Intelligent Data Analysis — Summer 2013
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Exercise Sheet 7

Exercise 26 — c-Means Clustering

Consider the following two-dimensional data set:

x	1	6	8	3	2	2	6	6	7	7	8	8
y	5	2	1	5	4	6	1	8	3	6	3	7

Process this data set with c-means clustering with $c = 3$ (i.e., try to find 3 clusters)! Use the first three data tuples als initial positions for the cluster centers and observe the migration of the centers.

Exercise 27 — c-Means Clustering

In exercises 17 and 18 on sheet 7 we considered a simple two-dimensional data set. Reconsider this data set, but assume that that no class information is available for the data points. That is, consider the following data set:

x	3	3	4	4	5	6	7	7	8	9	1	2	2	3	4	5	5	6	7	7
y	1	2	2	3	3	4	4	6	5	7	3	4	5	6	6	7	8	8	8	9

a) Which problem of c-means clustering becomes obvious when this data set is processed with $c = 2$ (i.e., if one tries to find two clusters)?
Hint: What is the desired result? What is produced by c-means clustering?
(You need not compute the exact result of the algorithm, a qualitative description suffices. Compare the result to a naive Bayes classifier.)

b) How could one try to cope with this problem?
Hint: Recall what distinguishes a full and a naive Bayes classifier.

Additional Exercise — Lagrange Theory

Determine the minimum of the function $f(x, y) = xy^2 + x + 2y$ under the constraints $xy = 1$ and $x > 0$ with the help of the method of Lagrange multipliers!

Exercise 28 Fuzzy Clustering

Consider the one-dimensional data set

$$1, 3, 4, 5, 8, 10, 11, 12.$$

We want to process this data set with fuzzy c-means clustering with $c = 2$ (two clusters) and a fuzzifier of $w = 2$. Assume that the cluster centers are initialized to 1 and 5. Execute one step of alternating optimization as it is used for fuzzy clustering, i.e.:

a) Compute the membership degrees of the data points for the initial cluster centers!

b) Compute new cluster centers from the membership degrees computed in this way!

Exercise 29 Expectation Maximization

Consider again the one-dimensional data set used in exercise 28, which we want to process in this exercise with the expectation maximization algorithm to estimate the parameters of a mixture of two normal/Gaussian distributions. Let the prior probabilities of the two clusters be fixed to $\theta_i = \frac{1}{2}$ and the variances to $\sigma_i^2 = 1$, $i = 1, 2$. (That is, only the expected values of the normal distributions — the cluster centers — are to be adapted.) Use the same values for the initial cluster centers as in exercise 28, that is, 1 and 5. Computeone expectation step and one maximization step, i.e.:

a) Compute the posterior probabilities of the data points for the initial cluster centers!

b) Estimate new cluster centers from the data point weights computed in this way!