

Fuzzy Sets and Fuzzy Techniques

Lecture 5 – Fuzzy thresholding and clustering

Joakim Lindblad
joakim@cb.uu.se

Centre for Image Analysis
Uppsala University

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Fuzzy and crisp thresholding of fuzzy sets

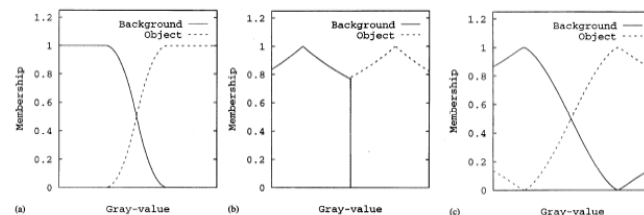
Two methods based on minimizing fuzziness

- Pal and Rosenfeld (1988)
- Huang and Wang (1995)

Pal and Rosenfeld also describes a method based on shape...
More on this later.

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Fuzzy and crisp thresholding of fuzzy sets



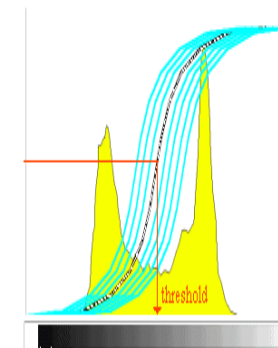
Membership distributions assigned using

- Pal and Rosenfeld (1988)
- Huang and Wang (1995)
- Fuzzy c-means (Bezdek 1981) algorithms.

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Thresholding of fuzzy sets

Pal and Rosenfeld



- A family of S-functions are tested, with different choices of cross-over points, and same band-width.
- The S-function with parameters providing the minimal fuzziness in the image is selected.
- The fuzzy segmented image is obtained by applying the selected S-function to the image.
- Thresholding at 0.5 provides crisp segmentation.

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Thresholding of fuzzy sets

Huang and Wang

Huang and Wang's algorithm

- Object and background are fuzzy sets with mutually exclusive supports;
- For each tested threshold, a point is assigned either to the object, or to the background, with the membership between 0.5 and 1;
- The closer the intensity of the point to the mean of the region, the higher its membership to that region;
- The threshold is chosen so that the entropy in the image is minimized.

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Fuzzy c-means clustering

Bezdek

Chapter 13.2

Algorithm

- make initial guess for cluster means
- iteratively
 - use the estimated means to assign samples to clusters
 - update means
- until there are no changes in means

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Fuzzy c-means clustering

Bezdek

- a partition of the observed set is represented by a $c \times n$ matrix $U = [u_{ik}]$, where u_{ik} corresponds to the membership value (anything between 0 and 1!) of the k th element (out of n), to the i th cluster (out of c)
- boundaries between subgroups are not crisp
- each element may belong to more than one cluster - its "overall" membership equals one
- objective function includes parameter controlling degree of fuzziness

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Fuzzy c-means clustering

Fuzzy thresholding by using fuzzy c-means algorithm

Algorithm by Bezdek

- Number of cluster is $c=2$ (object and background);
- Number of elements to be classified is equal to the number of different grey-levels;
- The membership of an element to the class is expressed in terms of frequency of occurrence of a grey level j , and the membership value j to each cluster;
- The cluster mean is, for each cluster, the mean grey-level of the region;
- Objective function is iteratively minimized by updating the cluster means and memberships;
- Two classes complement each other - memberships of the elements to the object and the background sum up to 1.

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