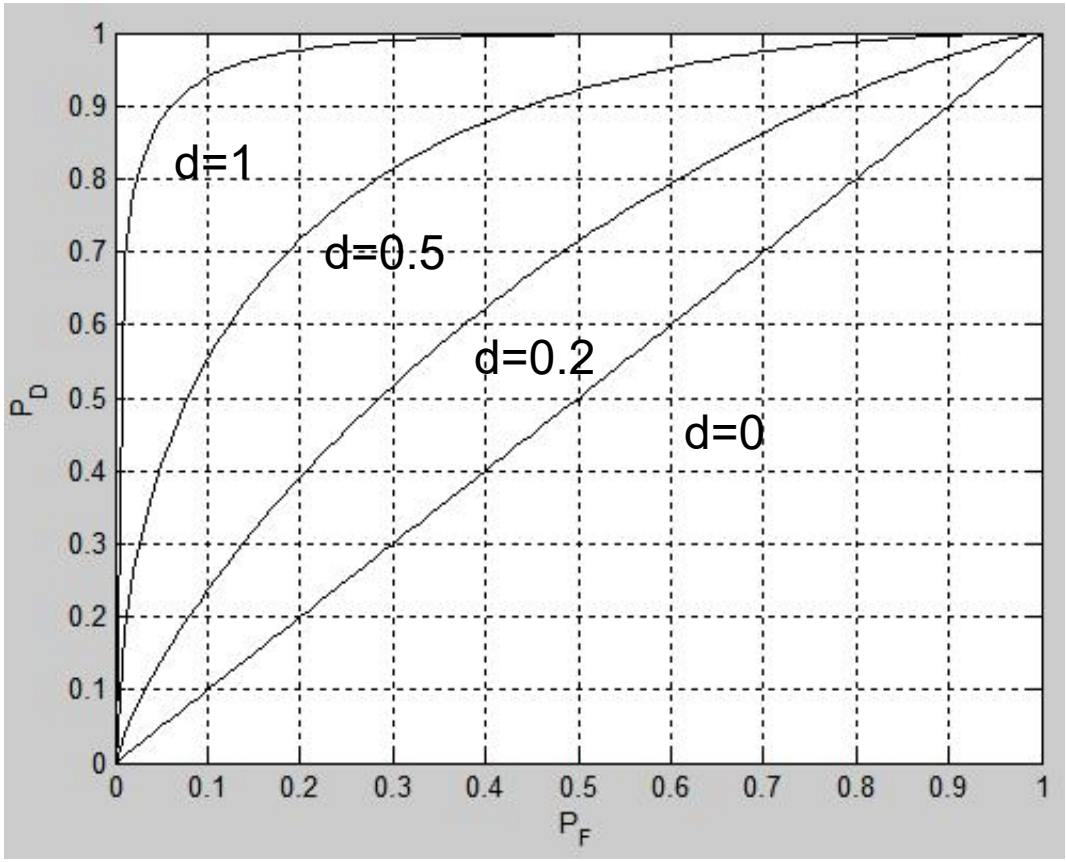
信号检测MATLAB编程

例3.1：接收机工作特性（ROC）。基于贝叶斯准则的高斯白噪声中恒定电平检测的收机工作特性。

$$P_F = Q\left(\frac{\sqrt{N}\gamma}{\sigma}\right)$$

$$P_D = Q\left(\frac{\sqrt{N}(\gamma - A)}{\sigma}\right)$$

```
clf;
N=8;
pf=0:0.01:1;
d=0;
pd1=1-normcdf(sqrt(2).*erfinv(1-2.*pf)-sqrt(N).*d);
d=0.2;
pd2=1-normcdf(sqrt(2).*erfinv(1-2.*pf)-sqrt(N).*d);
d=0.5;
pd3=1-normcdf(sqrt(2).*erfinv(1-2.*pf)-sqrt(N).*d);
d=1;
pd4=1-normcdf(sqrt(2).*erfinv(1-2.*pf)-sqrt(N).*d);
plot(pf,pd1,'k',pf,pd2,'k',pf,pd3,'k',pf,pd4,'k','linewidth',1);
grid;
xlabel('P_F');ylabel('P_D');
```


d=1
d=0.5
d=0.2
d=0
P_D
P_F
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

例3.2： 高斯白噪声中已知信号的检测。

数据模型和检测器为：

$$x[n] = As[n] + w[n]$$

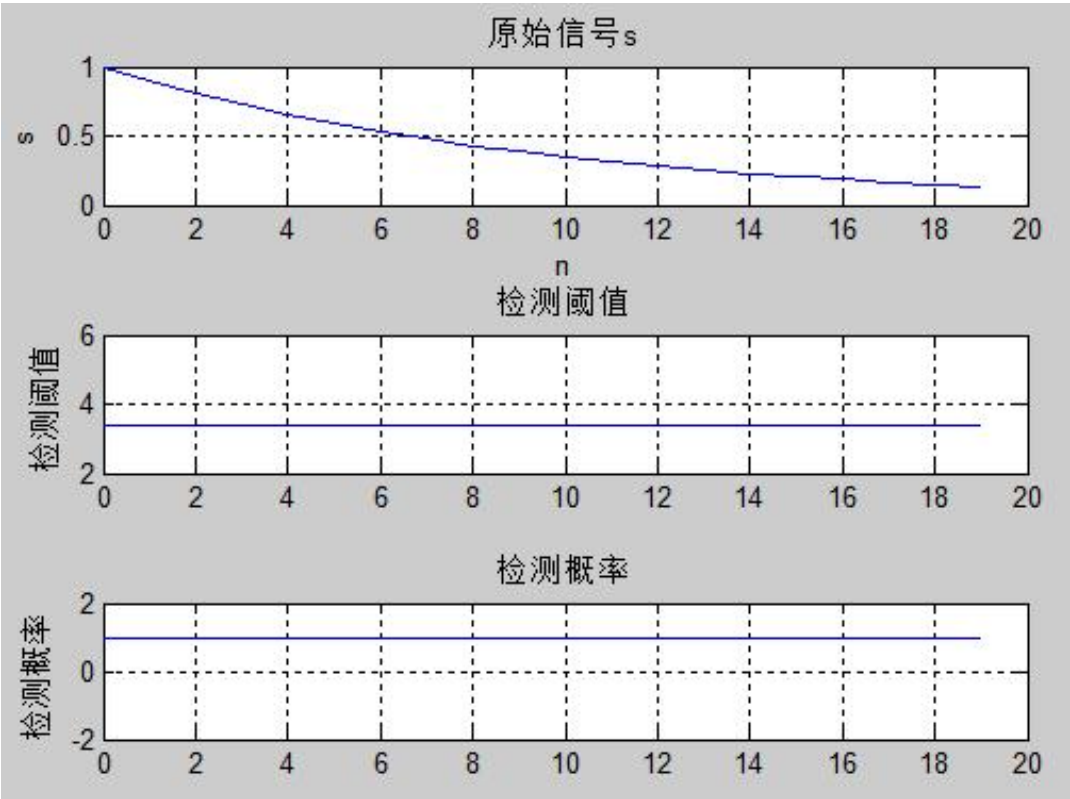
$$T(x) = \sum_{n=0}^{N-1} x[n]s[n] > \gamma = \sqrt{\sigma^2 E}\, Q^{-1}(P_{FA})$$

$$s[n] = r^n,\quad r = 0.9,\quad N = 20,\quad \sigma^2 = 0.16,\quad P_{FA} = 0.01$$

```
% This program determines the threshold for a replica-correlator detector
% .  It assumes the signal is a damped exponential.
%
clear all
close all
N=20;
n=[0:N-1]'; % set up time samples
r=0.9;
s=r.^n; % compute signal samples
sig2=0.16; % WGN variance
Pfa=0.0001; % set lower Pfa
x=ones(N,1); % arbitrary since not needed for threshold calculation
[T0,gamma]=FSSP3alg10_1_sub(s,x,sig2,Pfa) % call subprogram to
                                          % obtain threshold
E=s'*s; % signal energy
Pd=Q(Qinv(Pfa)-sqrt(E/sig2)) % compute theoretical Pd
A1=ones(1,N);
A2=A1.*gamma;
A3=A1.*Pd;
```

```
subplot(311);
plot(n,s);
xlabel('n');ylabel('s');
title(‘原始信号s');grid;
subplot(312);
plot(n,A2);
ylabel(‘检测阈值');
title(‘检测阈值');grid;
subplot(313);
plot(n,A3);
ylabel(‘检测概率');
title(‘检测概率');grid;
```

```
%  This function subprogram detects a known signal
%  embedded in WGN with known variance.  It computes the detection
%  statistic and the threshold.
%
%  Input parameters:
%    s  - real array of dimension N x 1 containing signal samples
%    x  - real array of dimension N x 1 containing data
%    sig2 - variance of WGN
%    Pfa  - probability of false alarm desired
%
%  Output parameters:
%    T   - detection statistic
%    gamma - threshold required
%
%  External function subprograms required:
%    Qinv.m
%
function [T,gamma]=FSSP3alg10_1_sub(s,x,sig2,Pfa)
T=(x'*s);
gamma=sqrt(sig2*(s'*s))*Qinv(Pfa);
```



$$\gamma = 3.3875$$

$$P_d = 0.9758$$

例3.3： 高斯白噪声中未知信号的检测。

数据模型和检测器(广义似然比检验)为：

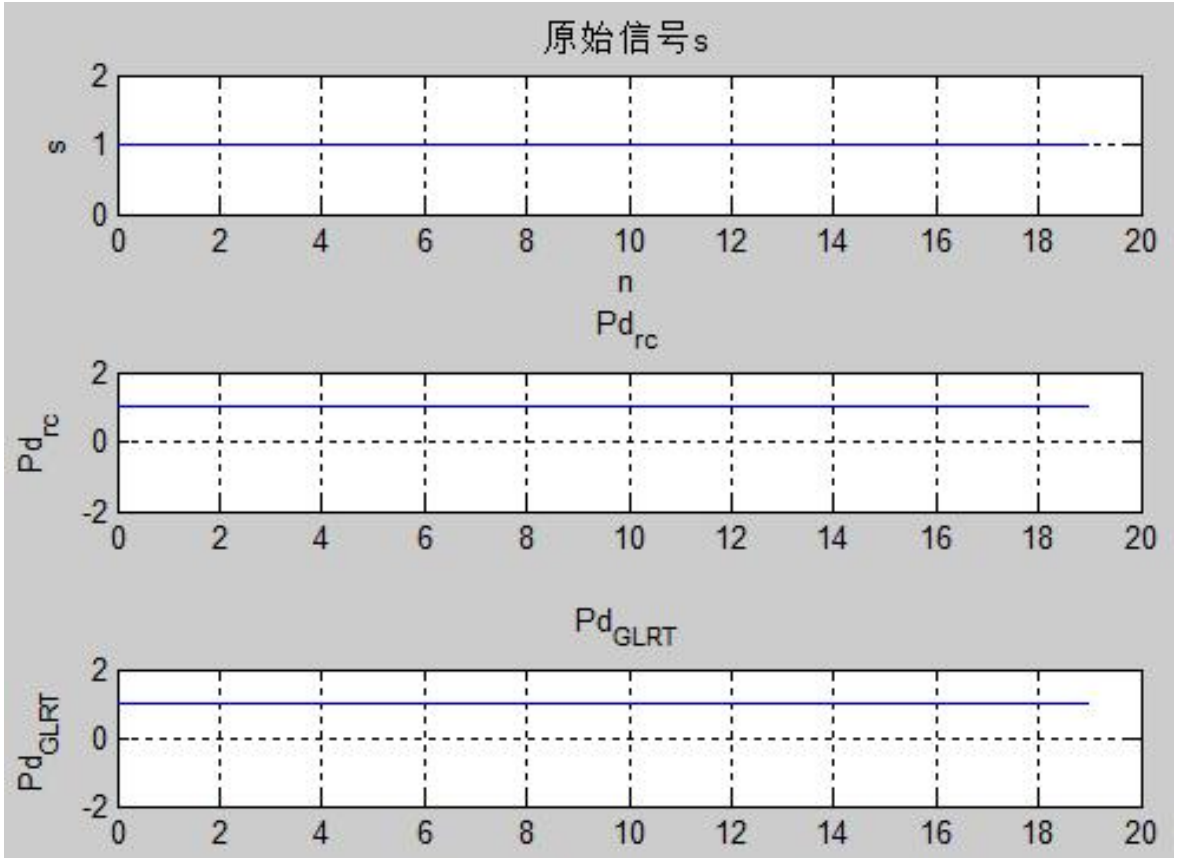
$$x[n] = As[n] + w[n]$$

$$T(x) = \frac{\left(\sum_{n=0}^{N-1} x[n]s[n]\right)^2}{\sigma^2 \sum_{n=0}^{N-1} s^2[n]} > \gamma = \left(Q^{-1}\left(P_{FA}/2\right)\right)^2$$

$$A = 1,\ \ N = 20,\ \ \sigma^2 = 1,\ \ P_{FA} = 0.01$$

```
% This program compares the detection performance for a DC level in WGN
% when a replica-correlator is used, assuming the value of A is known,
% versus a GLRT is used, which assumes that A is unknown.
%
clear all
close all
N=20;
A=1;
s=A*ones(N,1); % set up DC level signal
E=s'*s;  % compute energy
sig2=1;
Pfa=0.01;
d2=E/sig2; % compute deflection coefficient
Pd_rc=Q(Qinv(Pfa)-sqrt(d2)) % performance for replica-correlator
Pd_GLRT=Q(Qinv(Pfa/2)-sqrt(d2))+Q(Qinv(Pfa/2)+sqrt(d2))
                                % performance for GLRT
                                %
A1=ones(1,N);
```

```
A2=A1.*Pd_rc;
Phi=A1.*Pd_GLRT;
n=[0:N-1];
subplot(311);
plot(n,s);
xlabel('n');ylabel('s');
title(‘原始信号s');grid;
subplot(312);
plot(n,A2);
ylabel('Pd_rc');
title('Pd_rc');grid;
subplot(313);
plot(n,Phi);
ylabel('Pd_GLRT');
title('Pd_GLRT');grid;
```



$$\gamma = 6.6349$$

$$P_d\_rc = 0.9841$$

$$P_d\_GLRT = 0.9710$$

放映结束