# Homework 3

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*Due 11/1/2019*

In this homework assignment, you will use the Gapminder dataset to build a Shiny app with two tabs. Otherwise, the layout of your Shiny app does not matter, as long as your final product is easy to navigate and interpret. Some inspiration can be found here or by browsing the Shiny gallery.

Note that for this assignment you will need to push 3 files to your HW3 repository:

1. **HW3.Rmd** with all of your written answers to questions 1, 3, 5, 8, 9 and 10.
2. **HW3.html**, the knitted HW3.Rmd file
3. **app.R** file for your Shiny app

Also note that both the .Rmd file and Shiny app file need to run on our computers as well as yours.

The Gapminder Foundation is an organization dedicated to educating the public by using data to dispel misconceptions about global development. You can load the dataset from the `dslabs` package. The `gapminder` data frame contains health and income outcomes for 184 countries from 1960 to 2016, with the variables listed below. We will focus on life expectancy as our outcome of interest. **For the purpose of this assignment, don't worry about handling missing values and ignore all messages informing you that rows with missing values have been removed**.

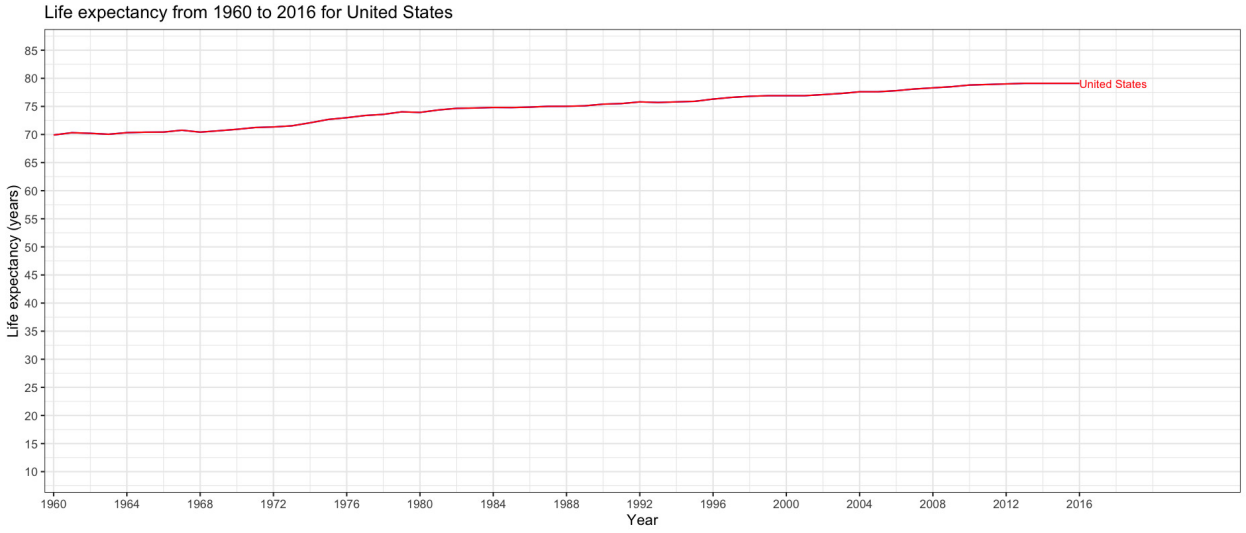
- `country`
- `year`
- `infant_mortality`: Infant deaths per 1000.
- `life_expectancy`: Life expectancy in years.
- `fertility`: Average number of children per woman.
- `population`: Country population.
- `gdp`: GDP according to World Bankdev. in US dollars
- `continent`
- `region`: Geographical region.

```
library(dslabs)
data(gapminder)
```

### Question 1

Create a Shiny app with a line plot of life expectancy against year, restricted to observations from the United States. How has life expectancy in the United States changed over time?

**As shown in the plot below, the United States has seen a steady increase in life expectancy from 1960 to 2016 that appears mostly linear. The rise is fairly consistent, starting from approximately 70 years old to just below 80 over a span of 6 decades.**




### Question 2

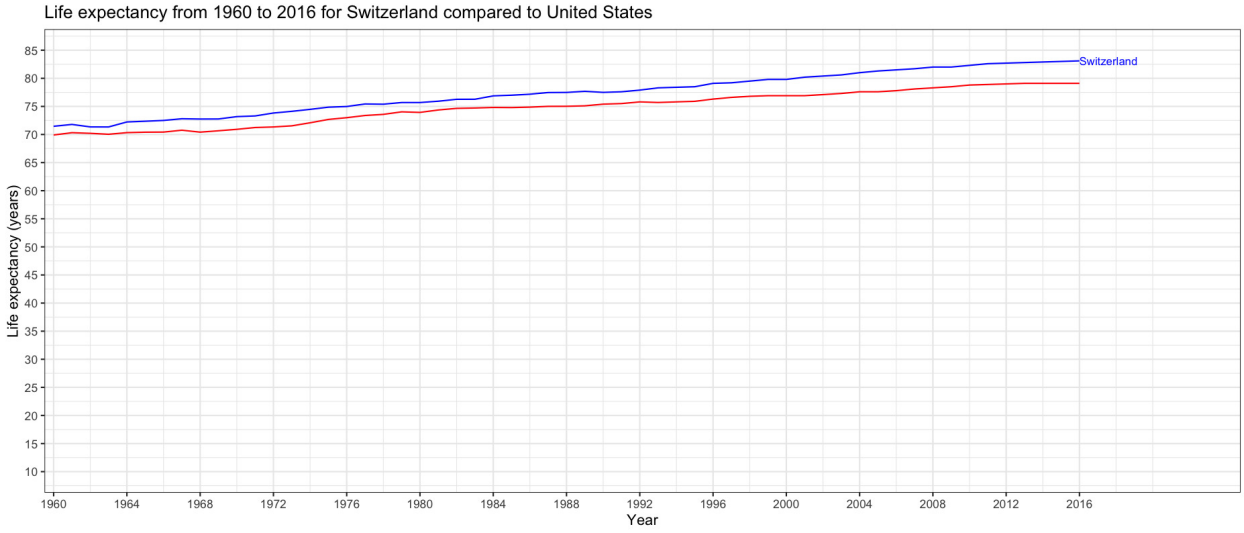
It might be interesting to compare life expectancy over time in the United States with trends in other countries. Use the `selectInput` function to create a select list input widget that allows you to select another country. Update your time series plot so that it now has two lines: one that plots life expectancy in the United States against year, and one that plots life expectancy in the selected country against year.

*No written answer needed*

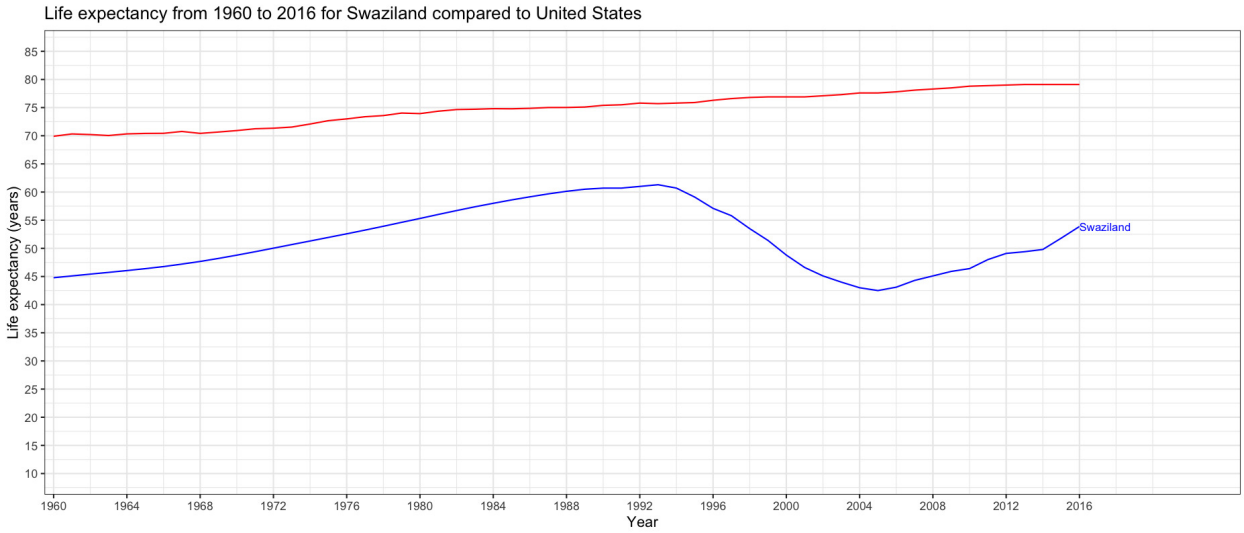
### Question 3

Compare life expectancy over time in the United States with life expectancy over time in Switzerland. Then compare the United States and Swaziland (renamed Eswatini in 2018, but referred to as Swaziland in the `gapminder` dataset).

**As shown in the plot below, both the United States and Switzerland have experienced an increase in life expectancy over time. The rate of this increase is fairly similar for the two countries, with Switzerland slightly in the lead starting in 2000. Additionaly, throughout this time period, Switzerland has always had longer life expectancy than the United States, starting at just above 70 and rising up to almost 85 years of age. This is not a huge gap on its own, but we do see similar patterns for other western and central European nations in comparison to the United States.**




**The plot below for Swaziland versus the United States tells a different story. Situated in southern Africa, Swaziland has not seen a steady increase in life expectancy as with the United States and many European countries. Starting in the early 1990s, there has been a sharp decline until mid-2000s, where the life expectancy of the country was shorter than that in 1960, the beginning of data collection. The history of Swaziland has been an uneasy one, with a terrible drought in 1992 and ongoing political unrest throughout the decade. There has also been an HIV/AIDS epidemic in the country, which has contributed largely to high mortality rates among productive Swazi age groups. All these factors may explain the decline in life expectancy over these years. Fortunately, the Swazi government has been investing in resources to combat the disease by implementing action plans that focus on HIV prevention, care and support, impact mitigation, communications, monitoring and evaluation, and management/coordination. Thanks to these efforts, we are now seeing growing life expectancies in the country, with a rate of increase that is arguably greater than the United States. However, the life expectancy of Swaziland was below 55 in 2016 in terms of raw numbers; we still have a long ways to go in settling the political and medical difficulties before the citizens get to enjoy the fruits of longevity.**




## Question 4

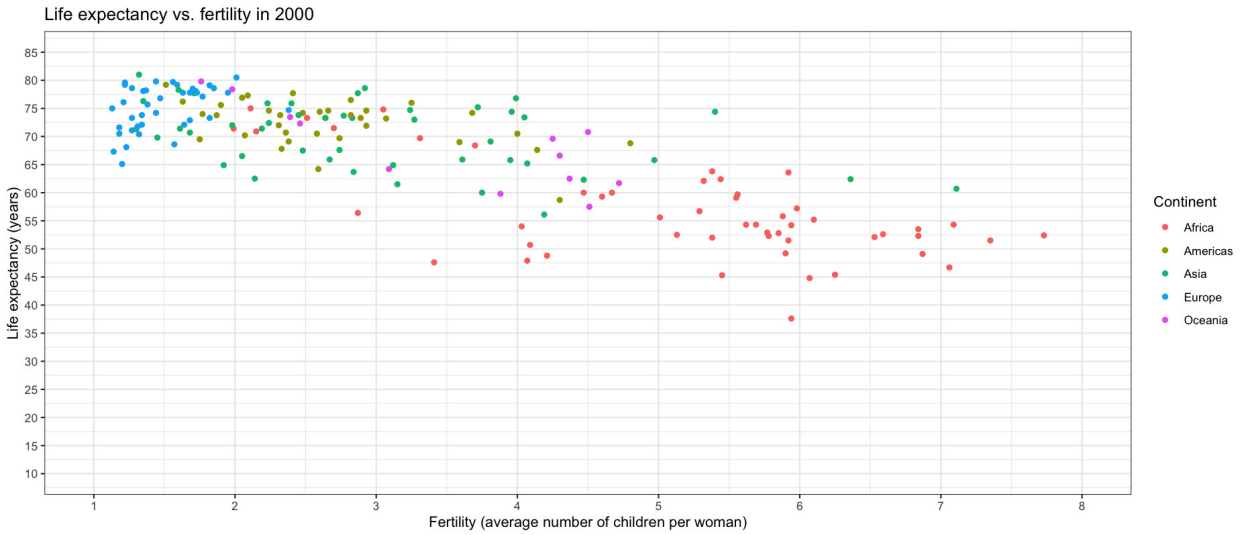
Use `tabsetPanel` and `tabPanel` to make two tabs for your Shiny app. Move your time series plot and country selector widget from Questions 1-3 to the first tab.

*No written answer needed*

### Question 5

In the second tab, make a scatterplot of life expectancy against fertility rate, filtering for the year 2000 and coloring by continent. What trends do you see?

**We see mostly an inverse relationship between life expectancy and fertility in 2000, *ie.* life expectancy seems to be higher when women have fewer children. Most of the data points congregate around 1 to 3 children per woman, with fewer and more spread out observations towards higher fertility values. In 2000, most countries in Europe and the Americas have an average fertility of less than 2 children per woman. These are also the countries/continents that lived the longest, with many above 80. Most Asian and Oceanian (with the exception of Australia and New Zealand; very easy to spot) countries had an average fertility between 2 and 5 children per woman, and their life expectancy hovered around 70. Most African and a few Asian countries had an average fertility of >4 children per woman. Unfortunately, they also experienced the lowest life expectancy, with an average of around 50 to 55 years. The data also appear to be heteroscedastic: the variability in life expectancy tend to be greater for higher values of fertility.**




### Question 6

Still in the second tab, use `sliderInput` to add a slider widget that allows the user to select year. Update your scatterplot so that it plots life expectancy against fertility rate for the selected year. Optional: experiment with the arguments of `sliderInput` to make your widget look nice (e.g., get rid of the comma, make sure that the years are always integers, etc.).

*No written answer needed*

### Question 7

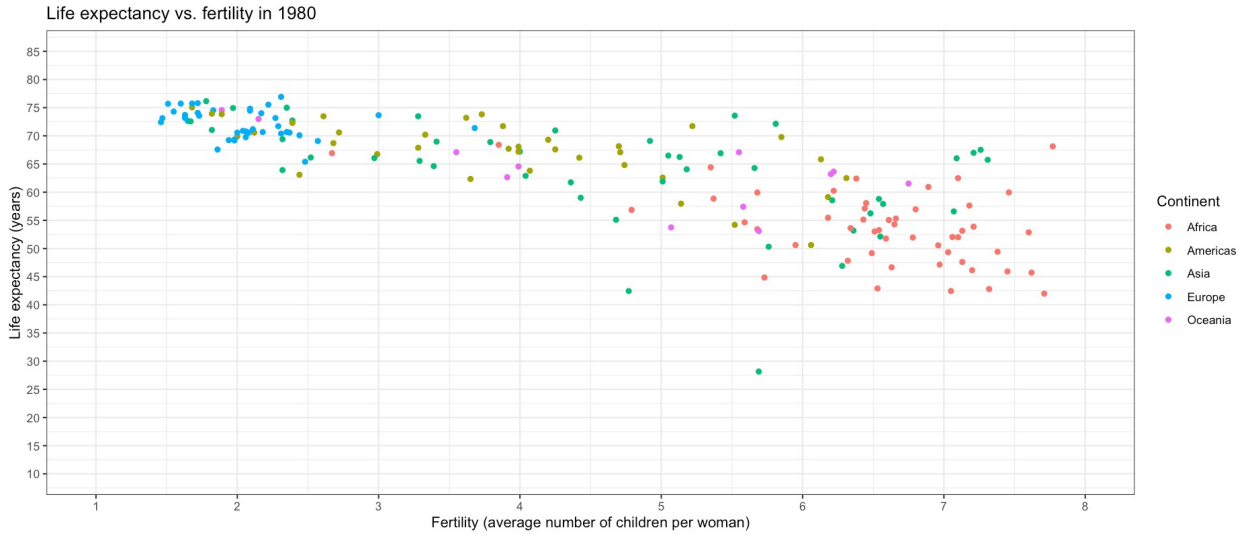
Make your scatterplot interactive by allowing the user to click on a point to get more information about the observation. You can do this by including calls to `plotOutput` in the UI and `nearPoints` in the server; a demo is available here. When the user clicks somewhere on the plot, your app should print a data frame with the corresponding life expectancy, fertility, country, and continent for all points near the click.

*No written answer needed*

### Question 8

Look at your scatterplot of life expectancy against fertility rate with the year selected as 1980. Do you see a major outlier? Does the outlier have an unusual value for life expectancy and fertility, or for only one of the variables? Click on this point to get more information. What country is the outlier?

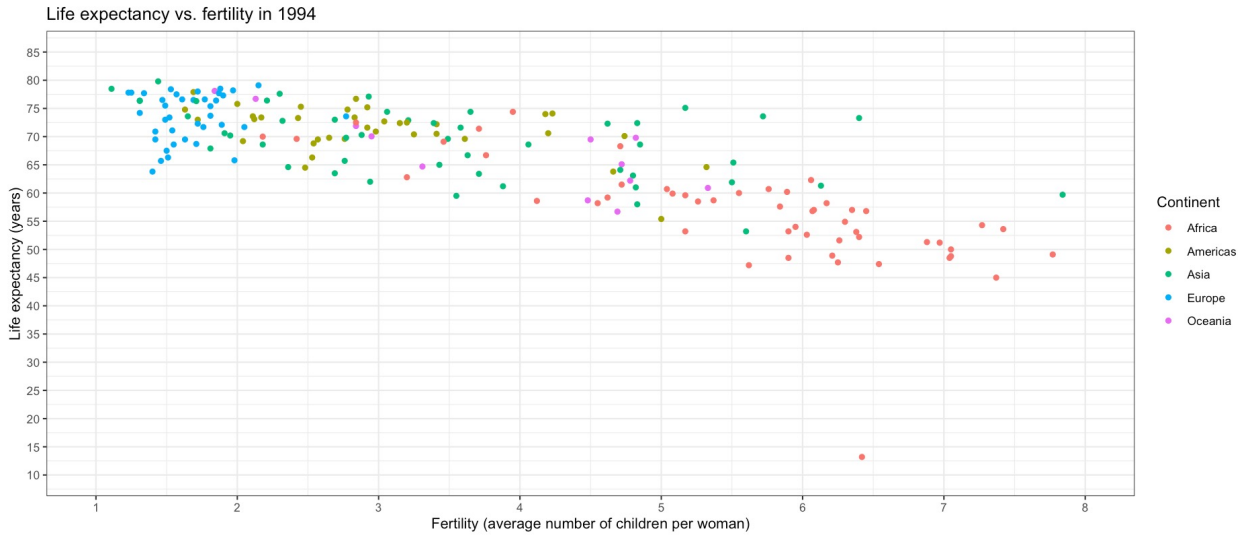
**The major outlier is Cambodia, with fertility of just above 5.5 children per woman and a meager life expectancy of 28.16 years. The fertility was not an outlier, as several other Asian countries at the time had similar if not higher numbers of children per woman. However, the life expectancy of Cambodia during this time was at a shocking low. This was a tragic result of the Cambodian genocide that lasted from 1975 to 1979, where the communist regime Khmer Rouge mass executed, enslaved, exiled, and abused approximately 1.5 to 2 million people. The massacre was brought to an end by the defeat of the Khmer Rouge in 1979 as a result of the Vietnamese invasion of Cambodia.**




Click anywhere on the plot to view life expectancy at a glance

```
  life_expectancy fertility  country continent
1           28.16      5.69 Cambodia      Asia
```

**Similar - although bitter - stories have happened in the past. The lowest life expectancy of all countries during the data collection period throughout the entire Gapminder dataset was found in Rwanda in 1994, with an average number of 6.42 children per woman and life expectancy of only 13.2 years. Similar to Cambodia, the fertility of Rwandan women was not uncommon compared to their other African counterparts. The 3 months long Rwandan genocide took place in 1994 and sent shockwaves across the rest of the world. The core Hutu political elite waged a mass slaughter of Tutsi, Twa, and moderate Hutu in the country, killing an estimated 500,000 to 1,000,000 Rwandans, including 70% of the Tutsi population. An estimated 250,000 to 500,000 women were raped, and children were not spared. The impact of the genocide was lasting and profound and continues to haunt the nation and the rest of the world until this day.**



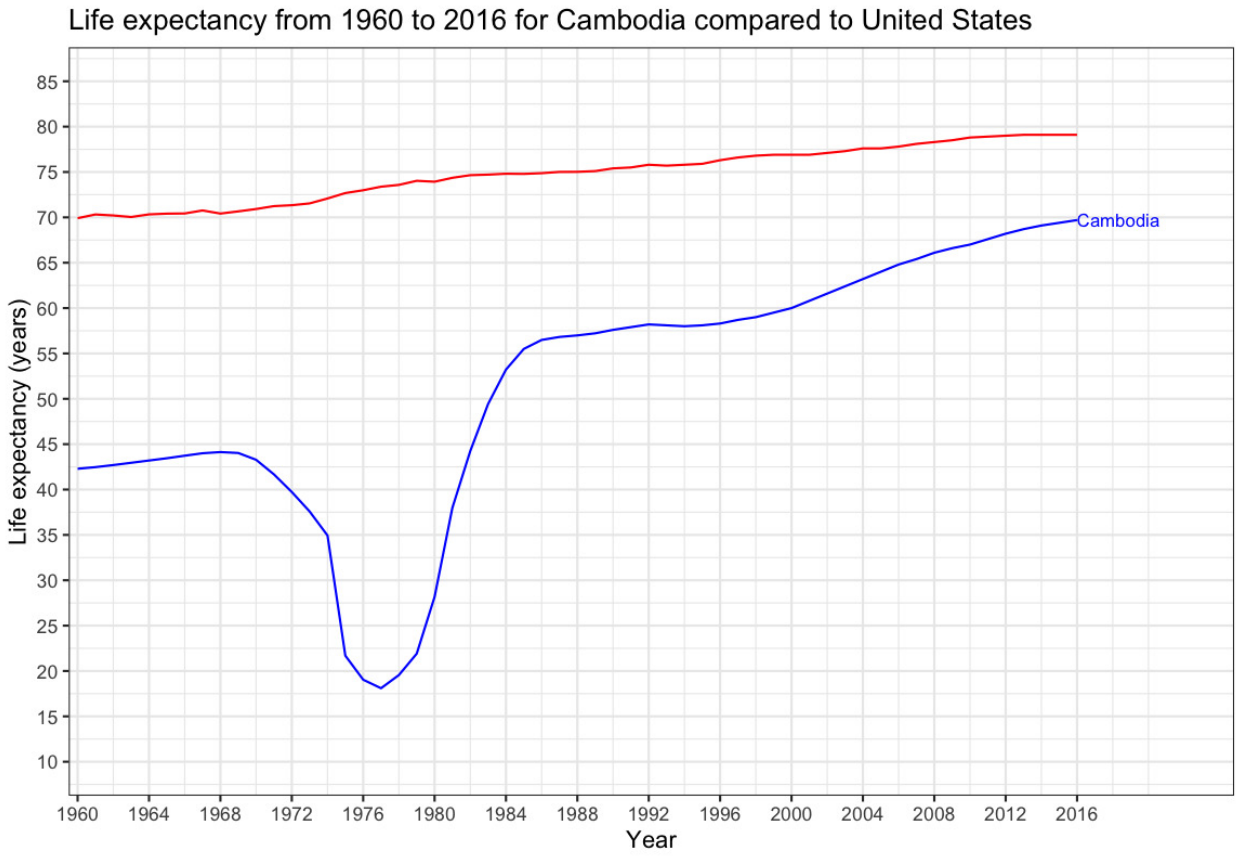

Click anywhere on the plot to view life expectancy at a glance

```
  life_expectancy fertility country continent
1            13.2      6.42  Rwanda    Africa
```

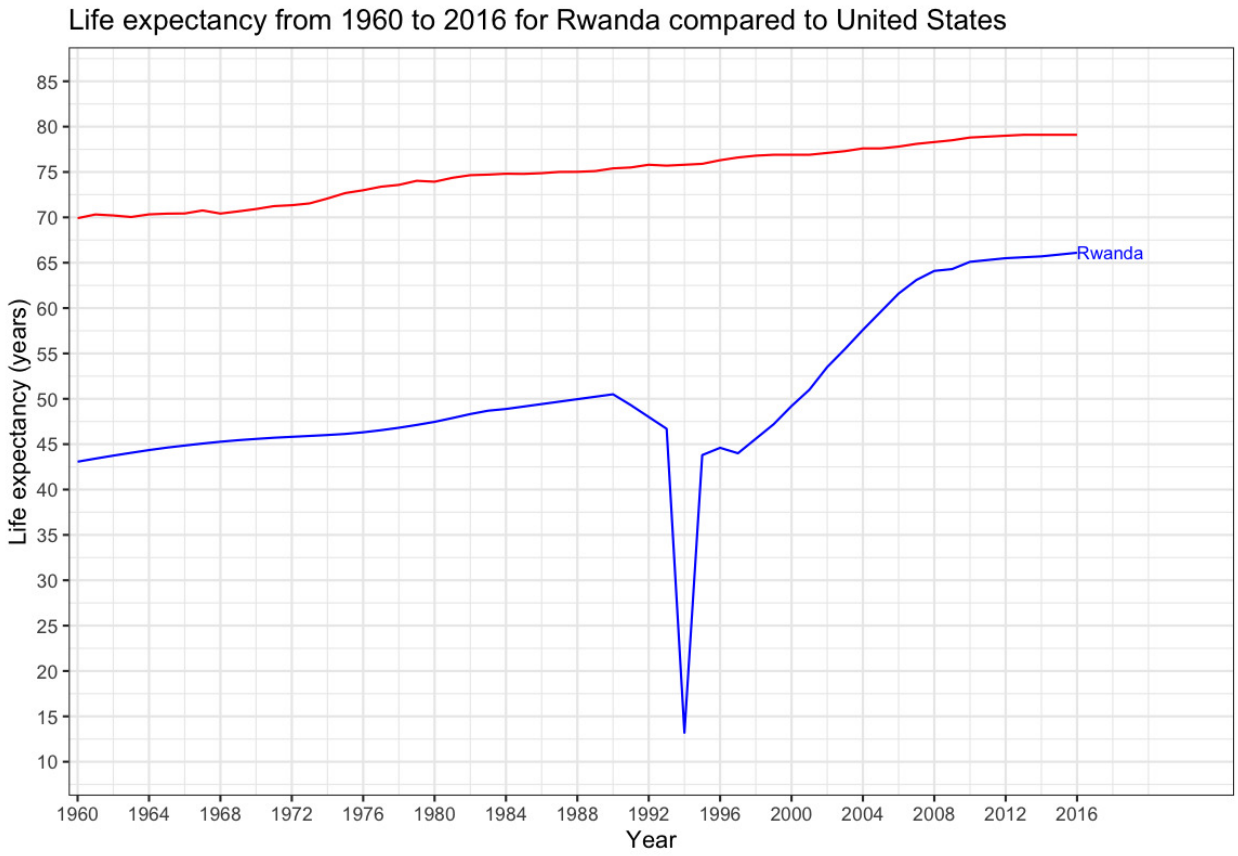
### Question 9

How has life expectancy changed over time for the outlier country from Question 8? You can use your time series plot in the first tab to answer this question.

**Thankfully, the life expectancy of Cambodia has steeply increased once the genocide was over. There was a huge boom in life expectancy between 1980 and 1985, after which we also see a steady rise. In fact, the life expectancy in Cambodia was 70 in 2016 (I would consider 70 years a well-lived life). The outlook is positive, and at this rate I am optimistic that the life expectancy of Cambodia will catch up to that of the developed nations (so to speak) in due time.**




**Similar positive trends are seen in Rwanda, with life expectancy elevating in almost the same year after the genocide. The Rwandan government has outlawed denial of the genocide, and it is heartwarming to know that we as the human race are resilient and capable of admitting and reversing our wrongdoings.**




**Question 10**

Suggest another interactive feature that you could incorporate into your Shiny app, perhaps involving one (or more) of the other variables in the `gapminder` dataset. What `R/shiny` function(s) would you use to implement this feature? Optional: add the feature to your Shiny app, as long as it doesn't interfere with the functionality of the non-optional parts of this assignment.

**One additional feature I would like to add is to display the country, continent, life expectancy, and fertility values as a character string right next to the closest point as the user hovers over it in the second plot. To implement this, I would first add arguments related to `hover` (*eg.* `hoverOpts()`) to the `pointPlot` output in the UI, followed by calling `verbatimTextOutput()` to define the feature. Later in the `server()` function, I would call `renderPrint()` to produce the tooltip. Inside the `renderPrint()` function, I would also include an argument for `dist`, as R needs to find a way to locate the point closest in distance to the mouse action. I can then use a printing function such as `cat()` to reactively display the information. An example of this interactive feature can be found here.**