Statistical Analysis and Visualization on Life Expectancy and Factors

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Motivating Example

"To infinity, and beyond!"
- Buzz Lightyear, Toy Story I

Growing up watching Toy Story, our favorite character was Buzz Lightyear, the charismatic space ranger. A central aspect of Buzz Lightyear's unending quest to protect the galaxy is the crucial need to replace his batteries when they inevitably deplete over time. As children it was easy to overlook the implications of changing his batteries, but we were unintentionally concerning ourselves with the idea of life expectancy. By obtaining new batteries, our goal was to help improve and extend Buzzes longevity. In this data analysis report we aim to move past toys and anayze human life expectancy around the world. Our goal is to better understand life expectancy, possibly some of the factors that influence and extend human life expectancy and how these findings can make a difference.

Introduction

Topic

Life Expectancy is a significant indicator of a nation's overall health, economic development, and quality of life. By definition, life expectancy is the measure of number of years an individual is expected to live, an estimate on the average age of a person when they die. Throughout history, life expectancy across the world has improved substantially with improvements in technology, living conditions, and increased access to healthcare to name a new. Many factors have been proven to impact life expectancy, whether that be positively or negatively. (Example)

In this article we hope to tackle many questions relating to life expectancy and some of its factors. Within our dataset we have many variables we intend on exploring, all of which will be described in the Dataset section. Significant research has been done surrounding

will be described in the Dataset section. Significant research has been done surrounding this topic, many claims have been proven or disproven relating to life expectancy and its many factors. We hope to not only create interactive visualizations for our reader to explore, but also tie in prior research and observe if we can create similar conclusions or disprove claims that have been made.

We intend to make many visualizations which are both static and interactive, allowing the viewer freedom to manipulate the visualization as they wish. These viewers may have a variety of reasoning for reading this article, most likely due to an interest in the topic of life expectancy.

Dataset

Background

Our dataset originates from Kaggle (link), which include the variable representing life expectancy and many factors which influence it. The dataset contains data from 179 countries from the years 2000-2015. The data itself comes from World Bank Data under the World Health Organization(WHO) within The Global Health Observatory (GHO). This dataset was cleaned and made for use for data analysis, as the original dataset had some missing values which could easily be found from other WHO public datasets, so missing data was filled in accordingly. Corresponding economic data, such as GDP per capita, was obtained from the United Nations (UN) website. So, this dataset was created from both the WHO and UN websites, combined into one large dataset. Using these factors we can make the conclusion that this is a authentic dataset with correct values

It is worthy to note that not every country was represented in this dataset. Here are some key limitations:

- There are multiple missing countries which could hurt the overall analysis. Some missing data within the original WHO dataset, where the *missmap* command in R handled some of this missing data.
- The majority of missing data was for population, Hepatitis B, and GDP from lesser known countries to the general public such as Togo, Tonga, etc. Some of these lesser known countries were then removed entirely from the dataset since there was little resources to obtain the missing data.
- This caused many problems in some parts of our analysis, such as the interactive map where countries which weren't represented were grayed out, and any plot which visualizes different countries and their life expectancy.

Also, no data was specifically filtered out of the dataset, just some countries were removed due to insufficient data. No transformations were also done, just some variable renaming and adding one additional variable which will be noted in the variable descriptions below

descriptions below.

The programming language R was used to aggregate variables and create new datasets, such as mean calculation for countries and regions. All datasets are imported in the data imports section.

Variable Description

There are a total of 21 variables in this dataset, but using R software one additional variable was created, which will be described and highlighted below. Other variable names were also changed to make it easier to understand, again using R denoted below. We do assume readers have some knowledge of diseases such as Measles or HIV. If not, we have provided links next to terms which help define the terms from the World Health Organization themselves.

Variables:

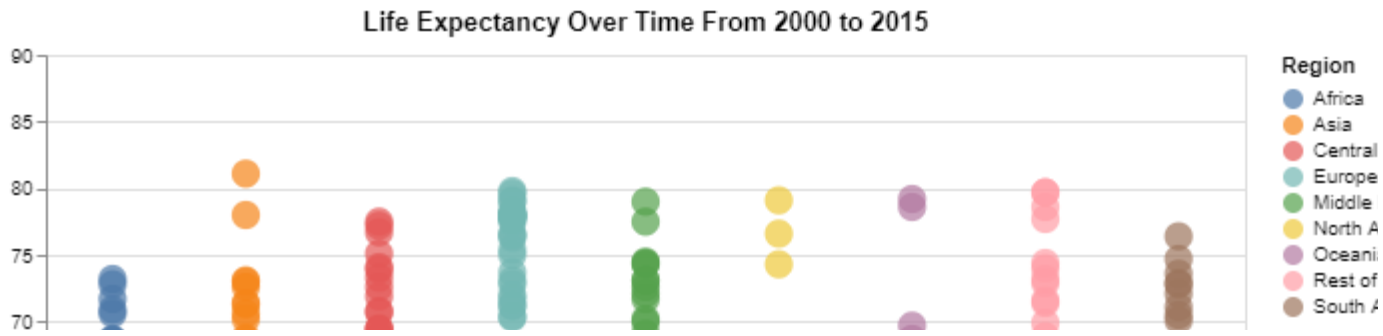
- Country: Country Observed
- Region: The Region in the world the Country is in (Asia, Africa, Oceania, etc.)
- Year: Year Observed
- Infant Deaths: Represents the infant deaths per 1000 population. (Generally infant is defined a 0-1 years old)
- Under Five Deaths: Represents the deaths of children under 5 years old per 1000 population. (Changed from Under_five_deaths)
- Adult Mortality: Represents the deaths of adults per 1000 population. (Changed from Adult_morality)
- Alcohol Consumption: Represents the alcohol consumption, recorded in liters of pure alcohol per capita for those 15+ years old. (Changed from Alcohol_consumption)
- Hepatitis B: Represents percent of coverage of Hepatitis B immunization among 1 year olds. (Changed from Hepatitis_B)
- Measles: Represents the percent of first dose of Measles-containing vaccine immunization among 1 year olds. (Measles Definition)
- BMI: BMI (Body Mass Index) represents a measure of nutritional status in adults and is defined as a numerical value calculated based on a person's weight and height. The exact formula is dividing a person's weight in kilograms by the square of their height in meters, (weight/height^2).
- Polio: Represents the percent of coverage of polio immunization among 1 year olds. (Polio Definition)
- Diphtheria: Represent the percent of coverage of Diphtheria tetanus toxoid and pertussis immunization among 1 year olds. (Diphtheria Definition)
- HIV Incidents: Incidents of HIV per 1000 population for those aged 15-49. (HIV Definition)

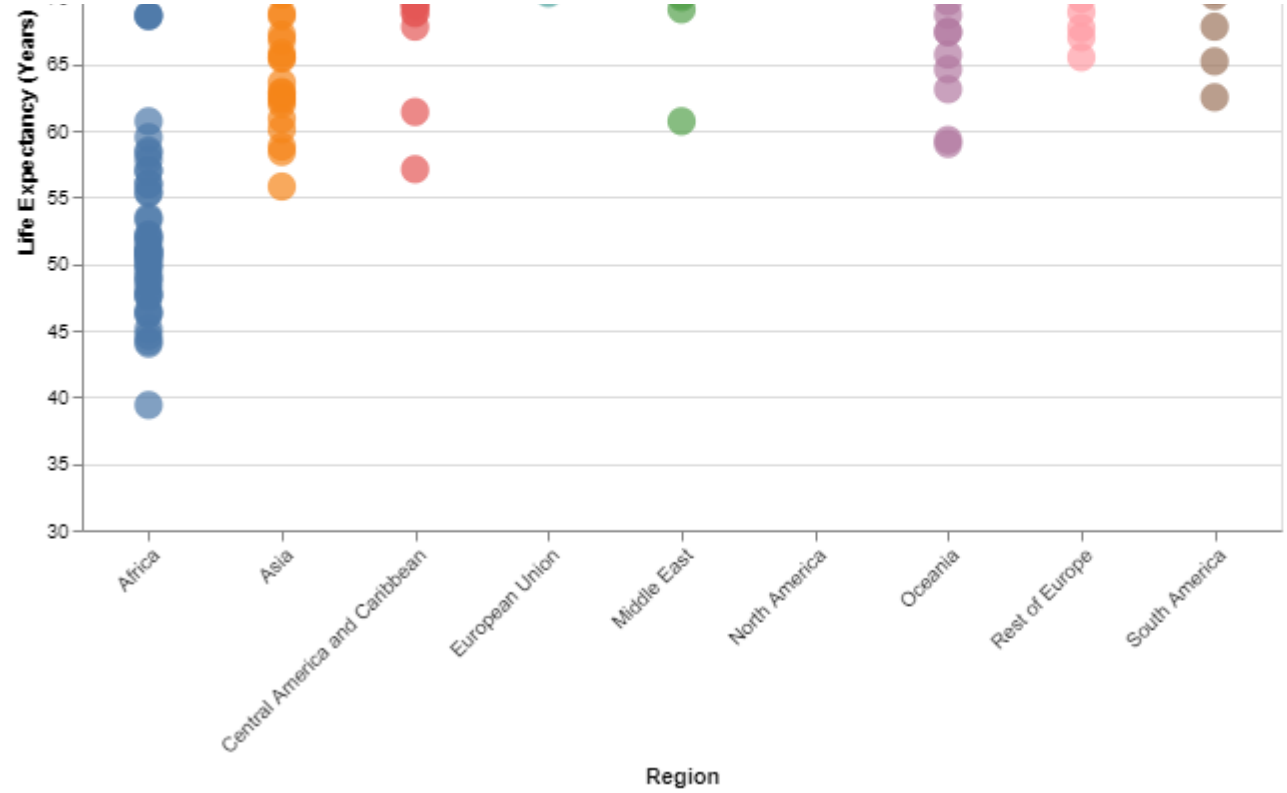
- GDP_per_capita: The GDP per capita of a country in USD. The GDP per capita in simple terms for those who may not be familiar is the calculating of diving the value of an economy's GDP by the number of inhabitants.
- Population_mln: Total population in millions
- Thinness_ten_nineteen_years: Prevalence of thinness among adolescents aged 10-19 years, defined as those with a BMI < -2 standard deviations below the median.
- Thinness_five_nine_years: Prevalence of thinness among adolescents aged 5-9 years, defined as those with a BMI < -2 standard deviations below the median.
- Schooling: Average years that people aged 25+ spent in formal education.
- Economy_status_Developed: Developed Country or not (1 yes, 0 no)
- Economy_status_Developing: Developing Country or not (1 yes, 0 no)
- Life_expectancy: Average life expectancy for both genders in different years.
- Develop_Status (New Variable added in R): Denotes whether or not a country is developed or developing in accordance to the variables Economy_status_Developed and Economy_status_Developing. By definition from the WHO, each countries is defined as Developed or Developing. These terms are usually used to categorize nations off their economic and social development and are generally broad classification for countries. The UN has a list for analytical purposes which classifies countries as either developed or developing.

Exploratory Analysis and Understanding Factors

First, we want a general understanding of how life expectancy is changing over time. This initial graph displays the life expectancy over different regions per year. By analyzing this graph we may gain insight into the trends and patterns of life expectancy in different parts of the world. In the graph, each column represents a different region of the world and each dot represents an individual country in that region.

In this visualization, users have the ability to interactively change the year being used in the visualization using the "Year:" slider. As a reminder, the years are from 2000-2015, where the life expectancy for different countries in specific regions are displayed. Also, interactively hovering over a specific point will display the country, year, and life expectancy for each point, where each point is colored by their respective region. This could answer the general question of how life expectancy is changing over time.





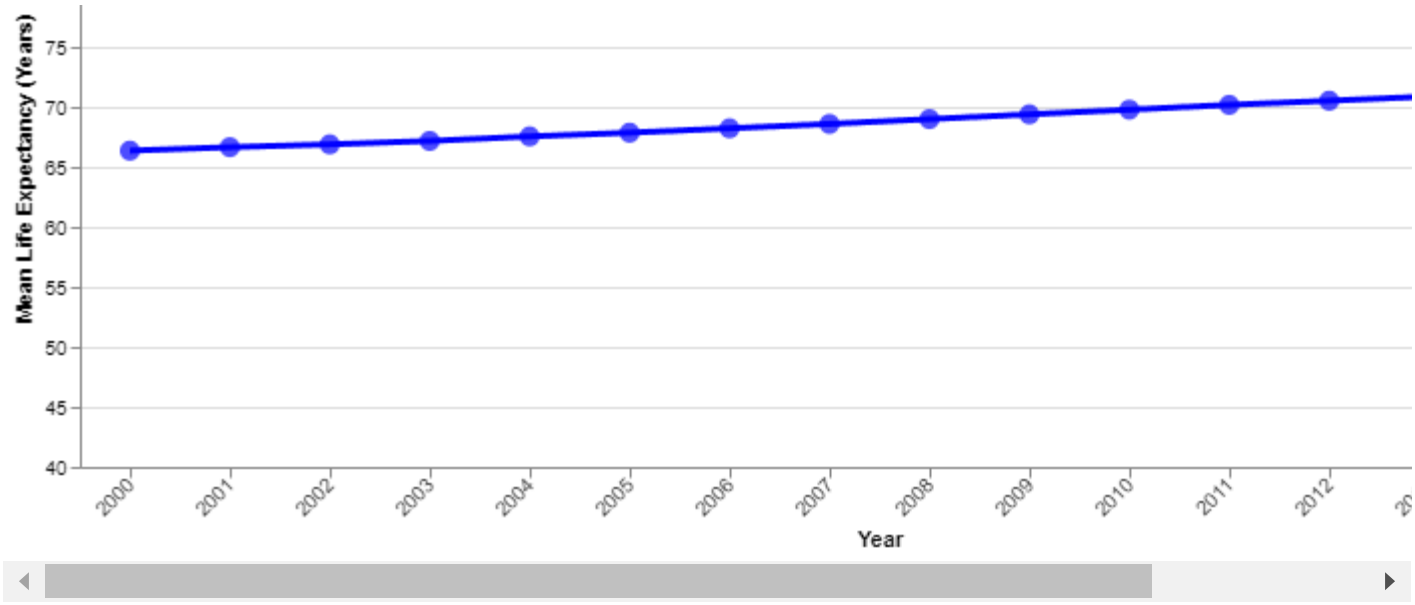
Year: 2000

For reference, to know which countries are in the European Union, visit this link. "Rest of Europe" would include any Countries in Europe not on this list.

Key Observations/Takeaways:

- Life expectancy is, for the most part, increasing as time moves forward. Although there are regions with notably lower or high life expectancies, each region shows an improvement.
- We can see that in the year 2000, majority of the life expectancies are around 65-75 years old, wheras in 2015, there is a high frequency of life expectancies in the range of 70-80 years old.
- Africa tends to have lower life expectancy than the other regions regardless of year and the other regions are all relatively similar in terms of life expectancy.

Building off this, another interesting visualization to observe would be how the actual life expectancy has changed overtime, where the mean life expectancy for each year can be displayed on a line plot. Hovering over a point will display the mean life expectancy for that year.



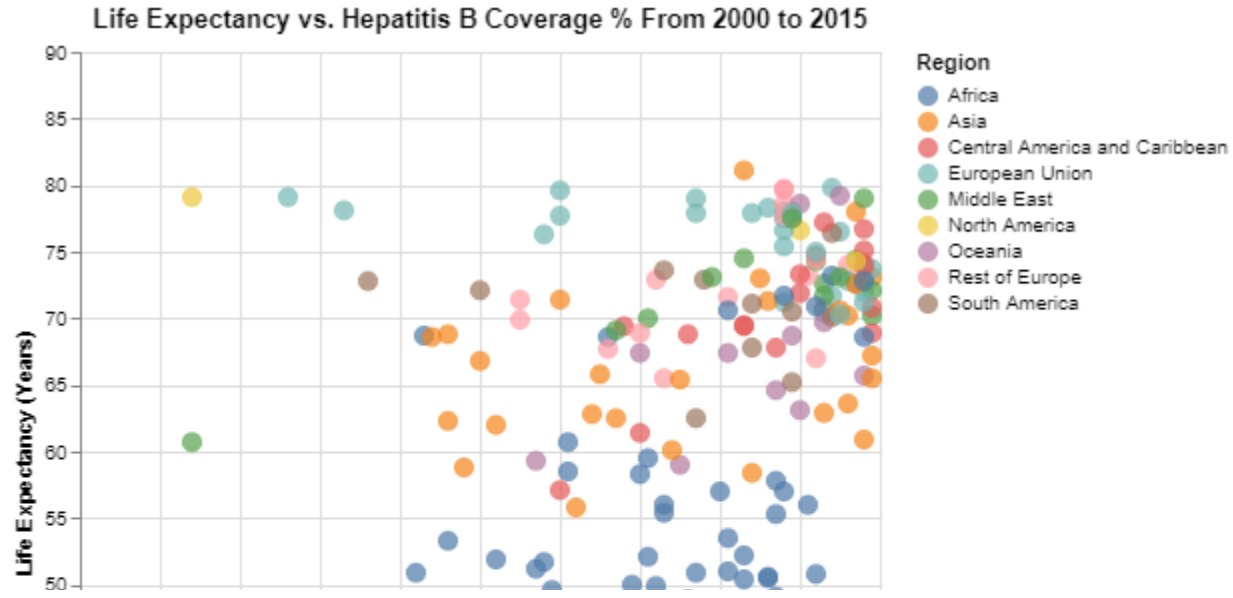
It is interesting to see that mean life expectancy has increased over time every year since 2000 to 2015, with about the same increase for each individual year to the next. This supports the previous claim and prior research, Forbes article linked in introduction, that in general life expectancy has increased over time, in our case from 2000 to 2015.

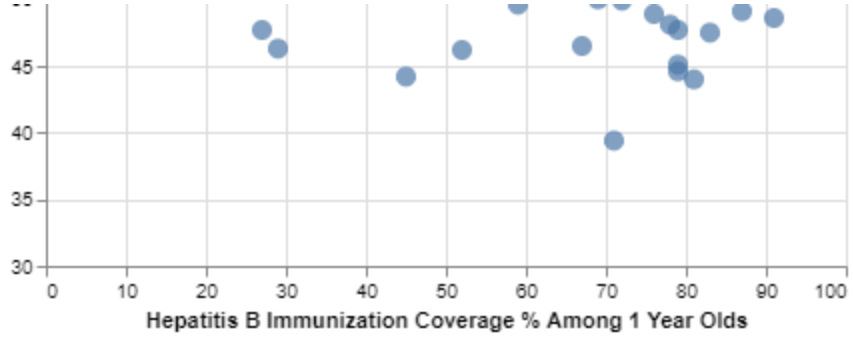
Life Expectancy With Different Health Factors

In this visualization users may interactively change the health factor being displayed in the scatterplot, where each point again represents a specific country using the "Health Factor:" selector. Also, like the previous plot the user may also change the year being displayed in the plot, one point for each Country in a given year with the slider. Each point is colored in the region they are in. Interactively hovering over the points will again yield similar results, dependent on the health factor chosen to analyze.

Health Factor:

Hepatitis B





Year: 2000

This graph allows us to visualize how certain health factors are different in each region and how they change over time. It also shows us what type of relationship each factor has with life expectancy and how certain health conditions may improve or hurt life expectancy. Recall from variable description exact description of these variables.

Key Observations for Different Variables

- We can see that over time both life expectancy and the immunization coverage against Hepatitis B for 1 year olds increase and maintain some linear relationship. This suggests that a higher immunization rate against Hepatitis B might lead to higher life expectancies.
- At first glance it seems like there is not a strong relationship between measles and life expectancy. However, if we use the drag to see the change over time, we can see that more and more 1-year-olds are getting immunization coverage against Measles.
- For Polio, over time both life expectancy and the polio immunization coverage among one year olds increase and maintain some linear relationship. Which again, suggests that a higher immunization rate against Polio might lead to higher life expectancies.
- For Diphtheria, we can make the same conclusions as the polio and hepatitis factors, a higher immunization rate against Diphtheria might lead to higher life expectancies.

Overall, this second graph provides insight into the variations of health factors and how they might impact life expectancy. This serves as a good foundation for each health factor, but to truly see cause and effect relationships we may need to do more in depth analysis into specific factors.

Key Questions

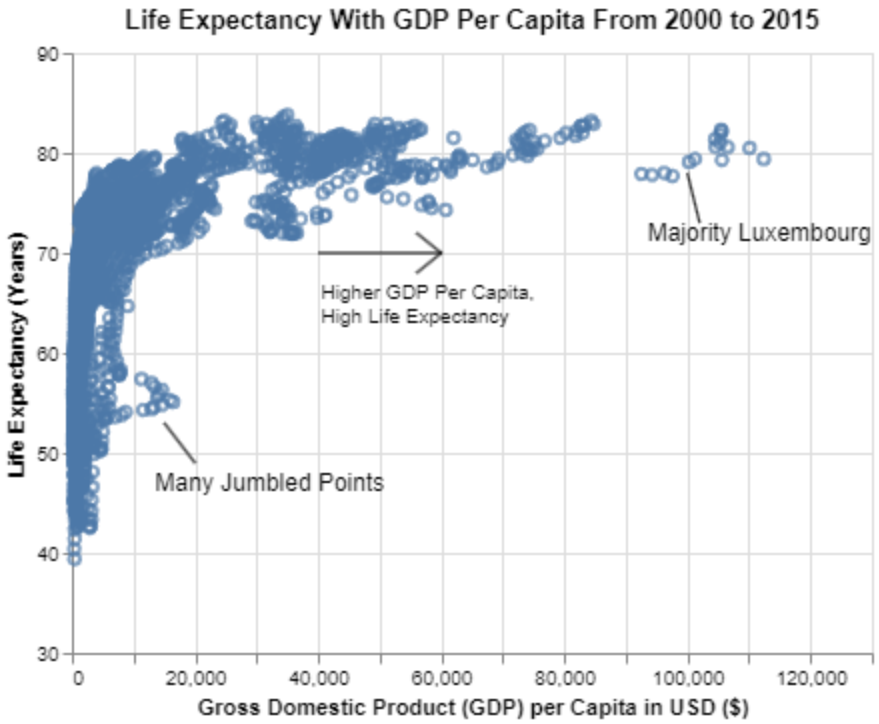
This first question is split into 3 subsections. Each question builds off the other, with every corresponding subsection adding an extra layer to the given question to explore even more trends.

Question 1a: Does GDP Per Capita Have Any Correlation With Life

Question 1a: Does GDP Per Capita Have Any Correlation With Life Expectancy?

There have been many studies done which assess various factors with Life Expectancy, example. One common factor is the Gross Domestic Product (GDP) of a nation, which represents the total monetary/market value of all the finished goods and services produced within a country's borders within a time period, where GDP Per capita divides this by the nations population. GDP Per Capita Definition. We can explore this relationship and observe any correlations.

In this visualization we will use GDP per capita, defined in the previous variables description, making a scatterplot comparing this with life expectancy. Hovering over specific points yields general information about the Country, year, GDP per capita, and life expectancy for a point.



Key Observations/Takeaways:

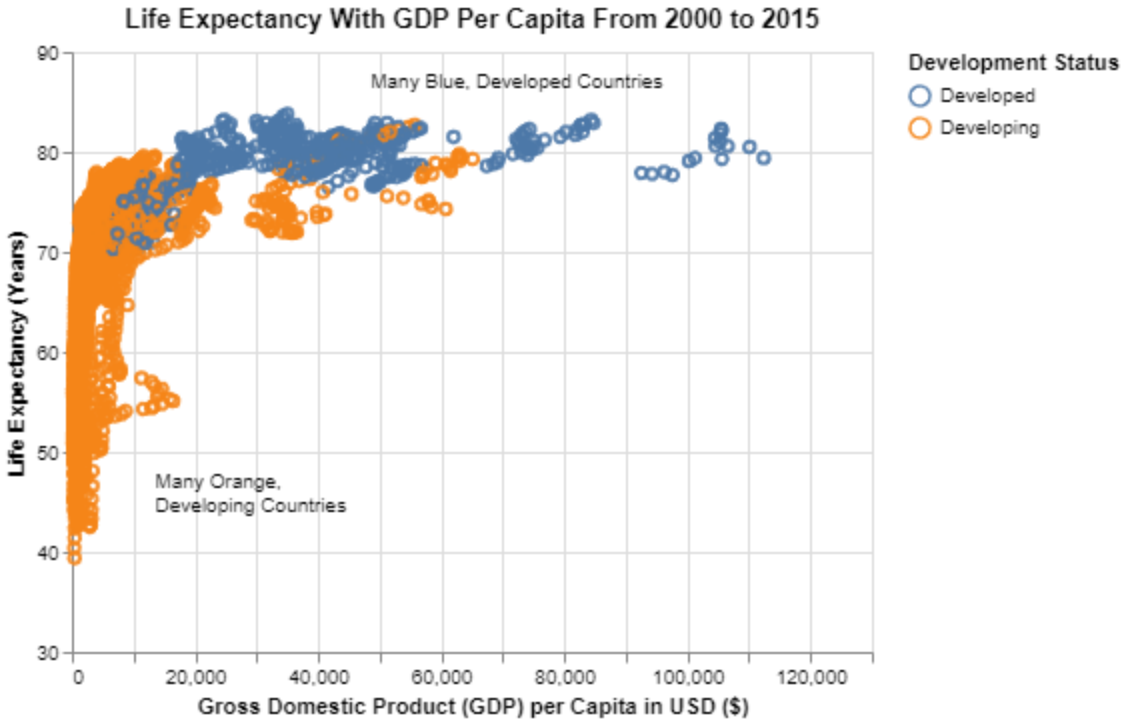
- Majority of countries have a smaller GDP per capita have a very wide variety of life expectancies.
- For those with a higher GDP per capita it seems like they have a high life expectancy as the majority of the countries towards the middle and right sides of the graph have very high life expectancies.
- Overall, for those with a higher GDP per capita it seems like they have a high life expectancy, while those with a lower GDP per capita are a bit scattered.
- No significant correlation present as the majority of the points are jumbled towards the left of the plot. Weak positive linear relationship possibly.
- Supports research linked, higher GDP per capita leads to higher life expectancy.

This visualization prompts more questions though, since many factors could affect a nations GDP per capita, it would be interesting to explore other traits. Building off this plot it would be a good idea to possibly observe how the nation status would affect this, the nation status being whether or not a Country is Developed or Developing. A short description of a developed country would be countries which has an effective rate of industrialization, individual income and Human Development Index relative to other countries. On the other hand, developing countries have slower rates of industrialization and lower individual income. This term was also defined above previously.

Question 1b: Does GDP Per Capita Affect Life Expectancy and How Does the Development Status of a Nation Affect This?

After observing the previous visualization, one may wonder how the difference could be magnified based off of other factors, such as development status of a country. Changing the color based off if a nation is developed could be interesting to explore, since one may assume developing nations would have a lower life expectancy. Users may change the development status of a region to change the opacity of points with the Development Status selector. Hovering over a point yields the same output as question 1a, but also highlights a countries development status.

(Note that the "null" option will highlight both Developed and Developing Countries)



Development Status: null

Looking at this visualization, we have now colored each point by the development status of a country.

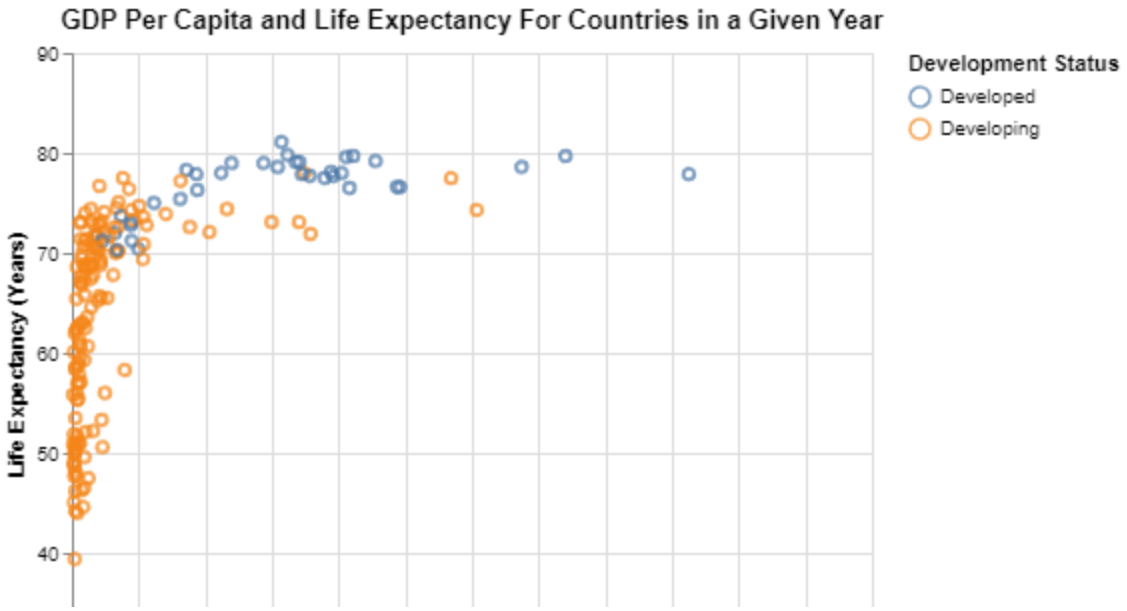
Key Observations/Takeaways

- The blue points, which represent a developed country, have a high concentration towards the top of the plot. These countries have high life expectancies.
- The GDP per capita for these developed countries are relatively spread out. However, most of the points further towards the right (Higher GDP Per Capita) of the plots are developed countries.
- The orange points, which represent a developing country, have a high concentration towards the left of the plot with lower GDP Per Capita, the points are very jumbled with no particular pattern.
- On average the developed countries have a higher GDP per capita than the developing countries, and a higher life expectancy.

This visualization helped answer more questions and created a broader picture for the original. However, there are still more questions that can be answered with similar visualizations. In both visualizations so far every year of the data was used, which could be unnecessary as the same nations were repeated 16 times for every year to create each point. One may now question how each nation has changed over time with respect to the 3 factors being discussed.

Question 1c: How has GDP Per Capita and Life Expectancy Changed Over Time From 2000-2015 for Developed and Developing Nations?

We leave this as a generally broad question, as we can answer how the factors have changed over time alone and with respect to one another. In this plot the user has the ability to interactively change the year being displayed on the visualization with the slider. Each point on the visualization represents a countries GDP per capita, Life Expectancy, and is colored by their development status for a given year. Hovering over each point will display multiple factors used in the visualization, the same ones from the previous.



Year: 2000

Key Observations/Takeaways:

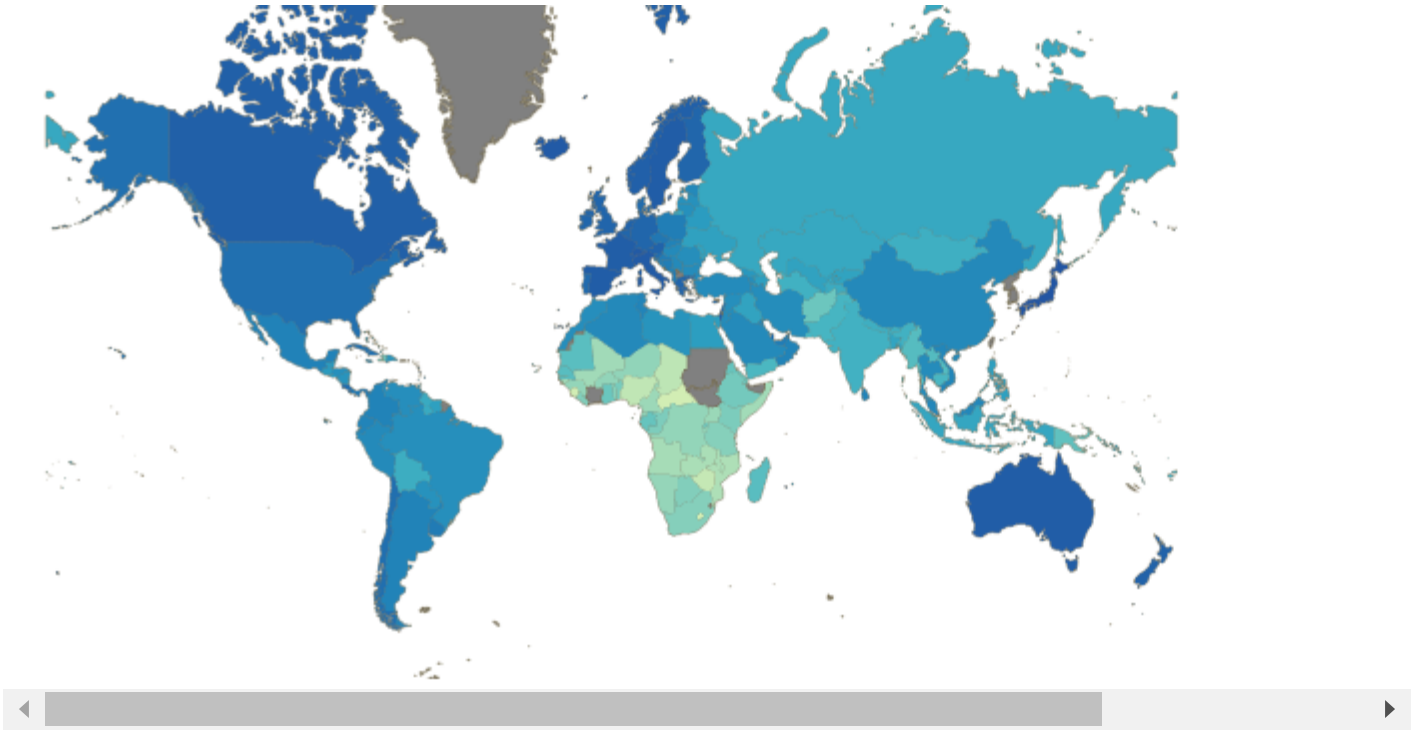
- This plot follows the same trend as the previous plot, as every year in the dataset the developing countries have on average a much lower GDP per capita and lower life expectancy than developed countries in every year.
- Additionally, we can see that there is an upward movement for the majority of the dots.
- In every year, developed (blue) countries are all towards the higher end of the plot.
- It seems like GDP Per capita doesn't change too much over the time period, especially for countries towards the left of the plot.
- Like the other plots, there is so significant linear relationship between the variables for any given year. They all follow approximately the same pattern.

Overall, these three graphs which built off one another help identify how GDP per capita has influenced Life Expectancy in different ways, including the addition of new variables within two of the visualizations.

Using these results, one may also question how life expectancy is varied in general around the world, as hovering over each individual point within these visualizations wouldn't be sufficient. Also building off the development status takeaways it could be interesting to further analyze how the development of a country influences life expectancy. Both these questions can be answered.

Question 2: How Does Life Expectancy Vary Across the World?

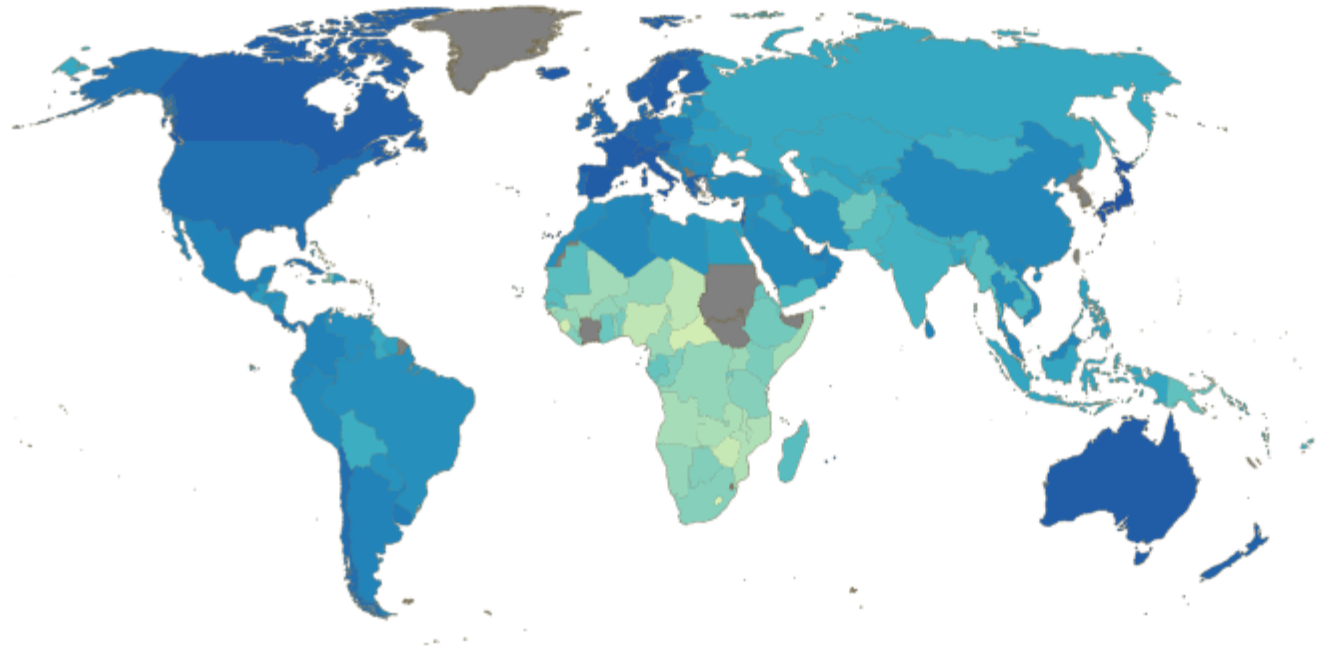
Throughout the world, many Countries and nations have significantly different life expectancies. As mentioned earlier, a nations life expectancy is a key contributor to its overall development and health, so having a high life expectancy is important for everyone. To assess this, one could be interested in observing a map of the world which displays the average life expectancy in each country. In our data, we are lucky enough to have 16 years worth of data, where one can observe the mean life expectancy in each country over this time period. Users may interactively hover over different countries to display the country name and mean life expectancy in years. If the country is grayed out, it will not display any results.



We decided to use the Mercator projection since it is one of if not the most commonly used map projections, so we hope many users have had previous knowledge and experience with it to make this as user friendly as possible.

However, we understand others would rather have a different map due to the distortion in the Mercator, which we will now provide. This map has the same interactive features as the mercator map.

Average Life Expectancy Across the World From 2000-2015

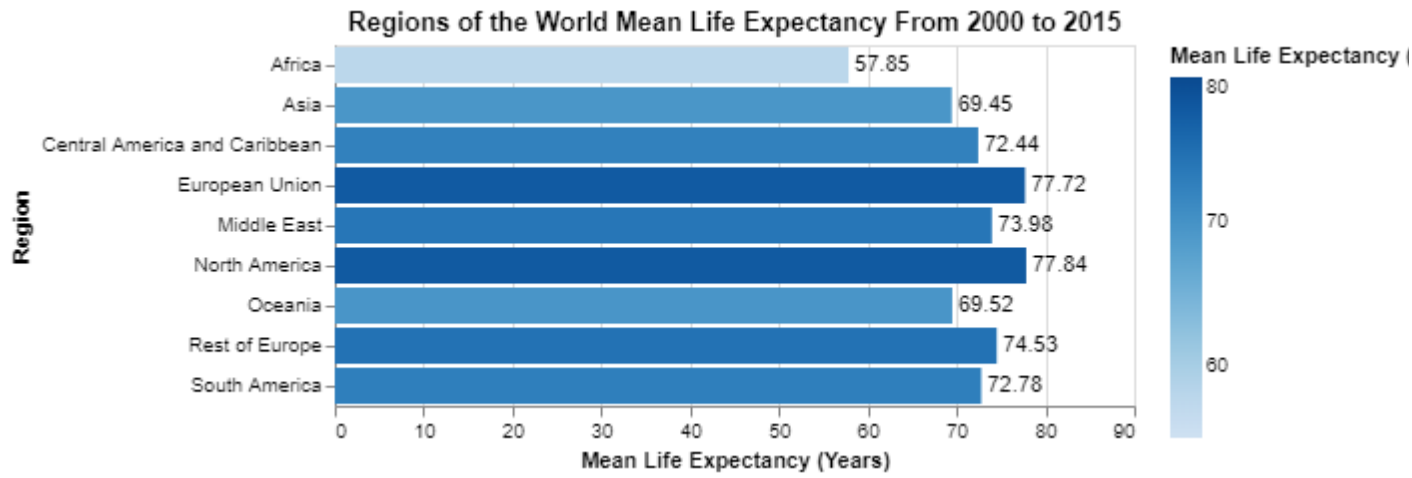


Many regions in this dataset unfortunately didn't have data collected by the WHO in this study, which were all displayed as gray. For the other countries however, the color over their region indicates their life expectancy on the color scale indicated on the right of the plot.

Key Observations/Takeaways:

- One can see that many of the countries in Africa have lower mean life expectancies, as indicated by the lighter color.
- Many countries in North America and Europe seem to have generally high life expectancies, possibly the highest in the map. Possibly investigate this claim with a follow up visualization.
- Africa seems to be the region with the most countries with missing data.

It could be interesting, after making these observations, to actually calculate what the mean life expectancy truly is in these regions of the world rather than the specific countries, which can now be displayed in the bar plot below. This allows us to further answer our question and expand it to regions rather than countries. Hovering over the specific bar gives information about the region and mean life expectancy.



Looking at this bar plot the Region of the world with the lowest mean life expectancy was in fact Africa, one key takeaway from the world map. It is also observed that the European Union and North America both have the highest mean life expectancy, which also could be seen in the map. Again, for countries which are in the European Union, click this link. We decided to order the plot on the y-axis by name so it would be easier to find a region one may be interested in.

As mentioned, natural follow up question one could make would be what specific countries actually have the lowest or highest mean life expectancies, as just looking at the

world map it would be hard to hover over every Country to find it. It also could be interesting to observe the Countries with the highest life expectancy in a given year. These follow up's help answer the primary question at hand.

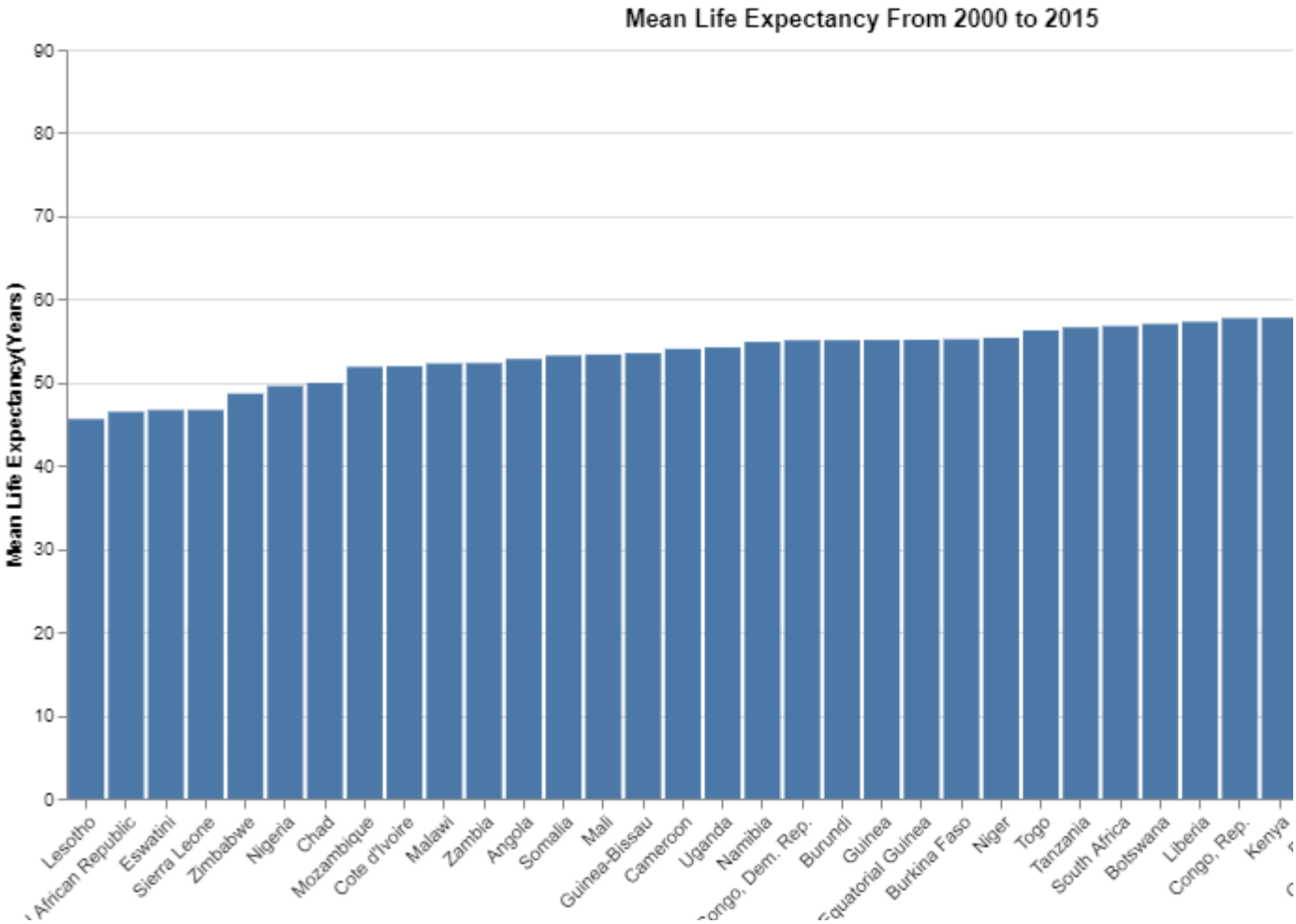
Follow up: Observe the Countries with the Lowest and Highest Mean Life Expectancy Over 2000-2015

This visualization is able to observe which Countries have the lowest and highest overall mean life expectancies. The user has the ability to change 2 aspects of the graph:

1. The user may change the ordering of the displayed bars with the "Sort By:" filter. The 2 options are ascending and descending, ascending will display the Countries with the lowest mean life expectancies, while the descending option will display the Countries with the highest mean life expectancies.
2. Also, the user may choose the number of Countries displayed in the graph, with at least 10 and up to 40 countries with the "Amount of Countries" slider. The default value is 40 countries, as this nearly would cover half the countries in our dataset and isn't too cluttered. This also gives some extra room in case someone is interested in a specific interval in this range.

Sort By:

ascending



Users are able to see the different countries which have the lowest mean life expectancy from 2000-2015 in our dataset and the highest. If viewers are only interested in a specific interval, say the top 20, they may interactively filter for the valid interval.

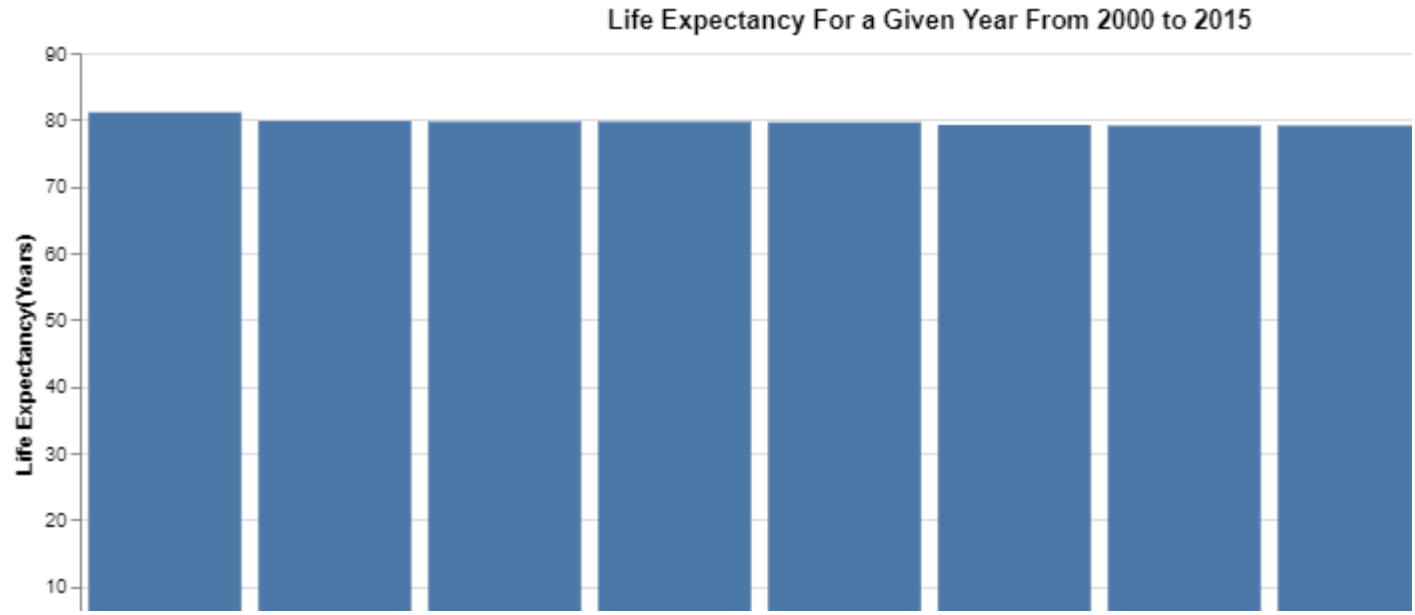
Key Takeaways/Observations:

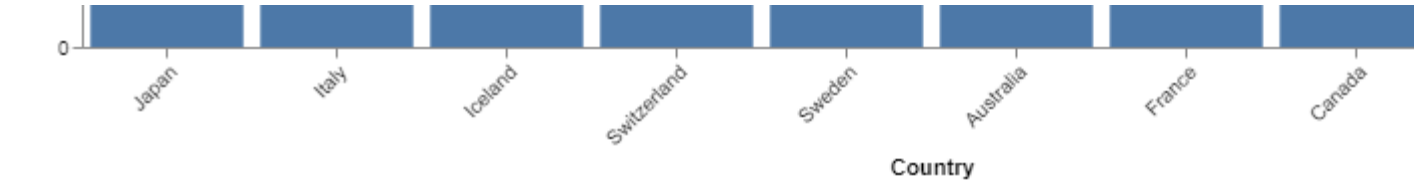
- Lesotho has the lowest mean life expectancy, followed by many countries in Africa which we observed in the map.
- When changing the ordering with the sort by feature, Japan has the highest mean life expectancy.
- Many "well-known" and popular countries dominate the high mean life expectancies plot. Well known could mean that they are common tourist destinations, or are frequently heard of in the news.

This visualization helps answer more about life expectancy around the world, as instead of searching on the map for the smallest or highest life expectancies, it is easily displayed on this bar chart.

Follow up: Observe the Countries with the Highest Life Expectancy Over 2000-2015 During a Given Year

In this visualization the top 10 countries during a given year with the highest mean life expectancies are displayed. However, if there is a tie for the 10th place spot, an additional country is added to the visualization for a total of 11 bars so we don't exclude anyone. The user may interactively change the year of data being displayed with the year slider.





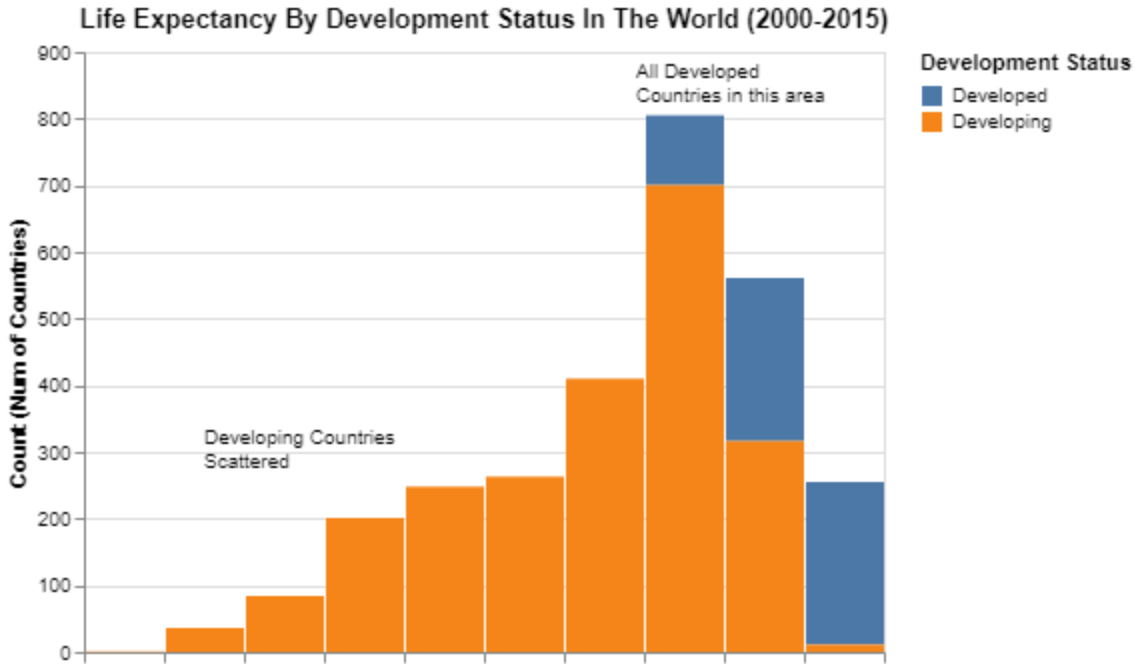
Year: 2000

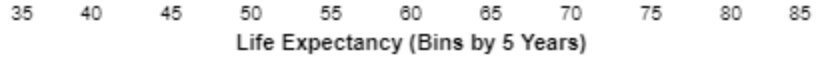
As we can see, Japan has the highest life expectancy almost every year, which naturally follows from the previous plot showing Japan has the greatest mean life expectancy. This can help us figure out over a given year what countries have the highest life expectancy. Many countries in Europe are also displayed for each year, which is noteworthy and supports previous claims that Europe generally had high life expectancies.

Question 3: How is Life Expectancy Distributed Across the World and for Developed and Developing Countries?

From question 1 we observed multiple plots which compared Life Expectancy with GDP Per Capita of a Country, where each point was colored by the Development Status of a region. One key takeaway from initial observations is that Countries with a higher Life Expectancy were usually Developed Countries. On the other hand, many of the Countries with lower life expectancies corresponded to a Country which was developing.

With this in mind, it would be interesting to further explore this trend between the development status of a region and the corresponding life expectancy, and how life expectancies are generally distributed. In this visualization, a histogram is created to display the life expectancy counts in each bin colored by the countries development status. Hovering over the bars and specific colors will show the life expectancy bins, the count for each bar color in a column, and the development status.





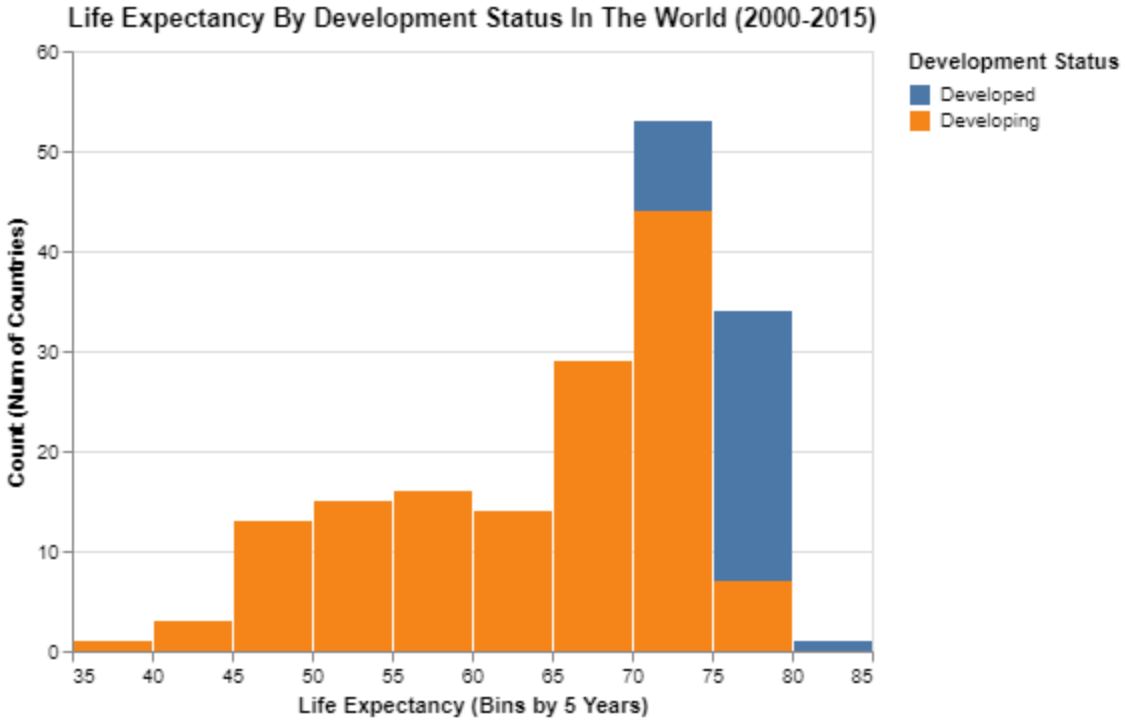
Viewers are able to see how life expectancy differs within these developed and developing countries.

Key Observations/Takeaways:

- The overall distribution for life expectancy across the world looks left skewed.
- It is obvious from the plot that the developed countries are clustered towards the higher end, right side, of the plot with a greater life expectancy.
- The developing countries are more scattered, with no specific pattern.
- Distribution also left skewed for developing countries.

Overall this helps to observe the distribution of life expectancy for the overall world, but also for developing and developed countries separately.

A natural follow up through this article is observing the changes over time, in this case it would be appropriate to see how the life expectancy has changed over time in these developed and developing countries. In this visualization, the user is able to move a slider, changing the year of data displayed in the plot.



Year: 2000

It is interesting to see in this graph the changes overtime between the 2 variables.

Key Takeaways/Observations:

- Overall it seems the distribution for life expectancy has increased around the world

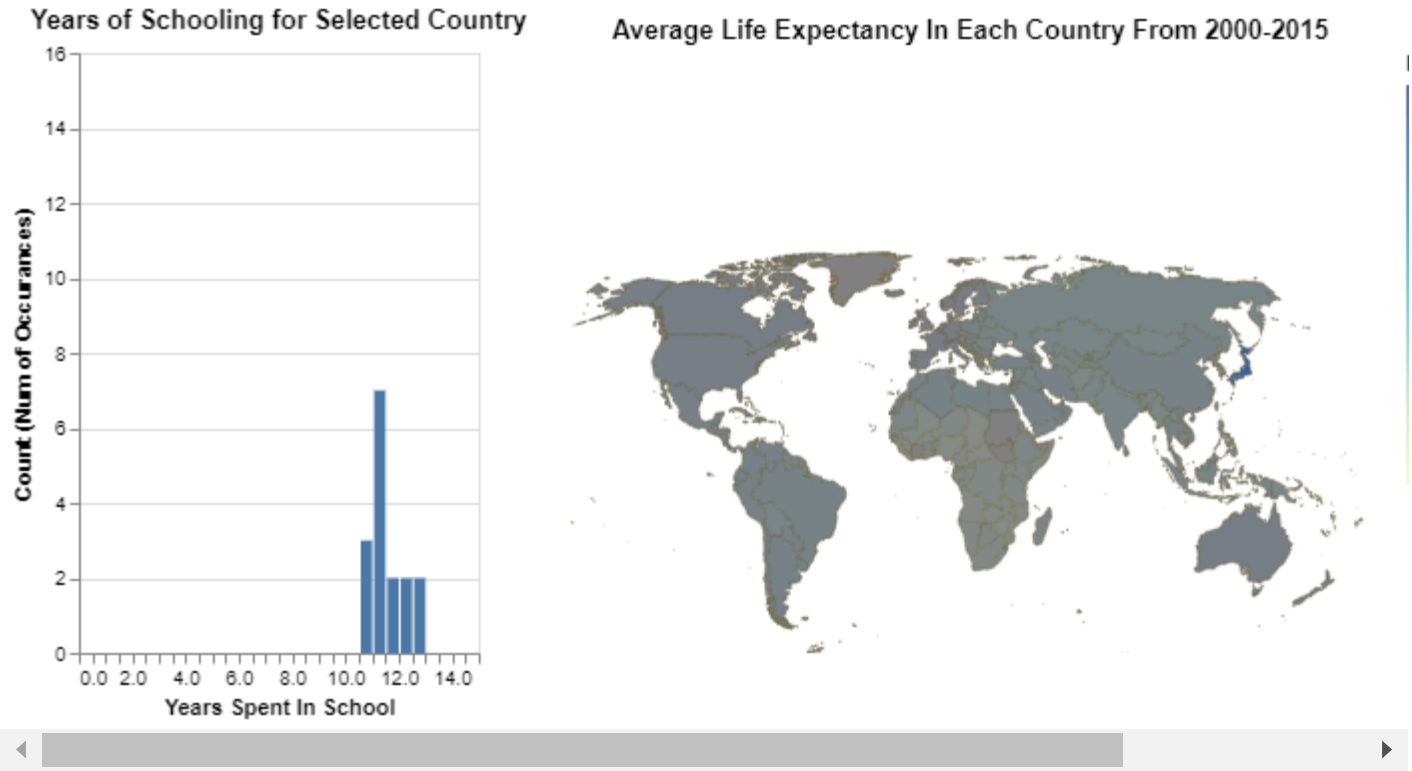
and for both developed and developing countries.

- As late as 2015, the majority of developed countries have life expectancies around 80-85 years. Still though, the developed countries are more cluttered towards the higher life expectancy portion of the graph.
- In each year, the overall distribution of life expectancy still looks left skewed.
- The distribution shifts more towards the right as the years increase. The distribution also begins to look more normally distributed.
- Tie in with previous results that most likely countries in Africa account for the left skew.

Question 4: How does education affect life expectancy?

One interesting topic that could affect Life Expectancy could be the years of schooling for a country. One might expect countries with lower life expectancies to also have less years of schooling. So, if we tie in previous results we have already observed from question 2, we could now observe the years of schooling for each of these countries.

In the visualization below, the bar chart and map interconnect with on another. The user has the ability to interactively click on a specific country on the map, which had data in our dataset. Once selected, this country will be highlighted and their years of schooling will be displayed on the bar chart on the left, if there is data present. The default country before any interaction is done is Japan, as observed earlier they have the highest mean life expectancy. Countries without data cannot be interacted with.



This extension of the previous visualization significantly enhances our comprehension of educational attainment in each country. By allowing users to focus on specific countries

educational attainment in each country. By allowing users to focus on specific countries of interest, it empowers them to gain valuable insights.

Key Takeaways/Observations

- Many Countries in Africa seem to have a smaller number of years spent in school, which corresponds with their lower life expectancy as seen in question 2.
- A notable trend observable in this visualization is the positive correlation between higher life expectancy and greater years spent in school.
- From question 2 we recall that fact that North American and Europe were the regions with the greatest mean life expectancy, observing the years of schooling for their countries it is also on the high end.

Conclusion

This interactive article dove into the topic of life expectancy and some of its many factors. Several questions were asked and answered through these visualizations, many of which build off the other. The hope of this article was to flow from one visualization to the other with reasoning. We were able to explore some previously well explored topics relating to life expectancy, such observing how a higher GDP per capita corresponded with a higher life expectancy. We were also able to provide more general visualizations, such as the interactive map, which provided viewers more freedom to not only answer the question proposed, but answer personal questions they may have.

This report scraped the surface of life expectancy. There could easily be more done to expand on what we have created in order to explore life expectancy even more. We hope that this can be a stepping stone in someone else's research or personal interests to explore life expectancy further.

Reflection

We learned how impactful interactive visualizations can be to answer any given question. None of us had previous experience creating interactive visualizations, so this assignment was the first step in doing so for us. We learned different methods we could use to make these visualizations as details as we could, without going overboard. There were also some outside references used in addition to the techniques learned in class, all of which have been cited. We used a majority of what we did in both section and class work in order to create these visualizations.

There were no specific "roles" assigned to this project. We usually discussed as a team, in person or online, regarding steps to be taken in this project. We were all responsible and contributed to every question and visualization in this project. So, we can't give a specific breakdown of roles but rather we worked as a team to complete this.

For responsibilities and contributions, we again all made sure we worked together and

were on the same page. We usually had in person check ins together, as we have several classes together it was easy to discuss and meet in person. We had plans in place for each checkpoint, CP1, CP2, and CP3, where we made sure we submit our best work for each.

Data Attachments

```
Lifeexpectancy = ▶ FileAttachment {name: "LifeExpectancyCleaned.csv", mimeType: "text/csv"}

LifeExpectancyTyped = ▶ Array(2864) [Object, Object, Object, Object, Object, Object, Object,

Lifeexpectancy_means = ▶ FileAttachment {name: "LifeExp_means@1.csv", mimeType: "text/csv"}

Lifeexpectancy_meansTyped = ▶ Array(179) [Object, Object, Object, Object, Object, Object, Ob

map = ▶ FileAttachment {name: "ExpMeans@6.csv", mimeType: "text/csv"}

mapTyped = ▶ Array(215) [Object, Object, Object, Object, Object, Object, Object, Object, Obj

Region_means = ▶ FileAttachment {name: "Regions_Mean_life_expectancy.csv", mimeType: "text/c

Region_meansTyped = ▶ Array(9) [Object, Object, Object, Object, Object, Object, Object, Obje

Year_means = ▶ FileAttachment {name: "Year_Mean_life_expectancy.csv", mimeType: "text/csv"}

Year_meansTyped = ▶ Array(16) [Object, Object, Object, Object, Object, Object, Object, Objec
```

Imports

```
import {vl} from "@vega/vega-lite-api-v5"

import {printTable} from "@jonfroehlich/data-utilities"

import {printTableTypes} from "@jonfroehlich/data-utilities"

import {uniqueValid} from "@jonfroehlich/data-utilities"

datasets = ▶ Object {annual-precip.json: ƒ(), anscombe.json: ƒ(), barley.json: ƒ(), birdstri

world = ▶ Object {type: "Topology", transform: Object, objects: Object, arcs: Array(985)}

nationTypes = ▶ Array(3) [null, "Developed", "Developing"]

yearTypes = ▶ Array(17) [null, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2
```

```
import {toc} from "@jonfroehlich/collapsible-toc"
```

References

(1) https://observablehq.com/@jonfroehlich/deceptive-visualizations

(2) https://observablehq.com/@uwdata/cartographic-visualization

Life Expectancy Prior Research: https://www.forbes.com/sites/quora/2022/09/15/4-reasons-life-expectancy-has-increased-in-the-past-200-years/?sh=253b15924d57#:~:text=Over%20the%20last%20200%20years,diet%2C%20and%20improved%20m

GDP Per Capita definition: https://www.investopedia.com/terms/p/per-capita-gdp.asp#:~:text=Economists%20use%20GDP%20per%20capita,a%20nation%20by%20its%20populat

GDP Per Capita Study & Life Expectancy: https://genus.springeropen.com/articles/10.1186/s41118-019-0071-0#:~:text=GDP%20per%20capita%20increases%20the,to%20the%20prolongation%20of%20longevity

In class work occasionally looked back on and referenced:
https://observablehq.com/@jonfroehlich/intro-to-vega-lite
https://observablehq.com/@jonfroehlich/intro-to-interaction-in-vega-lite