# W271 - Applied Regression and Time Series Analysis - HW7

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## Question 1:

#### 1.1 Load hw07_series1.csv

```
# load data
setwd("~/Desktop/W271Data")
x1 <- read.csv('hw07_series1.csv', header = T)
```

#### 1.2 Describe the basic structure of the data and provide summary statistics of the series

```
str(x1)
```

```
## 'data.frame':    74 obs. of  1 variable:
##  $ X10.01: num  10.07 10.32 9.75 10.33 10.13 ...
```

```
head(x1)
```

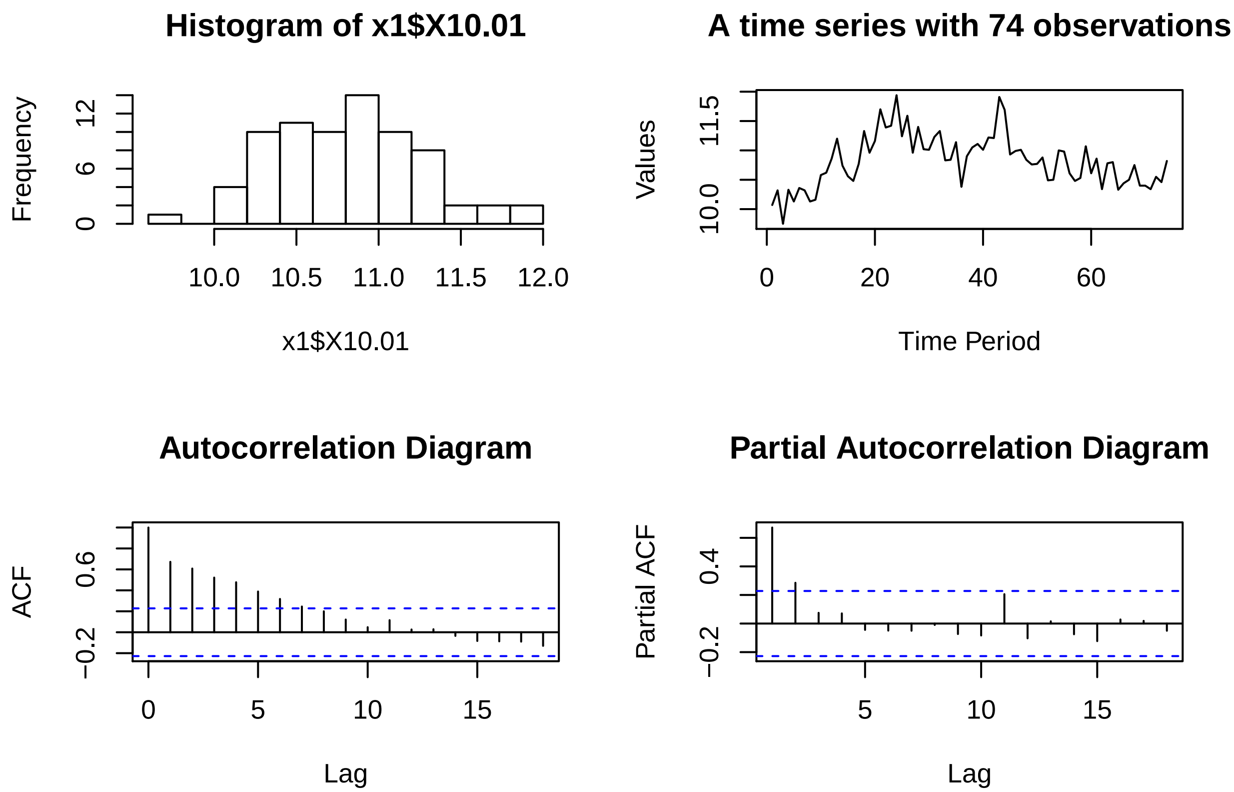
```
##   X10.01
## 1  10.07
## 2  10.32
## 3   9.75
## 4  10.33
## 5  10.13
## 6  10.36
```

```
summary(x1$X10.01)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
##    9.75   10.48   10.82   10.82   11.07   11.94
```

#### 1.3 Plot histogram and time-series plot of the series. Describe the patterns exhibited in histograrm and time-series plot. For time series analysis, is it sufficient to use only histogram to describe a series?

```
par(mfrow=c(2,2))
    hist(x1$X10.01)
    plot.ts(x1, type='l',
         main="A time series with 74 observations",
         ylab="Values", xlab="Time Period")
    acf(x1, main="Autocorrelation Diagram")
    pacf(x1, main="Partial Autocorrelation Diagram")
```




the histogram shows some negative skew. The time-series plot is increasing at the beginning, then drops a bit before another cycle of increase and drop. With limited sample size, it's hard to conclude if there is any trend or seasonal pattern in the data. Histogram alone is **not** enough, as it doesn't show the temporal information in the data, thus we can tell the dynamics of the series.

### 1.4 Plot the ACF and PACF of the series. Describe the patterns exhibited in the ACF and PACF.

The ACF has shown a gradual decay with positive value, and the PACF drops significantly after 2 lags. Based on these observation, it is like the series is an $AR(1)$ model.

### 1.5 Estimate the series using the ar() function.

```r
ar.1 <- ar(x1$X10.01, method="mle")
ar.1
```

```
##
## Call:
## ar(x = x1$X10.01, method = "mle")
##
## Coefficients:
##      1       2
## 0.4821  0.3050
##
## Order selected 2  sigma^2 estimated as  0.09195
```

### 1.6 Report the estimated AR parameters, the order of the model, and standard errors.

The order the model is `2`, and standard errors is `0.3032`.

# Question 2:

**2.1 Simulate a time series of lenght 100 for the following model. Name the series $x$.**

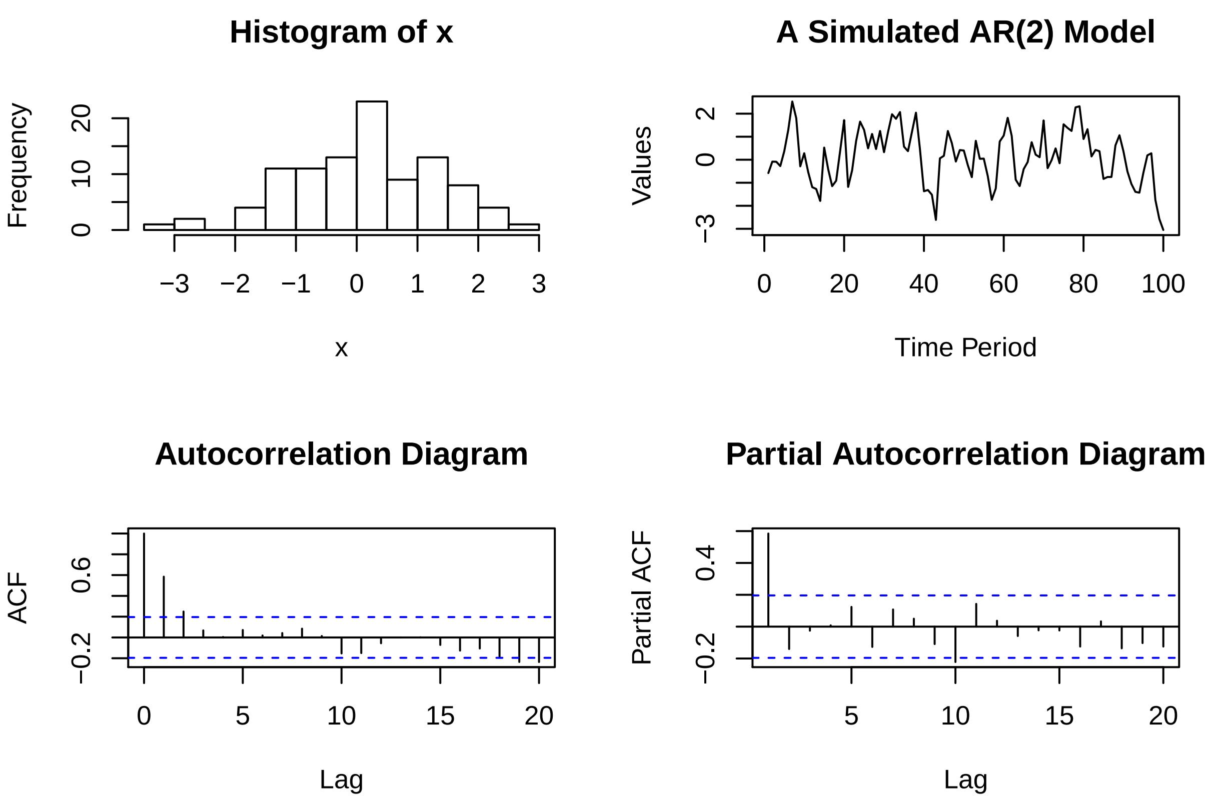
$$x_t = \frac{5}{6}x_{t-1} - \frac{1}{6}x_{t-2} + \omega_t$$

```
set.seed(898)
    n <- 100
    x <- w <- rnorm(n)
    for (t in 3:n) x[t] <- 5*x[t-1]/6 - x[t-2]/6 + w[t] # a zero-mean AR(2) process
    summary(x)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
## -3.0520 -0.6126  0.2504  0.1485  1.0380  2.5300
```

**2.2 Plot the correlogram and partial correlogram for the simulated series. Comments on the plots.**

```
par(mfrow=c(2,2))
    hist(x)
    plot.ts(x, type='l',
         main="A Simulated AR(2) Model",
         ylab="Values", xlab="Time Period")
    acf(x, main="Autocorrelation Diagram")
    pacf(x, main="Partial Autocorrelation Diagram")
```



There isn't any trend or seasonal pattern from the series, both ACF and PACF oscillate. However, the PACF drops significantly just after 1st leg, which indicates an AR order of 1.

**2.3 Estimate an AR model for this simulated series. Report the estimated AR parameters, standard erros, and the order of the AR model.**

```
ar.2 <- ar(x, method="mle")
ar.2
```

```
##
## Call:
## ar(x = x, method = "mle")
##
## Coefficients:
##      1
## 0.6301
##
## Order selected 1  sigma^2 estimated as  0.8326
```

The order the model is `1`, and standard errors is `0.9125`.

**2.4 Construct a 95% confidence intervals for the parameter estimates of the estimated model. Do the "true" model parameters fall within the confidence intervals? Explain the 95% confidence intervals in this context.**

The 95% confidence intervals for the estimated paramter is:

```
ar.2$ar + c(-2,2)*sqrt(ar.2$asy.var)
```

```
## [1] 0.4717157 0.7885164
```

the "true" model does not have the same order with estimated model.

**2.5 Is the estimated model stationary or non-stationary?**

For the estimated model:

```
polyroot(c(1,-ar.2$ar))
```

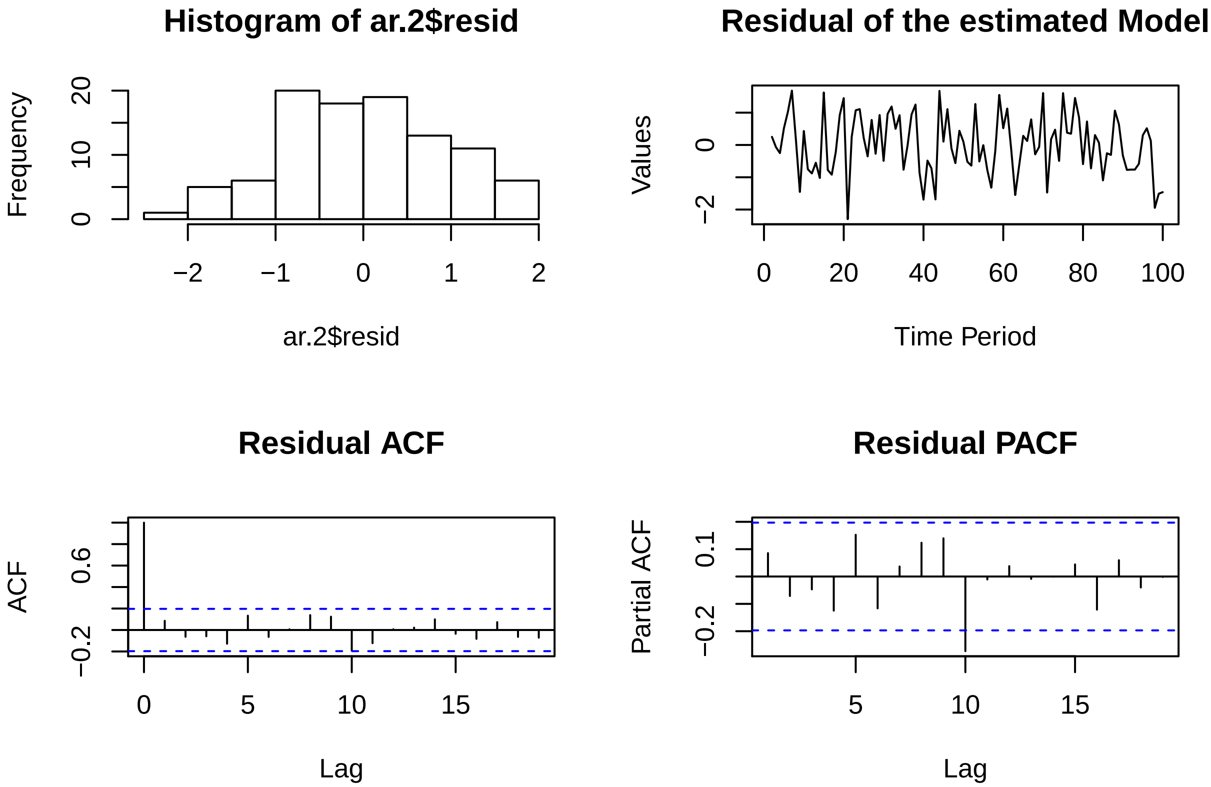
```
## [1] 1.587009+0i
```

the single root is bigger than zero, thus the model is stationary.

**2.6 Plot the correlogram of the residuals of the estimated model. Comment on the plot.**

Check the residual:

```
par(mfrow=c(2,2))
    hist(ar.2$resid)
    plot.ts(ar.2$resid, type='l',
         main="Residual of the estimated Model",
         ylab="Values", xlab="Time Period")
    acf(ar.2$resid, main="Residual ACF", na.action = na.omit)
    pacf(ar.2$resid, main="Residual PACF", na.action = na.omit)
```




From both ACF and PACF the residuals don't have any correlation and demonstrate random pattern.