Module: Digital Health (SS 24)

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Problem Description and Stakeholders

Many factors, including demographic variables, income distribution, and mortality rates, shape life expectancy. Despite extensive Research in this area, the specific impacts of immunization and the Human Development Index (HDI) have yet to be comprehensively examined. Historically, studies have relied on single-year data across all countries, primarily employing multiple linear regression models. This study, however, takes a novel approach by filling these gaps and utilizing mixed-effects models and multiple linear regression techniques, analyzing data from 2000 to 2015 for 193 countries. Key immunizations, such as those for Hepatitis B, Polio, and Diphtheria, are integral to this analysis. By examining immunization, mortality, economic, social, and other health-related factors, this study seeks to identify determinants of lower life expectancy, thereby enabling countries to prioritize interventions that improve population longevity.

Stakeholders and Challenges

1. Policymakers

Problem Description: Policymakers are tasked with designing and implementing health policies that enhance public health outcomes. They require robust data and comprehensive analyses to identify the critical determinants of life expectancy, facilitating effective resource allocation.

Challenges:

a. Translating complex statistical data into actionable policies can be challenging.

b. Efficiently distributing limited resources to maximize health benefits necessitates identifying the most impactful interventions.

c. The political and economic feasibility of implementing ideal interventions can restrict their implementation.

2. Healthcare Professionals

Problem Description: Healthcare professionals, including doctors, nurses, and public health workers, are on the front lines of implementing health interventions and directly influencing patient outcomes.

Challenges:

a. Shortages of vaccines, medicines, and other essential supplies are prevalent in many regions.

c. Encouraging adherence to vaccination schedules and preventive measures can be difficult, particularly in areas with low health literacy.

3. Researchers

Problem Description: Public health and epidemiology researchers aim to uncover the underlying factors affecting life expectancy and assess the effectiveness of various health interventions.

Challenges:

a. Ensuring data availability and quality, especially in low-resource settings, is often challenging.

b. Analyzing complex, multi-year datasets require advanced expertise in employing appropriate statistical models.

c. Securing funding for longitudinal studies and comprehensive research initiatives can be difficult.

4. International Organizations

Problem Description: Organizations such as the World Health Organization (WHO) and the United Nations (UN) are critical in setting global health priorities and supporting health initiatives across countries.

Challenges:

a. Coordinating health initiatives across diverse healthcare systems and needs is inherently complex.

b. Establishing robust systems for monitoring and evaluating health intervention impacts requires significant resources and coordination.

c. Varying political, economic, and cultural contexts can pose challenges in encouraging countries to adopt and implement international health recommendations.

5. General Public

Problem Description: Health policies and interventions directly affect the general public, with their health behaviors and access to healthcare services significantly influencing life expectancy outcomes.

Challenges:

a. Low health literacy levels can impede understanding the importance of vaccinations and other health interventions.

b. Geographic, economic, and social barriers can limit access to essential health services and immunizations.

c. Mistrust and misinformation about vaccines can reduce compliance with health interventions.

Pathway to the Solution

1. Identifying the Problem

Numerous factors affect life expectancy, yet the roles of immunization and HDI remain underexplored. Previous Research often relied on single-year data, missing longitudinal insights. This study aims to bridge these gaps by incorporating multi-year data and a broader range of variables.

2. Conducting Research

A thorough literature review on life expectancy determinants focused on demographic variables, income distribution, mortality rates, and healthcare factors. This review highlighted the need for detailed analysis, including immunization and HDI.

3. Assessing the Data

Data were sourced from the Global Health Observatory (GHO) of the World Health Organization (WHO) and economic data from the United Nations, covering 193 countries from 2000 to 2015. The initial inspection revealed missing values, especially in population, Hepatitis B, and GDP data from less prominent countries, which led to their exclusion from the final analysis.

4. Identifying the Stakeholders

These findings are essential to primary stakeholders, including policymakers, healthcare professionals, and researchers. They can use the study's findings to prioritize healthcare interventions and policies to improve life expectancy. Secondary stakeholders, such as international organizations like WHO and the United Nations, can leverage these insights to guide global health strategies.

5. Solving the Problem

The data were analyzed using mixed-effects models and multiple linear regression techniques to identify critical life expectancy factors. The findings, which aim to inform policy decisions and healthcare practices, have the potential to significantly enhance life expectancy through targeted interventions such as immunization coverage and economic development. This promising outlook can inspire hope and optimism among the audience.

Data Visualization and Implementation Process

The data visualization in this report illustrates trends in life expectancy across various countries from 2000 to 2015. Despite observable improvements, recent studies indicate that global health challenges such as pandemics and economic crises significantly impact these trends. This underscores the need for continuous and coordinated efforts by stakeholders to enhance life expectancy through targeted interventions.

Improving healthcare access, promoting healthy lifestyles, and ensuring robust economic development are crucial to addressing these challenges. Efforts should be directed towards increasing immunization coverage, enhancing healthcare infrastructure, and addressing social determinants of health. By doing so, it is possible to mitigate the adverse effects of emerging health threats and sustain gains in life expectancy. This emphasis on the ongoing commitment to improving life expectancy can motivate and inspire the audience.

Implementation Process

This section outlines the critical tasks performed to produce the data visualization, followed by the code generated throughout the process. Detailed steps are provided to ensure reproducibility and transparency. The final visualizations are accessible at the following link:

1. https://afrataha95.shinyapps.io/NewLEX/
2. https://afrataha95.shinyapps.io/lifeex/

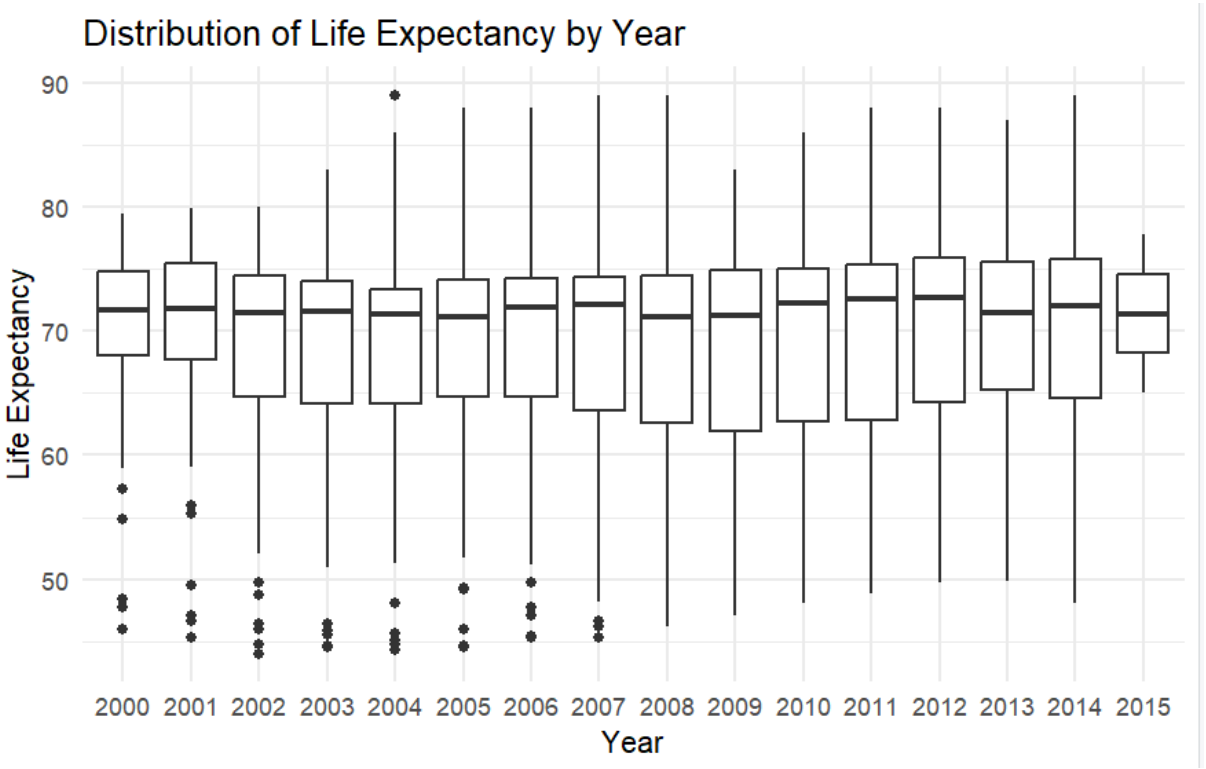
Part One

1. Downloading and installing RStudio and R.
2. Select a suitable "life expectancy" dataset from Kaggle and download it to a desktop folder.
3. Unzipping the files and importing the datasets into RStudio.
4. Setting the working directory to the desktop folder containing the datasets.
5. Installing necessary packages and loading them using the library function.
6. Reading the data.
7. Interacting with data functions and packages to create data frames.
8. Creating plots—a line plot and tables.

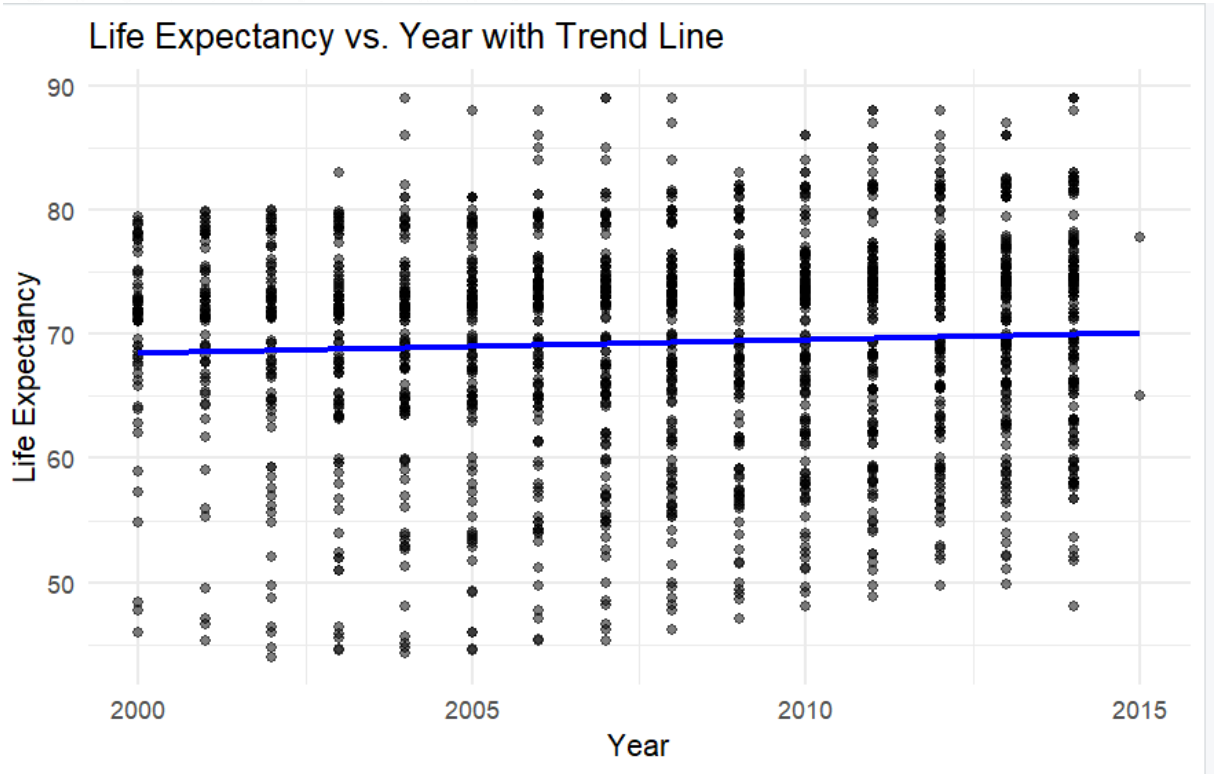
```
Getwd()

# Install necessary packages

install.packages("ggplot2")

install.packages("dplyr")
```

```
install.packages("readr")

# Load the packages
library(ggplot2)
library(dplyr)
library(readr)

# Set the working directory
setwd("C:/Users/moham/OneDrive/Desktop/New")

# Load the dataset
life_expectancy_data <- read_csv("Life_Expectancy_Data.csv")

# Explore the dataset
head(life_expectancy_data)
summary(life_expectancy_data)
str(life_expectancy_data)

# Check for missing values
sum(is.na(life_expectancy_data))

# Handling missing values (e.g., removing rows with NA values)
life_expectancy_data <- na.omit(life_expectancy_data)

# Line plot of life expectancy over time for each country
ggplot(data = life_expectancy_data, aes(x = Year, y = LifeExpectancy, color = Country)) +
  geom_line() +
  labs(title = "Life Expectancy Over Time by Country",
       x = "Year",
       y = "Life Expectancy") +
  theme_minimal()
```

Box plot of life expectancy distribution by year
ggplot(data = life_expectancy_data, aes(x = as.factor(Year), y = LifeExpectancy)) +
  geom_boxplot() +
  labs(title = "Distribution of Life Expectancy by Year",
       x = "Year",
       y = "Life Expectancy") +
  theme_minimal()



Scatter plot with a trend line
ggplot(data = life_expectancy_data, aes(x = Year, y = LifeExpectancy)) +
  geom_point(alpha = 0.5) +
  geom_smooth(method = "lm", se = FALSE, color = "blue") +
  labs(title = "Life Expectancy vs. Year with Trend Line",
       x = "Year",
       y = "Life Expectancy") +
  theme_minimal()




```
# Faceted plot by country
ggplot(data = life_expectancy_data, aes(x = Year, y = LifeExpectancy)) +
  geom_line() +
  facet_wrap(~ Country) +
  labs(title = "Life Expectancy Over Time by Country",
       x = "Year",
       y = "Life Expectancy") +
  theme_minimal()

# Customized line plot with corrected linewidth
ggplot(data = life_expectancy_data, aes(x = Year, y = LifeExpectancy, color = Country)) +
  geom_line(linewidth = 1) +
  labs(title = "Life Expectancy Over Time by Country",
       subtitle = "Data from 2000 to 2020",
       x = "Year",
       y = "Life Expectancy") +
  theme_minimal() +
  theme(legend.position = "bottom",
```

plot.title = element_text(hjust = 0.5),

plot.subtitle = element_text(hjust = 0.5))

By following these steps and utilizing the provided code, stakeholders can explore and analyze the factors influencing life expectancy, enabling them to make informed decisions to improve public health outcomes.

Part Two:

1. creating an account on Shiny.io and linking it to RStudio.

2. Creating a Shiny web application file in RStudio.

3. Saving it in the desktop folder containing the original CSV files from Kaggle.

4. Loading relevant packages, including the Shiny package.

5. Preparing data for plotting.

6. Defining the UI for the Shiny application.

7. Defining the server logic.

8. A comparative line plot was drafted to show life expectancy trends for all countries from 2000 to 2015.

9. Running the application.

10. Publishing the app.R code to Shiny.

11. Testing the generated link in the Shiny application to ensure it opens in the browser.

12. Utilizing ChatGPT to resolve any errors during these tasks.

The following code details the implementation process for the Shiny application:

```
# Load necessary libraries

library(shiny)

library(ggplot2)

library(dplyr)

library(plotly)

library(shinythemes)

library(thematic)

library(shinyjs)
```

```
# Check the current working directory
getwd()

setwd("C:/Users/moham/OneDrive/Desktop/New/New")



# Verify if the file exists in the working directory
file.exists("Life_Expectancy_Data.csv")

# Define UI for the app
ui <- fluidPage(
  useShinyjs(),  # Enable shinyjs
  theme = shinytheme("superhero"),  # Set the theme to 'superhero'
  titlePanel("Life Expectancy Over Time by Country"),
  sidebarLayout(
    sidebarPanel(
      selectInput("selected_country", "Select Country:",
                  choices = unique(life_expectancy_data$Country),
                  selected = unique(life_expectancy_data$Country)[1])
    ),
    mainPanel(
      plotlyOutput("country_plot")
    )
  )
)

# Define server logic for the app
server <- function(input, output) {

  output$country_plot <- renderPlotly({
    filtered_data <- filter(life_expectancy_data, Country == input$selected_country)
```

```
    p <- ggplot(data = filtered_data, aes(x = Year, y = LifeExpectancy, text = paste("Year:", Year, "<br>Life Expectancy:", LifeExpectancy))) +
      geom_line(color = "#2c3e50", size = 1.2) +
      geom_point(color = "#e74c3c", size = 2, alpha = 0.8) +
      labs(title = paste("Life Expectancy Over Time for", input$selected_country),
           x = "Year",
           y = "Life Expectancy") +
      theme_minimal() +
      theme(
        plot.title = element_text(color = "#ecf0f1", size = 16, face = "bold", hjust = 0.5),
        axis.title = element_text(color = "#ecf0f1", size = 12),
        axis.text = element_text(color = "#bdc3c7"),
        panel.background = element_rect(fill = "#34495e", color = "#34495e"),
        plot.background = element_rect(fill = "#34495e", color = NA),
        panel.grid.major = element_line(color = "#7f8c8d"),
        panel.grid.minor = element_line(color = "#7f8c8d")
      )

    ggplotly(p, tooltip = "text") %>%
      layout(
        plot_bgcolor = "#34495e",
        paper_bgcolor = "#34495e",
        font = list(color = "#ecf0f1")
      )
  })
}

# Create the Shiny app
shinyApp(ui = ui, server = server)
```

Install the rsconnect package

install.packages("rsconnect")

Load the rsconnect package

library(rsconnect)

Part three

1. Setting the CRAN mirror to ensure the correct R packages could be downloaded.

2. Loading necessary libraries.

3. Loaded the life expectancy data from a CSV file into a data frame.

4. Defining the user interface (UI) for the Shiny app, setting a theme and creating a sidebar layout with inputs for selecting a country, year range, and variables to plot.

5. Adding additional informational text to the sidebar panel for user guidance.

6. Implementing the server logic, including data filtering based on user input, creating the Plotly plot, and rendering the interactive DataTable.

7. Customizing the plot to include tooltips, a line graph with points, and formatted text for better visual appeal.

8. Customizing the DataTable for enhanced interactivity, including pagination, search, and export options.

9. Ran the Shiny app using the `shinyApp` function locally to verify functionality.

10. Attempted to publish the Shiny app on shinyapps.io, ensuring that the working directory contained both the app script and the CSV file.

11. Encountered an error indicating the application failed to start, despite verifying the directory setup and consulting ChatGPT for troubleshooting assistance.

Set CRAN mirror

options(repos = c(CRAN = "https://cran.rstudio.com"))

Load necessary libraries

library(shiny)

library(ggplot2)

library(plotly)

library(shinythemes)

```
library(thematic)
library(shinyjs)
library(shinydashboard)
library(dplyr)
library(DT)
library(tidyr)

# Load the data
life_expectancy_data <- read.csv("life_expectancy.csv", stringsAsFactors = FALSE)

# Define UI
ui <- fluidPage(
  useShinyjs(),  # Enable shinyjs
  theme = shinytheme("superhero"),  # Set the theme to 'superhero'

  titlePanel("Life Expectancy Data Visualization"),

  sidebarLayout(
    sidebarPanel(
      selectInput("country", "Select Country:", choices = unique(life_expectancy_data$Country), selected = "United States"),
      sliderInput("yearRange", "Select Year Range:", min = min(life_expectancy_data$Year), max = max(life_expectancy_data$Year), value = c(min(life_expectancy_data$Year), max(life_expectancy_data$Year))),
      checkboxGroupInput("variables", "Select Variables to Plot:", choices = names(life_expectancy_data)[4:length(names(life_expectancy_data))], selected = c("LifeExpectancy", "GDP")),

      # Additional Information
      HTML("<br /><h5 style='font-size: 14px;'>Understanding the Data</h5>
          <p style='font-size: 12px;'> </p>")
    ),
```

```
    mainPanel(
      tabsetPanel(
        tabPanel("Plot", plotlyOutput("lifeExpPlot")),
        tabPanel("Table", dataTableOutput("dataTable"))
      )
    )
  )
)

# Define server logic
server <- function(input, output) {

  filteredData <- reactive({
    life_expectancy_data %>%
      filter(Country == input$country & Year >= input$yearRange[1] & Year <= input$yearRange[2])
  })

  output$lifeExpPlot <- renderPlotly({
    plotData <- filteredData()
    plotData <- plotData[, c("Year", input$variables)]
    plotData <- gather(plotData, key = "Variable", value = "Value", -Year)

    p <- ggplot(plotData, aes(x = Year, y = Value, color = Variable, text = paste("Year:", Year, "<br>Value:", Value))) +
      geom_line(size = 1.2) +
      geom_point(size = 2) +
      labs(title = paste("Trends in", input$country), x = "Year", y = "Value") +
      theme_minimal() +
      theme(
```

```
      plot.title = element_text(size = 18, face = "bold"),
      axis.title = element_text(size = 14),
      axis.text = element_text(size = 12),
      legend.title = element_text(size = 14),
      legend.text = element_text(size = 12),
      legend.position = "bottom"
    )

  ggplotly(p, tooltip = "text") %>%
    layout(legend = list(orientation = "h", x = 0.1, y = -0.3))
})

output$dataTable <- renderDataTable({
  datatable(
    filteredData(),
    options = list(
      pageLength = 10,
      autoWidth = TRUE,
      dom = 'Bfrtip',
      buttons = c('copy', 'csv', 'excel', 'pdf', 'print'),
      lengthMenu = list(c(10, 25, 50, -1), c('10', '25', '50', 'All')),
      initComplete = JS(
        "function(settings, json) {",
        "$(this.api().table().header()).css({'background-color': '#485563', 'color': '#fff'});",
        "}"
      )
    ),
    class = "stripe hover cell-border order-column"
  ) %>% formatStyle(
    columns = names(filteredData()),
    backgroundColor = styleInterval(5, c('white', 'lightblue')),
```

```
      color = 'black'
    )
  })
}

# Run the application
shinyApp(ui = ui, server = server)
```

References:

1. (no date) (PDF) Life expectancy prediction through immunization and HDI factor analysis using machine learning regression algorithms. Available at: https://www.researchgate.net/publication/364430951_Life_Expectancy_Prediction_through_Analysis_of_Immunization_and_HDI_Factors_using_Machine_Learning_Regression_Algorithms (Accessed: 23, 2024).

2. (No date) (PDF) multilevel modeling of country effects: A cautionary tale. Available at: https://www.researchgate.net/publication/276454120_Multilevel_Modeling_of_Country_Effects_A_Cautionary_Tale (Accessed: 23, 2024).

3. Rodrigues, C.M.C. and Plotkin, S.A. (2020), Impact of Vaccines: Health, economic and Social Perspectives, Frontiers in microbiology. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7371956/ (Accessed: 23, 2024).

4. Life expectancy at birth, total (years) (no date) World Bank Open Data. Available at: https://data.worldbank.org/indicator/SP.DYN.LE00.IN (Accessed: 23, 2024).