

Image segmentation techniques



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 - Non-hierarchical
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Introduction

- What is segmentation ?
- Several approaches :
 - Globals
 - Locals
 - Hybrids

Thresholding⁸

- A parameter θ called the brightness threshold is chosen and applied to an image $A[x,y]$.

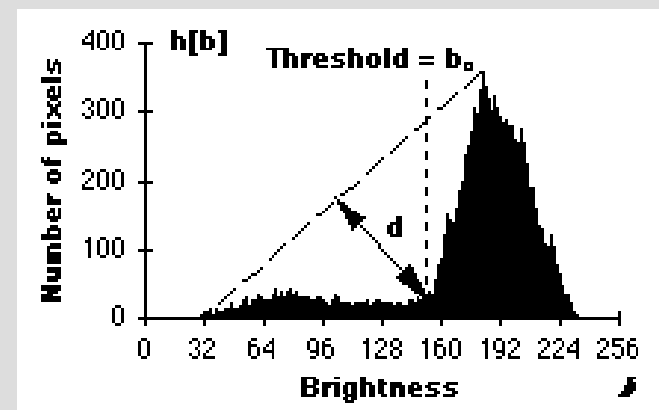
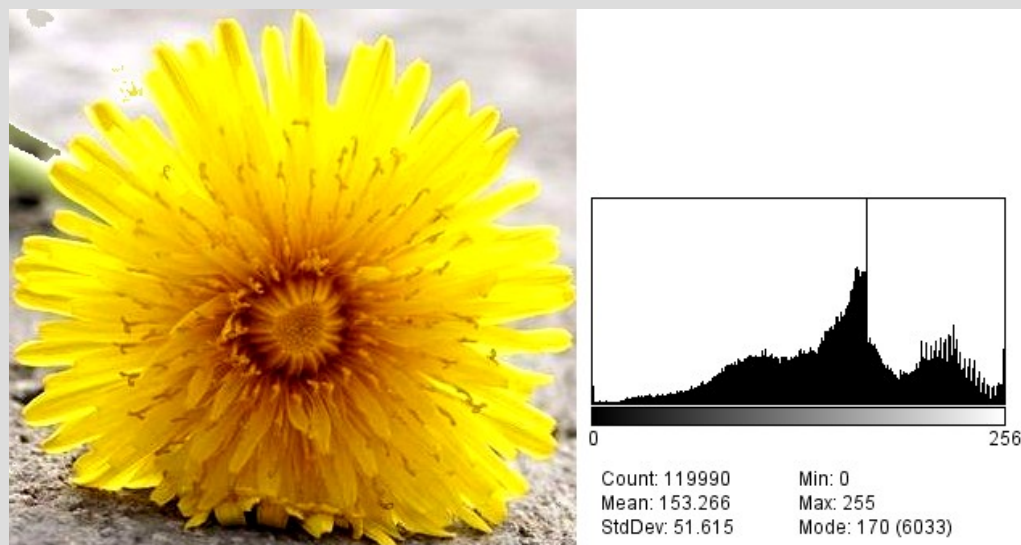
**If $A[x,y] \geq \theta$ $A[m,n] = \text{object} = 1$
else $A[m,n] = \text{background} = 0$**

- The results is a binary image, but that alone is not yet segmentation. This must further be worked out by joining pixels together into one or more regions or areas.

Thresholding

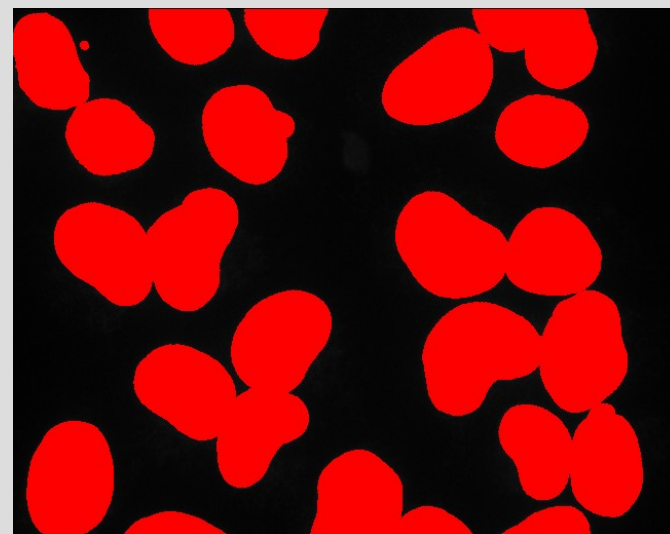
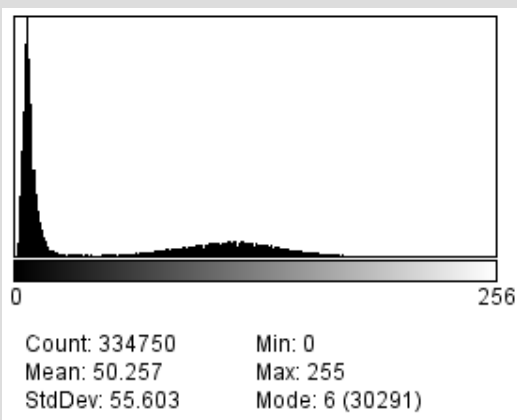
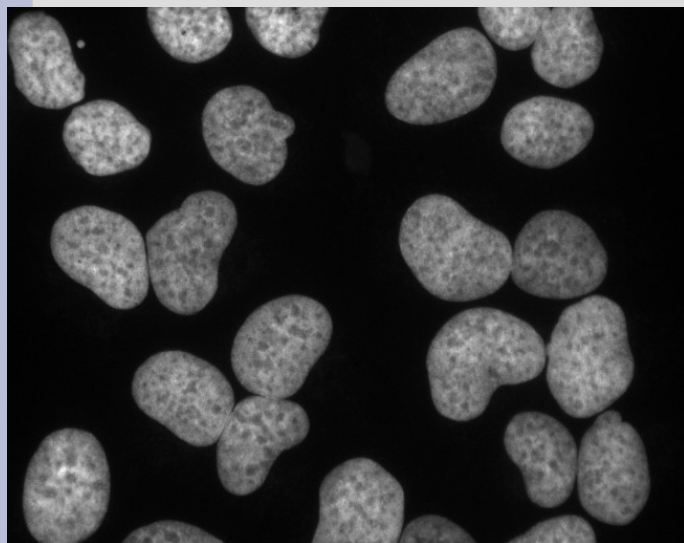
How to select the threshold ?

- Fixed threshold
- Histogram-derived thresholds :
- Computed threshold (Triangle algorithm) :



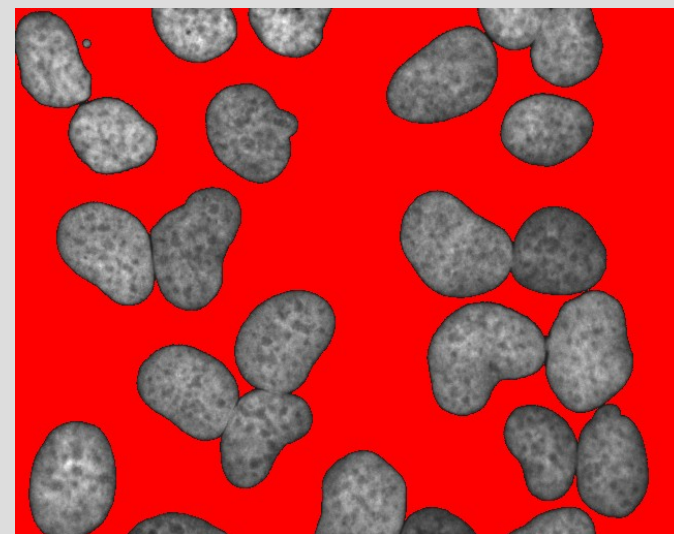
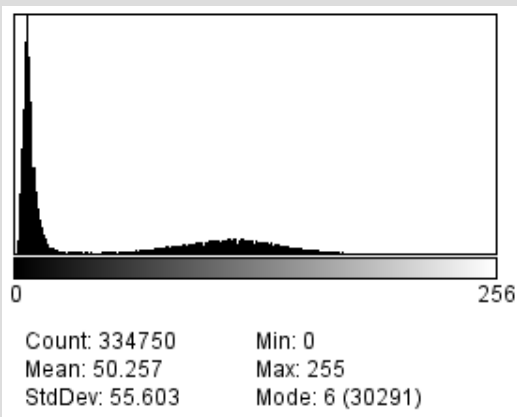
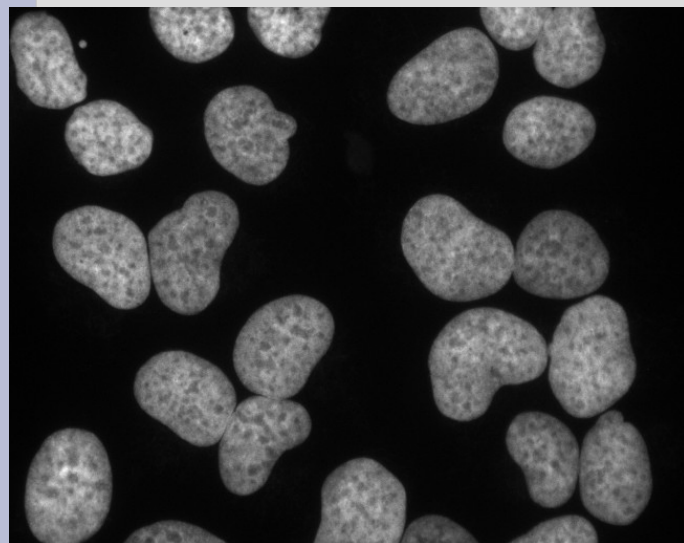
Thresholding

Pixels with intensity > 25



Thresholding

Pixels with intensity < 25



Thresholding

- Advantages :

- Very fast
- The threshold segmentation method is easy to grasp

- Drawbacks :

- The threshold method depends on the possibility to define a threshold that works well everywhere in the image
- Require a region growing or other technique of segmentation if two objects have the same color

Edge finding¹⁰

- The goal of edge detection is to mark the points in a digital image at which the luminous intensity changes sharply.
- It's a preliminary stage for algorithms of image processing.
- Sobel, Prewitt, Roberts...

Edge finding

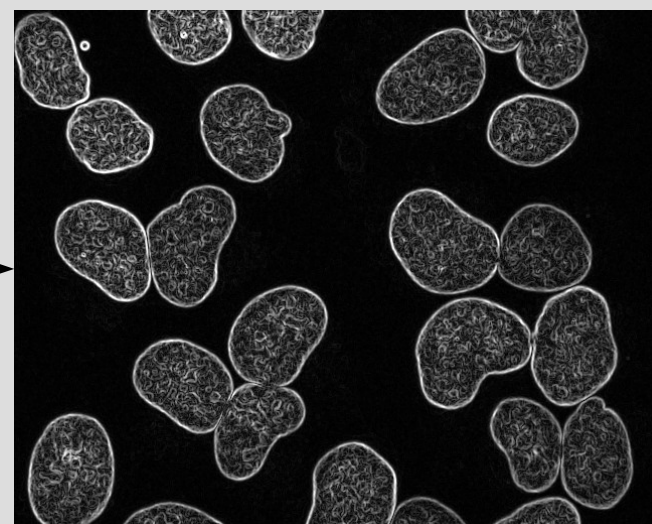
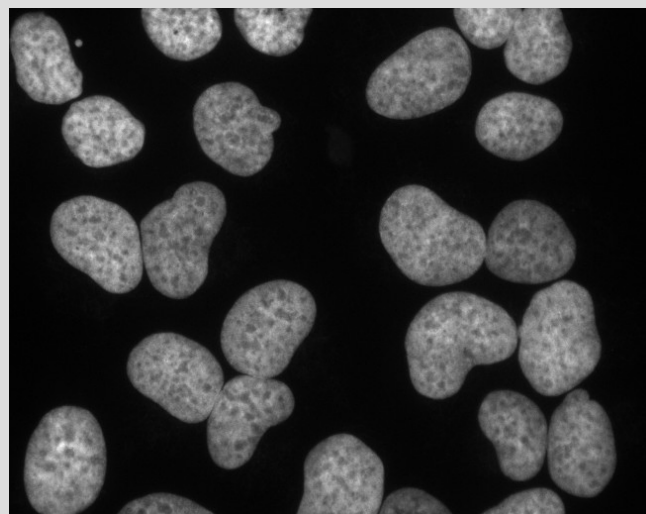
- Sobel technique :

-1	0	+1
-2	0	+2
-1	0	+1

+1	+2	+1
0	0	0
-1	-2	-1

- La valeur du gradient selon l'axe X est $G_x = -p_0 + p_2 - 2 \cdot p_3 + 2 \cdot p_5 - p_6 + p_8$
- La valeur du gradient selon l'axe Y est $G_y = p_0 + 2 \cdot p_1 + p_2 - p_6 - 2 \cdot p_7 - p_8$
- La norme du gradient $G(x,y)$ calculé pour le pixel p_4 est $G(x,y) = |G_x| + |G_y|$

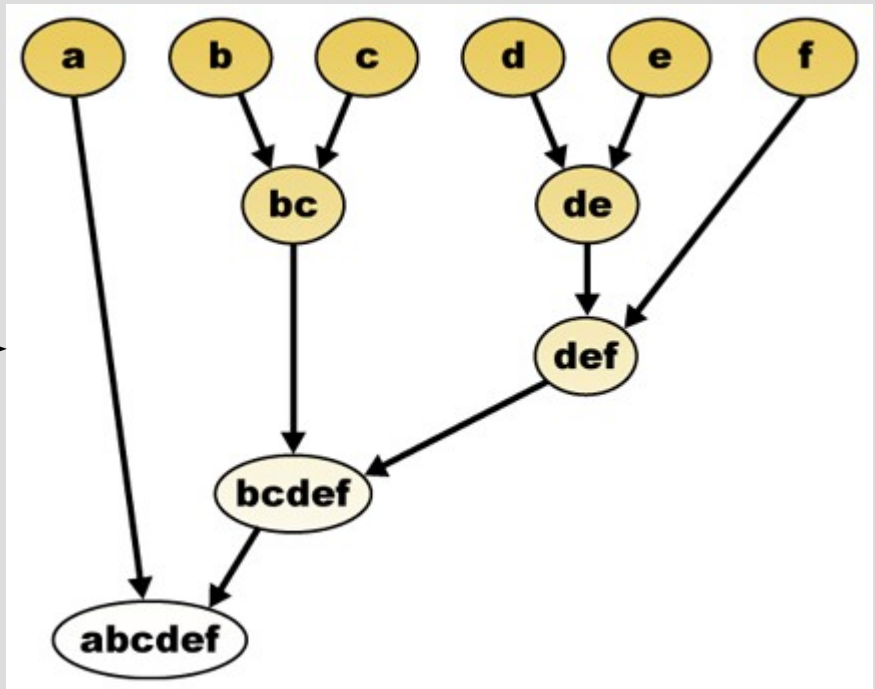
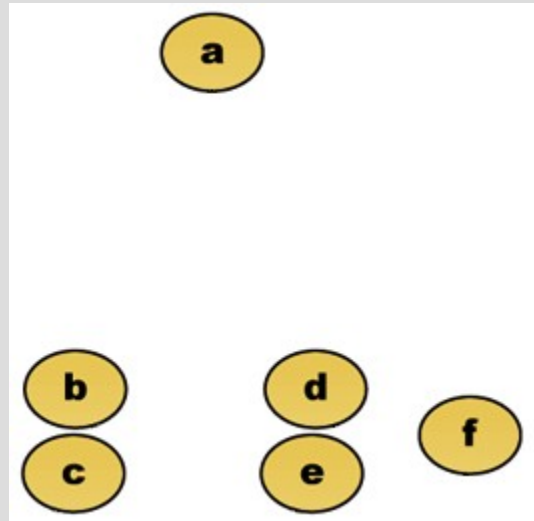
Edge finding



Clustering method¹

- Clustering is the classification of objects into different groups, or more precisely, the partitioning of a data set into clusters.
- Data clustering algorithms can be :
 - Hierarchical : algorithms find successive clusters using previously established clusters
 - Non Hierarchical : algorithms determine all clusters at once.

Clustering method Hierarchical¹



Clustering method

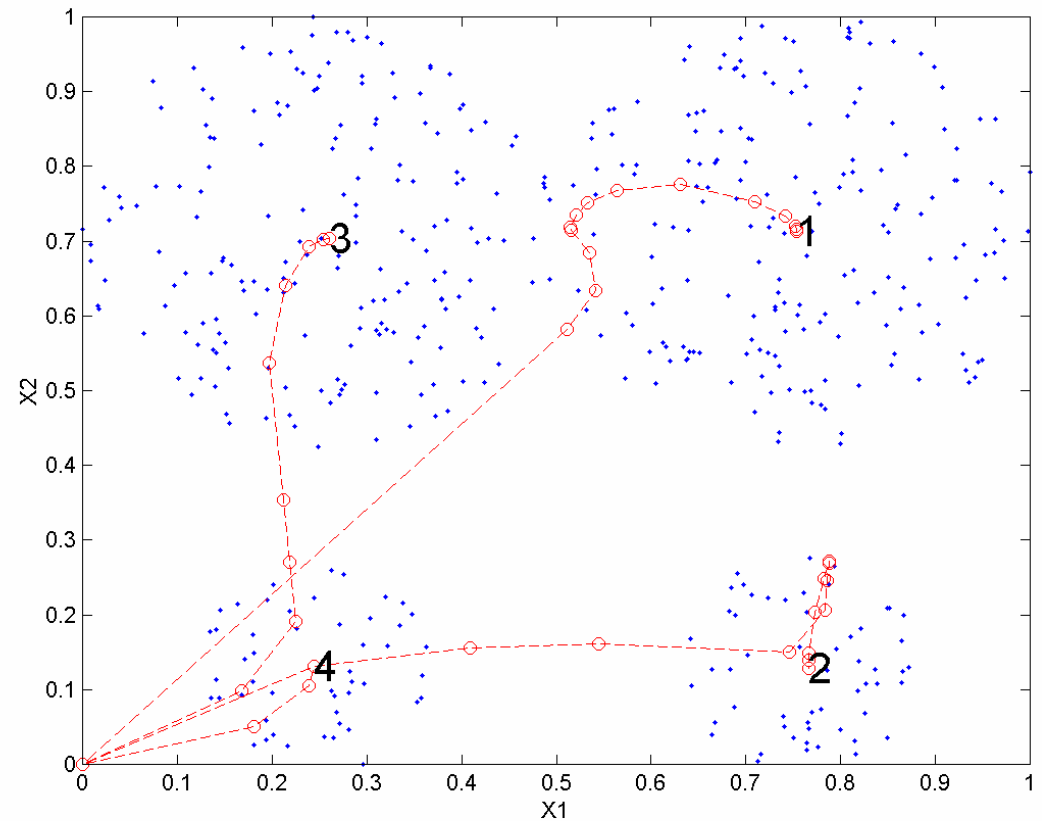
Non-hierarchical¹

- K-means steps :
 - Choose the number k of clusters.
 - Randomly generate k clusters and determine the clusters center.
 - Assign each point to the nearest cluster center.
 - Recompute clusters centers.
 - Repeat the two previous steps until some convergence criterion is met.

Clustering method

Non-hierarchical

- K-means²



Clustering method

Non-hierarchical¹

- Fuzzy C-means steps :
 - Choose a number of clusters.
 - Assign randomly to each point coefficients for being in a cluster.
 - Repeat until the algorithm has converged :
 - Compute the center of each cluster.
 - For each point, compute its coefficients of being in the cluster.

Clustering method

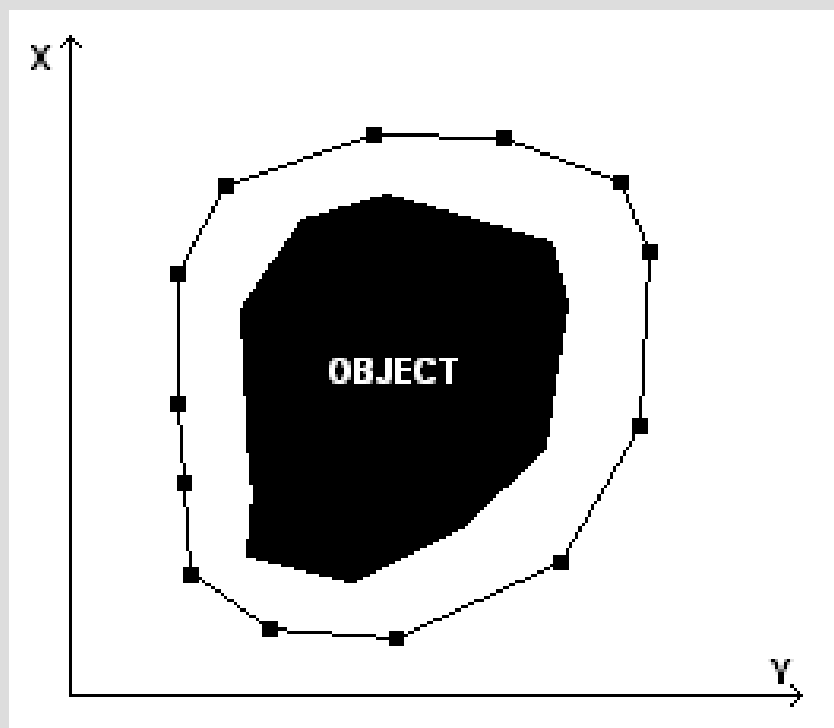
- Advantages :

- Many clusters

- Drawbacks :

- Necessity to identify the clusters.
- Depends on the initial number of cluster.

Active contour Snakes³



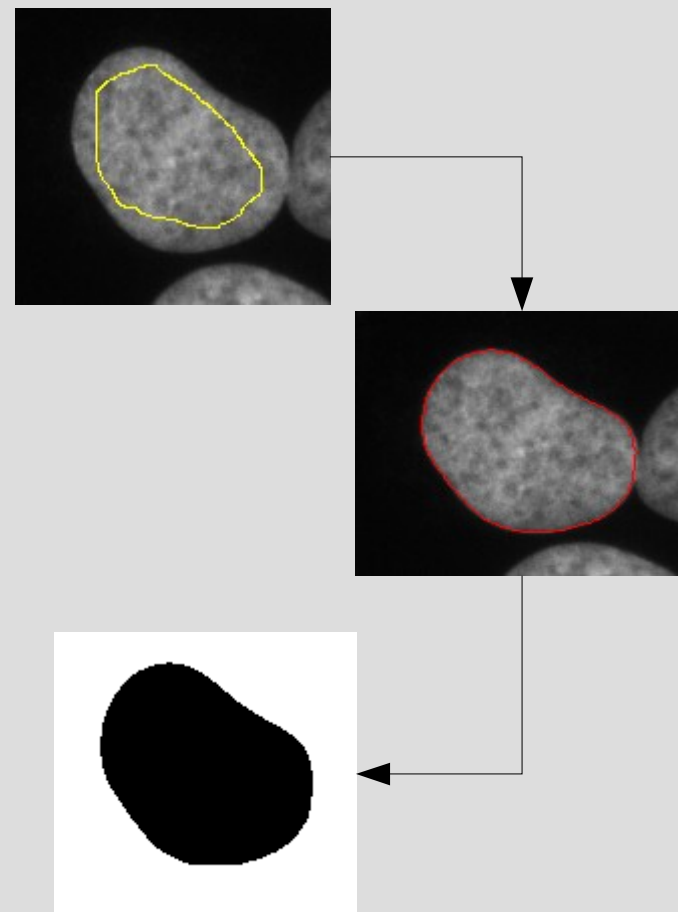
- The user suggest an initial contour, as it is shown in the figure.
- The contour is controlled by minimising a function which converts high-level contour information like curvature and discontinuities and low-level image information like edge gradients and terminations into energies.

Active contour Snakes⁹

The energy function for a snake is in two parts, the internal and external energies :

$$E_{\text{snake}} = E_{\text{internal}} + E_{\text{external}}$$

- The internal energy is the part that depends on intrinsic properties of the snake, such as its length or curvature.
- The external energy depends on factors such as image structure, and particular constraints the user has imposed.



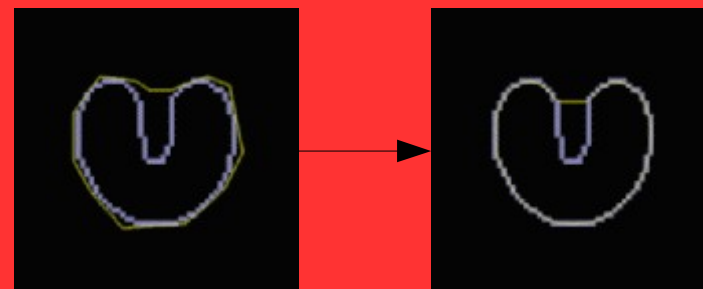
Active contour Snakes

- Advantages :

- Fast when initialization is close to the solution.
- Very powerful for tracking video.

- Drawbacks :

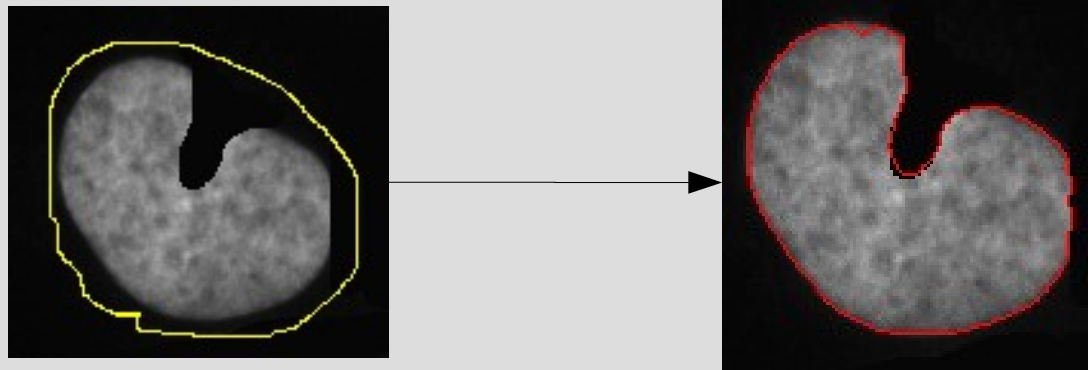
- Snakes cannot move toward objects that are too far away
- Snakes cannot move into boundary concavities or indentations



Active contour

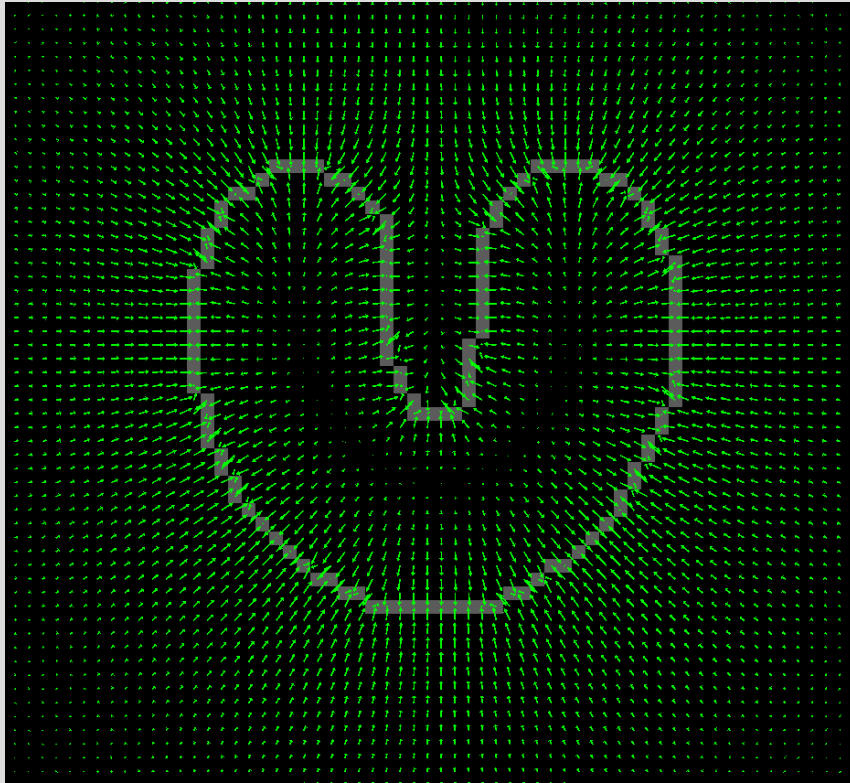
GVF : Gradient Vector Flow

- Calculation of a field of forces, called the GVF forces, over the image
- The GVF forces are used to drive the snake towards the boundaries of the object



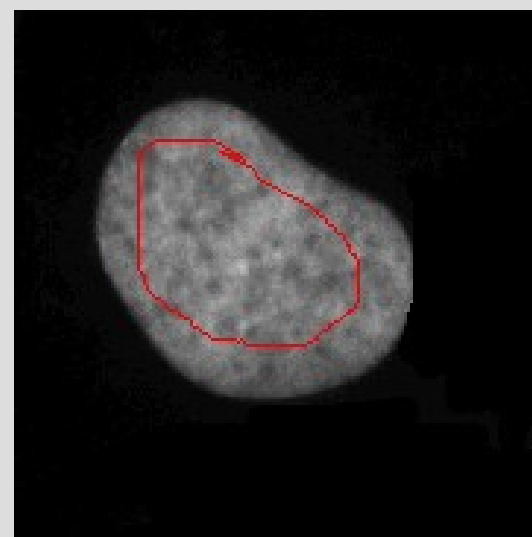
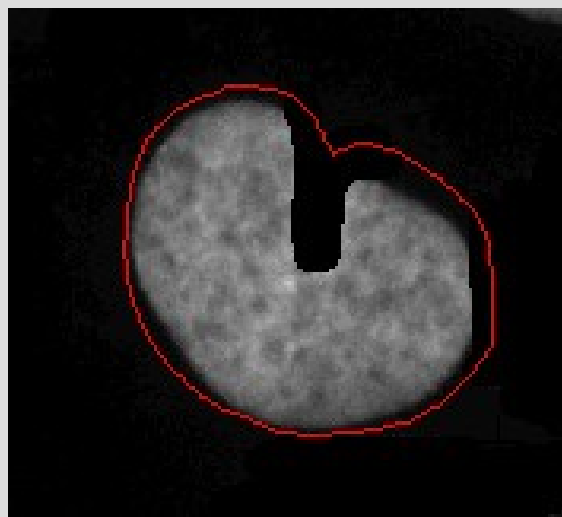
Active contour

GVF : Gradient Vector Flow



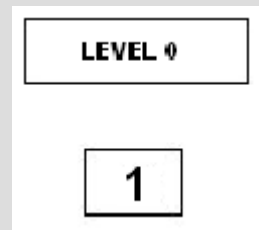
- This is a gradient vector flow⁴ (GVF) field for a U-shaped object. These vectors will pull an active contour towards the object boundary.

Active contour



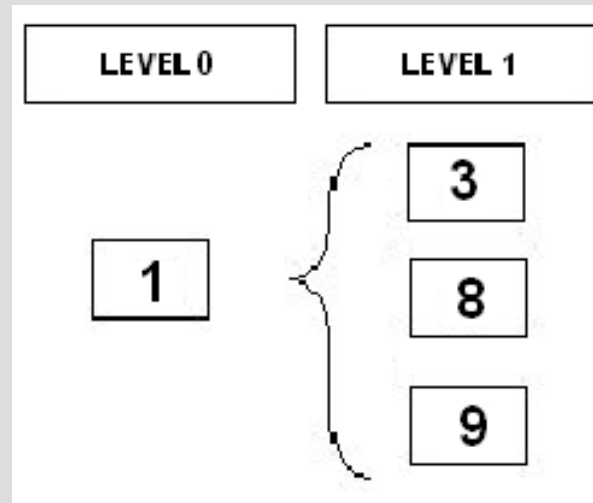
Hierarchic region growing⁵

- The algorithm starts the aggregation of objects from a randomly extracted point.
- This point is placed in the level 0 of a tree structure.



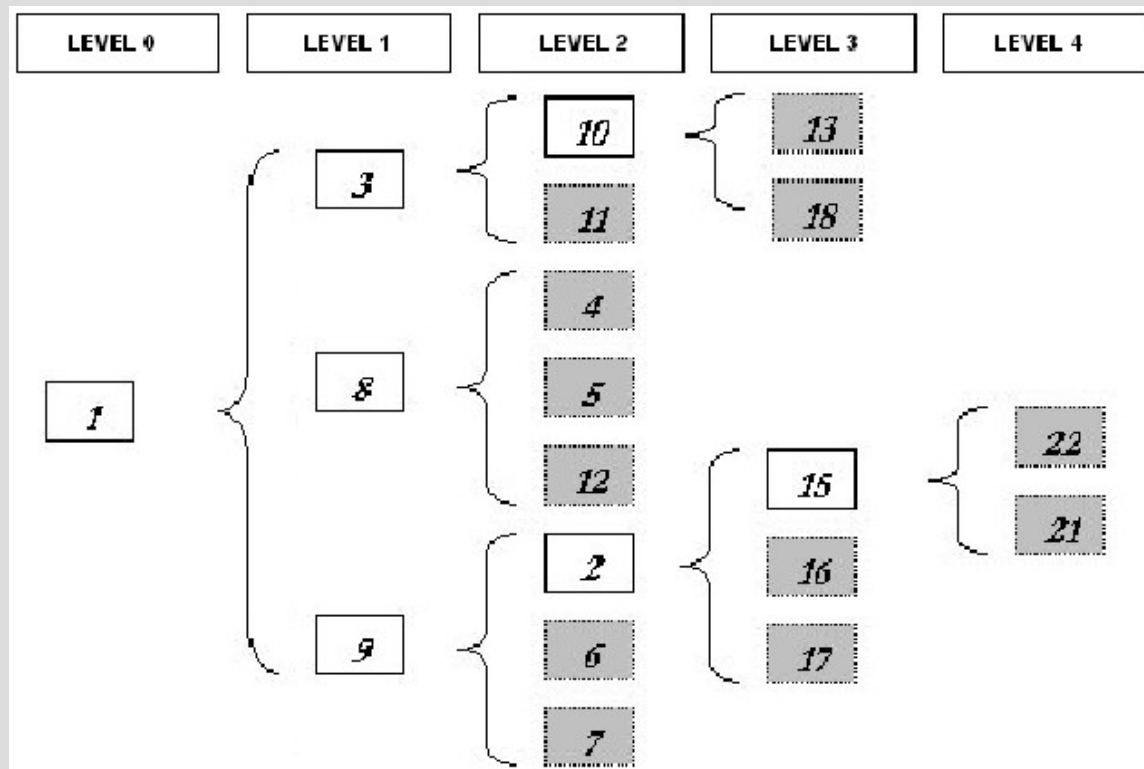
Hierarchical region growing⁵

- The points in the neighbourhood that match the aggregation criteria, are now aggregated to the object and placed at level 1 tree structure, a new branch of the tree.



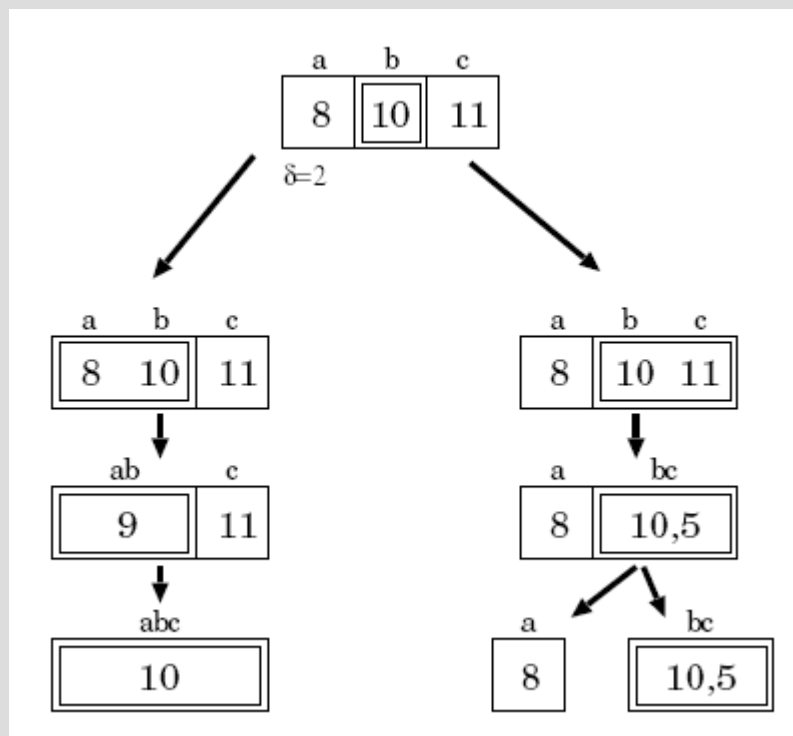
Hierarchical region growing⁵

- Then the linking algorithm continues the aggregation, starting from the points in the new level, and so on to the terminal branches



Hierarchic region growing

- Drawbacks :



Hierarchic region growing

- Advantages :

- This method of segmentation is very easy to understand and apply.

- Drawbacks :

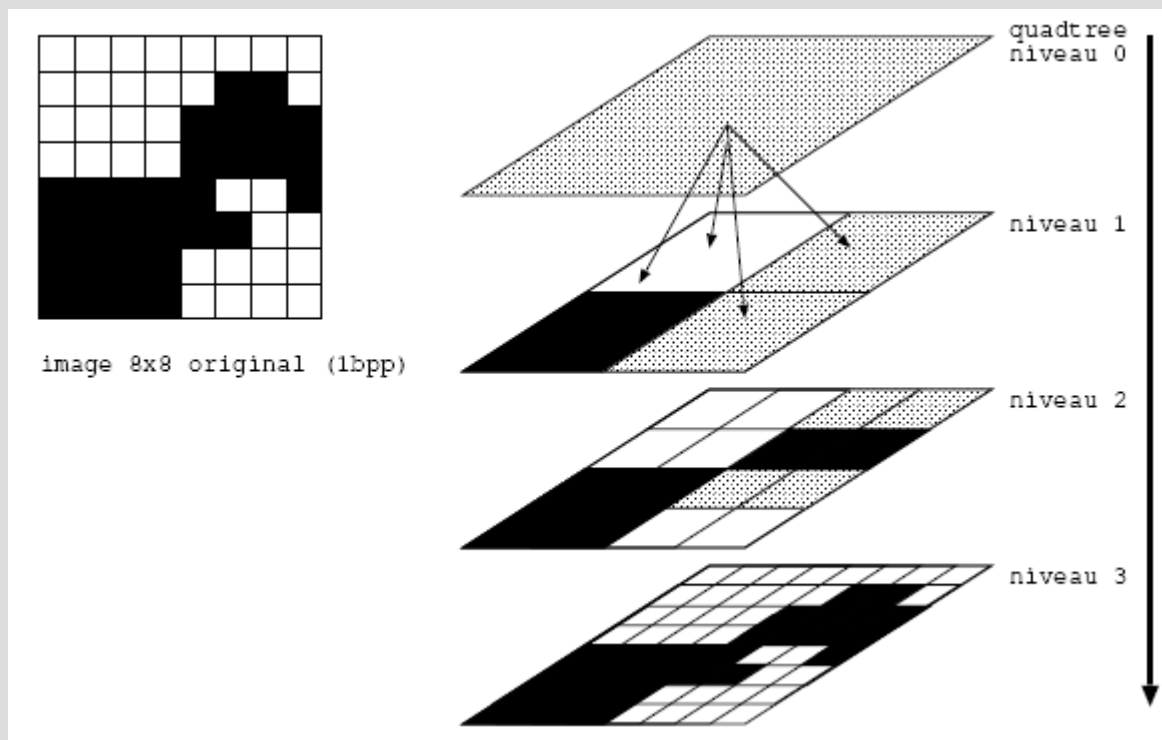
- Regions obtained depend strongly of the first pixel chosen and the order in which the border pixels are examined.
- Result is very sensitive to the threshold value..

Split and merge

- Split⁶ :

- The subsequent splitting process attempts to identify areas which respond to similar criteria of homogeneity.

- Following this process, a tree of layers is produced, where the original image is the root of the tree and the layers produced are the nodes.



Example

Split and merge

0	1	0	0	7	7	7	7
1	0	2	2	7	7	7	7
0	2	2	2	7	7	7	7
4	4	2	2	7	7	7	7
0	0	1	1	3	3	7	7
1	1	2	2	3	7	7	7
2	4	3	0	5	7	7	7
2	3	3	5	5	0	7	7

Image initiale

0	1	0	0	7	7	7	7
1	0	2	2	7	7	7	7
0	2	2	2	7	7	7	7
4	4	2	2	7	7	7	7
0	0	1	1	3	3	7	7
1	1	2	2	3	7	7	7
2	4	3	0	5	7	7	7
2	3	3	5	5	0	7	7

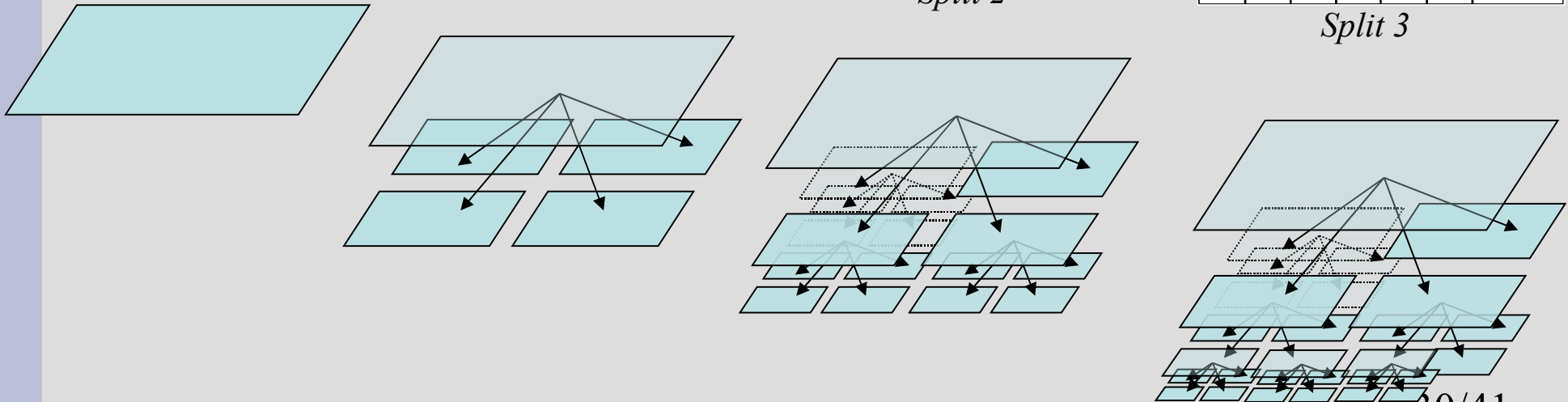
Split 1

0	1	0	0	7	7	7	7
1	0	2	2	7	7	7	7
0	2	2	2	7	7	7	7
4	4	2	2	7	7	7	7
0	0	1	1	3	3	7	7
1	1	2	2	3	7	7	7
2	4	3	0	5	7	7	7
2	3	3	5	5	0	7	7

Split 2

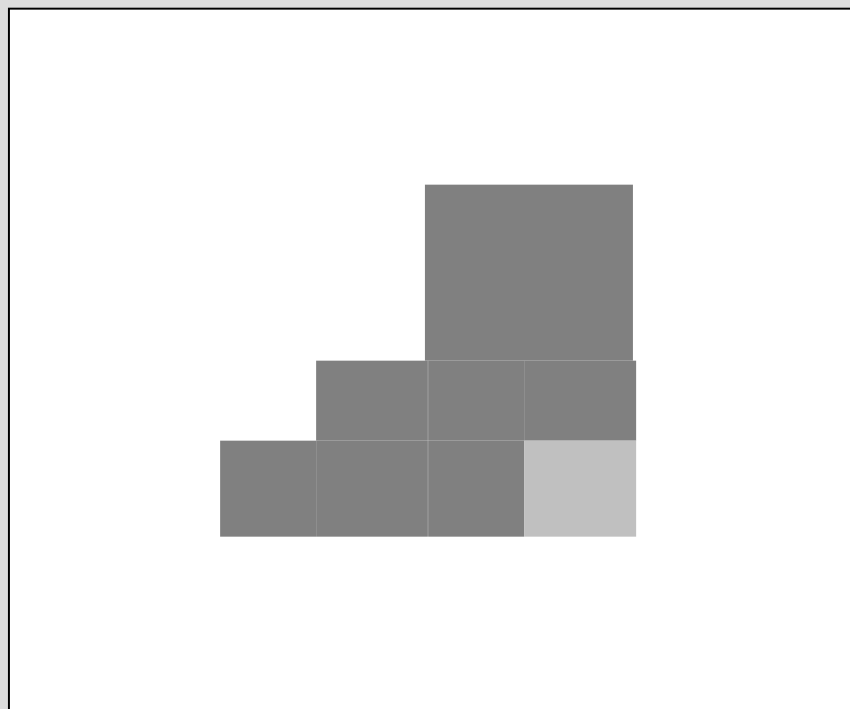
0	1	0	0	7	7	7	7
1	0	2	2	7	7	7	7
0	2	2	2	7	7	7	7
4	4	2	2	7	7	7	7
0	0	1	1	3	3	7	7
1	1	2	2	3	7	7	7
2	4	3	0	5	7	7	7
2	3	3	5	5	0	7	7

Split 3



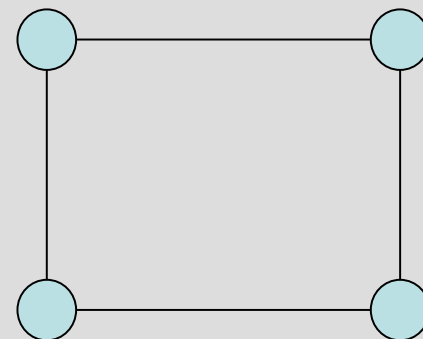
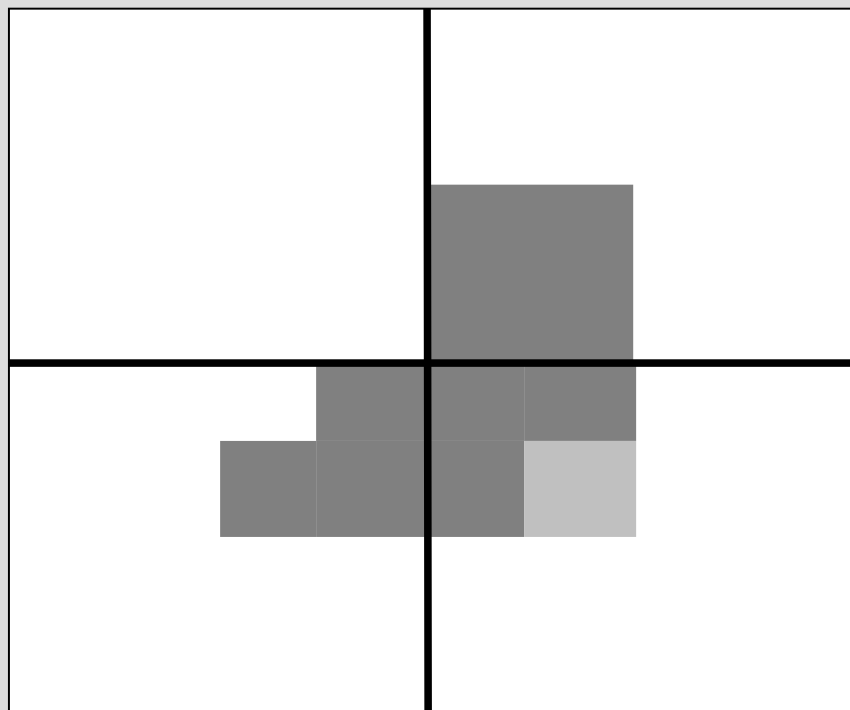
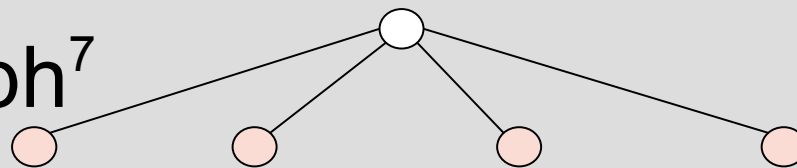
Split and merge

- Region Adjacency Graph⁷



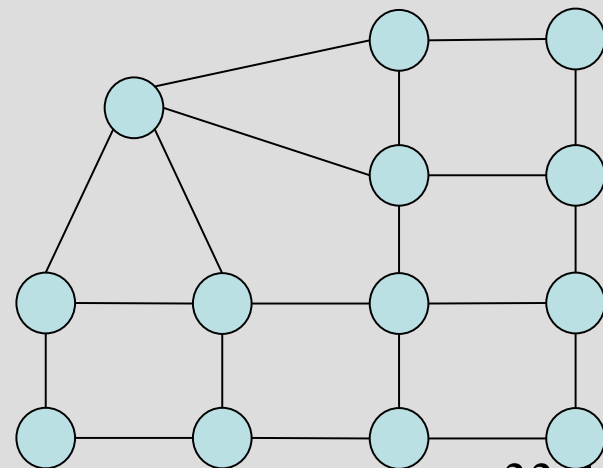
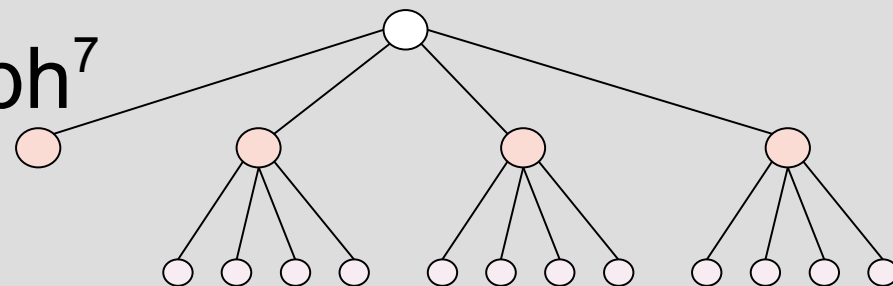
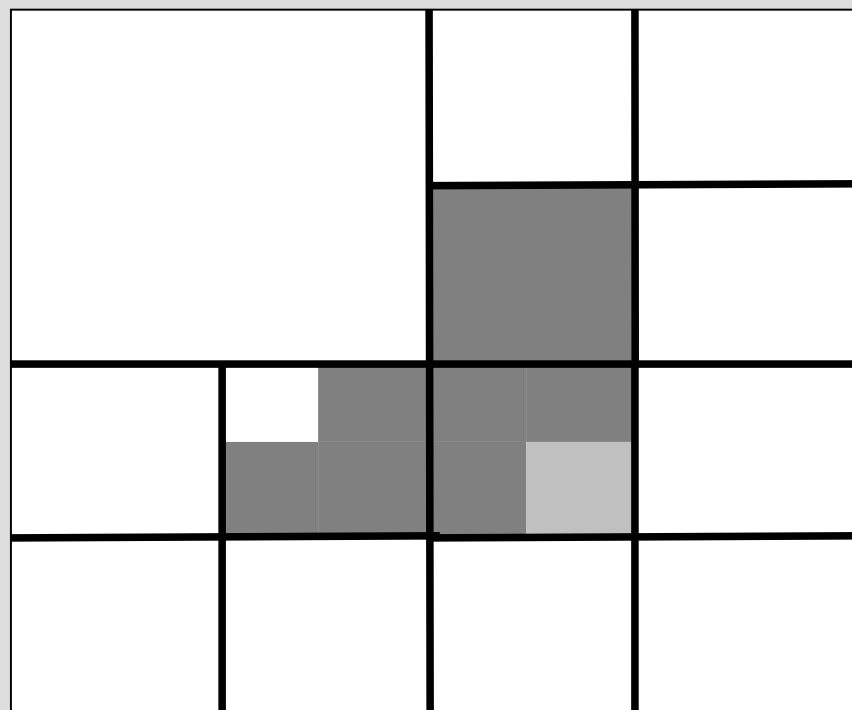
Split and merge

- Region Adjacency Graph⁷



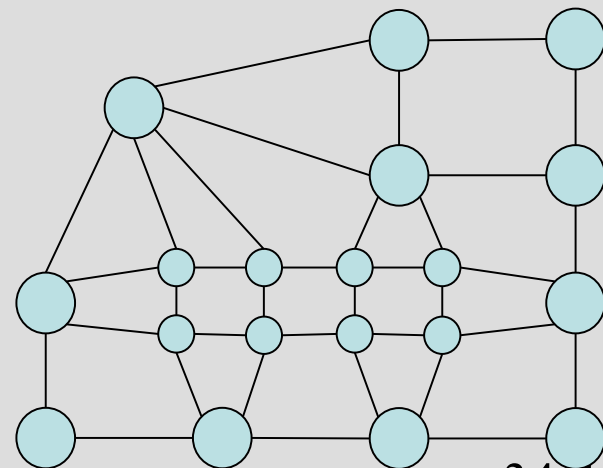
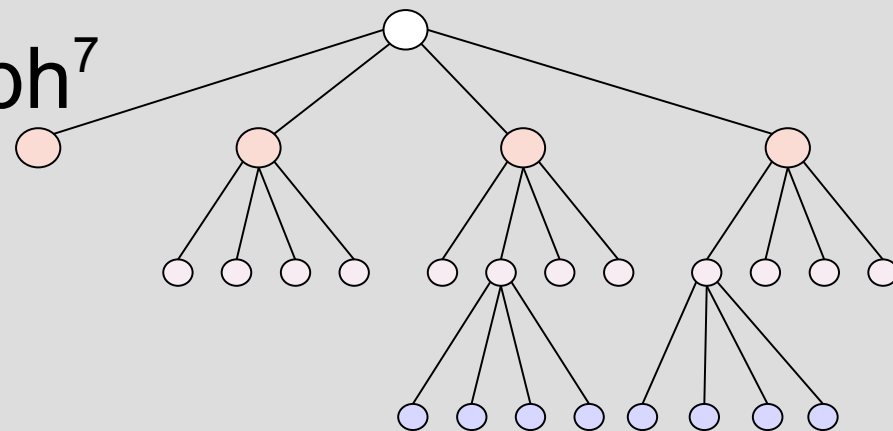
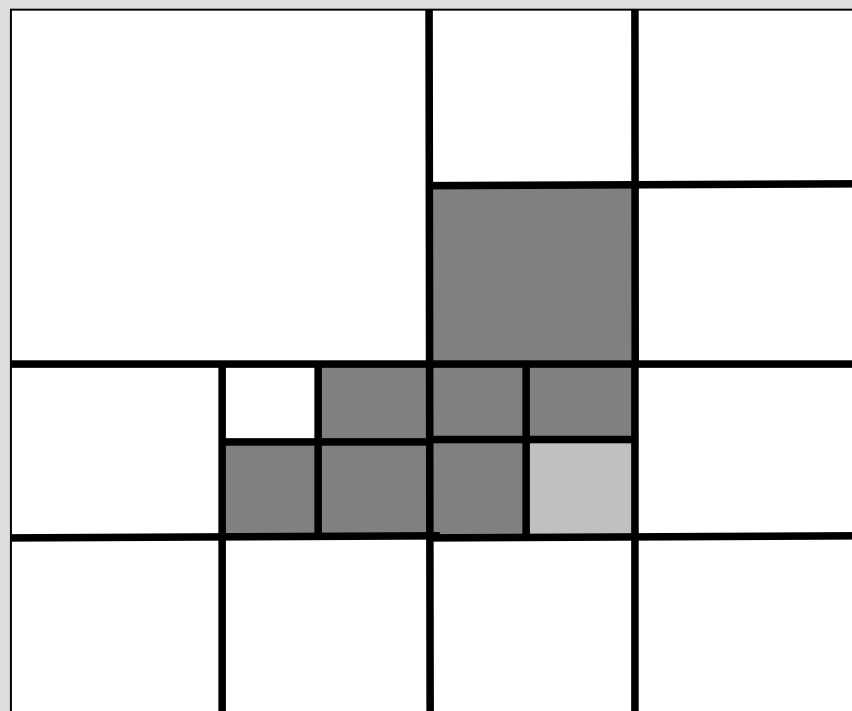
Split and merge

- Region Adjacency Graph⁷



Split and merge

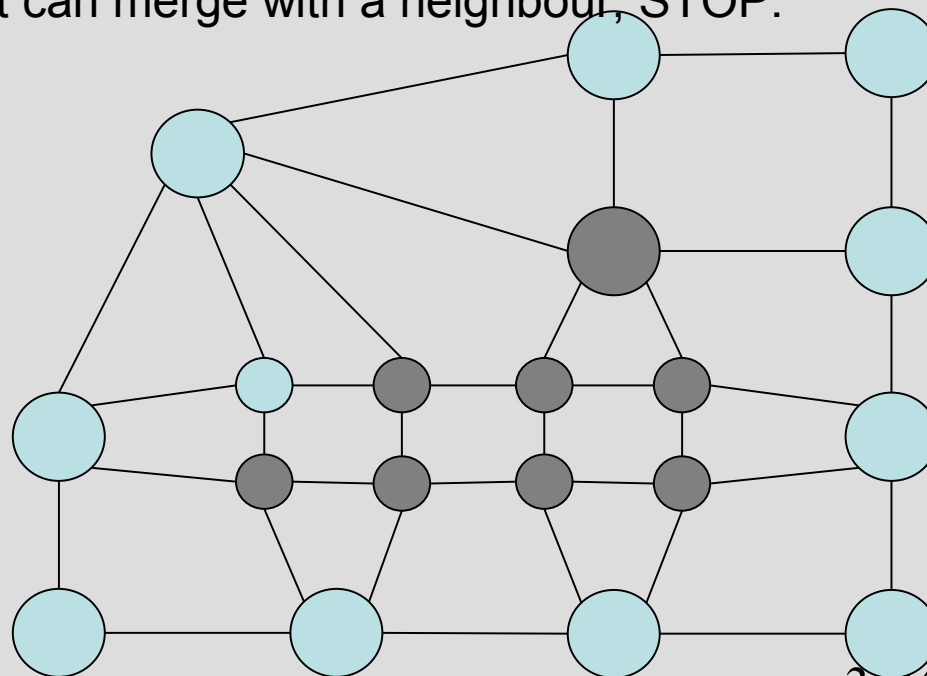
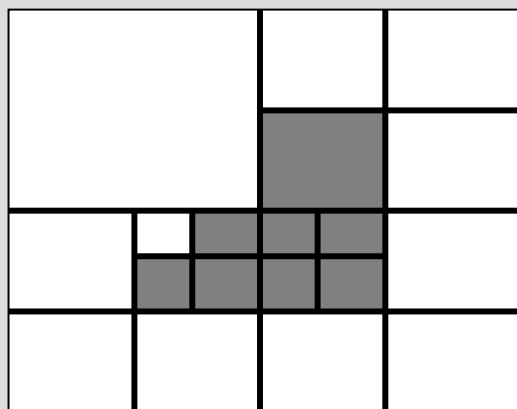
- Region Adjacency Graph⁷



Split and merge

- Merge⁷ :

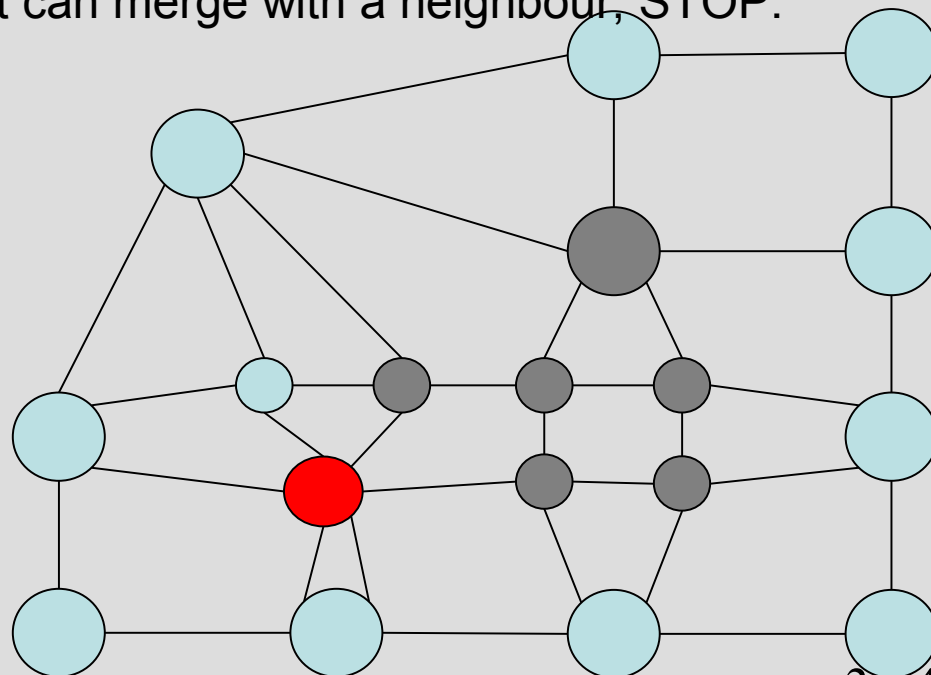
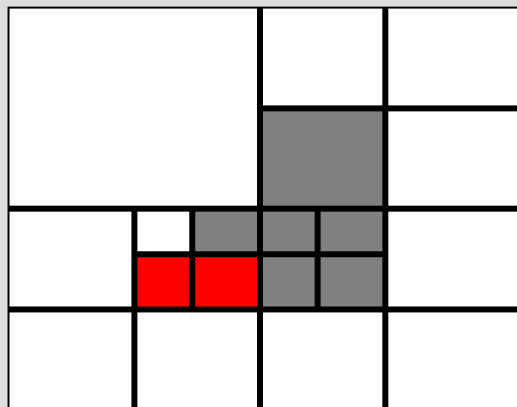
- Each node of the Region Adjacency Graph is examined.
- If one of its neighbours responds to similar criteria of homogeneity, both merge in the RAG.
- When there are no more nodes that can merge with a neighbour, STOP.



Split and merge

- Merge⁷ :

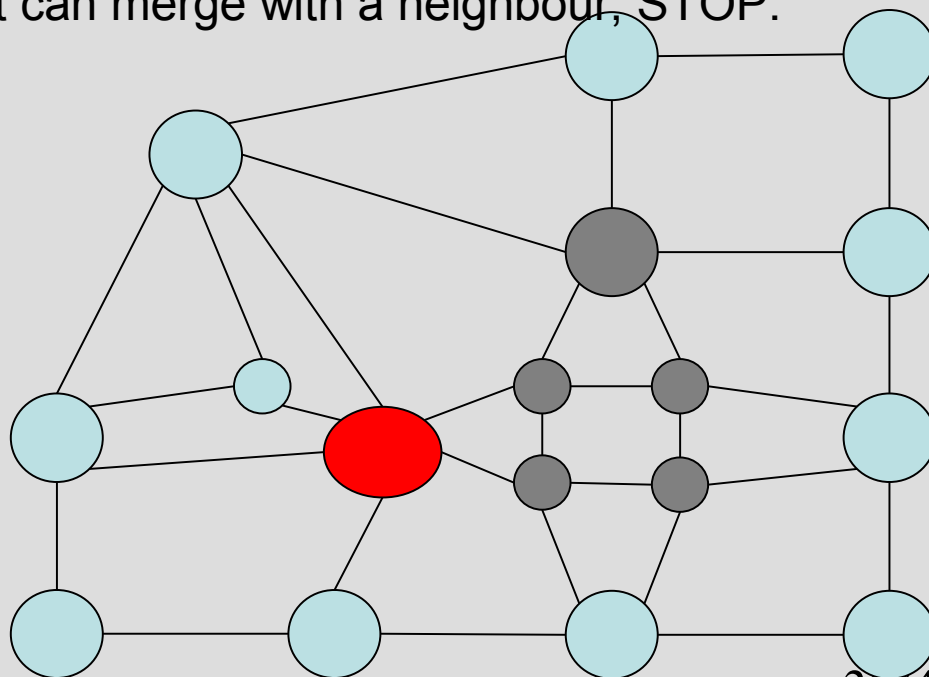
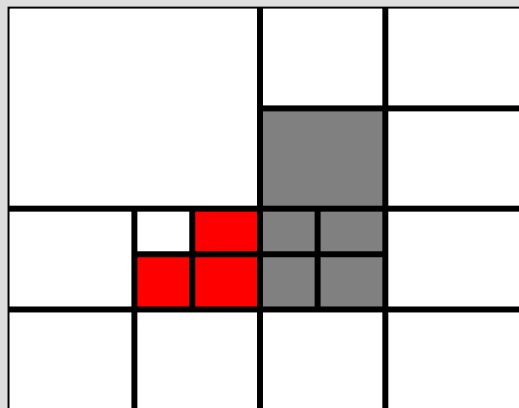
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Split and merge

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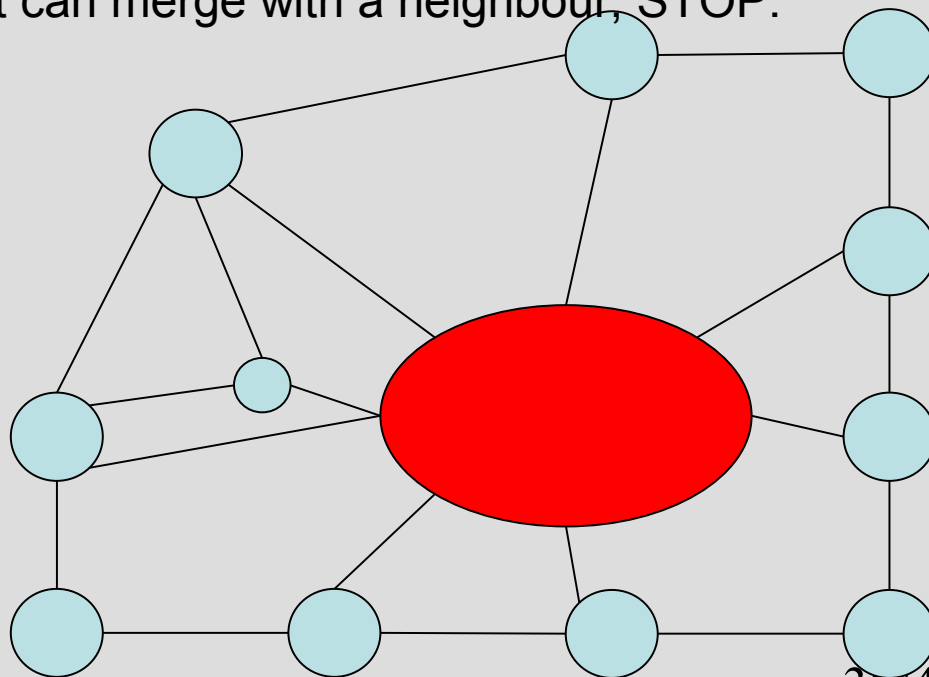
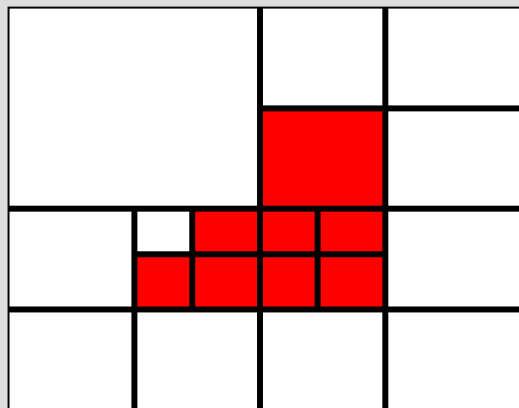
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Split and merge

- Merge⁷ :

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Conclusion

- A universal algorithm of segmentation doesn't exist, as each type of image corresponds to a specific approach.

Links

- [1] http://en.wikipedia.org/wiki/Data_clustering
- [2] MÉMOIRE DE STAGE DE MASTER - NICOLAS PASSALACQUA - Méthodes de clustering flou appliquées au "filtrage parental" d'Internet – 2006 - Effectué au LGI2P sous la direction de GERARD DRAY
- [3] 5th Slovakian-Hungarian Joint Symposium on Applied Machine Intelligence and Informatics - Marián Bakoš - Active Contours and their Utilization at Image Segmentation – 2007 - http://www.bmf.hu/conferences/sami2007/31_Bakos.pdf
- [4] <http://iacl.ece.jhu.edu/projects/gvf/>
- [5] PCVO2 Photogrammetric Computer Vision ISPRS Commission III, Symposium 2002 September 9 - 13, 2002, Graz, Austria - Marco Roggero - OBJECT SEGMENTATION WITH REGION GROWING AND PRINCIPAL COMPONENT ANALYSIS
- [6] ENSTA Module D9 – ES322 - Jean-Christophe Baillie - Traitement d'Image et Vision Artificielle - 2003

Links

[7] <http://uei.ensta.fr/baillie/assets/ES322%20-%20Segmentation.ppt>

[8] <http://www.ph.tn.tudelft.nl/Courses/FIP/noframes/fip-Segmenta.html#Heading118>

[9] http://perso.enst.fr/~maitre/BETI/snakes_coul/MBAI.html

[10] <http://www.cs.ru.nl/~ths/rt2/col/h7/7contourENG.html>