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### STAT 5814 HW3/PROBLEM 1
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library(TSA)
library(forecast)
library(snpar)

wd = "/home/montimaj/Documents/MST/STAT_5814/HW/STAT_TSA/Data/HW3_Data"
setwd(wd)
gasprices = read.table('gasprices.txt')
internet = read.table('ibm.txt')
ibm_stock = read.table('internet.txt')

par(mfrow=c(2,2))
plot(c(1:nrow(gasprices)),
      gasprices$V1,
      xlab="Time (Weeks)",
      ylab="Gas Price (USD/Gallon)",
      type="l",
      main="Gas Prices")
plot(c(1:nrow(ibm_stock)),
      ibm$V1,
      type="l",
      ylab="Stock Prices (USD)",
      xlab="Time (Days)",
      main="IBM Stock")
plot(c(1:nrow(internet)),
      internet$V1,
      type="l",
      ylab="Number of Loggedin Users",
      xlab="Time (Minute)",
      main="Internet Users")

par(mfrow=c(2,2))
max_lag = 40
gasprices.acf = acf(gasprices, plot=TRUE, lag.max=max_lag, main="ACF Gas
Prices")
ibm_stock.acf = acf(ibm_stock, plot=TRUE, lag.max=max_lag, main="IBM Stock
ACF")
internet.acf = acf(internet, plot=TRUE, lag.max=max_lag, main = "Internet ACF")

### GASPRICES DATA
gasprices.train = ts(gasprices, start=1, end=125)
gasprices.test = ts(gasprices, start=126, end=145)
gasprices.fit = auto.arima(gasprices.train)
summary(gasprices.fit)
```

```
gasprices.residuals = rstandard(gasprices.fit)
par(mfrow=c(2,2))
plot(gasprices.residuals, ylab="Standardized Residuals", type='l',
main='Standardized Residual Plot')
abline(h = 0)
hist(gasprices.residuals, main="Model Residual Histogram", xlab="Residual")
qqnorm(gasprices.residuals, main="QQ Plot for Residuals")
qqline(gasprices.residuals, col="red")
acf(gasprices.residuals, main="Gas Prices Residual ACF")
shapiro.test(gasprices.residuals)
runs.test(gasprices.residuals, exact=TRUE)

### IBM STOCK DATA
ibm_stock.train = ts(ibm_stock, start=1, end=80)
ibm_stock.test = ts(ibm_stock, start=81, end=100)
ibm_stock.fit = auto.arima(ibm_stock.train)
summary(ibm_stock.fit)
ibm_stock.residuals = rstandard(ibm_stock.fit)
par(mfrow=c(2,2))
plot(ibm_stock.residuals, ylab="Standardized Residuals", type='l',
main='Standardized Residual Plot')
abline(h = 0)
hist(ibm_stock.residuals, main="Model Residual Histogram", xlab="Residual")
qqnorm(ibm_stock.residuals, main="QQ Plot for Residuals")
qqline(ibm_stock.residuals, col="red")
acf(ibm_stock.residuals, main="IBM Stock Residual ACF")
shapiro.test(ibm_stock.residuals)
runs.test(ibm_stock.residuals, exact=TRUE)

### INTERNET DATA
internet.train = ts(internet, start=1, end=80)
internet.test = ts(internet, start=81, end=100)
internet.fit = auto.arima(internet.train)
summary(internet.fit)
internet.residuals = rstandard(internet.fit)
par(mfrow=c(2,2))
plot(internet.residuals, ylab="Standardized Residuals", type = 'l',
main='Standardized Residual Plot')
abline(h = 0)
hist(internet.residuals, main="Model Residual Histogram", xlab="Residual")
qqnorm(internet.residuals, main="QQ Plot for Residuals")
qqline(internet.residuals, col="red")
acf(internet.residuals, main="Internet Residual ACF")
shapiro.test(internet.residuals)
runs.test(internet.residuals, exact=TRUE)
```

Series: gasprices.train
ARIMA(1,1,0) with drift

Coefficients:

	ar1	drift
	0.4147	0.0168
s.e.	0.0848	0.0074

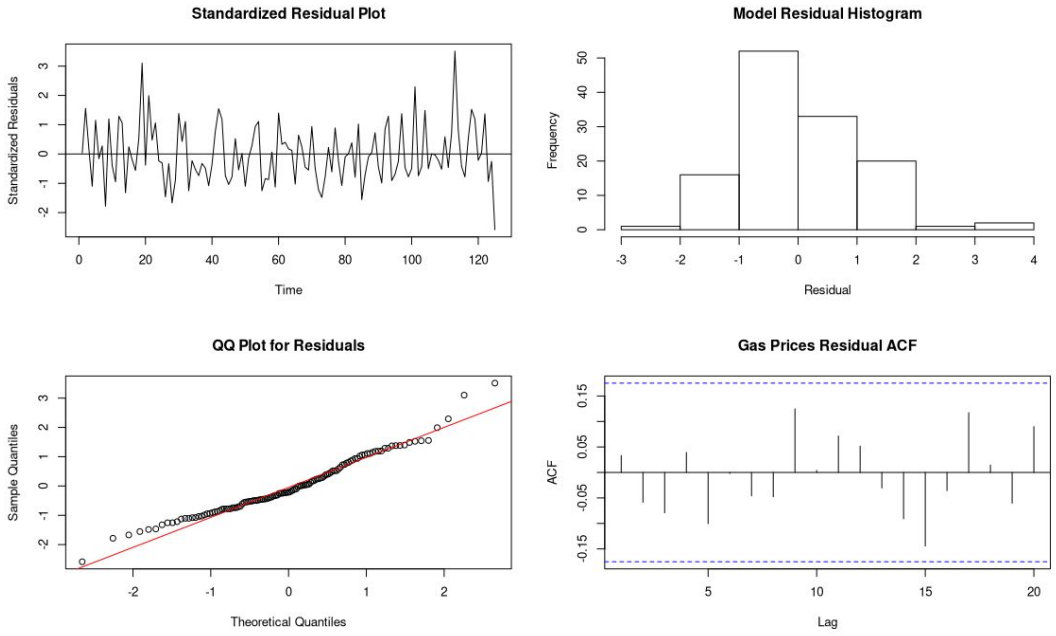
sigma^2 estimated as 0.002373: log likelihood=199.66
AIC=-393.33 AICc=-393.13 BIC=-384.87

Training set error measures:

	ME	RMSE	MAE	MPE	MAPE	MASE	ACF1
Training set	-0.0003231191	0.0481271	0.03825364	-0.01130971	1.468076	0.9048935	0.03315253

Shapiro-Wilk normality test
data: gasprices.residuals
W = 0.96935, p-value = 0.006098

Exact runs test
data: gasprices.residuals
Runs = 60, p-value = 0.5911
alternative hypothesis: two.sided



Series: ibm_stock.train
ARIMA(1,1,1)

Coefficients:

	ar1	ma1
	0.6239	0.4856
s.e.	0.1020	0.1056

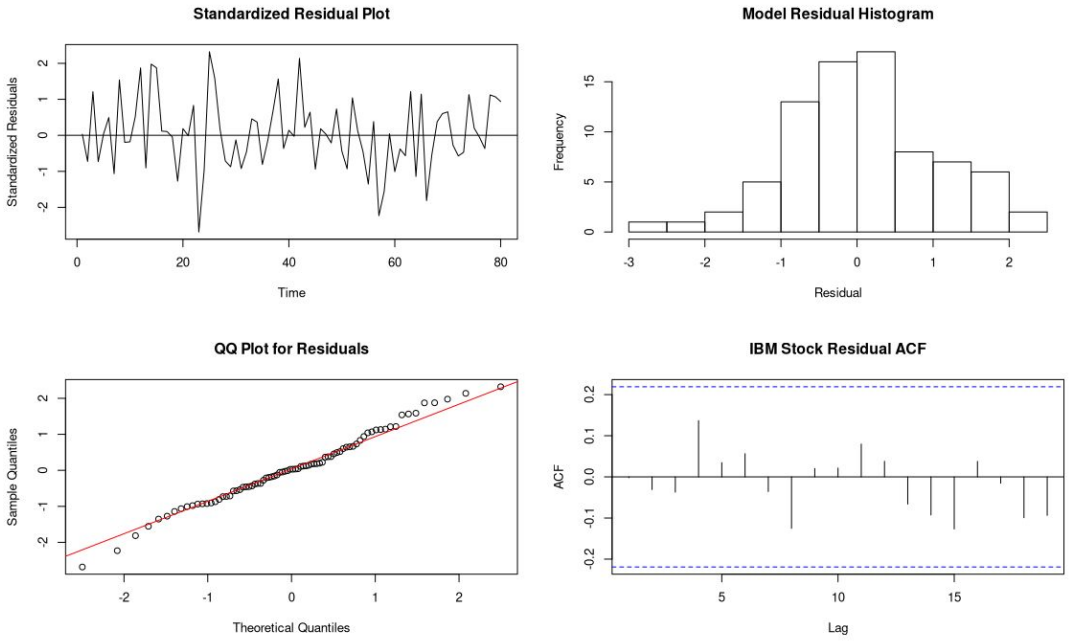
sigma^2 estimated as 10.09: log likelihood=-203.04
AIC=412.09 AICc=412.41 BIC=419.2

Training set error measures:

	ME	RMSE	MAE	MPE	MAPE	MASE	ACF1
Training set	0.1392471	3.116697	2.406878	0.1923048	2.052624	0.5905072	-0.001943443

Shapiro-Wilk normality test
data: ibm_stock.residuals
W = 0.98928, p-value = 0.7492

Exact runs test
data: ibm_stock.residuals
Runs = 44, p-value = 0.4303
alternative hypothesis: two.sided



Series: internet.train
ARIMA(3,0,1) with non-zero mean

Coefficients:

	ar1	ar2	ar3	ma1	mean
	1.1294	-0.1771	-0.2827	-0.6700	1104.4082
s.e.	0.1453	0.1795	0.1122	0.1139	19.5421

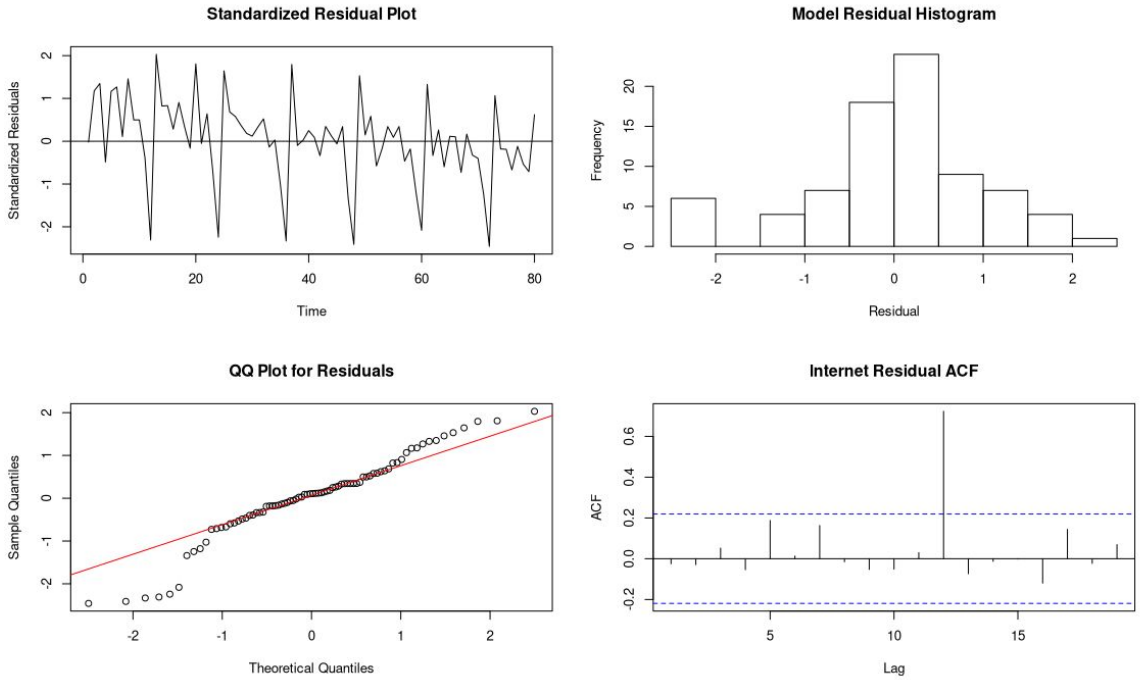
sigma^2 estimated as 30618: log likelihood=-524.57
AIC=1061.14 AICc=1062.29 BIC=1075.43

Training set error measures:

	ME	RMSE	MAE	MPE	MAPE	MASE	ACF1
Training set	4.56612	169.4234	123.7262	-3.413828	13.99911	0.8038797	-0.02497261

Shapiro-Wilk normality test
data: internet.residuals
W = 0.94805, p-value = 0.00267

Exact runs test
data: internet.residuals
Runs = 38, p-value = 0.575
alternative hypothesis: two.sided



```
### STAT 5814 HW3/PROBLEM 2
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library(TSA)
library(forecast)
library(snpar)
library(Rfit)
library(latex2exp)

data(co2)
co2_data = ts(co2, frequency=12)
har. = harmonic(co2_data, 1)
fit = lm(co2_data ~ har.+time(co2_data))
summary(fit)

par(mfrow=c(1,1))
model = ts(fit$fitted.values, frequency=12)
plot(co2_data, main=TeX('$\\textbf{Plot\\,for\\,CO_2\\,level$}'),
ylab=TeX('$CO_2\\,Level$'), type="l", col="Blue")
lines(model, col="Red")
legend(1, 380, legend=c("Actual", "Fitted"), col=c("Blue", "Red"), lty=1:1,
cex=0.7)

co2_data.residuals = rstudent(fit)
par(mfrow=c(2,2))
hist(co2_data.residuals, main="Residuals Histogram")
qqnorm(co2_data.residuals, main="QQ Plot for Residuals")
qqline(co2_data.residuals, col="Red")
acf(co2_data.residuals, main=TeX("$\\textbf{CO_2\\,Residuals\\,ACF}$"))
plot(co2_data.residuals, ylab="Standardized Residuals", type='l', main='Plot
for Standardized Residuals')
abline(h = 0)

shapiro.test(co2_data.residuals)
runs.test(co2_data.residuals, exact=TRUE)


(a)

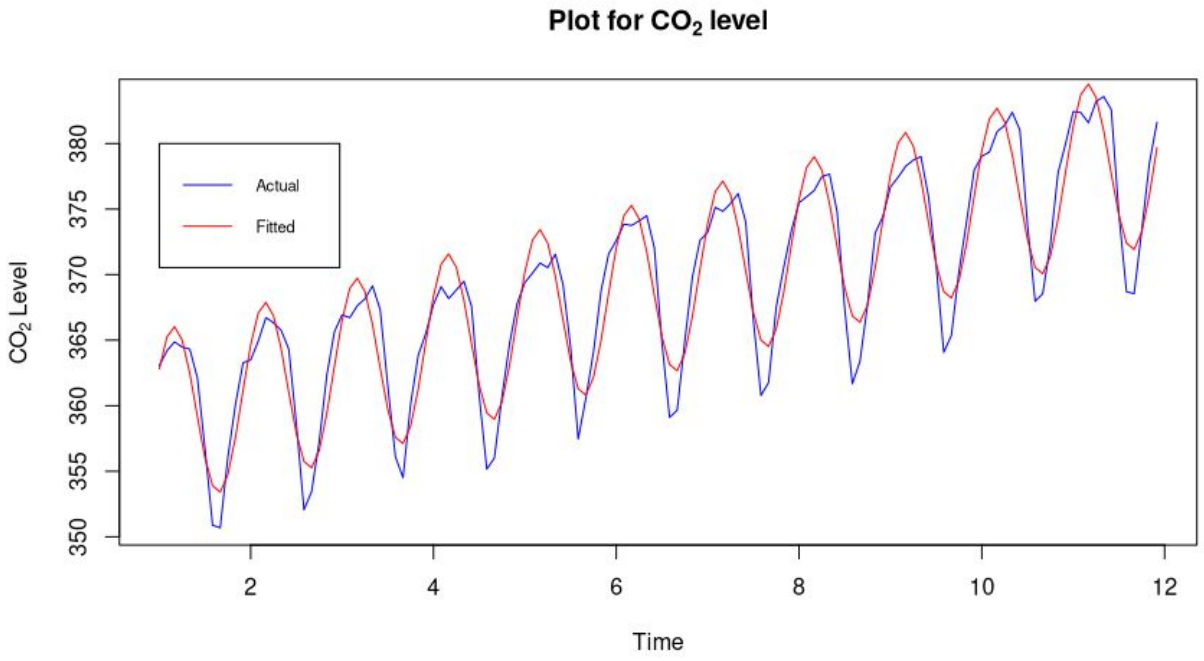
Residuals:
      Min    1Q  Median   3Q     Max
-5.1804 -1.7916 -0.1045  1.8986  5.1809

Coefficients:
                  Estimate Std. Error t value Pr(>|t|)
(Intercept)  357.09694    0.46045  775.54   <2e-16 ***
```

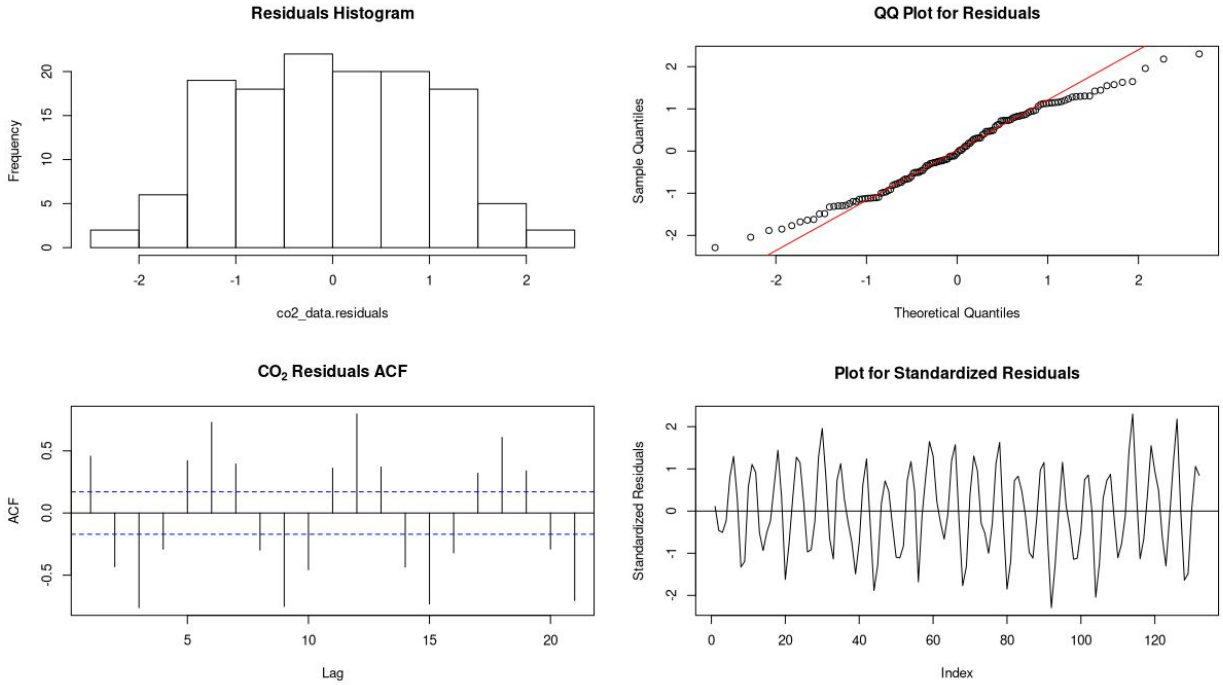
```
har.cos(2*pi*t)    3.85105      0.28677   13.43   <2e-16 ***
har.sin(2*pi*t)    5.59556      0.28741   19.47   <2e-16 ***
time(co2_data)     1.85083      0.06401   28.91   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2.329 on 128 degrees of freedom
Multiple R-squared:  0.9109,    Adjusted R-squared:  0.9088
F-statistic: 436.3 on 3 and 128 DF,  p-value: < 2.2e-16
```

(b)



(c)




```
Shapiro-Wilk normality test
data:  co2_data.residuals
W = 0.98308, p-value = 0.1003

Exact runs test
data:  co2_data.residuals
Runs = 45, p-value = 0.0001504
alternative hypothesis: two.sided
```

```
### STAT 5814 HW3/PROBLEM 3
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library(TSA)
library(forecast)
library(snpar)
library(Rfit)

tb =
read.table("/home/montimaj/Documents/MST/STAT_5814/HW/STAT_TSA/Data/HW3_Data/tb
.txt")
tb_data = ts(tb, frequency=12, start=c(2000, 1), end=c(2009, 12))
decomposed_tb = decompose(tb_data, type="mult")
plot(decomposed_tb)

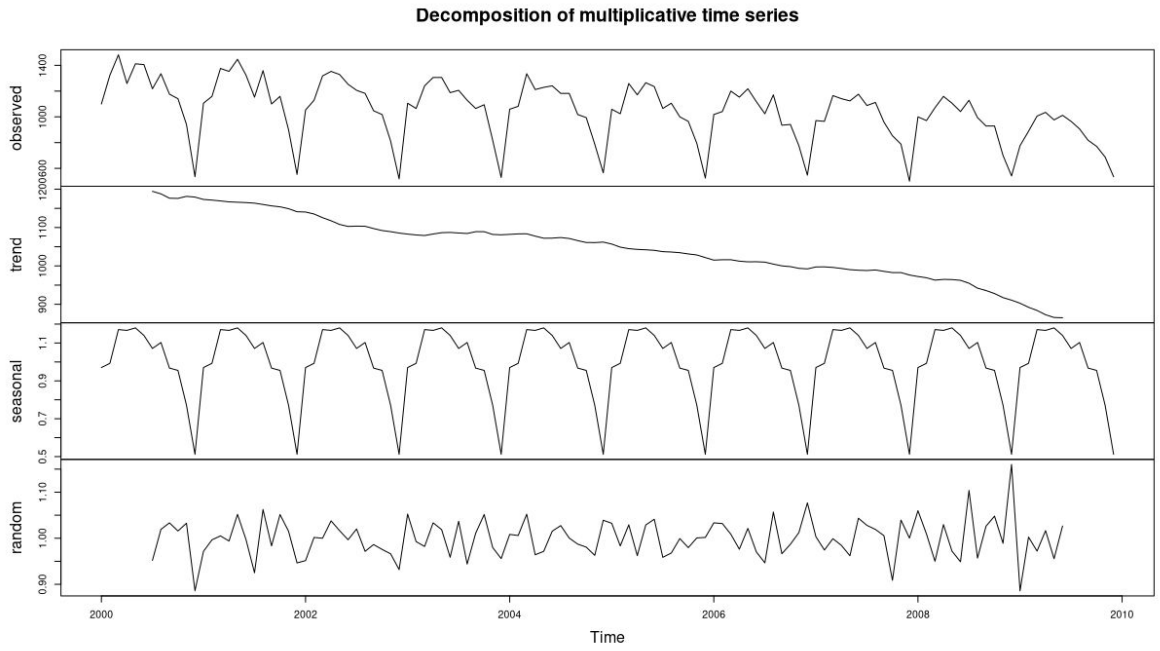
har. <- harmonic(tb_data, 1)
fit <- lm(tb_data ~ har.+time(tb_data))
tb_data.residuals <- rstudent(fit)
summary(fit)

par(mfrow=c(1,1))
model = ts(fit$fitted.values, frequency=12, start=c(2000,1), end=c(2009,12))
plot(tb_data, main='Plot for TB data', ylab='TB', type="l", col="Blue")
lines(model, col="Red")
legend(2008, 1400, legend=c("Actual", "Fitted"), col=c("Blue", "Red"), lty=1:1,
cex=0.55)

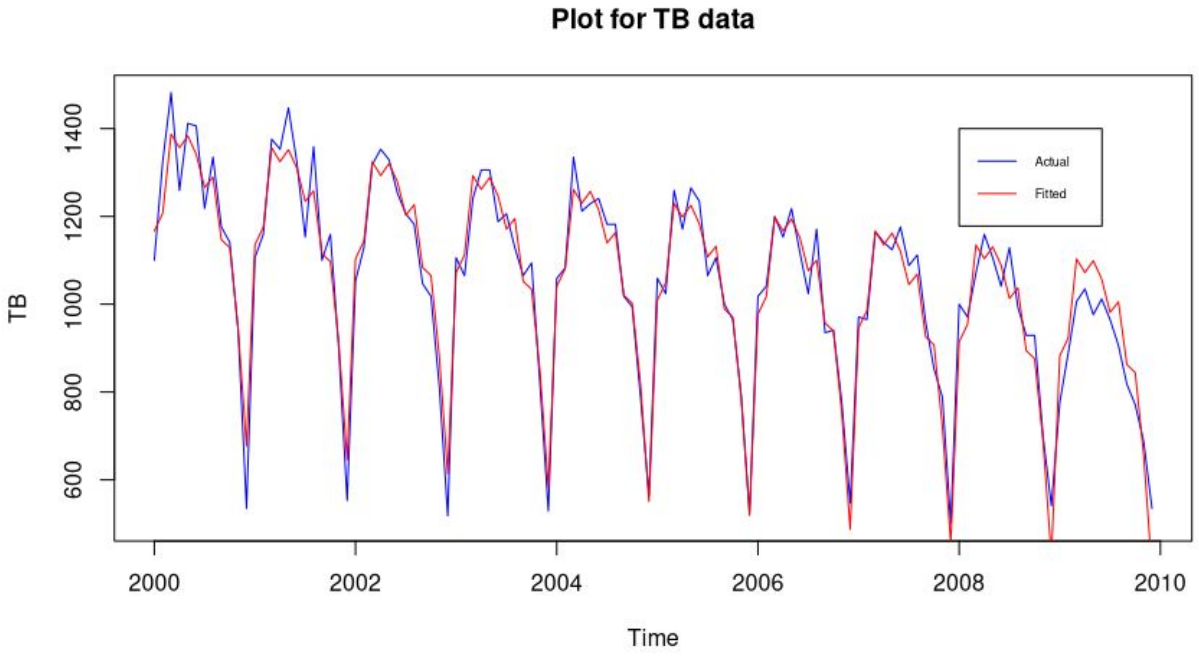
tb_data.residuals = rstudent(fit)
par(mfrow=c(2,2))
hist(tb_data.residuals, main="Residuals Histogram")
qqnorm(tb_data.residuals, main="QQ Plot for Residuals")
qqline(tb_data.residuals, col="Red")
acf(tb_data.residuals, main='TB Residuals')
plot(tb_data.residuals, ylab="Standardized Residuals", type='l', main='Plot for
Standardized Residuals')
abline(h = 0)

shapiro.test(tb_data.residuals)
runs.test(tb_data.residuals, exact=TRUE)
```

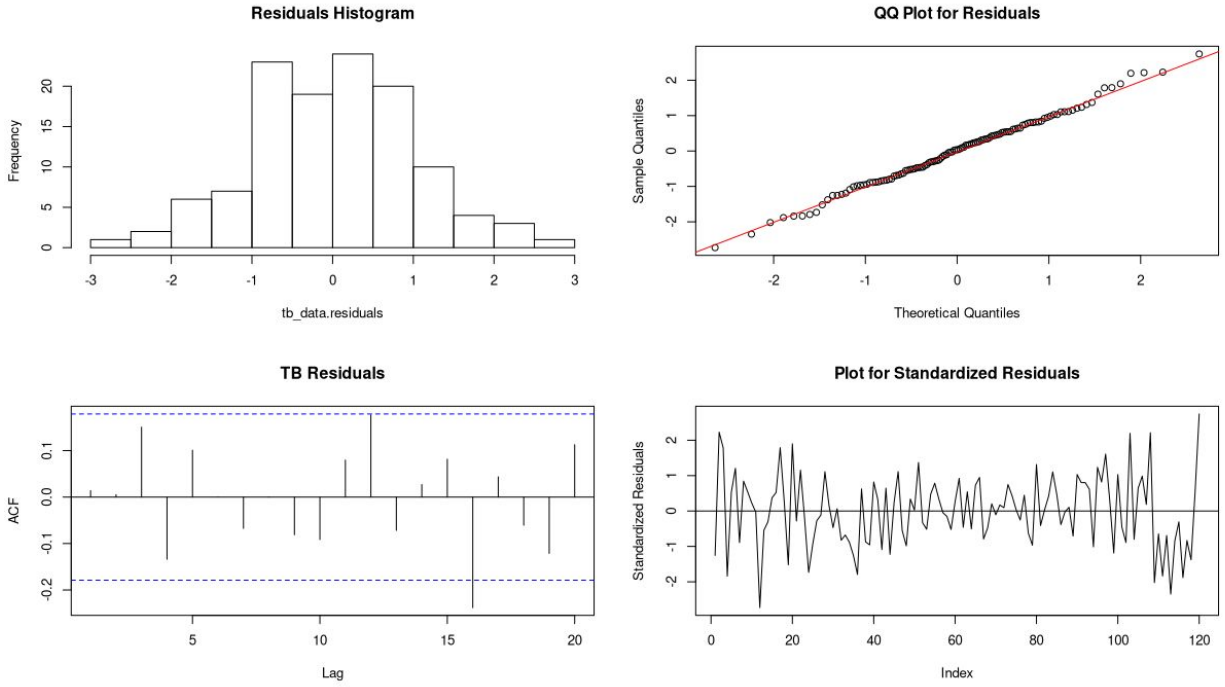
(a)


Decomposition of multiplicative time series
observed
trend
seasonal
random
Time
2000
2002
2004
2006
2008
2010

(b)


Plot for TB data
TB
Time
Actual
Fitted
600
800
1000
1200
1400
2000
2002
2004
2006
2008
2010

(c)




```
Shapiro-Wilk normality test
data:  tb_data.residuals
W = 0.99538, p-value = 0.9653

Exact runs test
data:  tb_data.residuals
Runs = 60, p-value = 0.9276
alternative hypothesis: two.sided
```