Stat 510, Lab 9

1 In Class

Let's look at the Australian labour data which was seen in previous labs. We would like to estimate the spectral density of the data. We may generate the raw periodogram using the following code:

```
labour<-scan("labour.dat")
labour<-labour[1:144]
tlabour<-diff(diff(log(labour)),12)
labourpgram<-spec.pgram(tlabour,taper=0, log="no")
```

It is pretty hard to tell what's going on with the unsmoothed periodogram. We will start by adding some smoothing with the following command:

```
spec.pgram(tlabour, spans=3, taper=0, log="no")
```

The argument "spans" corresponds to the "L" that we've been using in class which means that this will be the total window size used in the argument. By default the modified Daniell kernel is used. If we would like to use one expansion of this kernel, then we can use the command

```
spec.pgram(tlabour, spans=c(3,3), taper=0, log="no")
```

This yields a total number of five coefficients, so the smoothing window is five. We can obtain which coefficients are being used with the following command:

```
spec.pgram(tlabour, spans=c(3,3), taper=0, log="no")$kernel
```

A practical suggestion would be to keep the numbers the same, and try different odd sized windows. What happens with values of 3, 5, 7, 9, and 11.

2 Homework

1. In this exercise, we will simulate time series that follows an AR model with $\phi_1 = 0.8$ (with $\sigma^2 = 1$). We can use the following command to simulate observations from this model:

```
x<-arima.sim(n = 200, list(ar = c(0.8), ma = 0), sd = 1)
```

There is a closed form representation for the spectral density of ARMA models. So, we will try to determine how much smoothing is necessary to obtain a good representation for the spectral density. Load the functions found in "lab9function.R". We may now use the following command to obtain a plot of the periodogram along with the TRUE spectral density:

```
specplot(spec.pgram(x,taper=0, log="no"),phi=c(0.8))
```

   (a) Introduce smoothing into this setup. How much smoothing is required to obtain a fairly good estimate of the spectral density without over smoothing? Are there certain features of the true spectral density that are difficult to obtain?

   (b) Simulate a new time series with the same model but with 400 data points. Repeat attempts to smooth the periodogram. Are there differences here with more data?

   (c) Now simulate a data set of 400 points from an ARMA model with coefficients $\phi_1 = 0.6$,$\phi_2 = -0.2$, and $\theta_1 = -0.7$. How much smoothing is necessary to obtain a good estimate of the spectral density.

2. Estimate the spectral density airline data.

```
airline<-scan("airline.dat")
plot(diff(diff(log(airline),12)))
tairline<-diff(diff(log(airline),12))
airpgram<-spec.pgram(tairline,taper=0,log="no")
```

3. Estimate the spectral density of the ozone data.

```
ozone<-scan("ozone.dat")
tozone<-diff(diff(log(ozone)),12)
ozonepgram<-spec.pgram(tozone,taper=0,log="no")
```