

# Pattern Recognition Practical 3

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September 30, 2015

## Assignment 1 Classification error, hit/false alarm rates, ROC curve, discriminability

### 1

Figure 1 shows the ROC-curves we acquired using the code given in the listing for assignment 1.1 in the appendix. The figure shows that the higher the difference between the means of the two distributions is (i.e. the further away the distributions are from each other), the higher the number of hits is per number of false alarms. This means that classification will go better when distributions are farther away from each other, which is intuitively comprehensible as well.

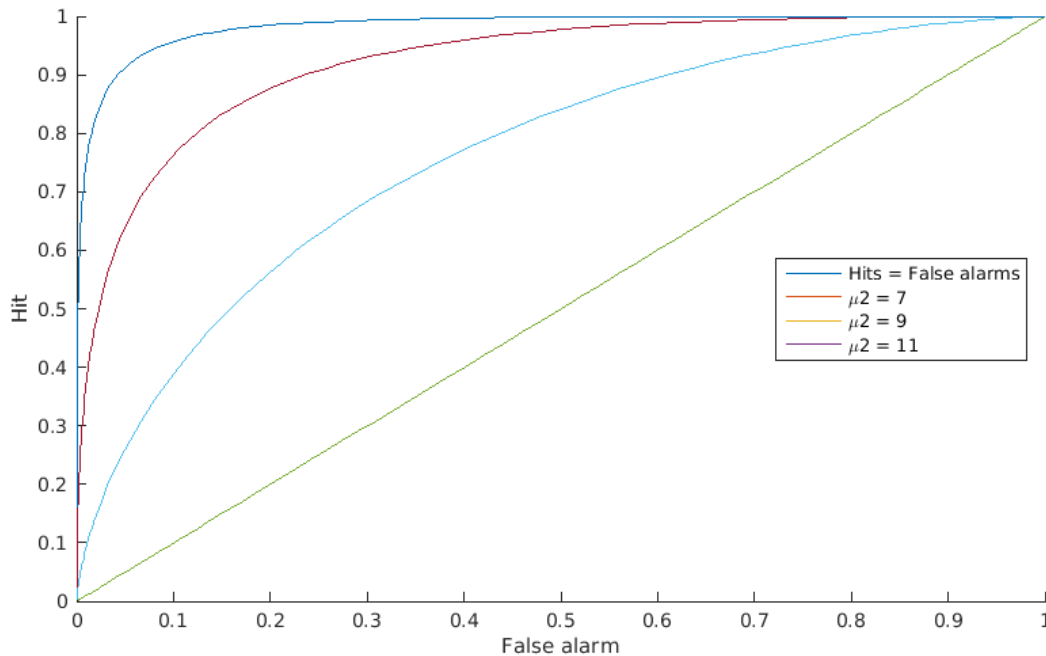


Figure 1: ROC-curves for  $\mu_2 = 7, 9, 11$  and the hits = false alarms marker line.

### 2

Figure 2 shows the point  $(fa, h)$  of the two given binary vectors plotted in the plot computed in assignment 1.1. The listing for assignment 1.2 in the appendix gives the code used to compute this point and to

compute the ROC-curve with the associated discriminability value  $d'$ . Trial and error yielded a ROC-curve with  $d' \approx 1.5$  (this is an approximation, the exact value is a decimal value that is time-consuming to find by trial and error). We computed this using  $\sigma_{1,2} = 1$ , which yields  $\mu_2 - \mu_1 = 1.5$  for the found discriminability value. Note that the code in the listing gives  $\sigma = 2$ , which means  $\mu_2 - \mu_1 = 3$ , since  $d' = \frac{\mu_2 - \mu_1}{\sigma}$ . So as long as the discriminability value between two distributions is the same, the sigma does not matter for classification.

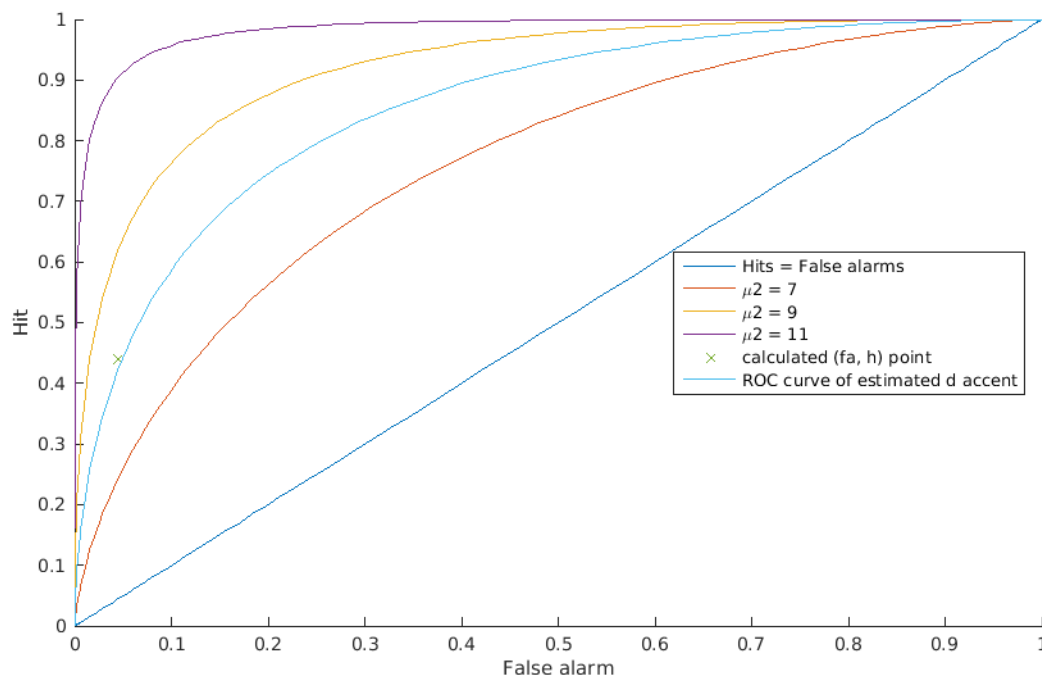


Figure 2: Plot of the  $(fa, h)$  point, the ROC-curves for  $\mu_2 = 7, 9, 11$ , the hits = false alarms marker line, and the ROC-curve with  $d' = 1.5$ .

## Assignment 2 K-nearest neighbor classification

## Assignment 3 Parzen windows, posterior probabilities

## Appendix

../Code/assign1\_1.m

```

1 % 1. Choose a value of x      and compute the probabilities of hit (h) and false
   alarm (fa).
2 % x* = 6
3 % hit = integral 6 to inf for dist 2 = 1 - integral -inf to 6 =
4 1 - normcdf(6, 7, 2)
5 % fa = integral 6 to inf for dist 1 = 1 - integral -inf to 6 =
6 1 - normcdf(6, 5, 2)
7
8 % Plot the point (fa, h) in a graph with horizontal axis fa and vertical axis h.
```

```

9 % Choose a few other values of  $x$  in the interval  $[-1, 3]$  ;  $2 + 3$  ] ( $-1$ 
;  $13$ )
10 % and plot the corresponding  $(fa, h)$  points too. Repeat the computation of a ROC
11 % curve for the cases  $2 = 9$  and  $2 = 11$  and plot all three ROC curves in the
same
12 % diagram.
13 x = []; y1 = []; y2 = []; y3 = [];
14 for xStar = -1:0.1:13
15 x(end+1) = (1 - normcdf(xStar, 5, 2));
16 y1(end+1) = (1 - normcdf(xStar, 7, 2));
17 y2(end+1) = (1 - normcdf(xStar, 9, 2));
18 y3(end+1) = (1 - normcdf(xStar, 11, 2));
19 end
20 hold on
21 plot(x,x)
22 plot(x,y1)
23 plot(x,y2)
24 plot(x,y3)
25 xlabel('False_alarm')
26 ylabel('Hit')
27 legend('Hits=False_alarms', '\mu2=7', '\mu2=9', '\mu2=11', 'Location', 'east')
28
29 % What is the value of the discriminability  $d$  for
30 % each of these cases?
31 %  $D(9) = (9-5)/2 = 2$ ,
32 %  $D(11) = (11-5)/2 = 3$ 

```

../Code/assign1.2.m

```

1 % Compute the values of the hit rate  $h$  and the false alarm rate  $fa$  and plot the
point  $(fa, h)$  in the plot computed in assignment 1.1 above. This point lies on a
ROC curve
2 hitrate = sum(outcomes(:,1) == 1 & outcomes(:,2) == 1)/length(outcomes)
3 false = sum(outcomes(:,1) == 0 & outcomes(:,2) == 1)/length(outcomes)
4 plot(false, hitrate, 'x')
5 % with a given discriminability value  $d$ . Determine this value by trial and error, i.
e. taking different values  $d$  and drawing the corresponding ROC curves until you
find a value of  $d$  for which the corresponding ROC curve passes through the
experimentally determined point.
6
7 x = []; y4 = [];
8 for xStar = -100:1:100
9 x(end+1) = (1 - normcdf(xStar, 5, 2));
10 y4(end+1) = (1 - normcdf(xStar, 8, 2));
11 end
12 plot(x,y4)
13 legend('Hits=False_alarms', '\mu2=7', '\mu2=9', '\mu2=11', 'calculated_(fa,h)
point', 'ROC_curve_of_estimated_d_accent', 'Location', 'east')
14 % So  $d$  is approximately 1.5.

```