Homework 5

Tadesse Zemicheal

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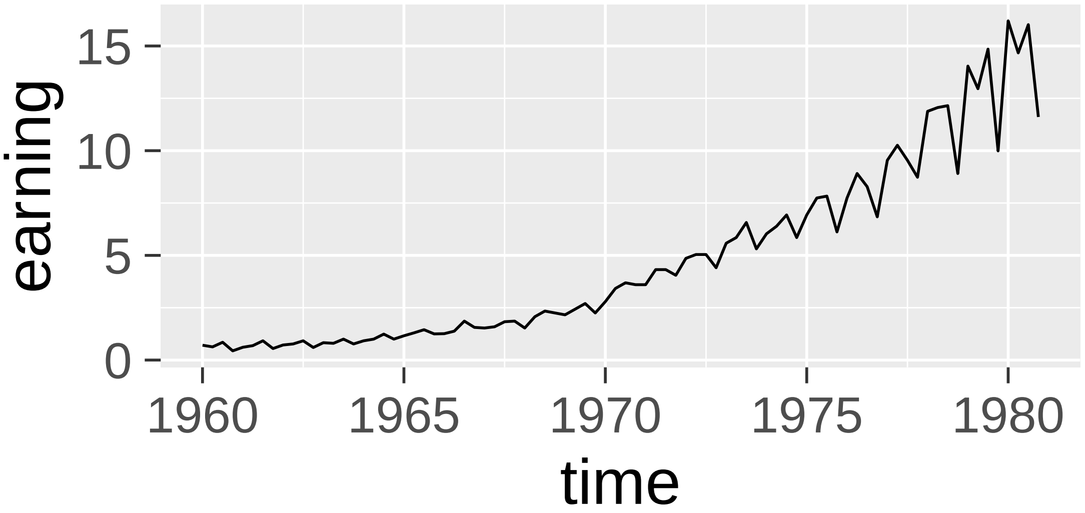
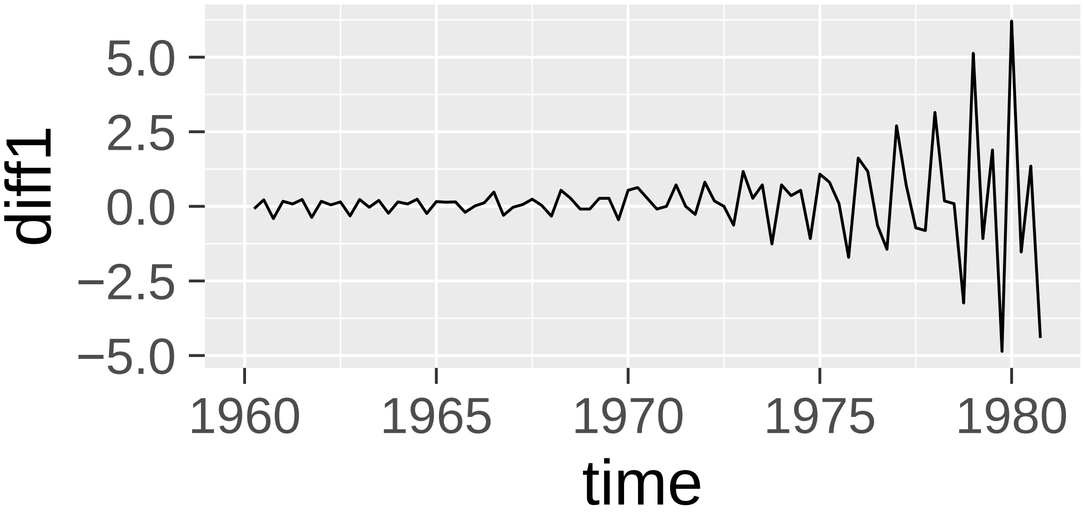
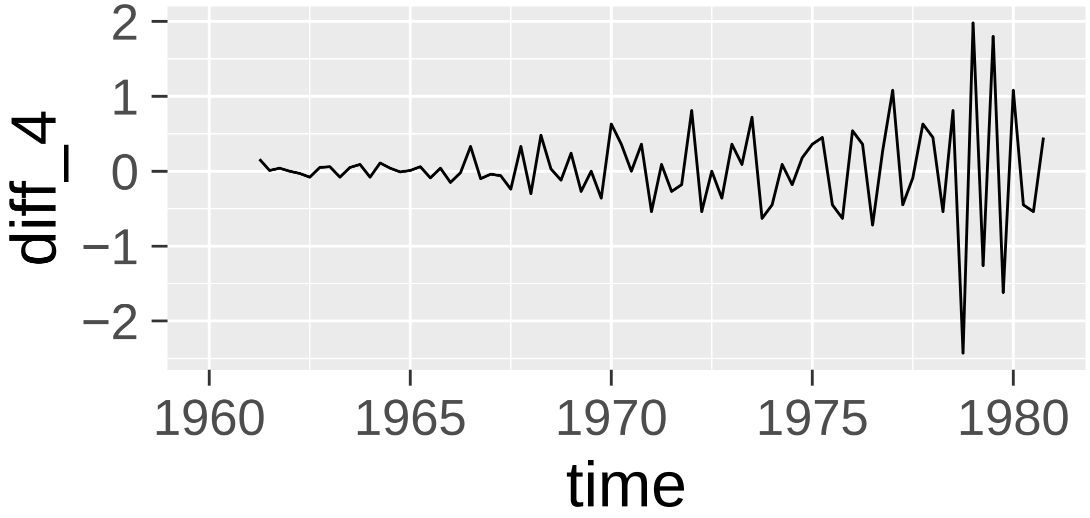
Fit a seasonal ARIMA model to the Johnson and Johnson quarterly returns





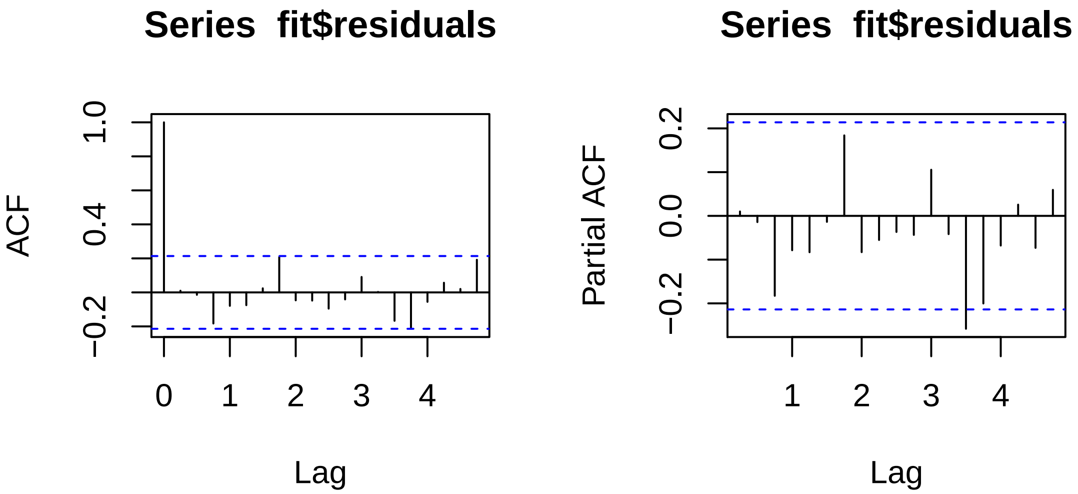


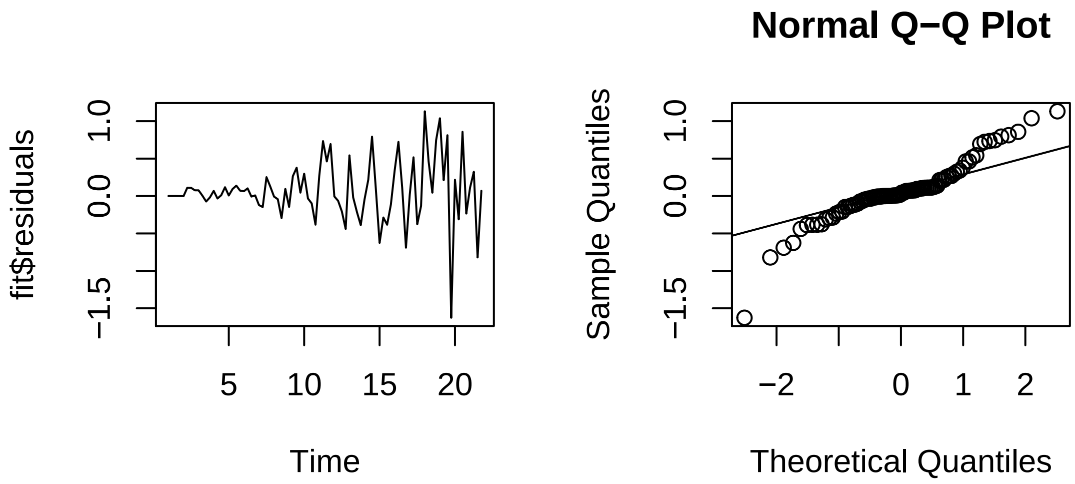
###

Fit model

Result from auto.arima shows ARIM(1,1,2)(0,1,0)$_4$ fits the model best. The diagnosis for the model can be shown as.

Diagnosis





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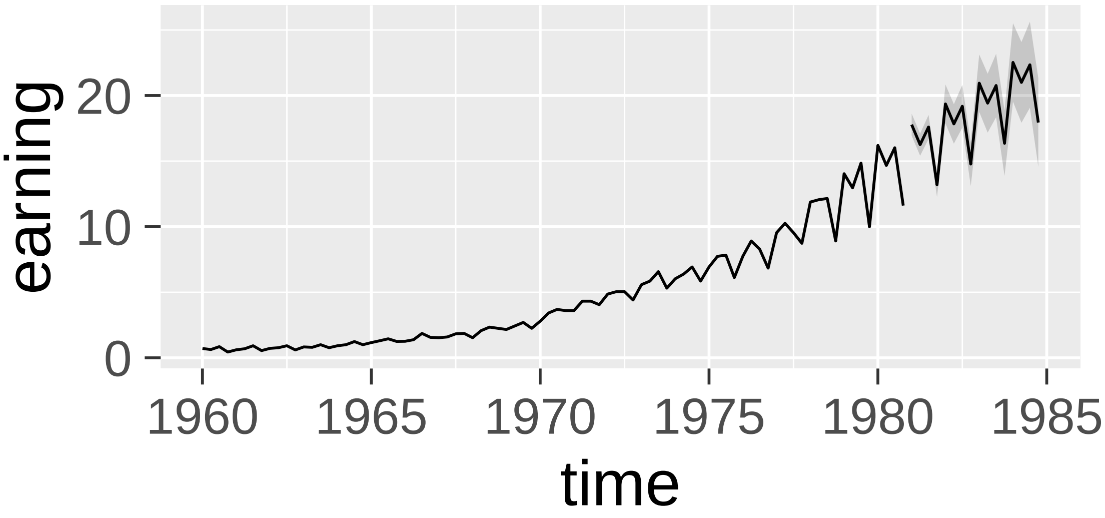


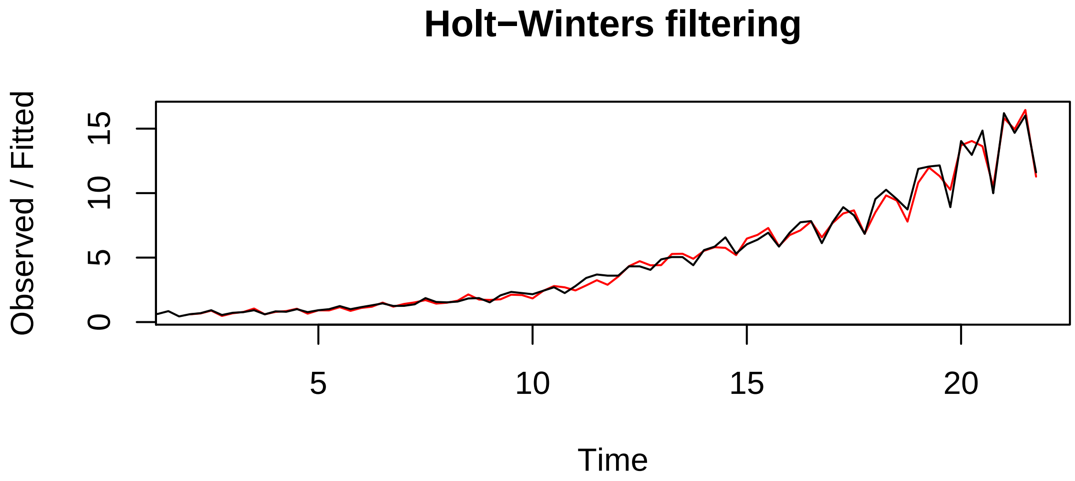
Forecat
2 The Holt Winters Method

What decisions need to be made to use a Holt Winters forecasting approach? What starting values do you need to specify? What parameters need estimating?

- If the data has trend an seasonality, we use Holdt Winters method instead of simple exponential smoothing method.
- Examine a graph of the data to check whether additive or multiplicative appropriate
- Provide starting value for L_1 and T_1 as well as seasonal value for the first years, using few observations in the series.
- Estimate value of parameters α, γ , σ by minimizing the squared error $\sum e_t^2$ for the fitted value
- Decide whether to normalize the seasonal indices at regular intervals.
- Choose an automatic or non automatic approach

The starting value that need to be specified are L_1, T_1 and seasonal values for the first years. Then α, γ , σ are estimated by minimizing squared error $\sum e_t^2$. ### Investigate the R function HoltWinters. How do you specify the decisions from above? How does the function choose starting values and estimate parameters? The R package for Holt-Winter is

Based from the R-package documentation the function choose starting values as follows. For seasonal models, start values for a, b and s are inferred by performing a simple decomposition in trend and seasonal component using moving averages (see function decompose) on the start.periods first periods (a simple linear regression on the trend component is used for starting level and trend). For level/trend-models (no seasonal component), start values for a and b are x[2] and x[2] - x[1], respectively. For level-only models (ordinary exponential smoothing), the start value for a is x[1]. ### Use the function to produce forecasts (along with prediction intervals) for Johnson and Johnson returns in question 1.



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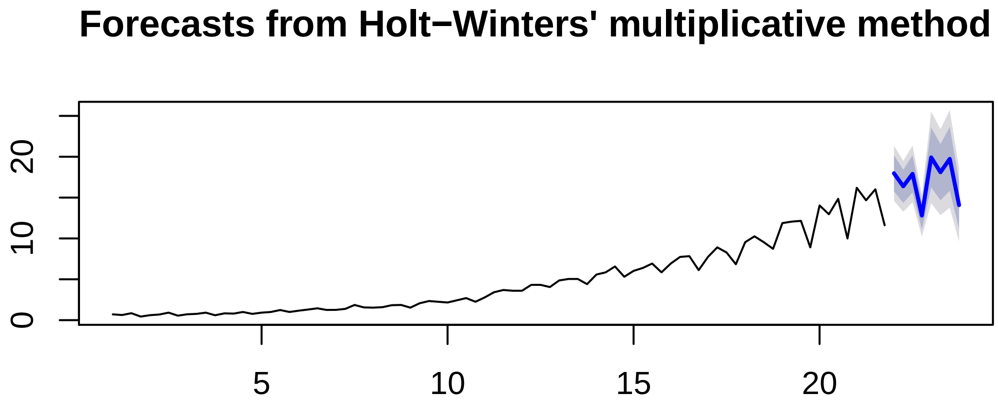
Forecasting usng HoltWinters method.



```
knitr::opts_chunk$set(echo=FALSE, message = FALSE,
  warning = FALSE, results = "hide", fig.height = 3, fig.width = 6)
library('astsa')
library('dplyr')
library('ggplot2')
```

```r
library('forecast')
big_font <- theme_grey(base_size = 24)
source("../common/fortify-ts.r")
data(jj)
jj <- fortify(jj) %>% rename(earning=x)

qplot(time,earning, data = jj, geom = "line") +
    big_font

jj$diff1 <- c(rep(NA,1),diff(jj$earning,lag=1))
qplot(time,diff1,data=jj,geom="line") +big_font

#seasonality
jj$diff_4 <- c(rep(NA, 4), diff(jj$diff1, lag = 4))
qplot(time,diff_4, data = jj, geom = "line") +
    big_font
#fit using auto.arima model
fit <- forecast::auto.arima(jj$diff_4)  #this fits ARIMA(1,0,2)
#or simply fitting inthe original gives
fit <-forecast::auto.arima(ts(jj$earning,frequency = 4)) # ARIM(1,1,2)(0,1,0)_4
par(mfrow=c(1,2))
acf(fit$residuals)
pacf(fit$residuals)
plot(fit$residuals)
qqnorm(fit$residuals)
qqline(fit$residuals)
pred.df <- as.data.frame(predict(fit, n.ahead = 4*4))
pred.df$time <- max(jj$time) + (1:(4*4))/4

qplot(time, earning, data = jj, geom = "line") +
  geom_ribbon(aes(ymin = pred- 2*se, ymax = pred + 2*se, y = NULL), data = pred.df, alpha = 0.2) +
  geom_line(aes(y = pred), data = pred.df) +
  big_font
HoltWinters(x, alpha = NULL, beta = NULL, gamma = NULL,
            seasonal = c("additive", "multiplicative"),
            start.periods = 2, l.start = NULL, b.start = NULL,
            s.start = NULL,
            optim.start = c(alpha = 0.3, beta = 0.1, gamma = 0.1),
            optim.control = list())
#library('HoltWinters')
hwt <- HoltWinters(ts(jj$earning,frequency = 4), seasonal = "multiplicative", start.periods = 2)
plot(hwt)
#Forecasting
# predict.hw <- predict(hwt,n.ahead = 12, prediction.interval = TRUE, level = 0.95)
# predict.df <- data.frame(predict.hw)
# qplot(time, earning, data = jj, geom = "line") +
#   geom_ribbon(aes(ymin =lwr,ymax =upr, y = NULL), data =pred, alpha = 0.2) +
#   geom_line(aes(y = fit), data = pred.df) +
#   big_font

hw.fit <- hw(ts(jj$earning,frequency = 4), seasonal="multiplicative")
plot(hw.fit)
```