Part 1 Crystal Wang & Kevin Jiang

$R_{yy} = R_{ss} * R_{cc}$ $R_{rr} = R_{yy} + R_{dd}$

$R_{rr}[n] = R_{dd}[n] + R_{ss}[n] * R_{cc}[n]$

$R_{dd}[n] = 0$ except when $n = 0$

$\therefore R_{rr}[n] = R_{ss}[n] * R_{cc}[n] = \bar{R}_{cc}[n]$

$R_{ss}[n]$ is an impulse

$$\bar{R}_{cc}[n] = \sum_{n=-\infty}^{\infty} C[n+m]C[n]$$

$R_{rs}[n] = C[n] * R_{ss}[n] = C[n]$

$R_{sr}[n] = C[-n]$

$$\begin{bmatrix} R_{rr}[0] & R_{rr}[-1] & R_{rr}[-2] & R_{rr}[-3] \\ R_{rr}[1] & R_{rr}[0] & R_{rr}[-1] & R_{rr}[-2] \\ R_{rr}[2] & R_{rr}[1] & R_{rr}[0] & R_{rr}[-1] \\ R_{rr}[3] & R_{rr}[2] & R_{rr}[1] & R_{rr}[0] \end{bmatrix} \begin{bmatrix} h[0] \\ h[1] \\ h[2] \\ h[3] \end{bmatrix} = \begin{bmatrix} R_{\hat{s}r}[0] \\ R_{\hat{s}r}[1] \\ R_{\hat{s}r}[2] \\ R_{\hat{s}r}[3] \end{bmatrix}$$

$R_{\hat{s}r} = R_{sr}$

$$\begin{bmatrix} 1.2 & 0.28 & 0.4 & 0 \\ 0.28 & 1.2 & 0.28 & 0.4 \\ 0.4 & 0.28 & 1.2 & 0.28 \\ 0 & 0.4 & 0.28 & 1.2 \end{bmatrix} \begin{bmatrix} h[0] \\ h[1] \\ h[2] \\ h[3] \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

$$h = \begin{bmatrix} 0.99 \\ -0.20 \\ -0.31 \\ 0.14 \end{bmatrix}$$

```
clear;

% Stoch Project #5 by Crystal Wang and Kevin Jiang
c = [1 .2 .4];
MSEvec = zeros(1,3);
count = 1;
siglen = 1000; %Generated signal length
s = randi(2, 1, siglen); % random generated signal wiht +/-1
s(find(s == 2)) = -1;
[Rss, lags] = xcorr(s); % index 1000 is time delay = 0;
sd = 0.5; % Standard deviation of the noise
y = filter(c, 1, s); % The output of the filter c[n]
r = y + normrnd(0, sd, 1, length(y)); % The input of the second filter
 h[n]
for N = [4, 6, 10]% for loop for each lenght of the FIR filter
Rrr = xcorr(r); % Autocorrelation of r
Rrrmid = (length(Rrr)+1)/2; %the Midpoint of Rrr, where Rrr[0] existed
Rsr = xcorr(s,r); %Rsr
Rsrmid = (length(Rsr)+1)/2; % The Midindex of Rsr where Rsr[0] is
A = zeros(N);
for i = 1:1:N
    A(i,:) = transpose(Rrr(Rrrmid-i+1:Rrrmid-i+N)); % The left side of
 the equation
end
b = transpose(Rsr(Rsrmid:Rsrmid+N-1)); % The right side of the
 dquation
h = A\b; % how to calculate h


s_hat = filter(transpose(h), 1, r); %the output of the system
MSEvec(count) = sum((s_hat-s).^2)/siglen; % MSE
count = count + 1;
end

table(MSEvec(1), MSEvec(2), MSEvec(3), 'VariableNames', ["N = 4", "N =
 6", "N = 10"],...
    'RowNames', "MSE")
```

```
ans =

  1×3 table

            N = 4      N = 6      N = 10
           _______    _______    _______

    MSE    0.21119    0.20711    0.20657
```

Published with MATLAB® R2019b