Devon Quaternik
ELEN 431
HW#3
10/13/2016

1) $R = \begin{bmatrix} 1 & 0.7 \\ 0.7 & 1 \end{bmatrix}$ $p = \begin{bmatrix} 1 \\ \frac{1}{2} \end{bmatrix}$ $p^H = \begin{bmatrix} 1 & \frac{1}{2} \end{bmatrix}$

$\det(R) = 1 - (0.7)^2 = 0.51$

$R^{-1} = \frac{1}{.51}\begin{bmatrix} 1 & -.7 \\ -.7 & 1 \end{bmatrix}$

$= \begin{bmatrix} 1.961 & -1.37 \\ -1.37 & 1.961 \end{bmatrix}$

$w_o = R^{-1}p$

$= \begin{bmatrix} 1.961 & -1.37 \\ -1.37 & 1.961 \end{bmatrix}\begin{bmatrix} 1 \\ \frac{1}{2} \end{bmatrix}$

$= \begin{bmatrix} 1.275 \\ -0.39 \end{bmatrix}$

$\sigma_d^2 = p^H R^{-1} p = \begin{bmatrix} 1 & \frac{1}{2} \end{bmatrix}\begin{bmatrix} 1.961 & -1.37 \\ -1.37 & 1.961 \end{bmatrix}\begin{bmatrix} 1 \\ \frac{1}{2} \end{bmatrix} = \begin{bmatrix} 1.078 \end{bmatrix}$

$J_{min} = \sigma_d^2 - w^H p - p^H w + w^H R w$

$= 1.078 - \begin{bmatrix} 1.275 & -0.39 \end{bmatrix}\begin{bmatrix} 1 \\ \frac{1}{2} \end{bmatrix} + \begin{bmatrix} 1 & \frac{1}{2} \end{bmatrix}\begin{bmatrix} 1.275 \\ -0.39 \end{bmatrix} + \begin{bmatrix} 1.275 & 0.39 \end{bmatrix}\begin{bmatrix} 1 & 0.7 \\ 0.7 & 1 \end{bmatrix}\begin{bmatrix} 1.275 \\ 0.39 \end{bmatrix}$

$= 1078 - 1.08 + 1.08 + 1.082 = \boxed{2.16 = J_{min}}$

ii) $J = 1.078 - \begin{bmatrix} w_0 & w_1 \end{bmatrix}\begin{bmatrix} 1 \\ \frac{1}{2} \end{bmatrix} + \begin{bmatrix} 1 & \frac{1}{2} \end{bmatrix}\begin{bmatrix} w_0 \\ w_1 \end{bmatrix} + \begin{bmatrix} w_0 & w_1 \end{bmatrix}\begin{bmatrix} 1 & 0.7 \\ 0.7 & 1 \end{bmatrix}\begin{bmatrix} w_0 \\ w_1 \end{bmatrix}$

$= 1.078 - w_0 - .5w_1 + w_0 + .5w_1 + \begin{bmatrix} w_0 + .7w_1 & .7w_0 + w_1 \end{bmatrix}\begin{bmatrix} w_0 \\ w_1 \end{bmatrix}$

$= 1.078 + w_0^2 + .7w_1w_0 + .7w_0w_1 + w_1^2$

$\boxed{J(w_0, w_1) = 1.078 + w_0^2 + 1.4 w_0 w_1 + w_1^2}$

Devon Quaternik

Table of Contents

ELEN 431 HW #3

Problem 2

```
R=0.3.*[3 -2 1; -2 3 -2; 1 -2 3];
p=[-2; 1; -0.5];

%optimum weights
wo = inv(R)*p

sigd = p'*inv(R)*p;

%find minimum point on performance function
Jmin = sigd - wo'*p - p'*wo + wo'*R*wo
```

```
wo =

   -2.7083
   -0.8333
   -0.2083


Jmin =

  -1.7764e-15
```

Problem 3

```
R=0.25.*[4 3 2 1; 3 4 3 2; 2 3 4 3; 1 2 3 4];
p=[0.5; 0.375; 0.25; 0.175];

wo = inv(R)*p
sigd = p'*inv(R)*p;

Jmin = sigd - wo'*p - p'*wo + wo'*R*wo
```

```
wo =
```

```
    0.5200
   -0.0000
   -0.1000
    0.1200


Jmin =

  -5.5511e-17
```

Problem 4

```
%Assume abs(alpha)<1, for example here alpha=0.5
n=1000;
m=1;
a=0.5;
u=wgn(m,n,0);

num1=[sqrt(1-a^2) 0];
den1=[1 -a];

x=filter(num1,den1,u);
v=0.1*randn(1,n);

num2=[1 4];
den2=[1];

d=v+filter(num2,den2,x);

[X,R]=corrmtx(x,m);

R
p=[mean(x(1)*conj(d(1)));mean(x(2)*conj(d(2)))]

%Part 2
wo=inv(R)*p;

%Part3
sigd = p'*inv(R)*p;
Jmin = sigd - wo'*p - p'*wo + wo'*R*wo


R =

    1.0688    0.5409
    0.5409    1.0688


p =

    1.2341
    0.3211
```

```
Jmin =

  -2.2204e-16
```

Problem 5

```
R=[1 0.5 0.25; 0.5 1 0.5; 0.25 0.5 1];
p=[3; 1; 0];

wo = inv(R)*p

%Part b
sigd = 10;

%Jmin equation
Jmin = sigd + wo'*R*wo

%Part c
[V,D] = eig(R);

VH = V';

for k =1:3
    lam(k)=D(k,k);
    f(k)=(1/lam(k))*V(k,:)*VH(:,k);
end

sum1 = sum(f);

%Filter according to eigenvalues and vectors
wo = sum1*p


wo =

    3.3333
   -0.3333
   -0.6667


Jmin =

   19.6667


wo =

   13.0000
    4.3333
         0
```

Published with MATLAB® R2015a