

Homework 7 Code

Jared Yu

March 14, 2019

```
library(xlsx); library(astsa) # Load libraries
global_temp <- read.xlsx('GlobalTemp_NASA.xlsx', sheetIndex = 1) # Load data

X_t <- diff(global_temp$Temp.Anomaly) # First differenced data

par(mfrow=c(2,2))
# plot periodogram of X_t
p_0 <- spec.pgram(X_t, log = 'no',
                  main = 'Periodogram of First Differenced Series', ylim = c(0,0.07))
# 3 smoothed periodogram (modified Daniell) spans 5, 15, 25
p_5 <- spec.pgram(x = X_t, spans = 5, log = 'no',
                  main = 'Smoothed Periodogram, span = 5', ylim = c(0,0.07))
p_15 <- spec.pgram(x = X_t, spans = 15, log = 'no',
                  main = 'Smoothed Periodogram, span = 15', ylim = c(0,0.07))
p_25 <- spec.pgram(x = X_t, spans = 25, log = 'no',
                  main = 'Smoothed Periodogram, span = 25', ylim = c(0,0.07))
dev.off()

### 1 b
specselect=function(y,kmax){
  # Obtains the values of the criterion function for
  # obtaining the the optimal number of neighbors for
  # spectral density estimate for modified Daniell's method.
  # input: y, observed series; kmax=max number of neighbors to
  # be considered
  # output: ctr - the criterion function
  # output: kopt - the value of k at which the criterion function
  # is minimized
  ii=spec.pgram(y,log="no",plot=FALSE)
  ii=ii$spec
  cc=norm(as.matrix(ii),type="F")^2
  ctr=rep(1,kmax)
  for(k in 1:kmax) {
    ss=2*k+1; kk=1/(2*k)
    ff=spec.pgram(y,spans=ss,log="no",plot=FALSE)
    fspec=ff$spec
    ctr[k]=norm(as.matrix(ii-fspec),type="F")^2+kk*cc
  }
  kopt=which.min(ctr)
  result=list(ctr=ctr,kopt=kopt)
  return(result)
}

# a = specselect(X_t, kmax = 12)
# plot(1:12, a$ctr, type = 'l')

### 1 c
```

```

fit <- arima(X_t, order = c(2,0,2))
arma_fit <- arma.spec(ar = fit$coef[1:2], ma = fit$coef[3:4],
                      log = 'no', var.noise = fit$sigma2)
p_7 <- spec.pgram(x = X_t, spans = 2*7+1, log = 'no',
                  main = 'Smoothed Periodogram, span = 15', ylim = c(0,0.03))
lines(arma_fit$freq, arma_fit$spec)

### 2 c
w = seq(from = -0.5, to = 0.5, by = 0.01)
sdf <- function(w) {
  2.98 + 2.8*cos(2*pi*w)
}
sdf2 <- function(w) {
  3.16-0.36*cos(2*pi*w)-2.8*cos(4*pi*w)
}

sdf_y_lim <- range(range(sdf(w)), range(sdf2(w)))
sdf_y_lim[1] <- sdf_y_lim[1] - 0.1
sdf_y_lim[2] <- sdf_y_lim[2] + 0.1

plot(w, sdf(w), type = 'l', ylim = sdf_y_lim,
     main = 'Spectral Density of X_t and Differenced X_t',
     xlab = 'Frequency', ylab = 'Spectrum')
lines(w, sdf2(w), type = 'l', col = 'red', lty = 2)
legend('bottomleft', legend = c('X_t', 'differenced X_t'),
      col = c('black', 'red'), lty = c(1,2))

### 3 b
sdf3 <- function(w) {
  (2/3) * (1 + 4*cos(2*pi*w) + 4*cos(2*pi*w)^2)
}
plot(w, sdf3(w), type = 'l', main = 'Spectral Density of White Noise with Variance = 2',
     xlab = 'Frequency', ylab = 'Spectrum')
abline(h = 2, col = 'red', lty = 2)
legend('topleft', legend = c('Z_t', 'X_t'), lty = c(1,2), col = c('black', 'red'))

```