Series

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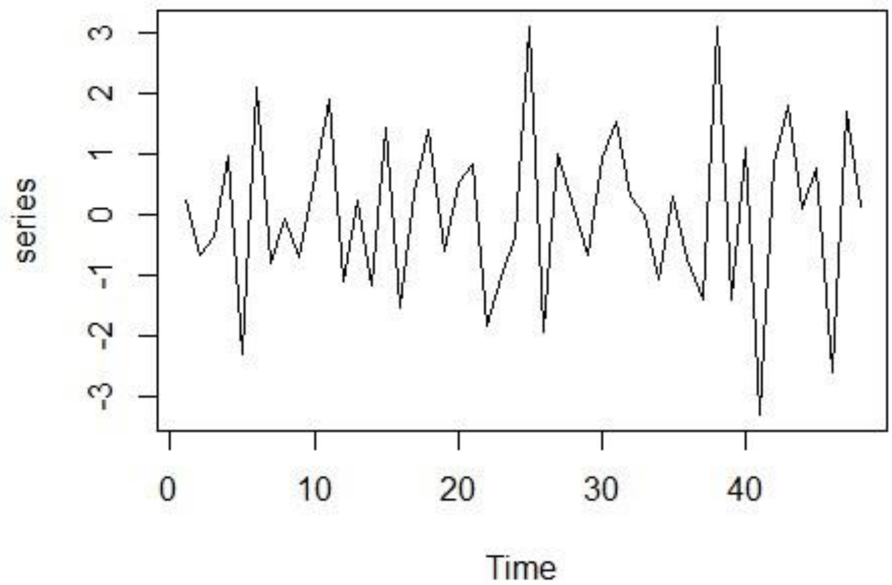
```
library(TSA)

## Warning: package 'TSA' was built under R version 4.3.2

##
## Attaching package: 'TSA'

## The following objects are masked from 'package:stats':
##
##     acf, arima

## The following object is masked from 'package:utils':
##
##     tar

library(tseries)

## Warning: package 'tseries' was built under R version 4.3.2

## Registered S3 method overwritten by 'quantmod':
##   method            from
##   as.zoo.data.frame zoo
```

7.9 Simulate an MA(1) series with θ = 0.8 and n = 48.

a) Find the method-of-moments estimate of θ.

```
set.seed(12345)
series = arima.sim(n = 48, list(ma = -0.8))
plot(series)
```




```
#method of moments estimate for
MA(1) print("The estimate is:") ## [1]
"The estimate is:"

estimate.ma1.mom=function(x){
  r=acf(x,plot=F)$acf[1]; if (abs(r)<0.5) return((-1+sqrt(1-4*r^2))/(2*r))
else return(NA)}  estimate.ma1.mom(series)

## [1] 0.7100616
```

(b)Find the conditional least squares estimate of θ and compare it with part (a).

```
arima(series,order=c(0,0,1),method='CSS')

##
## Call:
## arima(x = series, order = c(0, 0, 1), method = "CSS") ##
## Coefficients:
##             ma1   intercept
##         -0.8552      0.0407 ##
s.e.   0.0953     0.0253
##
## sigma^2 estimated as 1.188:  part log likelihood = -72.25
```

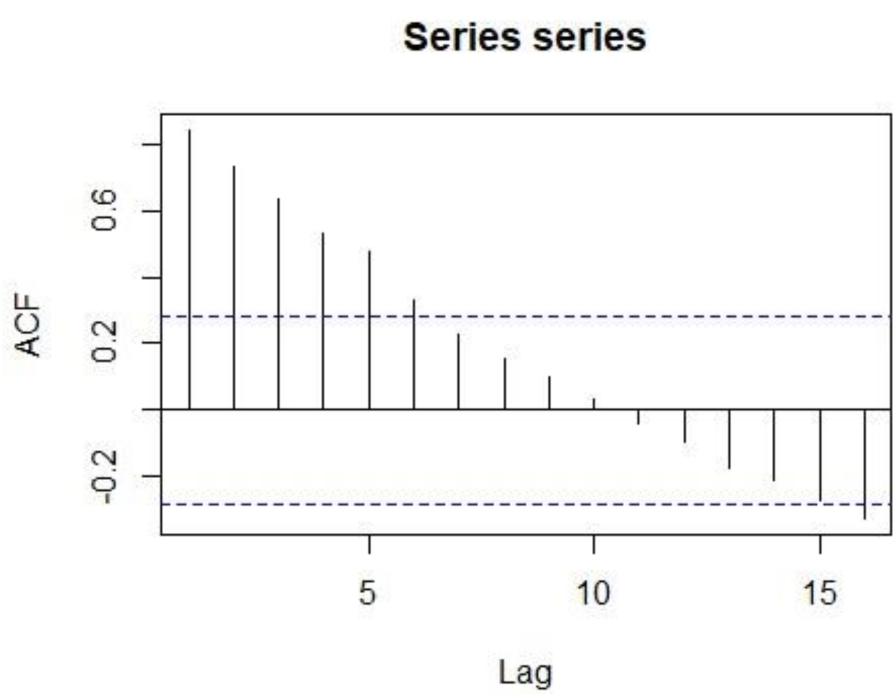
THe least sqaure estimate is 0.8552. This estimate is closer than the estimate from part a.
(c)Find the maximum likelihood estimate of θ and compare it with parts (a) and (b).

```
arima(series,order=c(0,0,1),method='ML')

##
## Call:
## arima(x = series, order = c(0, 0, 1), method = "ML") ##
## Coefficients:
##            ma1  intercept
##        -1.0000     0.0552 ##
s.e.   0.0719     0.0104
##
## sigma^2 estimated as 1.063:  log likelihood = -71.53,  aic = 147.06
```

The estimate of theta is 1 and this is the best of the estimates.

7.13 Simulate an AR(1) series with φ = 0.8 and n = 48.

```
series=arima.sim(n=48,list(ar=0.8)) acf(series)$acf[1]
```




```
## [1] 0.8408491
```

(a)Find the method-of-moments estimate of φ.

```
arima(series,order=c(1,0,0),method='CSS')$coef[1]
##       ar1
## 0.8528083
```

The method of moments estimate is 0.8528083 (b)Find the conditional least squares estimate of φ and compare it with part (a).

```
arima(series,or
der=c(1,0,0),me
thod='CSS')$coe
f[1]
```

```
##       ar1  ##
0.8528083
```

The estimates are very close.

(c)Find the maximum likelihood estimate of φ and compare it with parts (a) and (b)

```
arima(series,order=c(1,0,0),method='ML')$coef[1]
```

```
##       ar1
## 0.8361307
```

All three of the estimates are very close. This maximum likelihood is smaller than the estimates from part a and part b.

7.28 The data file named deere3 contains 57 consecutive values from a complex machine tool at Deere &Co. The values given are deviations from a target value in units of ten millionths of an inch. The process employs acontrol mechanism that resets some of the parameters of the machine tool depending on the magnitude of deviationfrom target of the last item produced.

```
data(deere3)
```

(a)Estimate the parameters of an AR(1) model for this series.

```
arima(deere3,order=c(1,0,0))
```

```
##  ## Call:
## arima(x = deere3, order = c(1, 0, 0))
##
## Coefficients:
##          ar1  intercept
##       0.5255   124.3832
## s.e.  0.1108   394.2067
##
## sigma^2 estimated as 2069355:  log likelihood = -
495.51,  aic = 995.02
```

The estimated parameter of the AR(1) model for the series is 0.5256

(b)Estimate the parameters of an AR(2) model for this series and compare the results with those in part (a)

```
arima(deere3,order=c(2,0,0))
```

```
##
## Call:
## arima(x = deere3, order = c(2, 0, 0))
##
## Coefficients:
##          ar1     ar2  intercept
##       0.5211  0.0083   123.2979
## s.e.  0.1310  0.1315   397.6134 ##
## sigma^2 estimated as 2069208:  log likelihood = -495.51,  aic = 997.01
```

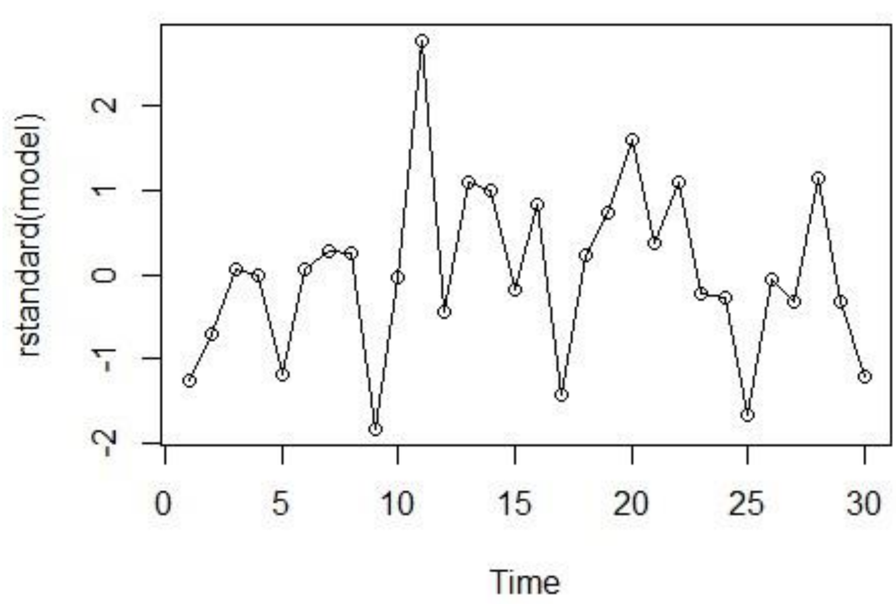
The AR2 coefficient 0.0083. The AR(2) coefficients is relatively small, indicating that adding the AR(2) term doesn't significantly improve the model fit in this case.

8.4 Simulate an AR(1) model with n = 30 and φ = 0.5.

```
set.seed(1000)
series<-arima.sim(n=30,list(ar=0.5))
```

(a)Fit the correctly specified AR(1) model and look at a time series plot of the residuals. Does the plot support the AR(1) specification?

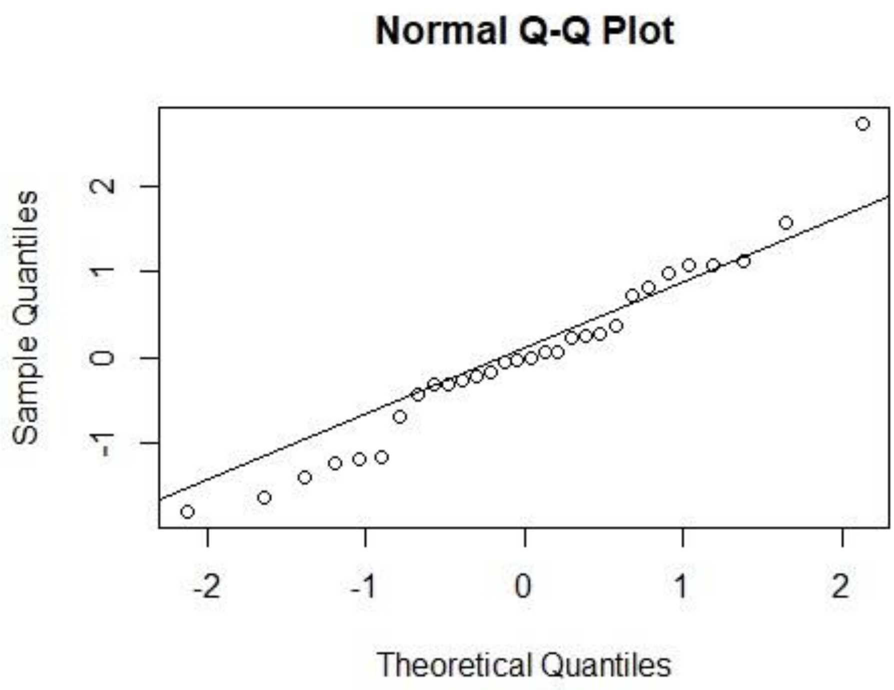
```
 model<- arima(series,order=c(1,0,0))
plot(rstandard(model), type='o')
```



NO, the points are random.

(b)Display a normal quantile-quantile plot of the standardized residuals. Does the plot support the AR(1) specification

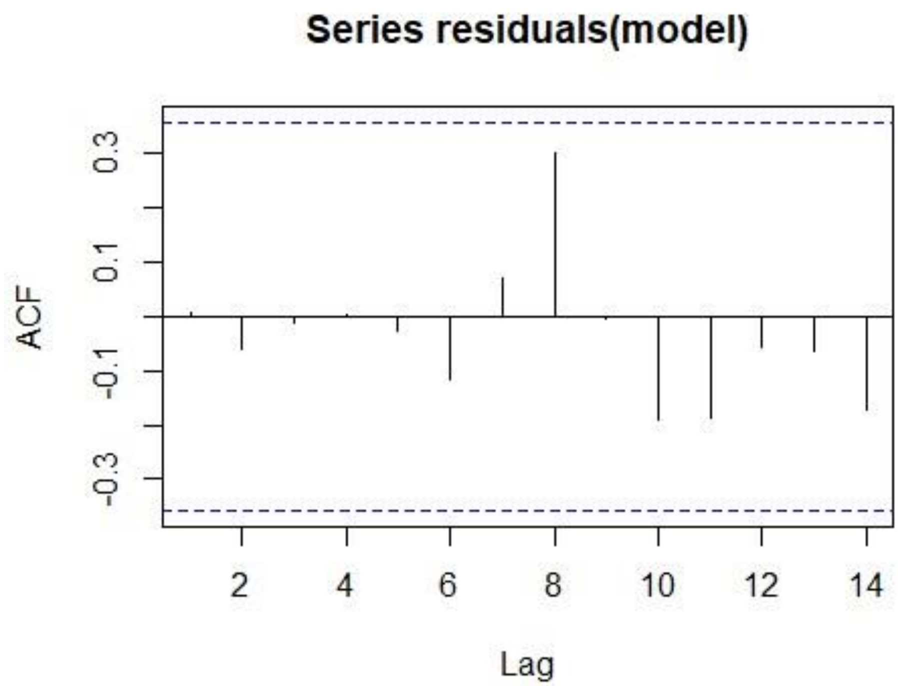
```r
qqnorm(residuals(model))
qqline(residuals(model))
```



There are very few outliers with minor violation. The plot is almost normal.

Display the sample ACF of the residuals. Does the plot support the AR(1) specification?

```r
acf(residuals(model))
```



The plot support.

(d)Calculate the Ljung-Box statistic summing to K = 8. Does this statistic support the AR(1) specification?

```
LB.test(model,lag=8)

##
##  Box-Ljung test
##
## data:  residuals from  model
## X-squared = 4.8905, df = 7, p-value = 0.6733
```

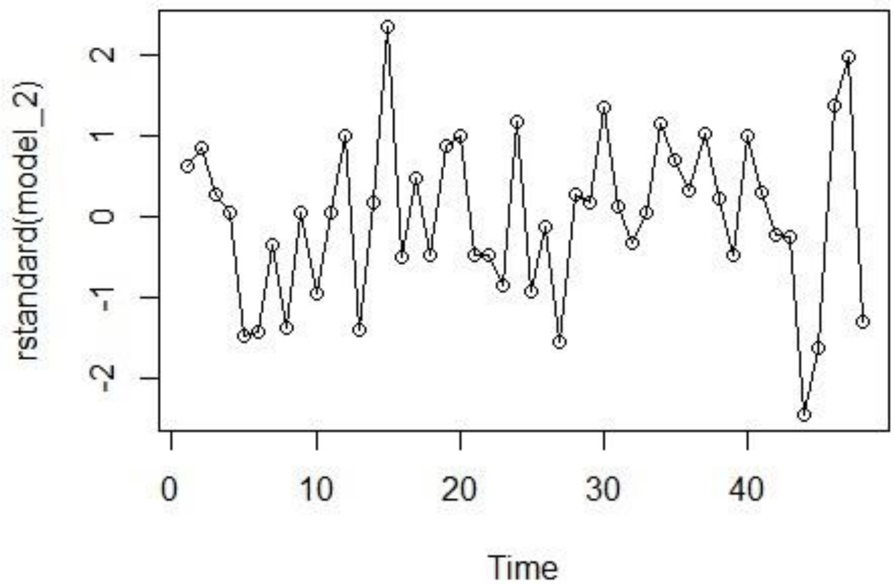
Pvalue >.05 The test Fail to reject

8.6 Simulate an AR(2) model with n = 48, φ1 = 1.5, and φ2 = −0.75.

```
set.seed(1000)  series <-
arima.sim(n=48,list(ar=c(1.5,-0.75)))
```

(a)Fit the correctly specified AR(2) model and look at a time series plot of the residuals. Does the plot support the AR(2) specification?

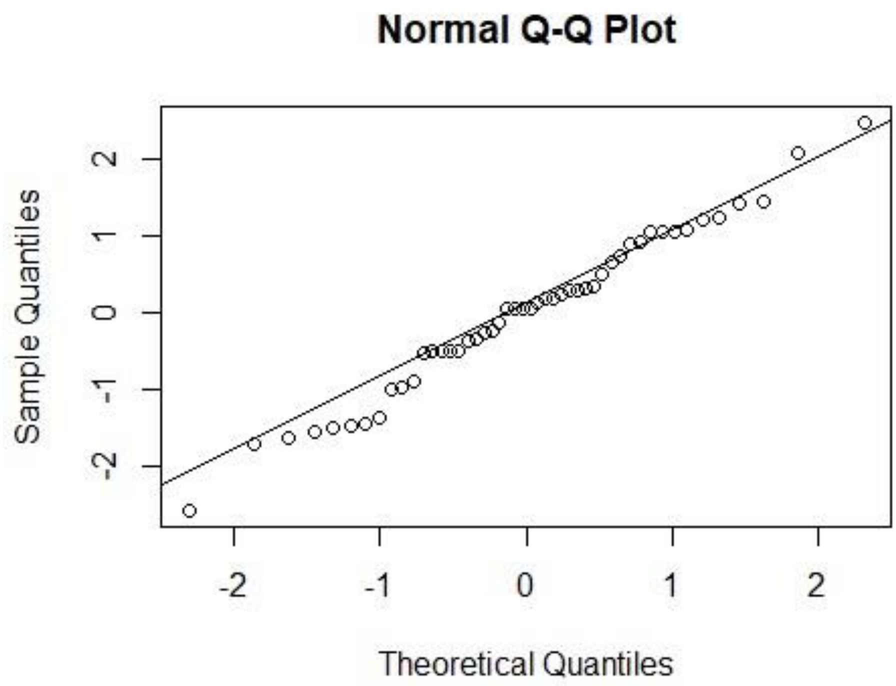
```
model_2 <-arima(series,order=c(2,0,0))
plot(rstandard(model_2), type='o')
```



The residual is random.

(b)Display a normal quantile-quantile plot of the standardized residuals. Does the plot support the AR(2) specification?

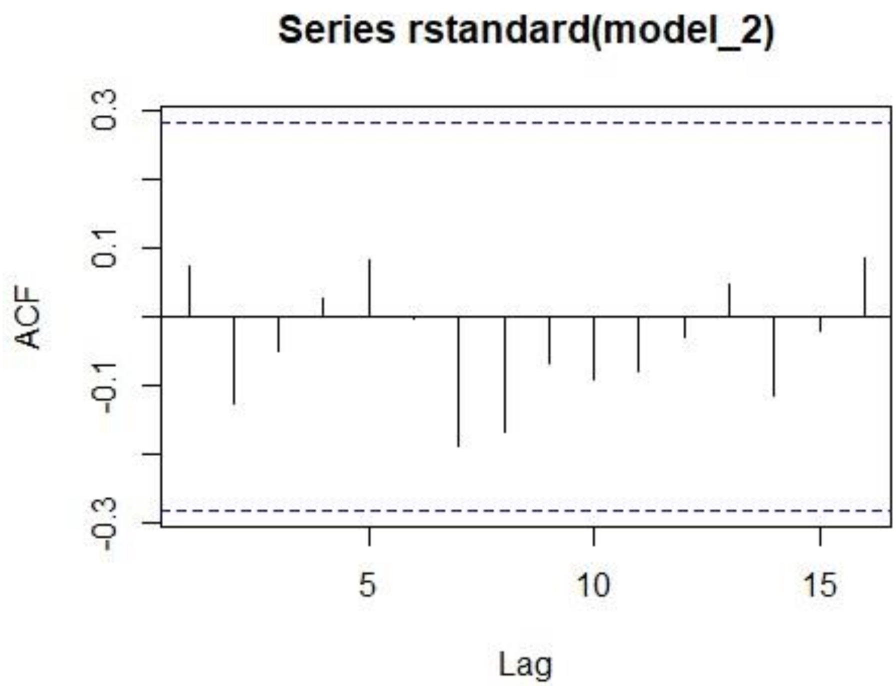
```
qqnorm(residuals(model_2))
qqline(residuals(model_2))
```



The plot support normality.

(c) Display the sample ACF of the residuals. Does the plot support the AR(2) specification?

```
acf(rstandard(model_2))
```



THere are no residual auto correlations that are significant

(d)Calculate the Ljung-Box statistic summing to K = 12. Does this statistic support the AR(2) specification?

```
LB.test(model_2,lag=12)
```

```
##
##  Box-Ljung test
##
## data:  residuals from  model_2
## X-squared = 6.7585, df = 10, p-value = 0.748
```

pvalue 0.748 >0.05 The test Fail to reject