UNIVERSITY OF THE PHILIPPINES MINDANAO
College of Science and Mathematics
Department of Mathematics, Physics, and Computer Science

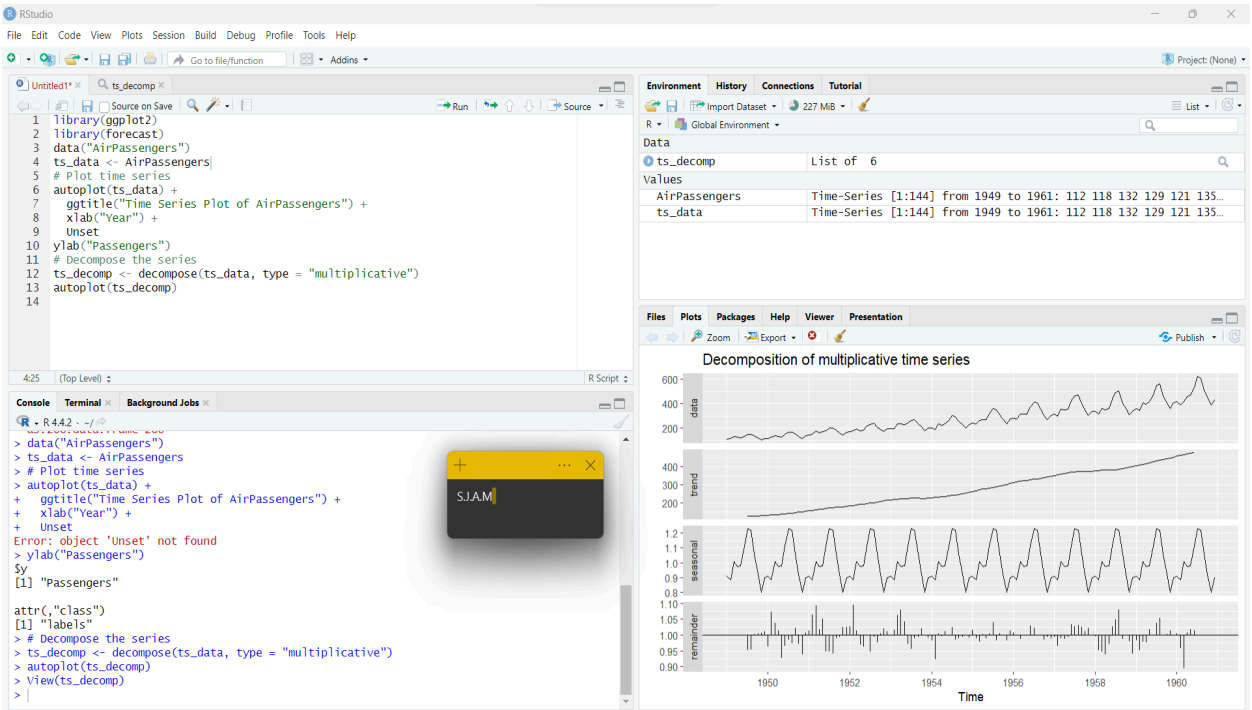
AMAT 132 (Introductory Forecasting) — Exercise 3: Time Series Properties

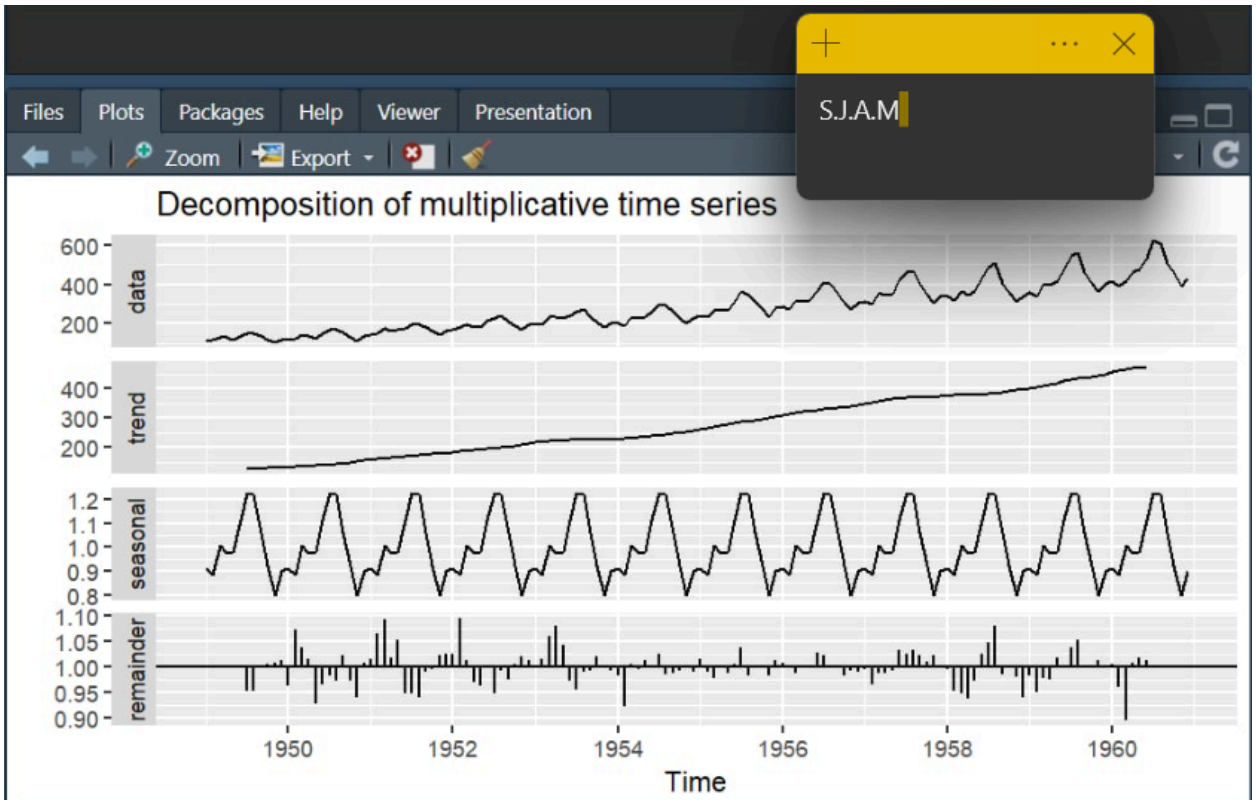
Saintjoy Mandalinao

General Objectives: This exercise aims to help students:
1. Distinguish trend and seasonal components in a time series.
2. Compute and interpret skewness in time series data.
3. Differentiate seasonal patterns from cyclical patterns.

Exercise 3a: Identifying Trend and Seasonality

Objective: To visually analyze a time series dataset and identify trend and seasonal components. Instructions:
1. Load the dataset in R using the built-in AirPassengers data.
2. Plot the time series to observe its behavior.
3. Decompose the series into its trend and seasonal components.
4. Answer the discussion questions based on your findings.





Discussion Questions:

1. Does the time series exhibit a trend? If yes, describe its direction.
2. Is there a seasonal pattern? What is the frequency of the seasonality?
3. How does decomposition help in forecasting?

1. **Does the time series exhibit a trend? If yes, describe its direction.**
   Yes, the airline passenger time series itself shows an increase in the upward direction over the passage of time. The second panel indicates that the trend component demonstrates a clear upward movement with a rise in the number of passengers, confirming the increasing air travel demand. The reasons may include population increases, economic development, greater ease of access to air travel, or better service from airlines.

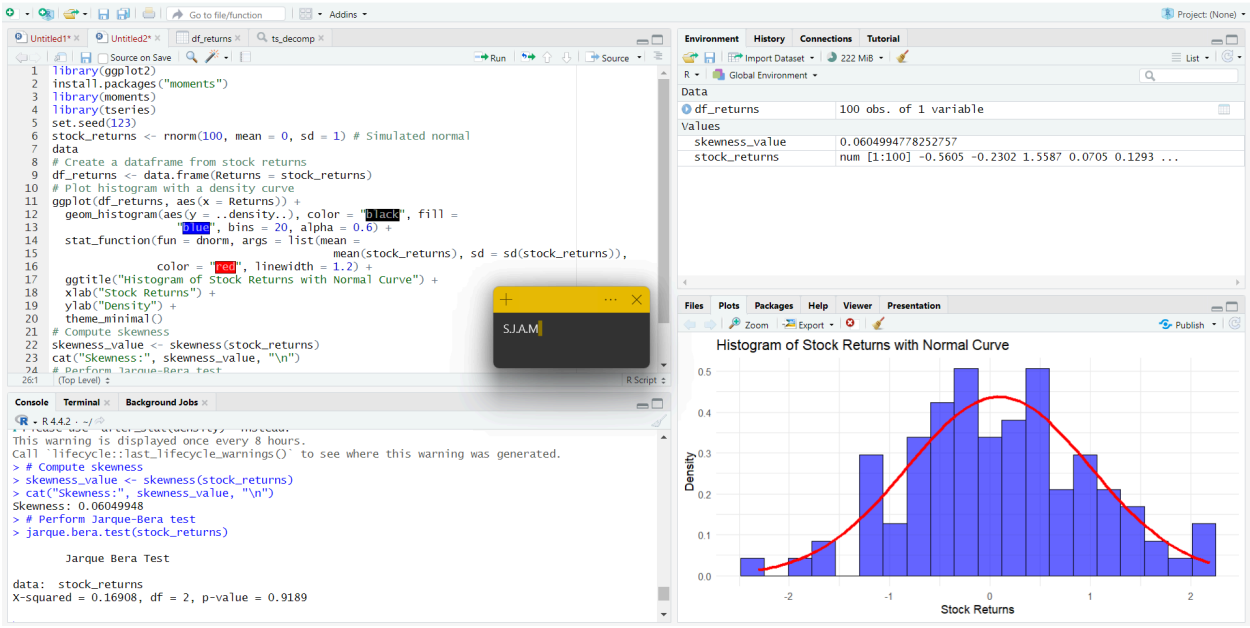
2. **Is there a seasonal pattern? What is the frequency of the seasonality?**
   Yes, the time series has a definite seasonal pattern. The seasonal component, evident in the third panel, reveals periodic peaks and troughs at regular intervals. Because the x-axis is in years, the pattern seems to repeat every year, indicating

that air passenger volumes vary according to seasonal considerations. Greater peaks could be associated with holiday periods or summer holidays when travel demand is higher, and lower values might represent off-peak travel seasons. Also, the seasonality effect increases over time, suggesting that seasonal variations in the number of passengers are becoming greater as total air travel rises.

3. **How does decomposition help in forecasting?**
   Decomposition assists in enhancing airline passenger number forecasting by decomposing the time series into significant components. The trend component indicates long-term expansion in air travel, enabling airlines and policymakers to forecast future demand. The seasonal component picks up on recurring fluctuations, enabling airlines to make capacity, price, and scheduling adjustments in response to peak and off-peak travel seasons. The residual factor is representative of random fluctuations, and these can reflect external disturbances in the form of weather conditions, economic crises, or variations in travel policies. Through separate examination of these components, forecasting techniques can be formulated to reflect long-term patterns and seasonal patterns as well, and hence provide better estimates of passenger demand. Airlines are thus able to better manage operations, enhance customer service, and make better strategic choices.

Exercise 3b: Computing and Testing for Skewness Objective: To compute and test the skewness of a time series dataset.

Instructions:
1. Load a sample stock return dataset (or use a dataset provided by the instructor).
2. Plot a histogram of the stock returns to check for skewness visually.
3. Compute skewness using statistical functions.
4. Apply the Jarque-Bera test to check for normality.
5. Answer discussion questions based on your findings.



Discussion Questions:

1. What does the computed skewness value indicate about the dataset?
2. Based on the histogram, does the dataset appear to be symmetric?
3. What does the Jarque-Bera test tell us about the normality of the data?

Answers:

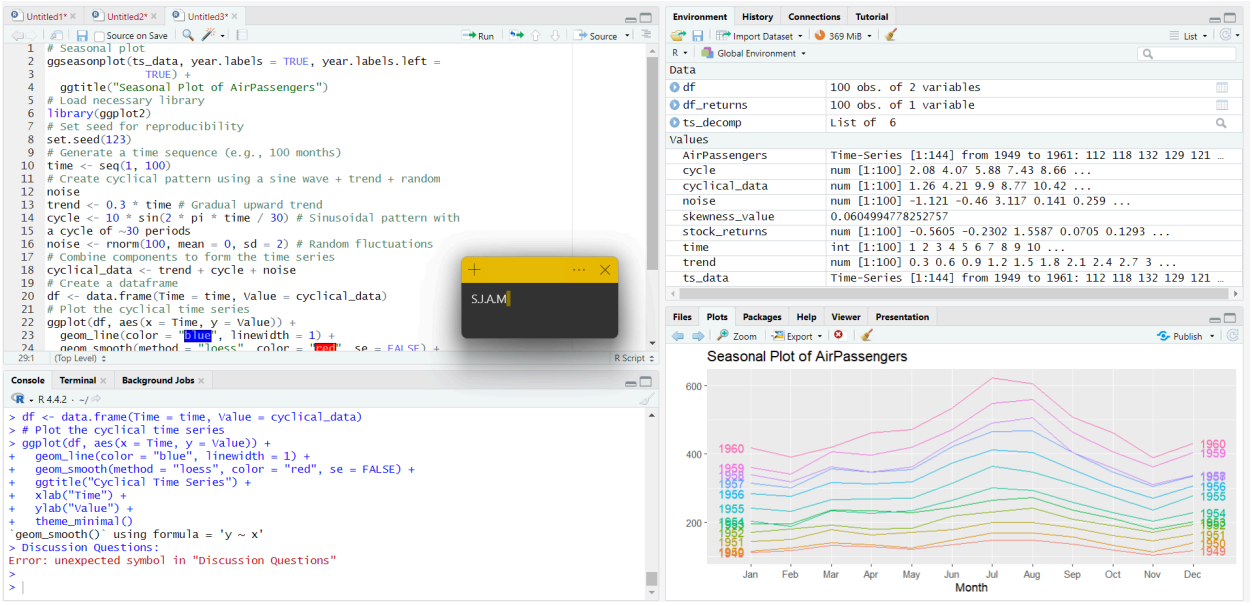
1. The skewness value calculated as 0.0605 indicates that the dataset is almost symmetric, as it is very close to zero. This means that there is very little skewness in the distribution, i.e., the stock returns are quite balanced with no strong tendency toward very high or very low values.

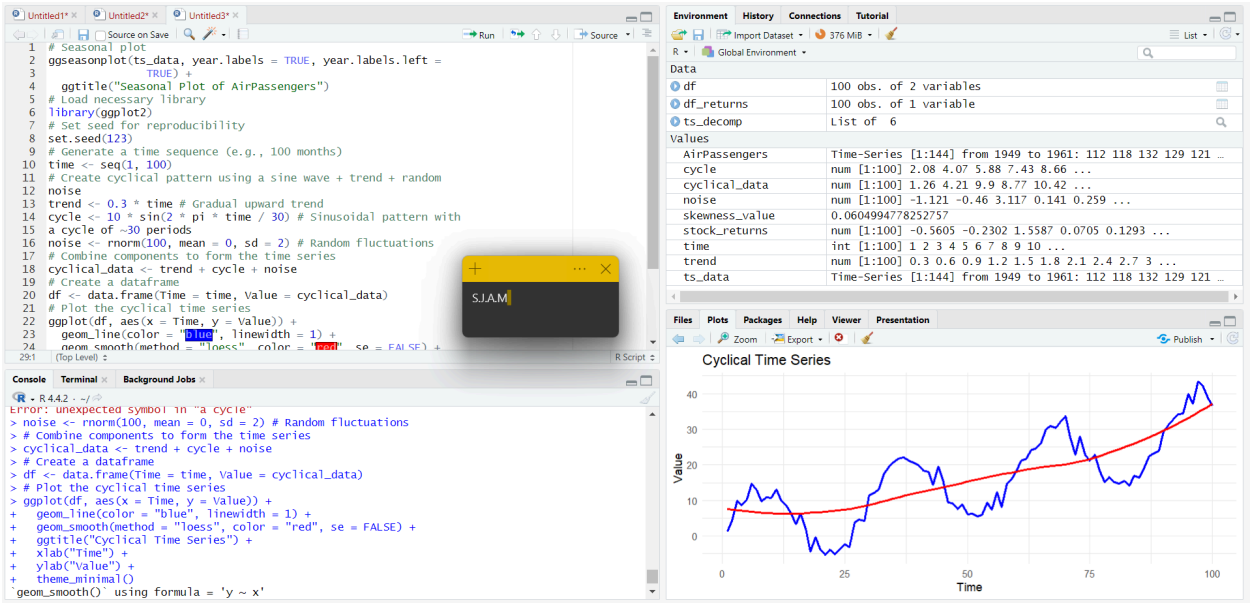
2. From the histogram, the data set seems to be approximately symmetric. The bars are spread out evenly around the middle, and the normal curve (red line) fits the histogram well. There is no apparent long tail on either side, further supporting that the distribution does not have strong skewness.

3. The Jarque-Bera or JB value of 0.16908 is near zero, and thus the values of kurtosis and skewness are near zero as well.Since the p-value (0.9189) is greater than 0.05, we fail to reject H_0., and hence we cannot reject the null hypothesis of the Jarque-Bera test. This implies that the data adheres to a normal distribution. Hence, there isn't sufficient evidence against the normality of the dataset, in favor of the presumption that stock returns are roughly normal.

Exercise 3c: Seasonal vs. Cyclical Patterns
Objective: To compare seasonal and cyclical patterns in time series data.

Instructions:
1. Load a seasonal dataset (AirPassengers) and a cyclical dataset.
2. Plot the seasonal time series and identify its frequency.
3. Compare it to a cyclical dataset to observe differences.
4. Answer discussion questions based on your findings.





Discussion Questions:

1. How does a seasonal pattern differ from a cyclical pattern?
2. Which type of pattern is easier to predict? Why?
3. How would you adjust a forecasting model for seasonality?

1. **How does a seasonal pattern differ from a cyclical pattern?**
   In the provided dataset, the "Seasonal Plot of AirPassengers" illustrates a recurring pattern annually, which reflects seasonality. It indicates that the number of air passengers goes up and down predictably at certain periods of the year, possibly due to vacation and holiday travel patterns. The "Cyclical Time Series" plot, however, illustrates a pattern that goes up and down with time but is not fixed at an interval. The cycles in such a situation are the result of a mixture of trends and chance fluctuations as opposed to firm season changes.

2. **Which type of pattern is easier to predict? Why?**
   The seasonal pattern in the AirPassengers dataset is easier to predict because it follows a consistent yearly trend. In contrast, the cyclical pattern in the generated time series is more unpredictable since it is influenced by long-term trends and random noise, making it harder to model with precision.

3. **How would you adjust a forecasting model for seasonality?**
   To adjust a forecasting model for seasonality, we first determine the seasonal pattern of the data. Next, is removing the trend but retaining the seasonal effect. If necessary, normalize the data to stabilize fluctuations. Last, use models with explicit consideration of seasonality to enhance predictive accuracy.