Part 1: Visualizing Time Series Data

- o **Create or Load a Time Series Dataset:**
- o Start by creating a sample time series dataset or loading a real dataset (e.g., monthly sea surface temperatures, fish stock levels):

```
# Example: Creating a sample time series dataset
set.seed(42)
time_series_data <- ts(cumsum(rnorm(120)), frequency = 12,
start = c(2010, 1))

# Plot the time series
plot(time_series_data, main = "Sample Time Series Data", xlab =
"Year", ylab = "Value")
```

- o **Task**: Run the code to visualize the time series data. Observe any trends, seasonal patterns, or anomalies. What can you infer from the plot?

2. **Optional: Load a Real Dataset:**
   - o If you have a real marine ecology dataset (e.g., sea temperature, fish stock levels), load it into R using read.csv() or a similar function:

```
# Example: Loading a real dataset (replace
'path/to/your/dataset.csv' with the actual path)
# data <- read.csv("path/to/your/dataset.csv")
```

Part 2: Detecting Trends with Moving Averages

1. **Calculate and Plot a Moving Average**:
   - o Use the zoo package to calculate and plot a moving average for the time series:

```
# Install and load the zoo package
install.packages("zoo")
library(zoo)

# Calculate the moving average (k=12)
moving_avg <- rollmean(time_series_data, k = 12, fill = NA)

# Plot the original data with the moving average
plot(time_series_data, main = "Time Series with Moving
Average", xlab = "Year", ylab = "Value")
lines(moving_avg, col = "red", lwd = 2)
```

- o **Task**: Add a moving average to the time series plot to smooth the data and detect trends. What long-term trends or changes can you identify in the time series?

Part 3: Decomposing the Time Series

1. **Decompose the Time Series into Components:**

   o Decompose the time series into trend, seasonal, and residual components using the decompose() function:

   ```
   # Decompose the time series
   decomposed_data <- decompose(time_series_data)

   # Plot the decomposed components
   plot(decomposed_data)
   ```

   o **Task:** Decompose the time series data and interpret the results. What does the trend component reveal? Can you identify any seasonal patterns in the data?

Part 4: Breakpoint Analysis

1. **Perform Breakpoint Analysis Using the strucchange Package:**

   o Breakpoint analysis helps detect significant changes in the time series data. Use the strucchange package to identify breakpoints:

   ```
   # Install and load the strucchange package
   install.packages("strucchange")
   library(strucchange)

   # Perform breakpoint analysis
   breakpoints_result <- breakpoints(time_series_data ~ 1)

   # Plot the time series with breakpoints
   plot(time_series_data, main = "Breakpoint Analysis of Time
   Series Data")
   lines(breakpoints_result, col = "red")
   ```

   o **Task:** Perform breakpoint analysis on the time series data:
   - Identify the detected breakpoints. Where do these occur in the time series?
   - Suggest possible explanations for these shifts (e.g., environmental changes, policy changes, or ecological events).

2. **Interpret the Breakpoint Results:**

   o View a summary of the detected breakpoints to better understand the changes in your data:

   ```
   # Summary of the breakpoint analysis
   summary(breakpoints_result)
   ```

   o **Task:** Based on the summary output, analyze the significance of each detected breakpoint:

- How does each breakpoint correlate with changes in the trend or seasonal components identified earlier?
- If you used a real dataset, consider whether these shifts align with known events or disturbances in marine ecosystems.

Part 5: Reflection and Discussion

1. **Reflect on the Analysis:**
   - Reflect on the visualizations and analyses performed. How did the moving average, decomposition, and breakpoint analysis help you better understand the time series data?
   - **Task**: Write a brief summary (150-200 words) discussing what you learned from each technique and how it helped reveal different aspects of the data.
2. **Document Your Work**:
   - Add comments to your script explaining each step and the insights gained.
   - Save your script as week6_exercise.R and be prepared to discuss your findings in the next class.

Submission Instructions

- **Save your script**: Ensure your script is well-commented and saved as
  `week6_exercise_name.R`.
- **Upload**: Submit your script via TEAMS.
- **Discussion**: Be ready to discuss your experiences and any questions you have during the next class.

Expected Outcome

By the end of this exercise, you should be able to:

- Visualize time series data and detect trends using moving averages.
- Decompose time series into trend, seasonal, and residual components to understand their structure.
- Perform breakpoint analysis to identify significant changes in time series data and interpret their implications.
- Reflect on the real-world meaning of time series patterns in marine ecology and fisheries.