Student Info

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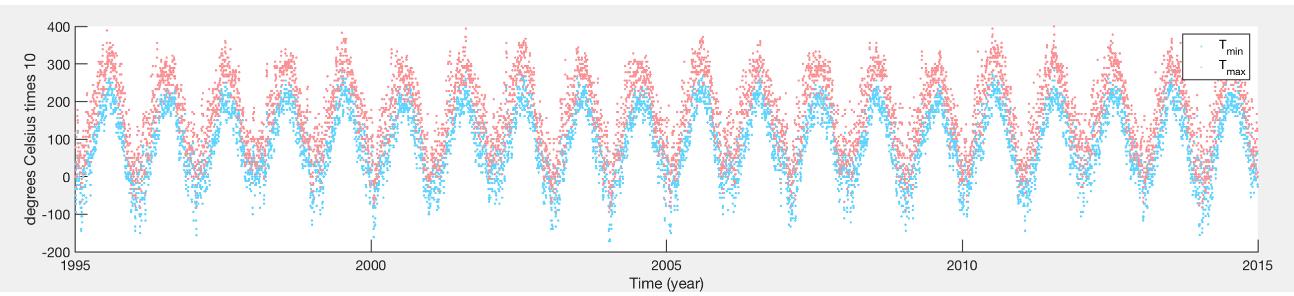
Homework 8

A.



Script:

```
% initiate variables

clearvars;
f=csvread('NYC_temp.csv',1,2);
t=f(:,1);
tmax=f(:,2);
tmin=f(:,3);

% Color setting:
Tmaxcolor = '#ef9a9a';
Tmincolor = '#81d4fa';

% A.
```

```
% creat new t
years=[1995:1:2014];
t_new=[];

leapyear=linspace(0,1,367);
leapyear=leapyear(1:366)';
normalyear=linspace(0,1,366);
normalyear=normalyear(1:365)';

for i = years
    if mod(i,4) == 0
        t_new = [t_new; i+leapyear];
    else
        t_new = [t_new; i+normalyear];
    end
end

% plot
figure(1);
hold on;
plot(t_new,tmin,
'Marker','.','LineStyle','none','Color',Tmincolor)
plot(t_new,tmax,'Marker','.','LineStyle','none','Color',Tmaxc
olor);
xlabel('Time (year)');
ylabel('degrees Celsius times 10');
legend('T_{min}','T_{max}')
set(gca,'LineWidth',1,'FontSize',14);
```

B.

I'm using Wiener filter on the frequency domain to obtain the smoothed version.

Script:

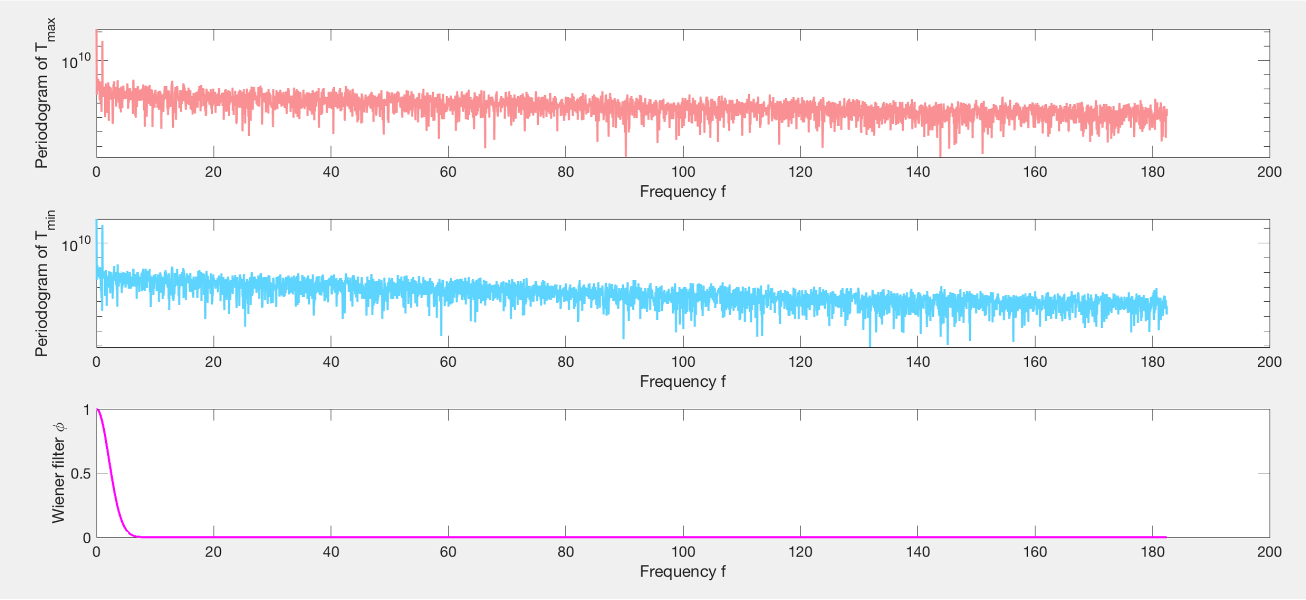
```
% B.

% compute fourier tranform of Tmax and Tmin
tmax_ft=fft(tmax);
tmax_pd=abs(tmax_ft).^2;
tmin_ft=fft(tmin);
tmin_pd=abs(tmin_ft).^2;

% compute vector of N +ve and -ve frequencies
N = length(t);
Nf = (N+1)/2;
dti = 1/365;
fNyq=1/(2*dti);  % Nyquist frequency
fpos=linspace(0,fNyq,Nf)';
fneg=flipud(-fpos(2:Nf));
freq=[fpos; fneg];

% periodogram  (+ve frequencies only!)
figure(2);

subplot(3,1,1);
semilogy(fpos,tmax_pd(1:Nf),'LineWidth',2,'Color',Tmaxcolor);
ylabel('Periodogram of T_{max}');
xlabel('Frequency f');
set(gca,'FontSize',14);

subplot(3,1,2);
semilogy(fpos,tmin_pd(1:Nf),'LineWidth',2,'Color',Tmincolor);
ylabel('Periodogram of T_{min}');
xlabel('Frequency f');
set(gca,'FontSize',14);

% Wiener filter phi = Gaussian lowpass filter
f0=3;  % controls width of frequency response
```

```
phi=exp(-(abs(freq)/f0).^2);
% plot
subplot(3,1,3);
plot(fpos,phi(1:Nf),'m-','LineWidth',2);
ylabel('Wiener filter \phi');
xlabel('Frequency f');
set(gca,'FontSize',14);

% Wiener deconvolution to get smoothed version of Tmin and
Tmax
tmax_filtered=(tmax_ft.*phi);
tmin_filtered=(tmin_ft.*phi);
tmax_filtered_ift=ifft(tmax_filtered);
tmin_filtered_ift=ifft(tmin_filtered);
```

C.

From `figure(2)` in B.:

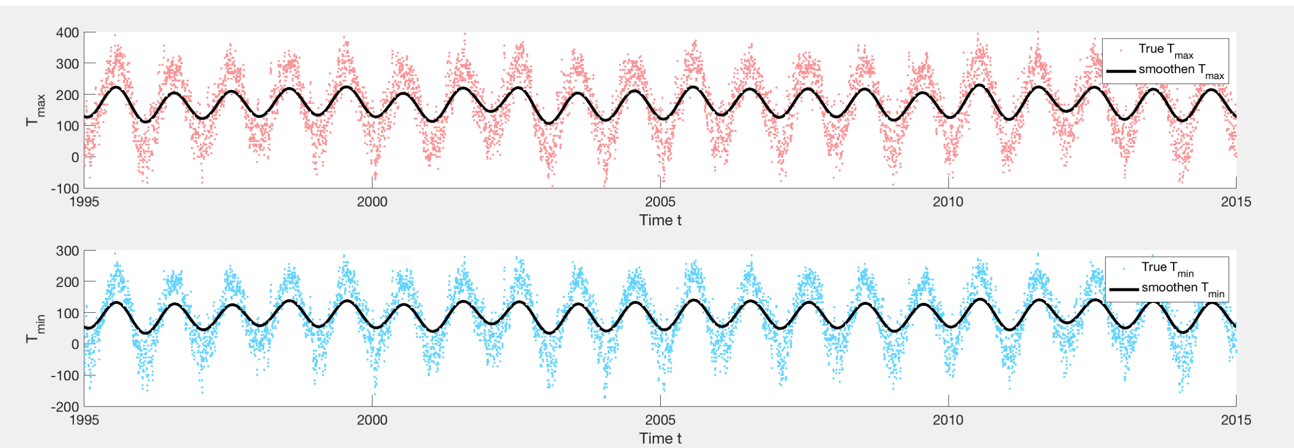
The shape is half gaussian because the periodogram of both T_{max} and T_{min} resemble this shape.



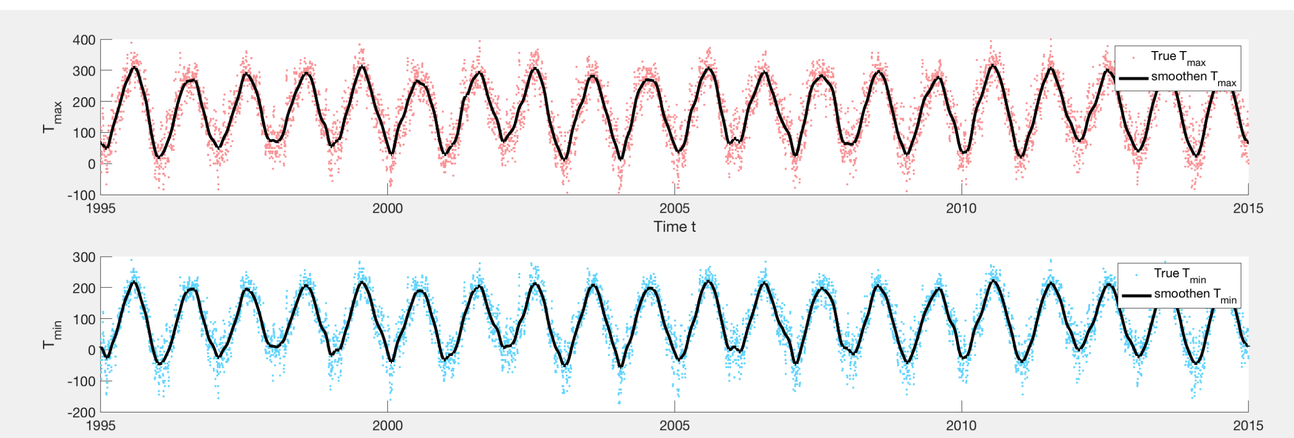
And width is 3. In this plot, there are obvious peak at $f = 1$, for the annual cycle. We should at least contain the $f = 1$ to keep the characteristic frequency.

If it's smaller, e.g., 1, the values of the peaks will be obviously smaller because it is filtering too much. If it's larger, e.g., 5, the smoothness is not as good because it will include more noise. The plots of both conditions are shown as following:

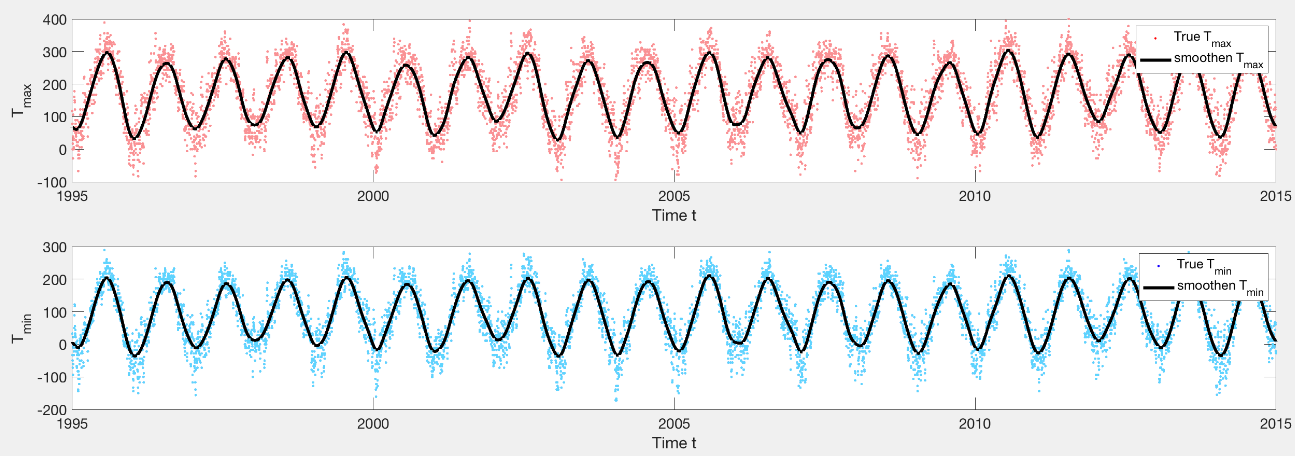
For small width of 1, `f0=1`;



For large width of 5 `f0=5`:

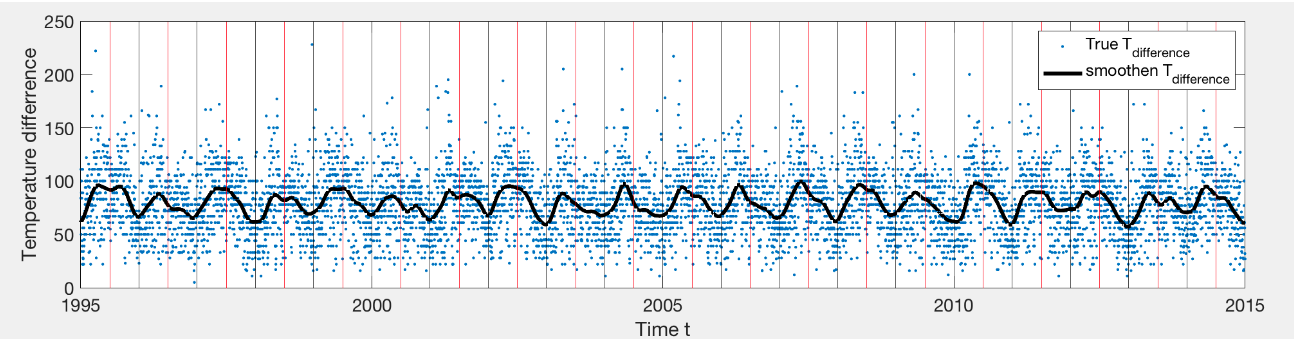


D.




```
% D.
% plot
figure(3);

subplot(2,1,1);
hold on;
plot(t_new,tmax,'Marker','.','LineStyle','none','Color',Tmaxc
olor);
plot(t_new,tmax_filtered_ift,'k-','LineWidth',3);

legend('True T_{max}','smoothen T_{max}');
ylabel('T_{max}');
xlabel('Time t');
set(gca,'FontSize',14);

subplot(2,1,2);
hold on;
plot(t_new,tmin,
'Marker','.','LineStyle','none','Color',Tmincolor)
plot(t_new,tmin_filtered_ift,'k-','LineWidth',3);

legend('True T_{min}','smoothen T_{min}');
ylabel('T_{min}');
xlabel('Time t');
set(gca,'FontSize',14);
```

E.



In this figure, the black vertical lines stand for Jan 1st of each year and the red lines stand for July 1st of each year. It's shown that the peaks of the smoothed temperature difference mostly lie at the red lines, which are in Summer.

So, The largest difference between T_{max} and T_{min} are in summer.

Script:

```
% E.
% obtain the difference between Tmin and Tmax
dt = tmax-tmin;
dt_filtered = tmax_filtered_ift - tmin_filtered_ift;



figure(4);

plot(t_new, dt,'.', t_new,dt_filtered,'k-','LineWidth',3);
for i = years
    xline(i,'k');
    xline(i+0.5,'r');
end

legend('True T_{difference}','smoothen T_{difference}');
```

```
ylabel('Temperature differrence');
xlabel('Time t');
set(gca,'FontSize',14);
```