Time Series Final Exam

104304033 統計四 劉書宏

Q1 U.S. tobacco production from 1871 to 1985 is shown in worksheet

(a) ARIMA model

Series: data

ARIMA(0,1,1) with drift

Coefficients:

ma1 drift

-0.594 11.6424

s.e. 0.097 7.6008

sigma^2 estimated as 39571: log likelihood=-764.36

AIC=1534.72 AICc=1534.94 BIC=1542.93

Training set error measures:

ME RMSE MAE MPE MAPE MASE ACF1

Training set 0.3101048 196.3133 140.4715 -1.298765 11.51846 0.8818144 0.06338094

By using auto.arima, the data was fitted with ARIMA(0,1,1)

(b) Forecast next 10 years with 95% forecast limits

|  |  |  |  |
| --- | --- | --- | --- |
| Year | predict\_10.mean | 95%lower | 95%upper |
| 1986 | 1688.827 | 1298.941 | 2078.713 |
| 1987 | 1700.469 | 1279.67 | 2121.268 |
| 1988 | 1712.112 | 1262.521 | 2161.703 |
| 1989 | 1723.754 | 1247.107 | 2200.402 |
| 1990 | 1735.397 | 1233.148 | 2237.645 |
| 1991 | 1747.039 | 1220.433 | 2273.645 |
| 1992 | 1758.681 | 1208.796 | 2308.567 |
| 1993 | 1770.324 | 1198.104 | 2342.543 |
| 1994 | 1781.966 | 1188.253 | 2375.68 |
| 1995 | 1793.609 | 1179.153 | 2408.065 |

Q2 U.S. monthly employment figures for young men between 16 and 19 of age from 1971 to 1981

(a)

Series: data

ARIMA(2,0,3) with non-zero mean

Coefficients:

ar1 ar2 ma1 ma2 ma3 mean

1.6125 -0.6344 -1.0692 -0.3389 0.5381 821.0805

s.e. 0.1780 0.1722 0.1609 0.1486 0.0788 54.7779

sigma^2 estimated as 14318: log likelihood=-816.62

AIC=1647.24 AICc=1648.14 BIC=1667.42

Training set error measures:

ME RMSE MAE MPE MAPE MASE ACF1

Training set 4.319159 116.9058 79.73285 -1.333272 9.500921 0.7908687 0.009577191

Using auto.arima and add seasonal = true ,then get this result.

(b)

|  |  |  |  |
| --- | --- | --- | --- |
| Index | mean | 99% lower | 99% upper |
| 1 | 927.4282 | 619.2126 | 1235.644 |
| 2 | 900.9468 | 550.1774 | 1251.716 |
| 3 | 901.2175 | 549.1709 | 1253.264 |
| 4 | 899.6357 | 547.4077 | 1251.864 |
| 5 | 896.9133 | 542.7228 | 1251.104 |
| 6 | 893.5268 | 535.4121 | 1251.642 |
| 7 | 889.7931 | 526.4135 | 1253.173 |
| 8 | 885.9208 | 516.624 | 1255.218 |
| 9 | 882.0453 | 506.7067 | 1257.384 |
| 10 | 878.2526 | 497.0882 | 1259.417 |
| 11 | 874.5955 | 488.0125 | 1261.178 |
| 12 | 871.1043 | 479.5986 | 1262.61 |

Q3 The Lydia Pinkham annual advertising (xt) and sales (yt) data

(a) Transfer function Noise model

|  |
| --- |
|  |
| |  | | --- | |  | |

Call:

arimax(x = data2$yt, order = c(1, 0, 0), include.mean = FALSE, xtransf = data.frame(data2$lag3x),

transfer = list(c(2, 0)))

Coefficients:

ar1 data2.lag3x-AR1 data2.lag3x-AR2 data2.lag3x-MA0

0.9891 -0.3611 -0.9603 -0.0921

s.e. 0.0111 0.0820 0.0928 0.0834

sigma^2 estimated as 50397: log likelihood = -350.39, aic = 708.77

(b)

|  |  |  |  |
| --- | --- | --- | --- |
| Month | 95% lower | mean | 95% upper |
| 1 | 1012.355 | 1354.004 | 1695.652 |
| 2 | 743.0841 | 1324.35 | 1905.615 |
| 3 | 483.138 | 1300.627 | 2118.115 |
| 4 | 230.1466 | 1281.648 | 2333.149 |
| 5 | -16.307 | 1266.465 | 2549.237 |
| 6 | -256.915 | 1254.319 | 2765.552 |
| 7 | -492.724 | 1244.602 | 2981.927 |
| 8 | -724.998 | 1236.828 | 3198.654 |
| 9 | -955.092 | 1230.609 | 3416.31 |
| 10 | -1184.36 | 1225.634 | 3635.632 |
| 11 | -1414.13 | 1221.654 | 3857.439 |
| 12 | -1645.64 | 1218.47 | 4082.58 |

Q4 The daily closing stock of Duke Energy Corporation between January 3, 2002, and August 31, 2002

(a)

Series: pre\_data

ARIMA(0,1,0)

sigma^2 estimated as 0.51: log likelihood=-138.52

AIC=279.05 AICc=279.08 BIC=281.9

Training set error measures:

ME RMSE MAE MPE MAPE MASE ACF1

Training set -0.08294729 0.7113454 0.5348822 -0.2643994 1.553825 0.9928207 0.02953077

Before intervention occurred, I used the first 129 rows to make an arima model.

Because the arima model (0,1,0), so next we will take difference to do the intervention model.

Before intervention occurred, I give the data a value 0, and give the data after the intervention occurred 1.

Call:

arimax(x = diff(ts(Q4)), order = c(0, 0, 1), include.mean = FALSE, xtransf = St[2:T],

transfer = list(c(0, 0)))

Coefficients:

ma1 T1-MA0

-0.0044 -0.0641

s.e. 0.0732 0.1409

sigma^2 estimated as 0.74: log likelihood = -209.29, aic = 422.57

(b)

The effect of the intervention causes the stock price dropping sharply.

(c)

|  |  |  |  |
| --- | --- | --- | --- |
| Day | 95% lower | mean | 95% upper |
| 1 | -0.07695 | -0.06402 | -0.05108 |
| 2 | -0.0796 | -0.06402 | -0.04843 |
| 3 | -0.08186 | -0.06402 | -0.04617 |
| 4 | -0.08387 | -0.06402 | -0.04416 |
| 5 | -0.08569 | -0.06402 | -0.04234 |
| 6 | -0.08737 | -0.06402 | -0.04066 |
| 7 | -0.08894 | -0.06402 | -0.03909 |
| 8 | -0.09041 | -0.06402 | -0.03762 |
| 9 | -0.0918 | -0.06402 | -0.03623 |
| 10 | -0.09313 | -0.06402 | -0.0349 |
| 11 | -0.0944 | -0.06402 | -0.03363 |
| 12 | -0.09562 | -0.06402 | -0.03241 |

R code

library(openxlsx)

library(tseries)

library(forecast)

### Q1

Q1 = read.xlsx("2019Spring\_Time\_Series\_Analysis\_final\_exam\_0620.xlsx", sheet = 1)

data = ts(Q1$Tobacco.Production)

model = auto.arima(data, seasonal = FALSE, test = "adf", ic = "aic")

summary(model)

predict\_10 = forecast(model, h = 10)

plot(predict\_10)

forecast\_result = data.frame(Year = c(1986:1995), predict\_10$mean, predict\_10$lower, predict\_10$upper)

forecast\_result = forecast\_result[,c(1,2,4,6)]

write.csv(forecast\_result, file = "Q1.csv")

### Q2

Q2 = read.xlsx("2019Spring\_Time\_Series\_Analysis\_final\_exam\_0620.xlsx", sheet = 2)

data = ts(Q2)

model = auto.arima(data, seasonal = TRUE, test = "adf", ic = "aic")

summary(model)

forecast\_result = forecast(model, h = 12, level = 99)

plot(forecast\_result)

forecast = data.frame(Index = c(1:12), forecast\_result$mean, forecast\_result$lower, forecast\_result$upper)

write.csv(forecast, file = "Q2.csv")

### Q3

Q3 = read.xlsx("2019Spring\_Time\_Series\_Analysis\_final\_exam\_0620.xlsx", sheet = 3)

library(TSA)

ts.xt<-ts(Q3$Ad)

lag3.x<-lag(ts.xt,-3)

ts.yt<-ts(Q3$sales)

dat3<-cbind(ts.xt,lag3.x,ts.yt)

dimnames(dat3)[[2]]<-c("xt","lag3x","yt")

data2<-na.omit(as.data.frame(dat3))

visc.tf <- arimax(data2$yt, order=c(1,0,0), xtransf=data.frame(data2$lag3x),

transfer=list(c(2,0)), include.mean = FALSE)

visc.tf

model = as.vector(fitted(visc.tf))

forecast\_result = forecast(model, h = 12, level = 95)

plot(forecast\_result)

forecast = data.frame(Index = c(1:12), forecast\_result$lower, forecast\_result$mean, forecast\_result$upper)

write.csv(forecast, file = "Q3.csv")

### Q4

Q4 = read.xlsx("2019Spring\_Time\_Series\_Analysis\_final\_exam\_0620.xlsx", sheet = 4)

prevention = Q4[1:129,]

pre\_data = ts(prevention)

model1 = auto.arima(pre\_data, seasonal = FALSE, test = "adf", ic = "aic")

summary(model1)

T <- nrow(Q4)

St <- c(rep(0,129),rep(1,(T-129)))

sales.tf<-arimax(diff(ts(Q4)), order=c(0,0,1), xtransf= St[2:T],

transfer=list(c(0,0)), include.mean = FALSE)

sales.tf

model = as.vector(fitted(sales.tf))

forecast\_result = forecast(model, h = 12, level = 95)

plot(forecast\_result)

forecast = data.frame(Index = c(1:12), forecast\_result$lower, forecast\_result$mean, forecast\_result$upper)

write.csv(forecast, file = "Q4.csv")