W3.Autoregressive Process

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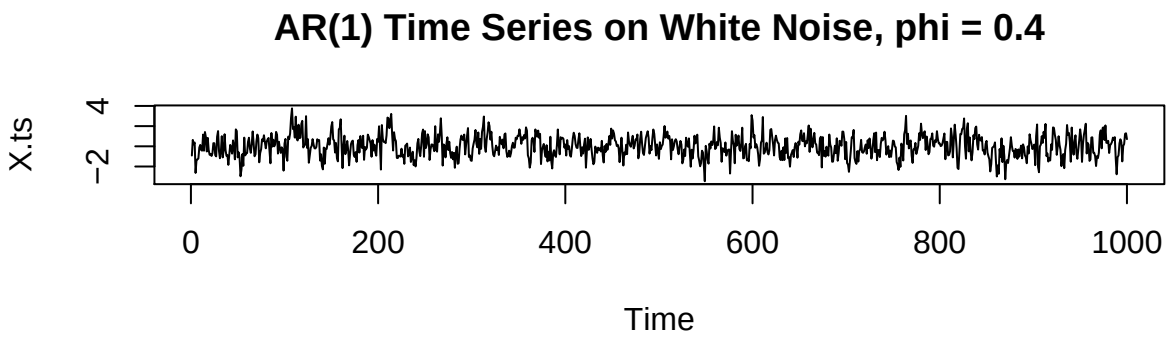
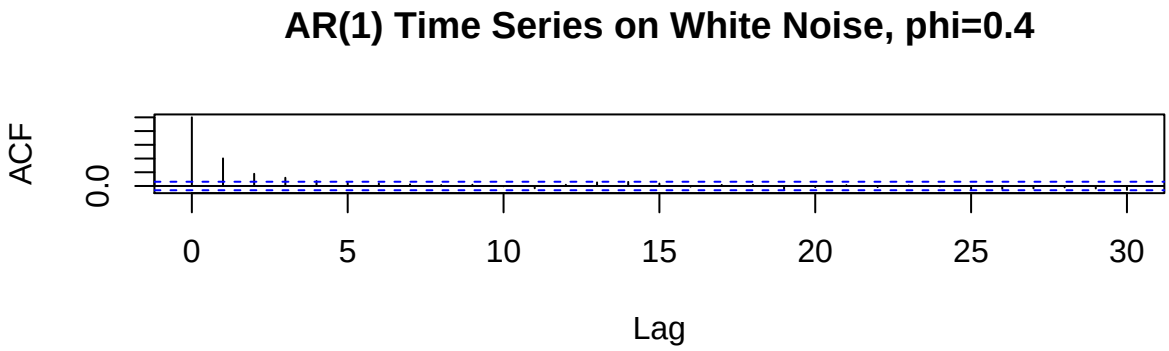
```r
#Xt=Zt+0.4*Xt-1 p=1, phi=0.4
set.seed(2016)  #everybody have same data-run simulation
N=1000
phi=0.4

Z=rnorm(N,0,1)  #standard normal distribution-a family of independent r.v.-white noise
X = NULL  #create a NULL variable named X
X[1]=Z[1]  #start filling X
for (t in 2:N) {
  X[t]=Z[t]+phi*X[t-1]
}  #create a new dataset-AR(1)

#print(X)  # only dataset-no struture
X.ts=ts(X)  #create time series object
#X.ts

par(mfrow = c(2,1))  #set up plots - 2 rows, 1 column
plot(X.ts, main= 'AR(1) Time Series on White Noise, phi = 0.4')
# plot time series-some dependence upon neighbors
#-not just noise, exist some correlation-not quantitative result
X.acf=acf(X.ts, main='AR(1) Time Series on White Noise, phi=0.4')
```





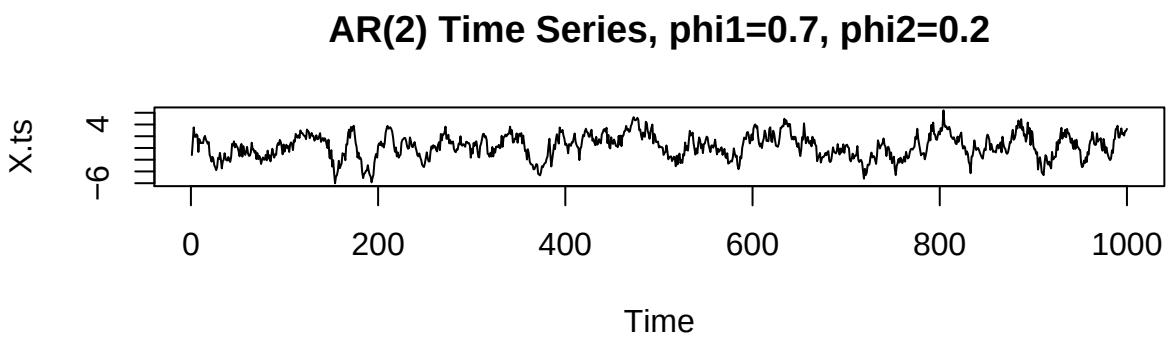

```r
#plot estimated ACF-get quantitative analysis
#-after 3 lags-correlation get down to noise

(r.coef = X.acf$acf)
```

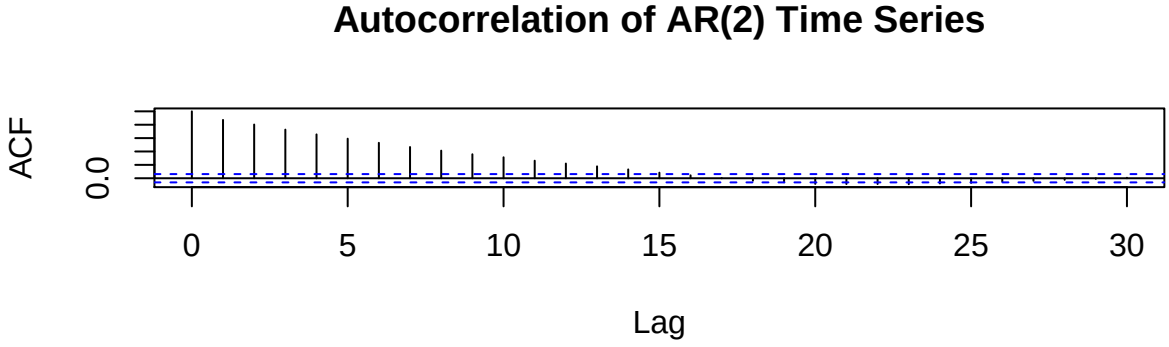
```
## , , 1
##
##               [,1]
##  [1,]  1.000000000
##  [2,]  0.401713170
##  [3,]  0.177573718
##  [4,]  0.119641043
##  [5,]  0.071904921
##  [6,]  0.047447351
##  [7,]  0.034636313
##  [8,]  0.023923786
##  [9,]  0.012689740
## [10,]  0.018391110
## [11,] -0.004244947
## [12,] -0.033390211
## [13,]  0.018022066
## [14,]  0.052141188
## [15,]  0.059632538
## [16,]  0.035110666
## [17,] -0.009958195
## [18,]  0.015682778
```

```
## [19,]  0.016614560
## [20,] -0.052974858
## [21,] -0.017245638
## [22,]  0.012411935
## [23,] -0.016436721
## [24,]  0.007832091
## [25,] -0.005686793
## [26,] -0.047648264
## [27,] -0.042295406
## [28,] -0.034836005
## [29,] -0.019864318
## [30,] -0.036108573
## [31,] -0.057826140
```

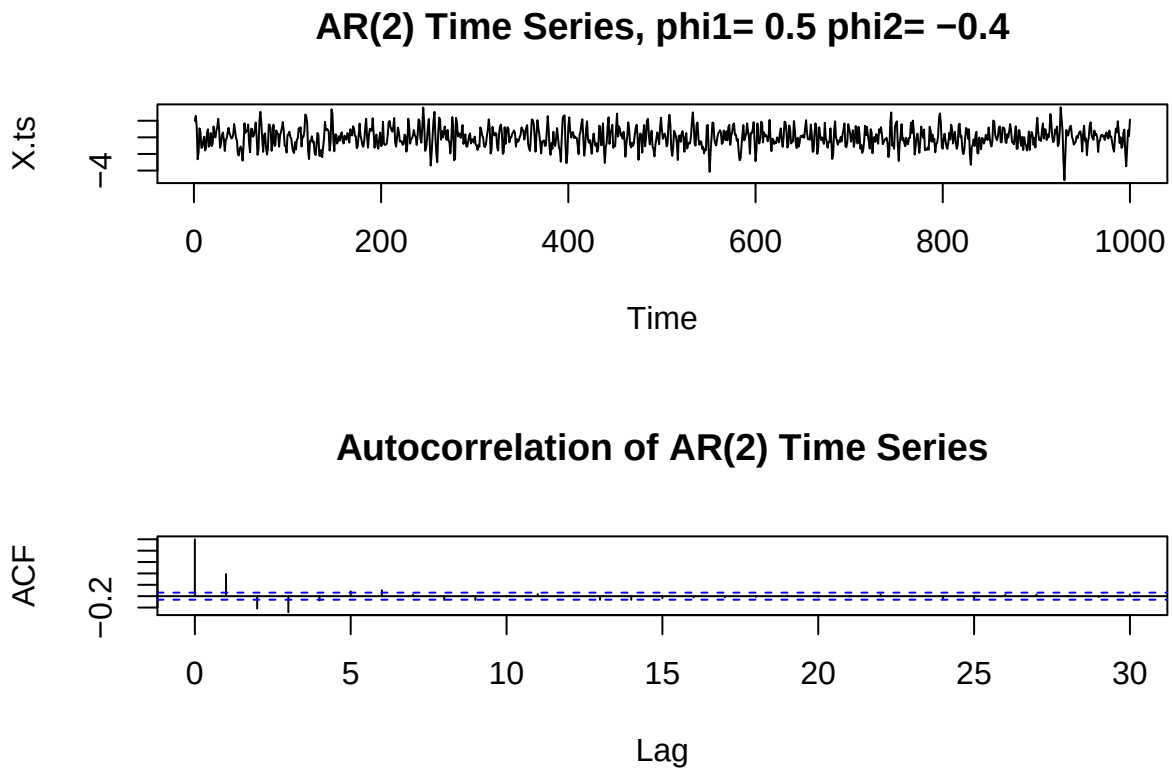
run many simulations codes-choose various coefficients-make observations-how plots and ACFs look share common features statinarity

```
# AR(2) process: Xt = Zt + 0.7Xt-1 + 0.2Xt-2
set.seed(2017)
X.ts=arima.sim(list(ar=c(0.7,0.2)), n=1000)
#give Auto Regressive Intergreted Moving Average Simulations-put in AR or MA term
#-list:AR term-coefficients-list(ar=c(0.7, 0.2))

par(mfrow=c(2,1))
plot(X.ts, main='AR(2) Time Series, phi1=0.7, phi2=0.2')
X.acf= acf(X.ts,main='Autocorrelation of AR(2) Time Series')
```





```r
phi1=0.5
phi2=-0.4 # parameters can be postive, negative

X.ts = arima.sim(list(ar=c(phi1, phi2)), n=1000)
par(mfrow=c(2, 1))
plot(X.ts, main=paste('AR(2) Time Series, phi1=', phi1, 'phi2=', phi2))
# paste-put variable into plot command
# plot:jump around
X.acf = acf(X.ts, main='Autocorrelation of AR(2) Time Series')
```




```r
# lag:ACF-1+, 2-, 3-,get noise
```

phi=1, random walk phi->0, correlation decay quickly phi=0, white noise phi<0, alternative positive and negative correlations-filp back and forth

```r
alpha1=0.9
alpha2=0.2
alpha3=-0.3
alpha4=-0.8

set.seed(2018)
X.ts1=arima.sim(list(ar=c(alpha1)),n=1000)
X.ts2=arima.sim(list(ar=c(alpha2)),n=1000)
X.ts3=arima.sim(list(ar=c(alpha3)),n=1000)
X.ts4=arima.sim(list(ar=c(alpha4)),n=1000)
```

```r
par(mfrow=c(2, 2))
acf(X.ts1, main=paste('AR(1) Time Series on White Noise, alpha=', alpha1))
acf(X.ts2, main=paste('AR(1) Time Series on White Noise, alpha=', alpha2))
acf(X.ts3, main=paste('AR(1) Time Series on White Noise, alpha=', alpha3))
acf(X.ts4, main=paste('AR(1) Time Series on White Noise, alpha=', alpha4))
```