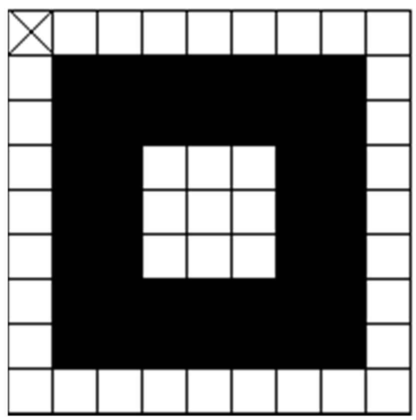
CSE 473/573 Fall 2010 December 13 2010

Final Exam Solutions

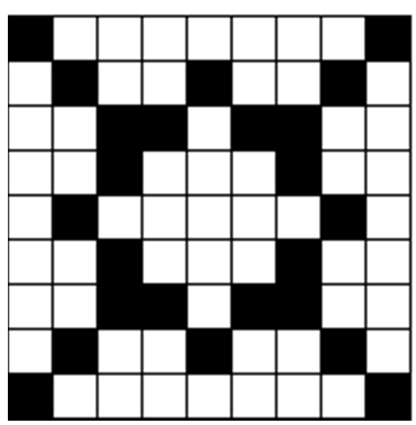
Instructions: ***Write your name above and on the top of the second page.*** *Do not remove the staple. Write answers here or in the bluebook provided as directed. This exam will be collected along with the blue book. 75 minutes closed book/notes* no electronic devices permitted.

1. Consider the blob X consisting of 80 object pixels arranged in a 9x9 square: X={(0,0),… ,(8,8)}, where the middle pixel of this square, the pixel at (4,4), is a background pixel.

(a) Find $S_8(X)$, the maximum ball skeleton of X using 8-connected distance measure. Show your answer by darkening each skeleton pixel in $S_8(X)$ on the graph below. Explain your reasoning in the bluebook.



(b) Find $S_4(X)$, the maximum ball skeleton using the 4-connected distance measure. Show your answer by darkening each pixel in $S_4(X)$ on the graph below. Explain your reasoning in the bluebook.



The max balls for part a all have radius 1. For part b, the skeleton pixels on the outer ring (first/last row/col) all have radius 0, next ring in radius 1, next ring in radius 2.

2. The discrimination boundaries for a three-class decision problem over a two-dimensional feature space of vectors ***x*** *are shown below. They intersect at* ***x*** *= (1,1).*

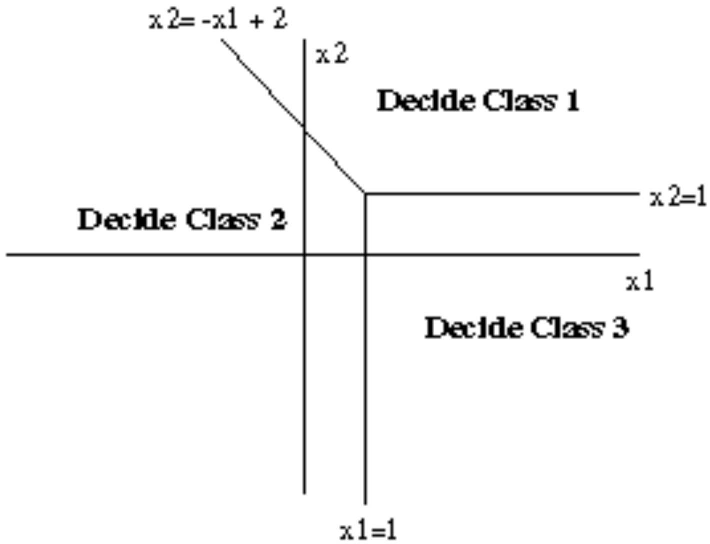
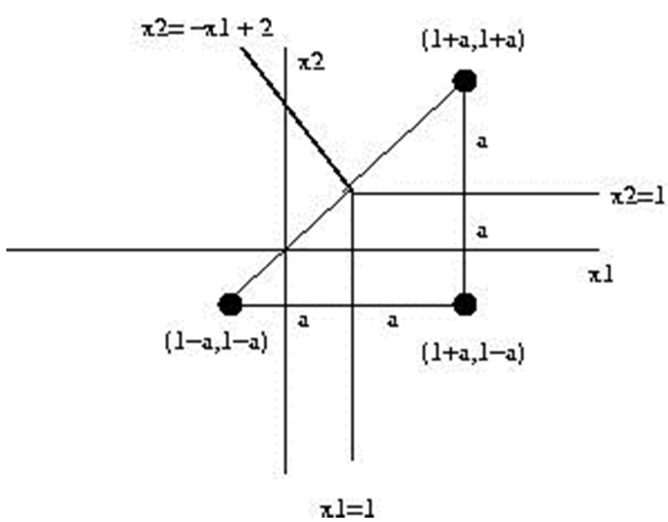


Figure 2

(a) Specify the (x1,x2) coordinates of 3 training atoms so that the <u>*minimum distance*</u> *classifier trained using just this training data set agrees with the figure above.*

For any a>0, the three points on the diagram below constitute such a training set. The discrimination regions coincide with the given problem statement.



(b) Is the set of 3 training data answering (a) above <u>*unique*</u>*? If not, specify* <u>*all*</u> *sets of 3 training data which solve (a) above.*

No its not unique. The solution above works with any scalar a>0.

(c) Could Fig 2 be consistent with a <u>*Gaussian minimum-error*</u> *classifier? If yes, specify mean vectors and covariance matrices* $\{\boldsymbol{\mu}_i, \boldsymbol{\Sigma}_i, i=1..3\}$*, also prior probabilities* $\{\pi_i, i=1..3\}$*, which make them consistent. If no, explain why not.*

Yes. Means equal to the three points in the above figure, variances all identity matrices, and equal priors.

3. In a certain image we have found $n \geq 3$ *objects* $R_1...R_n$*. We see that* R_1 *is blue,* R_2 *is green,* R_3 *is yellow and that* R_i *is adjacent to* R_{i+1} *for i=1..n-1. We wish to classify these objects using label set* $\{O_1,..,O_m\}$*. The rules are that only* O_1 *can be blue, and* O_i *and* O_{i+1} *must be adjacent for i=1..m-1. Now in the relaxation algorithm for constraint propagation we may check objects in any fixed order. Show that if we check objects in the order* R_1 *to* R_n *the algorithm converges much faster than if we check in the reverse order,* R_n *to* R_1*. Specify all consistent label sets, and the number of iterations to convergence in each case.*

3. <u>Check in order R1-Rn</u>: Checking properties, we find that R1 can only be O1, and that all other objects can be any of O1-On. Checking relations, first we check if R1, which must be O1, is consistent with the relations, it is. Then we check if R2 is consistent. Since R1 is O1 and O1 must be adjacent to O2, then R2 must be O2. Checking R3, Since R2 is O2 and O2 must be adjacent to O3, then R3 must be O3. And so on. We converge in just a single iteration classifying Ri=Oi for i=1..n.

<u>Check in order Rn-R1</u>: Checking properties, we find that R1 can only be O1, and that all other objects can be any of O1-On. Checking relations, first we check if Rn, which can be any O1-On, is consistent with the relations. It is, and we cannot eliminate any Rn label since the adjacent object Rn-1 can also be any O1-On. And so on down to R2, which must be O2, since R1 is O1. Thus, after one iteration we have labelled 2 objects. Each iteration yields one more object label (the last one checked), that means n-1 iterations. It takes n-1 as many iterations checking in this order as in the order R1-Rn.