_point(aes(x = gdpPercap, y = lifeExp))
```



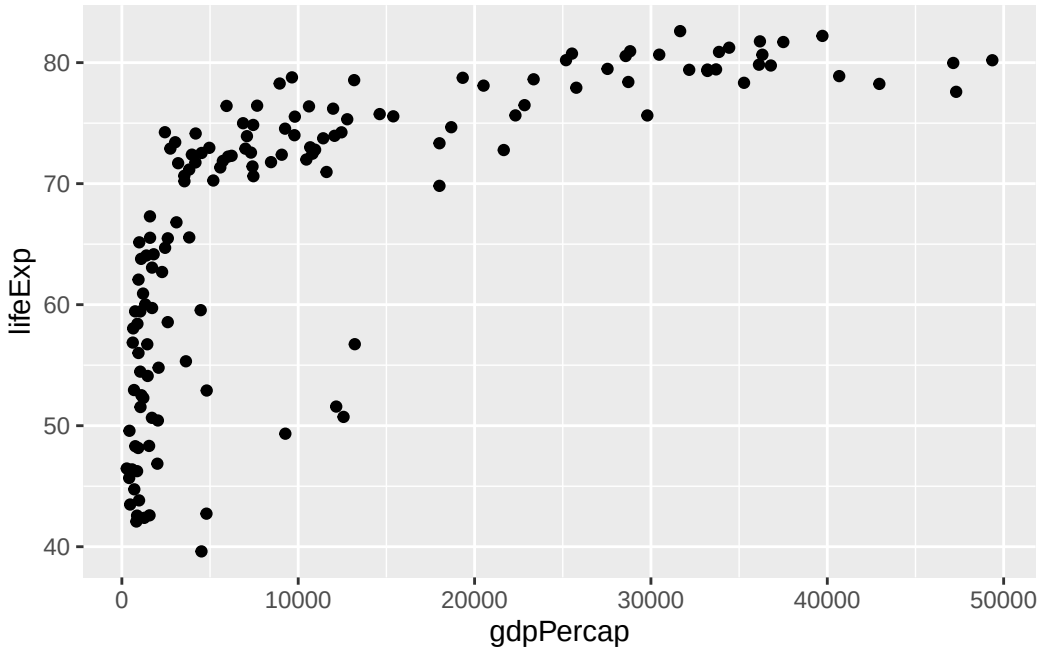
Pay attention to where I have used `|>` and `+` in the code above!

> ⚠ `+` versus `|>`
>
> Probably one of the most common errors I make when doing data analysis is getting confused about when I should use `+` and when I should use `|>`.
> When we are adding ggplot layers, we always use `+`, but when we are chaining functions together, we use the pipe, `|>`.
> To understand why, remember that the pipe, `|>` takes the object on the left and places it into the first argument of the function on the right. This is not what our ggplot2 functions are doing though, these are layering objects on top of one another, and so they use `+` instead of `|>`.

Alternatively, I could have defined a new object containing the `gapminder` data for 2007, and provided this filtered data frame object as the argument of the `ggplot()` function:

```
# define a new data frame
gapminder_2007 <- gapminder |> filter(year == 2007)
# provide this data frame as the argument of my ggplot() function
```

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



When do you think I might prefer to do the "all-at-once" approach:

```
gapminder |>
  filter(year == 2007) |>
  ggplot() +
  geom_point(aes(x = gdpPercap, y = lifeExp))
```

versus defining an intermediate `gapminder_2007` object and then creating my plot with `ggplot(gapminder_2007)`:

```
gapminder_2007 <- gapminder |> filter(year == 2007)
ggplot(gapminder_2007) +
  geom_point(aes(x = gdpPercap, y = lifeExp))
```

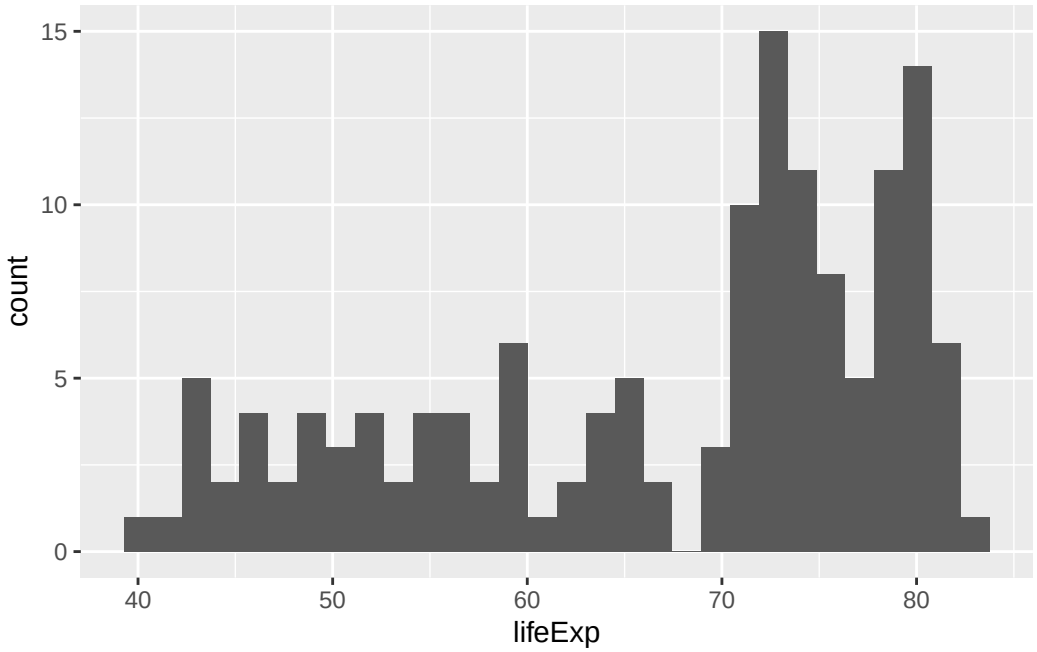
If I am going to use this filtered 2007 version of the data for anything other than this single plot (e.g., if I am going to create several plots using just the data from 2007), then I would prefer the latter approach, which defines the `gapminder_2007` object, rather than conducting the filtering every time. But if this is the only time I am going to use this 2007 data, then I would prefer the former approach, which avoids defining an unnecessary object, `gapminder_2007`.

In general, if you are going to be performing the same action multiple times, for example, to create several different plots, then it's more efficient to create an object that you can reuse.

Having defined `gapminder_2007`, I can now use it to create a new plot, this time a histogram of `lifeExp` values in 2007:

```
ggplot(gapminder_2007) +
  geom_histogram(aes(x = lifeExp))
```

```
`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



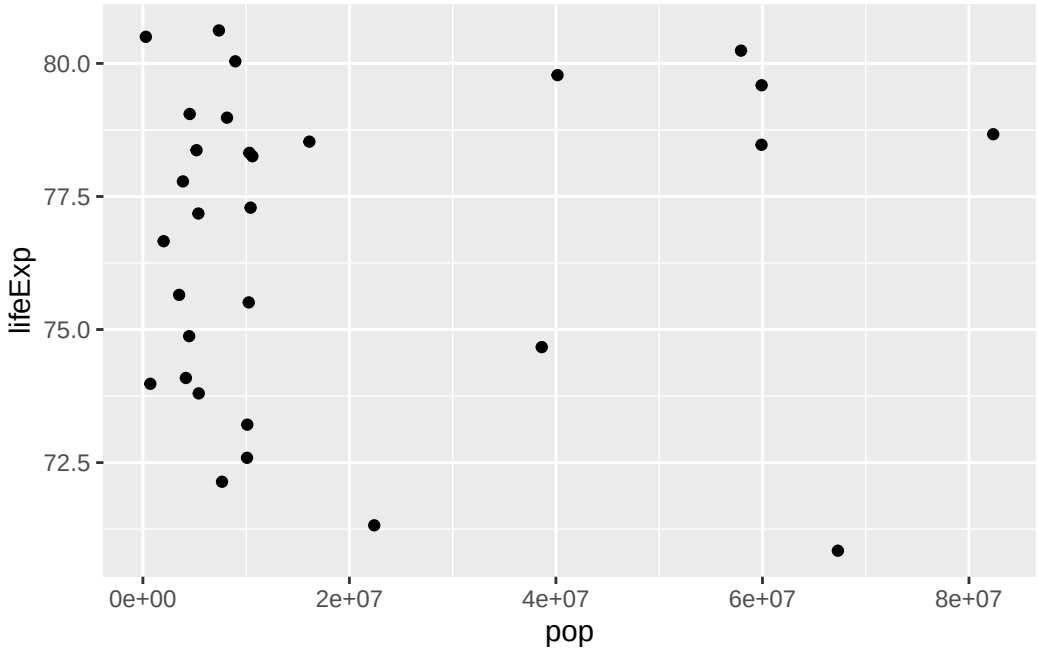
Note that to create a histogram using `geom_histogram()`, I just need to give it the x-axis variable, `lifeExp`, and it will do all of the binning and tallying up of counts needed to determine the y-axis for me.

7.2 Exercise

Create a ggplot scatterplot of population against life expectancy for all countries in Europe in 2002

7.3 Solution

```
gapminder |>
  filter(continent == "Europe", year == 2002) |>
  ggplot() +
  geom_point(aes(x = pop, y = lifeExp))
```



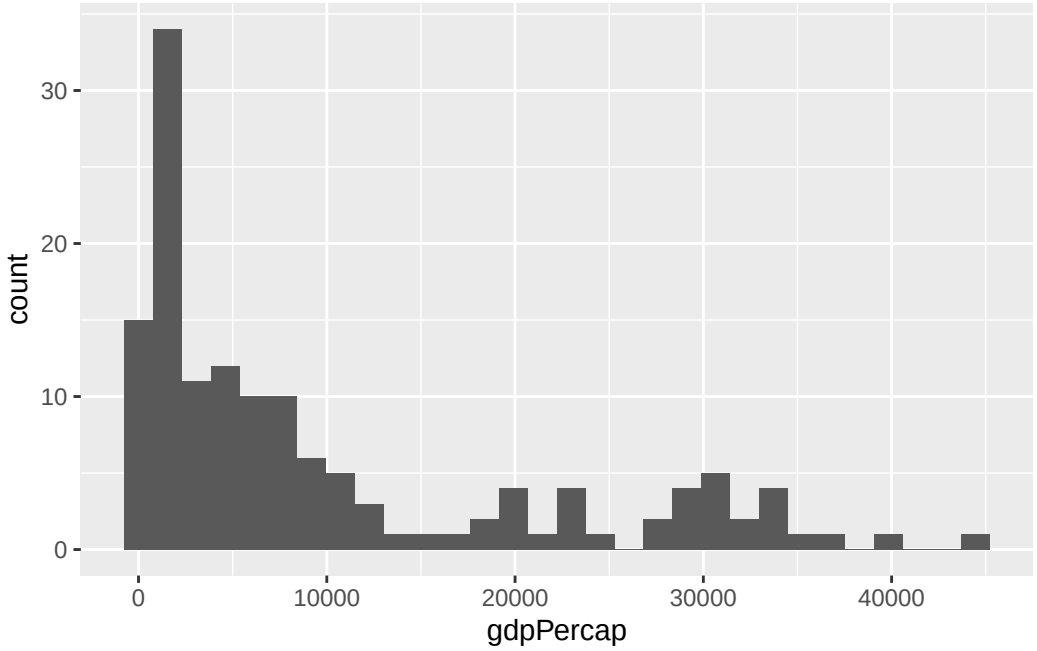
7.4 Exercise

Create a ggplot histogram of the GDP per capita in 2002

7.5 Solution

```
gapminder |>
  filter(year == 2002) |>
  ggplot() +
  geom_histogram(aes(x = gdpPercap))
```

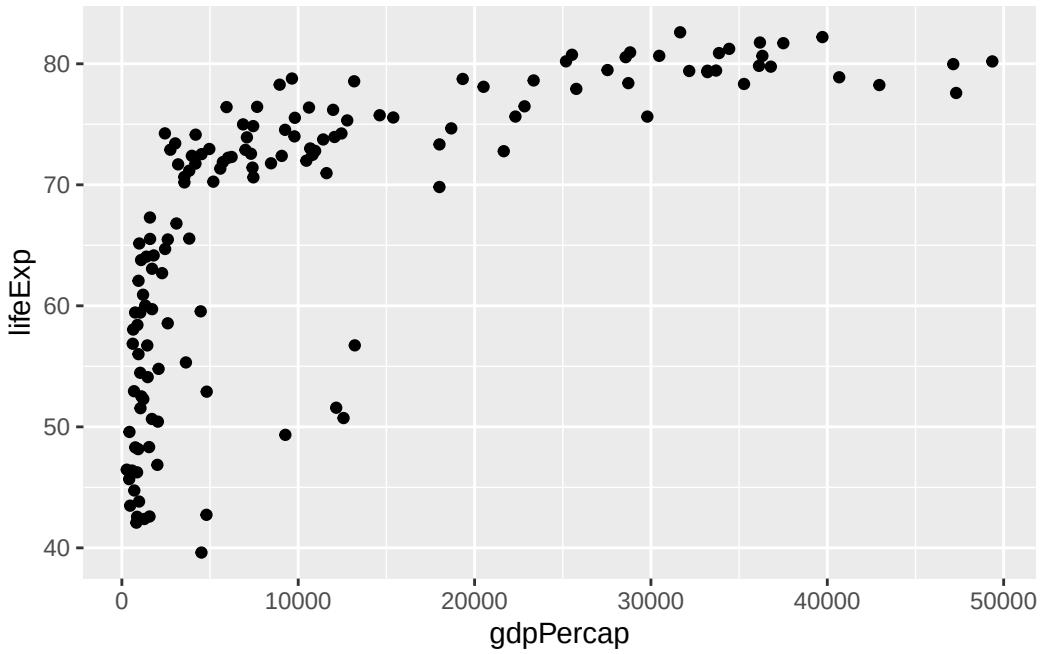
```
`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



7.6 Global versus local aesthetics

In the examples above, I provided the aesthetic properties as an argument of the `geom_point()` and `geom_histogram()` layers of my ggplot object. However, I could have provided these aesthetic properties inside the initial `ggplot()` function itself, leaving the `geom_point()` function without any arguments:

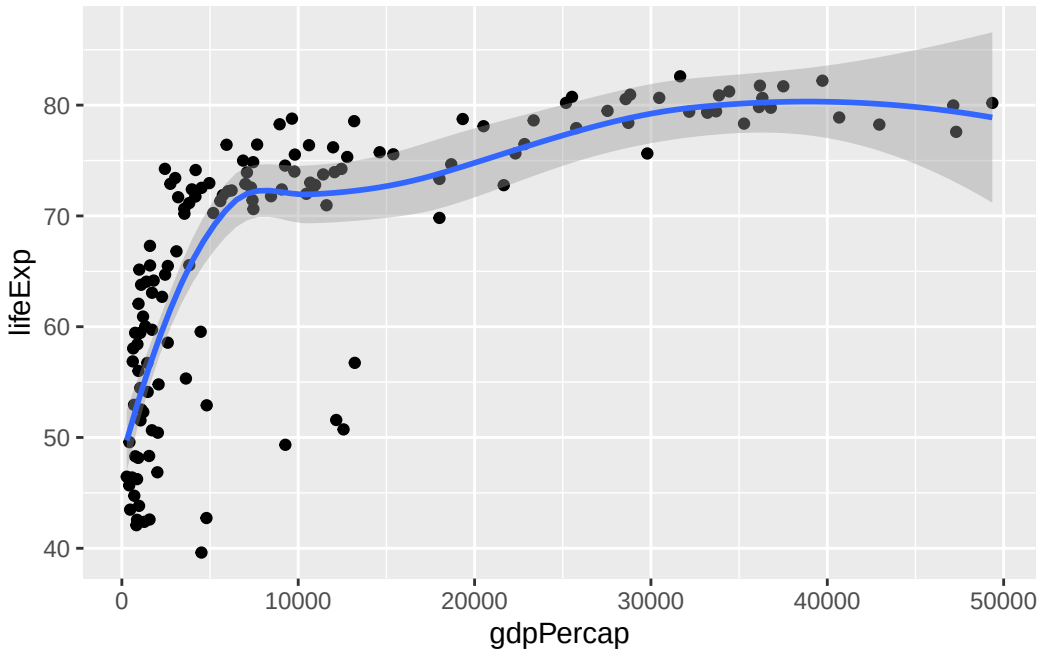
```
ggplot(gapminder_2007, aes(x = gdpPercap, y = lifeExp)) +
  geom_point()
```



This is common when you want to add many layers, all of which have the same aesthetic properties, for example, by adding a `geom_smooth()` layer, which will add a LOESS fitted curve to our scatterplot.

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

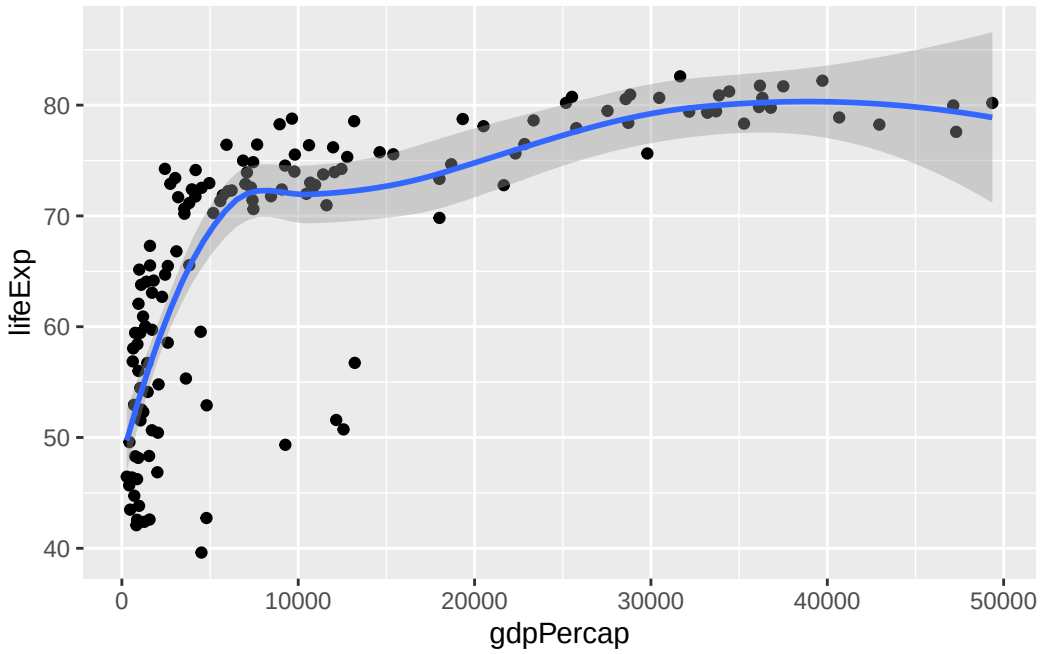
```
`geom_smooth()` using method = 'loess' and formula = 'y ~ x'
```



I could specify the aesthetic properties separately in each layer, but this is less efficient since it involves repeating the `aes(x = gdpPercap, y = lifeExp)` code in each layer like this:

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

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



When you specify the aesthetics inside the `ggplot()` function, you are specifying **global** aesthetics that will be applied to all layers of your ggplot figure, but when you specify the aesthetics inside the individual `geom_` layers, you are specifying **local** aesthetics that will be applied to that layer only.

For whatever reason, I tend to find myself mostly specifying local aesthetics unless I have many layers all of which are using the same aesthetics. This is just my personal preference though, and it may differ from yours.

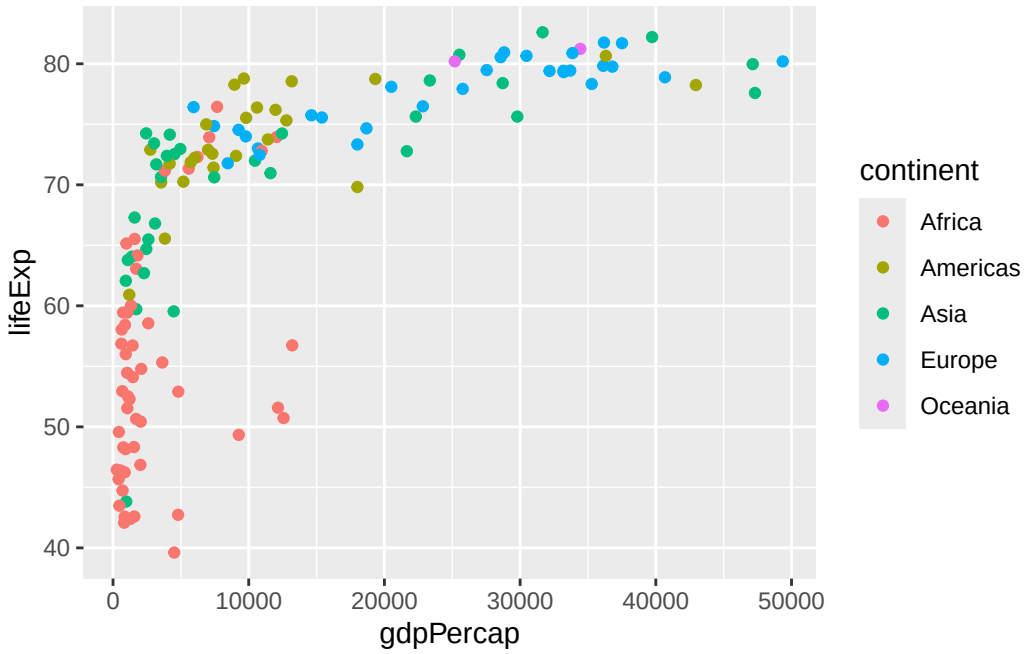
7.7 Additional ggplot2 aesthetics

So far we have seen that `x` and `y` are "aesthetic" properties of the points in a scatterplot, and `x` is an "aesthetic" property of the bars in a histogram. But they aren't the *only* aesthetic properties that we can specify.

For example, some other scatterplot aesthetic properties that we can specify include `color`, `size`, and `shape`.

You can specify the `color` of the points using the `color` aesthetic:

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

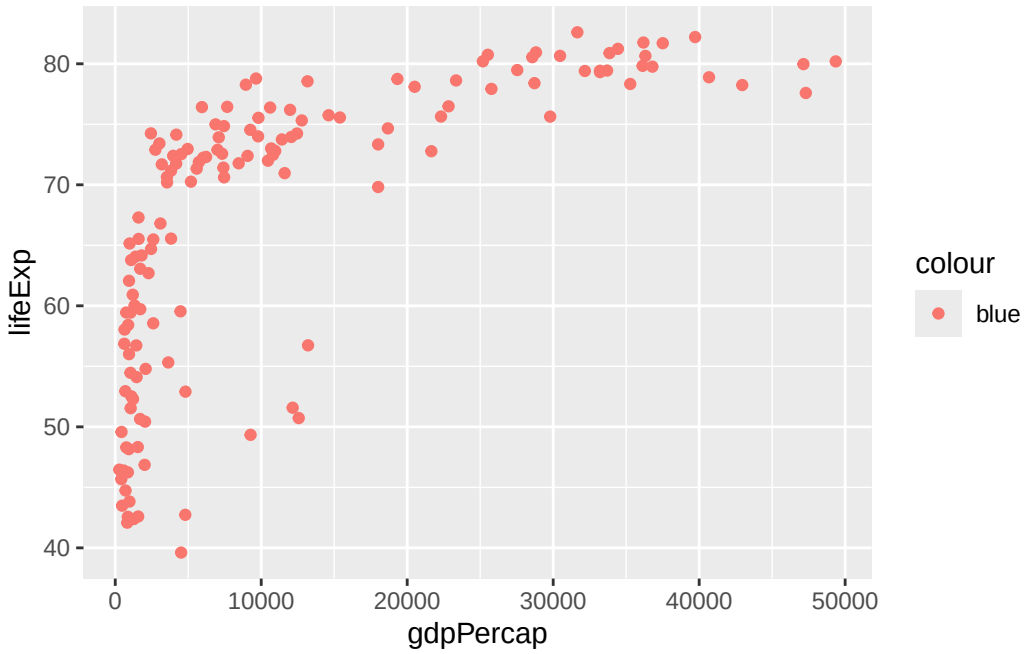


In this example, I'm specifying `color = continent` inside the `aes()` function, which, because it is inside the `aes()` function, tells ggplot2 that `continent` is a column in my data and that it should come up with a unique color for each unique `continent` value.

What if I wanted to just make all of the points in my scatterplot "blue", instead of based on the `continent` column?

If I just replace `color = continent` with `color = "blue"` (where I'm providing quotes around "blue" because I want to specifically pass the *character* value "blue"), I get pink-red (salmon?) points instead of blue points!

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

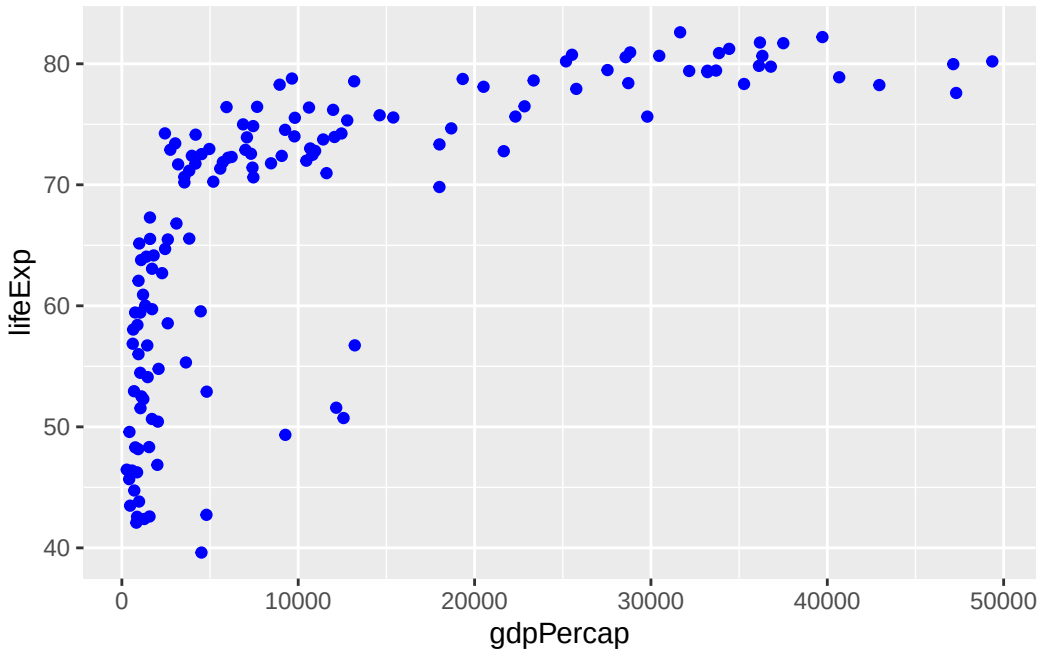


Why does this happen? The issue arises because a character value (rather than a column name) is provided inside the `aes()` function, which is intended for referencing columns of your data frame. When ggplot sees `"blue"` inside `aes()`, it temporarily creates a new column in the data frame filled entirely with the value `"blue"` for all data points. This effectively creates a categorical variable with only one category: `"blue"`.

Since this new "column" has just one unique value, ggplot assigns a single color to represent it. However, ggplot doesn't care what the value is–it just uses the first default color from the ggplot2 palette, which happens to be this nice salmony color (and definitely not blue).

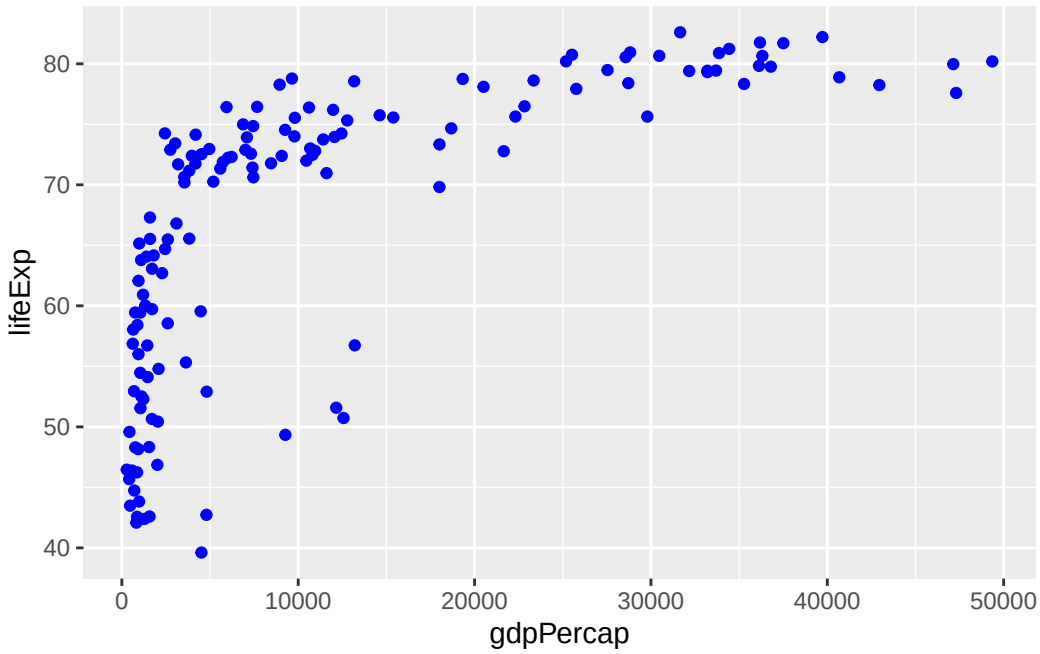
If you want to define an aesthetic of your plot that does *not* depend on a column in your data, you need to specify it *outside* the `aes()` function. So if we just move the `color = "blue"` argument *outside* `aes()`, we get what we wanted (pay close attention to the closing parentheses and compare with the code in the previous chunk):

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



Note that when I start having several aesthetic properties, I tend to place each one on its own line, but pay attention to the indentation of each line. Arguments of the inner `aes()` function, such as `x` and `y` are placed further to the right than arguments of the outer `geom_point()` function (such as `color`). RStudio will do this automatically for you when you hit "return" to move an argument to a new line. This indentation makes it a bit easier to see which arguments are for which function in a series of nested functions.

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



Keyboard shortcut for fixing code indentation

A handy keyboard shortcut for fixing the indentation of your code in RStudio is to highlight the misaligned code and use Cmd + I.
This shortcut will turn the following code with wacky nonsensical indentation:

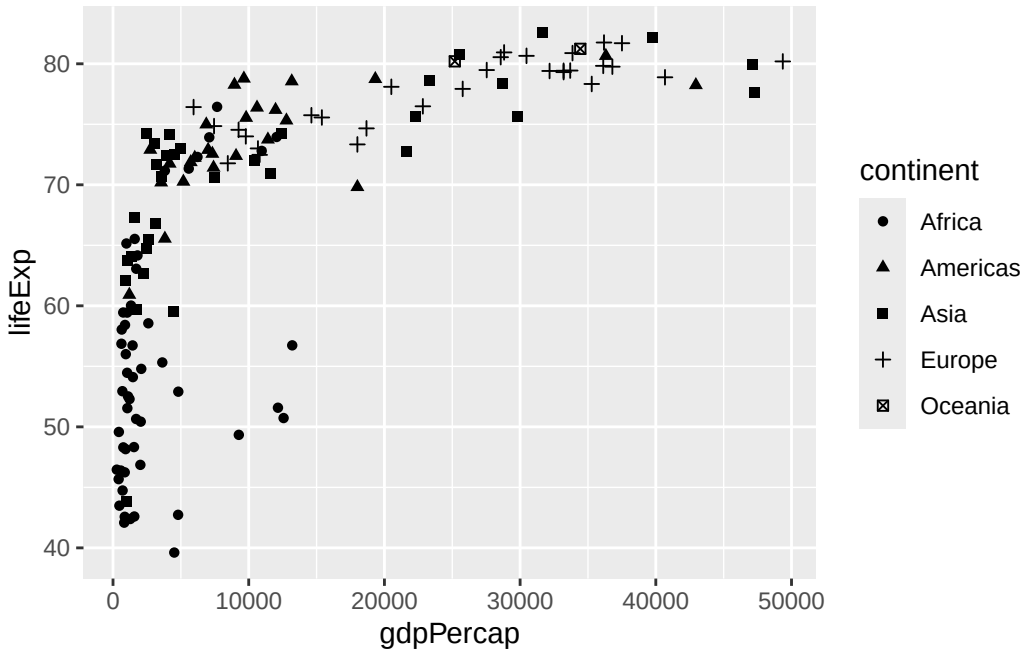
```
ggplot(gapminder_2007) +
      geom_point(aes(x = gdpPercap,
           y = lifeExp),
               color = "blue")
```

into nice, properly indented code like this:

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

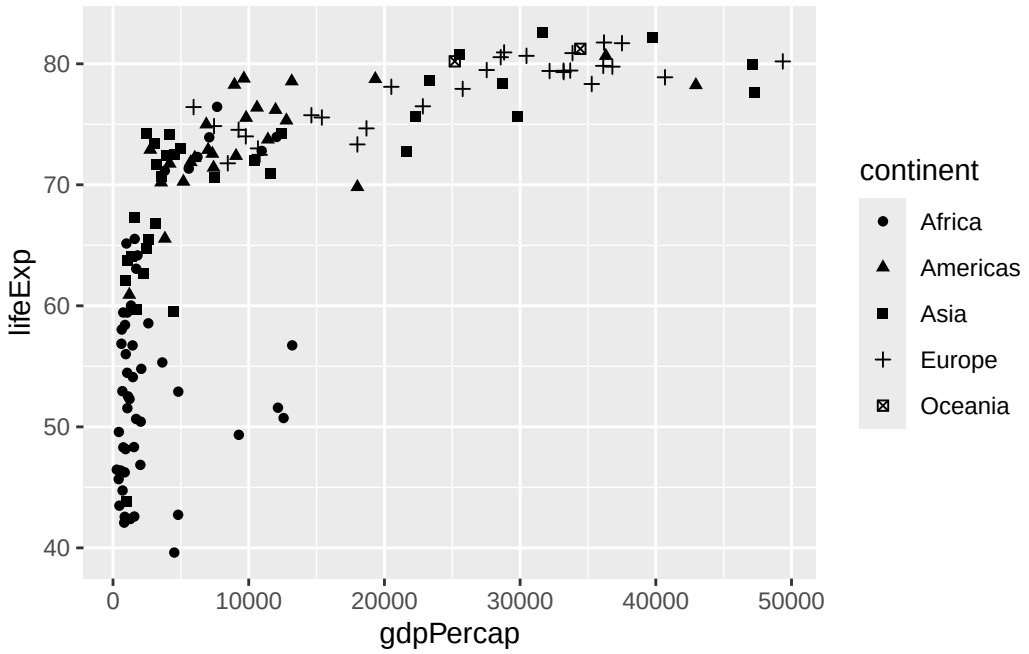
7.8 Exercise

Recreate the scatterplot of `lifeExp` and `gdpPercap` in 2007, but use the `continent` column to specify the `shape` aesthetic like this:



7.9 Solution

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

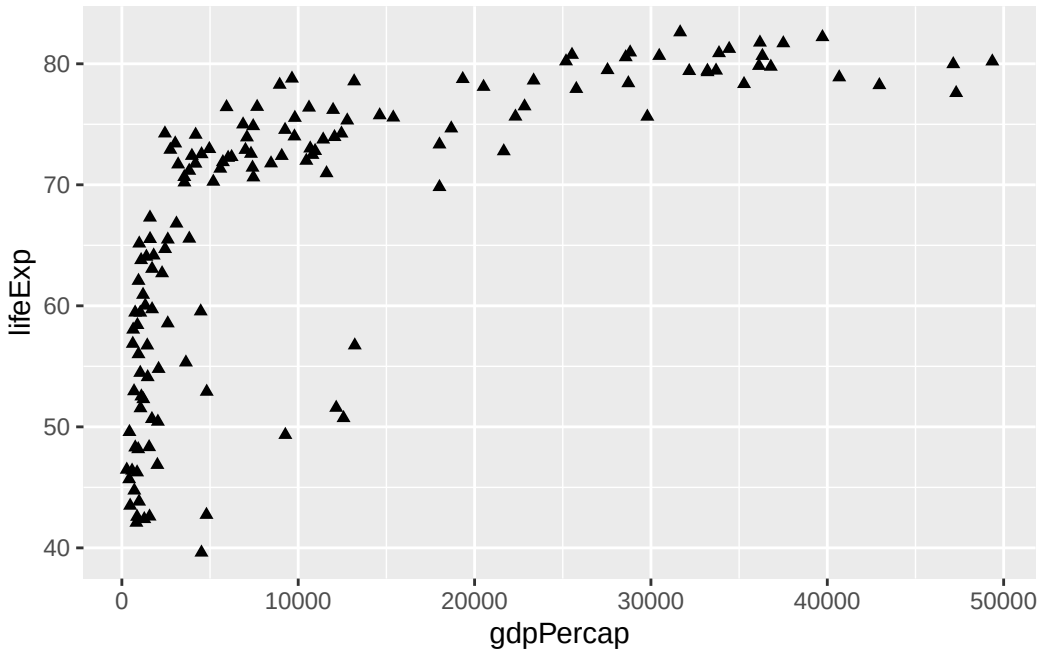


7.10 Exercise

Recreate the scatterplot of `lifeExp` and `gdpPercap` in 2007, but make *all* points have a "triangle" shape.

7.11 Solution

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

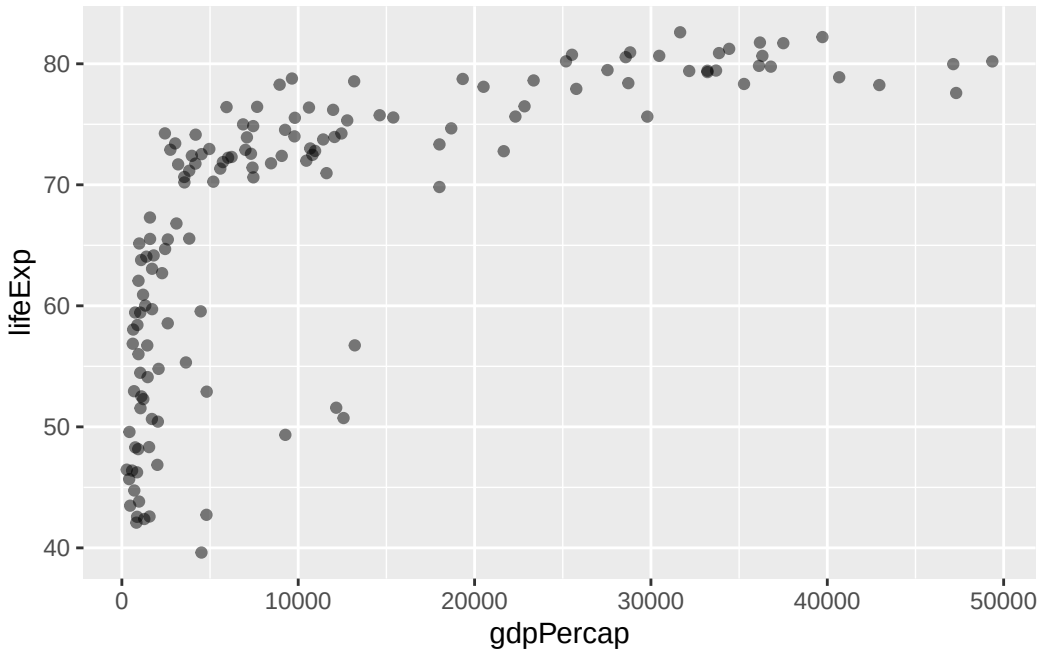


7.11.1 Transparency

Sometimes when you have a lot of data points all sitting on top of one another, it can be helpful to add some transparency. You can do this using the `alpha` argument.

`alpha` takes values between 0 and 1. `alpha = 1` is not transparent at all, and `alpha = 0` is completely transparent. The scatterplot below has `alpha = 0.5`:

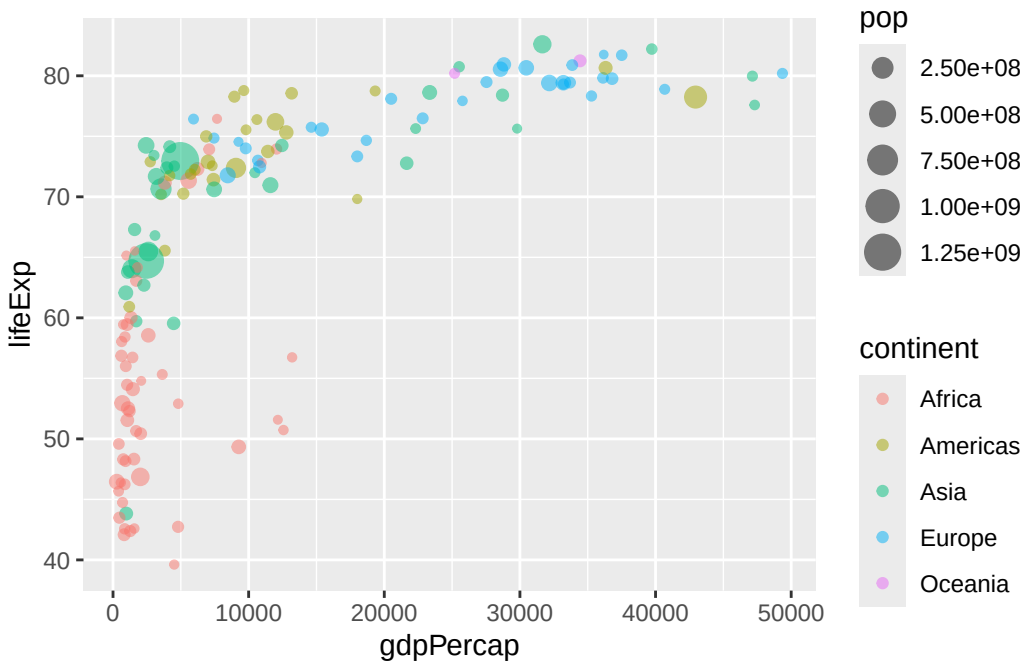
```
ggplot(gapminder_2007) +
  geom_point(aes(x = gdpPercap,
                 y = lifeExp),
             alpha = 0.5)
```



Since we are not using a column/variable in the data frame to specify `alpha`, note that it is *outside* the `aes()` function of `geom_point()`.

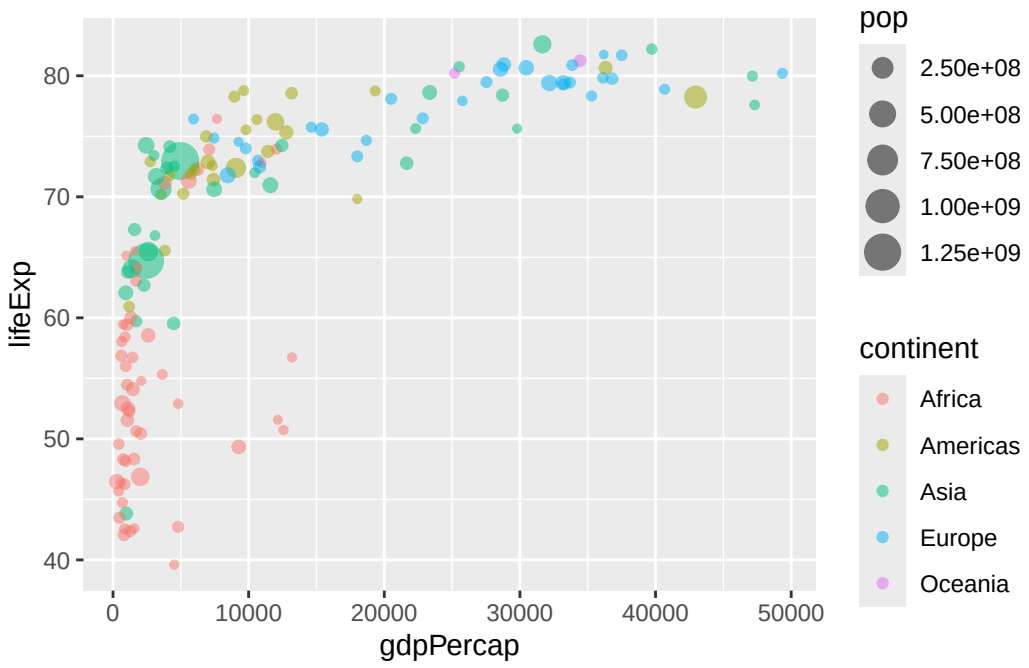
7.12 Exercise

Recreate the 2007 `gdpPercap` vs `lifeExp` plot where each point has color determined by `continent`, size determined by `pop`, and all the points have a transparency of 0.5 like this:



7.13 Solution

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



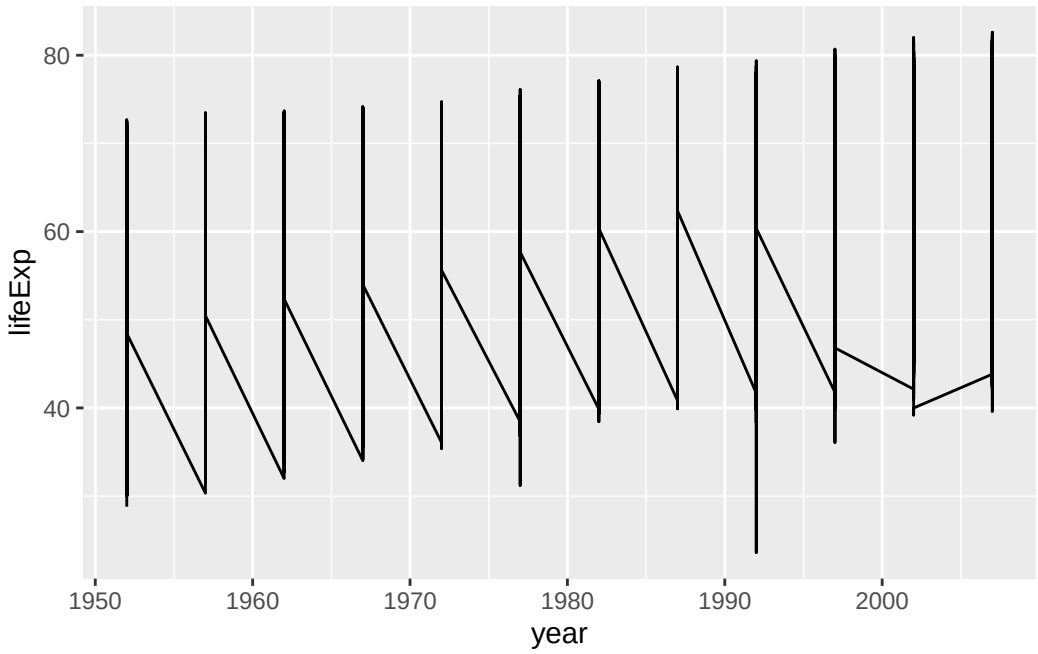
7.14 Other kinds of plots

7.14.1 Line plots

Line plots are great for showing how things change over time.

If I want to see how `lifeExp` changes by year, I can try to create a line plot using `geom_line()` with `lifeExp` on the y-axis, and `year` on the x-axis:

```
ggplot(gapminder) +
  geom_line(aes(x = year, y = lifeExp))
```



Ugh. gross. I don't like this plot at all. It looks terrible. What's with all the zigzags?

Can you figure out what's going on in this plot? As a hint... how many `lifeExp` values do we have for each `year`? We have many! One for each country (and there are almost 200 countries!)

Here are all the `lifeExp` values corresponding to 1962

```
gapminder |>
  filter(year == 1962) |>
  select(year, country, lifeExp)
```

```
# A tibble: 142 x 3
    year country     lifeExp
   <dbl> <chr>         <dbl>
 1  1962 Afghanistan    32.0
 2  1962 Albania        64.8
 3  1962 Algeria        48.3
 4  1962 Angola         34
 5  1962 Argentina      65.1
 6  1962 Australia      70.9
 7  1962 Austria        69.5
 8  1962 Bahrain        56.9
 9  1962 Bangladesh     41.2
```

```
10  1962 Belgium        70.2
# i 132 more rows
```

So the vertical lines we see in our "line plot" above correspond to the range of `lifeExp` values for each year, and then it probably just connects the final `lifeExp` value that year to the first `lifeExp` value for the next year, and those are the diagonal lines that we see.

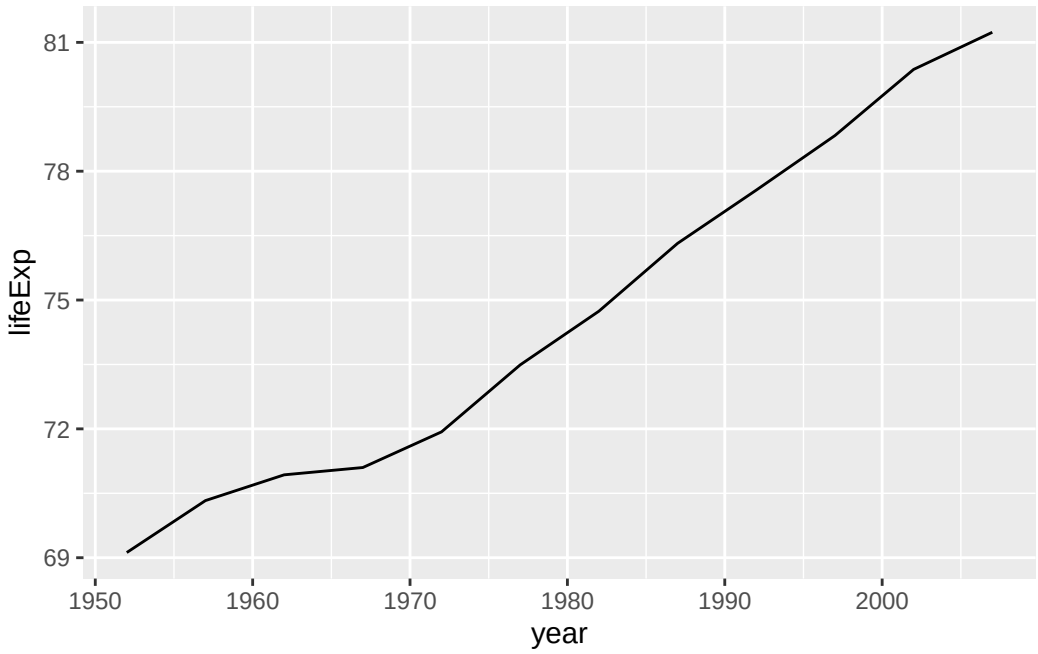
In general, to create a single line, we want just *one* value for the y-axis (e.g., `lifeExp`) per x-axis value (e.g., `year`). To satisfy this requirement, we can look at the data for just *one* country:

```
gapminder |>
  filter(country == "Australia") |>
  select(year, country, lifeExp)
```

```
# A tibble: 12 x 3
    year country   lifeExp
   <dbl> <chr>       <dbl>
 1  1952 Australia    69.1
 2  1957 Australia    70.3
 3  1962 Australia    70.9
 4  1967 Australia    71.1
 5  1972 Australia    71.9
 6  1977 Australia    73.5
 7  1982 Australia    74.7
 8  1987 Australia    76.3
 9  1992 Australia    77.6
10  1997 Australia    78.8
11  2002 Australia    80.4
12  2007 Australia    81.2
```

Now, we have just one `lifeExp` value for each `year`, and we could create a line plot using these values:

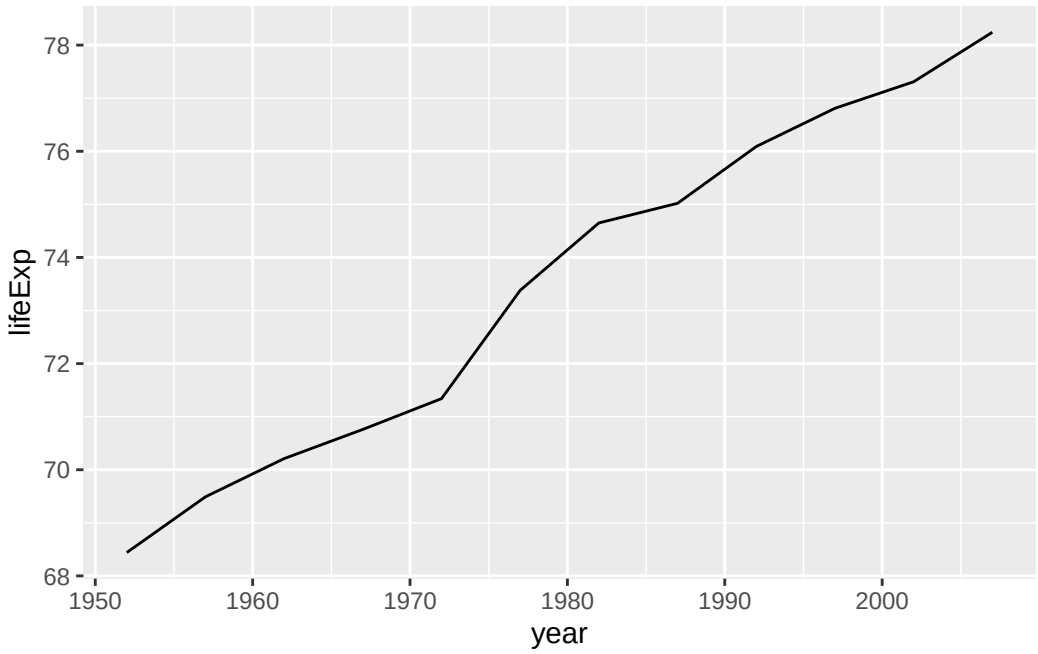
```
gapminder |>
  filter(country == "Australia") |>
  ggplot() +
  geom_line(aes(x = year, y = lifeExp))
```



Gee, wiz! That looks way better! It's a single line, and boy-oh-boy it sure looks like we Aussies are living longer and longer! Onya, Mate!

I could make the same plot for the US, by filtering to the US instead of Australia:

```
gapminder |>
  filter(country == "United States") |>
  ggplot() +
  geom_line(aes(x = year, y = lifeExp))
```



But what if I wanted to make a plot with *both* of these lines on it?

There are at least two ways I could do that. One is good, and the other is not so good.

I'll show you the not-so-good approach first (so you can really appreciate the good approach.)

The not-so-good approach involves creating separate data frames for Australia and the US and adding a separate line layer for each country. The first line layer will be just using `gapminder_us`, the data frame for the US, and the second line layer will have its own `data` argument to which I'll pass `gapminder_au`, the data frame for Australia:

```
# define the data frame for the US
gapminder_us <- gapminder |>
  filter(country == "United States")

# define the data frame for the Australia
gapminder_au <- gapminder |>
  filter(country == "Australia")

# Create a line plot for the US and then add a line plot layer for Australia
ggplot(gapminder_us) +
  geom_line(aes(x = year, y = lifeExp)) +
  geom_line(aes(x = year, y = lifeExp), data = gapminder_au)
```

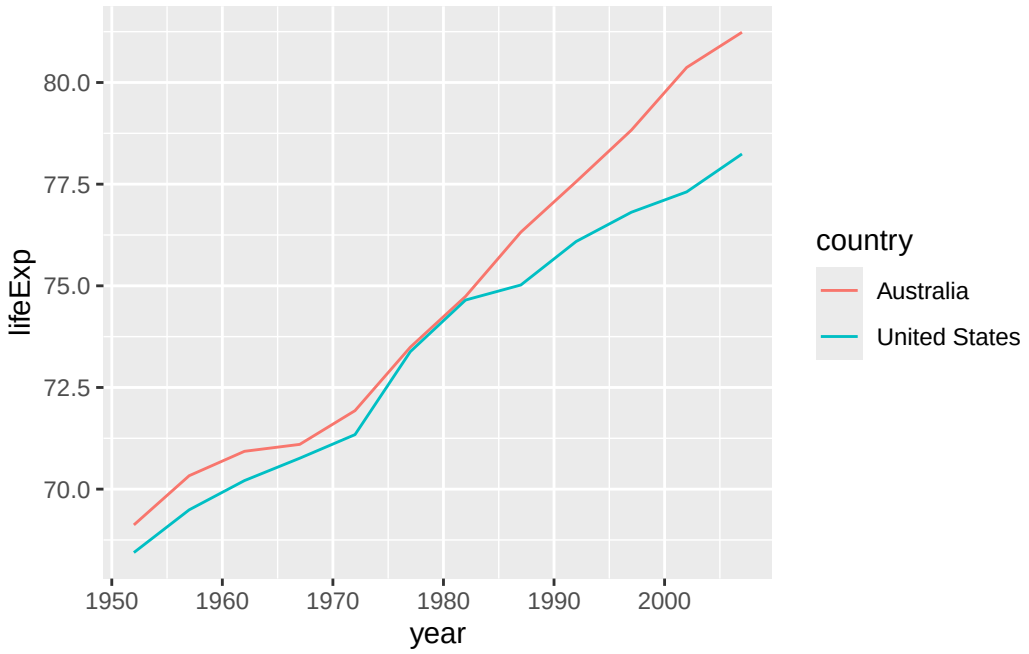
Here the first `geom_line()` layer is based on the "global" `gapminder_us` data frame provided as the argument of `ggplot()`, and the second line is based on the "local" `gapminder_au` data frame provided in the `data` argument of the second `geom_line()` layer (when you don't provide a `data` argument, each layer will be based on the global data frame provided to `ggplot()`)

While this technically works, this approach isn't great for a few reasons. First, I can't tell which line is which. There is no legend (and it's unfortunately not all that easy to add a legend manually to a ggplot2 figure). Another reason this approach sucks is that it's not scalable. If I wanted to do this for 10 countries, I'd have to create 10 different data frames and add 10 line layers to my plot. No thanks.

Instead of adding separate line layers for each country, I can use the `color` or `group` aesthetic to tell `ggplot()` that I want separate lines for each country.

In the code below, I create a single data frame that contains the data for Australia and the US only, and then I create a ggplot2 line plot, specifying `color = country` inside my `aes()` function, which will give me a separate line for each country:

```
gapminder |>
  filter(country %in% c("Australia", "United States")) |>
  ggplot() +
  geom_line(aes(x = year,
                y = lifeExp,
                color = country))
```



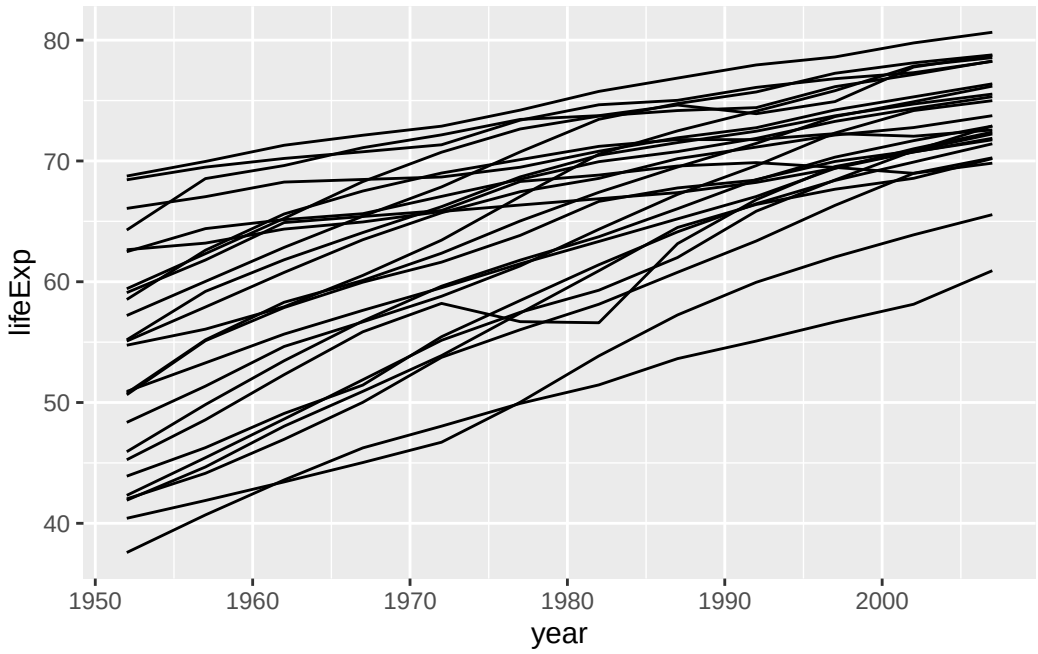
Now, each country's line has a different color *and* ggplot has created a legend for me.

An alternative if I want a separate line for each country, but don't want each line to have a different color, is to use the `group` aesthetic instead of the `color` aesthetic:

```
gapminder |>
  filter(country %in% c("Australia", "United States")) |>
  ggplot() +
  geom_line(aes(x = year,
                y = lifeExp,
                group = country))
```

For example, the following code creates a line plot of `lifeExp` by `year` for each country on the entire "Americas" `content` (with no colors or legend).

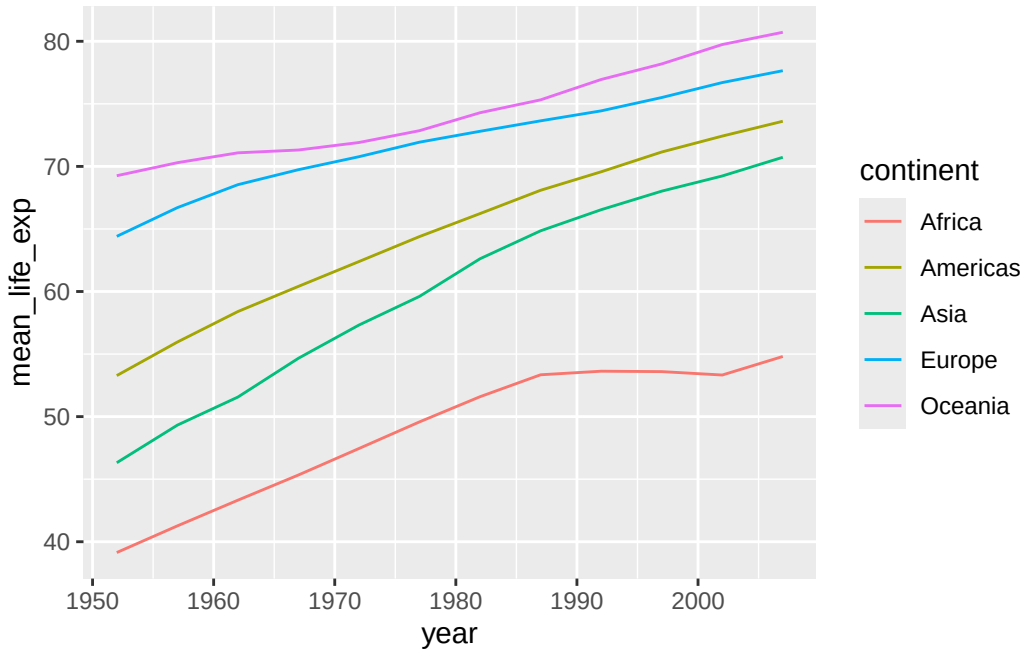
```
gapminder |>
  filter(continent == "Americas") |>
  ggplot() +
  geom_line(aes(x = year,
                y = lifeExp,
                group = country))
```



7.15 Exercise

Compute the average life expectancy for each continent for each year, and then create a line plot of the average life expectancy for each continent over time (each continent should have its own different colored line).

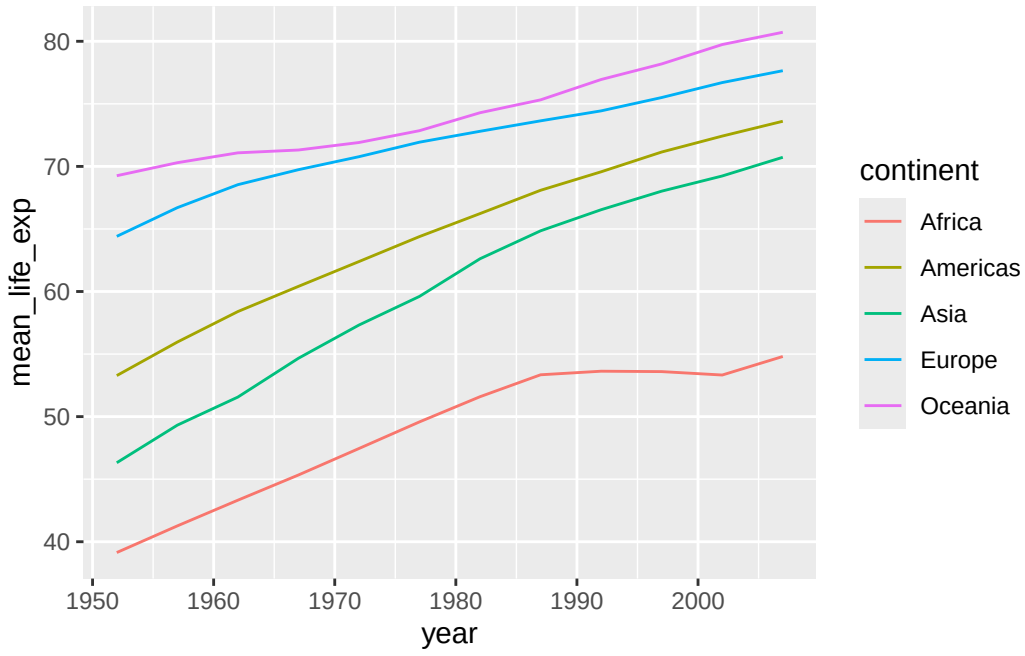
Here is an example of the plot I want you to make:



7.16 Solution

```
gapminder |>
  group_by(continent, year) |>
  summarize(mean_life_exp = mean(lifeExp)) |>
  ggplot() +
  geom_line(aes(x = year,
                y = mean_life_exp,
                color = continent))
```

```
`summarise()` has grouped output by 'continent'. You can override using the
`.groups` argument.
```

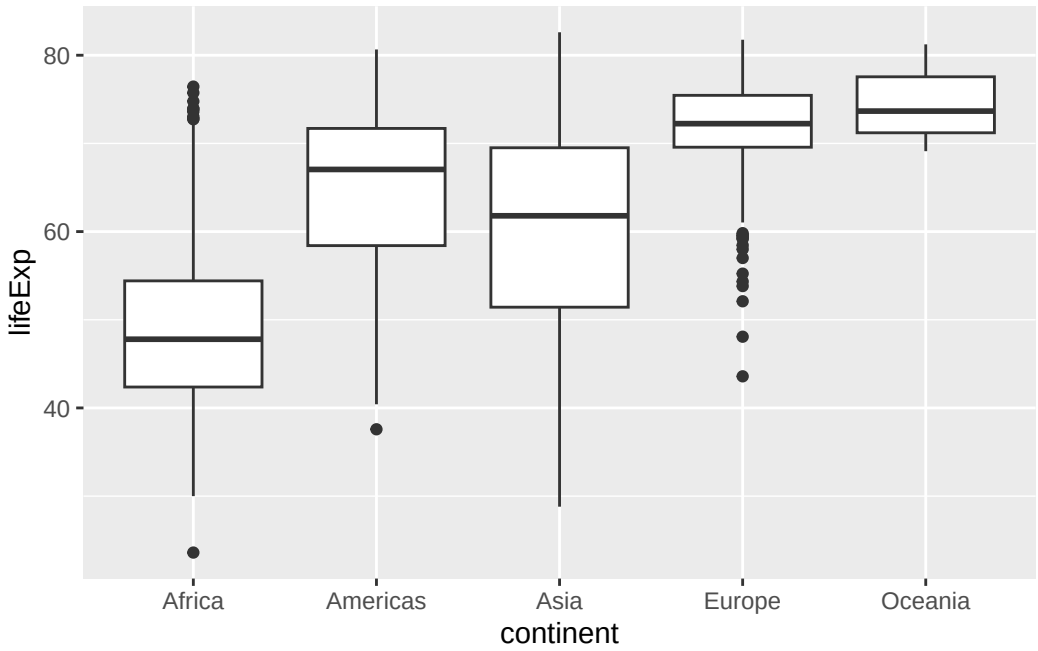


7.16.1 Boxplots

Like scatterplots created with `geom_point()`, boxplots created with a `geom_boxplot()` layer desire an `x` and a `y` aesthetic, however, unlike `geom_point()` which wants both the `x` and `y` variables to be continuous numeric variables, `geom_boxplot()` wants *one* of the `x` and `y` aesthetics to be a categorical (character or factor) variable and the other one to be numeric and `geom_boxplot()` will create a separate boxplot for each categorical value.

For example, below we create a boxplot of `lifeExp` for each `continent`:

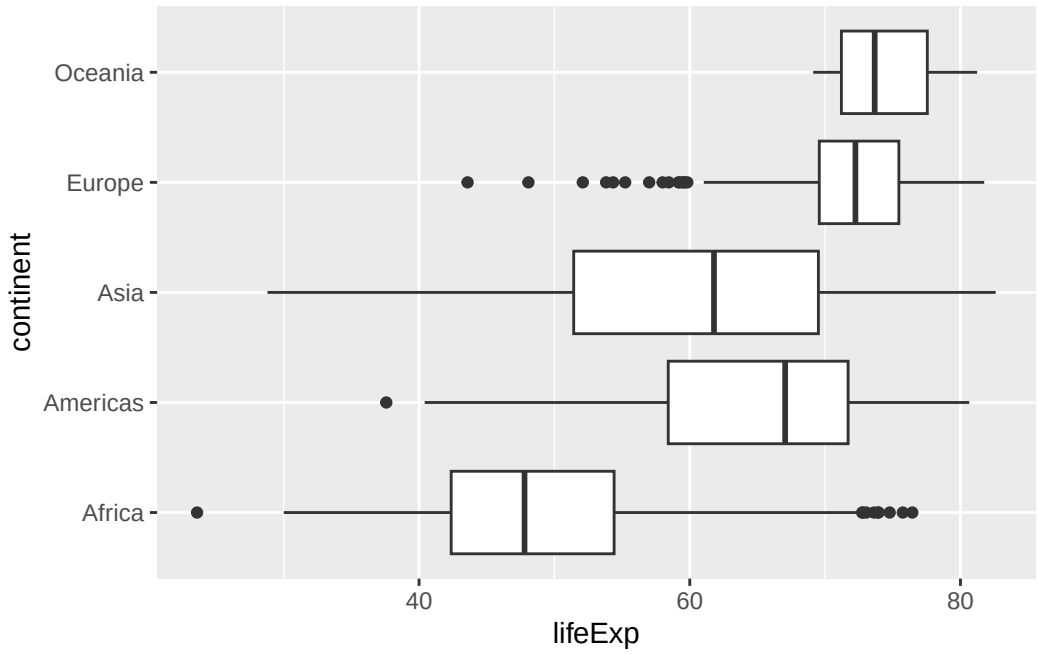
```
ggplot(gapminder) +
  geom_boxplot(aes(x = continent, y = lifeExp))
```



The bottom of the box part of a boxplot corresponds to Q_1, the first quartile of the variable (the value for which 25% of values are less than it) and the top of the box corresponds to the third quartile, Q_3 of the variable (the value for which 75% of values are less than it). The bar in the middle is the median, which corresponds to the second quartile, Q_2 (the value for which 50% of values are less than it). The lines that extend from the bottom and top of the boxplot reach as far as $Q_1 - 1.5(Q_3 - Q_1)$ and $Q_3 + 1.5(Q_3 - Q_1)$, respectively, and all values that are outside this range are shown as points and are called "outliers."

If you switch the `x` and the `y` so the `y` aesthetic is the categorical/character `continent` variable, then you get horizontal boxplots instead.

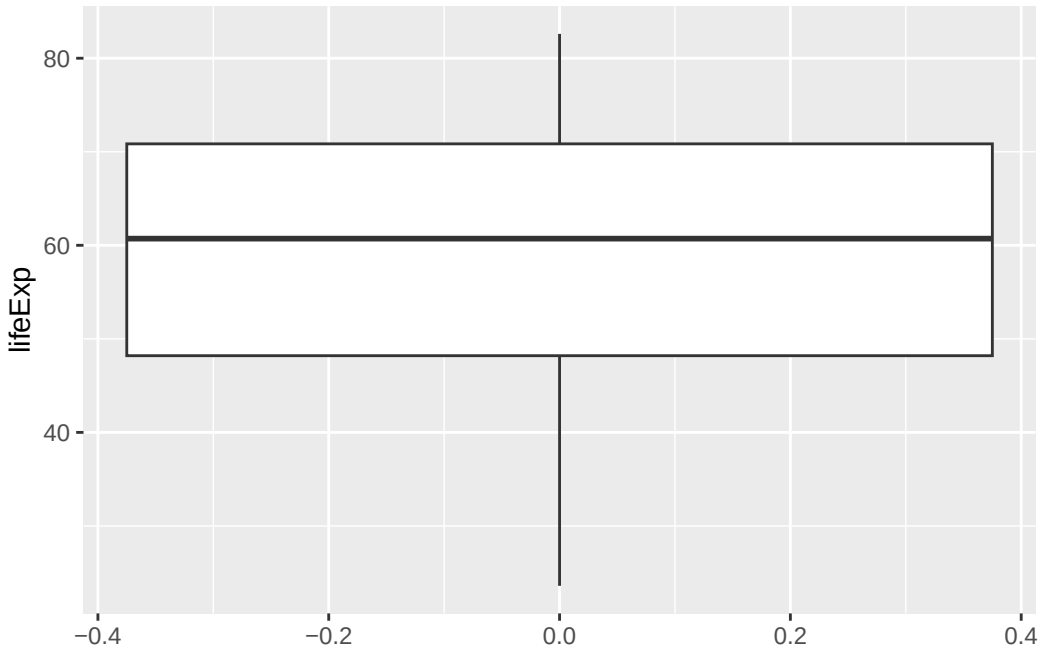
```
ggplot(gapminder) +
  geom_boxplot(aes(x = lifeExp, y = continent))
```



`geom_boxplot()` is great for creating side-by-side boxplots for the different levels/values of a categorical variable.

But you can create single boxplots for an entire variable, such as `lifeExp`, by just providing `y = lifeExp` to your aesthetic function (leaving `x` out entirely):

```
ggplot(gapminder) +
  geom_boxplot(aes(y = lifeExp))
```



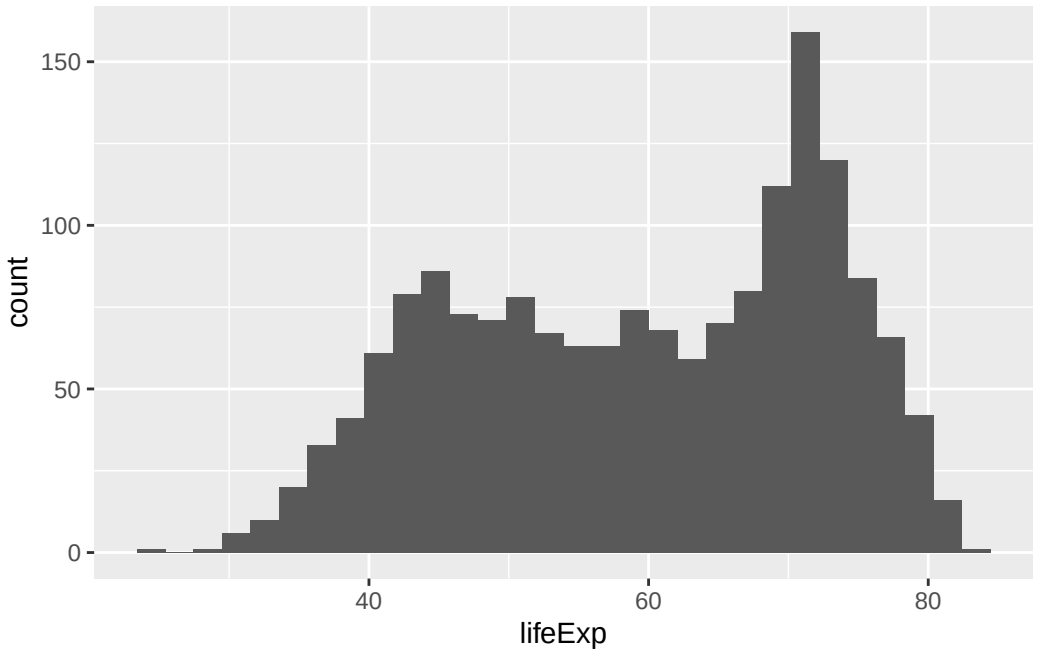
But I rarely do this–I find boxplots to be most helpful for *comparing* the distributions of a variable across different groups.

7.16.2 Histograms

If I want to look at the distribution of a single variable, I find it more useful to use a histogram, such as the histogram of `lifeExp` below:

```
ggplot(gapminder) +
  geom_histogram(aes(x = lifeExp))
```

```
`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

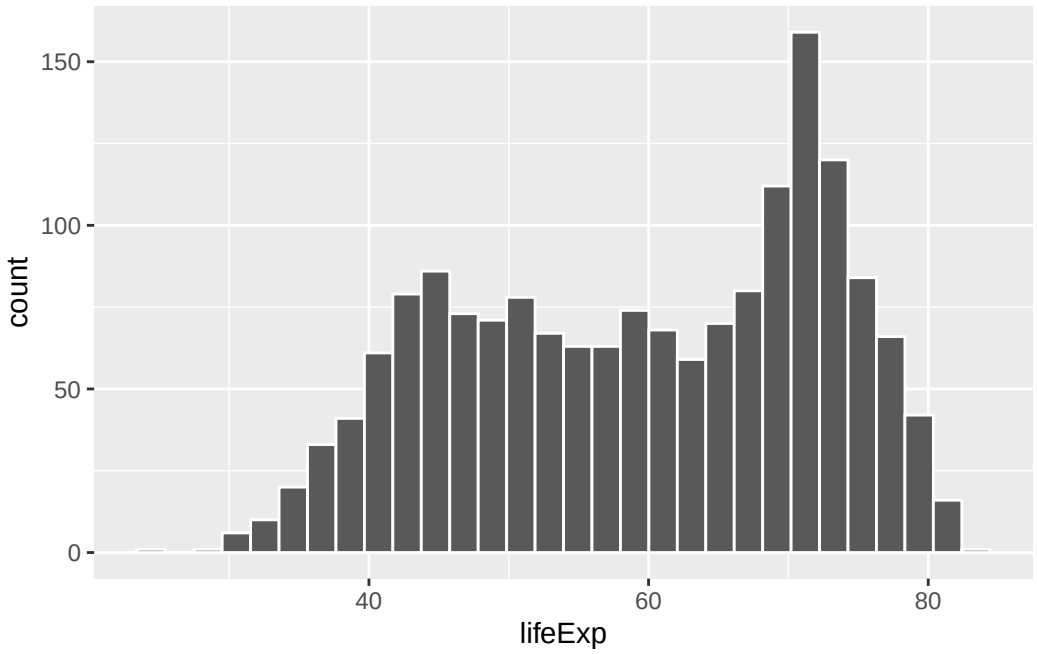


A histogram essentially takes the range of a continuous numeric variable, chops it up into binned intervals, and then uses bars to represent how many values fall into each binned interval.

I don't like that the histogram doesn't provide outlines for each of the bars, so I often add them in by providing a `color` value *outside* the `aes()` function in my `geom_histogram()` function:

```
ggplot(gapminder) +
  geom_histogram(aes(x = lifeExp),
                 color = "white")
```

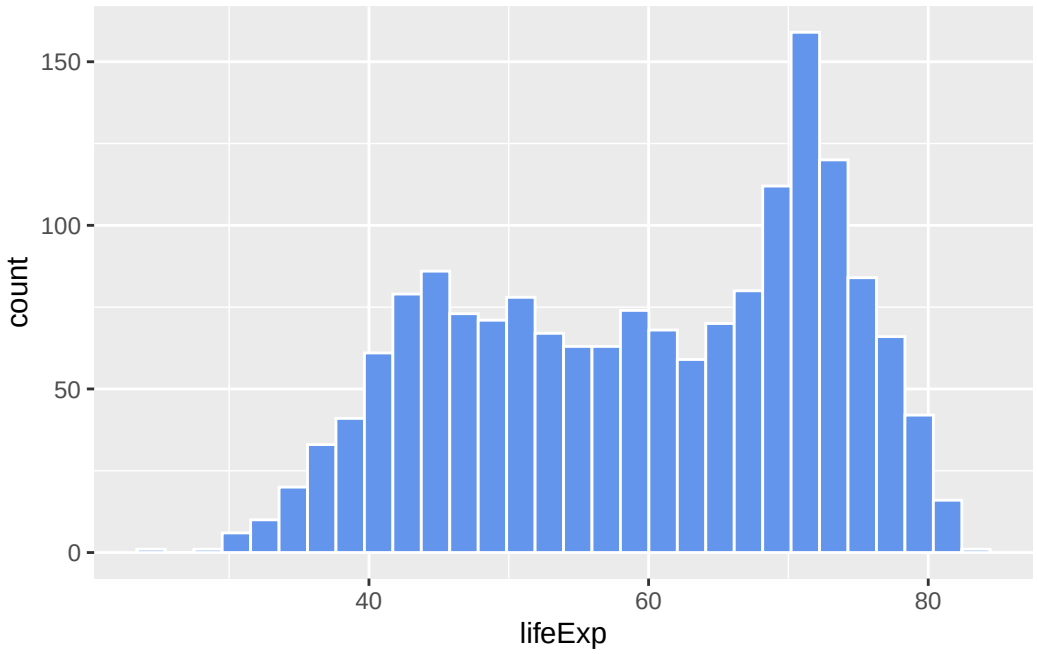
```
`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



Notice that `color` here refers to the *outline* of the bars, rather than the bars themselves. If you want the bars themselves to have a different color, you need to use the `fill` aesthetic.

```
ggplot(gapminder) +
  geom_histogram(aes(x = lifeExp),
                 color = "white",
                 fill = "cornflowerblue")
```

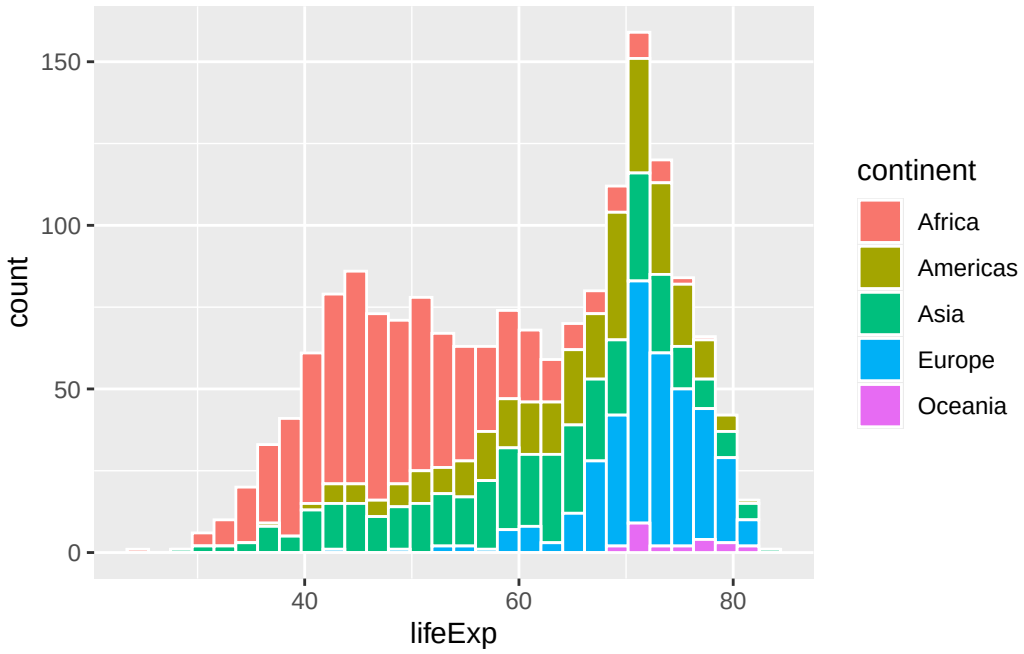
```
`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



You can also provide a `fill` to your histogram where the bars are colored using a categorical variable, such as `continent`:

```
ggplot(gapminder) +
  geom_histogram(aes(x = lifeExp,
                     fill = continent),
                 color = "white")
```

```
`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

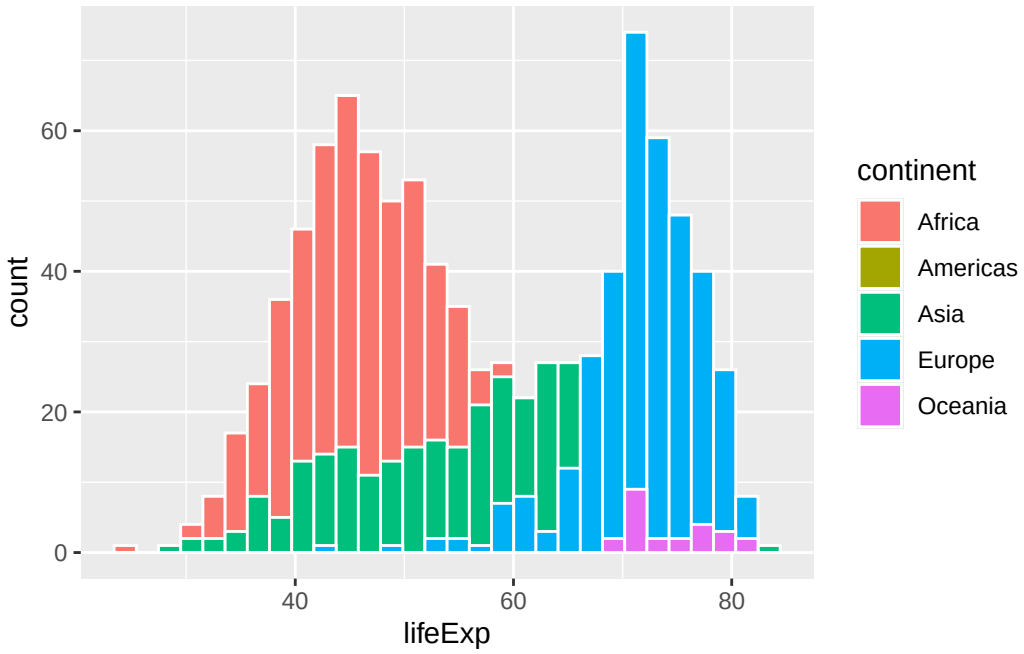


But be warned that these bars are *"stacked"* on top of one another, so the overall shape is the same as that of the entire variable in the histogram above.

If you want to *compare* the distributions of the `lifeExp` variable across each continent where each continent's histogram starts from 0, you need to specify an additional argument to `geom_histogram()`, `position = "identity"`.

```
ggplot(gapminder) +
  geom_histogram(aes(x = lifeExp,
                     fill = continent),
                 color = "white",
                 position = "identity")
```

```
`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

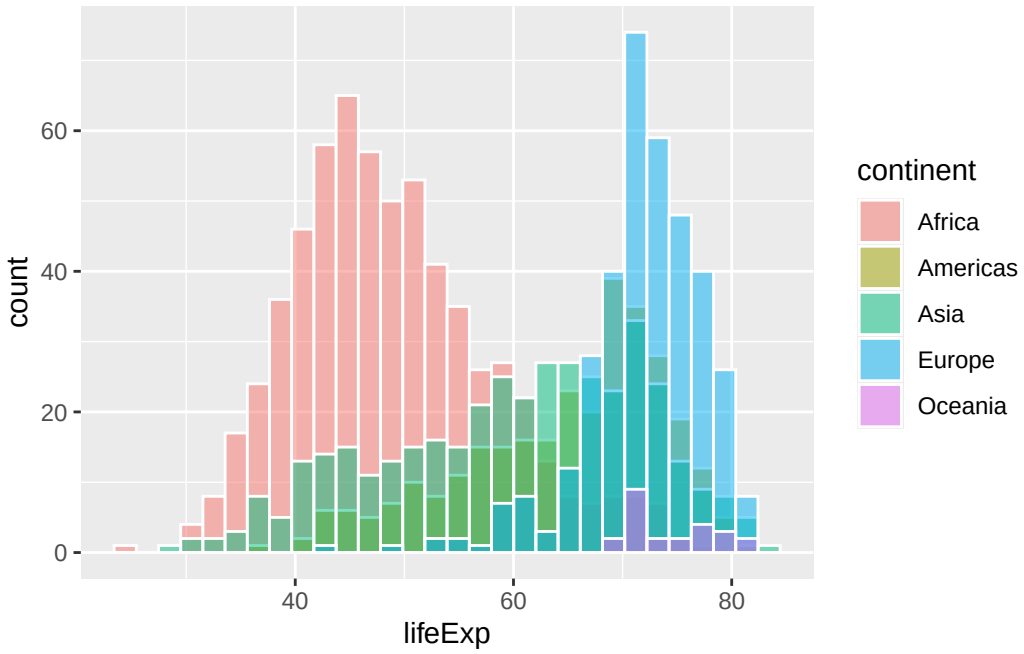


Now each continent's histograms start at y = 0, but because they are opaque, it's hard to properly see how the distributions overlap.

This is another place where transparency comes in handy! If we set `alpha = 0.5`, it becomes slightly easier to see how the distributions overlap.

```
ggplot(gapminder) +
  geom_histogram(aes(x = lifeExp,
                     fill = continent),
                 color = "white",
                 position = "identity",
                 alpha = 0.5)
```

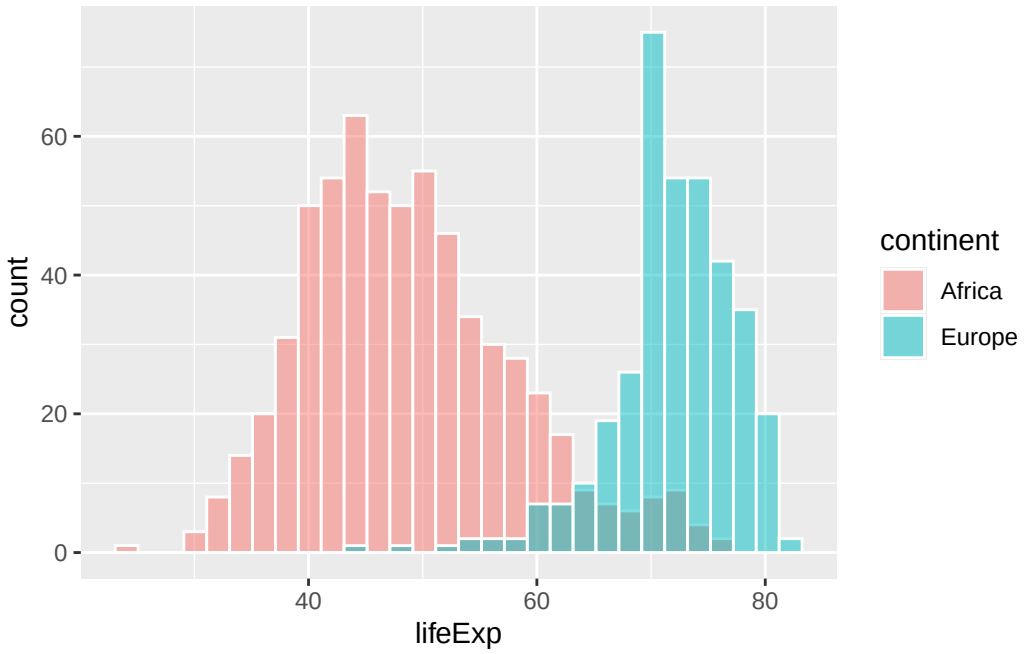
```
`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```



This plot is a bit busy though, so it might be a bit easier to just compare two groups, such as "Europe" and "Africa":

```
gapminder |>
  filter(continent %in% c("Europe", "Africa")) |>
  ggplot() +
  geom_histogram(aes(x = lifeExp,
                     fill = continent),
                 color = "white",
                 position = "identity",
                 alpha = 0.5)
```

```
`stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

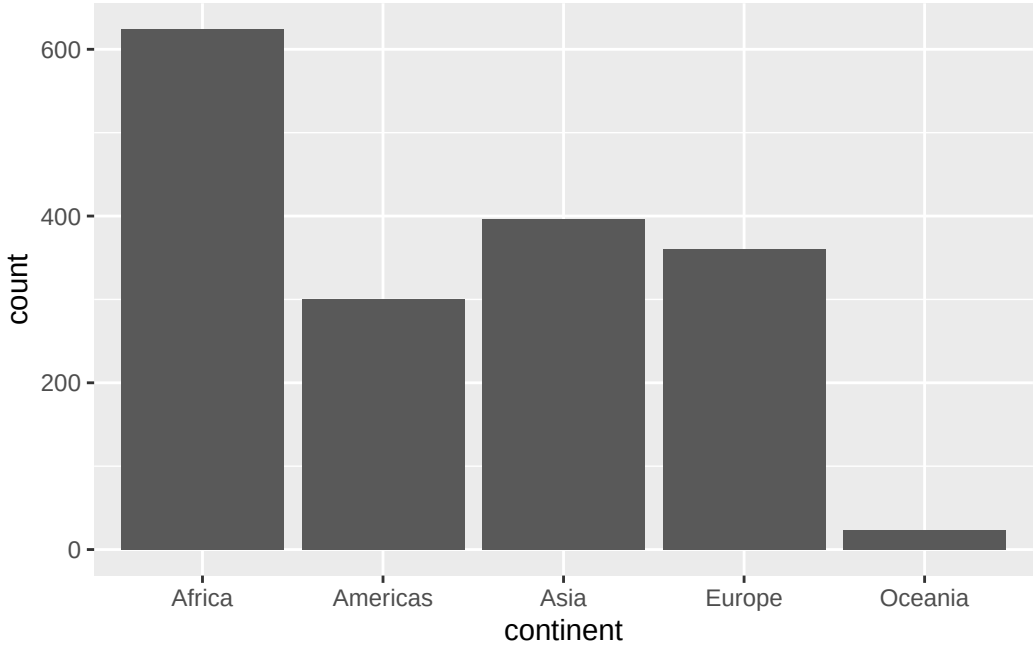


7.16.3 Bar charts

A bar chart is like a histogram but for categorical variables instead of continuous numeric ones.

You can create a *count* bar chart, by providing a categorical (character/factor) variable as your x-aesthetic to `geom_bar()`, which will then add up how many times each value of the categorical variable appears and use this as the height of the bars:

```
# create a bar chart of the continent *counts*
ggplot(gapminder) +
  geom_bar(aes(x = continent))
```

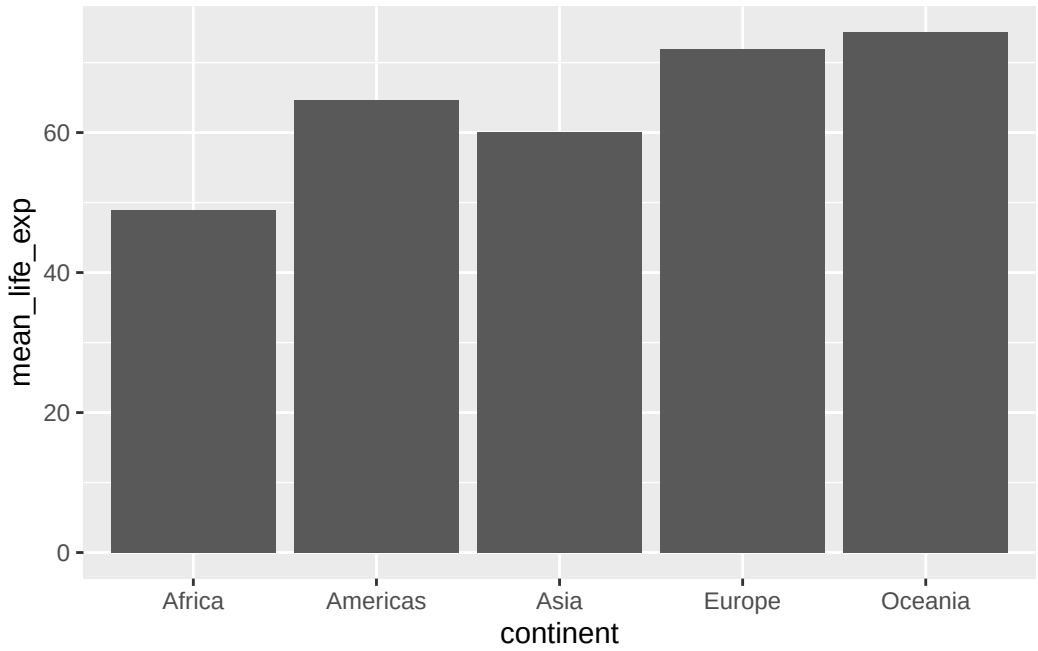


So the `"Africa"` continent appears over 600 times in the data, while the `"Asia"` appears around 400 times.

If you want to create bar charts in which you manually specify the height of each bar based on a variable in your data, you want to use `geom_col()` instead of `geom_bar()`.

For example, below, I create a bar chart that shows the *average life expectancy* for each continent, first you have to calculate the average life expectancy for each continent, and then you can pipe that into ggplot with a `geom_col()` layer that uses `x = continent` as the x-aesthetic which will be used to determine how many bars there are (and their names), and your calculated `y = mean_life_exp` as the height aesthetic.

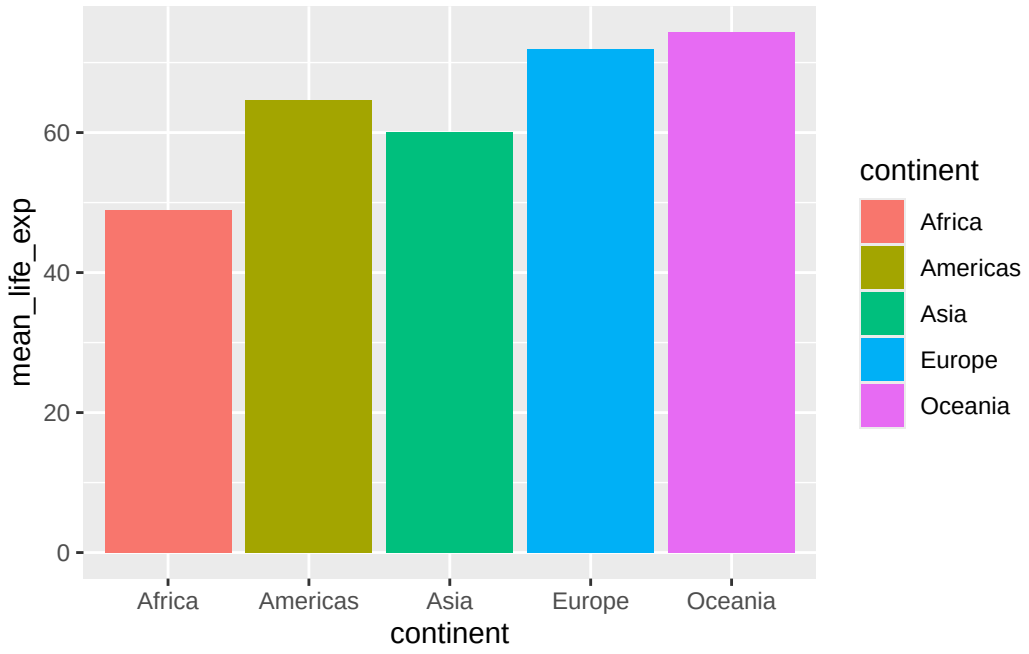
```
mean_life_exp <- gapminder |>
  group_by(continent) |>
  summarize(mean_life_exp = mean(lifeExp))

ggplot(mean_life_exp) +
  geom_col(aes(x = continent,
               y = mean_life_exp))
```



Like histograms, you can color your bars using the `fill` aesthetic.

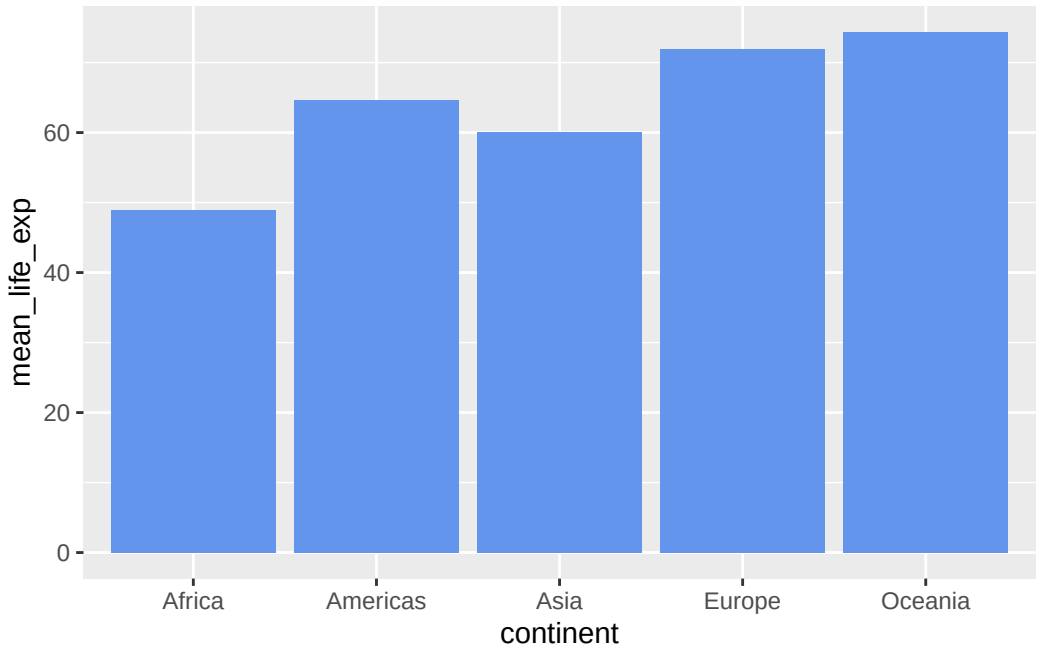
To give each bar a different color per continent, provide `fill = continent` *inside* the `aes()` function:

```
ggplot(mean_life_exp) +
  geom_col(aes(x = continent,
               y = mean_life_exp,
               fill = continent))
```



And to give each bar the same global color, provide your color to `fill` *outside* the `aes()` function (pay close attention to the closing parentheses and indentation):

```
ggplot(mean_life_exp) +
  geom_col(aes(x = continent,
               y = mean_life_exp),
           fill = "cornflowerblue")
```



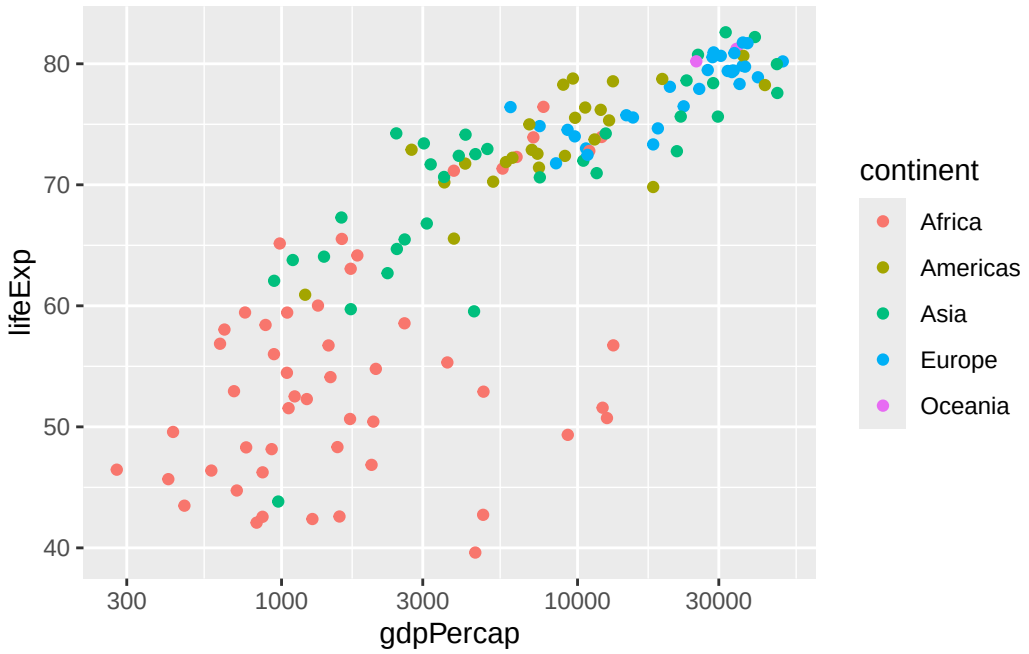
7.17 Getting fancy with ggplot2

Now that you've seen the most common ggplot2 layers I typically use, let's talk about how to do even fancier things with them.

7.17.1 Transformations

You can apply log-scale transformations to your axis by adding a scale layer. Below, the layer `scale_x_log10()` converts the x-axis to a $\log_{10}$ scale, so each break increases by an order of magnitude rather than by a fixed amount.

```
ggplot(gapminder_2007) +
  geom_point(aes(x = gdpPercap,
                 y = lifeExp,
                 color = continent)) +
  scale_x_log10()
```



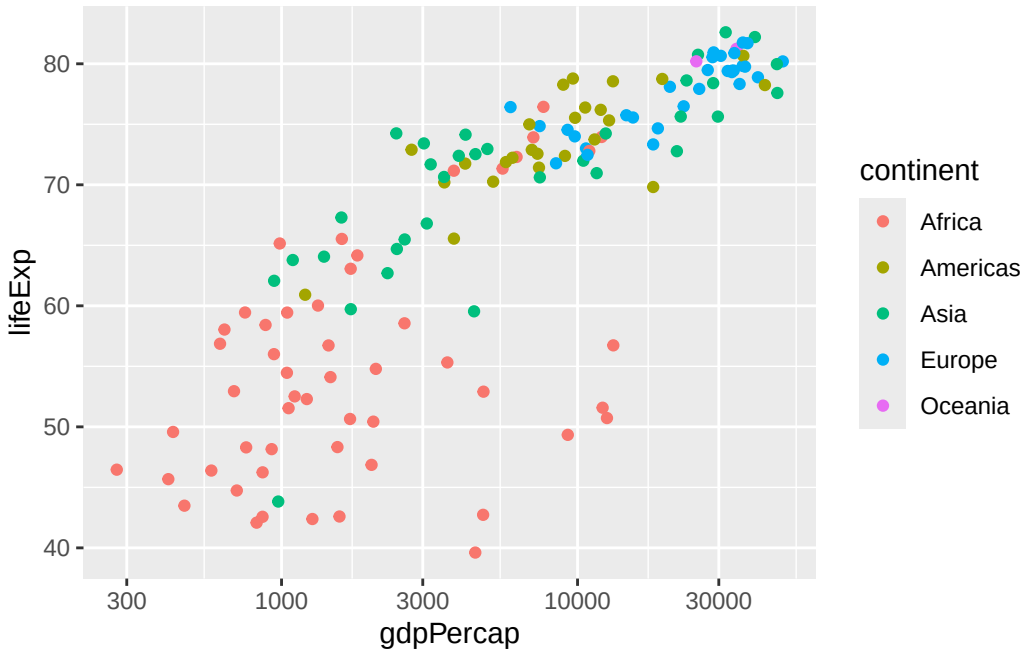
Because I want to keep using this plot as I show you more cool things, I'm going to save it as a variable!

I can do this by assigning it to a new variable name like this:

```
life_gdp_scatter <- ggplot(gapminder_2007) +
  geom_point(aes(x = gdpPercap,
                 y = lifeExp,
                 color = continent)) +
  scale_x_log10()
```

As usual, when I define a variable, no output is shown, but I can look at the object contained in this variable by typing its name:

```
life_gdp_scatter
```

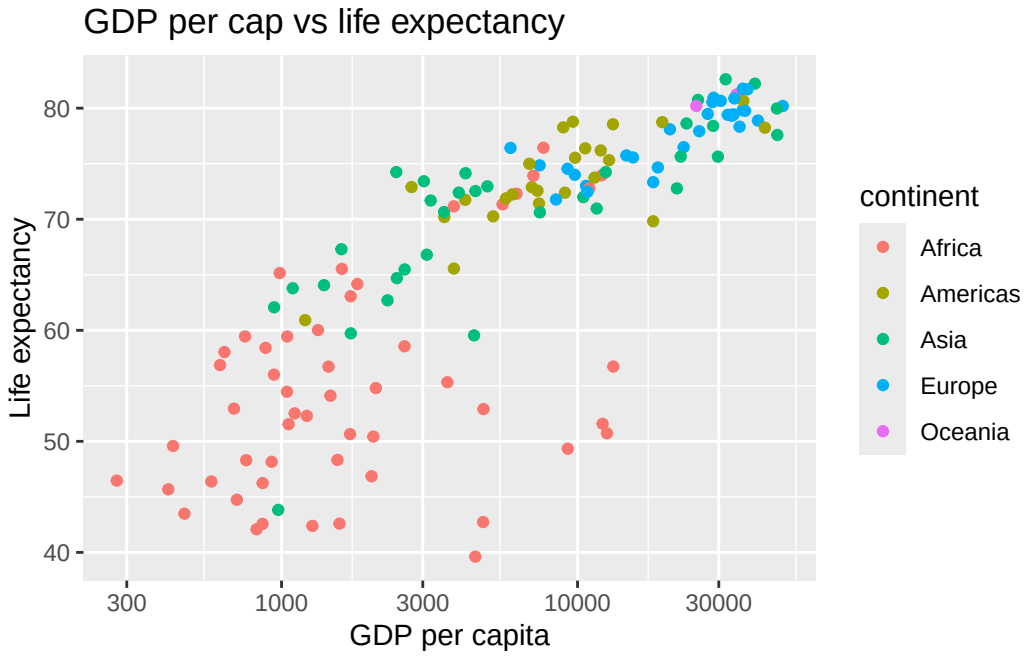


And the super neat thing is that because this is just a ggplot object, I can keep adding things to it using +!

7.17.2 Labels

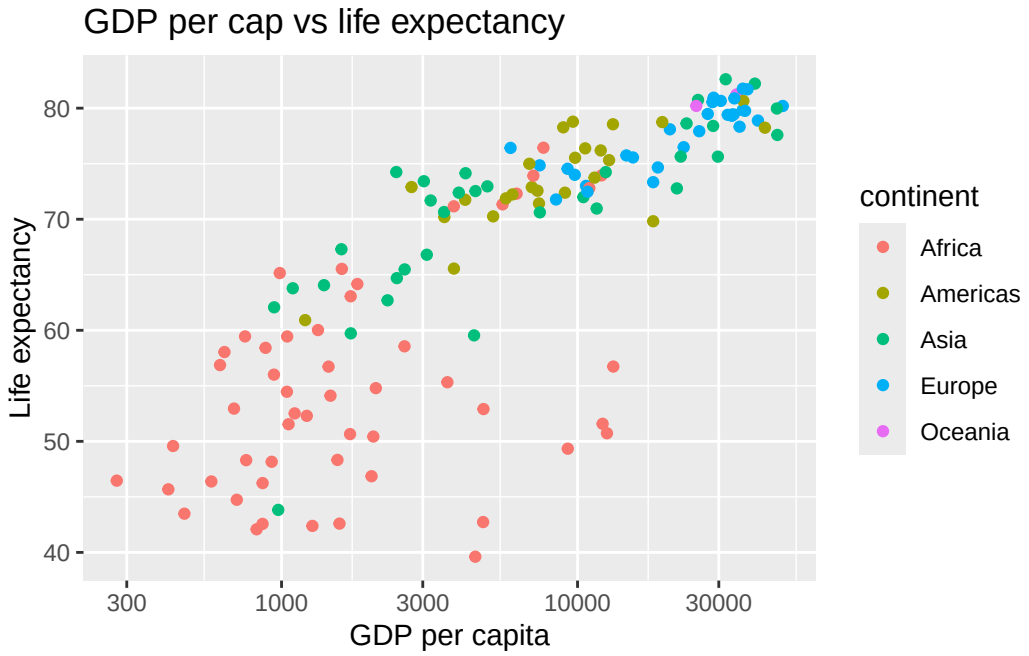
You can clean the labels of your figure by adding a `labs()` layer.

```
life_gdp_scatter +
  labs(x = "GDP per capita",
       y = "Life expectancy",
       title = "GDP per cap vs life expectancy")
```



This is equivalent to replacing `life_gdp_scatter` with the code that was used to define it:

```
ggplot(gapminder_2007) +
  geom_point(aes(x = gdpPercap,
                 y = lifeExp,
                 color = continent)) +
  scale_x_log10() +
  labs(x = "GDP per capita",
       y = "Life expectancy",
       title = "GDP per cap vs life expectancy")
```



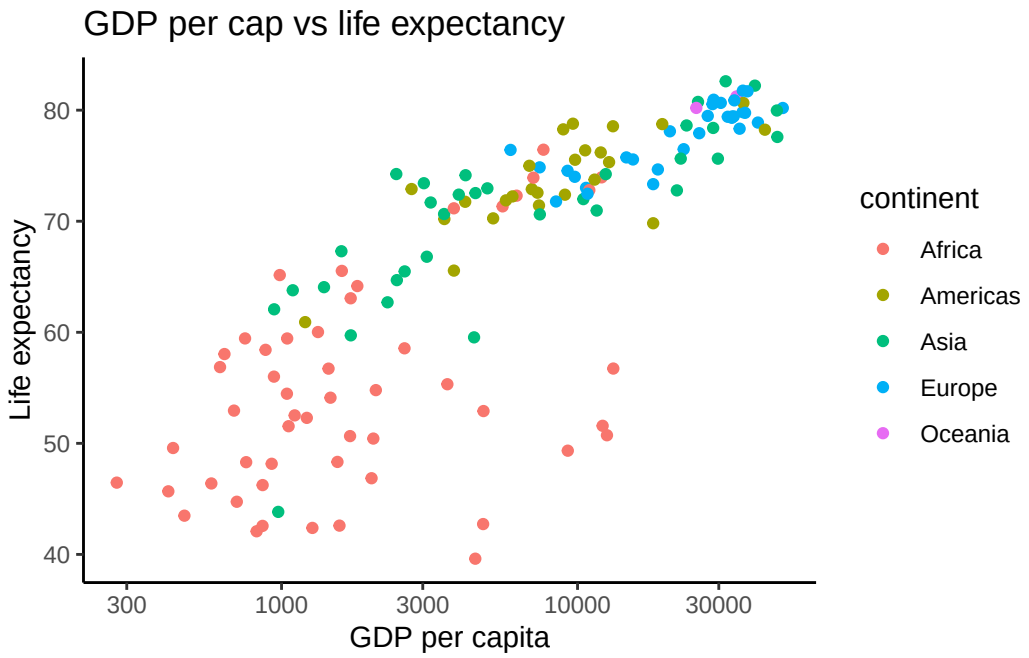
And I'm going to update my scatterplot object to contain these new labels by overwriting my `life_gdp_scatter` object with the old one plus the labels layer:

```
life_gdp_scatter <- life_gdp_scatter +
  labs(x = "GDP per capita",
       y = "Life expectancy",
       title = "GDP per cap vs life expectancy")
```

7.17.3 Themes

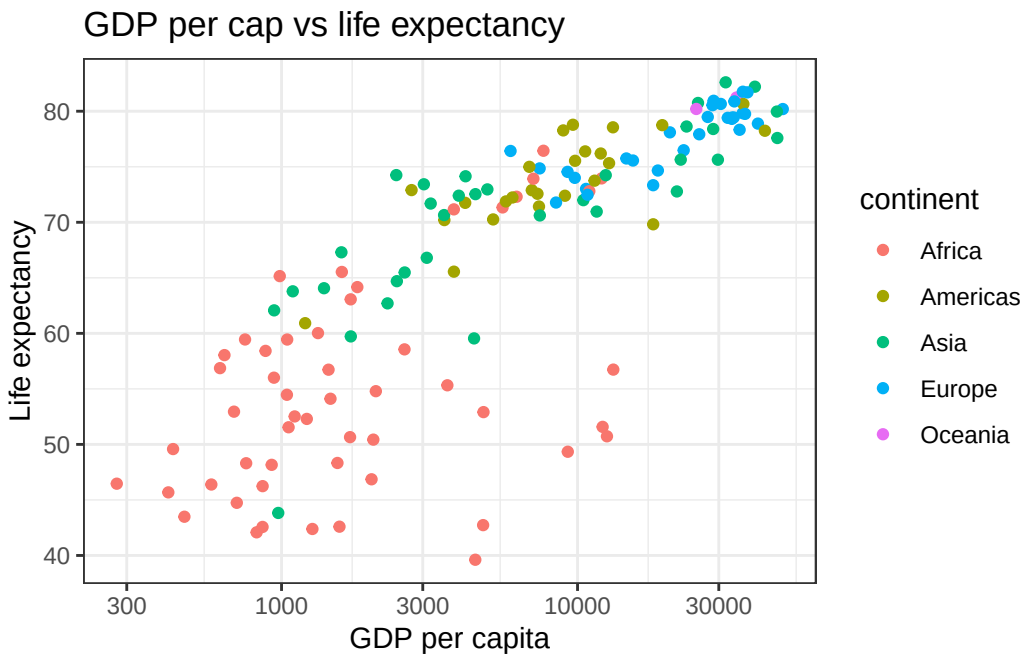
Next, I want to give my figure a theme by adding a themes layer. There are a lot of theme options. My favorite is `theme_classic()`:

```
life_gdp_scatter + theme_classic()
```



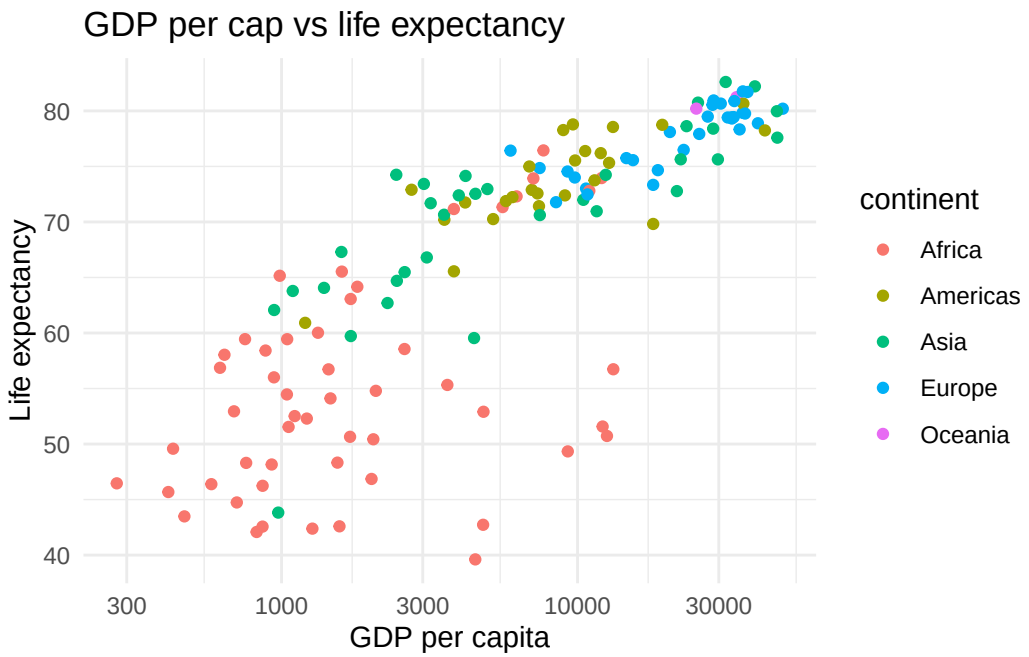
Another popular one is `theme_bw()`:

```
life_gdp_scatter + theme_bw()
```



and `theme_minimal()`:

```
life_gdp_scatter + theme_minimal()
```



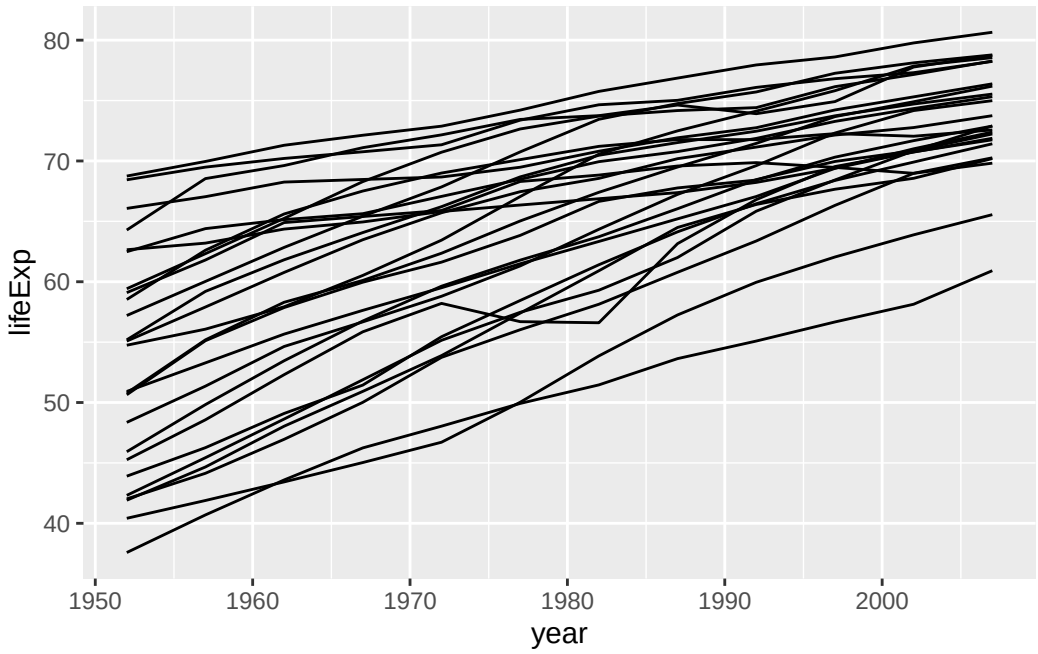
But there are lots of others too.

7.17.4 Faceted grids

The last neat ggplot2 thing I want to show you is how to create a grid of plots using `facet_wrap()`.

If I have a bunch of line plots on the same plot like this:

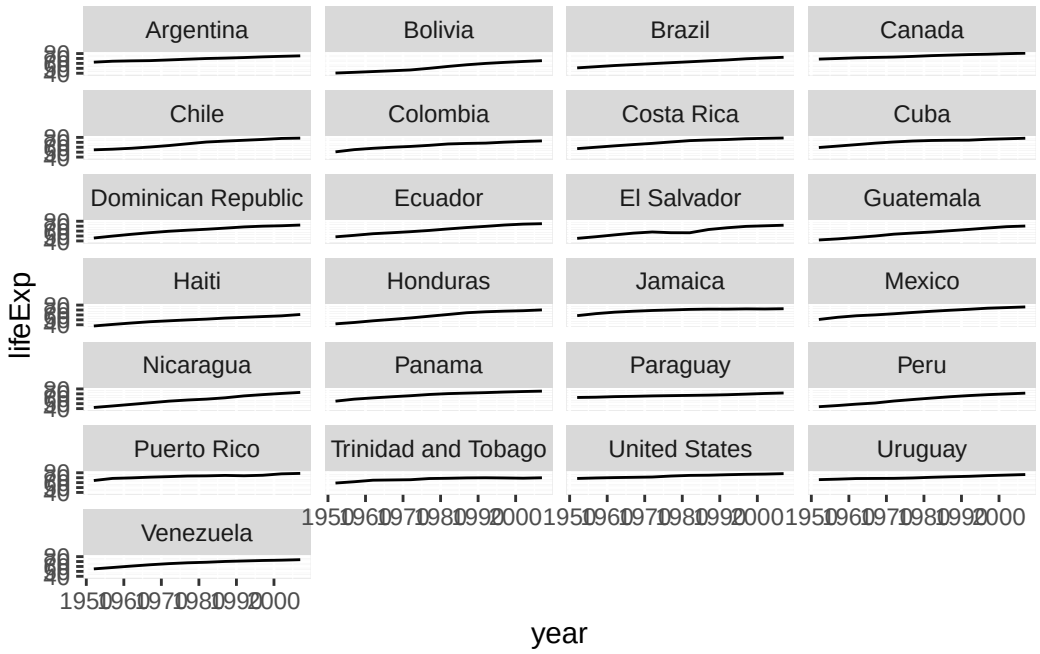
```
gapminder |>
  filter(continent == "Americas") |>
  ggplot() +
  geom_line(aes(x = year,
                y = lifeExp,
                group = country))
```



I might find myself wishing that I had a separate plot for each country, but I don't want to actually write the code to create a separate line plot for each country manually.

Fortunately, `facet_wrap()` (and `facet_grid()`) can do this for me. Below I take the same code and add a `facet_wrap()` layer where I specify which categorical variable in my data I want to use to specify the different plot panels (I write `~country` to create a separate panel for each value in `country`). This is essentially just taking each line in the plot above and giving it its own plot. Each plot will inherit the aesthetic properties of the `geom_line()` layer. Note that the `ncol = 4` argument of `facet_wrap()` tells ggplot2 that I want my plot grid to have 4 columns.

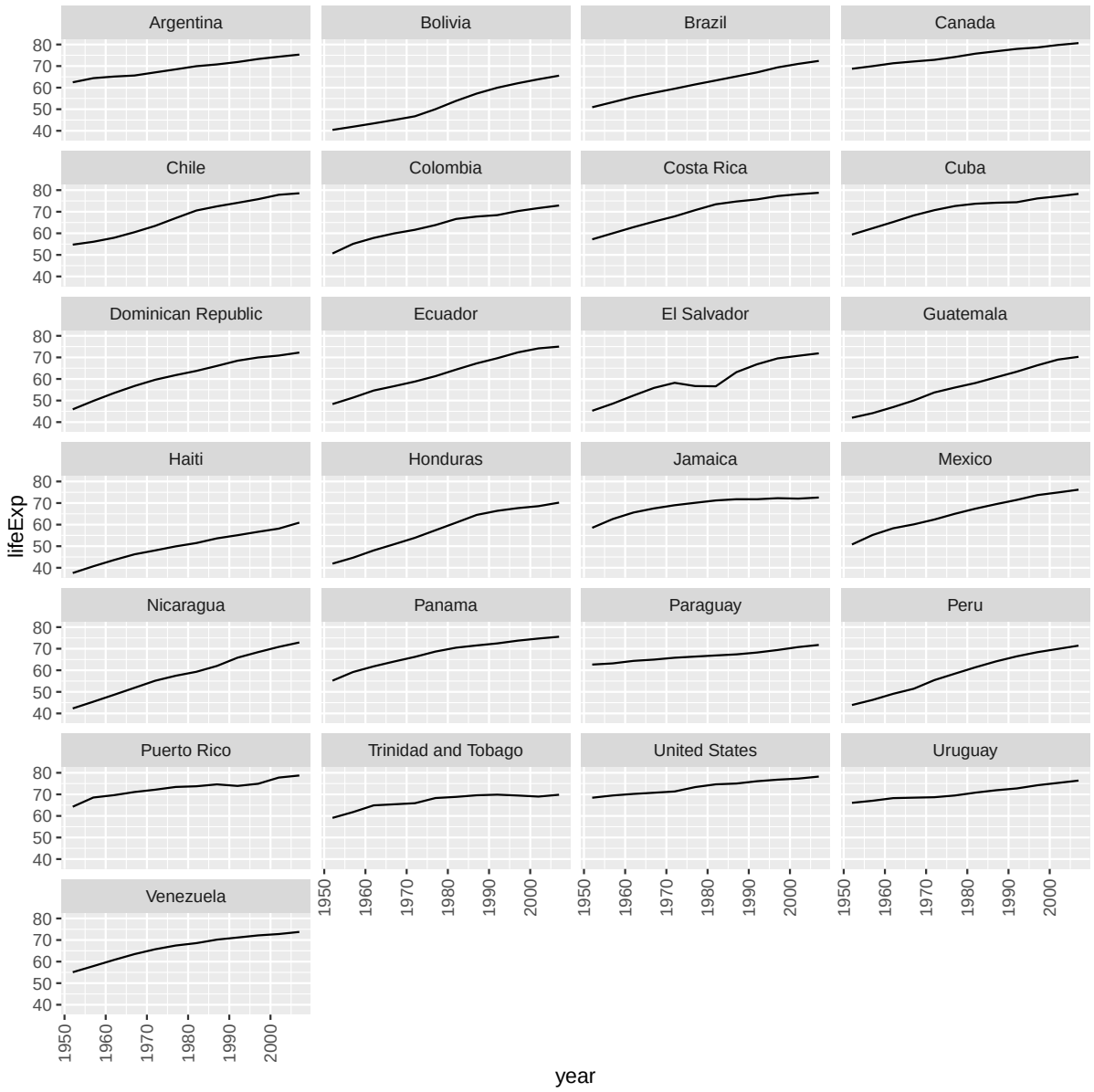
```
gapminder |>
  filter(continent == "Americas") |>
  ggplot() +
  geom_line(aes(x = year,
                y = lifeExp)) +
  facet_wrap(~country, ncol = 4)
```



7.17.5 Controlling figure output size in quarto

My previous plot is all cramped, but if I add some `#| fig-height` and `#| fig-width` options to the top of my quarto code chunk, I can control the size of the output in my rendered quarto document, such as

````
```{r}
#| fig-height: 8
#| fig-width: 8
gapminder |>
  filter(continent == "Americas") |>
  ggplot() +
  geom_line(aes(x = year,
                y = lifeExp)) +
  facet_wrap(~country, ncol = 4)
```
````



Note that I also rotated my x-axis text 90 degrees using a `theme()` layer. If you want to start truly customizing your your ggplots, you're going to get intimately familiar with the `theme()` layer options.

7.18 Exercise

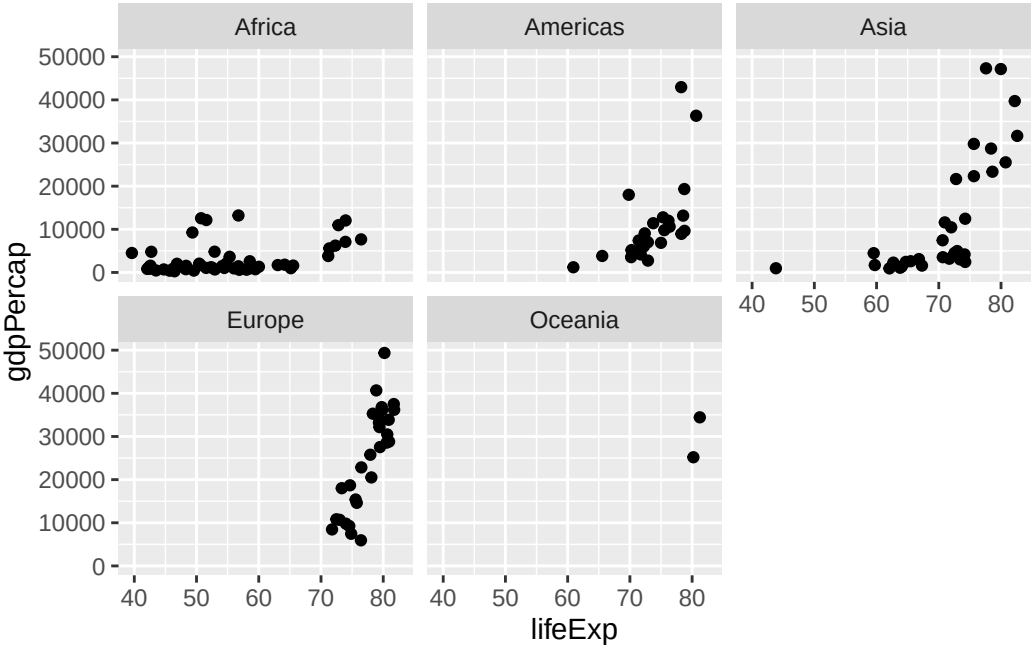
Create a faceted grid of scatterplots of `lifeExp` against `gdpPercap` in 2007 for each continent (i.e., there is a separate panel for each continent). Do some fancy things to make your plot

sparkle!

7.19 Solution

Here is a plot without much fun:

```
gapminder_2007 |>
  ggplot() +
  geom_point(aes(x = lifeExp, y = gdpPercap)) +
  facet_wrap(~continent)
```



Here is a plot with some fun:

```
gapminder_2007 |>
  ggplot() +
  geom_point(aes(x = lifeExp,
                 y = gdpPercap,
                 size = pop,
                 color = continent),
             alpha = 0.5) +
  scale_x_log10() +
  scale_y_log10() +
```

```
  theme_minimal() +
  facet_wrap(~continent) +
  labs(x = "Life Expectancy",
       y = "GDP per Capita",
       size = "Population",
       color = "Continent")
```