

TS Module 6 Moving average and autoregressive scatterplots

(The attached PDF file has better formatting.)

Cryer and Chan chapter 4 shows scatterplots for one and two lags for autoregressive and moving average processes. The final exam shows similar scatterplots and asks you to identify the time series process.

Exhibits 4.3 and 4.4 on pages 59 and 60 show scatterplots for an MA(1) process with $\theta = -0.9$, so ρ_1 is positive and ρ_2 is zero. The autocorrelations are evident from the scatter of points. Graphics like those in the textbook are shown below.

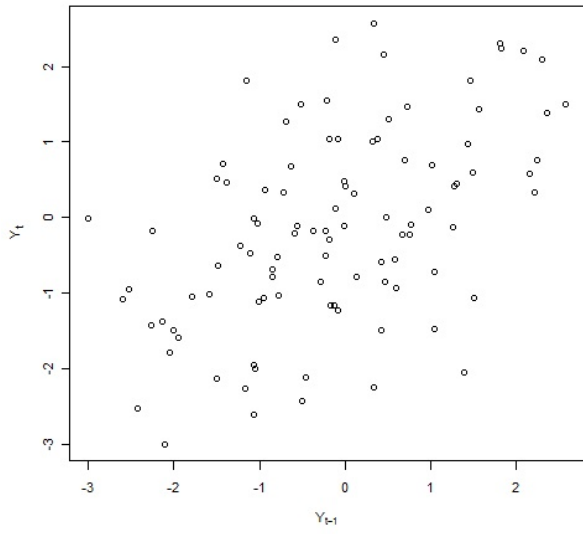
```
## MA(1) series with  $\theta = -0.9$  of length  $n=100$ 
ma1.n090 <- arima.sim(model = list(ma = -c(-0.90)), n=100)

par(mfrow=c(1,2))
plot(y = ma1.n090, x = zlag(vec = ma1.n090, lag = 1), ylab = expression(Y[t]), xlab =
expression (Y[t-1]), type = 'p')
title(main = expression(paste("Scatterplot of ", Y[t], " vs ", Y[t-1], " for MA(1) process with ",
theta == -0.9, sep="")), font = 2, cex = 1.2)
plot(y = ma1.n090, x = zlag(vec = ma1.n090, lag = 2), ylab = expression(Y[t]), xlab =
expression (Y[t-2]), type='p')
title(main = expression(paste("Scatterplot of ", Y[t], " vs ", Y[t-2], " for MA(1) process with ",
theta == -0.9, sep="")), font = 2, cex = 1.2)

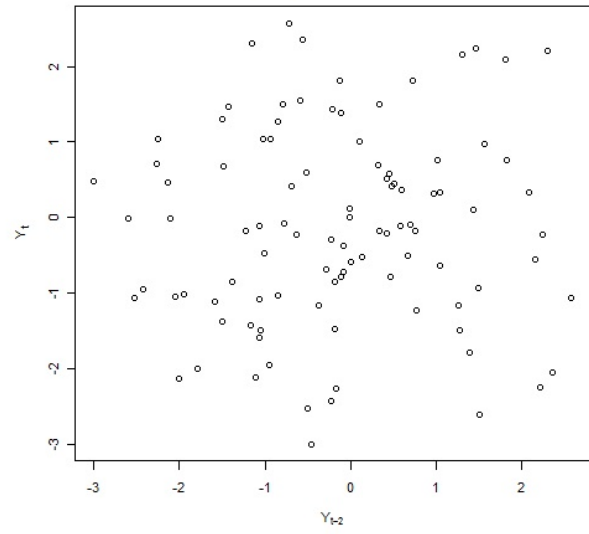
## zlag is like the zlag function in the TSA package

zlag <- function (vec, lag =1) {
len <- length(vec)
res <- vec[-((len-lag+1):len)]
res <- c(rep(NA, lag),res)
return(res)
}
```

Scatterplot of Y_t vs Y_{t-1} for MA(1) process with $\theta = -0.9$



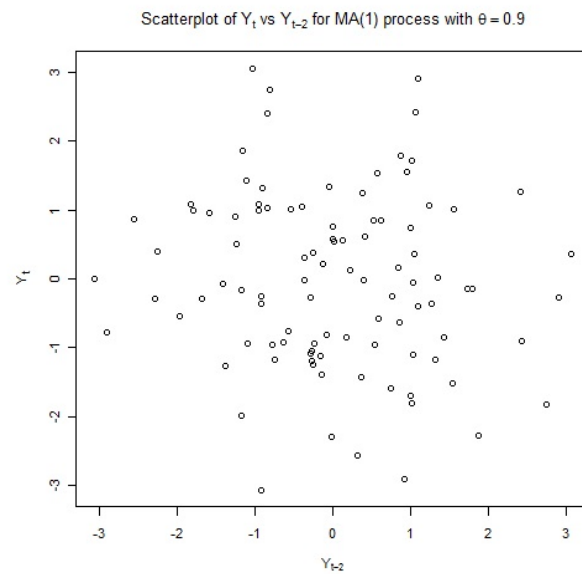
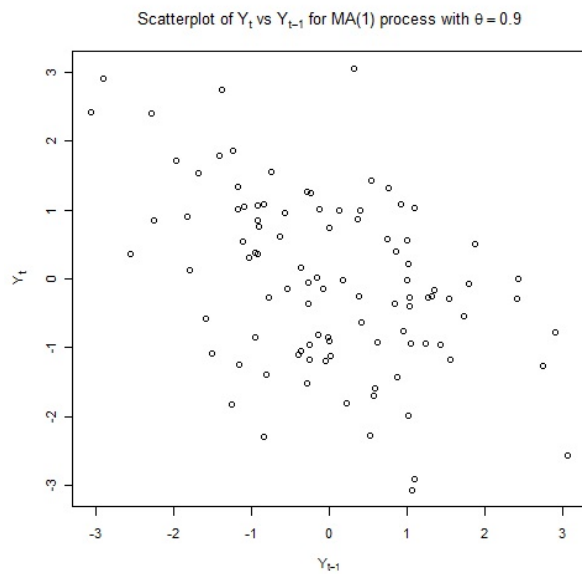
Scatterplot of Y_t vs Y_{t-2} for MA(1) process with $\theta = -0.9$



Exhibits 4.6 and 4.7 on pages 61 and 62 show scatterplots for an MA(1) process with $\theta = +0.9$, so ρ_1 is negative and ρ_2 is zero. The autocorrelations are evident from the scatter of points. Graphics like those in the textbook are shown below.

```
## MA(1) series with  $\theta = 0.9$  of length  $n=100$ 
ma1.090 <- arima.sim(model = list(ma = -c(0.90)), n=100)
```

```
par(mfrow=c(1,2))
plot(y = ma1.090, x = zlag(vec = ma1.090, lag = 1), ylab = expression(Y[t]), xlab =
expression (Y[t-1]), type = 'p')
title(main = expression(paste("Scatterplot of ", Y[t], " vs ", Y[t-1], " for MA(1) process with ",
theta == 0.9, sep="" ) ), font = 2, cex = 1.2)
plot(y = ma1.090, x = zlag(vec = ma1.090, lag = 2), ylab = expression(Y[t]), xlab =
expression (Y[t-2]), type='p')
title(main = expression(paste("Scatterplot of ", Y[t], " vs ", Y[t-2], " for MA(1) process with ",
theta == 0.9, sep="" ) ), font = 2, cex = 1.2)
```

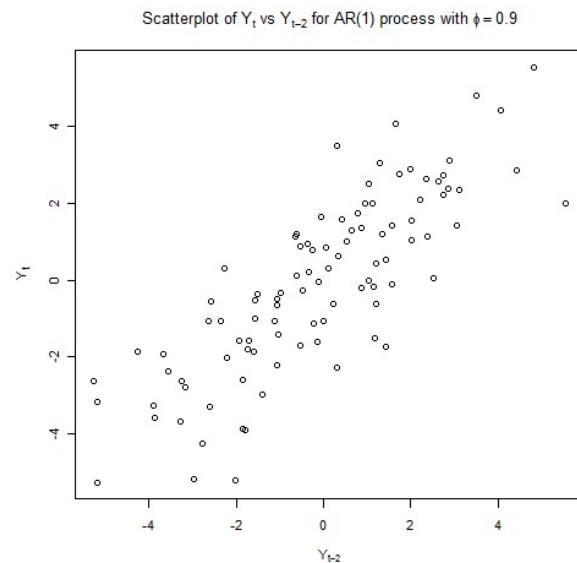
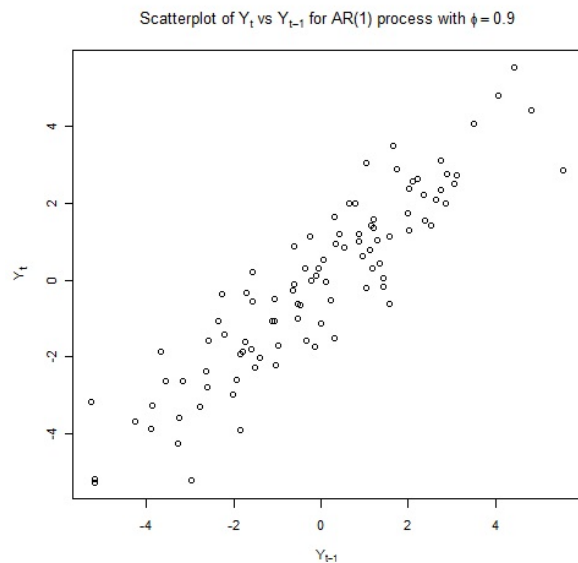


Exhibits 4.9 and 4.10 on page 64 show scatterplots for an MA(2) process. The values of θ_1 and θ_2 determine whether the autocorrelations are positive or negative. Final exam problems use parameter values that make the process clear.

Exhibits 4.14 and 4.15 on page 59 show scatterplots for an AR(1) process with $\theta = +0.9$, so ρ_1 and ρ_2 are both positive. Graphics iike those in the textbook are shown below.

```
## AR(1) series with  $\theta = 0.9$  of length  $n=100$ 
ar1.090 <- arima.sim(model = list(ar = c(0.90)), n=100)
```

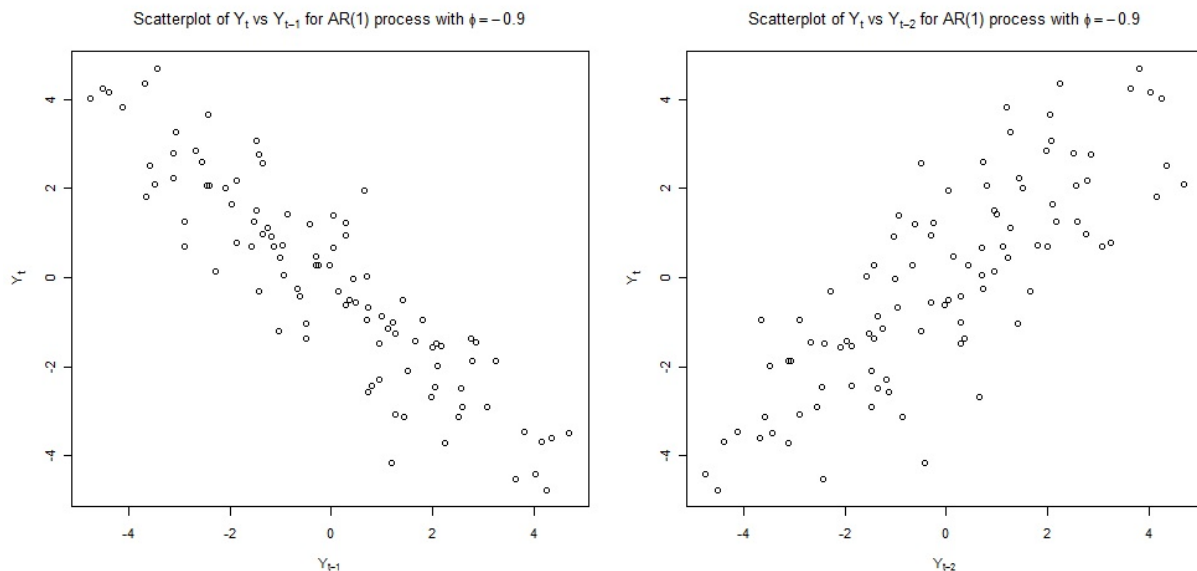
```
par(mfrow=c(1,2))
plot(y = ar1.090, x = zlag(vec = ar1.090, lag = 1), ylab = expression(Y[t]), xlab =
expression (Y[t-1]), type = 'p')
title(main = expression(paste("Scatterplot of ", Y[t], " vs ", Y[t-1], " for AR(1) process with ",
phi == 0.9, sep="")) ), font = 2, cex = 1.2)
plot(y = ar1.090, x = zlag(vec = ar1.090, lag = 2), ylab = expression(Y[t]), xlab =
expression (Y[t-2]), type='p')
title(main = expression(paste("Scatterplot of ", Y[t], " vs ", Y[t-2], " for AR(1) process with ",
phi == 0.9, sep="")) ), font = 2, cex = 1.2)
```



Changing θ to -0.9 makes ρ_1 negative, but ρ_2 stays positive.

```
## AR(1) series with  $\theta = -0.9$  of length  $n=100$   
ar1.n090 <- arima.sim(model = list(ar = c(-0.90)), n=100)
```

```
par(mfrow=c(1,2))  
plot(y = ar1.n090, x = zlag(vec = ar1.n090, lag = 1), ylab = expression(Y[t]), xlab =  
expression (Y[t-1]), type = 'p')  
title(main = expression(paste("Scatterplot of ", Y[t], " vs ", Y[t-1], " for AR(1) process with ",  
phi == -0.9, sep="" ) ), font = 2, cex = 1.2)  
plot(y = ar1.n090, x = zlag(vec = ar1.n090, lag = 2), ylab = expression(Y[t]), xlab =  
expression (Y[t-2]), type='p')  
title(main = expression(paste("Scatterplot of ", Y[t], " vs ", Y[t-2], " for AR(1) process with ",  
phi == -0.9, sep="" ) ), font = 2, cex = 1.2)
```



Final exam problems test the algebra and graphics of moving average and autoregressive processes: MA(1), MA(2), AR(1), AR(2), and ARMA(1,1).