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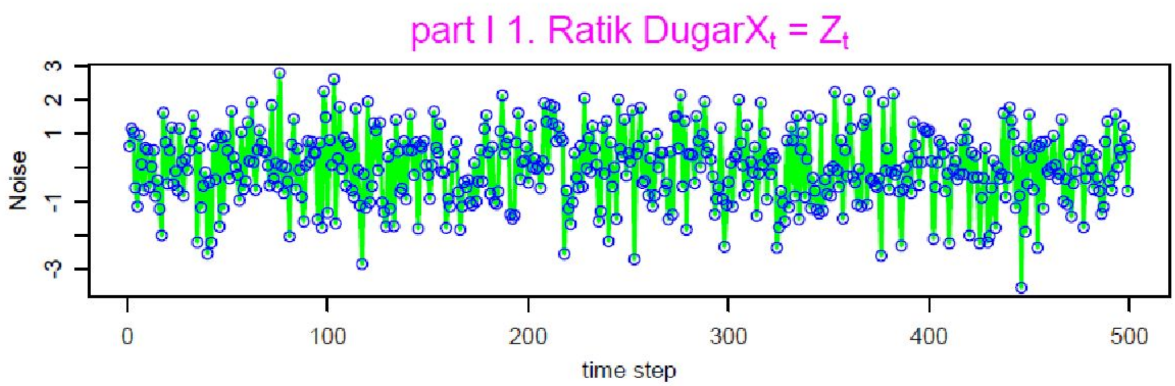
DIV I

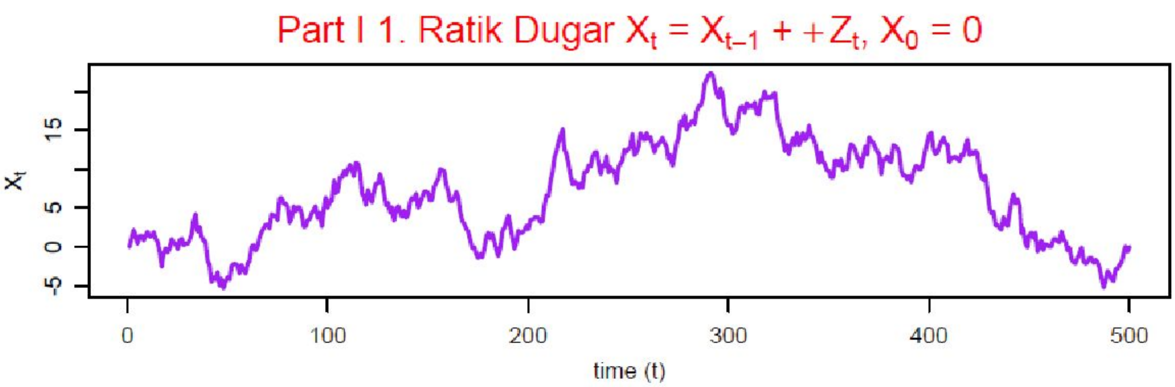
STAT 420 FINAL PROJECT

Part I: Simulation ,Using T=500

1. Simulate a pure random (Gaussian) times series Xt with mean 0 and variance 1. Report µXt and σ^2 Xt . In R, the functions mean() and var() may be used to find the mean and variance. Plot Xt = Zt , also plot Xt = Xt−1 + Zt (this is the cumulative sum).

1.

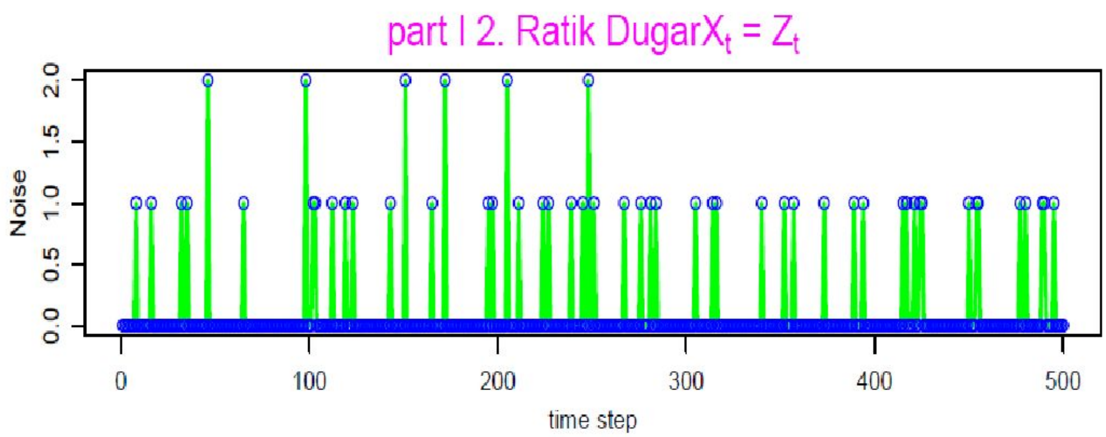


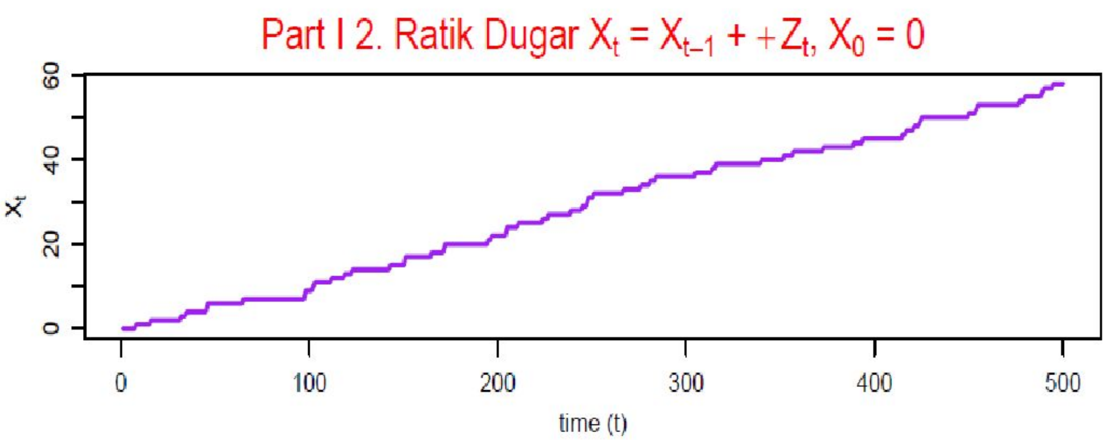


The variance (σ^{2}_{Xt}) is 40.5697. The mean (μ_{Xt}) is 7.09607.

2. Generate a Poisson random process Xt with mean = variance = 0.1. Report µXt and σ 2 Xt . To generate Poisson random numbers in R use the function rpois(size, lambda = #). Plot Xt = Zt , also plot Xt = Xt−1 + Zt (this is the cumulative sum).

2.

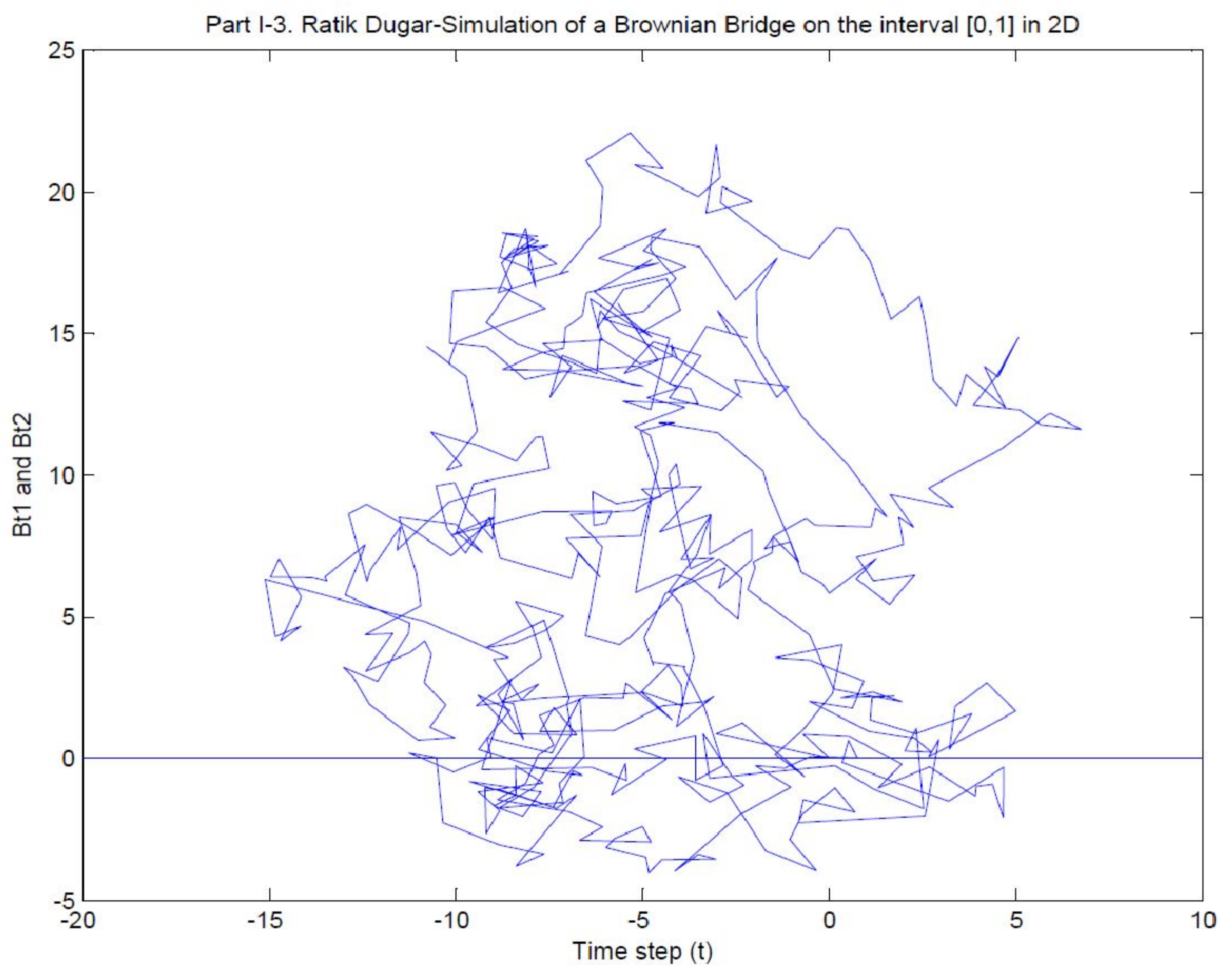




The variance (δ^2_{Xt}) is 187.1113. The mean (μ_{Xt}) is 25.17.

3. Simulate a Brownian bridge in 2D on the interval t ∈ [0, 1]. Verify that the starting and ending positions are the same, namely (0,0). The simulated 1D Brownian bridge in Matlab is a good start. To obtain a Brownian bridge define Bt = Xt − tX1, with X0 = X1 = 0.

3.



From matlab output,

ans =

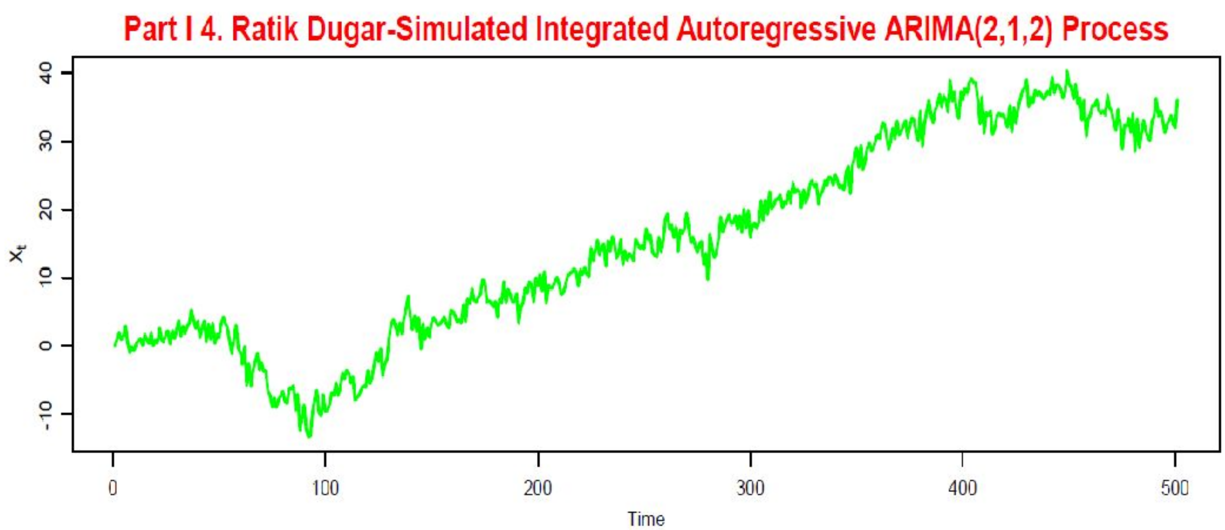
Bt1(1) = 0 and Bt1(T) = 0.

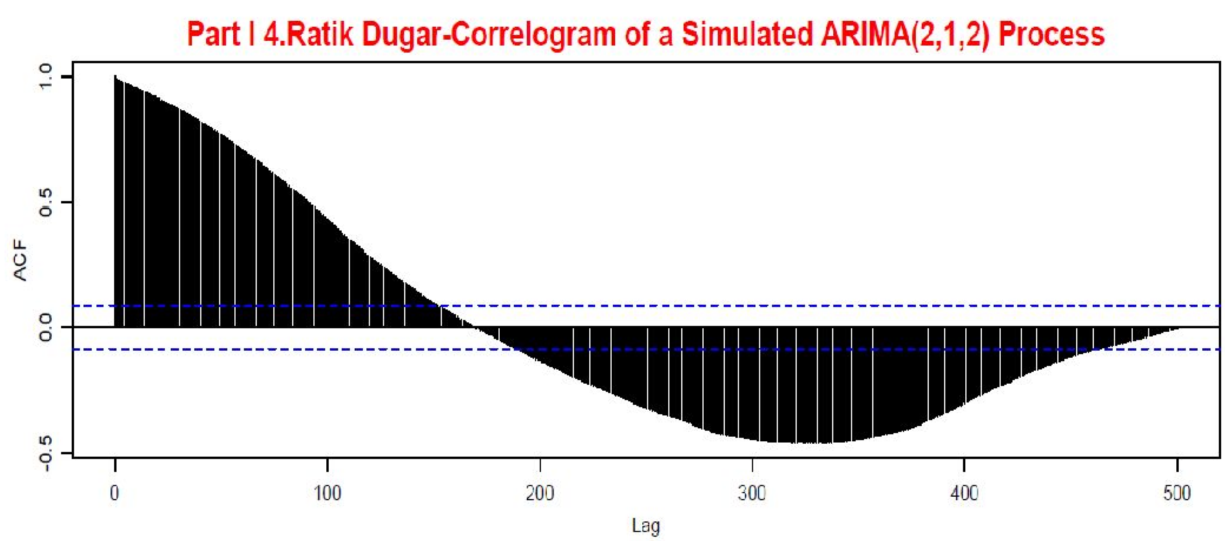
ans =

Bt2(1) = 0 and Bt2(T) = 0.

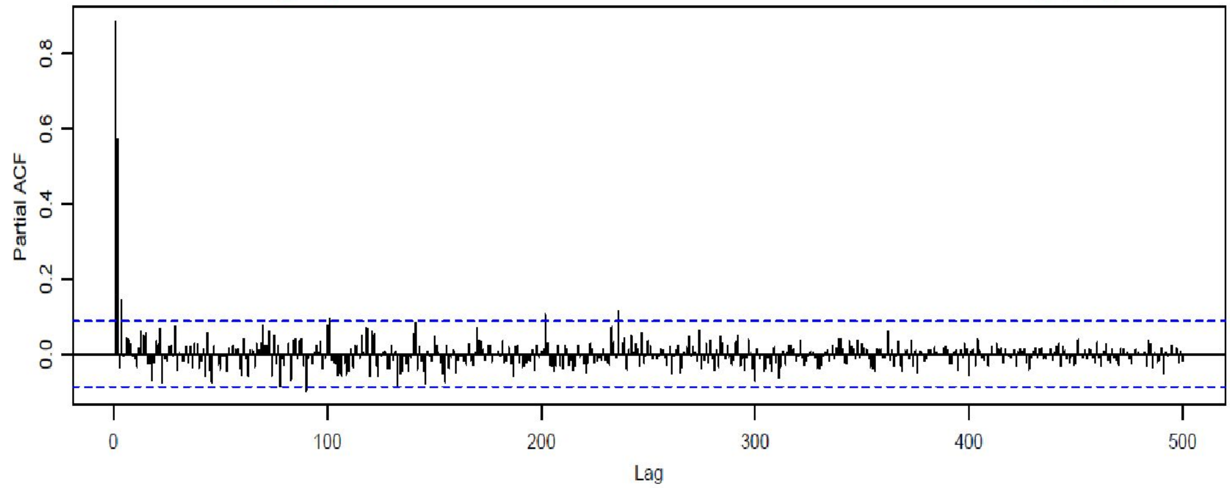
Thus, the starting and ending positions are (0,0).

4.Simulate the process Xt = ARIMA(p, 1, q) process with α1 = −0.6, α2 = 0.2, β1 = 1, and β2 = −1 then plot the autocorrelation and partial autocorrelation functions. Define Yt = ∇Xt . Report the probability model for Yt then plot its autocorrelation and partial autocorrelation functions. The R function diff may be useful.





Part I 4.Ratik Dugar-partial autocorrelation function of a Simulated ARIMA(2,1,2) Process

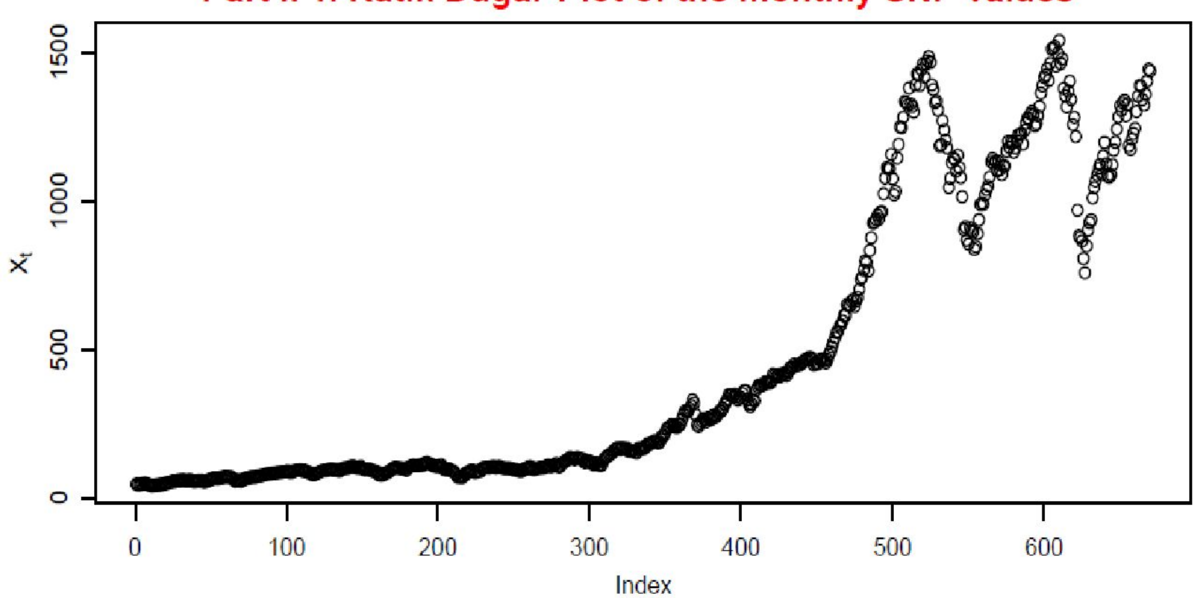


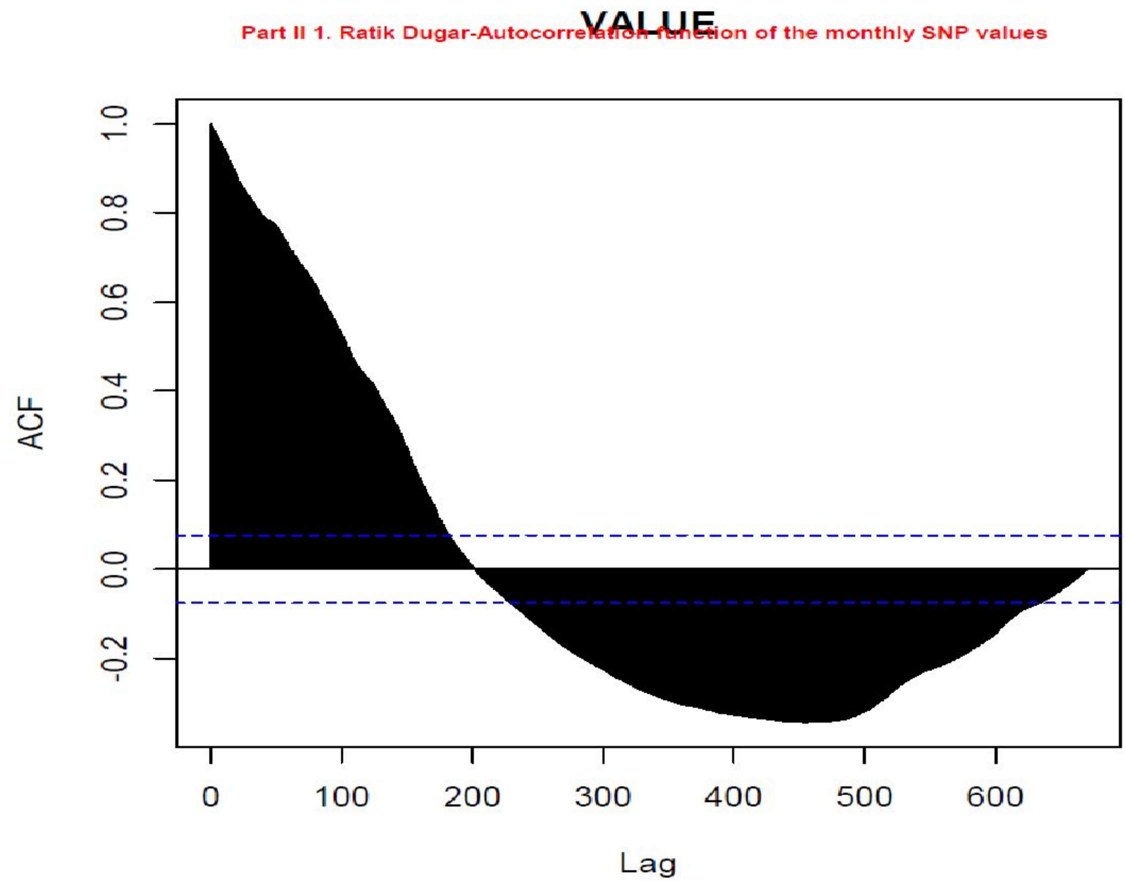
Part II: Modeling and Forecasting the SNP500

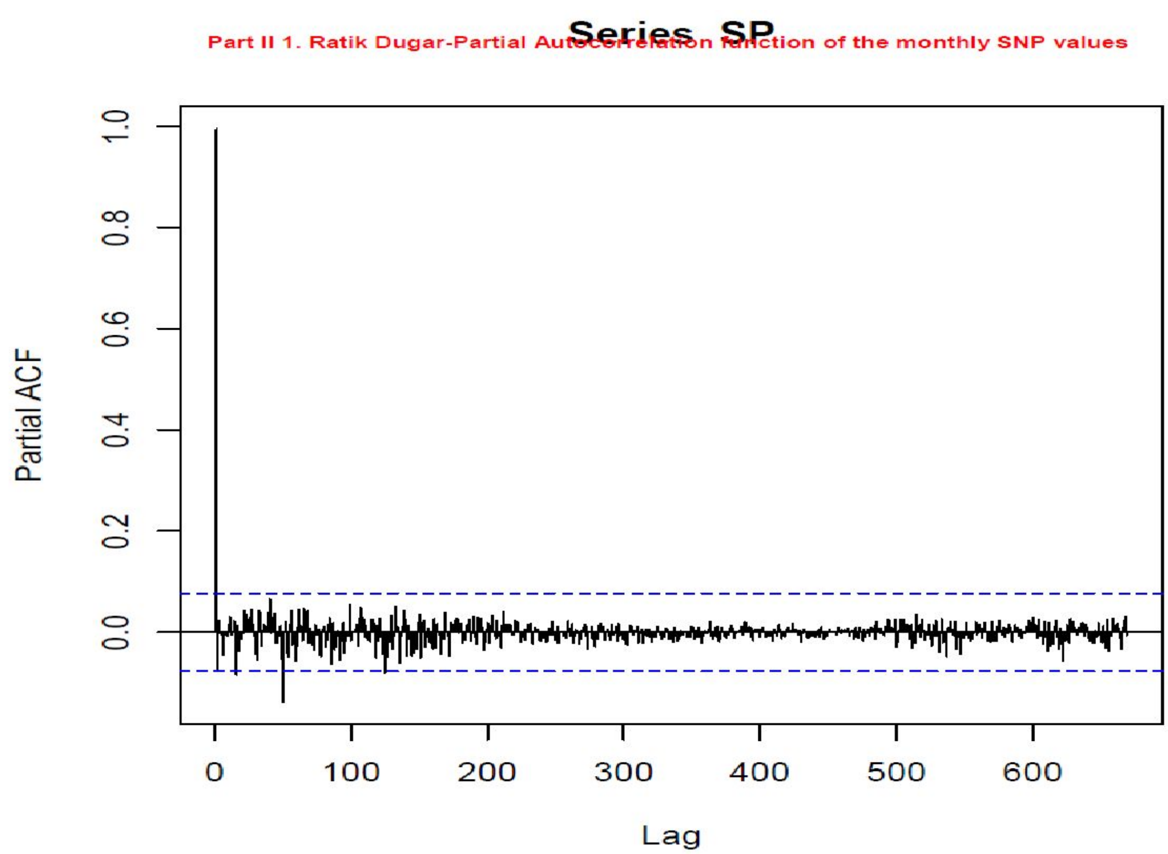
Consider the monthly S&P500 price index. Let Xt = the return on the S&P 500 index in month t. We have a sample of T months and in each month we see a return. Suppose we believe that the S&P 500 index returns in different months are iid: Xt iid~ with E(Xt) = μt and V ar(Xt) = σ^2_t . SNP exhibits geometric growth, i.e. non-stationary time series.

1. **Plot the data in “sp m.xls” together with its ACF and PACF. Report the mean and variance of the monthly SNP values.**

Part II 1. Ratik Dugar-Plot of the monthly SNP values

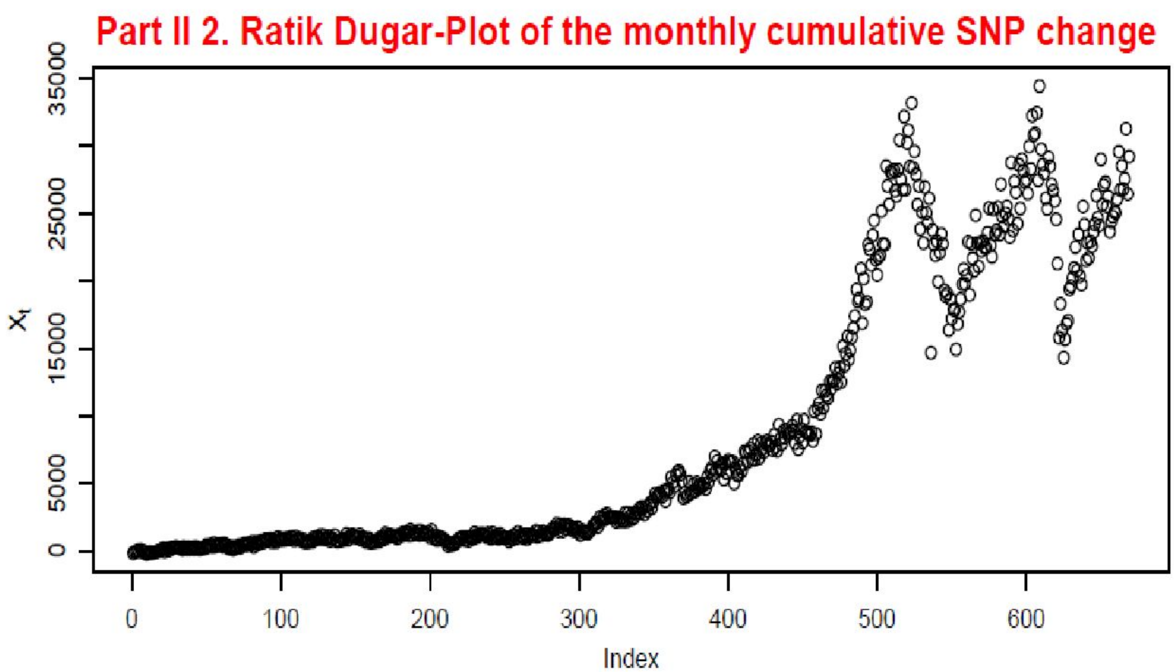



VALUE
Part II 1. Ratik Dugar-Autocorrelation function of the monthly SNP values
ACF
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
0
100
200
300
400
500
600
Lag


Series SP
Part II 1. Ratik Dugar-Partial Autocorrelation function of the monthly SNP values
Partial ACF
1.0
0.8
0.6
0.4
0.2
0.0
0
100
200
300
400
500
600
Lag

The mean of the monthly SNP values is 463.0866. The variance of the monthly SNP values is 231460.60

2. Use the file “sp m per change sum.xls”, which is the monthly percent change in the SNP values, to regenerate the cumulative SNP price index.



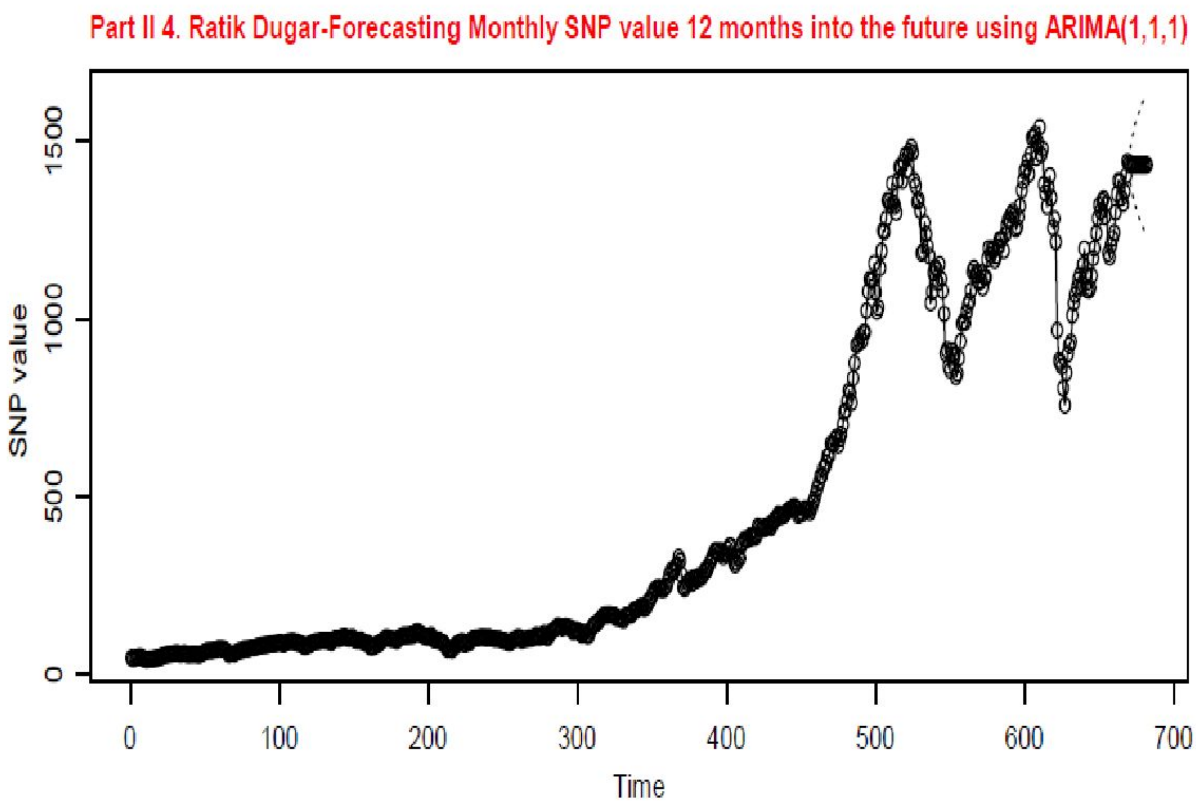
3. **Build the autoregressive integrated moving average ARIMA(1,1,1) model for the SNP500, report the parameter estimates and the time series (stochastic) model Xt.**

Parameter estimates are $\underline{\alpha_1=-0.2282}$ with S.E.=0.3130, $\underline{\beta_1=0.4679}$ with S.E.=0.2929 and we already know, n=670.

> Extra info :
> S.d.=sqrt(Var)=sqrt(615.4)=24.8073
> log likelihood = -3097.56, aic = 6201.11

$\underline{X_t = 0.7718X_{t-1} + 0.2282X_{t-2} + Z_t + 0.4679Z_{t-1}}$

4. **Use the model in part 3 to forecast the values of the SNP500 24 months in the future. Plot the original time series together with the forecast.**



Code:

PART I

1.

```
T=500;

Zt <- rnorm(T,0,1)

 par(mfrow=c(3,1), mar=c(3.5, 3.5, 2.2, 0.5), mgp=c(2, 0.8, 0), cex=.7)

 plot(Zt, main="", ylab='Noise', xlab='time step', type='l', col='green', lwd=2);

 points(Zt, col='blue')

 title(main = list(expression(paste("part I 1. Ratik Dugar", X[t], " = ", Z[t])),cex=1.5,
col="magenta", font=2))

Zt[1]=0

Xt = cumsum(Zt)

plot(Xt, main="", ylab=expression(X[t]), xlab='time (t)', type='l', col='purple', lwd=2);

title(main = list(expression(paste("Part I 1. Ratik Dugar ", X[t], " = ", X[t-1]," + ",

+ Z[t],", ",X[0]," = 0")), cex=1.5, col="red", font=2))

x=var(Xt)

y=mean(Xt)

print(x);

print(y);
```

2.

```
Zt <- rpois(500,0.1)

par(mfrow=c(3,1), mar=c(3.5, 3.5, 2.2, 0.5), mgp=c(2, 0.8, 0), cex=.7)

plot(Zt, main="", ylab='Noise', xlab='time step', type='l', col='green', lwd=2);

points(Zt, col='blue')

title(main = list(expression(paste("part I 2. Ratik Dugar", X[t], " = ", Z[t])),cex=1.5,
col="magenta", font=2))

Zt[1]=0

Xt = cumsum(Zt)

plot(Xt, main="", ylab=expression(X[t]), xlab='time (t)', type='l', col='purple', lwd=2);

title(main = list(expression(paste("Part I 2. Ratik Dugar ", X[t], " = ", X[t-1]," + ",

+ Z[t],", ",X[0]," = 0")), cex=1.5, col="red", font=2))

x=var(Xt)

y=mean(Xt)

print(x);

print(y);
```

3.(Matlab)

```
clear all;
t = 0 :0.002: 1;
T = length(t);
sample1 = randn(1,T); sample2=randn(1,T);
sample1(1) = 0; sample2(1) = 0;
Xt = cumsum(sample1); Yt = cumsum(sample2);
refline(0,0)
% for i = 1 : T
% Bt1(i) = Xt(i) - t(i)*Xt(T);
% Bt2(i) = Yt(i) – t(i)*Yt(T);
% end
Bt1 = Xt-t*Xt(T);
Bt2 = Yt-t*Yt(T);
plot(Bt1,Bt2)
title('Part I-3. Ratik Dugar-Simulation of a Brownian Bridge on the interval [0,1] in 2D');
xlabel('Time step (t)');
ylabel('Bt1 and Bt2');
refline(0,0)
```

```
sprintf('Bt1(1) = %d and Bt1(T) = %d.', Bt1(1), Bt1(T))
sprintf('Bt2(1) = %d and Bt2(T) = %d.', Bt2(1), Bt2(T))
```

4.

```
ts.sim <- arima.sim(list(order = c(2,1,2), ar = c(-0.6,0.2), ma = c(1,-1)), n = 500)

par(mfrow=c(2,1), mar=c(3.5, 3.5, 2.2, 0.5), mgp=c(2, 0.8, 0), cex=.7)

ts.plot(ts.sim, main='', ylab=expression(X[t]), col='green', lwd=2)

title(main = list("Part I 4. Ratik Dugar-Simulated Integrated Autoregressive ARIMA(2,1,2)
Process", cex=1.5, col="red", font=2))

acf(ts.sim, 500, main='')

title(main = list("Part I 4.Ratik Dugar-Correlogram of a Simulated ARIMA(2,1,2) Process",
cex=1.5, col="red", font=2))

pacf(ts.sim, 500, main='')

title(main = list("Part I 4.Ratik Dugar-partial autocorrelation function of a Simulated
ARIMA(2,1,2) Process", cex=1.5, col="violet", font=2))
```

PART II

1.

```
setwd("C:/Users/rdugar/Documents/datasets")

getwd()

SP=read.csv('data.csv',row.names=NULL,header=T)

par(mfrow=c(2,1), mar=c(3.5, 3.5, 2.2, 0.5), mgp=c(2, 0.8, 0), cex=.7)

SH=as.matrix(SP)

plot(SH, main='', ylab=expression(X[t]))

title(main = list("Part II 1. Ratik Dugar-Plot of the monthly SNP values ", cex=1.4, col="red",
font=2))

acf(SP,670)

title(main = list("Part II 1. Ratik Dugar-Autocorrelation function of the monthly SNP values
", cex=0.7, col="red", font=2))
```

```
pacf(SP,670)

title(main = list("Part II 1. Ratik Dugar-Partial Autocorrelation function of the monthly SNP values ", cex=0.7, col="red", font=2))

mean(SH)

var(SH)
```

2.

```
setwd("C:/Users/rdugar/Documents/datasets")

getwd()

SP=read.csv('data2.csv',row.names=NULL,header=T)

par(mfrow=c(2,1), mar=c(3.5, 3.5, 2.2, 0.5), mgp=c(2, 0.8, 0), cex=.7)

x=cumsum(SP)

SH=as.matrix(x)

print(x)

plot(SH, main='', ylab=expression(X[t]))

title(main = list("Part II 2. Ratik Dugar-Plot of the monthly cumulative SNP change ", cex=1.4, col="red", font=2))
```

3.

```
setwd("C:/Users/rdugar/Documents/datasets")

getwd()

SP=read.csv('data.csv',row.names=NULL,header=T)

par(mfrow=c(2,1), mar=c(3.5, 3.5, 2.2, 0.5), mgp=c(2, 0.8, 0), cex=.7)

SH=as.matrix(SP)

model.SP=arima(SH,order=c(1,1,1))

model.SP
```

4.

```r
setwd("C:/Users/rdugar/Documents/datasets")

getwd()

SP=read.csv('data.csv',row.names=NULL,header=T)

SH=as.matrix(SP)

data(SH)

par(mfrow=c(2,1), mar=c(3.5, 3.5, 2.2, 0.5), mgp=c(2, 0.8, 0), cex=.7)

model.SP=arima(SH,order=c(1,1,1))

plot(model.SP, n.ahead=12, type='b', xlab='Time', ylab='SNP value ')

abline(h=coef(model.SP) [names(coef(model.SP))=='intercept'])

title(main=list('Part II 4. Ratik Dugar-Forecasting Monthly SNP value 12 months into the
future using ARIMA(1,1,1)', col='red', font=2, cex=1))
```