REGION BASED SEGMENTATION

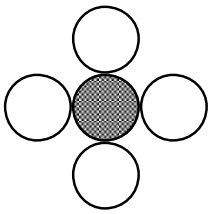
“The goal of segmentation is to partition an image into disjointed regions which correspond to objects or their parts”.

First step: grouping parts of an image into units which are uniform with respect to one or more characteristics.

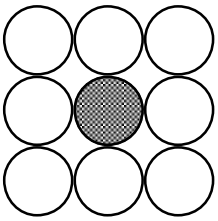
Segmentation

partitioning of an image into set of mutually non-overlapping regions, each of which is **maximum connected** and uniform region.

4-connected pixels



8-connected pixels



Maximum connected uniform region

no other pixel, adjacent to the region, can be added to it without the region becoming non-uniform

Uniformity

a measure of being of the same kind; consisting of parts of the same kind; being uniform

Criteria of uniformity

grey level value, edge strength, size, shape, shape simplicity, texture, ...

$$\forall\, p_i, p_j \in R \{ p_i = p_j \}$$

$$\forall\, p_i, p_j \in R \{ | p_i - p_j | < t \}$$

Region segmentation methods

- global - pixels grouped into regions on the basis of the properties of a large population of pixels.

- local - pixels assigned to regions on the basis of their of properties of their close neighbours

Pixel classification

Segmentation can be regarded as process of pixel classification.

The picture is segmented into subsets by assigning the individual pixels to classes

For global methods the choice of the class depends on the global properties (statistics) of the image.

Thresholding

Thresholding is the simplest case of classification

- single property (e.g. grey level)
- two classes (e.g. object and background)

The main problem is to find a threshold value which would separate the two classes.

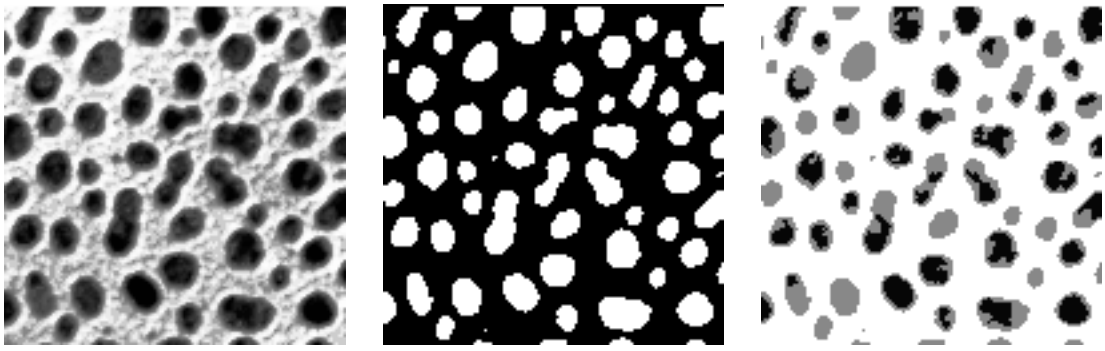
The simplest solution:- build a histogram and find the valley between two peaks

There exist methods for automatic threshold selection.

Multi-level thresholding

Segmentation into more than two classes

Classification according to single property, into many classes.



Classification

The task is to assign each pixel to one of a set of classes

Classes and their properties may be or may be not known in advance

Classes can be determined in spatial domain or in feature domain (statistical classification)

Statistical classification

Supervised classification (known classes)

- user selects initially some pixels from each possible class
- classification algorithm determines characteristics of each class
- each pixel is then assigned to a most likely class
- stages: training and classification

Unsupervised classification (unknown classes)

- the classes are determined by the algorithm by locating clusters in a feature space

- each cluster is assumed to correspond to a class

- each pixel assigned to the most likely class

Feature spaces

Histogram is a 1-dimensional feature space; a 'feature' (or property) is grey level

Scatter plot - 2 (or more) - dimensional histogram

Example of 2D scatter plots

grey level v/s average grey level in the neighbourhood

Pixel aggregation or partitioning

Sequential segmentation

Sequential methods take into account the result of processing of previous points.

The method of processing and criteria for acceptance depend on nature and location of the points already accepted.

Bottom-up and top-down methods are two major approaches.

Bottom-up

Region aggregation - "growing" object in all directions

- find starting pixels
- examine adjacent pixels
- incorporate if an acceptance criterion met
- terminate if no more candidates found

Results depend on

choice of starting points

order in which points are added

Output - normally another digital image

Pixel value = region label

Top-down

Start from an entire image and partition (split) it into uniform regions.

Example of the top-down method.

Combined methods

- start on an intermediate level
- first merge then split
- Example: split and merge method

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Iterative segmentation (relaxation)

- input - a set of probabilities that each pixel belongs to each possible class

- iterative technique to update these probabilities

- criteria for changing the probability:
  - possible assignments of neighbours
  - probabilities of these assignments
  - measure of compatibility of the pixel's and the neighbour's assignment

Pre- and post-processing

Dealing with noise

Region outlining