lab8_DerekSitu

Derek Situ (62222807)

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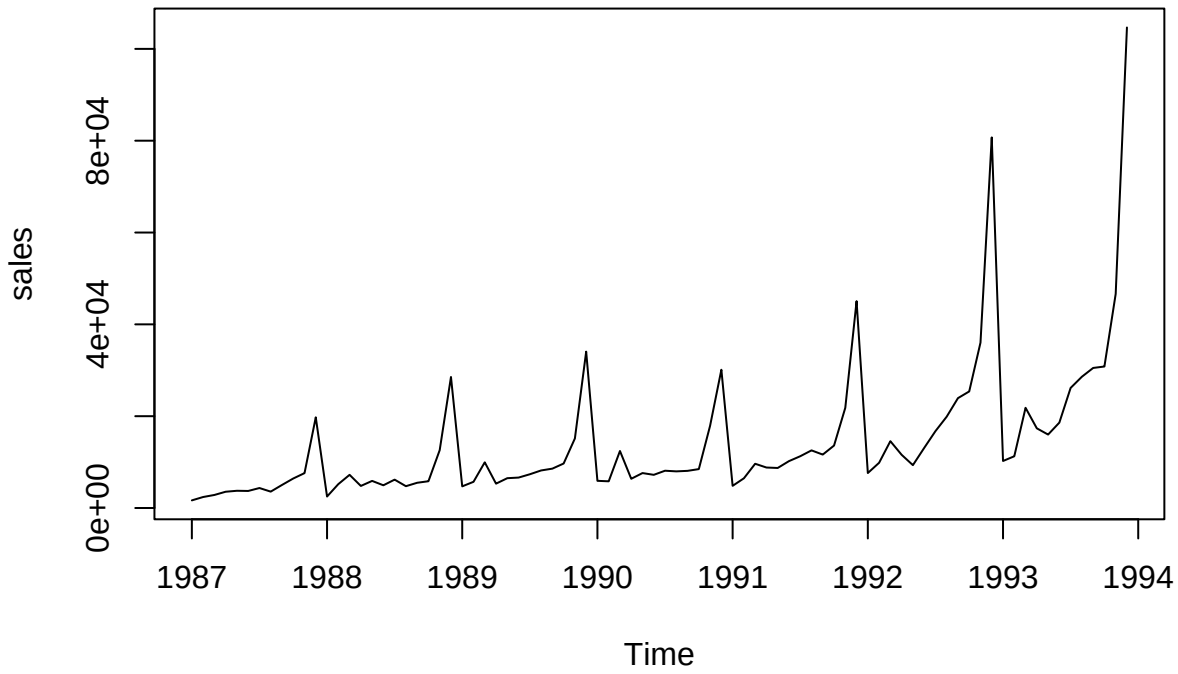
Data

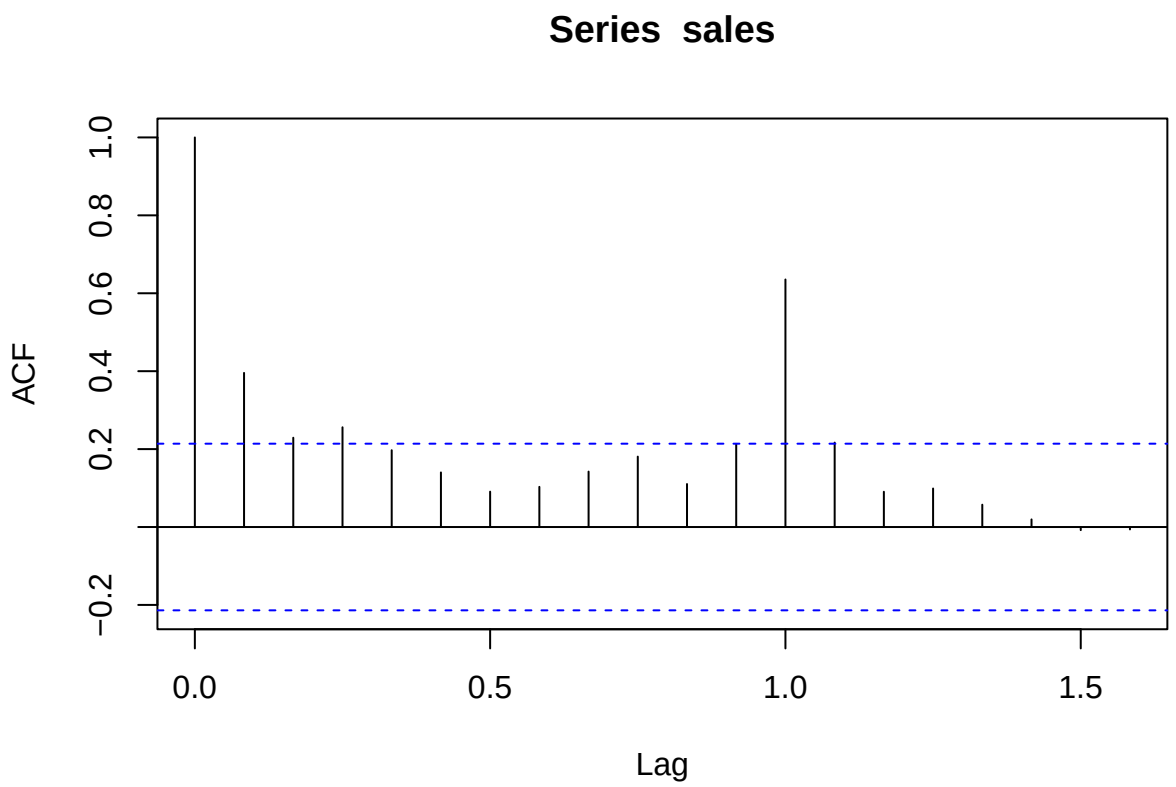
```
dat <- read.delim("souvenir.txt", header = FALSE)
sales <- ts(dat$V1, start = c(1987, 1), frequency = 12)
```

Question 1

```
plot(sales)
```



```
acf(sales)
```



From the plot of the series, we notice a seasonal pattern, and we notice that the variation increases over time. This fits a multiplicative model. The acf also displays the seasonal pattern. There also may be a trend.

Question 2

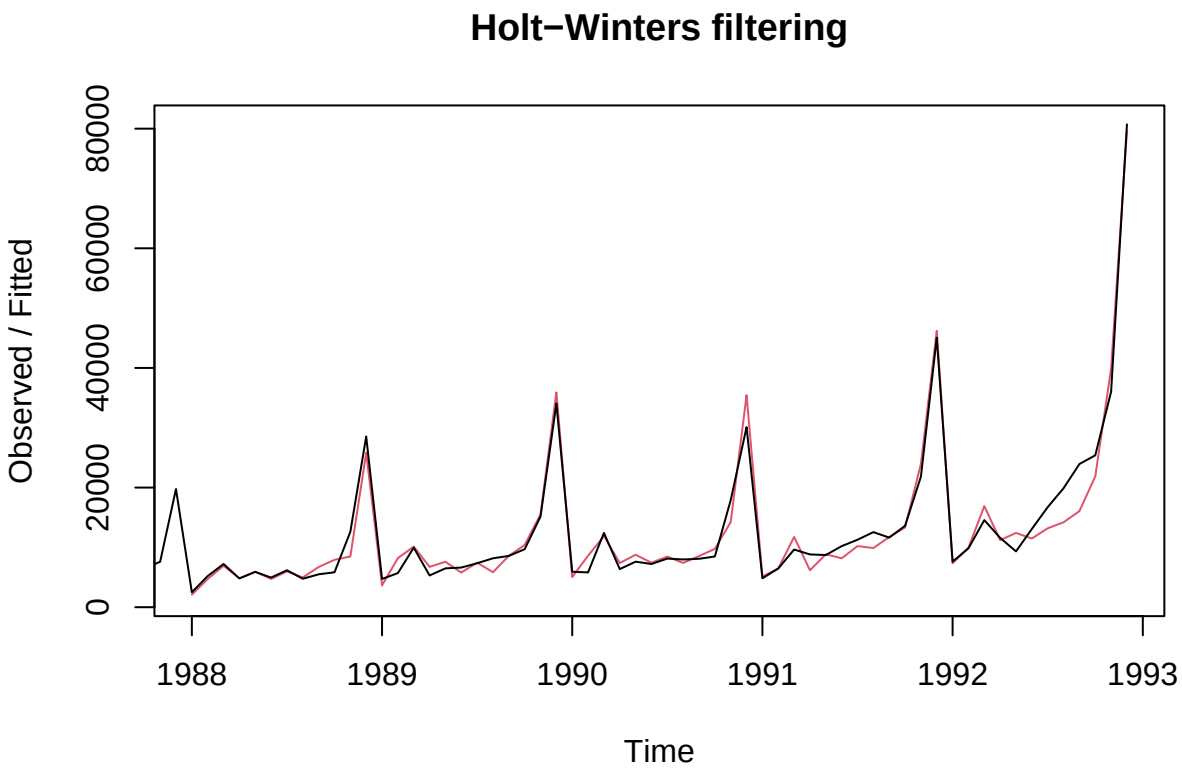
```
training <- window(sales, start = c(1987, 1), end = c(1992, 12))
hw_fit <- HoltWinters(training, seasonal = "multiplicative")

c(hw_fit$alpha, hw_fit$beta, hw_fit$gamma)
```

```
##      alpha       beta      gamma
## 0.34698417 0.07501578 0.57114780
```

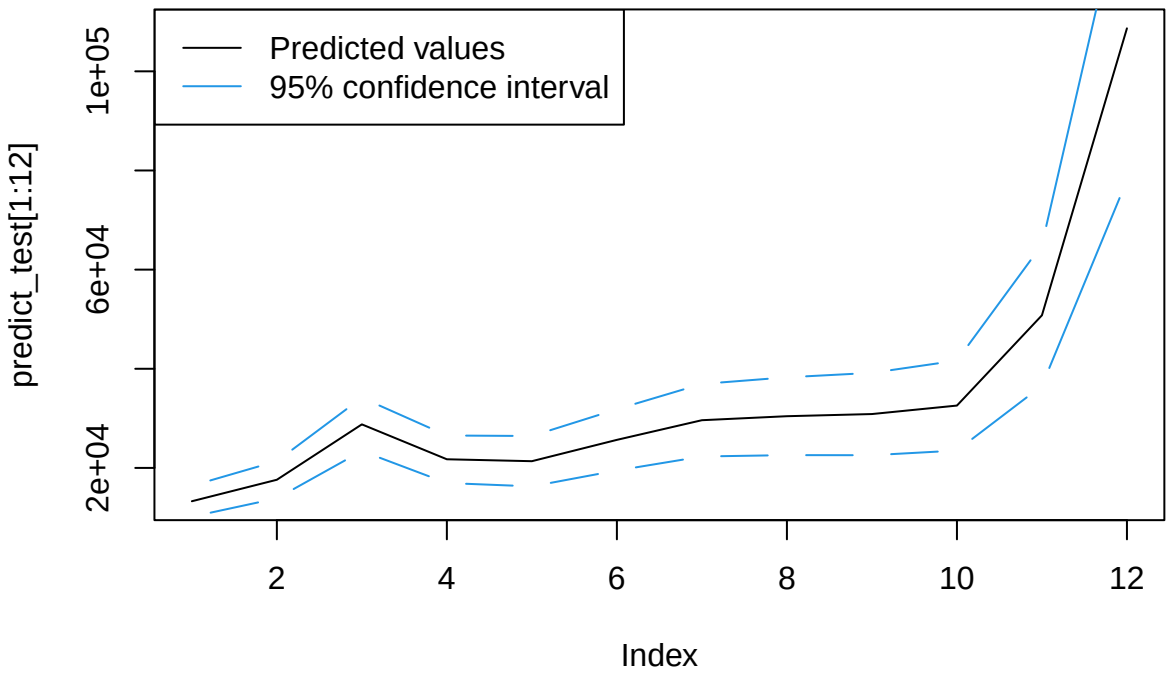
The parameters are $\alpha = 0.347, \beta = 0.075, \gamma = 0.571, p = 12$.

```
plot(hw_fit)
```



Question 3

```
predict_test <- predict(hw_fit, 12, prediction.interval = TRUE, level = 0.95)
plot(predict_test[1:12], type = "l")
lines(predict_test[13:24], type = "c", col = 4) # plot upper bound
lines(predict_test[25:36], type = "c", col = 4) # plot lower bound
legend("topleft", lty = 1, col = c(1, 4),
       legend = c("Predicted values", "95% confidence interval"))
```




```
predict_test[1:3] # predicted values for first 3 months
```

```
## [1] 13277.67 17609.17 28784.94
```

The forecast values for the first 3 months of 1993 are 1.3277667×10^4, 1.7609172×10^4, 2.8784935×10^4.

Question 4

```
data.frame(Observed = sales[73:75], CI_Upper = predict_test[13:15],
           CI_Lower = predict_test[25:27]) |>
             dplyr::mutate(Observed_in_CI =
                      ((Observed > CI_Lower) & (Observed < CI_Upper)))
```

```
##   Observed CI_Upper CI_Lower Observed_in_CI
## 1 10243.24 16397.24 10158.10           TRUE
## 2 11266.88 21360.94 13857.41          FALSE
## 3 21826.84 34162.65 23407.23          FALSE
```

Only the observed value for the first month of 1993 fits inside the 95% confidence interval.

Question 5

I would consider a log transformation since the series seems to be increasing exponentially. One useful property of logs is that the log of a product is the sum of the logs of the factors, so using this property we can change this multiplicative model into an additive model.