EE 779 Advanced topics in signal processing

Assignment 1 simulations

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1)

The code:

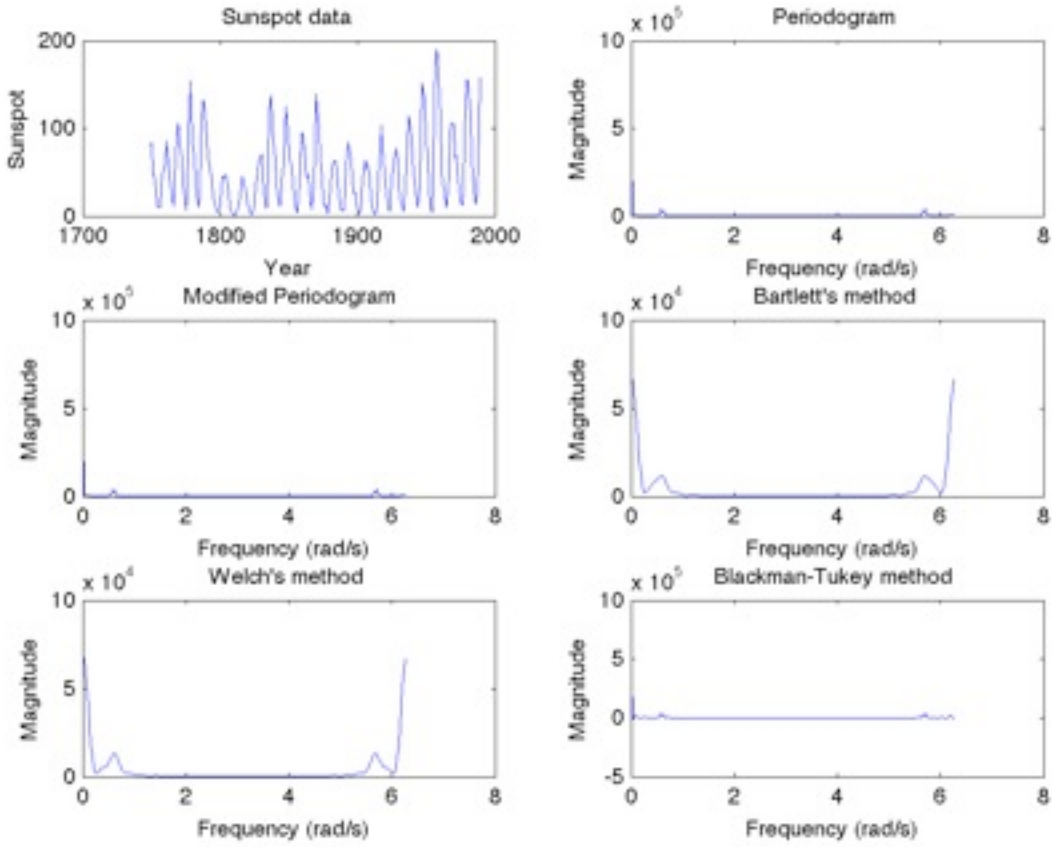
```
clear all; close all;
load('sunspotdata');
figure, subplot(3,2,1); plot(year, sunspot);
title('Sunspot data');
xlabel('Year');
ylabel('Sunspot');


y = sunspot;
L = length(y);
v = ones(L, 1);
Phi1 = correlogramse(y, L);
Phi2 = periodogramse(y, v, L);
Phi3 = bartlettse(y, 24, L);
v = ones(24, 1);
Phi4 = welchse(y, v, 10, L);
w = ones(200, 1);
Phi5 = btse(y, w, L);

% length(Phi1)
% length(Phi2)
% length(Phi3)
% length(Phi4)
% length(Phi5)
w = 0:L-1;
w = 2*pi*w/L;
subplot(3,2,2); plot(w, Phi1);
title('Periodogram');
xlabel('Frequency (rad/s)');
ylabel('Magnitude');
subplot(3,2,3); plot(w, Phi2);
title(' Modified Periodogram');
xlabel('Frequency (rad/s)');
ylabel('Magnitude');
subplot(3,2,4); plot(w, Phi3);
title('Bartlett''s method');
```

```
xlabel('Frequency (rad/s)');
ylabel('Magnitude');
subplot(3,2,5); plot(w, Phi4);
title('Welch''s method');
xlabel('Frequency (rad/s)');
ylabel('Magnitude');
subplot(3,2,6); plot(w, Phi5);
title('Blackman-Tukey method');
xlabel('Frequency (rad/s)');
ylabel('Magnitude');

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%% second part %%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

clear all;
load('lynxdata');
figure, subplot(3,2,1); plot(year, lynx);
title('Lynx data');
xlabel('Year');
ylabel('Lynx');

y = lynx;
L = length(y);
v = ones(L, 1);
Phi1 = correlogramse(y, L);
Phi2 = periodogramse(y, v, L);
Phi3 = bartlettse(y, 24, L);
v = ones(24, 1);
Phi4 = welchse(y, v, 10, L);
w = ones(70, 1);
Phi5 = btse(y, w, L);

% length(Phi1)
% length(Phi2)
% length(Phi3)
% length(Phi4)
% length(Phi5)
w = 0:L-1;
w = 2*pi*w/L;
subplot(3,2,2); plot(w, Phi1);
title('Periodogram');
xlabel('Frequency (rad/s)');
ylabel('Magnitude');
subplot(3,2,3); plot(w, Phi2);
title(' Modified Periodogram');
```

```
xlabel('Frequency (rad/s)');
ylabel('Magnitude');
subplot(3,2,4); plot(w, Phi3);
title('Bartlett''s method');
xlabel('Frequency (rad/s)');
ylabel('Magnitude');
subplot(3,2,5); plot(w, Phi4);
title('Welch''s method');
xlabel('Frequency (rad/s)');
ylabel('Magnitude');
subplot(3,2,6); plot(w, Phi5);
title('Blackman-Tukey method');
xlabel('Frequency (rad/s)');
ylabel('Magnitude');


%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

clear all;
load('lynxdata');
figure, subplot(3,2,1); plot(year, loglynx);
title('Lynx data');
xlabel('Year');
ylabel('logLynx');

avg = mean(loglynx(:));
y = loglynx-avg;
L = length(y);
v = ones(L, 1);
Phi1 = correlogramse(y, L);
Phi2 = periodogramse(y, v, L);
Phi3 = bartlettse(y, 24, L);
v = ones(24, 1);
Phi4 = welchse(y, v, 10, L);
w = ones(70, 1);
Phi5 = btse(y, w, L);

% length(Phi1)
% length(Phi2)
% length(Phi3)
% length(Phi4)
% length(Phi5)
w = 0:L-1;
w = 2*pi*w/L;
subplot(3,2,2); plot(w, Phi1);
title('Periodogram');
```

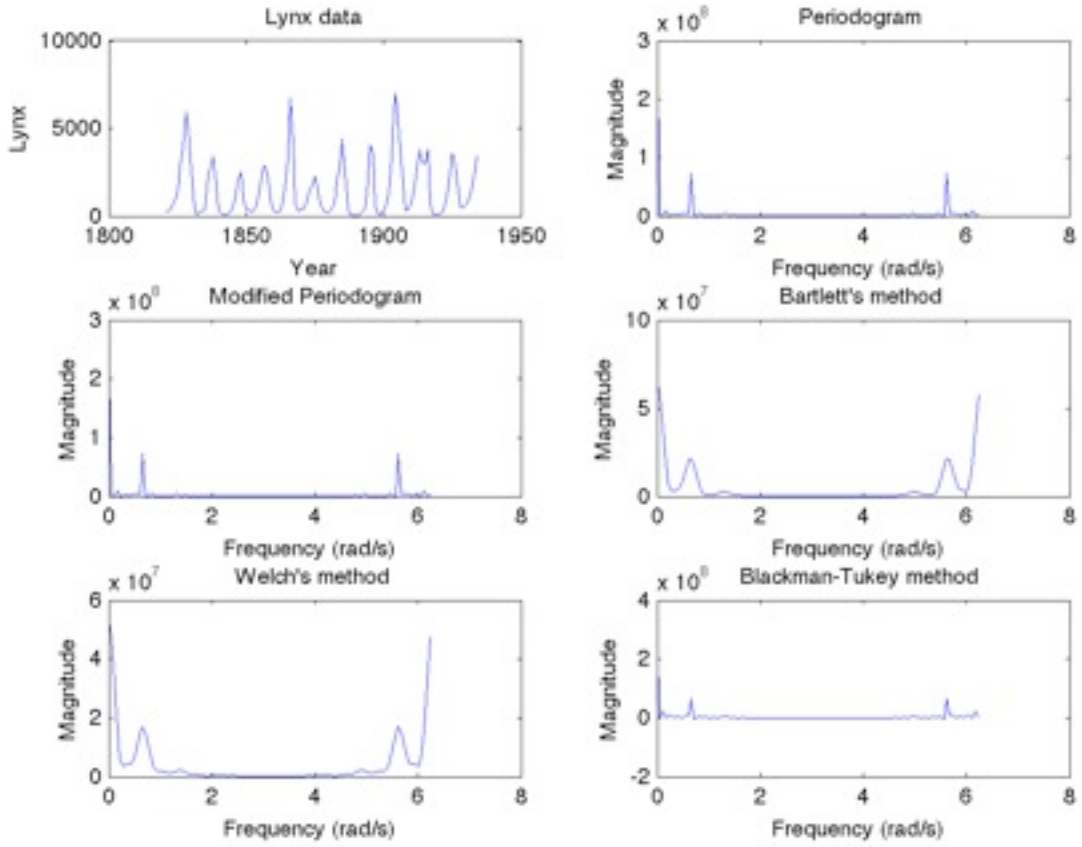
```
xlabel('Frequency (rad/s)');
ylabel('Magnitude');
subplot(3,2,3); plot(w, Phi2);
title(' Modified Periodogram');
xlabel('Frequency (rad/s)');
ylabel('Magnitude');
subplot(3,2,4); plot(w, Phi3);
title('Bartlett''s method');
xlabel('Frequency (rad/s)');
ylabel('Magnitude');
subplot(3,2,5); plot(w, Phi4);
title('Welch''s method');
xlabel('Frequency (rad/s)');
ylabel('Magnitude');
subplot(3,2,6); plot(w, Phi5);
title('Blackman-Tukey method');
xlabel('Frequency (rad/s)');
ylabel('Magnitude');
```

a)
The plot:

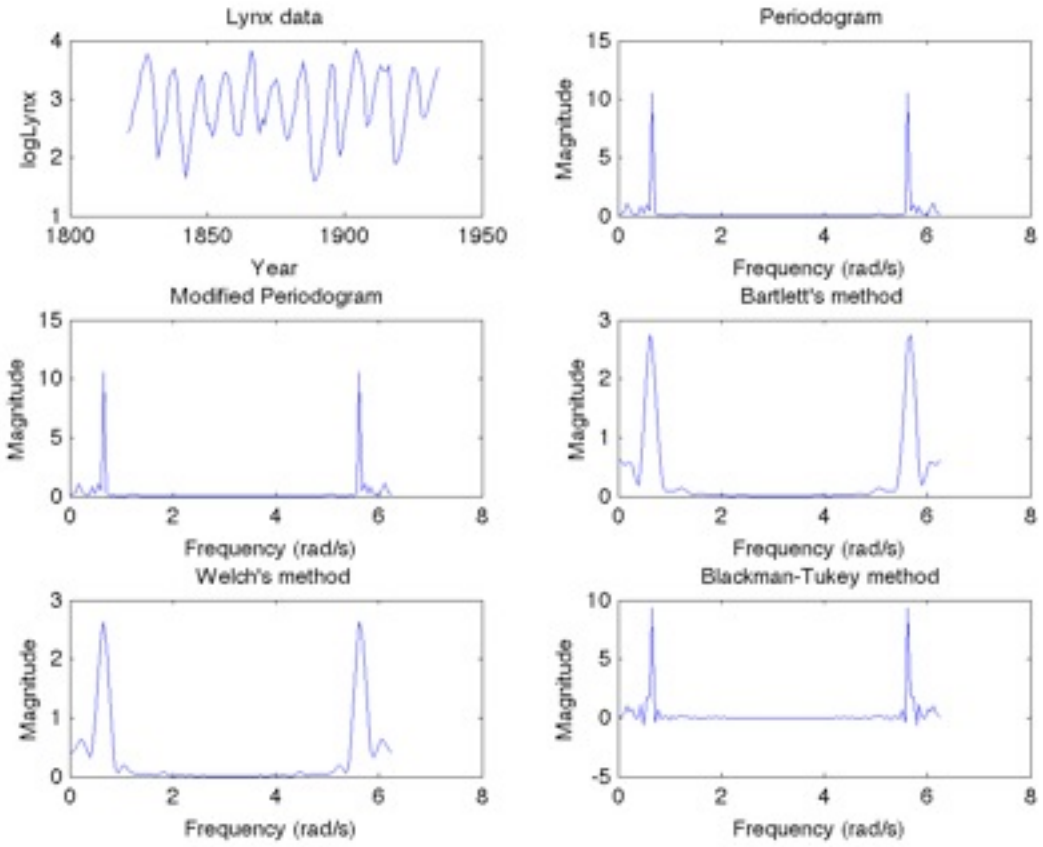


Yes this sample data has sinusoidal components especially near 0.3 rad/s and near 6 rad/s. The power spectral density plots show that. We are using just a rectangular window for modified periodogram and for the bartlett's method.
The Welch's method shows more frequency components than the rest of the methods. In Welch's method we have less resolution (in terms of ability to resolve and not by value) because the sample is subsampled. Resolution is better for samples with larger N(or larger sample values). The Blackman-Tukey method takes only safe values of the sample and gives a better estimate.

b)
The magnitude plot:



The log magnitude plot:



Yes the log-data has higher peaks in the power spectrum than the normal magnitude plot for the lynx data. So, log transformation does make the data more sinusoidal in nature.