

Blind Source Separation

Homework #13

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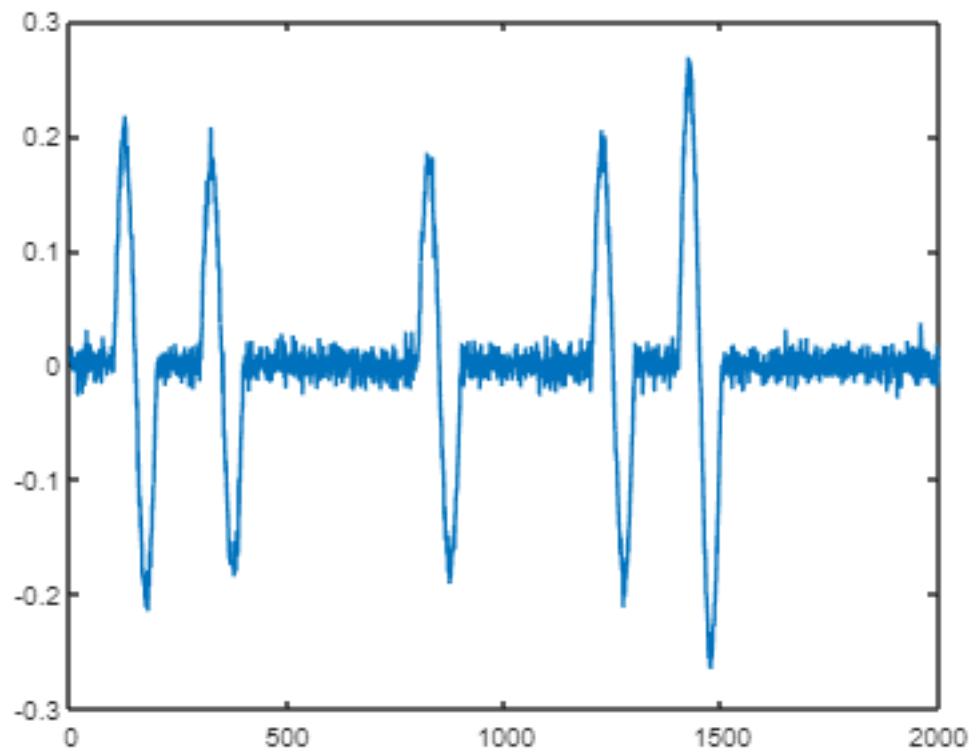
Loading

```
load('hw13.mat');  
  
L = 100;  
K = 5;
```

1)

A) Plot

```
figure  
plot(x1)
```

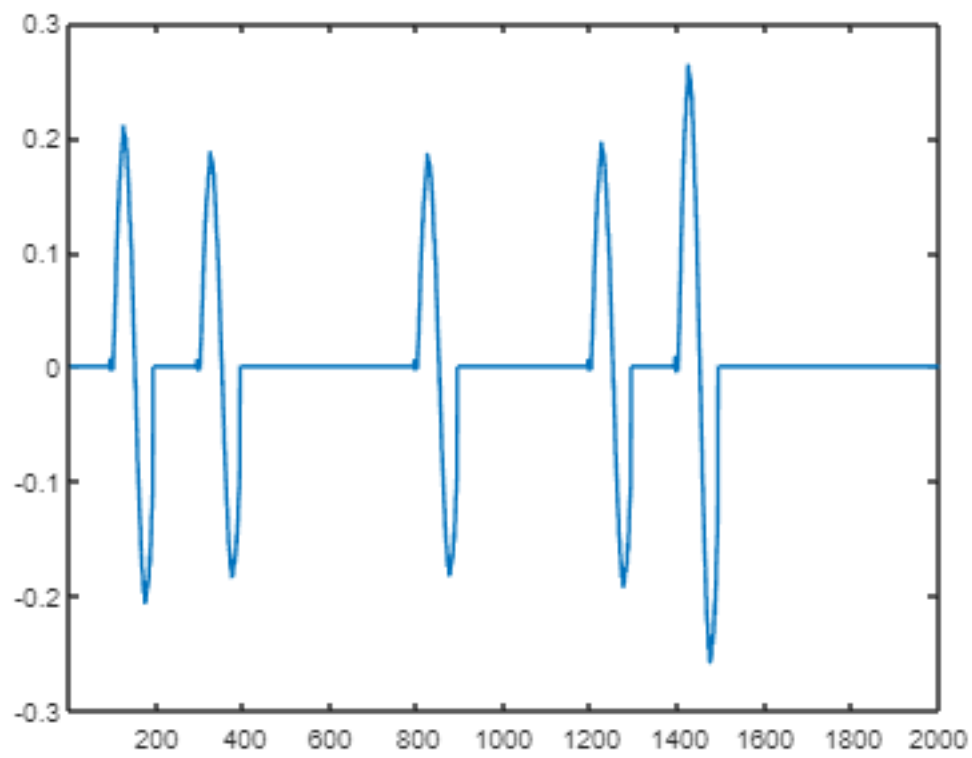


B) Deconvolution

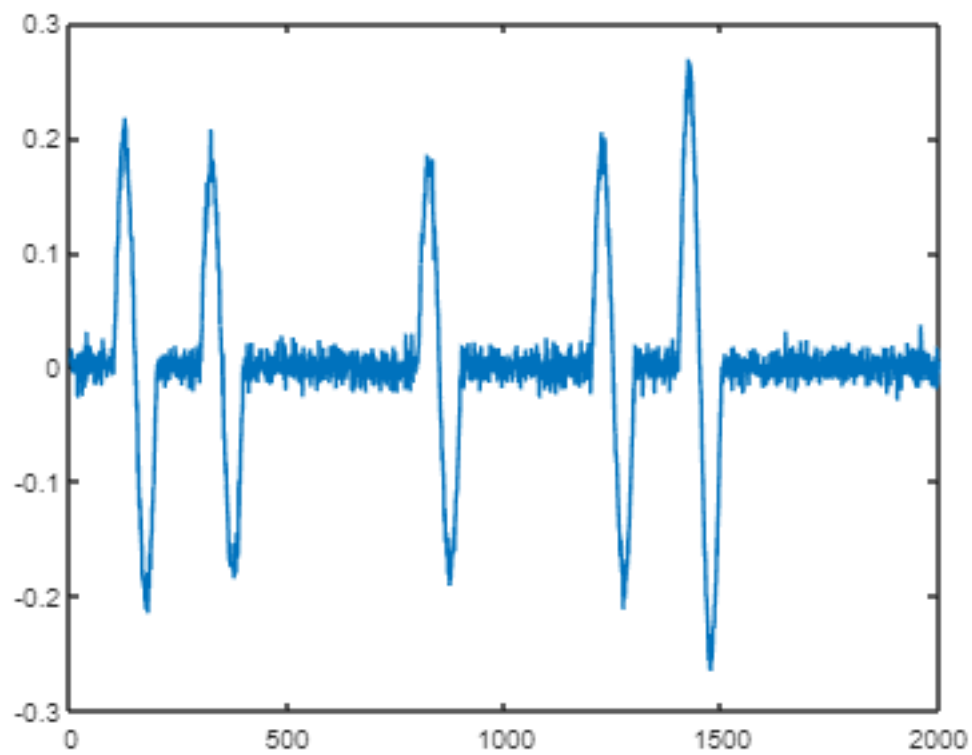
```
T = length(x1);
iterations = 50;
[s_hat,psi] = Deconvolve(x1,T,L,K,iterations);
```

The convolution of estimated spike and estimated impulse train should be like $x_1(t)$.

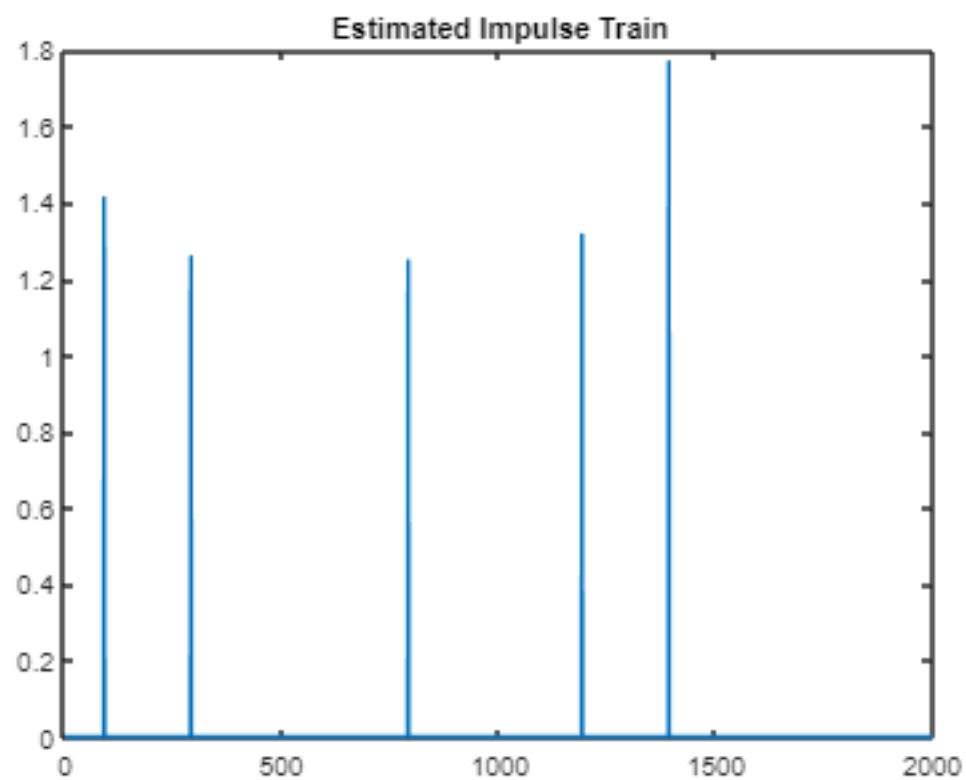
```
figure
plot(conv(s_hat,psi))
xlim([1,T])
```



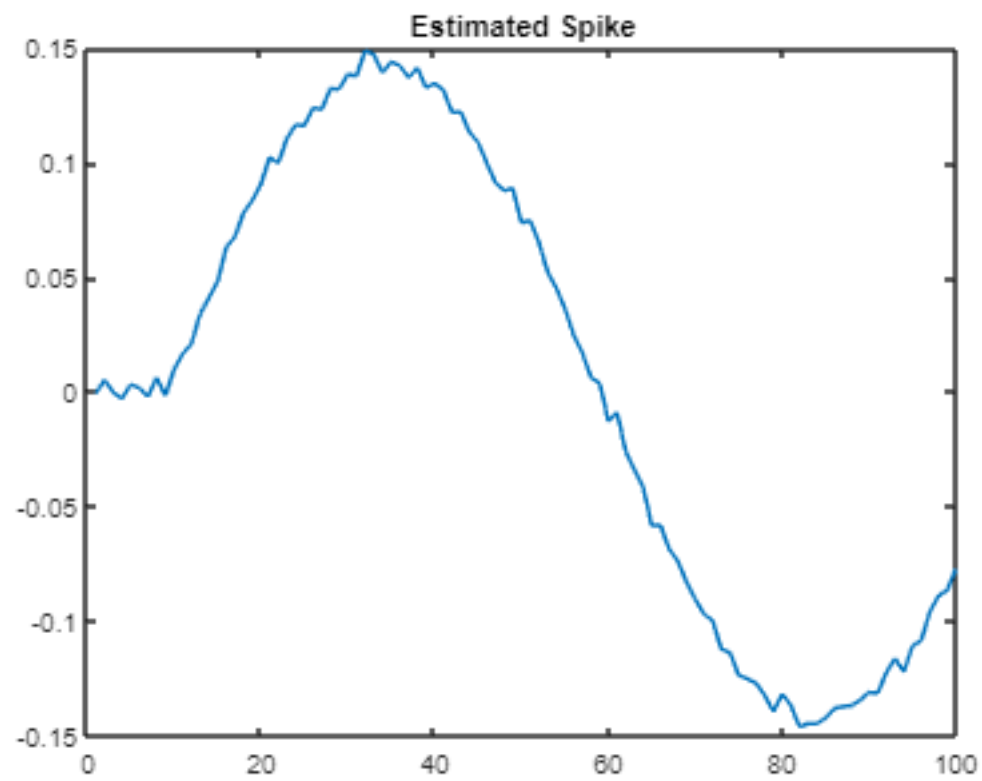
```
figure  
plot(x1)
```



```
figure
plot(psi)
title('Estimated Impulse Train')
```



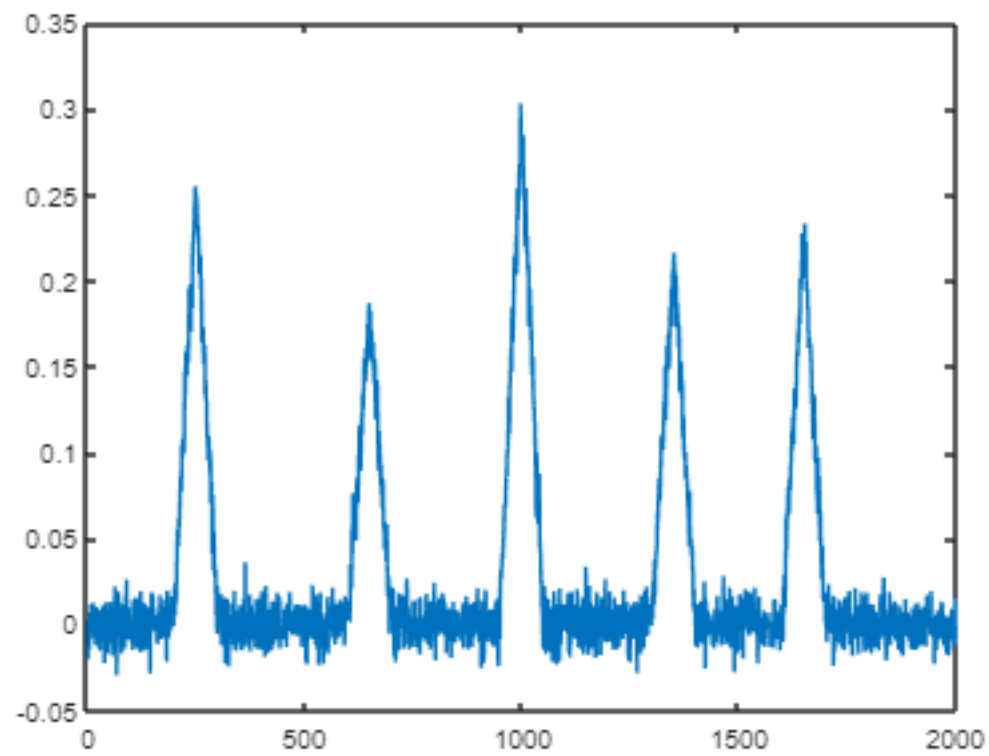
```
figure
plot(s_hat)
title('Estimated Spike')
```



2)

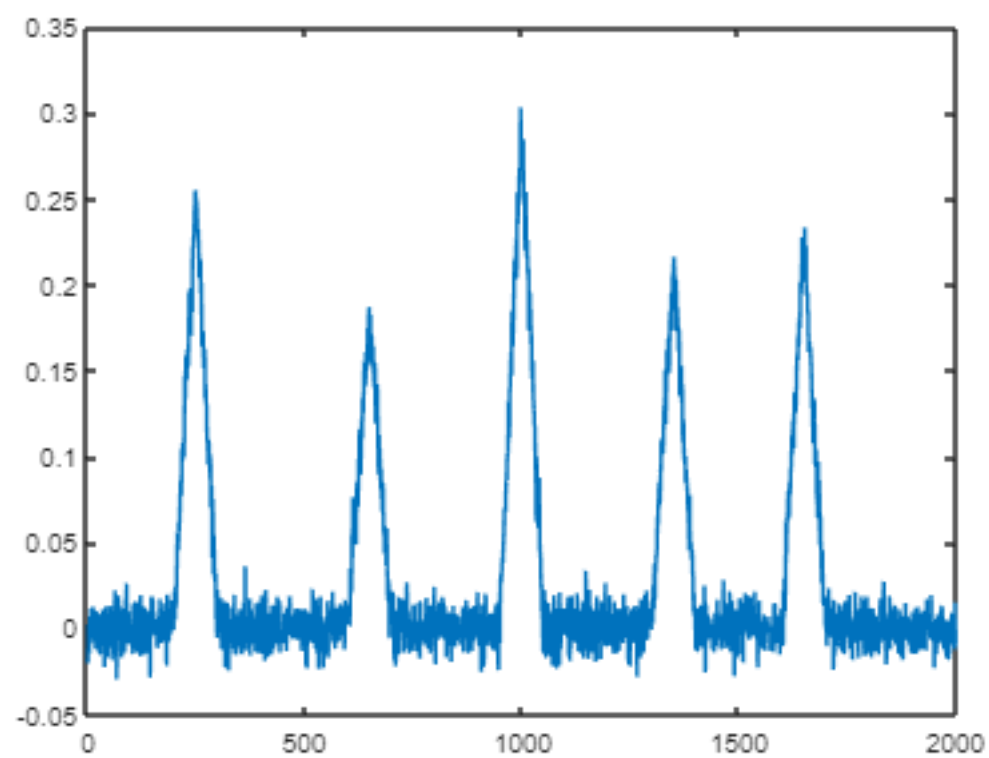
A) Plot

```
figure  
plot(x2)
```

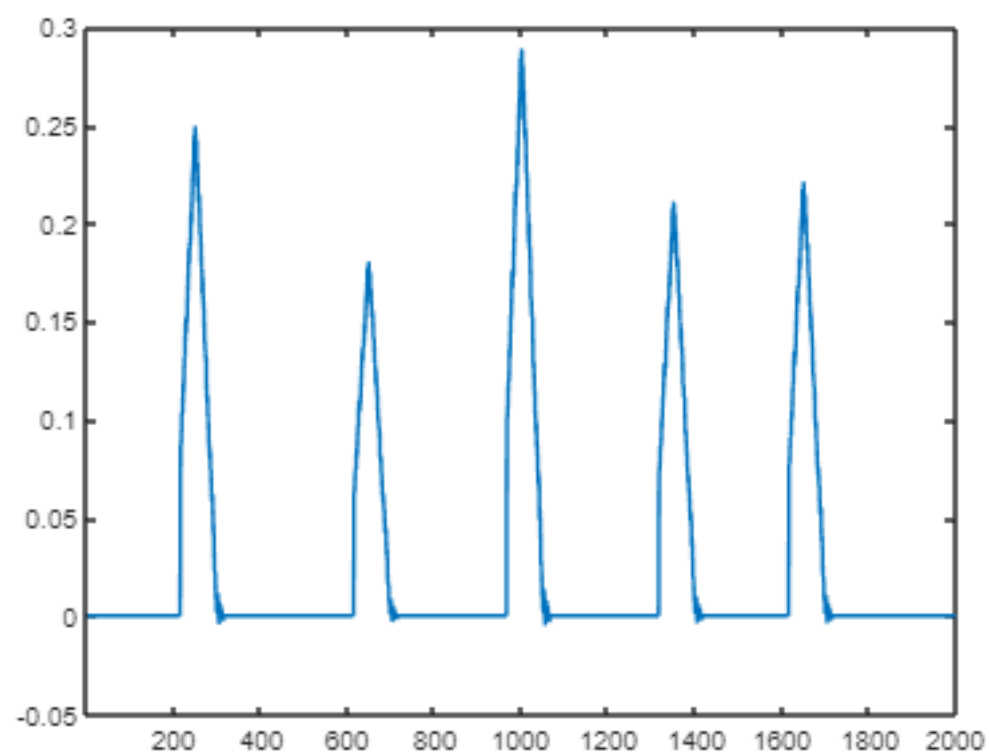


B) Deconvolution

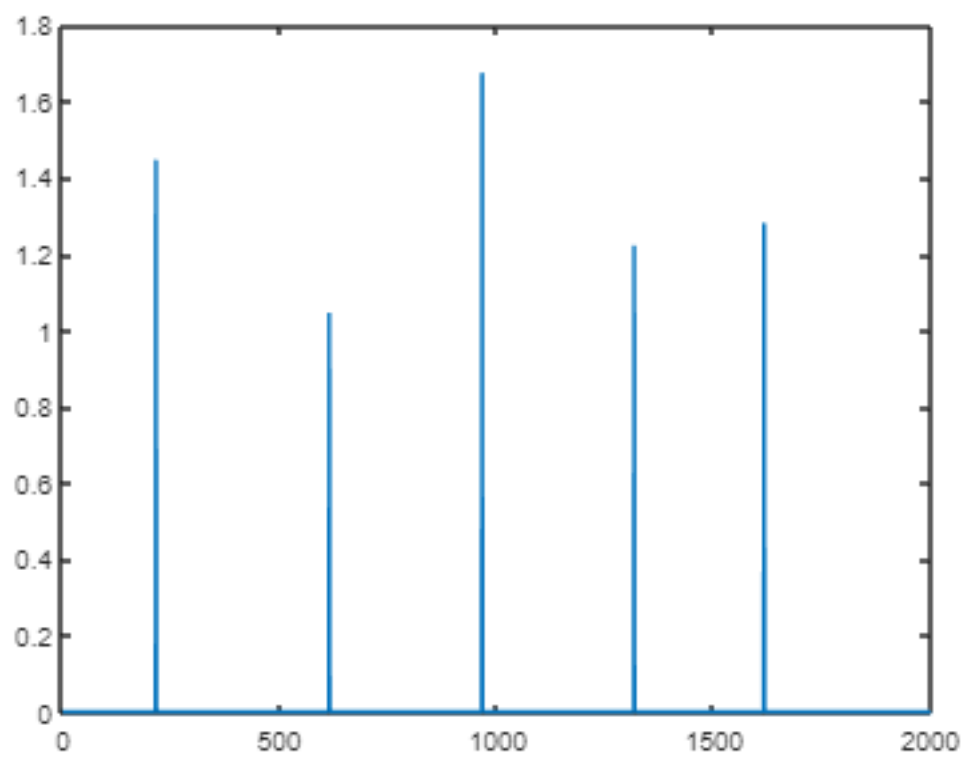
```
T = length(x2);  
iterations = 100;  
[s_hat,psi] = Deconvolve(x2,T,L,K,iterations);  
  
figure  
plot(x2)
```



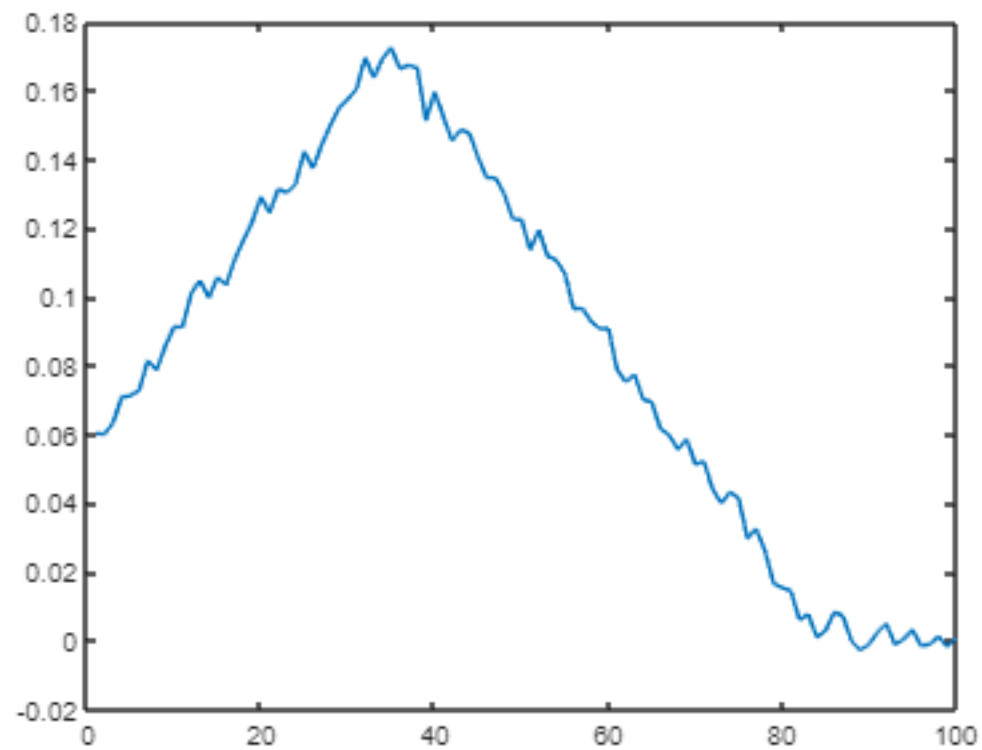
```
figure
plot(conv(s_hat,psi))
xlim([1,T])
```



```
figure  
plot(psi)
```



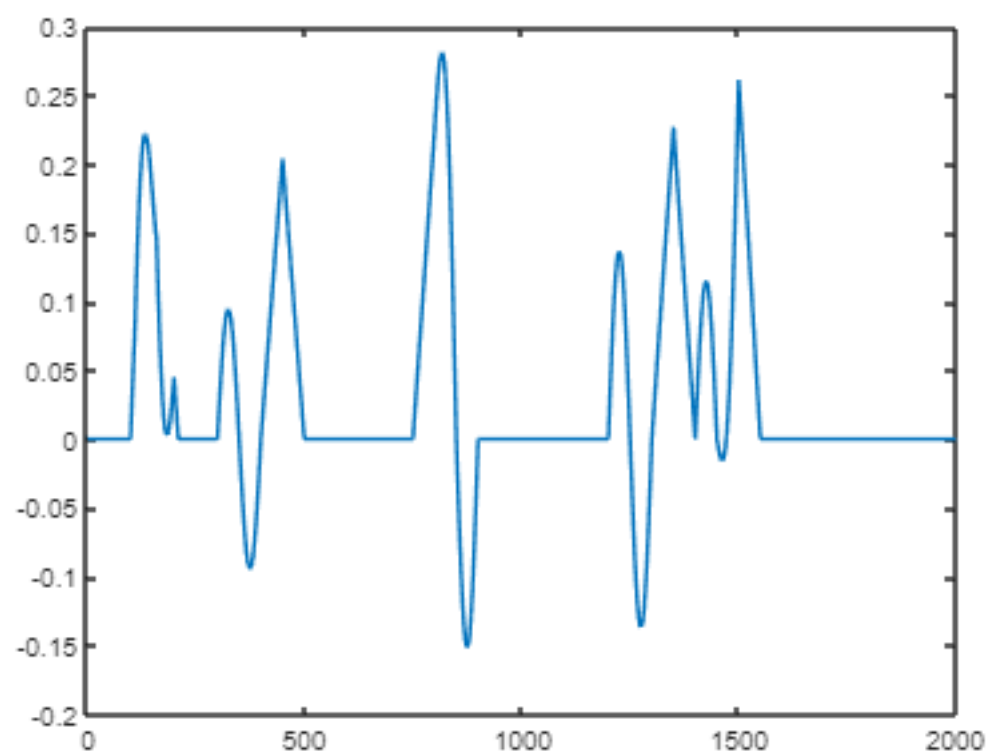

```
figure  
plot(s_hat)
```



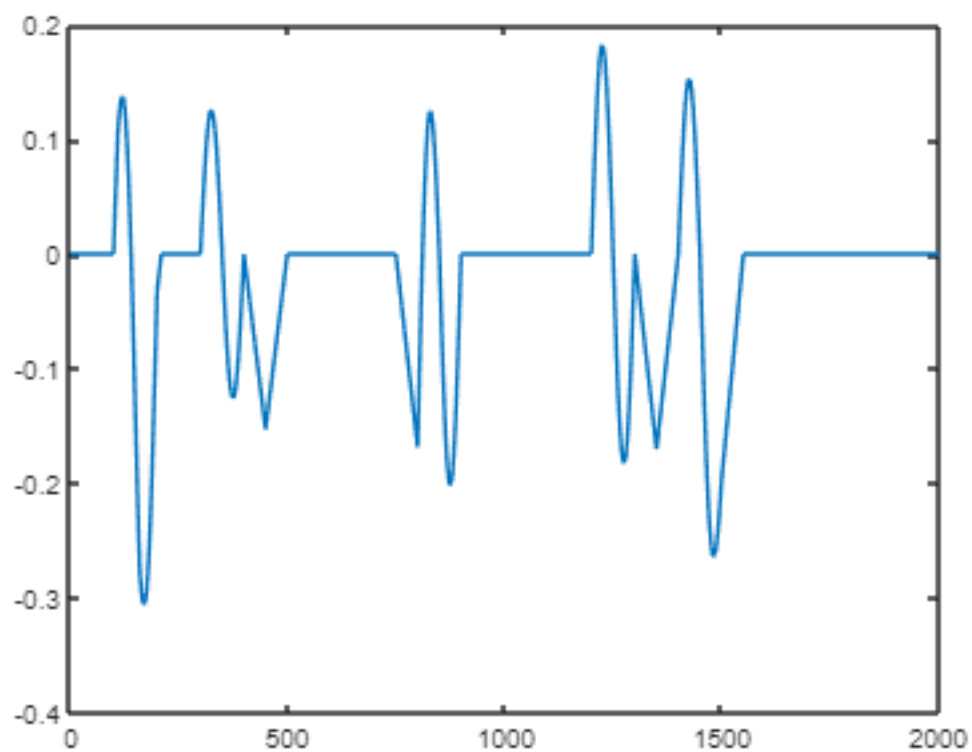
3)

A) Plot

```
figure  
plot(X(1,:))
```



```
figure  
plot(X(2,:))
```

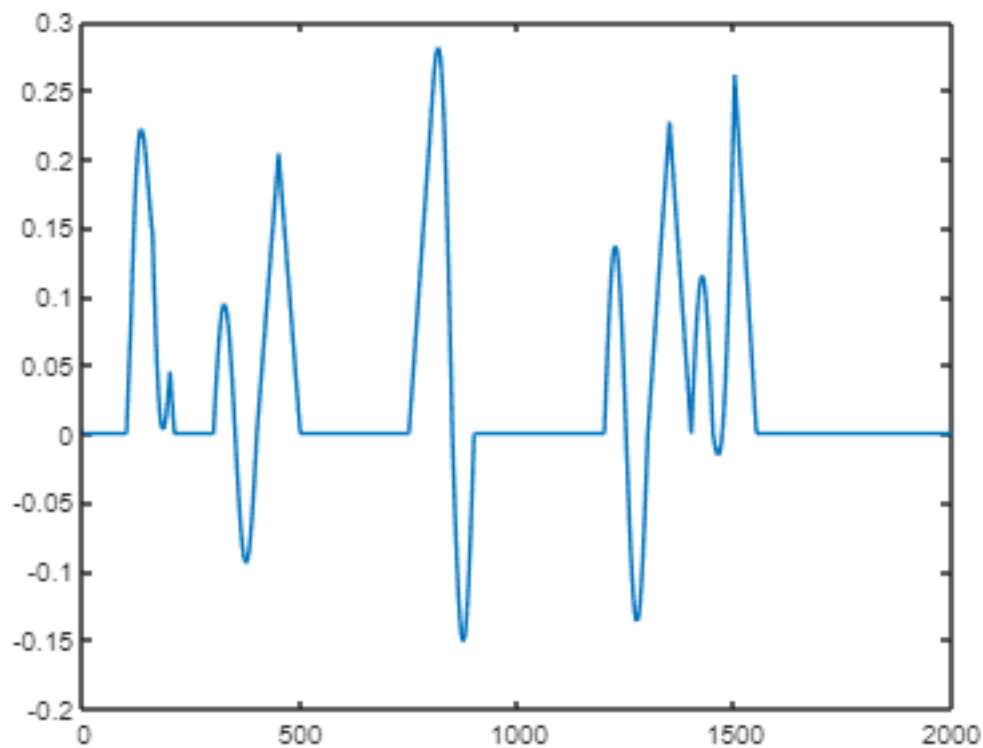


B) Deconvolution

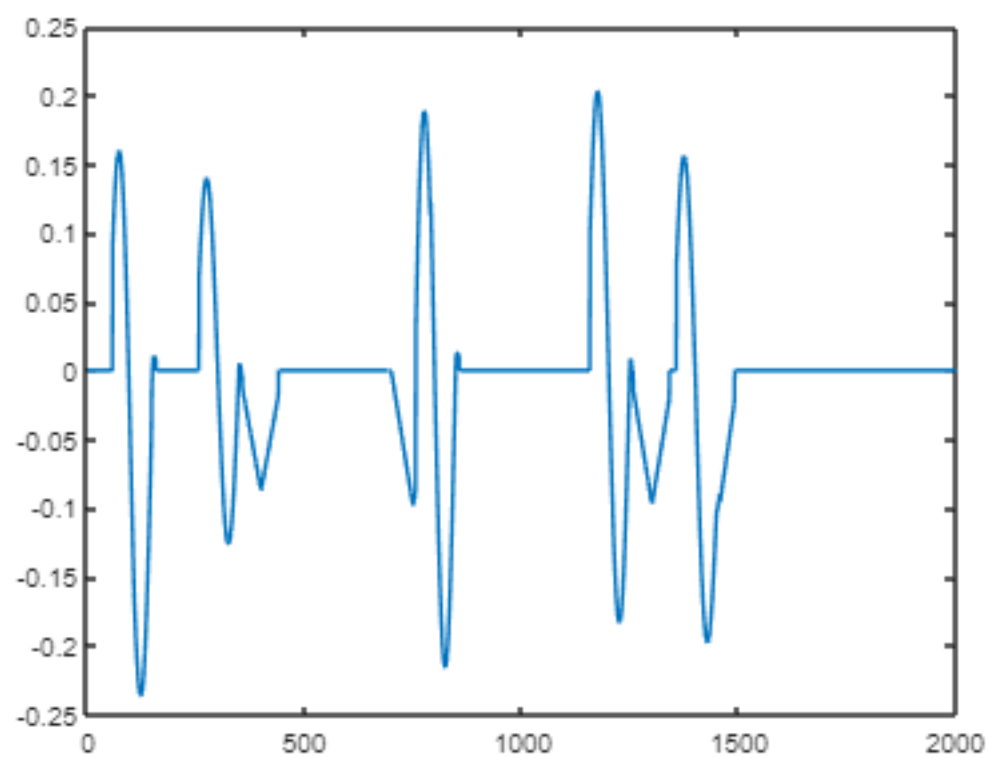
```
% initialize A
A = rand(2);
for col = 1:2
    A(:,col) = A(:,col)/norm(A(:,col));
end

iters = 15;
e = 0;
[s_hat1_T,s_hat2_T,S_hat_3T] = Multi_deconvolve(A,X,L,K,iters,e);
X_hat = A*S_hat_3T;
```

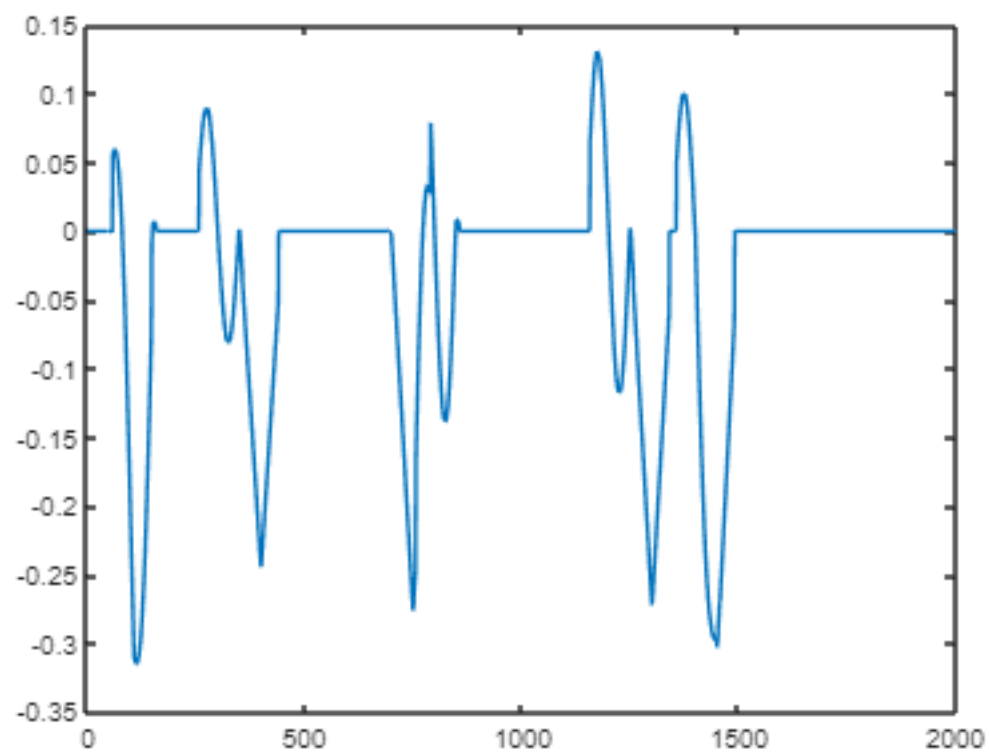
```
figure
plot(X(1,:))
```



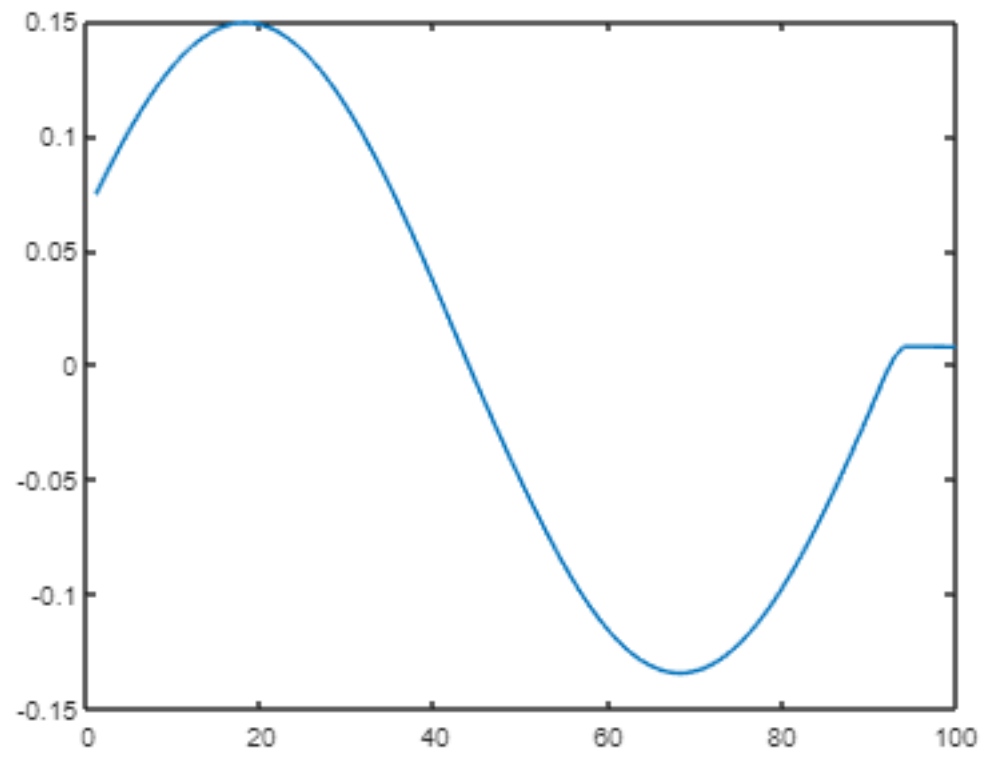
```
figure
plot(X_hat(1,:))
```



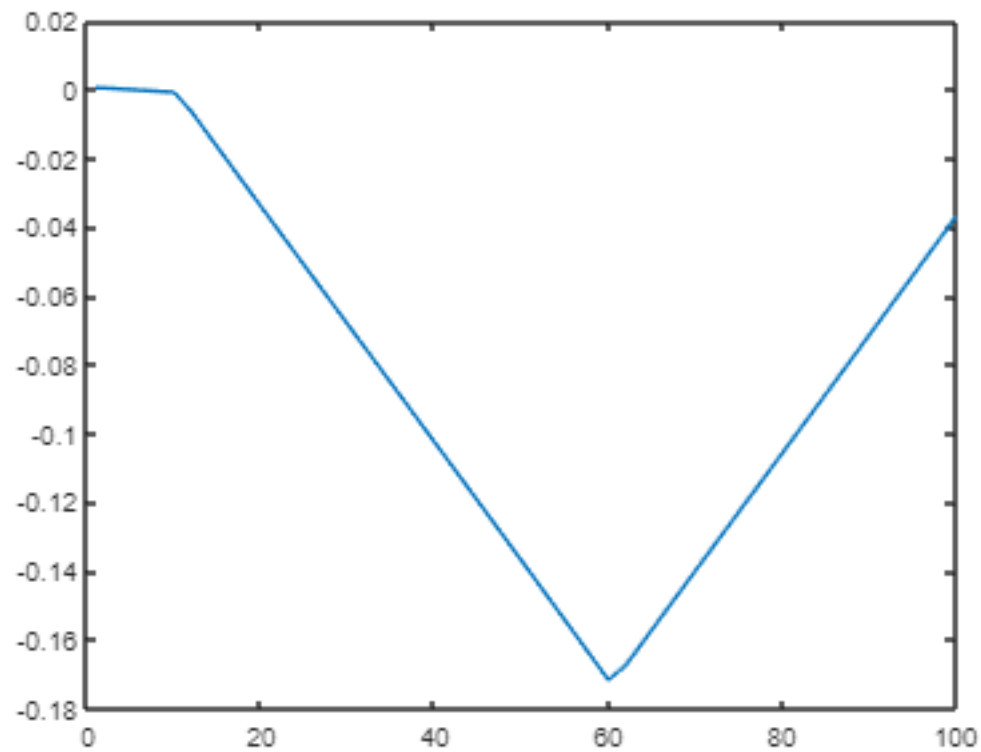
```
figure  
plot(X_hat(2,:))
```



```
figure  
plot(s_hat1_T)
```



```
figure  
plot(s_hat2_T)
```



Functions.

```
function [s_hat,psi] = Deconvolve(x,T,L,K,itters)

% initialize psi
tau = randi([1 T-L],1,K);

% |taui - tauj| > L
alpha = rand(1,K);
psi = zeros(1,T);

Y = zeros(L,K);
for i = 1:length(tau)
    psi(tau(i)) = alpha(i);
    Y(:,i) = (x(tau(i):tau(i)+L-1));
end

e = 0;
for iter = 1:itters

    % psi is fixed
    for i = 1:length(tau)
        psi(tau(i)) = alpha(i);
        Y(:,i) = x(tau(i):tau(i)+L-1);
    end
end
```

```

s_hat_ = Y*pinv(alpha);
if norm(s_hat_) ~= 0
    s_hat = s_hat_/norm(s_hat_);
else
    s_hat = s_hat_;
end

if norm(norm(x-conv(psi,s_hat,'same'))-e) < 1e-02
    break;
end
e = norm(x-conv(psi,s_hat,'same'));

% s is fixed
Z = zeros(L,T-(L-1));
for i = 1:T-(L-1)
    Z(:,i) = x(i:i+L-1);
end

b = zeros(1,T-(L-1));
for n = 1:K
    C = s_hat'*Z;
    [val,ind] = max(abs(C));

    b(ind) = val;

    Z_r = Z(:,max(1,ind-(L-1)):min(size(Z,2),ind+(L-1)));
    Z(:,max(1,ind-(L-1)):min(size(Z,2),ind+(L-1))) = zeros(size(Z_r));
end

psi = [b,zeros(1,L-1)];
alpha = zeros(1,K);

i = 1;
for j = 1:length(psi)
    if psi(j) ~= 0
        alpha(i) = psi(j);
        tau(i) = j;
        i = i+1;
    end
end
end
end

function [s_hat1_T,s_hat2_T,B] = Multi_deconvolve(A,X,L,K,itors,e)

for iter = 1:itors
    % A is fixed
    B = A\X;

```

```

% Blind Deconvolution
T = size(B,2);
[s_hat1_T,psi1_T] = Deconvolve(B(1,:),T,L,K,itors);
[s_hat2_T,psi2_T] = Deconvolve(B(2,:),T,L,K,itors);

B = [conv(psi1_T,s_hat1_T,'same');conv(psi2_T,s_hat2_T,'same')];

% S is fixed
A = X*pinv(B);
for col = 1:2
    A(:,col) = A(:,col)/norm(A(:,col));
end

if norm(norm(X-A*B),e) < 1e-02
    break;
end
e = norm(X-A*B);
end
end

```