MA653: Computational Financial Modelling

Time Series data Decomposition

Rahul Jain
B15228

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1 Time Series

Collection of data points indexed over time

Example:

Month	**International airline passengers monthly totals (in 1000s)**
1949-01	112
1949-02	118
1949-03	133
1949-04	129
1949-05	121

2 Decomposition of Time Series

Time series decomposition is a mathematical procedure which transforms a time series into multiple different time series. The original time series is often split into 3 component series:

- **Seasonal:** Patterns that repeat with a fixed period of time.
- **Trend:** The underlying trend of the metrics..
- **Random:** Also call noise, irregular or remainder, this is the residuals of the original time series after the seasonal and trend series are removed.

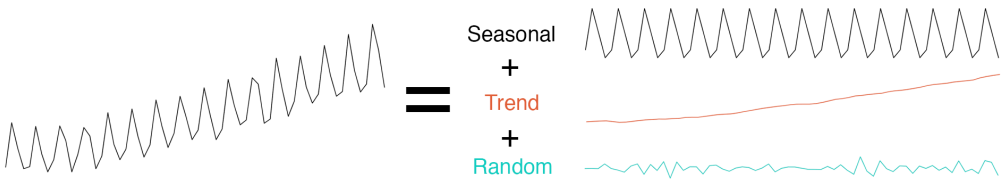


Figure 1: Time Series Decomposition

Source [**?**]

2.1 R commands for decomposition

```
#import data from csv into a dataframe object
data<-read.csv("filename.csv",header=T)

#Class of imported data
class(data) #data.frame

#Print column names of imported dataframe
colnames(data)

#Converting dataframe object into timeseries object
data.ts<-ts(data=data$num, frequency = 12, start=c(1949,01), end=c(1960,12))

#Use these command to check if dataframe object is converted into timeseries
class(data.ts) #ts
start(data.ts) #1949    1
end(data.ts) #1960   12
head(data.ts) #Jan Feb Mar Apr May Jun
            #1949 112 118 132 129 121 135
data.ts       #Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
            #1949 112 118 132 129 121 135 148 148 136 119 104 118
            #1950 115 126 141 135 125 149 170 170 158 133 114 140
            #1951 145 150 178 163 172 178 199 199 184 162 146 166...

#Decomposing the data
data.de<-decompose(data.ts)

#PNG file to plot the graph
png("International airline passengers.png")
plot(data.de)
dev.off()
```

3 Examples

3.1 Additive decomposition

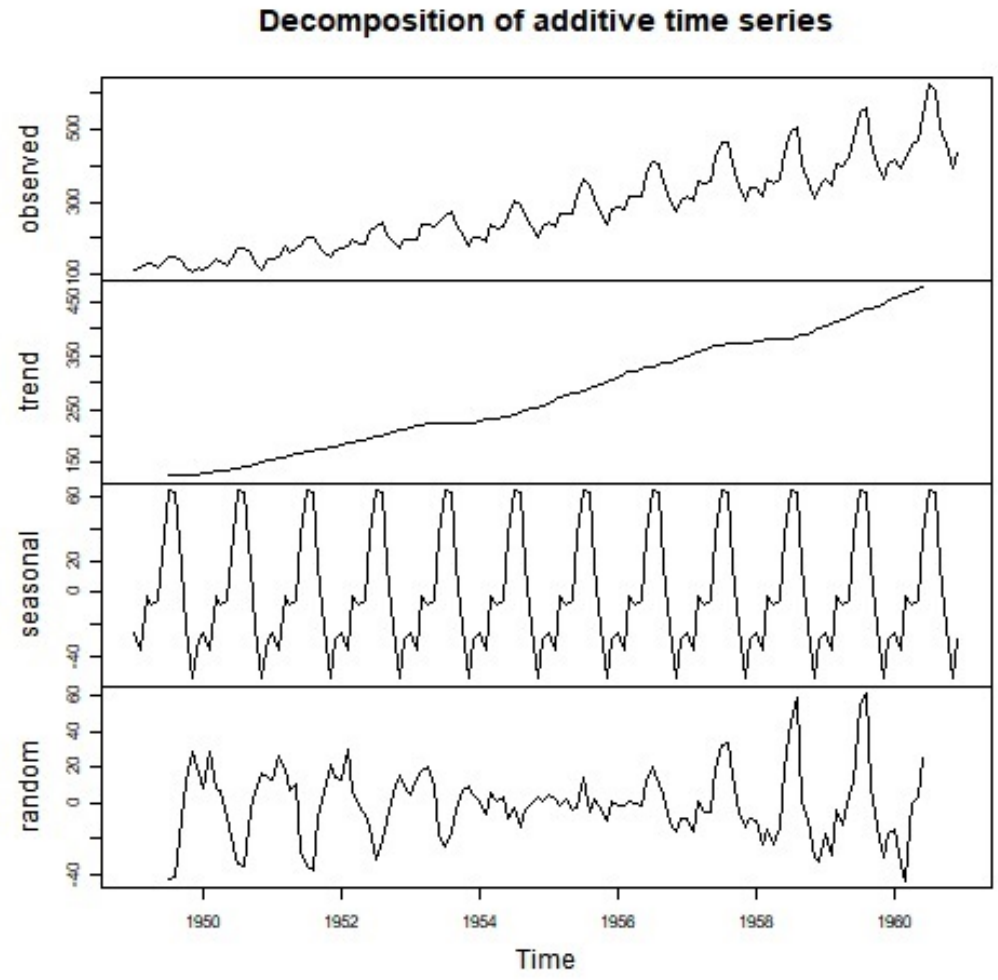


Figure 2: Additive decomposition of International airline passengers monthly totals (in 1000s)

3.2 Multiplicative decomposition

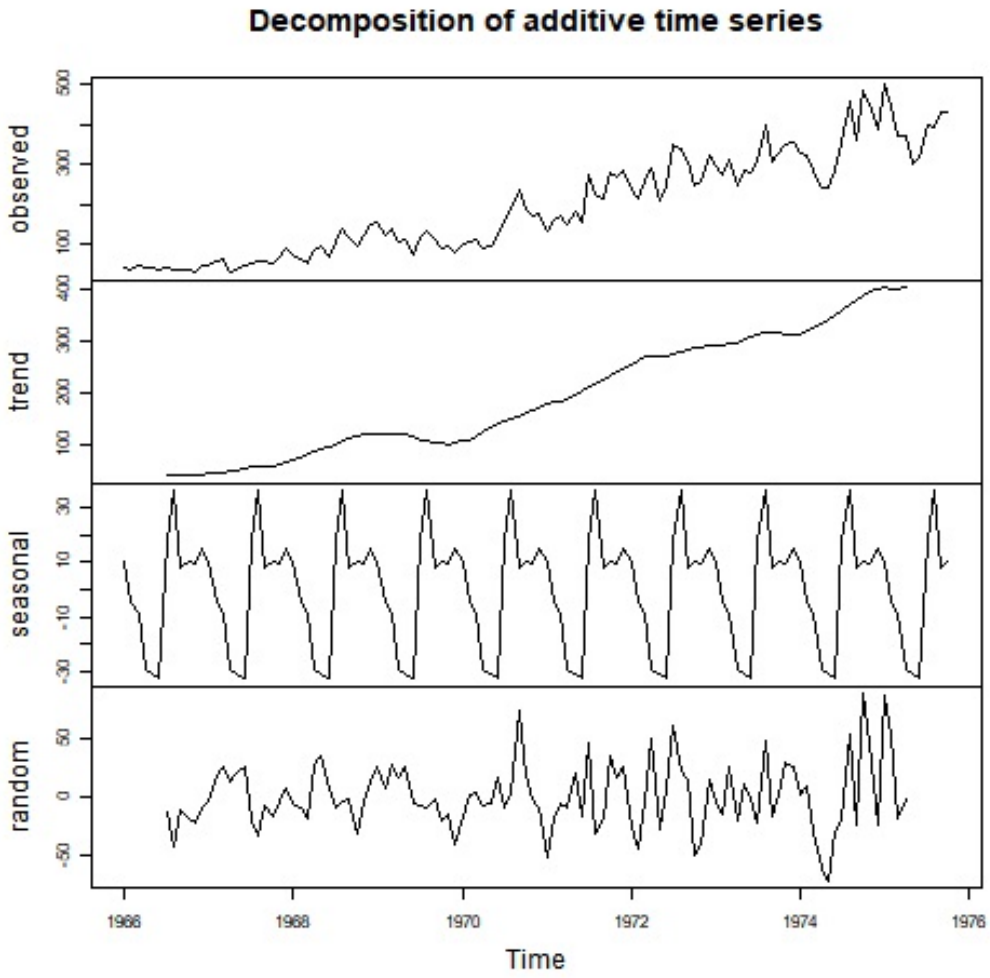


Figure 3: Additive decomposition of Monthly Boston armed robberies

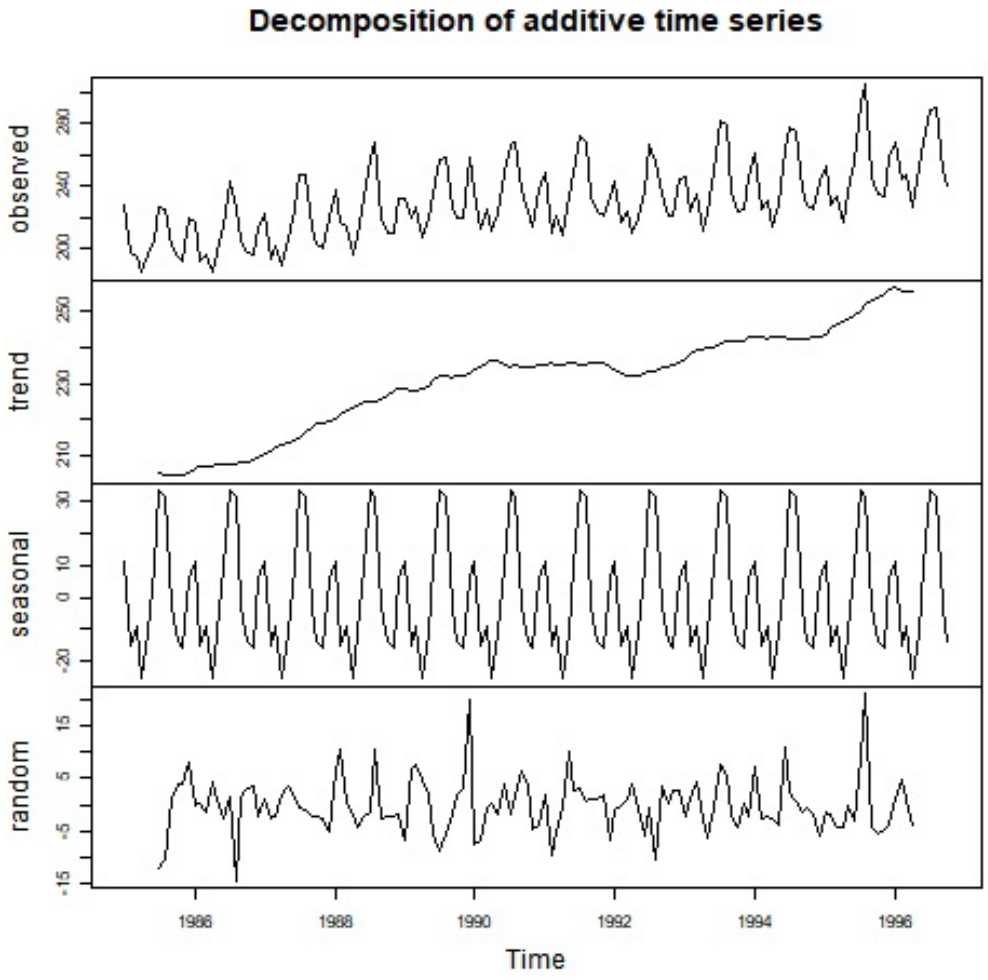


Figure 4: Additive decomposition of CPI data, Canada

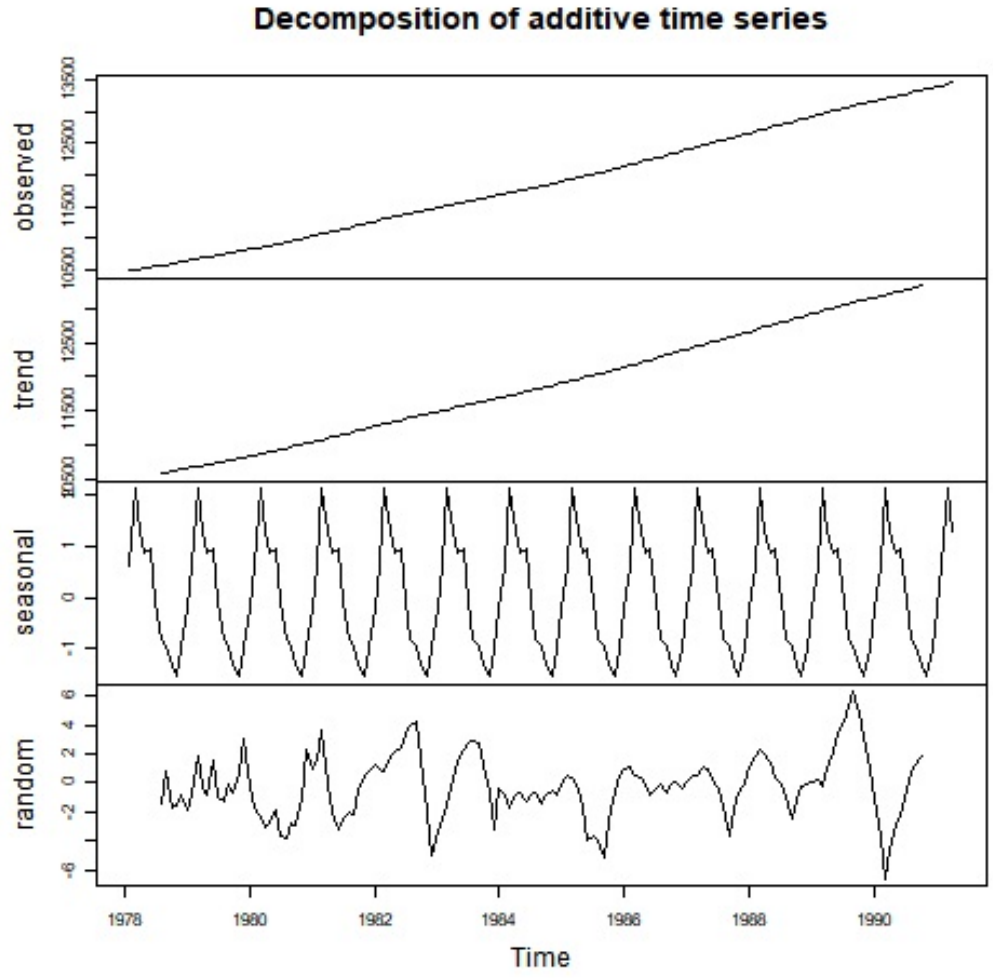


Figure 5: Additive decomposition of Monthly civilian population of Australia (in 1000 persons)

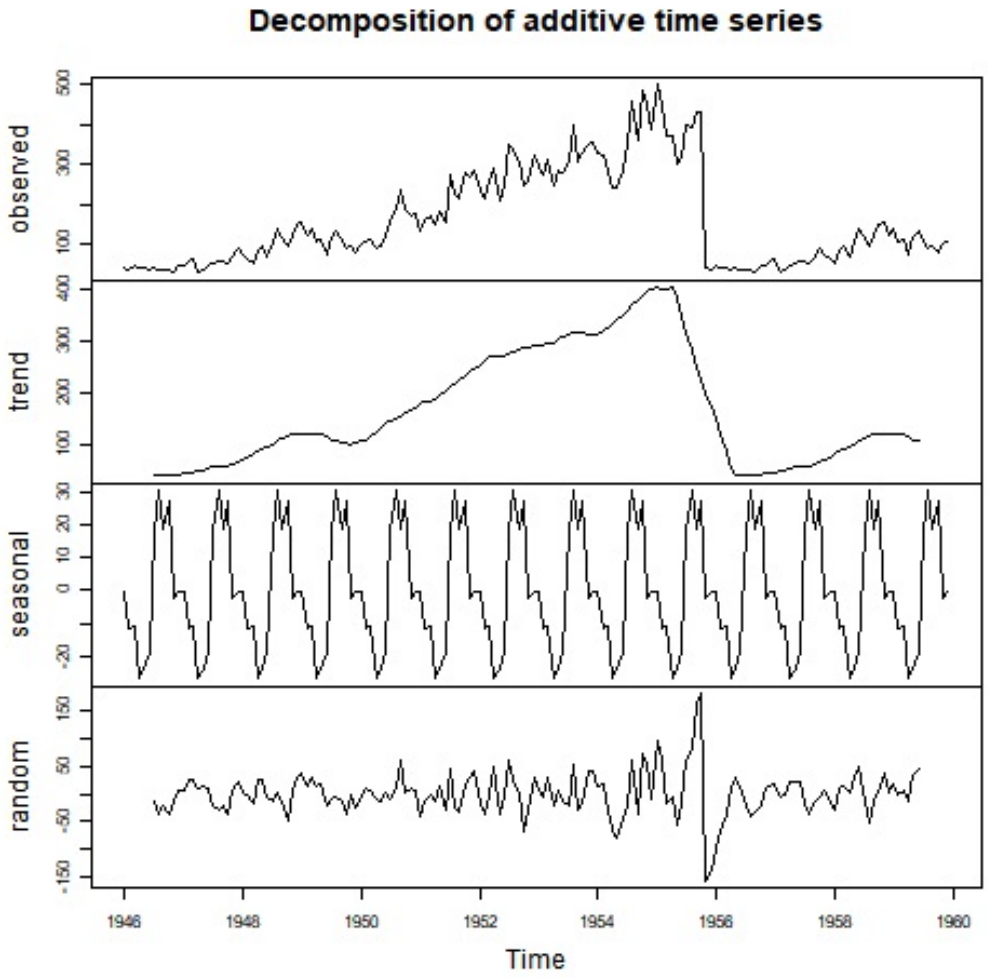


Figure 6: Additive decomposition of Monthly New York City birth rates

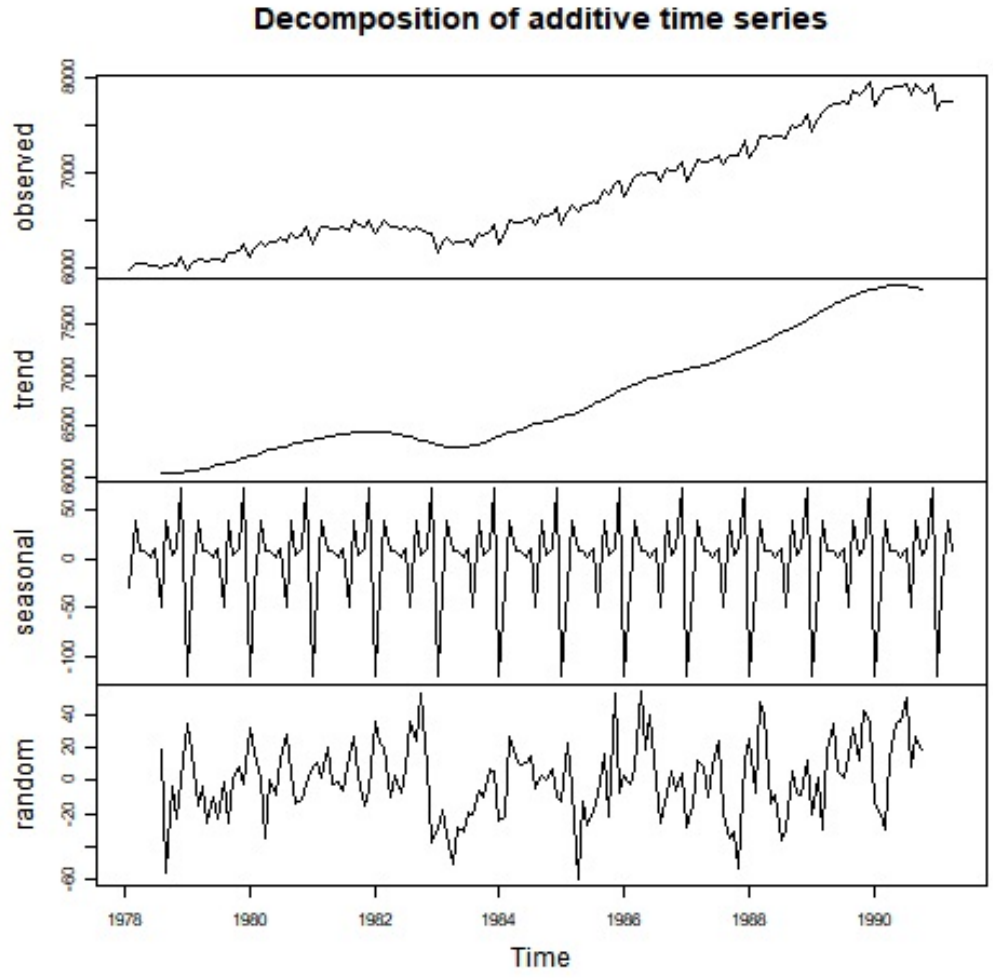


Figure 7: Additive decomposition of Monthly number of employed persons in Australia (in 1000s)

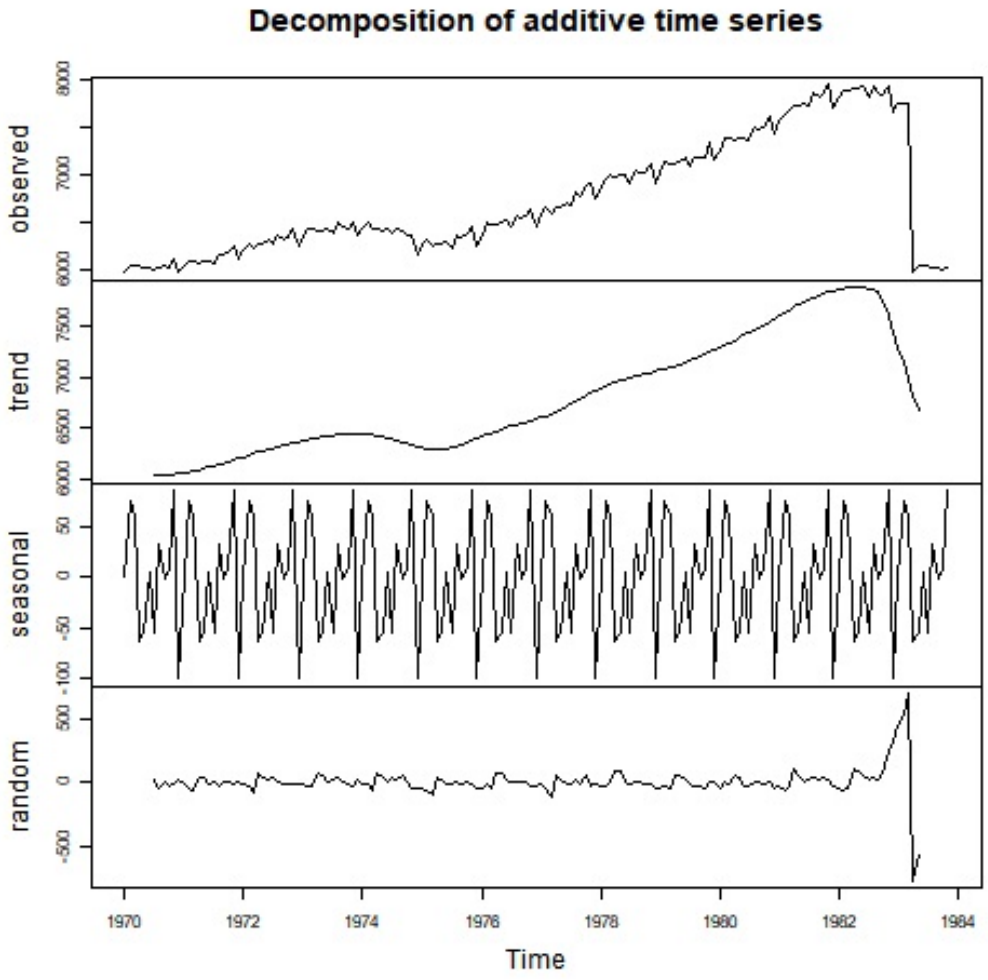


Figure 8: Additive decomposition of Monthly U.S. polio cases

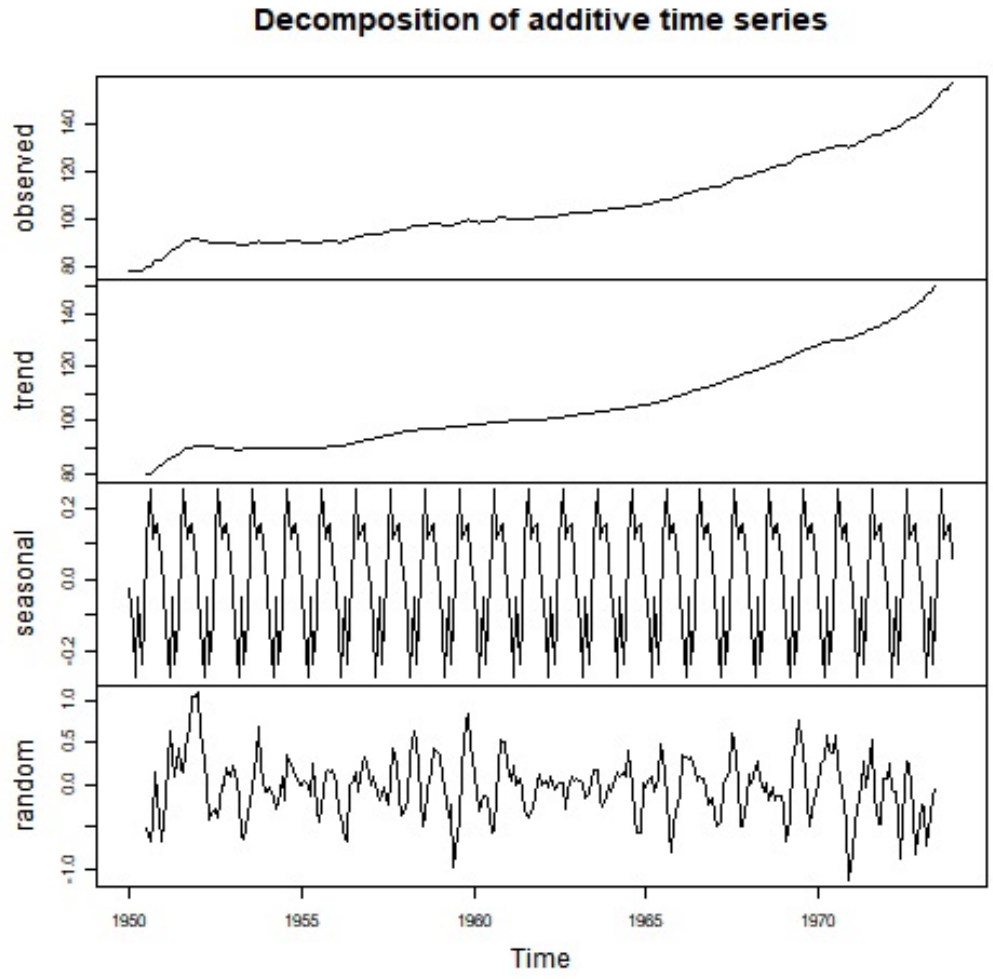


Figure 9: Additive decomposition of Precipitation in mm., Eastport, USA, 1887-1950

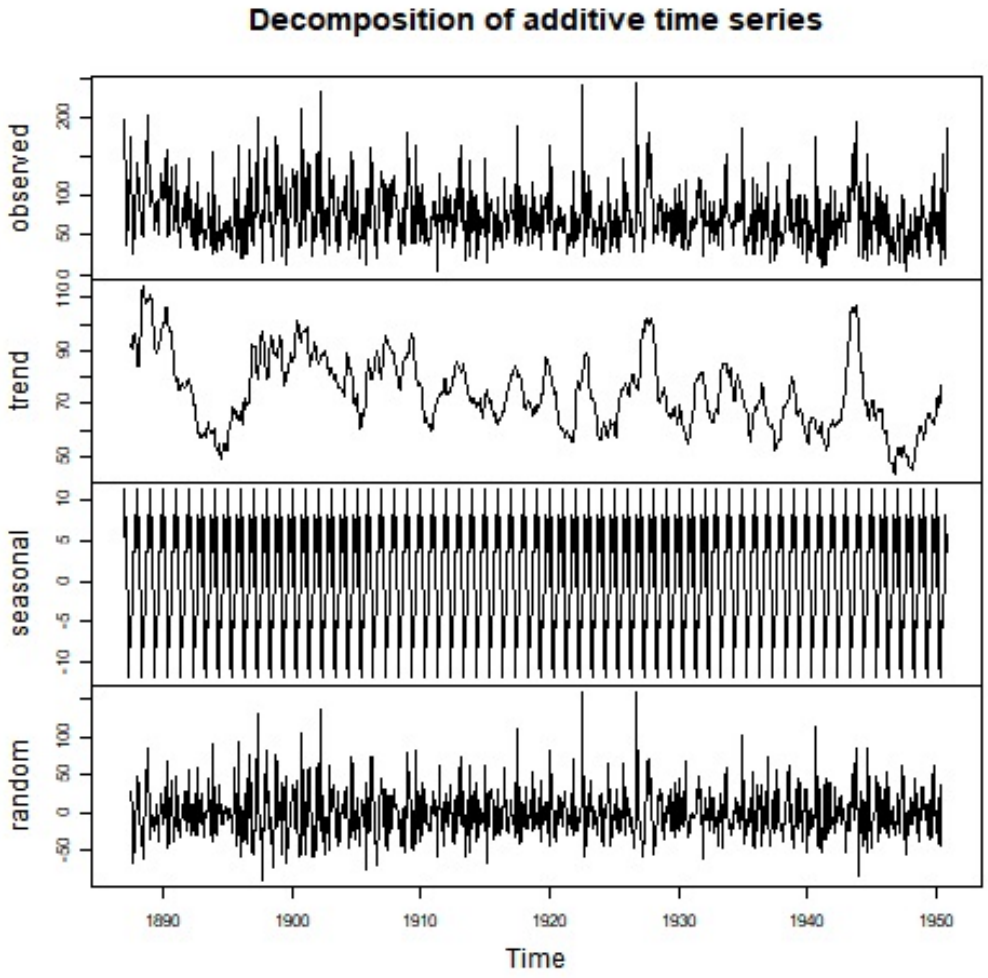


Figure 10: Additive decomposition of The total generation of electricity by the U.S. electric industry

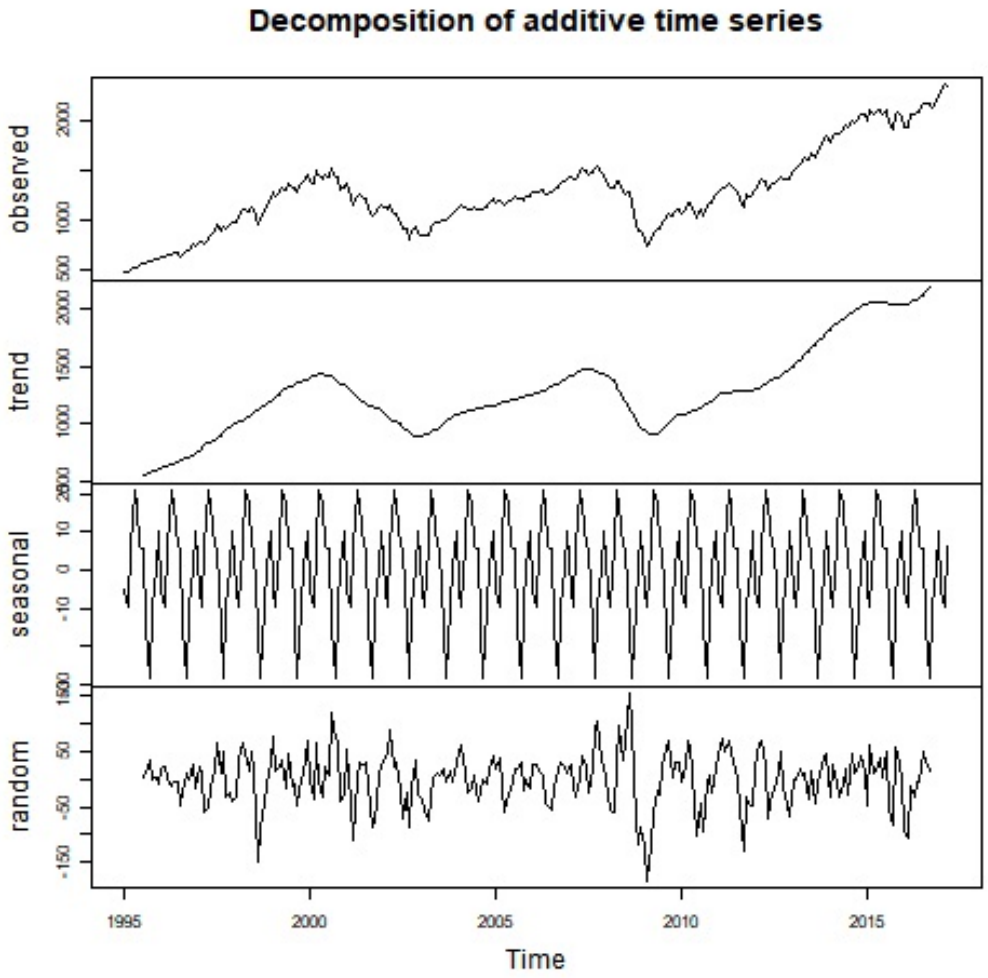


Figure 11: Additive decomposition of Closing Value of Stock

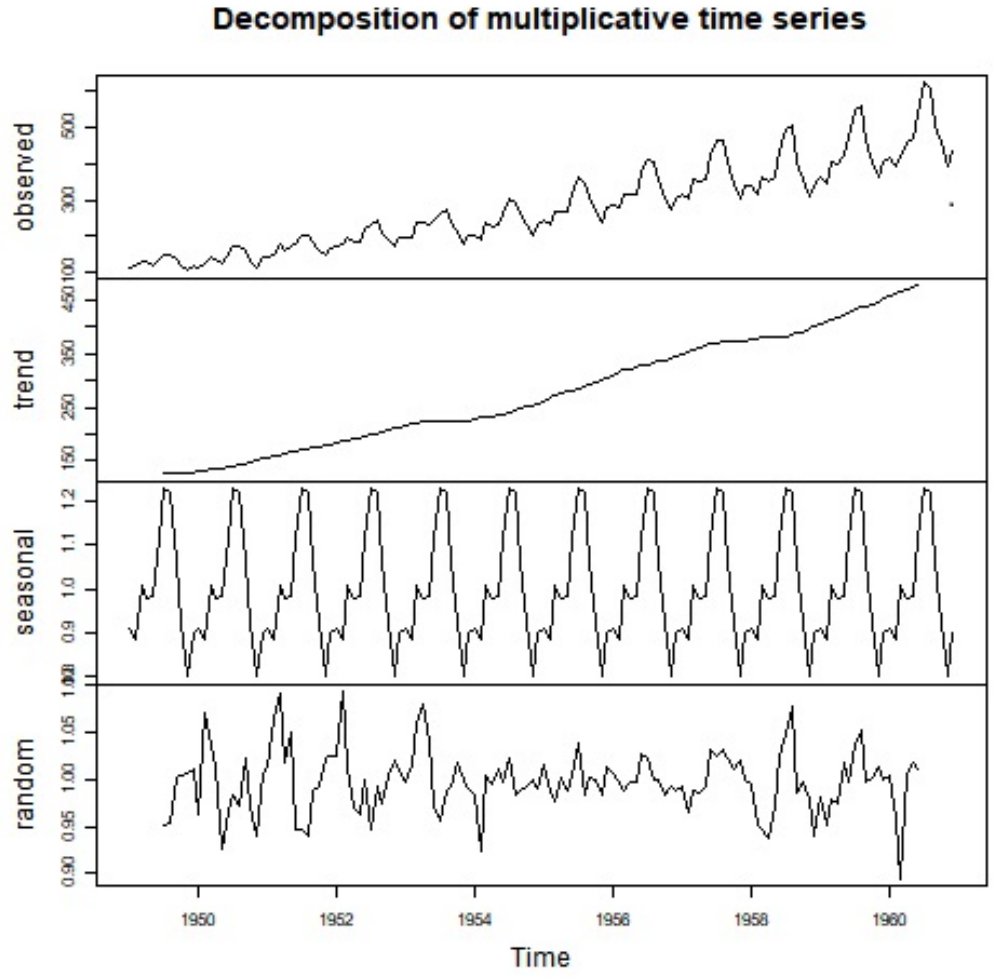
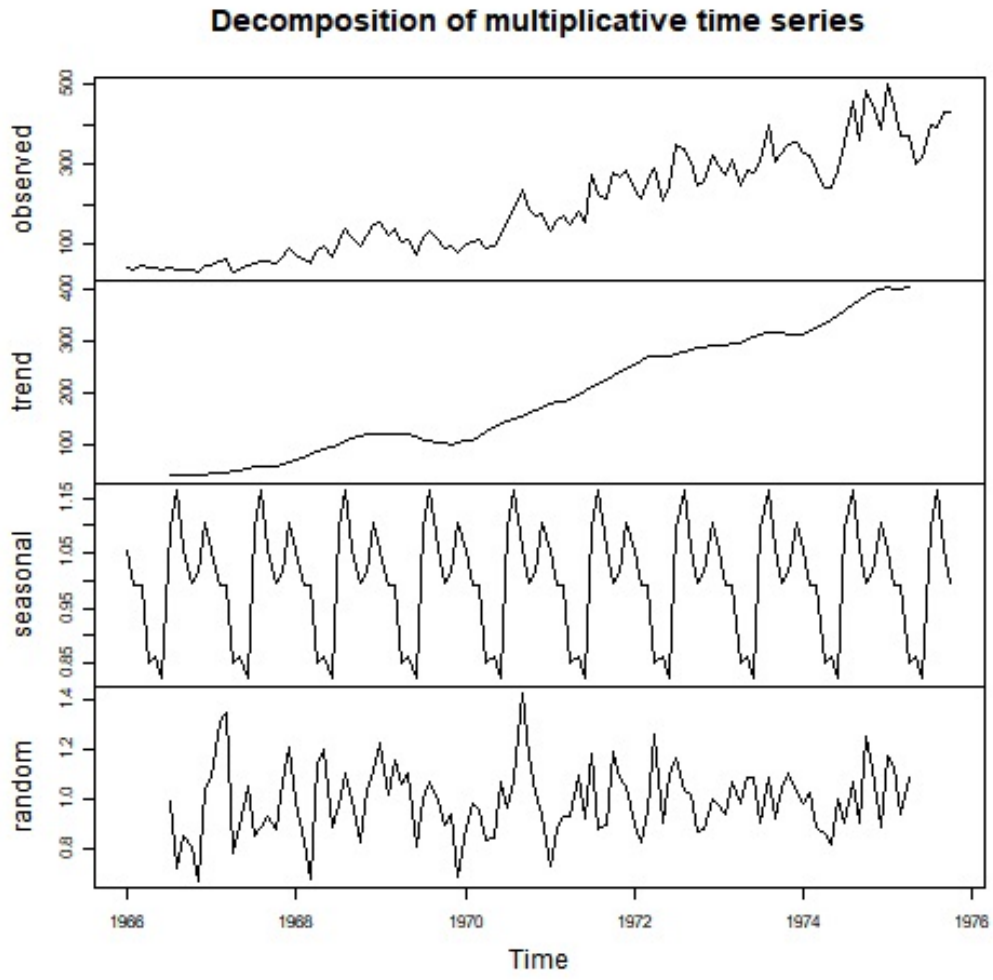


Figure 12: Multiplicative decomposition of International airline passengers monthly totals (in 1000s)



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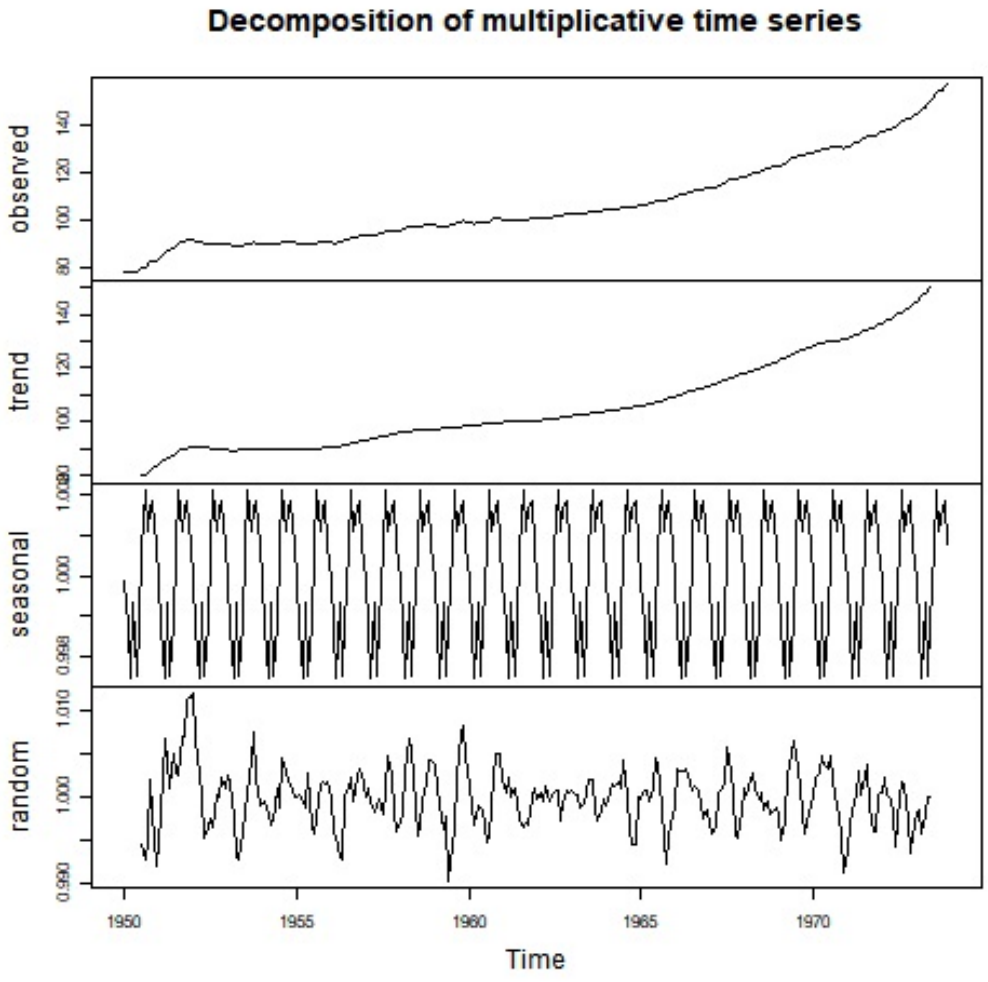
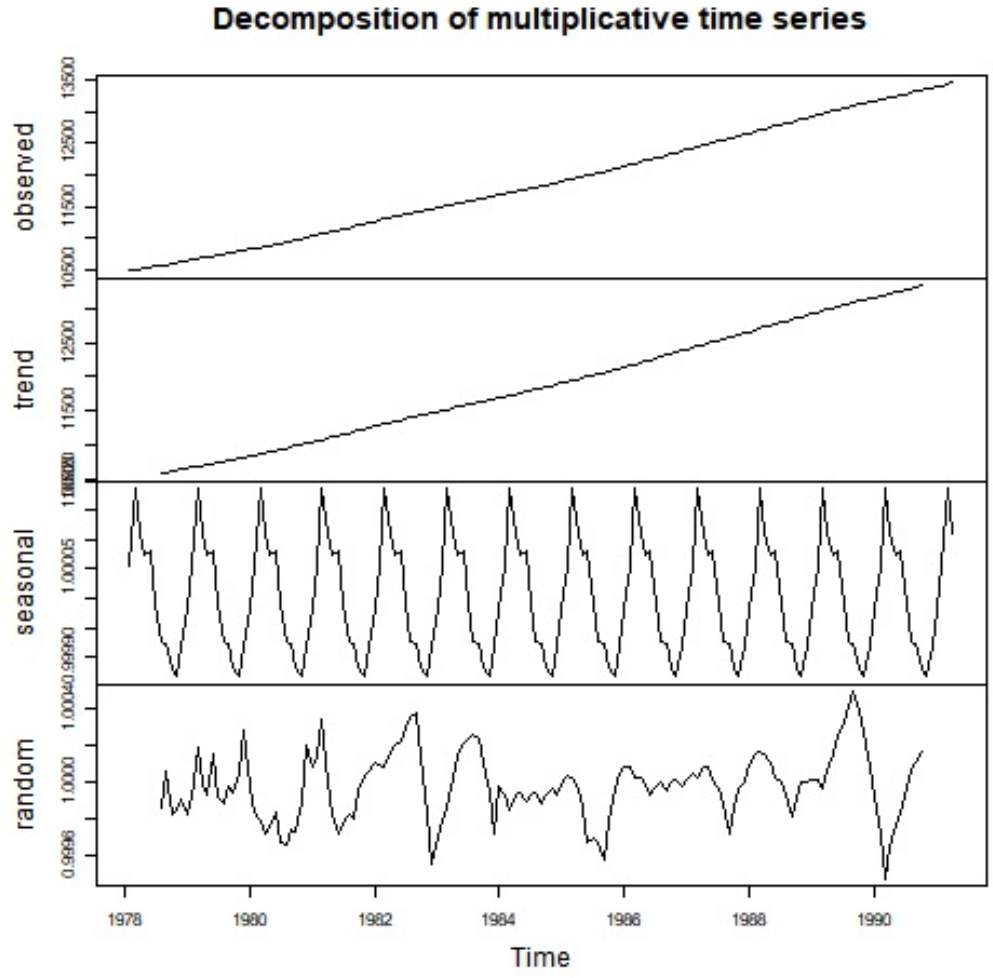


Figure 14: Multiplicative decomposition of CPI data, Canada



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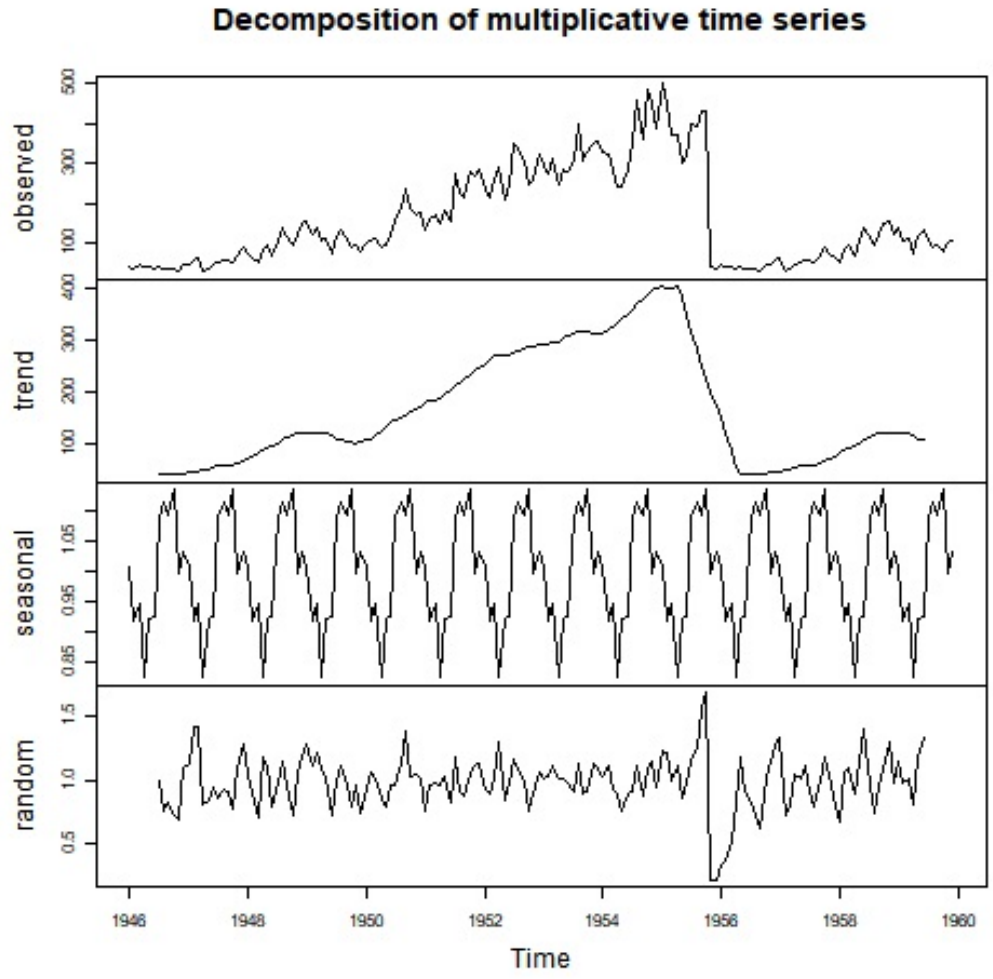

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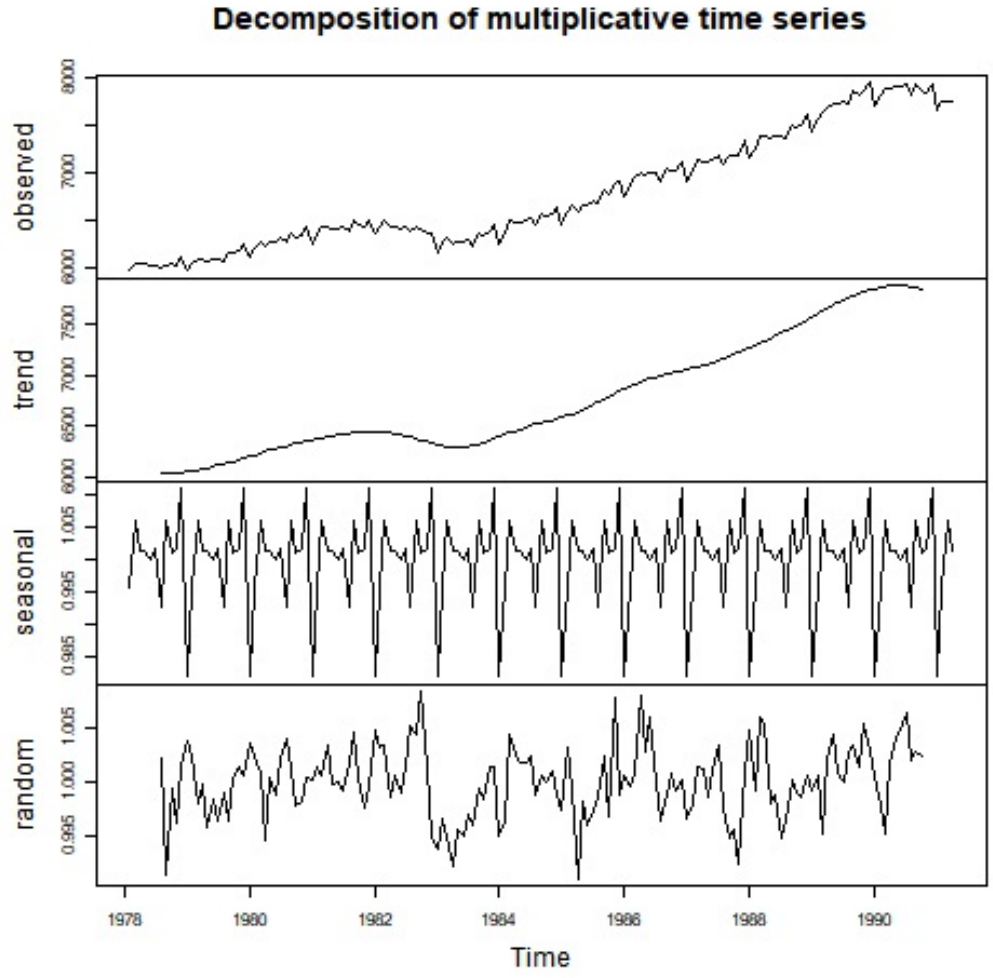

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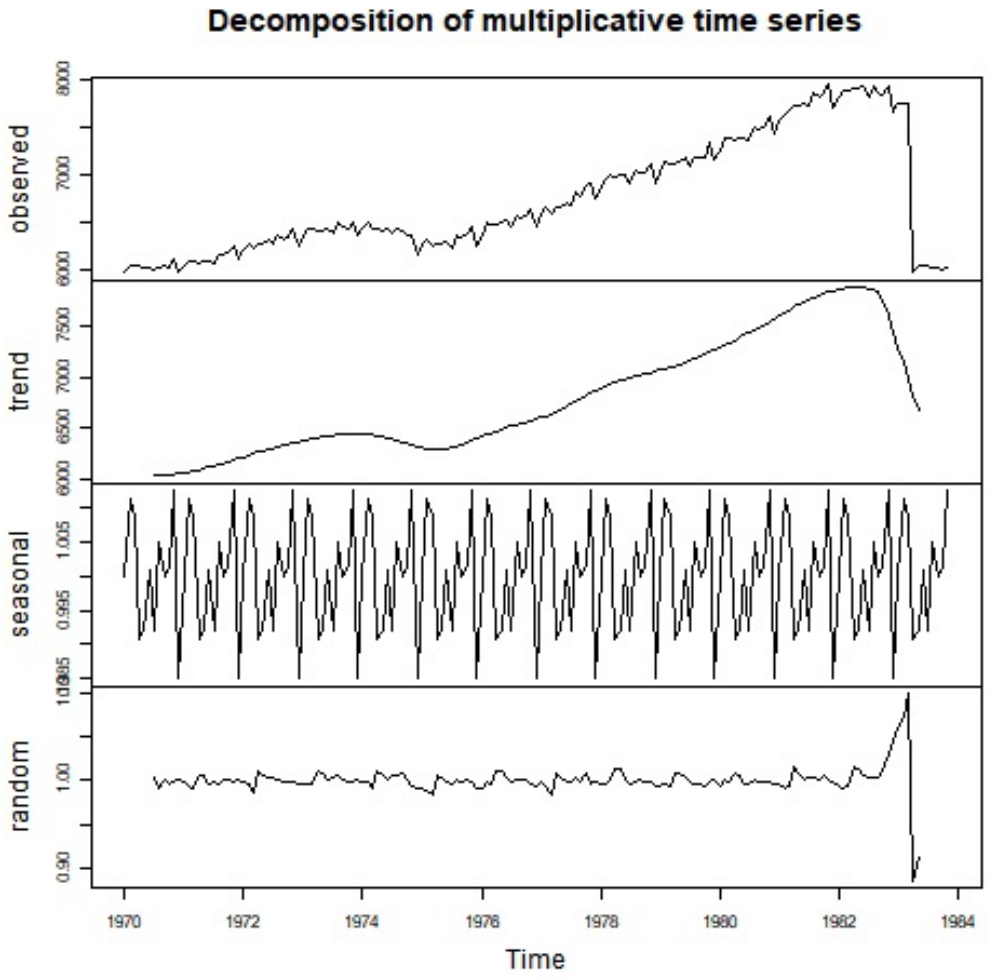

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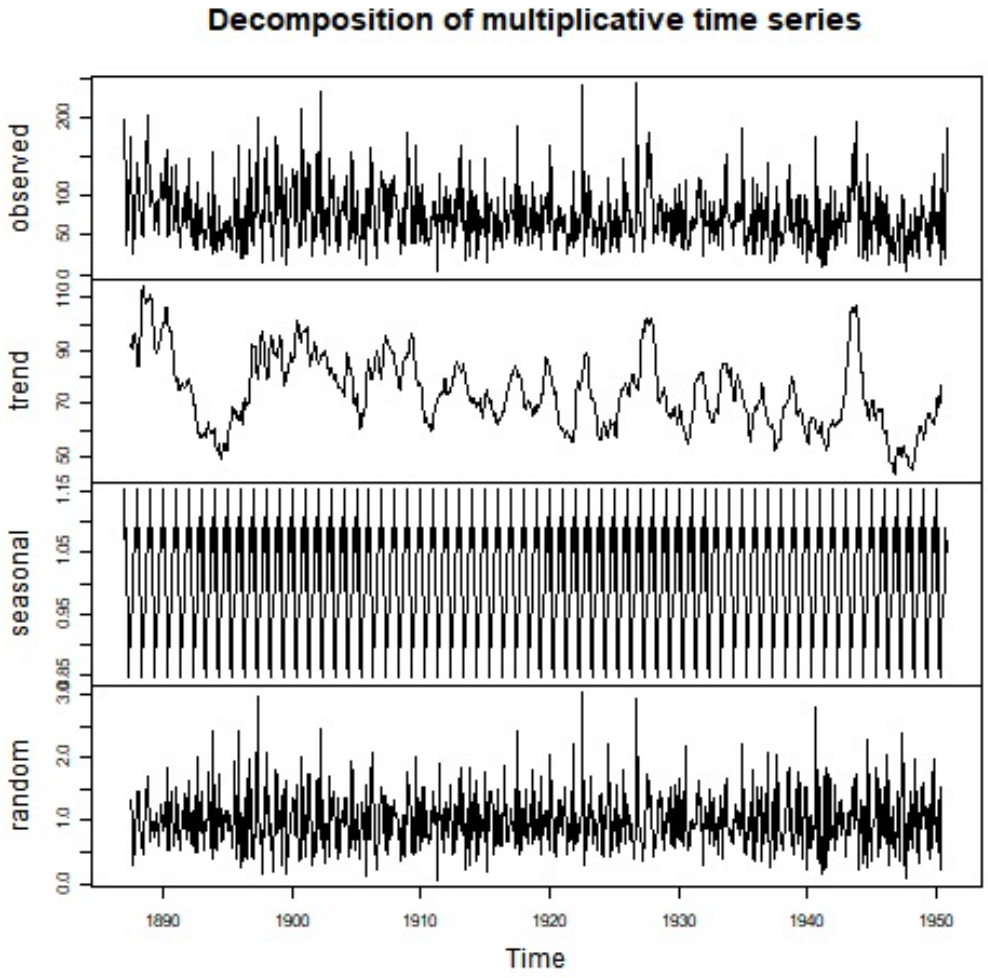

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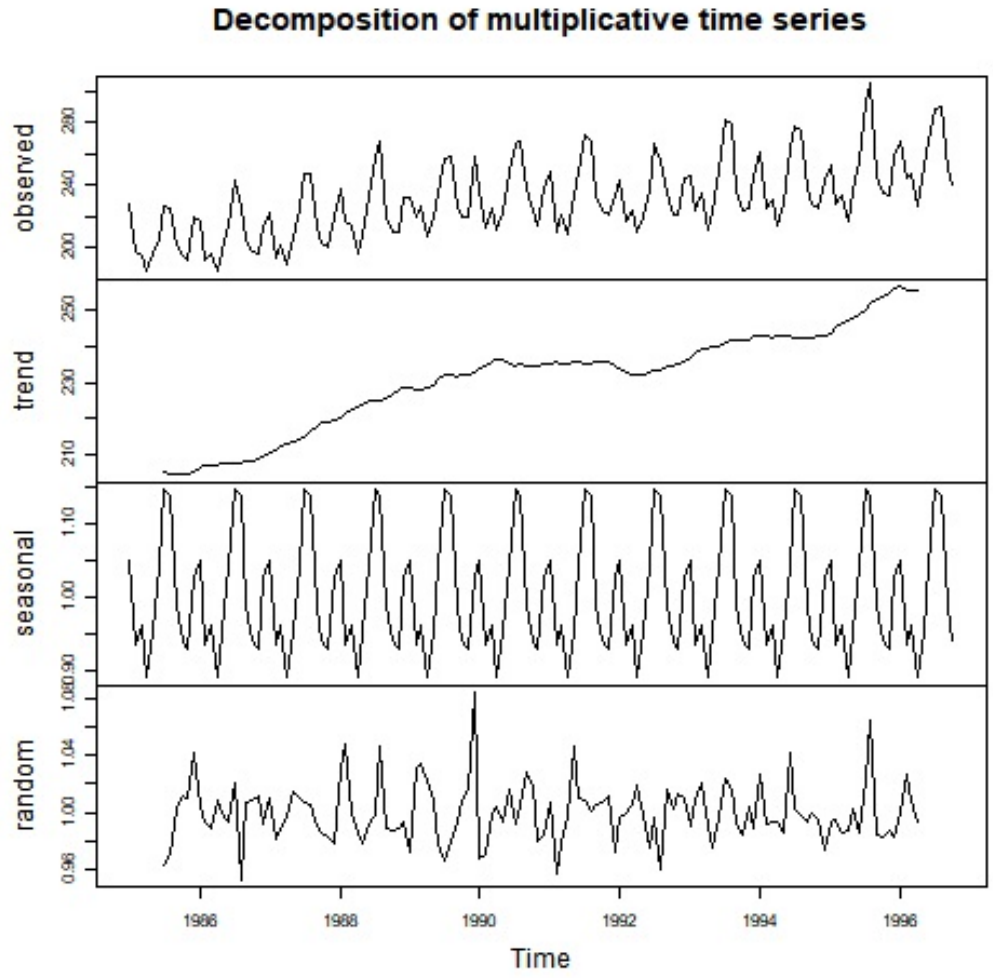

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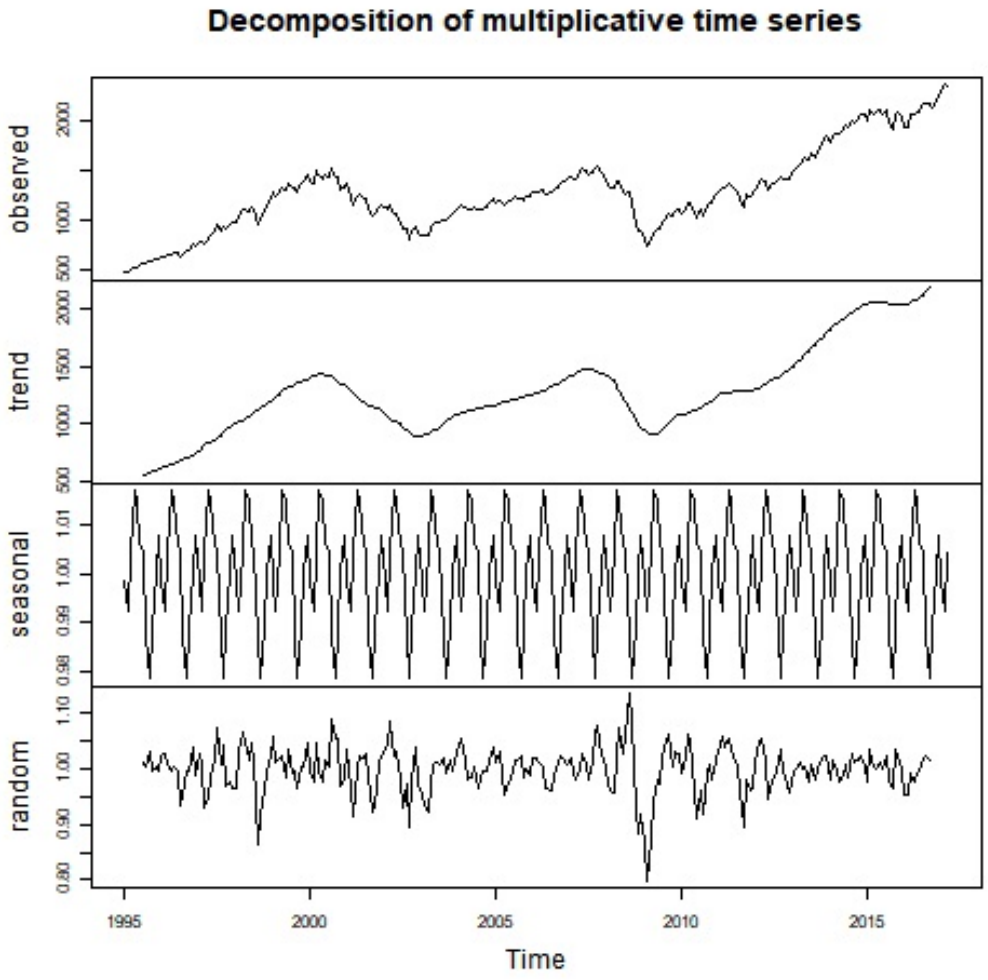

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