1. The TSA library contains the data set co2, which lists monthly carbon dioxide (CO_2) levels in northern Canada from 1/1994 to 12/2004. To load the data in R, remember that you need to first type

```
> library(TSA)
> data(co2)
```

(a) Construct a time series plot for these data using the following R command:

```
> plot(co2,ylab="CO2 levels",xlab="Year",type="o")
```

Describe all systematic patterns you see in the plot.
(b) To enhance the usefulness of the plot, add monthly plotting symbols using the following R commands:

```
> plot(co2,ylab="CO2 levels",xlab="Year",type='l')
> points(y=co2,x=time(co2),pch=as.vector(season(co2)),cex=0.75)
```

Which months are consistently associated with highest CO_2 levels? the lowest? **Note:** The `cex=0.75` part controls the size of the plotting symbols specified in `pch`. Making `cex` larger increases the size of the plotting symbols.

2. The course web site contains the data set `gasprices`, which lists the average price (US dollars per gallon) for regular gasoline in the United States. There are $n = 145$ weekly observations collected from 1/5/2009 to 10/10/2011 (**Source:** Rajon Coles, Fall 2011).
(a) Construct a time series plot for these data. Note that you will have to save the data first (e.g., as a `.txt` file) and then read the data into R. For example, I used

```
> gasprices <- ts(read.table(file = "C:\\Users\\Tebbs\\Desktop\\gasprices.txt"))
> plot(gasprices,ylab="Price (USD)",xlab="Week",type="o")
```

Describe all systematic patterns you see in the plot.
(b) Create a scatterplot with the observed series Y_t on the vertical axis and Y_{t-1} on the horizontal axis. This is called a **lag-1 scatterplot.** You can do this using the following R commands:

```
> plot(y=gasprices,x=zlag(gasprices,1),
    ylab=expression(Y[t]),xlab=expression(Y[t-1]),type='p')
```

This plot displays the observed data plotted against the lag-1 series; i.e., the scatterplot of the 144 points $(Y_1, Y_2), (Y_2, Y_3), ..., (Y_{144}, Y_{145})$. What does this plot suggests about the original series Y_t? To aid in your interpretation, you might also calculate the sample correlation for the data in the plot. You can do this using the following commands:

```
> cor(gasprices[2:145],zlag(gasprices,1)[2:145])
```

The `[2:145]` part in this code asks R to only consider the non-missing values because the 1st entry in `zlag(gasprices,1)` is vacuous.
(c) What does this plot look like for larger lags (e.g., 2, 3, 5, 10, 20, etc.)? When compared to

the lag-1 series, do the corresponding correlations between Y_t and Y_{t-k} increase or decrease as k increases? Interpret what is meant by this.

3. Suppose that Z_1, Z_2, Z_3 are random variables with

$$\begin{array}{ccc} E(Z_1) = 0 & E(Z_2) = 1 & E(Z_3) = -1 \\ \text{var}(Z_1) = 1 & \text{var}(Z_2) = 2 & \text{var}(Z_3) = 3 \\ \text{cov}(Z_1, Z_2) = -0.5 & \text{cov}(Z_2, Z_3) = 1.5 & \text{cov}(Z_1, Z_3) = 0. \end{array}$$

Calculate each of the following:
(a) $E(Z_1 - 6Z_2 - 2Z_3)$
(b) $\text{var}(2Z_1 + Z_3)$
(c) $\text{cov}(3Z_1 - Z_2, Z_2 + 2Z_3)$
(d) $\text{corr}(Z_1 - Z_2, Z_2 + Z_3)$

4. (a) Simulate and plot a white noise process $e_t \sim \text{iid } \mathcal{N}(0, 1)$ of length $n = 100$ using the following commands in R:

```
> wn.n01 = rnorm(100,0,1)
> plot(wn.n01,ylab="White noise process",xlab="Time",type="o")
```

(b) Repeat part (a) under the assumption that

- $e_t \sim \text{iid } t(1)$
- $e_t \sim \text{iid } \chi^2(1)$

To do this, just replace the first line of the code above with `wn.t1 = rt(100,1)` and `wn.chisq1 = rchisq(100,1)`, respectively. Comment on the differences among the 3 simulated white noise processes.
(c) For each of your simulated series in parts (a) and (b), create the corresponding random walk process $Y_t = Y_{t-1} + e_t$, for $t = 1, 2, ..., 100$. To do this for the normally distributed white noise series, for example, use the following code:

```
> random.walk.n01 <- wn.n01*0
> for(i in 1:length(wn.n01)){
      random.walk.n01[i]<-sum(wn.n01[1:i])
      }
> plot(random.walk.n01,ylab="Random walk from normal WN",xlab="Time",type="o")
```

Comment on the differences among the 3 simulated random walk processes.

5. Do the following problems from Cryer and Chan (Chapter 2): 2.4, 2.5, 2.11, and 2.12.