AAEC 4984/5984 – Applied Economic Forecasting

Master Key

Homework #1 – Spring 2020

The purpose of this assignment is to enhance your understanding of time series graphics and data pattern. It is intended to be rather straightforward and simple.

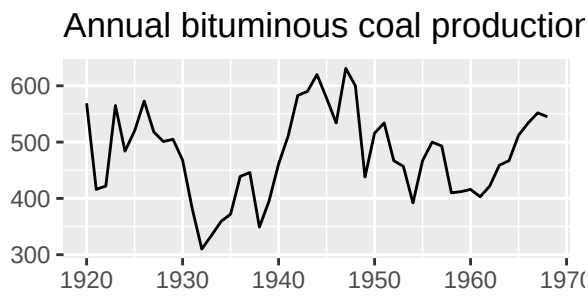
Instructions: In all cases, please ensure that your graphs and visuals have properly titles and axes labels, where necessary. Recall that you can use `help()` to find out about the data in each series. For your convenience, I have posted my R markdown file on our course website so that you can open and alter as you see fit. Refer to the output, whenever appropriate, when discussing the results

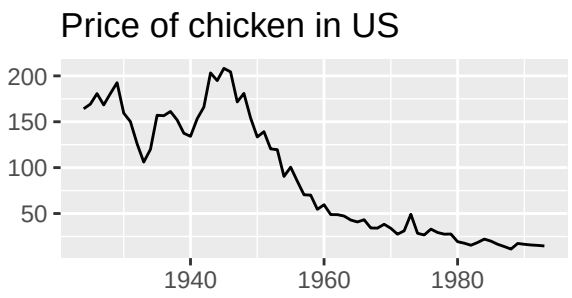
Question 1: Visualizing Time Series Data

Create time plots of the following time series: `bicoal`, `chicken`, `dole`, `usdeaths`, `lynx`, `goog`, `writing`, `fancy`, `a10`, `h02`.

- To allow multiple graphs on your page, please arrange your plots as grids. Below, I have provided the base code to achieve this (Note: you will need to install the `gridExtra` package before calling the `grid.arrange` command):

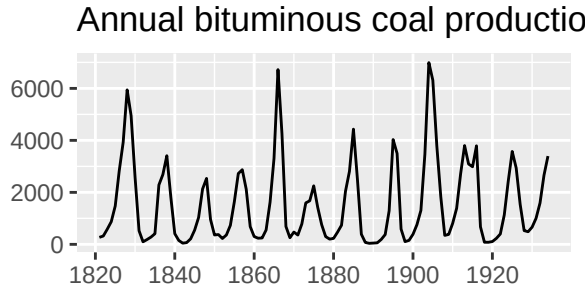
```
# Please feel free to edit accordingly!
g1 <- autoplot(bicoal) + ggtitle("Annual bituminous coal production") + labs(x = "",
    y = "  ")
g2 <- autoplot(chicken) + ggtitle("Price of chicken in US ") + labs(x = "", y = "  ")
g3 <- autoplot(dole) + ggtitle("Monthly total of people on unemployment benefits in Australia") +
    labs(x = "", y = "  ")
g4 <- autoplot(usdeaths) + ggtitle("Monthly accidental deaths in USA") + labs(x = "",
    y = "  ")
g5 <- autoplot(lynx) + ggtitle("Annual bituminous coal production") + labs(x = "",
    y = "  ")
g6 <- autoplot(goog) + ggtitle("Daily closing stock prices of Google") + labs(x = "",
    y = "  ")
g7 <- autoplot(writing) + ggtitle("Sales for printing and writing paper") + labs(x = "",
    y = "  ")
g8 <- autoplot(fancy) + ggtitle("Monthly sales for a souvenir shop") + labs(x = "",
    y = "  ")
g9 <- autoplot(a10) + ggtitle("Monthly anti-diabetic drug sales in Australia") +
    labs(x = "", y = "  ")
g10 <- autoplot(h02) + ggtitle("Monthly corticosteroid drug sales") + labs(x = "",
    y = "  ")

gridExtra::grid.arrange(g1, g2, g3, g4, g5, g6, g7, g8, g9, g10, nrow = 5, ncol = 2,
    newpage = TRUE)
```

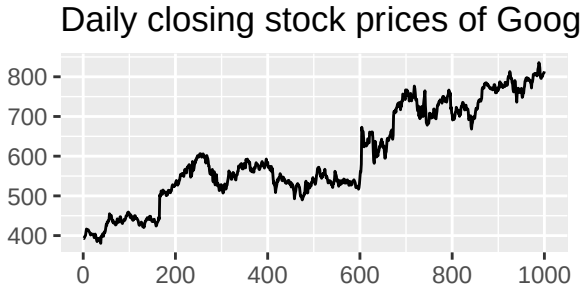

Annual bituminous coal productior
600
500
400
300
1920
1930
1940
1950
1960

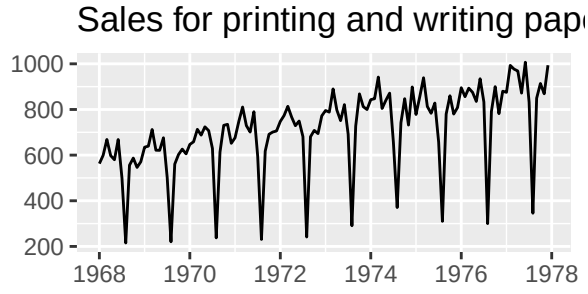

Price of chicken in US
200
150
100
50
1940
1960
1980


Monthly total of people on unen
750000
500000
250000
0
1960
1970
1980
1990

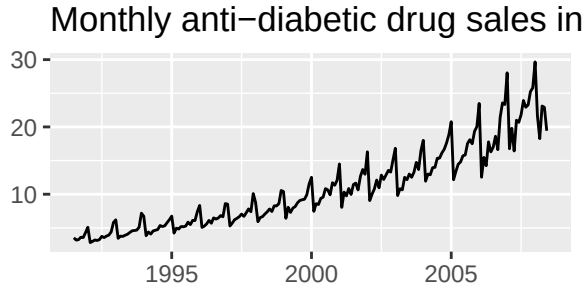

Monthly accidental deaths in US
11000
10000
9000
8000
7000
1974
1976
1978

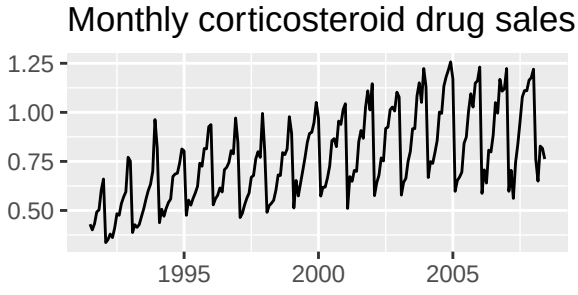

Annual bituminous coal productio
6000
4000
2000
0
1820
1840
1860
1880
1900
1920


Daily closing stock prices of Goog
800
700
600
500
400
0
200
400
600
800
1000


Sales for printing and writing pap
1000
800
600
400
200
1968
1970
1972
1974
1976
1978


Monthly sales for a souvenir sh
100000
75000
50000
25000
0
1988
1990
1992
1994


Monthly anti−diabetic drug sales in
30
20
10
1995
2000
2005


Monthly corticosteroid drug sales
1.25
1.00
0.75
0.50
1995
2000
2005

Question 2: Assessing Seasonality

i. Use the `ggseasonplot()`, `ggsubseriesplot()`, and `ggAcf`[1] functions to explore possible seasonality in the following time series: `writing`, `fancy`, `a10`, `h02`.

```
gg1 <- ggseasonplot(writing) + theme(legend.position = "bottom", legend.text = element_text(size = 6))
gg2 <- ggseasonplot(fancy) + theme(legend.position = "bottom", legend.text = element_text(size = 6))
gg3 <- ggseasonplot(a10) + theme(legend.position = "bottom", legend.text = element_text(size = 6))
gg4 <- ggseasonplot(h02) + theme(legend.position = "bottom", legend.text = element_text(size = 6))
gridExtra::grid.arrange(gg1, gg2, gg3, gg4, nrow = 2, ncol = 2)
```

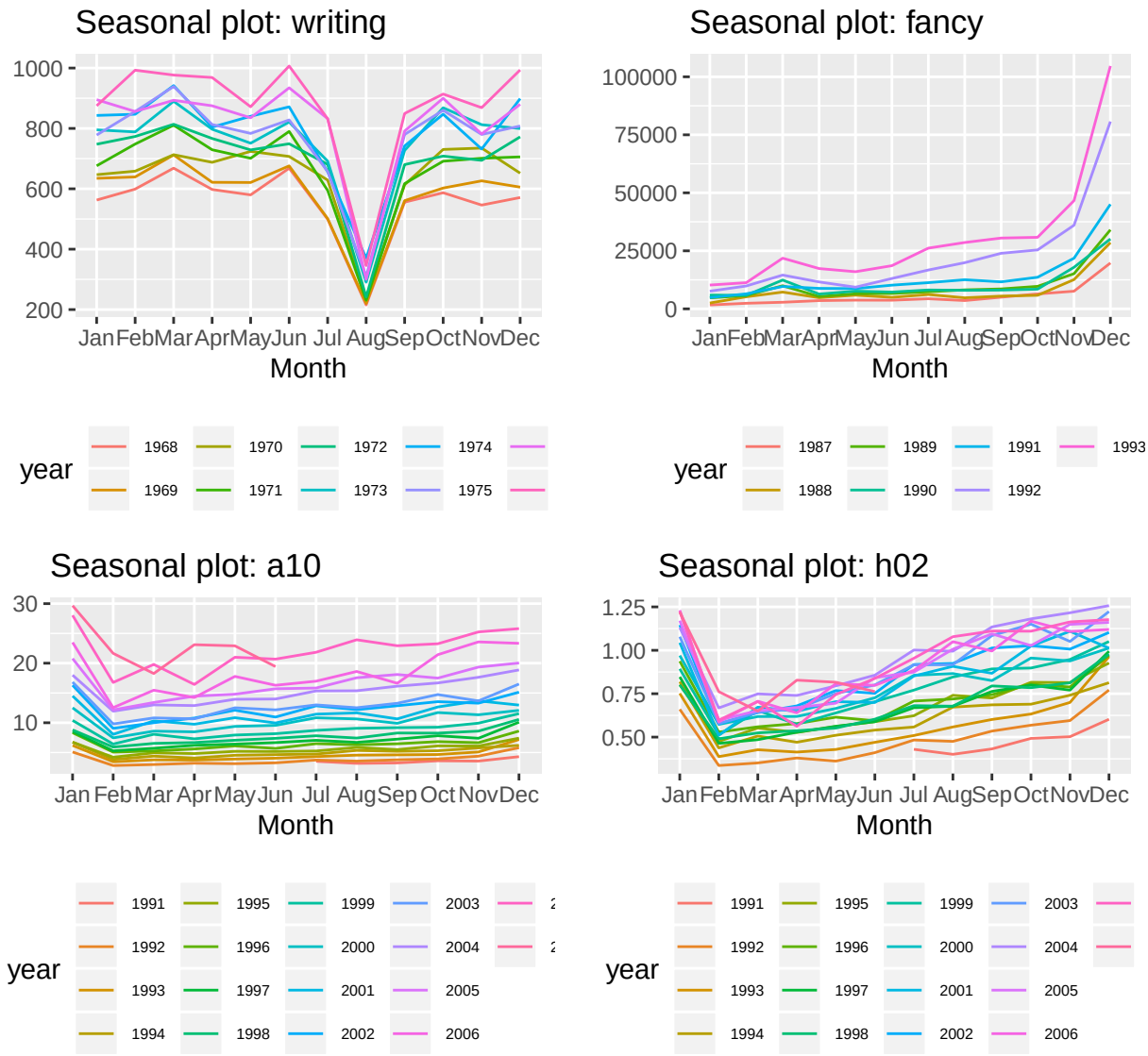


Figure 1: Seasonal plot of selected series

```
gg1 <- ggsubseriesplot(writing)
gg2 <- ggsubseriesplot(fancy)
gg3 <- ggsubseriesplot(a10)
gg4 <- ggsubseriesplot(h02)
gridExtra::grid.arrange(gg1, gg2, gg3, gg4, nrow = 2, ncol = 2)
```

[1] It might be useful to set the max lag in the ACF to 36 so that you can see a fair bit of the patterns in the correlogram.

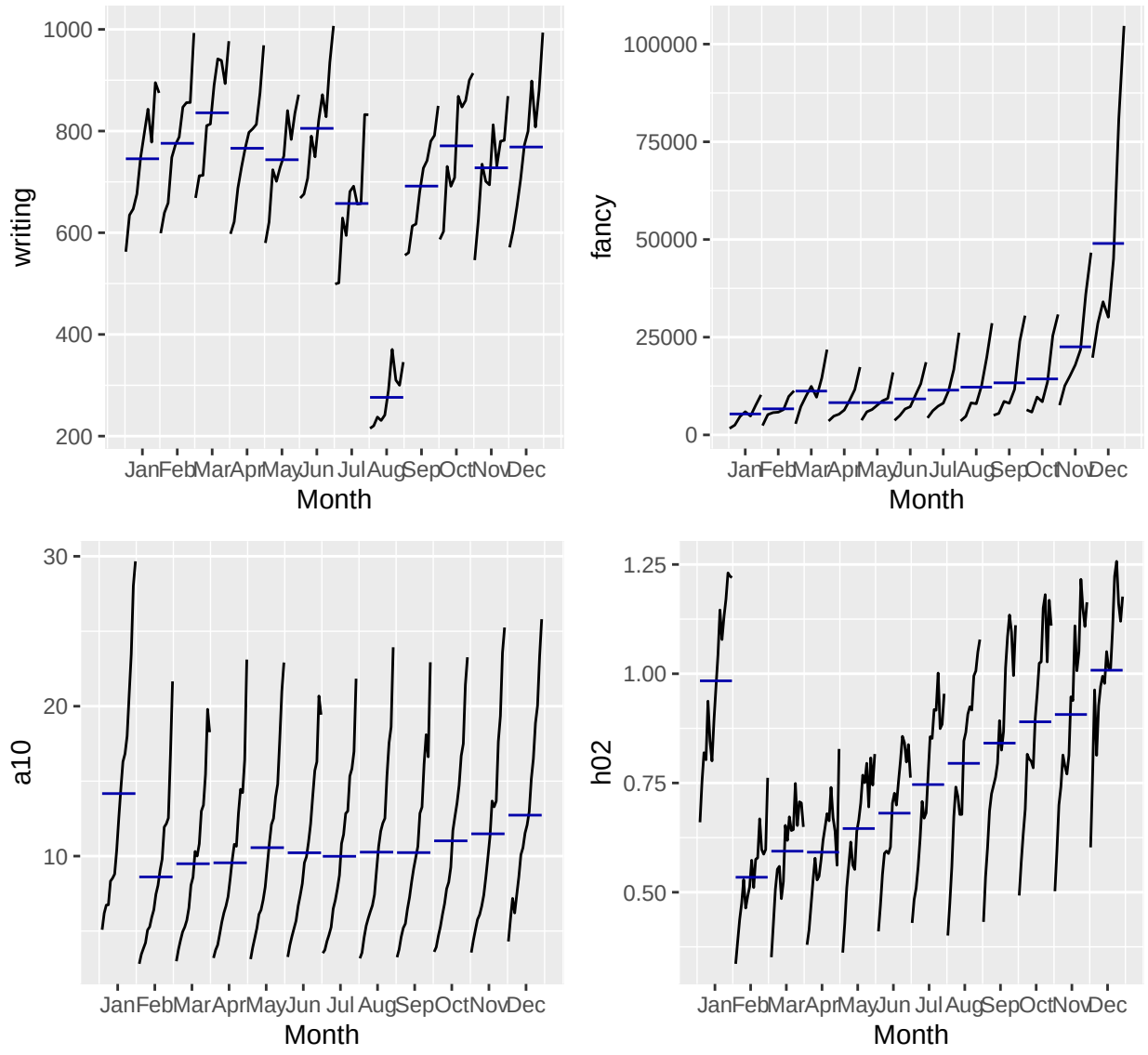


Figure 2: Subseries plot of selected series

```
gg1 <- ggAcf(writing, lag.max = 36)
gg2 <- ggAcf(fancy, lag.max = 36)
gg3 <- ggAcf(a10, lag.max = 36)
gg4 <- ggAcf(h02, lag.max = 36)
gridExtra::grid.arrange(gg1, gg2, gg3, gg4, nrow = 2, ncol = 2)
```

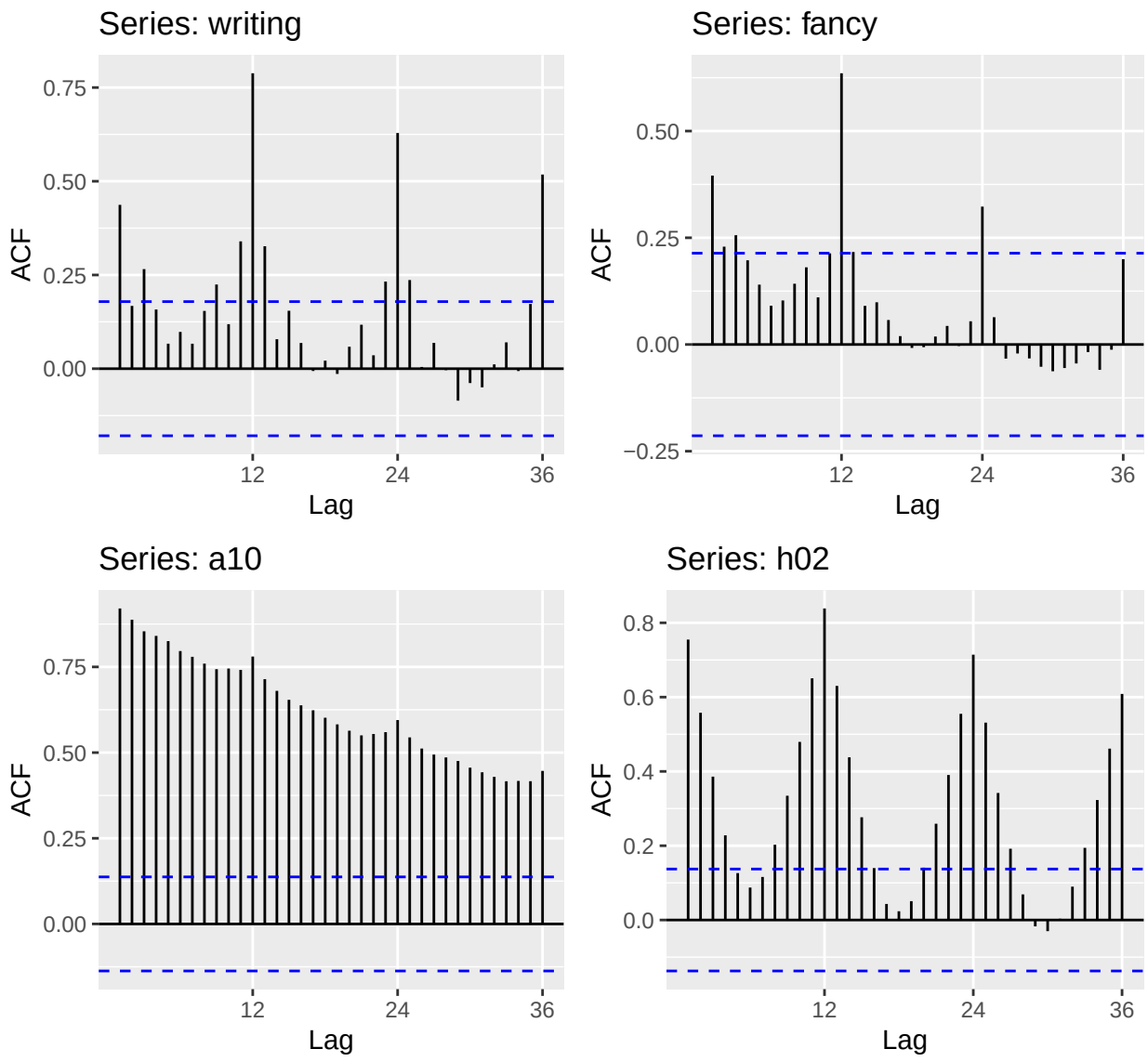


Figure 3: ACF plot of selected series

ii. What can you say about the seasonal patterns?

Answer: From the plots, we notice that there is clear seasonality across all three chart types. In Figure 1, we notice that the month of August is persistently lowest for the writing series. This is confirmed by Figure 2 where the mean for the month of August is lower than all the other months. The `h02` series has a similar pattern for the month of February but trends upwards for all the other months. The ACFs in Figure 3 confirms that there is indeed seasonality at the monthly frequency because there is a spike at the 12th (and multiples of 12) lag in all the data series. Our `a10` series displays a strong trend as well.

iii. Can you identify any unusual years?

Answer: In December, 1992 the monthly sales for a souvenir shop increased dramatically compared to the same month of the last year. We could see this a bit easier if we included the `polar=TRUE` command in the `ggseasonplot`. It is OK if you didn't notice this!

Question 3: White Noise

`dj` contains 292 consecutive trading days of the Dow Jones Index.

i. Plot this series and its ACF. Comment on any pattern noticed in both. Does this series look like white noise?

```
dj1 <- autoplot(dj,col="blue4") + ggtitle("Daily Dow-Jones index") + labs(x="",y="")
dj2 <- ggAcf(dj, col="red") + ggtitle("ACF: Daily Dow-Jones index")

gridExtra::grid.arrange(dj1,dj2)
```

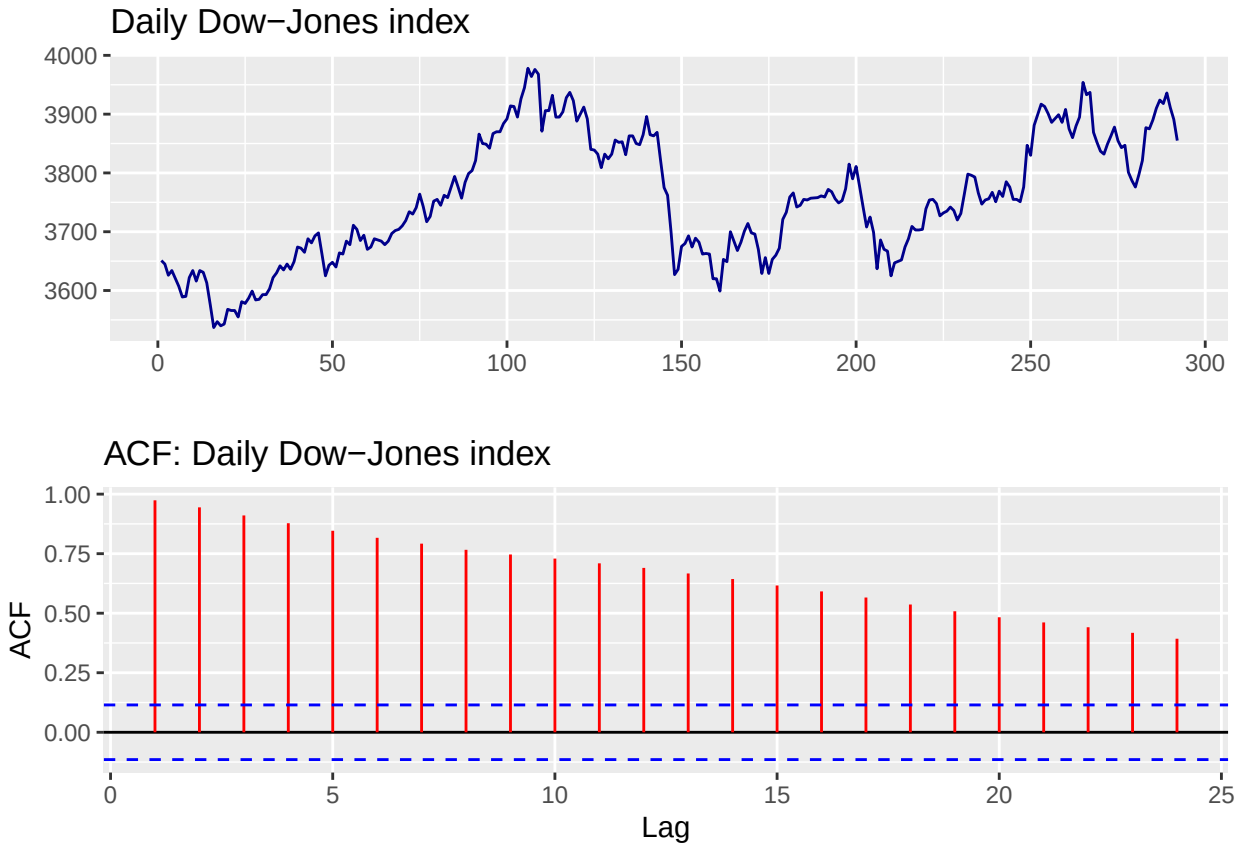


Figure 4: Time Plot & ACF of the Dow-Jones Index

Answer: There is a general upward trend in the Dow-Jones Index (see Figure 4). This is confirmed by the slowly decaying ACF in Figure 4. Clearly, this series is not WN.

ii. Now, use `ddj <- diff(dj)` to compute the daily changes in the index.

```
ddj <- diff(dj)
```

iii. Plot `ddj` and its ACF. Do the changes in the Dow Jones Index look like white noise?

```
ddj1 <- autoplot(ddj,col="blue4") + ggtitle("Differenced Daily Dow-Jones index") + labs(x="",y="")
ddj2 <- ggAcf(ddj, col="red") + ggtitle("ACF: Differenced Daily Dow-Jones index")

gridExtra::grid.arrange(ddj1,ddj2)
```

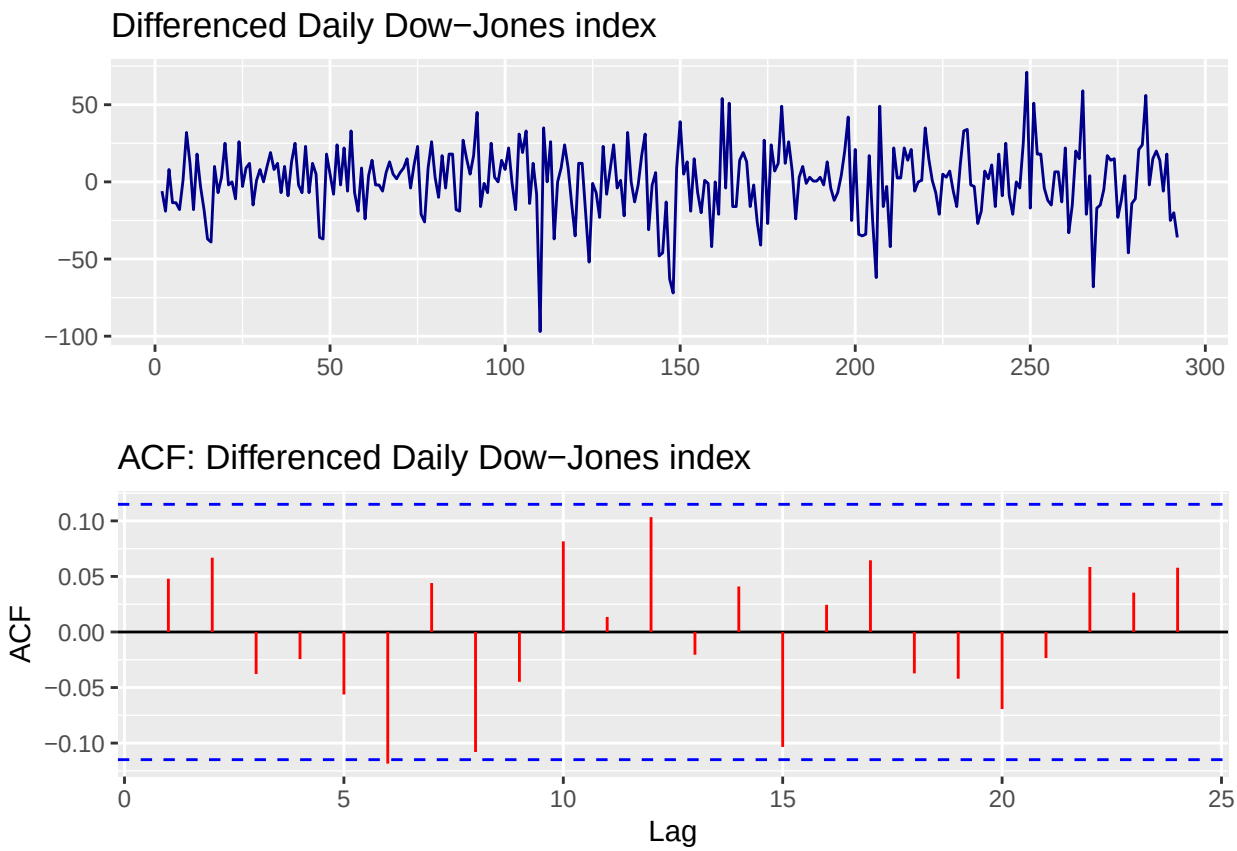


Figure 5: Time Plot & ACF of the Differenced Dow-Jones Index

Answer: Figure 5 indicates that the series can be WN. More than 95% of the autocorrelations lie within the CI.