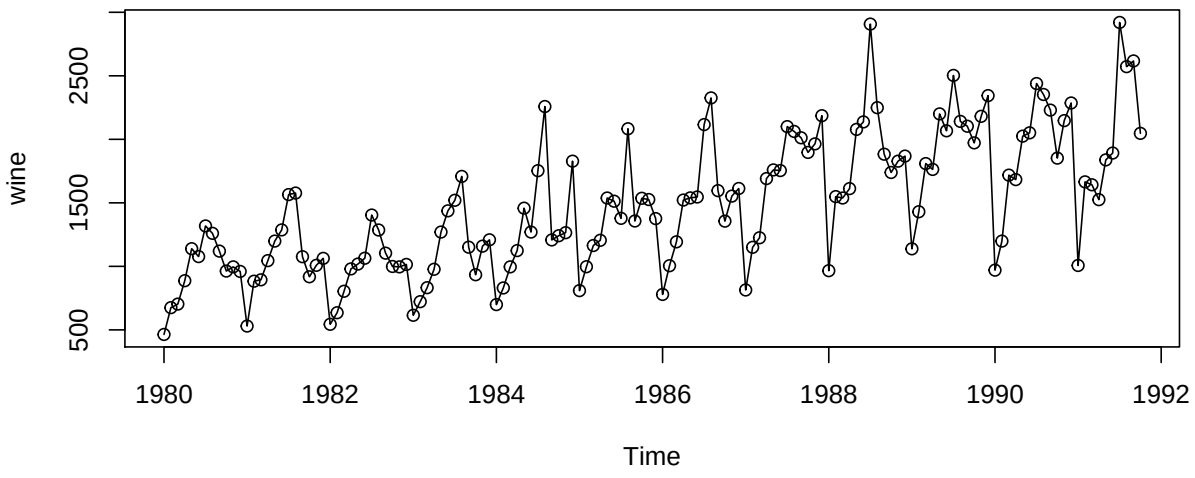
InClass-A3 Sample Analysis

Contents

Here is the code to load the data from the web.

```
source('https://nmimoto.github.io/R/TS-00.txt')

D  <- read.csv("https://nmimoto.github.io/datasets/wine.csv")
D1   <- ts(D, start=c(1980,1), freq=12)
plot(D1, type='o')
```



Now your "D1" in R contains monthly wine sales in Australia.

We will talke log of the data

1. auto.arima() analysis

```
  Fit11 <- auto.arima(D1, lambda=0, stepwise=FALSE, approximation=FALSE)
  Fit11
```

```
## Series: D1
## ARIMA(1,0,1)(0,1,1)[12] with drift
## Box Cox transformation: lambda= 0
##
## Coefficients:
##          ar1      ma1     sma1   drift
##       0.8930  -0.6841  -0.7372  0.0062
## s.e.  0.0785   0.1249   0.0951  0.0008
##
## sigma^2 estimated as 0.0125:  log likelihood=97.74
## AIC=-185.48   AICc=-185   BIC=-171.14
```

```
  Randomness.tests(Fit11$residuals)
```

```
##   B-L test H0: the series is uncorrelated
##   M-L test H0: the square of the series is uncorrelated
##   J-B test H0: the series came from Normal distribution
##   SD         : Standard Deviation of the series
```

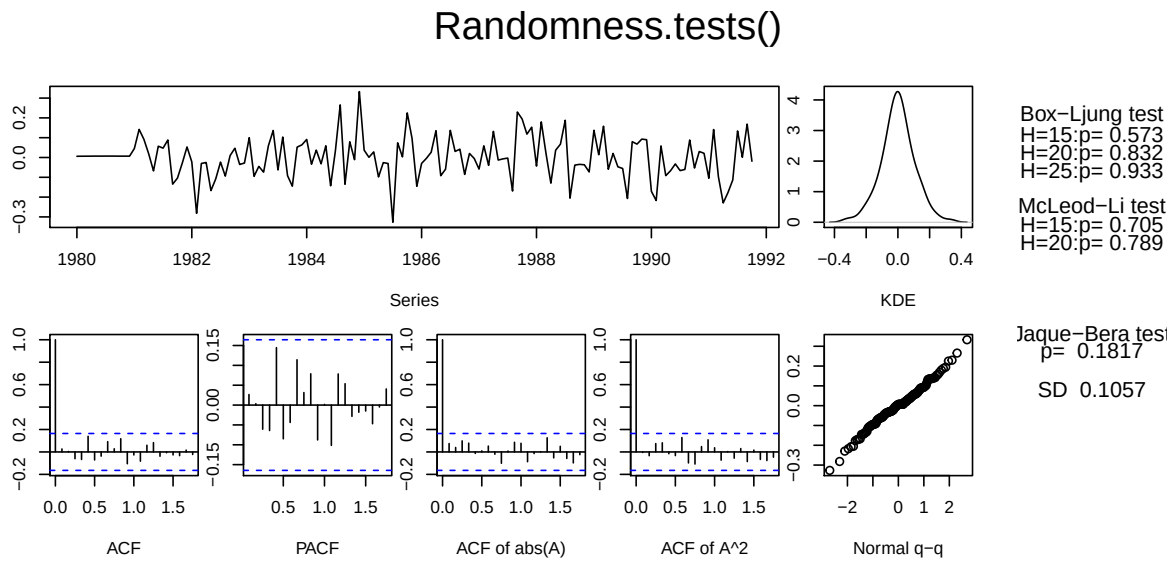
```
##       BL15  BL20  BL25  ML15  ML20    JB    SD
## [1,] 0.573 0.832 0.933 0.705 0.789 0.182 0.106
```

```
##  ARIMA(1,0,1)x(0,1,1)[12]  is suggested.
##  Residual analysis shows adequacy by both L-B test and M-L test.
##
##  Errors (after the log) seems to be nomally distributed, and
##  J-B test confirms that. (p-value > .05)
##
##  We must investigate the choice of d, D, and drift


  # Include drift
  Fit12 <- Arima(D1, lambda=0, order=c(1,0,1), seasonal=c(0,1,1), include.drift=TRUE)
  Fit12
```

```
## Series: D1
## ARIMA(1,0,1)(0,1,1)[12] with drift
## Box Cox transformation: lambda= 0
##
## Coefficients:
##          ar1      ma1     sma1   drift
##       0.8930  -0.6841  -0.7372  0.0062
## s.e.  0.0785   0.1249   0.0951  0.0008
```

```
##
## sigma^2 estimated as 0.0125:  log likelihood=97.74
## AIC=-185.48   AICc=-185   BIC=-171.14
```

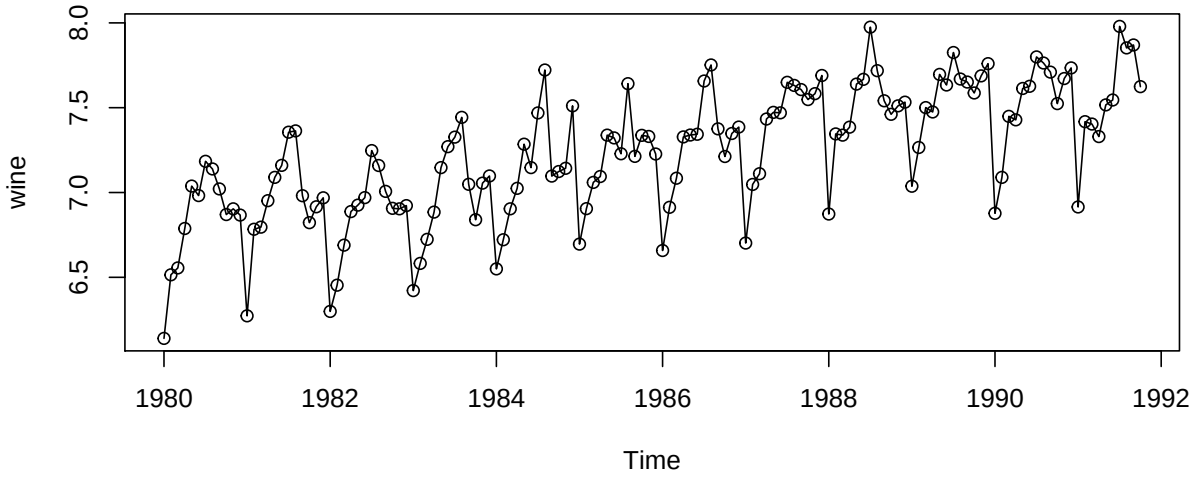
```
Randomness.tests(Fit12$residuals)
```



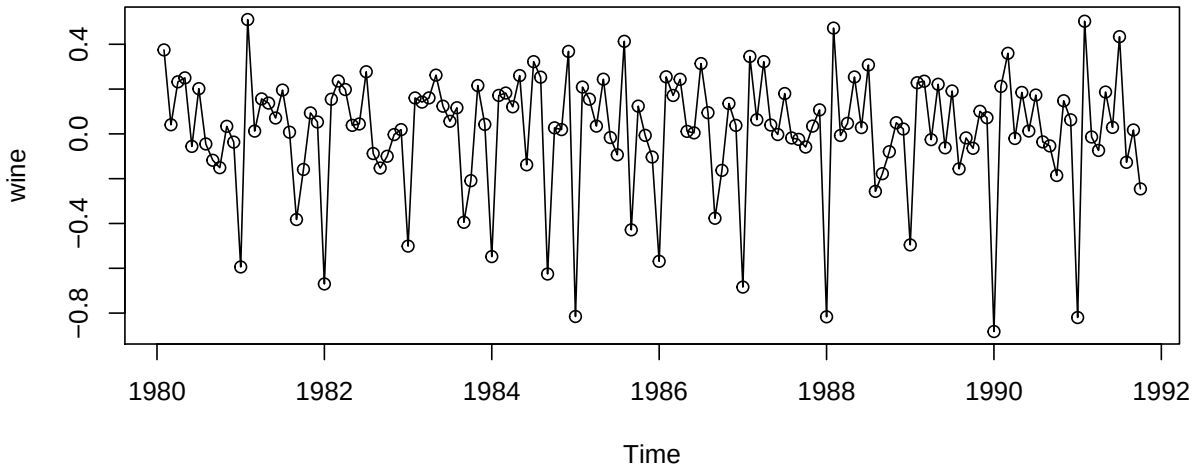

```
##   B-L test H0: the series is uncorrelated
##   M-L test H0: the square of the series is uncorrelated
##   J-B test H0: the series came from Normal distribution
##   SD         : Standard Deviation of the series

##       BL15  BL20  BL25  ML15  ML20    JB    SD
## [1,] 0.573 0.832 0.933 0.705 0.789 0.182 0.106
```

2. Preliminary Analysis

```
plot( log(D1), type='o')
```




```
plot( diff(log(D1)), type='o')  # d=1
```



Stationarity Check

```
Stationarity.tests( diff(log(D1)))
```

```
## Warning in adf.test(A): p-value smaller than printed p-value

## Warning in pp.test(A): p-value smaller than printed p-value
```

```
## Warning in kpss.test(A): p-value greater than printed p-value

##        KPSS  ADF   PP
## p-val:  0.1 0.01 0.01
```

```
  Stationarity.tests( diff(log(D1, 12)))
```

```
## Warning in adf.test(A): p-value smaller than printed p-value

## Warning in pp.test(A): p-value smaller than printed p-value

## Warning in kpss.test(A): p-value greater than printed p-value

##        KPSS  ADF   PP
## p-val:  0.1 0.01 0.01
```

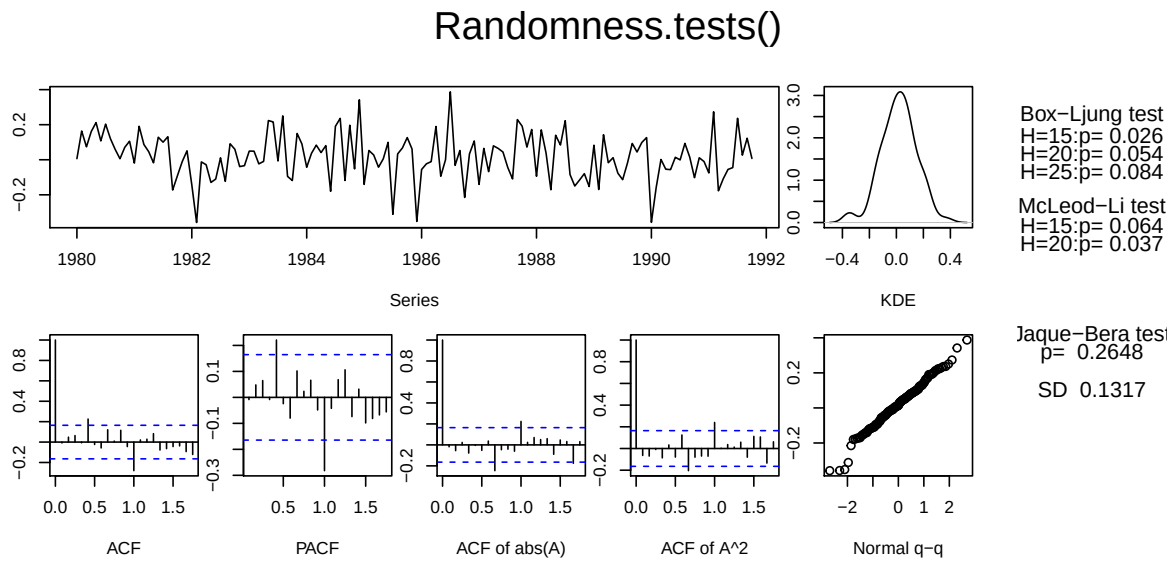
```
## d=1 alone makes it stationary
## D=1 alone makes it stationary
```

3. Difference only (d=1 D=0) model

```
Fit21 <- auto.arima(D1, d=1, D=0, lambda=0, stepwise=FALSE, approximation=FALSE)
Fit21
```

```
## Series: D1
## ARIMA(1,1,1)(1,0,0)[12]
## Box Cox transformation: lambda= 0
##
## Coefficients:
##          ar1      ma1    sar1
##       0.3604  -0.9522  0.8555
## s.e.  0.0876   0.0272  0.0395
##
## sigma^2 estimated as 0.01807:  log likelihood=76.3
## AIC=-144.6   AICc=-144.31   BIC=-132.81
```

```
Randomness.tests(Fit21$resid)
```




```
##   B-L test H0: the series is uncorrelated
##   M-L test H0: the square of the series is uncorrelated
##   J-B test H0: the series came from Normal distribution
##   SD         : Standard Deviation of the series
```

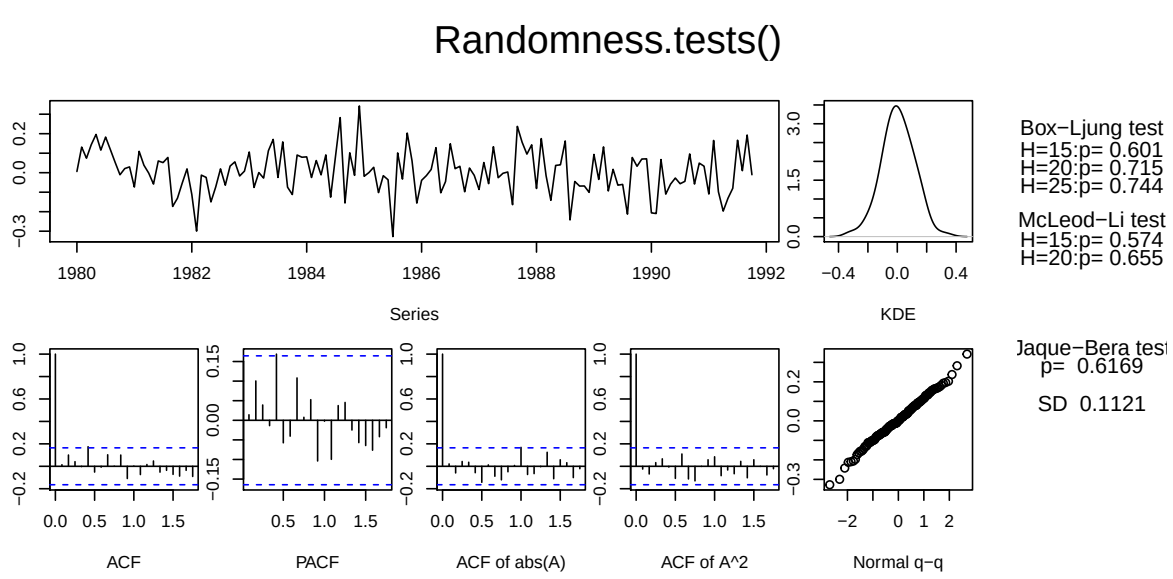
```
##       BL15  BL20  BL25  ML15  ML20    JB    SD
## [1,] 0.026 0.054 0.084 0.064 0.037 0.265 0.132
```

```
## Arima(1,1,1)x(1,0,0)[12] suggested
## Residual does not show adequate fit.  Large ACF at lag 12.
##
```

```
#  Fit21b <- Arima(D1, lambda=0, order=c(1,1,1), seasonal=c(2,0,0))
#  Fit21b
#  Randomness.tests(Fit21b$resid)

## Estimation problem


  Fit21c <- Arima(D1, lambda=0, order=c(1,1,1), seasonal=c(1,0,1))
  Fit21c
```

```
## Series: D1
## ARIMA(1,1,1)(1,0,1)[12]
## Box Cox transformation: lambda= 0
##
## Coefficients:
##          ar1      ma1    sar1     sma1
##       0.1699  -0.8586  0.9924  -0.7314
## s.e.  0.1157   0.0683  0.0066   0.0999
##
## sigma^2 estimated as 0.01296:  log likelihood=93.67
## AIC=-177.34   AICc=-176.9   BIC=-162.6
```

```
  Randomness.tests(Fit21c$resid)
```




```
##   B-L test H0: the series is uncorrelated
##   M-L test H0: the square of the series is uncorrelated
##   J-B test H0: the series came from Normal distribution
##   SD         : Standard Deviation of the series
```

```
##       BL15  BL20  BL25  ML15  ML20    JB    SD
## [1,] 0.601 0.715 0.744 0.574 0.655 0.617 0.112
```

```r
## Residual shows adequate fit.


  Fit21d <- Arima(D1, lambda=0, order=c(1,1,1), seasonal=c(1,0,1),
                                  include.drift=TRUE, method="CSS")
  Fit21d
```

```
## Series: D1
## ARIMA(1,1,1)(1,0,1)[12] with drift
## Box Cox transformation: lambda= 0
##
## Coefficients:
##           ar1      ma1    sar1     sma1    drift
##       -0.0006  -0.7195  0.9755  -0.6522  -0.0391
## s.e.   0.1046   0.0689  0.0170   0.0803   0.0593
##
## sigma^2 estimated as 0.01345:  part log likelihood=99.44
```

```r
## If method="CSS-MLE" (default) then gives error.
## with CSS, drift not significant.
```

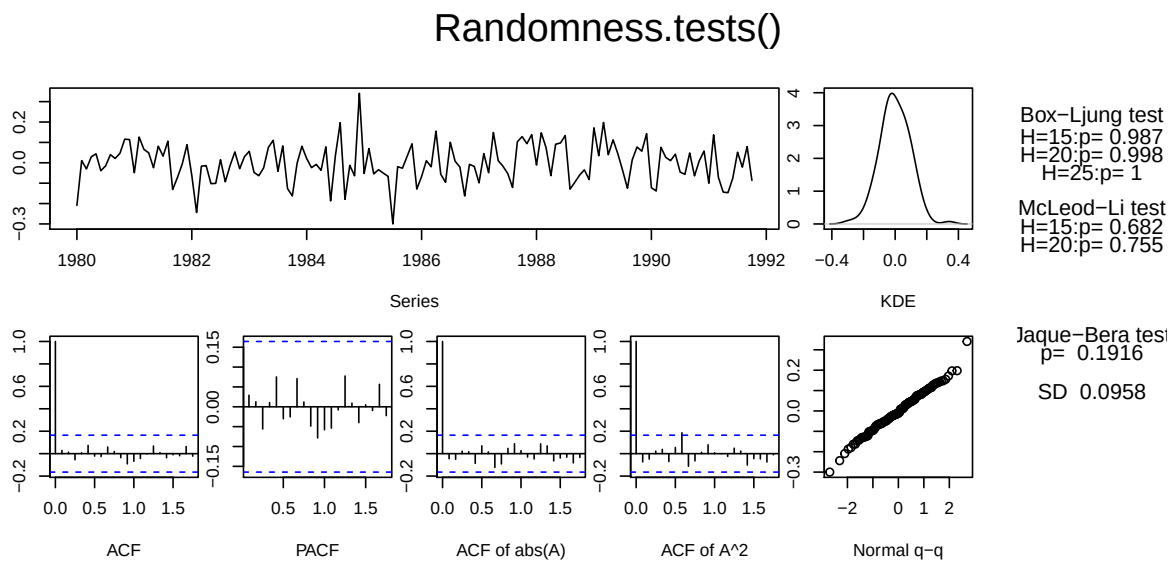
4. Linear Trend Model

From A3

```
Fit  <- Arima(D1, lambda=0, xreg=time(D1), order=c(15,0,15))
Fit
```

```
## Series: D1
## Regression with ARIMA(15,0,15) errors
## Box Cox transformation: lambda= 0
##
## Coefficients:
##           ar1     ar2     ar3     ar4      ar5      ar6      ar7
##       -0.4723  0.7913  0.5113  0.0027  -0.0318  -0.0503  -0.0142
## s.e.   0.3530  0.0957  0.2695  0.0191   0.0199   0.0178   0.0280
##           ar8      ar9     ar10    ar11    ar12    ar13     ar14
##       -0.0407  -0.0407  -0.0241  0.0006  0.9731  0.4417  -0.8183
## s.e.   0.0204   0.0200   0.0232  0.0189  0.0151  0.3394   0.1029
##          ar15     ma1      ma2      ma3      ma4     ma5     ma6
##       -0.5307  0.5832  -0.6181  -0.4634  -0.1164  0.0422  0.0239
## s.e.   0.2802  0.3259   0.1441   0.2274   0.1003  0.1085  0.1560
##           ma7     ma8     ma9    ma10     ma11     ma12     ma13
##       -0.1091  0.0861  0.0428  0.1037  -0.0420  -0.9408  -0.5722
## s.e.   0.1015  0.1174  0.1072  0.1052   0.0945   0.1757   0.2920
##         ma14    ma15  intercept    xreg
##       0.5252  0.4557  -154.8316  0.0816
## s.e.  0.1807  0.2074     5.2452  0.0026
##
## sigma^2 estimated as 0.01176:  log likelihood=113.56
## AIC=-161.11   AICc=-140.34   BIC=-63.57
```

```
Randomness.tests(Fit$resid)
```



```
##   B-L test H0: the series is uncorrelated
##   M-L test H0: the square of the series is uncorrelated
##   J-B test H0: the series came from Normal distribution
##   SD         : Standard Deviation of the series

##       BL15  BL20 BL25  ML15  ML20    JB    SD
## [1,] 0.987 0.998    1 0.682 0.755 0.192 0.096
```

Seasonal ARMA

```
  Fit51 <- auto.arima(D1, d=0, D=0, lambda=0, xreg=time(D1),
                              stepwise=FALSE, approximation=FALSE)
  Fit51
```

```
## Series: D1
## Regression with ARIMA(1,0,0)(1,0,0)[12] errors
## Box Cox transformation: lambda= 0
##
## Coefficients:
##          ar1    sar1  intercept    xreg
##       0.3660  0.8393  -134.4431  0.0713
## s.e.  0.0784  0.0410    25.8403  0.0130
##
## sigma^2 estimated as 0.01749:  log likelihood=80.41
## AIC=-150.82   AICc=-150.38   BIC=-136.05
```

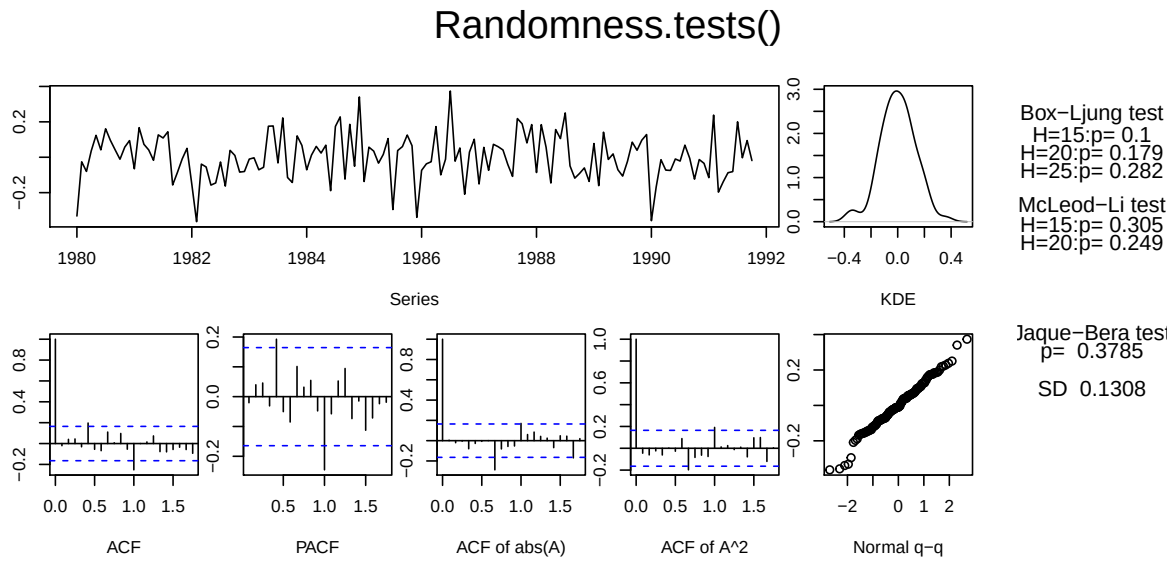
```
  Randomness.tests(Fit51$resid)
```

```
##   B-L test H0: the series is uncorrelated
##   M-L test H0: the square of the series is uncorrelated
##   J-B test H0: the series came from Normal distribution
##   SD         : Standard Deviation of the series

##      BL15  BL20  BL25  ML15  ML20    JB    SD
## [1,]  0.1 0.179 0.282 0.305 0.249 0.378 0.131
```

```
  Fit52 <- Arima(D1, lambda=0, xreg=time(D1), order=c(1,0,0), seasonal=c(1,0,1))
  Fit52
```

```
## Series: D1
## Regression with ARIMA(1,0,0)(1,0,1)[12] errors
## Box Cox transformation: lambda= 0
##
## Coefficients:
##          ar1    sar1     sma1  intercept    xreg
##       0.3549  0.9881  -0.7033  -140.8826  0.0746
## s.e.  0.0786  0.0108   0.1202    12.0115  0.0060
##
## sigma^2 estimated as 0.01342:  log likelihood=94.77
## AIC=-177.54   AICc=-176.92   BIC=-159.81
```

```
Randomness.tests(Fit51$resid)
```




```
##   B-L test H0: the series is uncorrelated
##   M-L test H0: the square of the series is uncorrelated
##   J-B test H0: the series came from Normal distribution
##   SD         : Standard Deviation of the series

##      BL15  BL20  BL25  ML15  ML20    JB    SD
## [1,]  0.1 0.179 0.282 0.305 0.249 0.378 0.131
```

```
Fit52 <- Arima(D1, lambda=0, xreg=time(D1), order=c(1,0,0), seasonal=c(2,0,2))
Fit52
```

```
## Series: D1
## Regression with ARIMA(1,0,0)(2,0,2)[12] errors
## Box Cox transformation: lambda= 0
##
## Coefficients:
##          ar1    sar1    sar2    sma1     sma2  intercept    xreg
##       0.3498  0.1027  0.8803  0.2497  -0.7501  -142.2997  0.0753
## s.e.  0.0789  0.0815  0.0763  0.2168   0.1810    11.1703  0.0056
##
## sigma^2 estimated as 0.01276:  log likelihood=95.72
## AIC=-175.45   AICc=-174.36   BIC=-151.8
```

```
Randomness.tests(Fit51$resid)
```

```
##   B-L test H0: the series is uncorrelated
##   M-L test H0: the square of the series is uncorrelated
##   J-B test H0: the series came from Normal distribution
##   SD         : Standard Deviation of the series
```

```
##      BL15  BL20  BL25  ML15  ML20    JB    SD
## [1,]  0.1 0.179 0.282 0.305 0.249 0.378 0.131
```

```
  Fit52 <- Arima(D1, lambda=0, xreg=time(D1), order=c(1,0,0), seasonal=c(3,0,3))
  Fit52
```

```
## Series: D1
## Regression with ARIMA(1,0,0)(3,0,3)[12] errors
## Box Cox transformation: lambda= 0
##
## Coefficients:

## Warning in sqrt(diag(x$var.coef)): NaNs produced

##          ar1    sar1     sar2    sar3     sma1    sma2     sma3
##       0.3567  1.1329  -0.1353  0.0007  -0.8441  0.0264  -0.0790
## s.e.     NaN  0.1468   0.1624  0.0157   0.0531  0.1667   0.1601
##       intercept    xreg
##       -140.4321  0.0744
## s.e.    10.9536  0.0055
##
## sigma^2 estimated as 0.01299:  log likelihood=96.14
## AIC=-172.28   AICc=-170.6   BIC=-142.72
```

```
  Randomness.tests(Fit51$resid)
```

```
##   B-L test H0: the series is uncorrelated
##   M-L test H0: the square of the series is uncorrelated
##   J-B test H0: the series came from Normal distribution
##   SD         : Standard Deviation of the series

##      BL15  BL20  BL25  ML15  ML20    JB    SD
## [1,]  0.1 0.179 0.282 0.305 0.249 0.378 0.131
```

```
  Fit52 <- Arima(D1, lambda=0, xreg=time(D1), order=c(5,0,4), seasonal=c(1,0,1))
  Fit52
```

```
## Series: D1
## Regression with ARIMA(5,0,4)(1,0,1)[12] errors
## Box Cox transformation: lambda= 0
##
## Coefficients:
##          ar1      ar2      ar3     ar4     ar5     ma1     ma2
##       0.0386  -0.5063  -0.2393  0.2270  0.2628  0.2256  0.8071
## s.e.  0.5987   0.2435   0.3111  0.4598  0.2308  0.6415  0.3719
##          ma3     ma4    sar1     sma1  intercept    xreg
##       0.5866  0.0294  0.9889  -0.6661  -140.7492  0.0745
## s.e.  0.4659  0.5931  0.0093   0.1190    16.3265  0.0082
##
## sigma^2 estimated as 0.01222:  log likelihood=102.23
## AIC=-176.46   AICc=-173.15   BIC=-135.08
```

```
  Randomness.tests(Fit51$resid)
```

```
##   B-L test H0: the series is uncorrelated
##   M-L test H0: the square of the series is uncorrelated
##   J-B test H0: the series came from Normal distribution
##   SD         : Standard Deviation of the series
```

```
##      BL15  BL20  BL25  ML15  ML20    JB    SD
## [1,]  0.1 0.179 0.282 0.305 0.249 0.378 0.131
```

```
  Fit52 <- Arima(D1, lambda=0, xreg=time(D1), order=c(0,0,0), seasonal=c(0,0,0))
  Fit52
```

```
## Series: D1
## Regression with ARIMA(0,0,0) errors
## Box Cox transformation: lambda= 0
##
## Coefficients:
##       intercept    xreg
##       -150.3167  0.0793
## s.e.    13.0042  0.0065
##
## sigma^2 estimated as 0.07206:  log likelihood=-13.74
## AIC=33.48   AICc=33.65   BIC=42.34
```

```
  Randomness.tests(Fit51$resid)
```

```
##   B-L test H0: the series is uncorrelated
##   M-L test H0: the square of the series is uncorrelated
##   J-B test H0: the series came from Normal distribution
##   SD         : Standard Deviation of the series
```

```
##      BL15  BL20  BL25  ML15  ML20    JB    SD
## [1,]  0.1 0.179 0.282 0.305 0.249 0.378 0.131
```

```
  Fit52 <- Arima(D1, lambda=0, xreg=time(D1), order=c(1,0,0), seasonal=c(3,0,0))
  Fit52
```

```
## Series: D1
## Regression with ARIMA(1,0,0)(3,0,0)[12] errors
## Box Cox transformation: lambda= 0
##
## Coefficients:
##          ar1    sar1    sar2    sar3  intercept    xreg
##       0.3607  0.4517  0.2502  0.2198  -133.2316  0.0707
## s.e.  0.0782  0.0847  0.0951  0.0910    17.9158  0.0090
##
## sigma^2 estimated as 0.01446:  log likelihood=92.27
## AIC=-170.53   AICc=-169.7   BIC=-149.84
```

```
  Randomness.tests(Fit51$resid)
```

```
##   B-L test H0: the series is uncorrelated
##   M-L test H0: the square of the series is uncorrelated
##   J-B test H0: the series came from Normal distribution
##   SD         : Standard Deviation of the series

##      BL15  BL20  BL25  ML15  ML20    JB    SD
## [1,]  0.1 0.179 0.282 0.305 0.249 0.378 0.131
```

```
  Fit52 <- Arima(D1, lambda=0, xreg=time(D1), order=c(1,0,1), seasonal=c(3,0,1))
  Fit52
```

```
## Series: D1
## Regression with ARIMA(1,0,1)(3,0,1)[12] errors
## Box Cox transformation: lambda= 0
##
## Coefficients:
##          ar1      ma1    sar1     sar2     sar3     sma1  intercept
##       0.7749  -0.5039  1.1739  -0.0402  -0.1341  -0.9482  -139.8386
## s.e.  0.1373   0.1935  0.1142   0.1423   0.1098   0.1546    13.9300
##         xreg
##       0.0741
## s.e.  0.0070
##
## sigma^2 estimated as 0.01207:  log likelihood=98.44
## AIC=-178.87   AICc=-177.51   BIC=-152.27
```

```
  Randomness.tests(Fit51$resid)
```

```
##   B-L test H0: the series is uncorrelated
##   M-L test H0: the square of the series is uncorrelated
##   J-B test H0: the series came from Normal distribution
##   SD         : Standard Deviation of the series

##      BL15  BL20  BL25  ML15  ML20    JB    SD
## [1,]  0.1 0.179 0.282 0.305 0.249 0.378 0.131
```

```
  # Skip some parameters (Phis, Thetas, icpt, xreg)
  Fit  <- Arima(D1, lambda=0, xreg=time(D1), order=c(15,0,15),
                fixed=c(NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,
                        NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,
                        NA,NA ) )
  Fit
  Randomness.tests(Fit$resid)


  # Skip some parameters (Phis, Thetas, icpt, xreg)
  Fit  <- Arima(D1, lambda=0, xreg=time(D1), order=c(15,0,15), method=("CSS"),
                fixed=c(NA,NA,NA,NA,NA,NA,NA,NA,NA,NA,  0,NA,NA,NA,NA,
                        NA,NA,NA,NA,NA,NA,NA,NA,NA, 0,  0,NA,NA,NA,NA,
```

```
                    NA,NA ) )
Fit
Randomness.tests(Fit$resid)



# Skip some parameters (Phis, Thetas, icpt, xreg)
Fit  <- Arima(D1, lambda=0, xreg=time(D1), order=c(15,0,14), method=("CSS"),
             fixed=c(NA,NA,NA,NA,NA,  NA,NA,NA, 0, 0,   0,NA,NA,NA,NA,
                     NA, 0,NA, 0,NA,  NA,NA,NA, 0, 0,   0,NA,NA,NA,
                     NA,NA ) )
Fit
Randomness.tests(Fit$resid)



# Skip some parameters (Phis, Thetas, icpt, xreg)
Fit  <- Arima(D1, lambda=0, xreg=time(D1), order=c(15,0,14), method=("CSS"),
             fixed=c(NA, 0,NA,NA,NA,   NA,NA, 0, 0, 0,   0,NA,NA,NA,NA,
                     NA, 0,NA, 0,NA,    0,NA, 0, 0, 0,   0,NA,NA,NA,
                     NA,NA ) )
Fit
Randomness.tests(Fit$resid)




# Skip some parameters (Phis, Thetas, icpt, xreg)
Fit  <- Arima(D1, lambda=0, xreg=time(D1), order=c(15,0,13), method=("CSS"),
             fixed=c(NA, 0,NA,NA,NA,   NA,NA, 0, 0, 0,   0,NA,NA,NA,NA,
                     NA, 0,NA, 0,NA,    0,NA, 0, 0, 0,   0,NA,NA,
                     NA,NA ) )
Fit
Randomness.tests(Fit$resid)


# Skip some parameters (Phis, Thetas, icpt, xreg)
Fit  <- Arima(D1, lambda=0, xreg=time(D1), order=c(15,0,12), method=("CSS"),
             fixed=c(NA, 0,NA,NA,NA,   NA,NA, 0, 0, 0,   0,NA,NA,NA,NA,
                     NA, 0,NA, 0,NA,    0,NA, 0, 0, 0,   0,NA,
                     NA,NA ) )
Fit
Randomness.tests(Fit$resid)


# Skip some parameters (Phis, Thetas, icpt, xreg)
Fit  <- Arima(D1, lambda=0, xreg=time(D1), order=c(15,0,12),
             fixed=c(NA, 0,NA,NA,NA,   NA,NA, 0, 0, 0,   0,NA,NA,NA,NA,
                     NA, 0,NA, 0,NA,    0,NA, 0, 0, 0,   0,NA,
                     NA,NA ) )
Fit
Randomness.tests(Fit$resid)
```

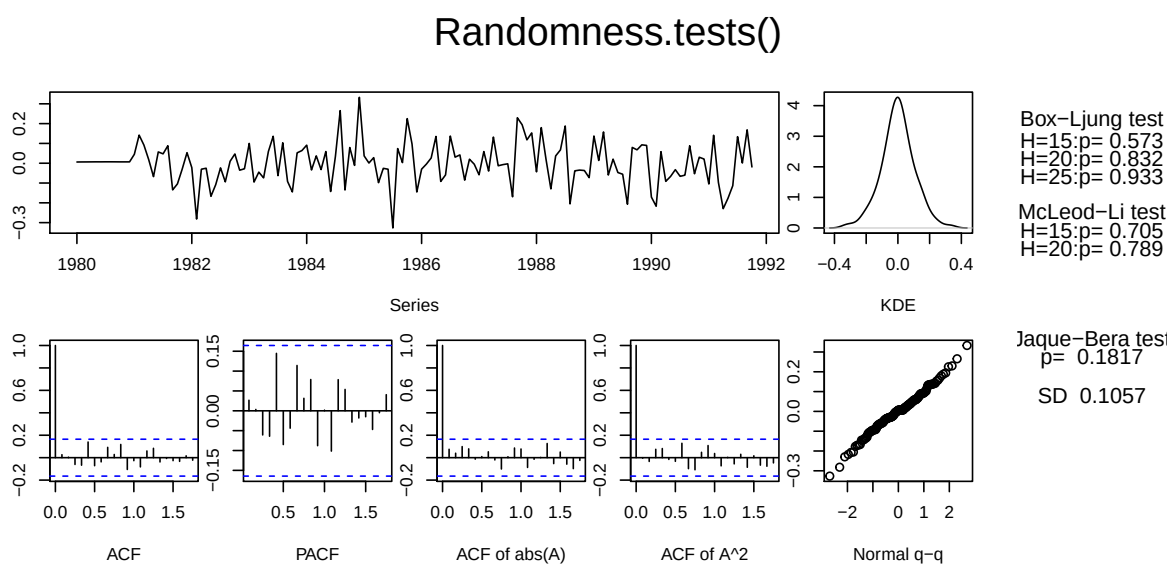
```r
# Skip some parameters (Phis, Thetas, icpt, xreg)
Fit  <- Arima(D1, lambda=0, xreg=time(D1), order=c(15,0,15))
Fit
Randomness.tests(Fit$resid)


# Skip some parameters (Phis, Thetas, icpt, xreg)
Fit  <- Arima(D1, lambda=0, xreg=time(D1), order=c(14,0,14))
Fit
Randomness.tests(Fit$resid)
```

5. Rolling 1-step with D=1 model

```
  Fit12
```

```
## Series: D1
## ARIMA(1,0,1)(0,1,1)[12] with drift
## Box Cox transformation: lambda= 0
##
## Coefficients:
##          ar1      ma1     sma1   drift
##       0.8930  -0.6841  -0.7372  0.0062
## s.e.  0.0785   0.1249   0.0951  0.0008
##
## sigma^2 estimated as 0.0125:  log likelihood=97.74
## AIC=-185.48   AICc=-185   BIC=-171.14
```

```
  Randomness.tests(Fit12$resid)
```



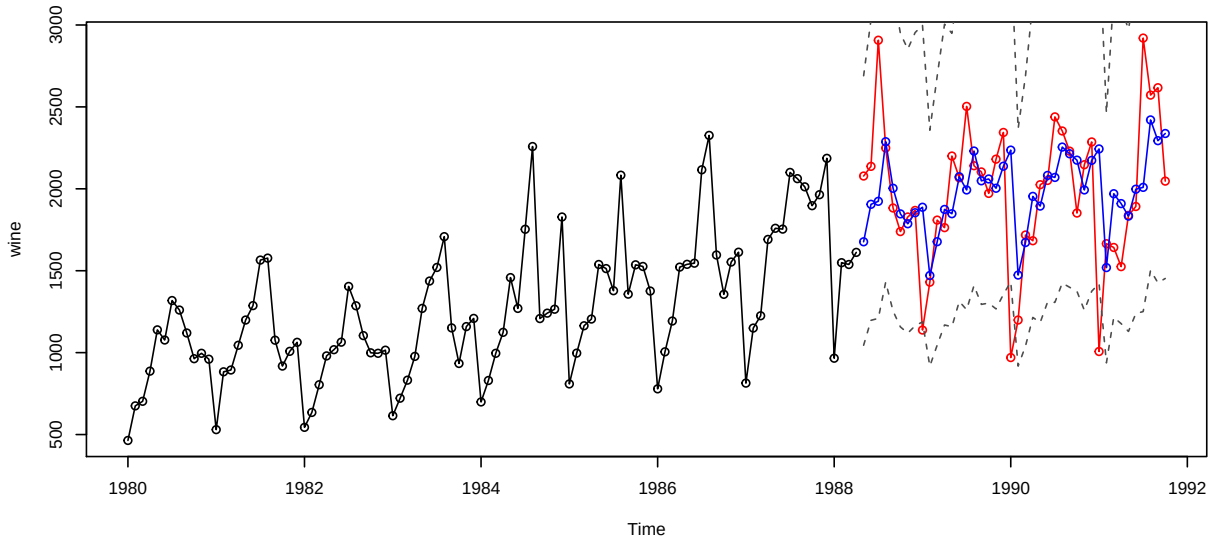

```
##   B-L test H0: the series is uncorrelated
##   M-L test H0: the square of the series is uncorrelated
##   J-B test H0: the series came from Normal distribution
##   SD         : Standard Deviation of the series
```

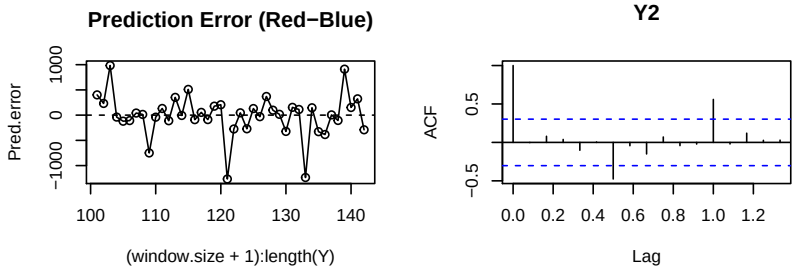
```
##       BL15  BL20  BL25  ML15  ML20    JB    SD
## [1,] 0.573 0.832 0.933 0.705 0.789 0.182 0.106
```

```
## Arima(1,0,1)x(0,1,1)[12] w drift
```

```r
#- Set options
Y <- D1                      # Original data
window.size <- 100           # Window size for estimation
Arima.order <- c(1,0,1)   # Arima(p,d,q) order
pred.plot   <- TRUE          # do you want plot at end?

#- set Arima() options:
include.mean  = TRUE         #
include.drift = TRUE         #
lambda    = 0                # NULL=no transformaton. 0=Log
xreg      = NULL             # NULL=no xreg. TRUE=Linear Trend is present
seasonal = c(0, 1, 1)        # seasonal component

#- then use the function
Rolling1step.forecast(Y, window.size, Arima.order, pred.plot,
                        include.mean, include.drift, lambda, xreg, seasonal)
```

```
##
## Last  42  obs fit retrospectively
##     with Rolling 1-step prediction
##   Average prediction error:  -7.055
##   root Mean Squared Error:   413.9975
```





```
##      mean pred error     rMSE
## [1,]          -7.055 413.9975
```

TS Class Webpage – R resource page