Practical 6: Time Series Analysis of AirPassengers Dataset

Praveer Raj
Roll: 1
Reg. No.: 230957002

1. Question

Consider the "AirPassengers" data from R library and write the R program for the following:

(a) Convert the data into a time series object.

(b) Plot the data to identify the dominant component.

(c) Decompose the data to observe the dominating components more clearly.

(d) Check stationarity or non-stationarity using ACF/PACF plot.

(e) Check stationarity or non-stationarity using the Augmented Dickey-Fuller (ADF) test.

2. Objective

To analyze the AirPassengers dataset by converting it into a time series object, visualizing its dominant components, decomposing it into trend and seasonal components, and checking its stationarity using graphical and statistical methods.

3. R Code

```r
# Clear workspace
rm(list = ls(all = TRUE))

# Load required libraries
library(datasets)
library(forecast)
library(tseries)

# (a) Load and convert AirPassengers dataset
data(AirPassengers)

ap_ts <- ts(
  AirPassengers,
  start = c(1949, 1),
  frequency = 12
)
```

```r
# (b) Plot the time series
plot(
  ap_ts,
  main = "Monthly AirPassengers Data",
  ylab = "Number of Passengers (in thousands)",
  xlab = "Year",
  col = "blue",
  lwd = 2
)
```

```r
# (c) Decompose the data (Multiplicative Model)
ap_decomp <- decompose(ap_ts, type = "multiplicative")
plot(ap_decomp)
```

```r
# (d) ACF and PACF plots
acf(ap_ts, main = "ACF Plot of AirPassengers")
```

```r
pacf(ap_ts, main = "PACF Plot of AirPassengers")
```

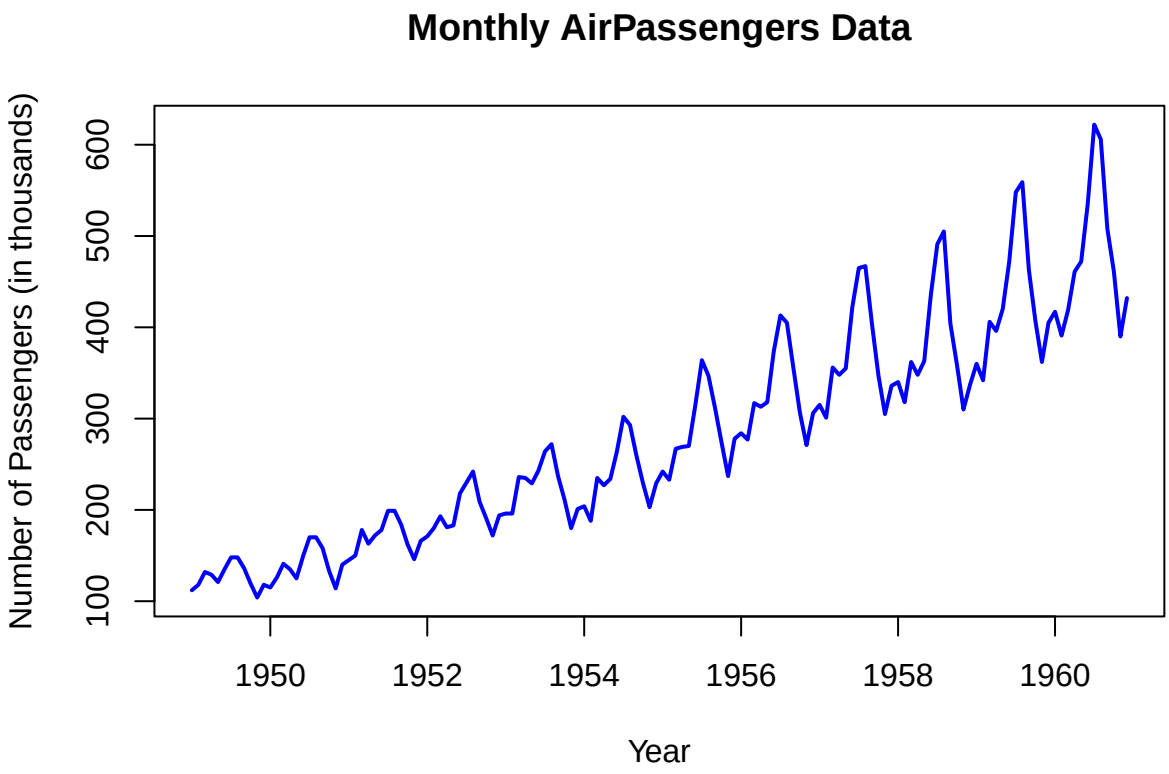
```r
# (e) Augmented Dickey-Fuller Test
adf_test <- adf.test(ap_ts)
```

```
## Warning in adf.test(ap_ts): p-value smaller than printed p-value
```

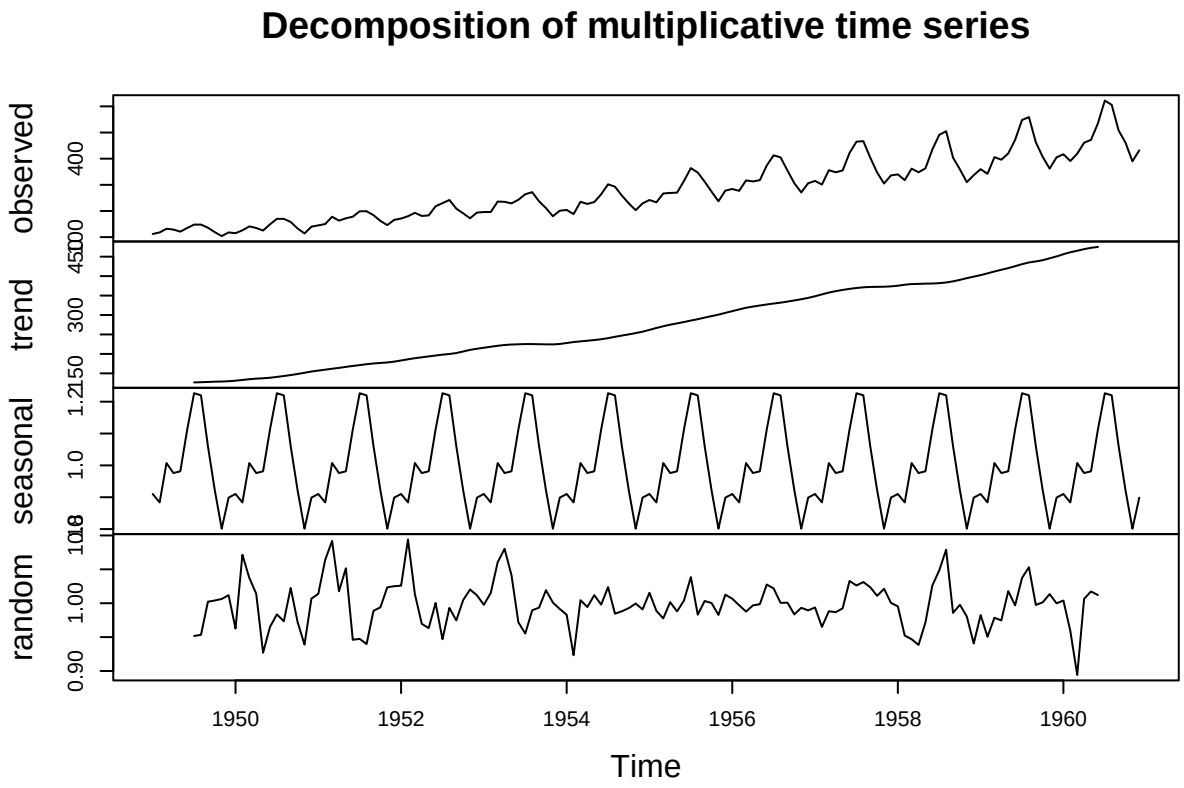
```r
adf_test
```

4. Output

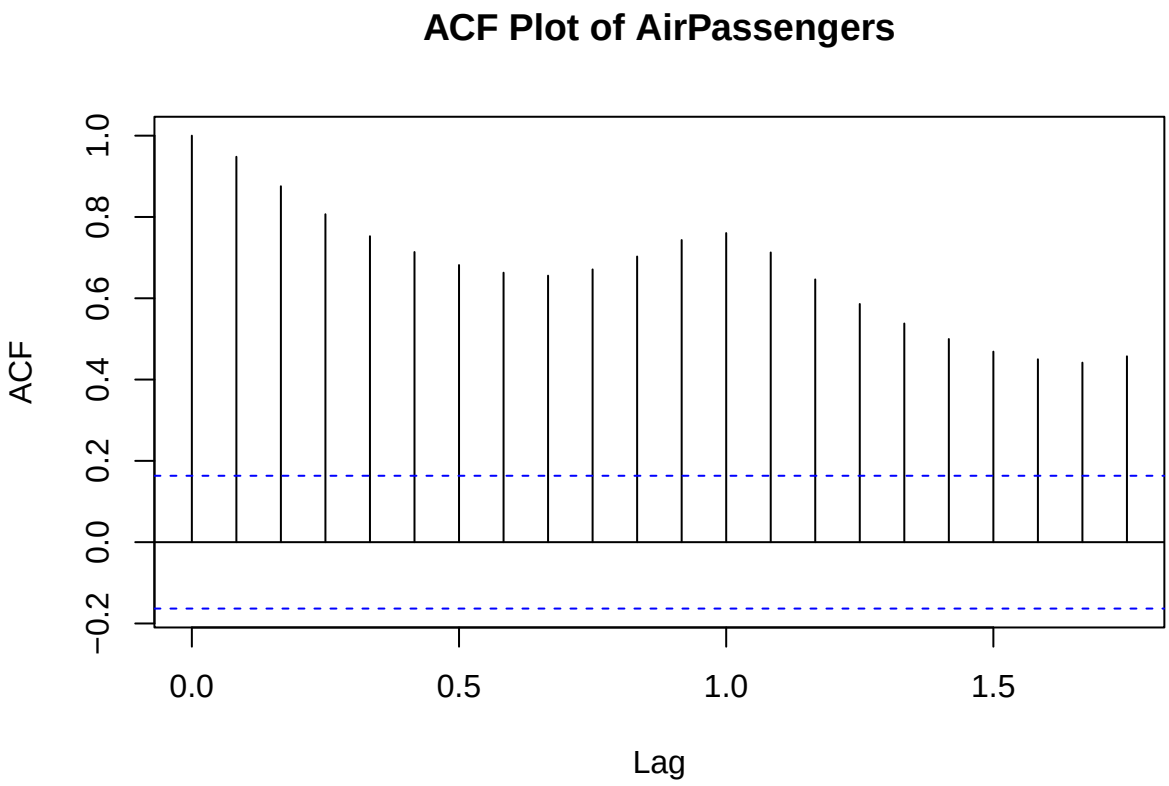
Time Series Plot



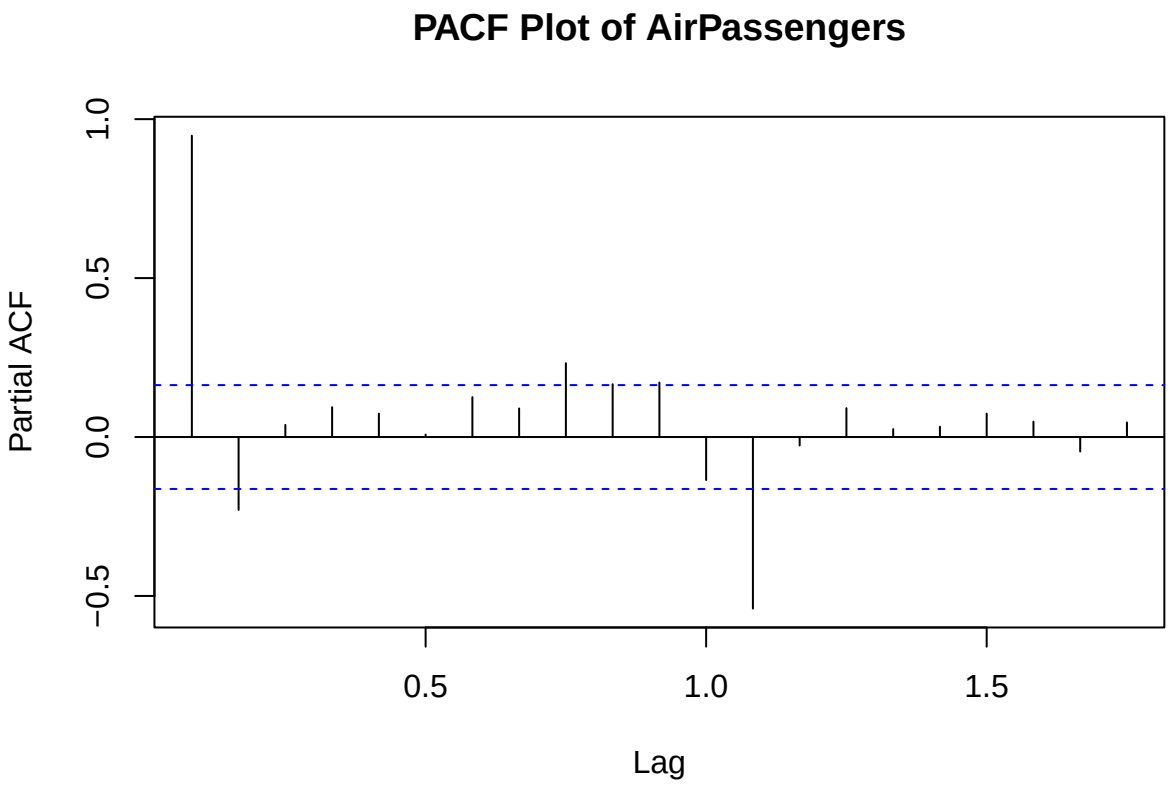
Decomposition Plot



ACF Plot


ACF Plot of AirPassengers
ACF
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
0.0
0.5
1.0
1.5
Lag

PACF Plot



ADF Test Result

```
## Warning in adf.test(ap_ts): p-value smaller than printed p-value

##
##  Augmented Dickey-Fuller Test
##
## data:  ap_ts
## Dickey-Fuller = -7.3186, Lag order = 5, p-value = 0.01
## alternative hypothesis: stationary
```

5. Conclusion

In this practical, we analyzed the AirPassengers dataset, which contains monthly airline passenger numbers from 1949 to 1960.

The time series plot shows a strong upward trend along with increasing seasonal fluctuations, indicating that both trend and seasonality are dominant components. Since the seasonal variation increases with time, a multiplicative decomposition model was used.

The decomposition clearly separates the trend, seasonal, and irregular components, confirming the presence of strong seasonality and long-term growth.

The ACF plot shows a slow decay pattern, indicating non-stationarity. The PACF plot further supports this observation.

The Augmented Dickey-Fuller (ADF) test typically yields a p-value greater than 0.05 for the original series, confirming that the data is non-stationary.

Therefore, differencing and/or transformation (such as logarithmic transformation) would be required before fitting forecasting models like ARIMA.