Country-Specific Insights: Marathon Performance Analysis

London Marathon 2024

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Contents

Introduction and Research Question

The London Marathon is one of the most prestigious and widely celebrated marathons in the world, forming part of the renowned "Big 6" marathon series. Each year, participants from across the globe gather to compete, whether as part of the Elite group or the Mass group. With such a diverse range of countries represented, this project aims to explore a central question: How did each country perform at the 2024 London Marathon?

By analyzing data from the event, the project provides insights into key performance metrics, including each country's average finish time, the distribution of finish times, the fastest and slowest recorded times, and other meaningful patterns. Through this analysis, we hope to uncover intriguing stories behind the numbers and celebrate the global spirit of the marathon.

Loading Packages

First we must check the packages are installed to the devices library folder, ensuring any that aren't get installed. These must then be loaded

```r
# A loop to install all the listed packages if needed
packages <- c("shiny", "plotly", "rvest", "tidyverse", "countrycode", "rsconnect")
for (i in packages) {
  if (!require(i, character.only = TRUE)) install.packages(i)
}

# Load necessary libraries
library(shiny)
library(plotly)
library(rvest)
library(tidyverse)
library(countrycode)
library(rsconnect)
```

Obtaining and Wrangling Data

The data was obtained via scraping the London Marathon 2024 results page: London Marathon 2024 Elite Results London Marathon 2024 Mass Results

Initially a data frame was created to save the data to, and a function was created to scrape the different URLs. This function removed aspects of the data that weren't needed, for example the country code was in the same data point as the participants name and thus the name had to be removed. It also had to remove the top line of the data pulled through as it included the column headers. Finally, certain participants did not have a country code and thus needed to removed from the data frame.

```r
# Initialize final results data frame
final_results <- data.frame(Country = character(), Time = character(), Category = character(), stringsA

# Function to scrape data from a given URL
scrape_results <- function(url, category) {
  page <- read_html(url)

  # Extract country codes
  country <- page %>% html_nodes(".type-fullname") %>% html_text()
  country <- gsub(".*\\(([^)]+)\\)", "\\1", country)
  country <- country[-1]

  # Extract finish times
  finish_time <- page %>% html_nodes(".pull-right .type-time") %>% html_text()
  finish_time <- gsub("^Finish", "", finish_time)
  finish_time <- finish_time[-1]

  # Filter valid countries (ISO-3166-1 alpha-3 codes)
  valid_countries <- grepl("^[A-Z]{3}$", country)
  country <- country[valid_countries]
  finish_time <- finish_time[valid_countries]

  # Return as a data frame
  return(data.frame(Country = country, Time = finish_time, Category = category, stringsAsFactors = FALS
}
```

The function was then used to scrape the data from the mass and elite race results pages. To create a unique URL both required the results being across multiple pages, thus scraping required the introduction of a 'for' loop to process each page. The mass event required 54 pages of 1000 participants. Whilst, the elite race required 2 pages of 25 participants. Sense checks were added to the scraping of each URL to show that the process was still ongoing, this was required due to the size of the mass race data to prove the code was still running.

```r
# Scrape Mass participants (54 pages with 1000 participants each)
cat("Starting to scrape Mass participants...\n")
```

```
## Starting to scrape Mass participants...
```

```r
for (page_result in seq(from = 1, to = 54, by = 1)) {
  mass_url <- paste0("https://results.tcslondonmarathon.com/2024/?page=",
                     page_result, "&event=MAS&num_results=1000&pid=search&pidp=start&search%5Bsex%5D=%25

  mass_data <- scrape_results(mass_url, "Mass")

  # Sense check: Output for each page
  cat(sprintf("Scraped %d rows for Mass - Page %d/54\n", nrow(mass_data), page_result))

  final_results <- rbind(final_results, mass_data)
}
```

```
## Scraped 1000 rows for Mass - Page 1/54
## Scraped 1000 rows for Mass - Page 2/54
## Scraped 1000 rows for Mass - Page 3/54
## Scraped 1000 rows for Mass - Page 4/54
## Scraped 1000 rows for Mass - Page 5/54
## Scraped 1000 rows for Mass - Page 6/54
## Scraped 1000 rows for Mass - Page 7/54
## Scraped 1000 rows for Mass - Page 8/54
## Scraped 999 rows for Mass - Page 9/54
## Scraped 999 rows for Mass - Page 10/54
## Scraped 1000 rows for Mass - Page 11/54
## Scraped 1000 rows for Mass - Page 12/54
## Scraped 1000 rows for Mass - Page 13/54
## Scraped 1000 rows for Mass - Page 14/54
## Scraped 999 rows for Mass - Page 15/54
## Scraped 1000 rows for Mass - Page 16/54
## Scraped 1000 rows for Mass - Page 17/54
## Scraped 999 rows for Mass - Page 18/54
## Scraped 998 rows for Mass - Page 19/54
## Scraped 999 rows for Mass - Page 20/54
## Scraped 1000 rows for Mass - Page 21/54
## Scraped 1000 rows for Mass - Page 22/54
## Scraped 999 rows for Mass - Page 23/54
## Scraped 998 rows for Mass - Page 24/54
## Scraped 998 rows for Mass - Page 25/54
## Scraped 999 rows for Mass - Page 26/54
## Scraped 999 rows for Mass - Page 27/54
## Scraped 999 rows for Mass - Page 28/54
## Scraped 999 rows for Mass - Page 29/54
## Scraped 1000 rows for Mass - Page 30/54
## Scraped 1000 rows for Mass - Page 31/54
## Scraped 998 rows for Mass - Page 32/54
## Scraped 997 rows for Mass - Page 33/54
## Scraped 999 rows for Mass - Page 34/54
## Scraped 999 rows for Mass - Page 35/54
## Scraped 998 rows for Mass - Page 36/54
## Scraped 999 rows for Mass - Page 37/54
## Scraped 999 rows for Mass - Page 38/54
## Scraped 999 rows for Mass - Page 39/54
## Scraped 1000 rows for Mass - Page 40/54
## Scraped 998 rows for Mass - Page 41/54
## Scraped 999 rows for Mass - Page 42/54
## Scraped 999 rows for Mass - Page 43/54
## Scraped 999 rows for Mass - Page 44/54
## Scraped 999 rows for Mass - Page 45/54
## Scraped 998 rows for Mass - Page 46/54
## Scraped 999 rows for Mass - Page 47/54
## Scraped 999 rows for Mass - Page 48/54
## Scraped 999 rows for Mass - Page 49/54
## Scraped 999 rows for Mass - Page 50/54
## Scraped 996 rows for Mass - Page 51/54
## Scraped 999 rows for Mass - Page 52/54
## Scraped 1000 rows for Mass - Page 53/54
## Scraped 875 rows for Mass - Page 54/54
```

```r
# Scrape Elite participants (2 pages with 25 participants each)
cat("Starting to scrape Elite participants...\n")
```

```
## Starting to scrape Elite participants...
```

```r
for (page_result in seq(from = 1, to = 2, by = 1)) {
  elite_url <- paste0("https://results.tcslondonmarathon.com/2024/?page=",
                      page_result,"&event=ELIT&pid=search&pidp=start&search%5Bsex%5D=%25&search%5Bage_cl

  elite_data <- scrape_results(elite_url, "Elite")

  # Sense check: Output for each page
  cat(sprintf("Scraped %d rows for Elite - Page %d/2\n", nrow(elite_data), page_result))

  final_results <- rbind(final_results, elite_data)
}
```

```
## Scraped 25 rows for Elite - Page 1/2
## Scraped 20 rows for Elite - Page 2/2
```

To facilitate plotting and analysis, the finish times were converted into total minutes using the following code.

```r
# Convert 'Time' column to total minutes
final_results$Time <- sapply(strsplit(final_results$Time, ":"), function(x) {
  as.numeric(x[1]) * 60 + as.numeric(x[2]) + as.numeric(x[3]) / 60
})
```

A sense check was then run to check the data was scraped correctly. We would expect: 53,875 rows, 4 columns, and 152 countries

```r
# SENSE CHECK: Verify data after scraping
cat("Data scraping complete. Final dataset has:\n")
```

```
## Data scraping complete. Final dataset has:
```

```r
cat(sprintf("%d rows and %d columns\n", nrow(final_results), ncol(final_results)))
```

```
## 53875 rows and 3 columns
```

```r
cat(sprintf("Unique countries: %d\n", length(unique(final_results$Country))))
```

```
## Unique countries: 152
```

The participants per country was counted; this allowed for a min participants filter

```r
# Counting participants per country
final_results$Country <- as.character(final_results$Country)
country_counts <- table(final_results$Country)
country_counts_df <- as.data.frame(country_counts)
colnames(country_counts_df) <- c("Country", "Count")
```

A column was added for continents and the country codes mapped to their relevant continent. This was done automatically for many of the countries via countrycode. However, the formatting of some of the country codes by London Marathon was incorrect, these countries had to manually have their continents mapped. This was to allow for the plot to select by continent. Countrycode auto grouped the Americas, so this was kept consistent in manual overrides.

```r
# Function to assign continents with manual overrides
assign_continents <- function(country_codes) {
  # Base continent mapping using countrycode
  country_continent_mapping <- countrycode(
    sourcevar = country_codes,
    origin = "iso3c",
    destination = "continent"
  )


  # Manual overrides for specific countries
  manual_overrides <- c(
    "ALG" = "Africa",
    "ANT" = "Americas", "ARU" = "Americas", "BAH" = "Americas", "BAR" = "Americas",
    "BER" = "Americas", "BIZ" = "Americas", "CAY" = "Americas", "CHA" = "Africa",
    "CHI" = "Europe", "CRC" = "Americas", "CRO" = "Europe", "DEN" = "Europe",
    "ESA" = "Americas", "GAM" = "Africa", "GER" = "Europe", "GRE" = "Europe",
    "GRN" = "Americas", "GUA" = "Americas", "HAI" = "Americas", "HON" = "Americas",
    "INA" = "Asia", "IRI" = "Asia", "ISV" = "Americas", "IVB" = "Americas",
    "KSA" = "Asia", "KUW" = "Asia", "LAT" = "Europe", "LBA" = "Africa",
    "LES" = "Africa", "LIB" = "Africa", "MAD" = "Africa", "MAS" = "Asia",
    "MGL" = "Asia", "MRI" = "Africa", "MYA" = "Asia", "NCA" = "Americas",
    "NED" = "Europe", "NEP" = "Asia", "NGR" = "Africa", "PAR" = "Americas",
    "PHI" = "Asia", "PLE" = "Asia", "POR" = "Europe", "PUR" = "Americas",
    "RSA" = "Africa", "SIN" = "Asia", "SLO" = "Europe", "SRI" = "Asia",
    "SUD" = "Africa", "SUI" = "Europe", "TAN" = "Africa", "TRI" = "Americas",
    "UAE" = "Asia", "URU" = "Americas", "VIE" = "Asia", "VIN" = "Americas",
    "ZAM" = "Africa", "ZIM" = "Africa", "BRU" = "Asia", "BHU" = "Asia", "BAN" = "Asia", "CAM" = "Africa
  )

  # Apply manual overrides
  country_continent_mapping <- ifelse(
    !is.na(manual_overrides[country_codes]),
    manual_overrides[country_codes],
    country_continent_mapping
  )

  # Replace any remaining NA values with "Other"
  country_continent_mapping[is.na(country_continent_mapping)] <- "Other"

  return(country_continent_mapping)
}

# Assigning the continents within the data frame
final_results$Continent <- assign_continents(final_results$Country)
```

A sense check was run to ensure no errors in the data

```
# SENSE CHECK: Verify continent mapping
cat("Continent mapping complete. Summary:\n")
```

```
## Continent mapping complete. Summary:
```

```
print(summary(final_results$Continent))
```

```
##    Length     Class      Mode
##     53875 character character
```

```
# Additional SENSE CHECK: Check for any "Other" values in the Continent column
other_continents <- sum(final_results$Continent == "Other")
cat("\nNumber of 'Other' continents found: ", other_continents, "\n")
```

```
##
## Number of 'Other' continents found:  0
```

```
if (other_continents > 0) {
  cat("Warning: There are 'Other' entries in the Continent column. Please check the country codes and ma
} else {
  cat("No 'Other' entries found in the Continent column. Data looks good.\n")
}
```

```
## No 'Other' entries found in the Continent column. Data looks good.
```

The data was saved. A sense check also occurred to view the top 5 lines of data to ensure no errors occurred. We should expect these top 5 rows to be populated with the same data as the top 5 rows of the London Marathon Mass event

```r
output_file <- "data/final_results.csv"

write.csv(final_results, output_file, row.names = FALSE)
cat(sprintf("Data saved successfully to '%s'\n", output_file))
```

```
## Data saved successfully to 'data/final_results.csv'
```

```r
# Perform a sense check: Display the top 5 rows
cat("Displaying the top 5 rows of the final_results dataframe:\n")
```

```
## Displaying the top 5 rows of the final_results dataframe:
```

```r
print(head(final_results, 5))
```

```
##   Country     Time Category Continent
## 1     RSA 134.4500     Mass    Africa
## 2     GBR 134.9833     Mass    Europe
## 3     GER 135.7000     Mass    Europe
## 4     IRL 136.5667     Mass    Europe
## 5     GBR 137.0333     Mass    Europe
```

Creating the Visualisation

The user interface for the interactive plot must be defined

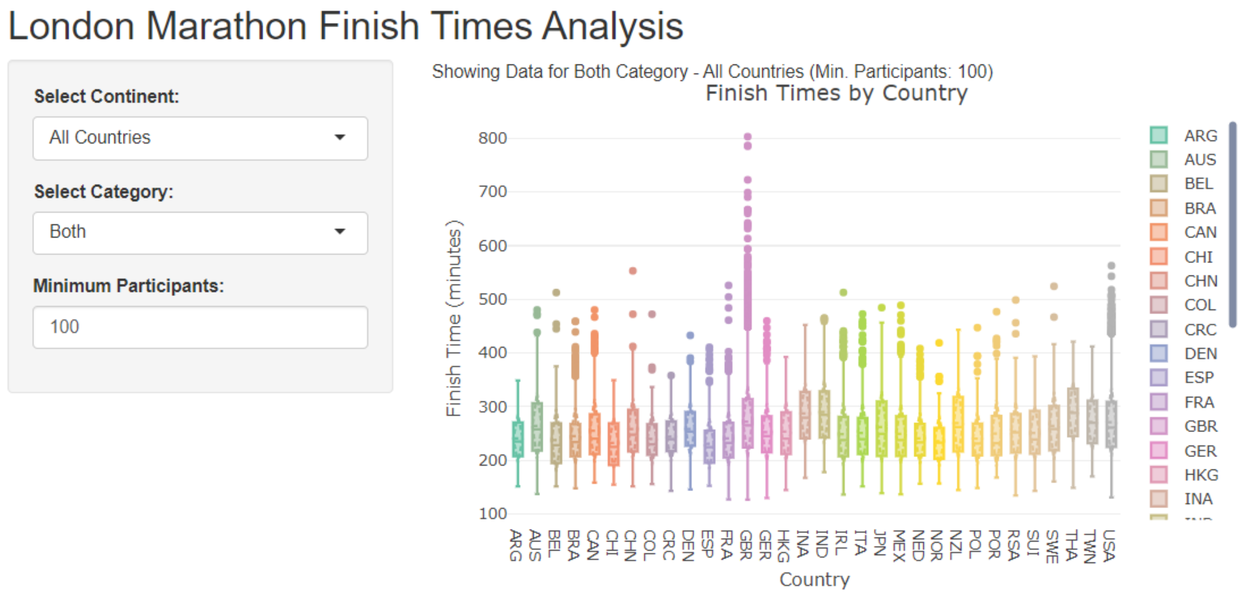
```r
# UI for the Shiny app
ui <- fluidPage(
  titlePanel("London Marathon Finish Times Analysis"),

  sidebarLayout(
    sidebarPanel(
      selectInput("continent_filter", "Select Continent:",
                  choices = c("All Countries", "Top 5 Countries by Participants", unique(final_results$C
                  selected = "All Countries"),
      selectInput("category_filter", "Select Category:",
                  choices = c("Both", "Elite", "Mass"),
                  selected = "Both"),
      numericInput("min_participants", "Minimum Participants:",
                   value = 100, min = 1, step = 1) # Added numeric input for minimum participants
    ),
    mainPanel(
      textOutput("dynamic_title"), # Added dynamic title
      plotlyOutput("boxplot")
    )
  )
)
```

Initial Visualisation

The main goal was to create an interactive plot that would allow users to explore the data by selecting various factors, such as event type, continent, and minimum participant thresholds. Initially the plan was to accomplish this with an interactive box plot, providing a dynamic way to visualise the data.

This visualisation, presented as a PNG, demonstrates the filtering functionality, which was implemented through a custom function to dynamically adjust the data displayed within the plot. This approach ensures that the plot remains flexible and responsive to user preferences.

```r
# Server logic for the Shiny app
server <- function(input, output) {

  # Reactive filtered data based on user inputs
  filtered_data <- reactive({
    data <- final_results

    # Filter by continent
    if (input$continent_filter == "All Countries") {
      data <- data
    } else if (input$continent_filter == "Top 5 Countries by Participants") {
      top_countries <- country_counts_df %>%
        arrange(desc(Count)) %>%
        head(5) %>%
        pull(Country)
      data <- data %>% filter(Country %in% top_countries)
    } else {
      data <- data %>% filter(Continent == input$continent_filter)
    }

    # Filter by category
    if (input$category_filter != "Both") {
      category <- input$category_filter
      data <- data %>% filter(Category == category)
    }

    # Filter by minimum participants
    min_participants <- input$min_participants
    country_filter <- country_counts_df %>%
      filter(Count >= min_participants) %>%
      pull(Country)
    data <- data %>% filter(Country %in% country_filter)

    return(data)
  })

  # Dynamic title based on filters
  output$dynamic_title <- renderText({
    title <- paste(input$category_filter, "Category -", input$continent_filter)
    title <- paste(title, sprintf("(Min. Participants: %d)", input$min_participants))
    paste("Showing Data for", title)
  })
# Render boxplot
  output$boxplot <- renderPlotly({
    data <- filtered_data()
    plot_ly(data,
            y = ~Time,
            color = ~Country,
            type = "box",
            boxmean = "sd") %>%
      layout(
        title = paste("Finish Times by Country"),
        xaxis = list(title = "Country"),
        yaxis = list(title = "Finish Time (minutes)")
      )
  })
}

knitr::include_graphics("figs/visualisation 1.png")
```



London Marathon Finish Times Analysis

Select Continent: All Countries

Select Category: Both

Minimum Participants: 100

Showing Data for Both Category - All Countries (Min. Participants: 100)

Finish Times by Country

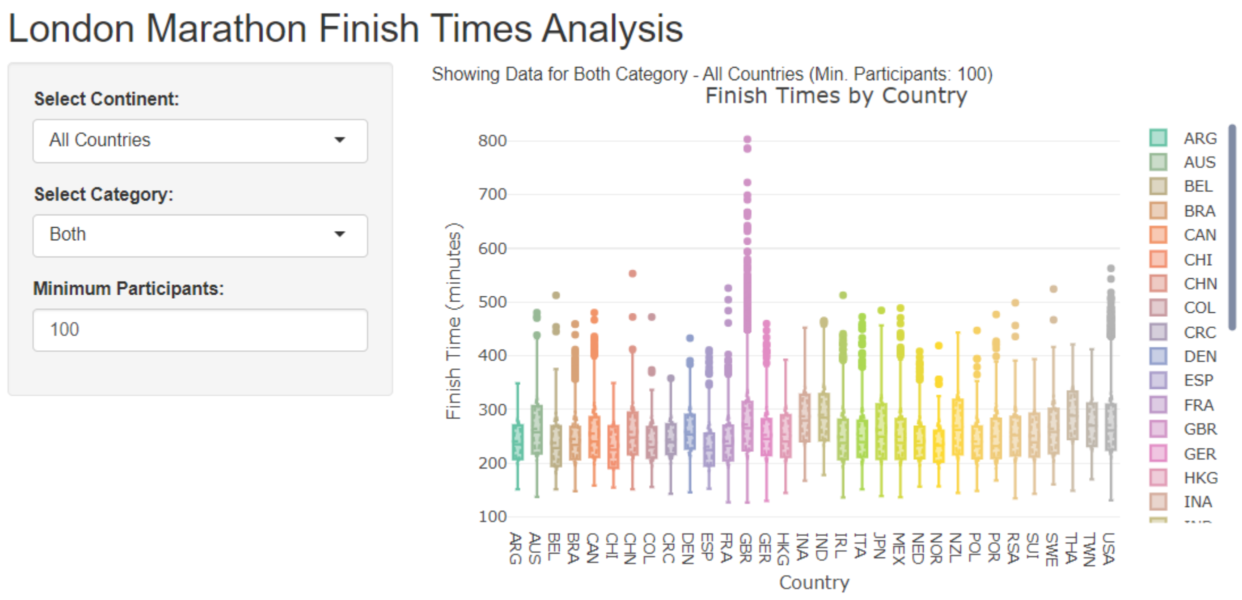
Final Visualisation

However, I decided that a violin plot provides a more effective representation of the distribution of finish times compared to the previously used box plot. A violin plot offers a clearer visualization of the most common finish times for each country, making it easier to identify patterns in the data.

While the exact mean, minimum, and maximum values are less immediately apparent compared to a box plot, the interactive features of the graph make it easy to access this detailed information when needed. Additionally, the violin plot retains the advantage of clearly illustrating the overall distribution.

Below is a screenshot of the interactive violin plot. Click the link below the code to access the fully interactive version.

```
# UI for the Shiny app
ui <- fluidPage(
  titlePanel("London Marathon Finish Times Analysis"),
  sidebarLayout(
    sidebarPanel(
      selectInput("continent_filter", "Select Continent:",
                  choices = c("All Countries", "Top 5 Countries by Participants", unique(final_results$
                  selected = "All Countries"),
      selectInput("category_filter", "Select Category:",
                  choices = c("Both", "Elite", "Mass"),
                  selected = "Both"),
      numericInput("min_participants", "Minimum Participants:",
                   value = 100, min = 1, step = 1) # Added numeric input for minimum participants
    ),
    mainPanel(
      textOutput("dynamic_title"), # Added dynamic title
      br(),  # Add a line break for extra space
      plotlyOutput("boxplot", height = "600px") # Set height to ensure plot is appropriately sized
    )
  )
)

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

  # Reactive filtered data based on user inputs
  filtered_data <- reactive({
    data <- final_results

    # Filter by continent
    if (input$continent_filter == "All Countries") {
      data <- data
    } else if (input$continent_filter == "Top 5 Countries by Participants") {
      top_countries <- country_counts_df %>%
        arrange(desc(Count)) %>%
        head(5) %>%
        pull(Country)
      data <- data %>% filter(Country %in% top_countries)
    } else {
      data <- data %>% filter(Continent == input$continent_filter)
    }

    # Filter by category
    if (input$category_filter != "Both") {
      category <- input$category_filter
      data <- data %>% filter(Category == category)
    }

    # Filter by minimum participants
    min_participants <- input$min_participants
    country_filter <- country_counts_df %>%
      filter(Count >= min_participants) %>%
      pull(Country)
    data <- data %>% filter(Country %in% country_filter)

    return(data)
  })

  # Dynamic title based on filters
  output$dynamic_title <- renderText({
    title <- paste(input$category_filter, "Category -", input$continent_filter)
    title <- paste(title, sprintf("(Min. Participants: %d)", input$min_participants))
    paste("Showing Data for", title)
  })

  # Render violin plot
  output$boxplot <- renderPlotly({
    data <- filtered_data()

    plot_ly(data,
            y = ~Time,
            color = ~Country,
            type = "violin",  # Change type to "violin" for violin plot
            box = list(visible = TRUE)) %>%  # Add box option for better comparison
      layout(
        title = paste("Finish Times by Country"),
        xaxis = list(title = "Country"),
        yaxis = list(title = "Finish Time (minutes)"),
        margin = list(t = 100)  # Add top margin to push plot down
      )
  })
}

knitr::include_graphics("figs/visualisation 1.png")
```



London Marathon Finish Times Analysis

Select Continent: All Countries

Select Category: Both

Minimum Participants: 100

Showing Data for Both Category - All Countries (Min. Participants: 100)

To view the interactive plot click Here

Alternative Visualisation

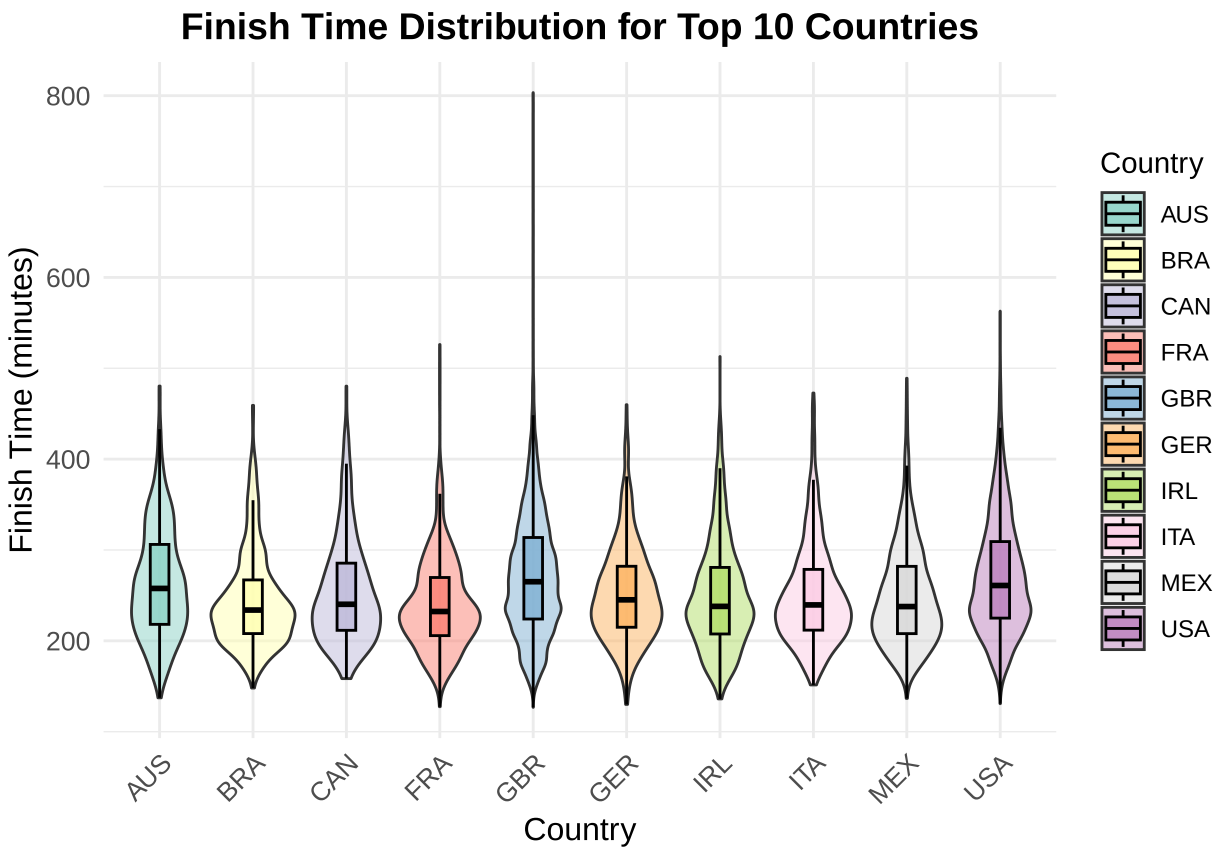
An alternative visualisation would be to create an overlay of the box plot and the violin plot, this would therefore allow for an immediate viewing of both the distribution of times and the mean, min and max times. However, this plot would not be interactive and would therefore require selecting countries within the code prior to creating the visual. The example code below creates the plot for the countries with the top 10 participants. This plot would be used in a visualisation where links could not be clicked to access the interactive plot.

```r
#visualisation 3

# Sort countries by the number of participants in descending order
top_10_countries <- head(country_counts_df[order(-country_counts_df$Count), ], 10)

# Filter final_results to include only these top 10 countries
top_10_data <- final_results[final_results$Country %in% top_10_countries$Country, ]

#Plot a graph with the top 10 countries

p <- ggplot(top_10_data, aes(x = Country, y = Time, fill = Country)) +

  # Violin plot
  geom_violin(alpha = 0.5, position = position_dodge(width = 0.75), trim = TRUE) +

  # Boxplot overlay
  geom_boxplot(width = 0.2, position = position_dodge(width = 0.75),
               alpha = 0.8, outlier.shape = NA, color = "black") +

  # Add plot title and axis labels
  ggtitle("Finish Time Distribution for Top 10 Countries") +
  xlab("Country") +
  ylab("Finish Time (minutes)") +

  # Customize appearance
  theme_minimal() +
  theme(axis.title.x = element_text(size = 12),
        axis.title.y = element_text(size = 12),
        plot.title = element_text(hjust = 0.5, size = 14, face = "bold"),
        axis.text.x = element_text(size = 10, angle = 45, hjust = 1),
        axis.text.y = element_text(size = 10)) +

  # Color customization (assign different colors for each country)
  scale_fill_manual(values = RColorBrewer::brewer.pal(10, "Set3"))  # Using a color palette for top 10


#Save plot and export as jpeg
ggsave(
  filename = "./figs/Top_10_Countries_Finish_Time_Distribution.jpeg",
  plot = p,
  dpi = 1200,
  width = 180,
  height = 170,
  units = "mm"
)
```

```
#sense check to show the plot is saved
cat("Plot saved successfully.\n")
```

```
## Plot saved successfully.
```

```
#display the plot
p
```



Discussion

The interactive violin plot provides a wealth of insights into the performance of participants at the London Marathon 2024. Among the countries with the top five participant numbers, France stands out with the lowest average finish time, while the UK recorded the fastest individual time. Italy, on the other hand, demonstrated the most consistent distribution, as reflected by its relatively uniform kernel shape compared to the other nations.

In the Elite category, the plot highlights an especially intriguing result with Kenya's victory. While Kenya secured the fastest time, its distribution skews noticeably toward longer finish times, suggesting a broader spread in performance among its participants. Lastly, for countries with at least 600 participants, France again stands out with a short, wide kernel, indicating the highest consistency in finish times across its participants. Overall, the violin plot serves as a powerful tool for uncovering patterns and offering valuable insights into each country's performance.

Limitations

One notable limitation of this analysis is that the data is scraped exclusively from the London Marathon, leading to a higher representation of participants from the UK. Additionally, the London Marathon requires participants to meet qualifying times for entry (though some gain entry through charity spots), which skews the data toward faster runners compared to the general marathon population. This results in an analysis that may not fully reflect the diversity of marathon performances globally.

To address these limitations, future work could involve scraping and aggregating data from multiple marathons throughout the year, including those with less stringent entry requirements and higher acceptance rates. This would provide a more comprehensive view of global marathon trends and performance distributions.