時間序列與分析 FinalProject

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```
dat <- read.csv("/Users/klin26/清華大學/時間序列分析/期末報告/出口貿易總額.csv",header = T)
dat.ts <- ts(dat$按新臺幣計算. 百萬元.,frequency=12,start=99)
idx <- 1:(length(dat[,2])-17)
dat_train=dat[idx,]
dat_test=dat[-idx,]
dat_train=ts(dat_train$按新臺幣計算. 百萬元.,frequency=12,start=99)
dat_test=ts(dat_test$按新臺幣計算. 百萬元.,frequency=12,start=111)
```

$$Z_t = \mu_t + T_t + S_t + a_t$$
where μ_t = level, T_t = trend, S_t = seasonality

$$\begin{aligned}
\bar{\mu}_t &= \alpha(Z_t - \bar{S}_{t-s}) + (1-\alpha)(\bar{\mu}_{t-1} + \bar{T}_{t-1}), && 0 < \alpha < 1,\\
\bar{T}_t &= \beta(\bar{\mu}_t - \bar{\mu}_{t-1}) + (1-\beta)\bar{T}_{t-1}, && 0 < \beta < 1,\\
\bar{S}_t &= \gamma(Z_t - \bar{\mu}_t) + (1-\gamma)\bar{S}_{t-1}, && 0 < \gamma < 1.
\end{aligned}$$
where α, β, γ are smoothing constants

$$\hat{Z}_t(k) = \bar{\mu}_t + k\bar{T}_t + \bar{S}_{t+k-hs},\ h = 1 + \text{int}(k/s)$$

```
par(mfrow=c(1,2))
holttrend <- HoltWinters(dat_train, gamma=FALSE)
holttrend
```

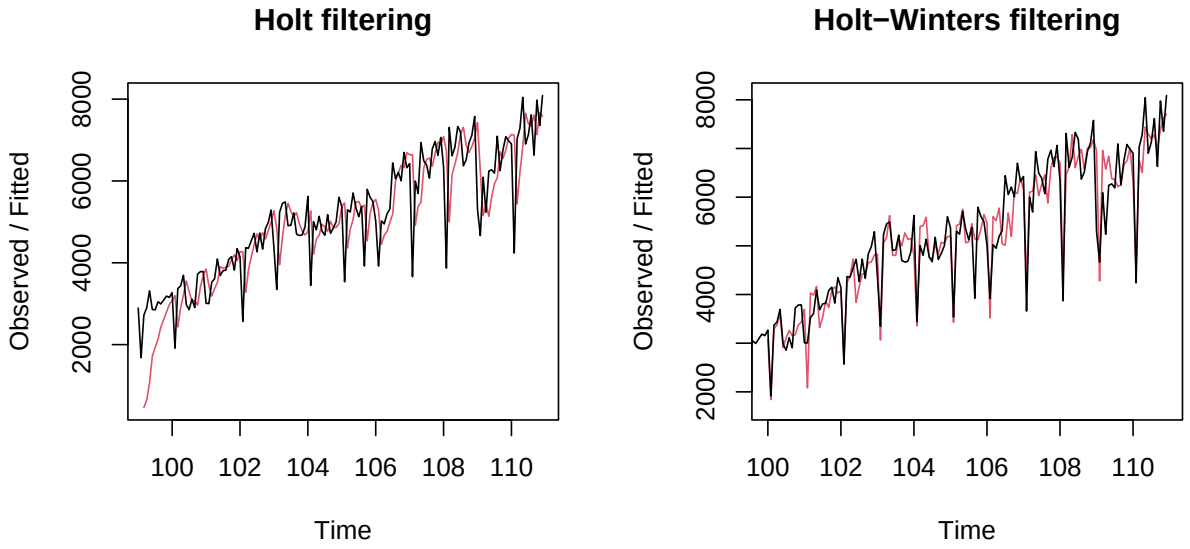
```
## Holt-Winters exponential smoothing with trend and without seasonal component.
##
## Call:
## HoltWinters(x = dat_train, gamma = FALSE)
##
## Smoothing parameters:
##  alpha: 0.5091814
##  beta : 0.2107366
##  gamma: FALSE
##
## Coefficients:
##        [,1]
## a 7840.9744
## b  129.2519
```

```
plot(holttrend,main="Holt filtering")

holtwinters <- HoltWinters(dat_train, seasonal=c("multiplicative"))
holtwinters
```

```
## Holt-Winters exponential smoothing with trend and multiplicative seasonal component.
##
## Call:
## HoltWinters(x = dat_train, seasonal = c("multiplicative"))
##
## Smoothing parameters:
##  alpha: 0.2164627
##  beta : 0
##  gamma: 0.2481529
##
## Coefficients:
##             [,1]
## a   7164.0203695
## b     23.6976981
## s1     0.9942581
## s2     0.6682512
## s3     1.0366536
## s4     1.0009350
## s5     1.1040573
## s6     1.0331569
## s7     1.0371040
## s8     1.0589817
## s9     0.9840298
## s10    1.0754349
## s11    1.0642417
## s12    1.0973951
```

```
plot(holtwinters)
```




```
# holttrend$fitted
holttrend$SSE
```

```
## [1] 113042143
```

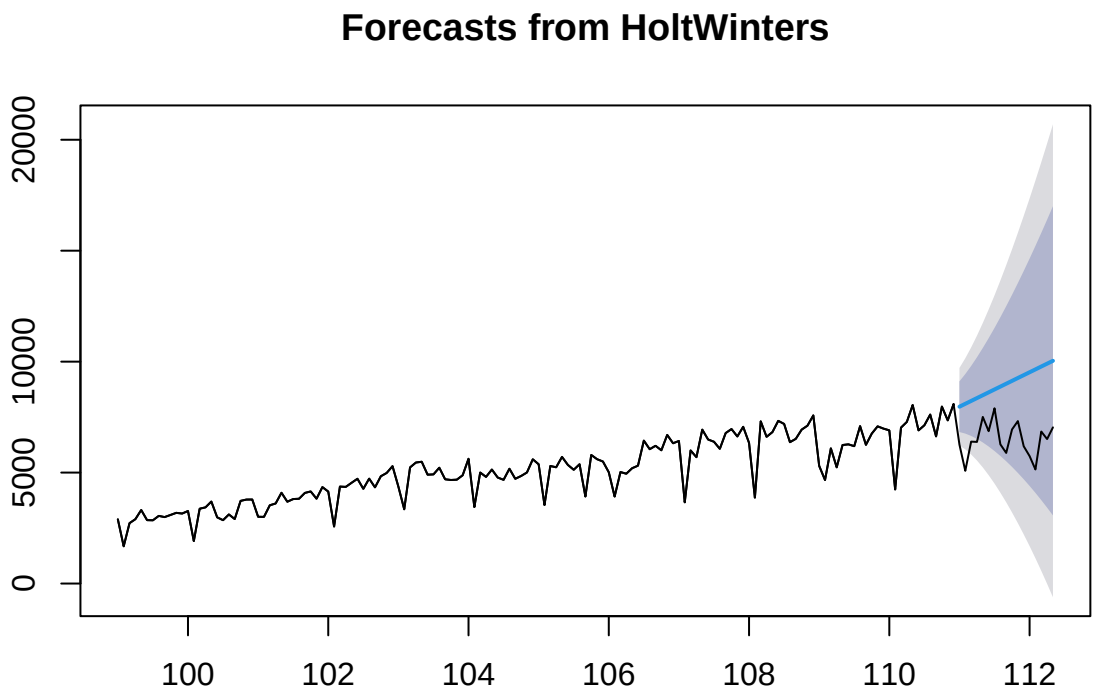
```
# holtwinters$fitted
holtwinters$SSE
```

```
## [1] 28367713
```

```
forecast_holttrend <- forecast(holttrend, h=17)
forecast_holttrend
```

```
##          Point Forecast    Lo 80     Hi 80      Lo 95     Hi 95
## Jan 111       7970.226 6828.365  9112.087 6223.90064  9716.552
## Feb 111       8099.478 6758.069  9440.887 6047.97043 10150.986
## Mar 111       8228.730 6653.160  9804.300 5819.10310 10638.357
## Apr 111       8357.982 6518.687 10197.276 5545.02360 11170.940
## May 111       8487.234 6358.584 10615.883 5231.74477 11742.723
## Jun 111       8616.486 6175.813 11057.158 4883.79870 12349.172
## Jul 111       8745.737 5972.611 11518.864 4504.60663 12986.868
## Aug 111       8874.989 5750.695 11999.283 4096.79370 13653.185
## Sep 111       9004.241 5511.411 12497.071 3662.41878 14346.063
## Oct 111       9133.493 5255.840 13011.146 3203.13406 15063.852
## Nov 111       9262.745 4984.867 13540.623 2720.29477 15805.195
## Dec 111       9391.997 4699.234 14084.760 2215.03487 16568.958
## Jan 112       9521.249 4399.572 14642.925 1688.32006 17354.177
## Feb 112       9650.500 4086.428 15214.573 1140.98555 18160.015
## Mar 112       9779.752 3760.280 15799.225  573.76337 18985.741
## Apr 112       9909.004 3421.552 16396.456  -12.69739 19830.706
## May 112      10038.256 3070.625 17005.887 -617.81547 20694.327
```

```
plot(forecast_holttrend)
lines(dat.ts,col="black")
```



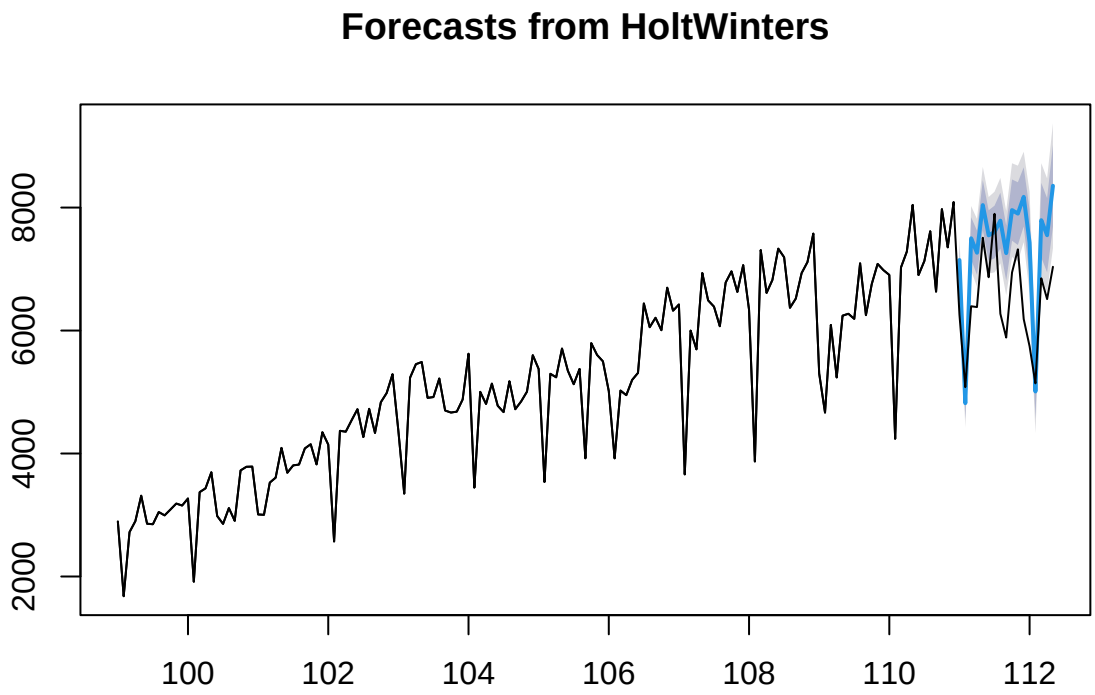

```
sqrt(mean((forecast_holttrend$mean-dat_test)^2))
```

```
## [1] 2691.283
```

```
forecast_holtwinters <- forecast(holtwinters, h=17)
forecast_holtwinters
```

```
##          Point Forecast    Lo 80    Hi 80    Lo 95    Hi 95
## Jan 111       7146.447 6901.937 7390.957 6772.501 7520.392
## Feb 111       4819.037 4559.653 5078.421 4422.344 5215.731
## Mar 111       7500.306 7157.160 7843.453 6975.509 8025.104
## Apr 111       7265.598 6906.026 7625.170 6715.680 7815.516
## May 111       8040.307 7634.674 8445.940 7419.945 8660.669
## Jun 111       7548.458 7140.971 7955.944 6925.261 8171.654
## Jul 111       7601.873 7173.414 8030.332 6946.602 8257.145
## Aug 111       7787.330 7333.288 8241.371 7092.932 8481.727
## Sep 111       7259.482 6811.717 7707.248 6574.684 7944.281
## Oct 111       7959.291 7461.631 8456.951 7198.185 8720.397
## Nov 111       7901.670 7391.746 8411.595 7121.808 8681.533
## Dec 111       8173.830 7693.541 8654.119 7439.291 8908.369
## Jan 112       7429.186 6888.577 7969.795 6602.396 8255.976
## Feb 112       5009.070 4566.376 5451.763 4332.029 5686.110
## Mar 112       7795.102 7189.537 8400.666 6868.971 8721.233
## Apr 112       7550.236 6946.651 8153.822 6627.132 8473.341
## May 112       8354.270 7690.098 9018.443 7338.506 9370.034
```

```
plot(forecast_holtwinters)
lines(dat.ts,col="black")
```




```
sqrt(mean((forecast_holtwinters$mean-dat_test)^2))
```

```
## [1] 1078.029
```

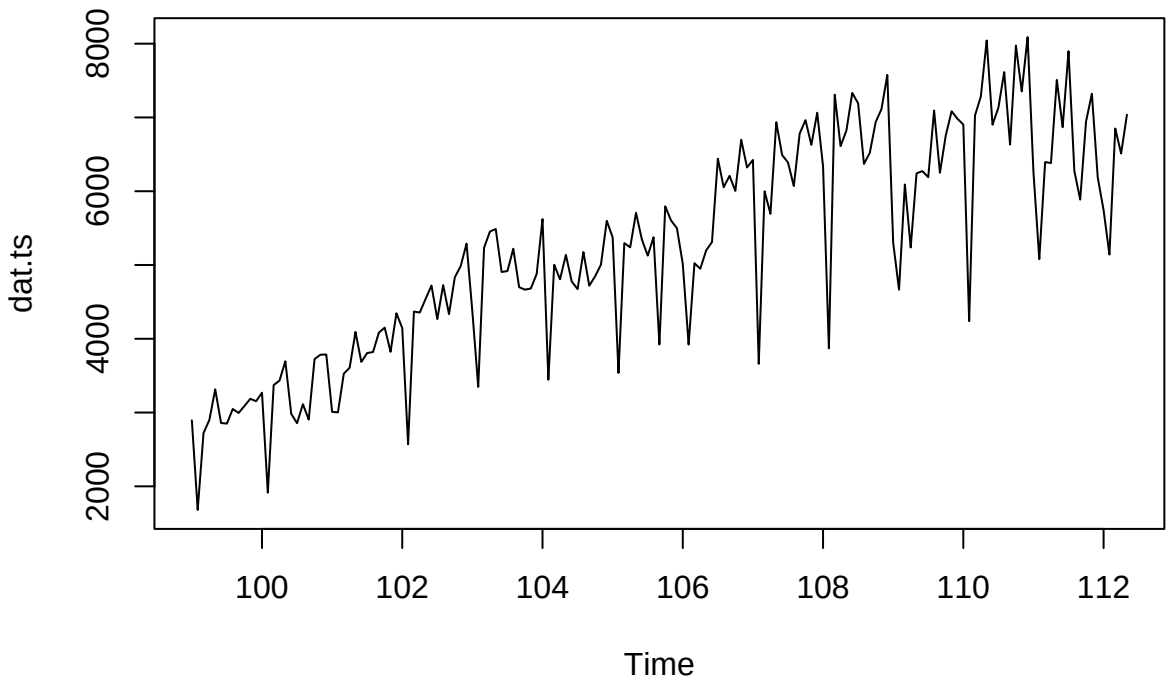
```
Box.test(forecast_holttrend$residuals, lag=20, type="Ljung-Box")
```

```
##
##  Box-Ljung test
##
## data:  forecast_holttrend$residuals
## X-squared = 64.131, df = 20, p-value = 1.604e-06
```

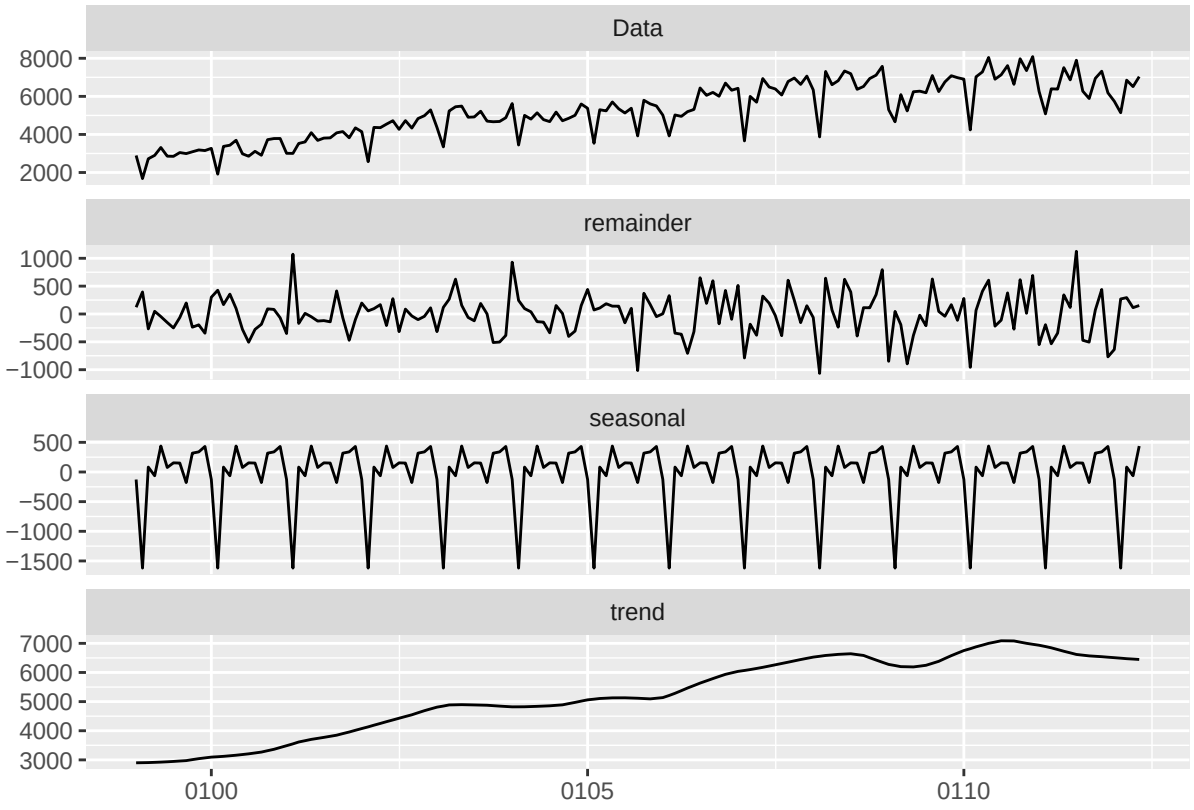
```
Box.test(forecast_holtwinters$residuals, lag=20, type="Ljung-Box")
```

```
##
##  Box-Ljung test
##
## data:  forecast_holtwinters$residuals
## X-squared = 15.807, df = 20, p-value = 0.7285
```

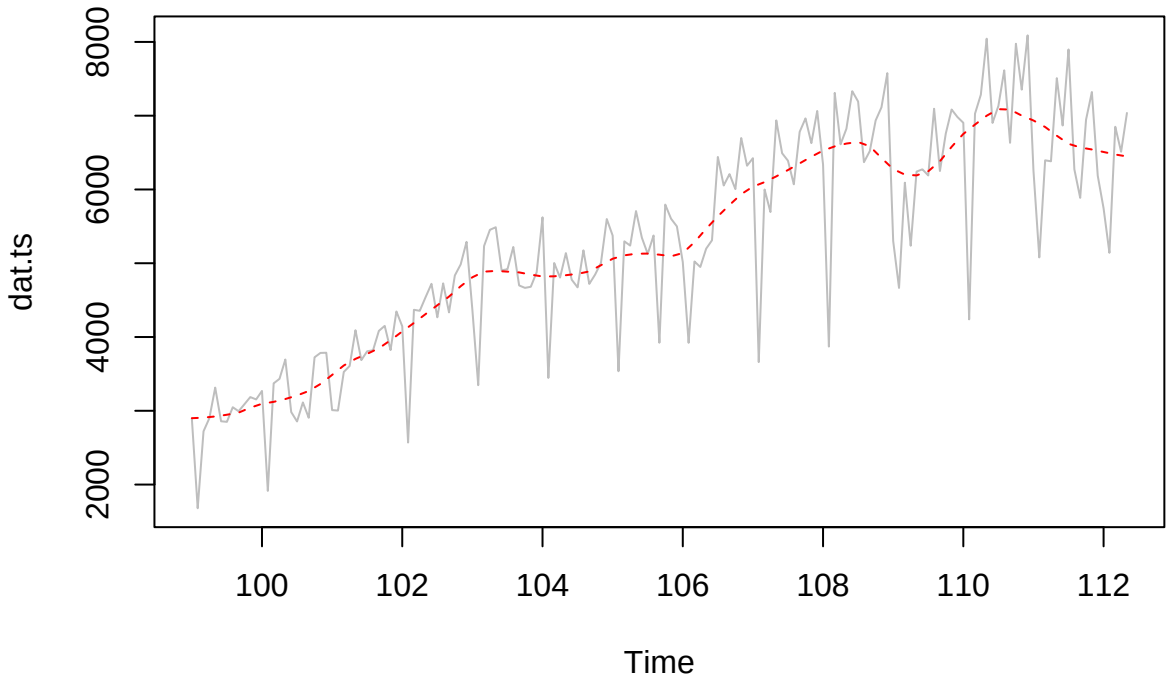
```
ts.plot(dat.ts)
```



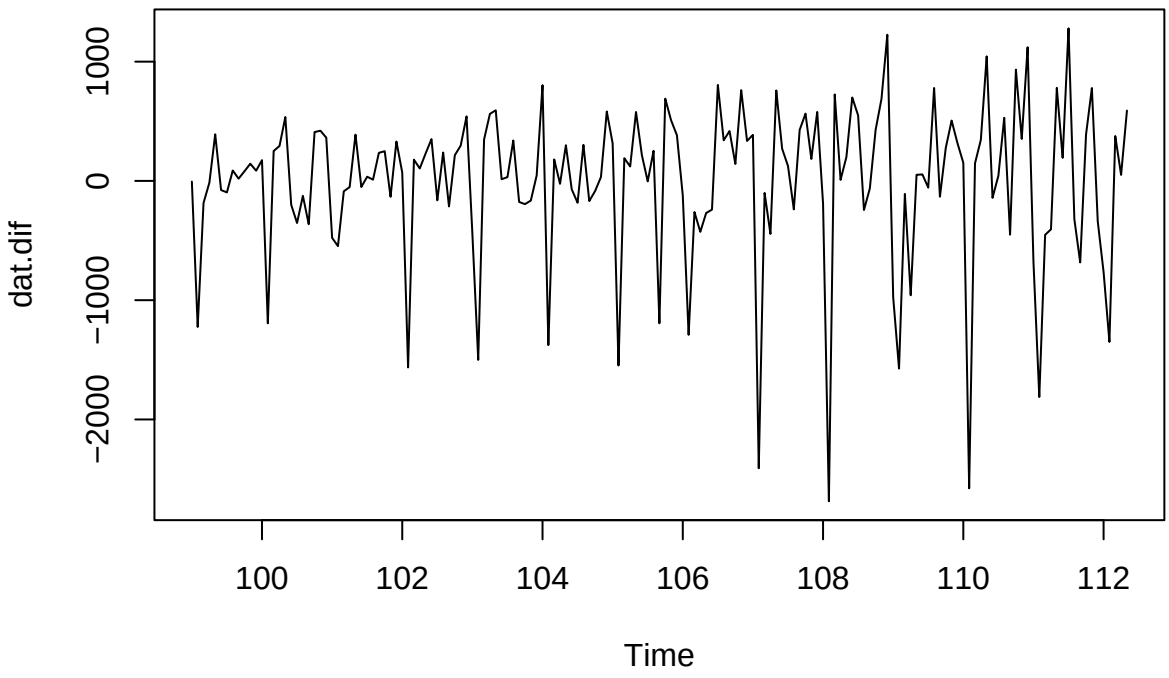

```
fit <- stl(dat.ts,s.window = "periodic")
autoplot(fit, ts.colour = 'black')
```



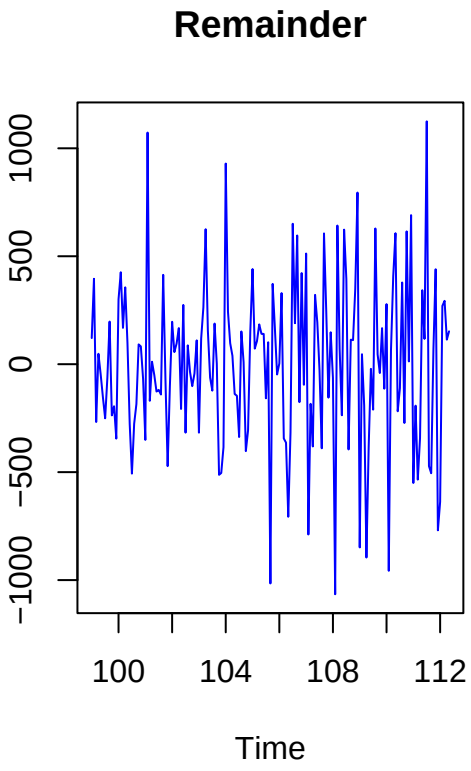

```
plot.ts(dat.ts, col = 'gray')
lines(fit$time.series[,2],
      col = "red", lwd = 1, lty = 2)
```

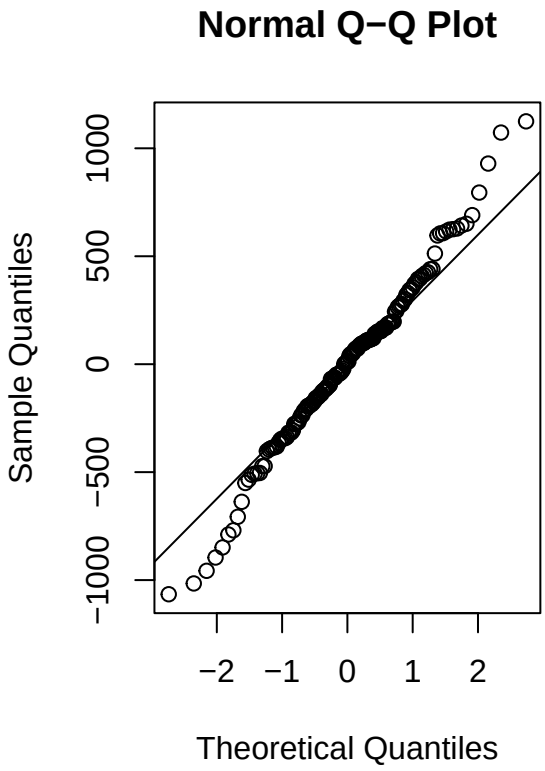



```
dat.dif <- dat.ts - fit$time.series[,2]
plot.ts(dat.dif)
```




```
par(mfrow = c(1,2))
plot(fit$time.series[,3],
     col = "blue", main = 'Remainder', ylab = "")
qqnorm(fit$time.series[,3])
qqline(fit$time.series[,3])
```


Remainder
1000
500
0
−500
−1000
100
104
108
112
Time


Normal Q−Q Plot
Sample Quantiles
1000
500
0
−500
−1000
−2
−1
0
1
2
Theoretical Quantiles