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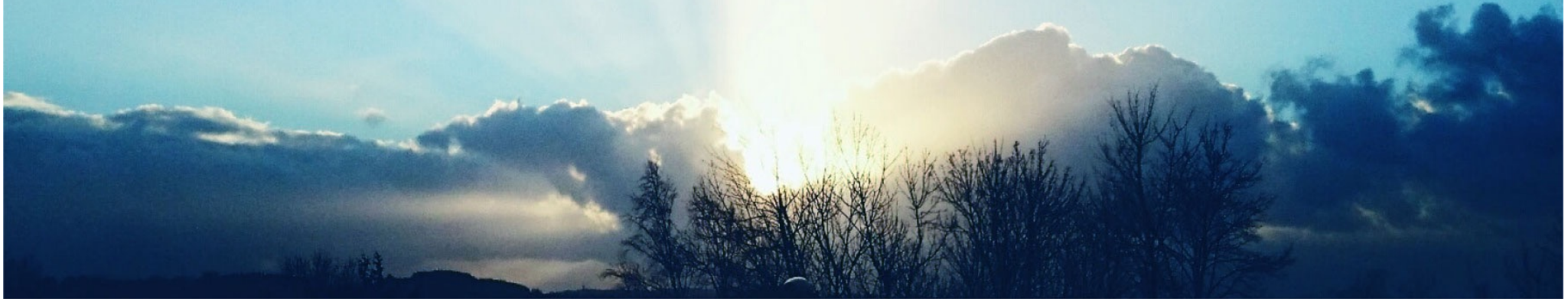
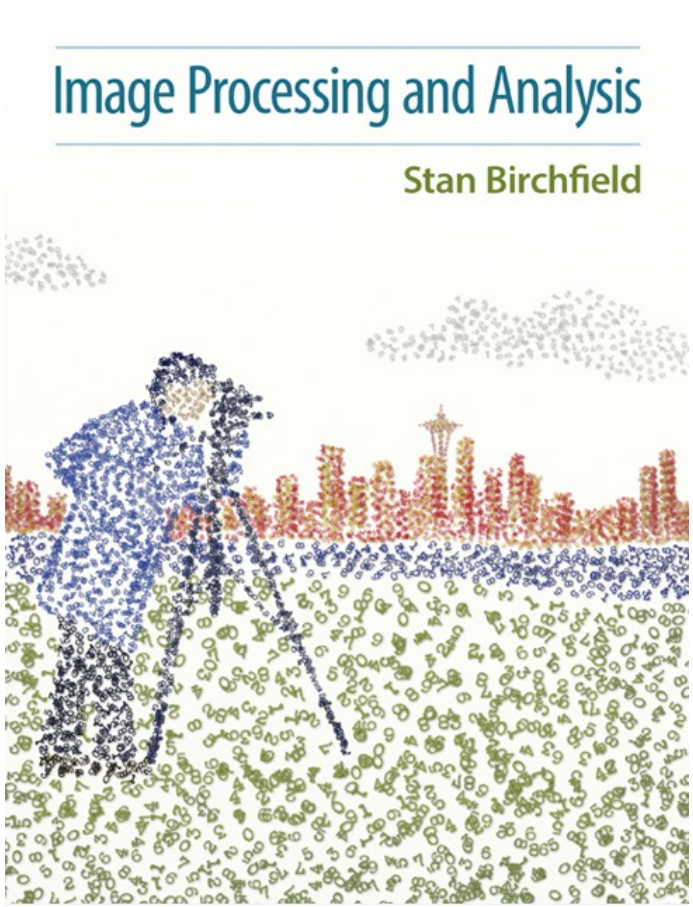
ELE510 Image processing and computer vision

Image segmentation (chap 10 Birchfield), 10.1 thresholding 2023





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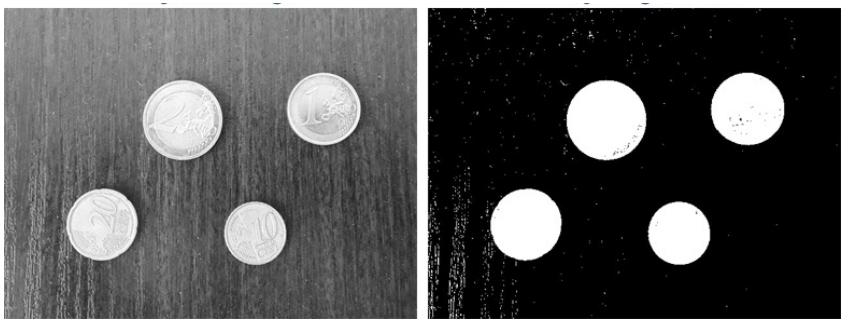
Segmentation by thresholding



Three points from the topic:

1. What do we mean by image segmentation in general and by thresholding in particular?
2. How does the much used Otsus method work?
3. Why would we need adaptive thresholding?

Image segmentation

Collecting together pixels or pattern elements into summary representations that emphasize *important*, *interesting*, or *distinctive properties*."

Extract the outlines of different regions in the image

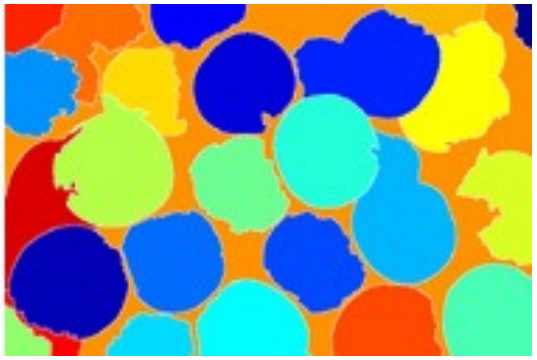
The regions have something in common

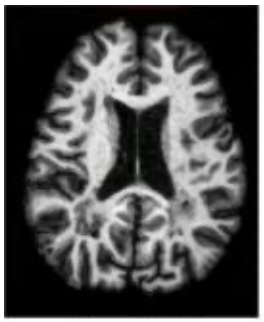
- Brightness
- Texture
- Colour etc..

Most segmentation methods are application dependent.

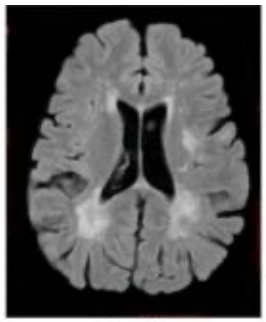
Examples

From W. Y. Ma and B. S. Manjunath, "Edge flow: a framework for boundary detection and image segmentation," Proc. IEEE International Conference on Computer Vision and Pattern Recognition (CVPR) 1997





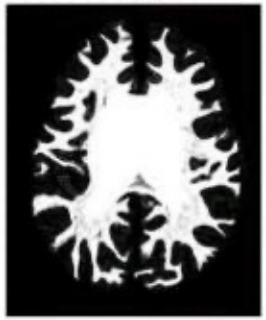
T1-weighted



FLAIR

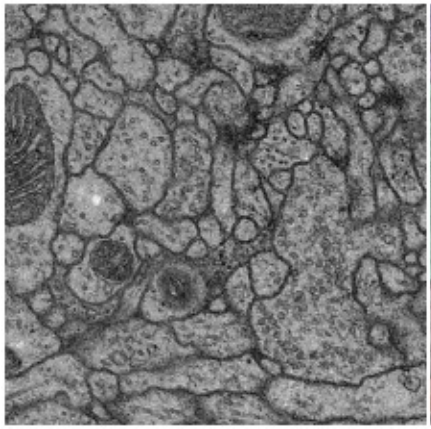
Segmentation

Filled mask



Filled membership

GM membership



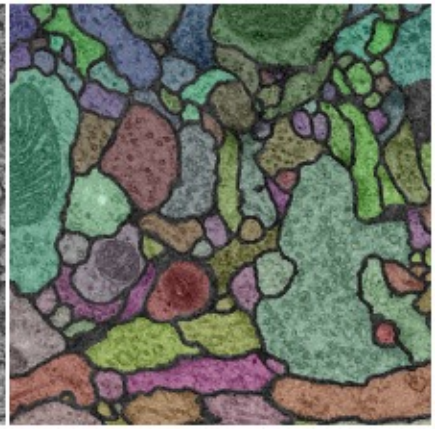


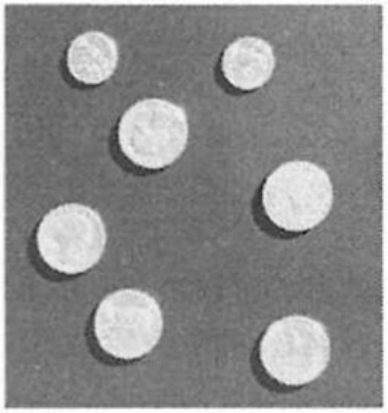
Image segmentation methods, examples

- Thresholding
  - Global / local
  - Otsu's method
- Region based
  - Region growing
  - Split and merge
- Morphological segmentation
  - Watershed
- Mean-shift segmentation
- Graph based methods *(not a part of this course)*
- Deformable models (*not a part of this course*)
  - Level set
  - Active contours (snakes)

- And many more …….

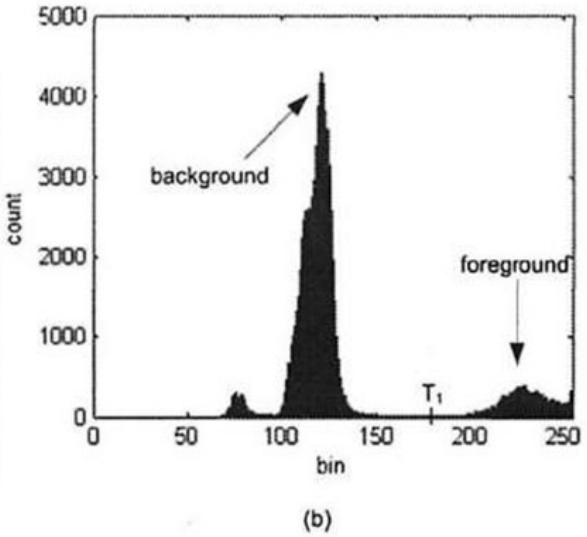
(10.1) Thresholding

- The simplest method used for segmentation is to *group pixels according to their intensity value* using the image histogram and ***thresholds***.
- A challenge is how to compute (find) the threshold(s) value(s)



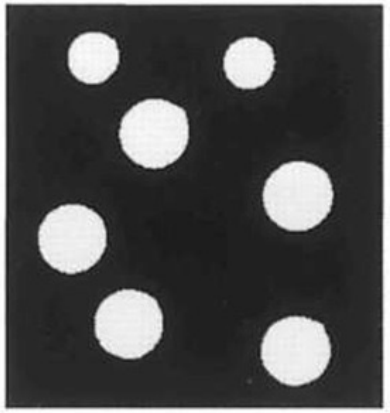
(a)

Gray level image



(b)

Histogram of gray level image



(c)

Label image. here: binary, because two classes: foreground and background

A label can be a number, color, letter ..

How to find the threshold(s) ?

- P – tile method
  - If we know that the object occupies approx. K part of the object, we can consider this as the overall probability for a pixel to be object. $K \in [0 , .. 1]$.
  - p(object)=K, p(background) = (1-K).
  - Consider the normalized histogram. Find the threshold T so that the fraction K of the total pixels are considered object.

How to find the threshold? Ridler-Calvard algorithm

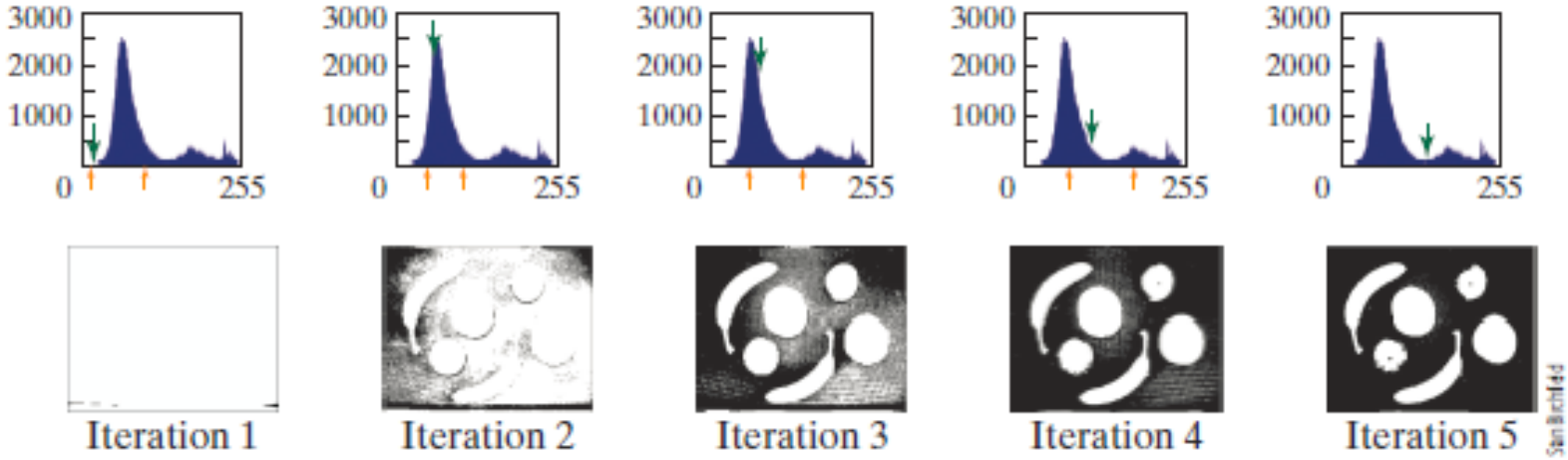
Simple iterative: Ridler-Calvard Algorithm.

Can be shown that optimal if background and foreground are Gaussian with the same σ (different μ, - μb, μo)

Threshold by Ridler Calvard - example

Simple iterative: Ridler-Calvard Algorithm,

Figure 10.2 Step-by-step example of the Ridler-Calvard algorithm applied to the image of Figure 10.1. Note that even with an initial threshold far from the true solution, the algorithm converges in only five iterations. The top row shows the histogram. The green arrow pointing down indicates the threshold at each iteration, while the gold arrows pointing up indicate the two means. The bottom row shows the result of thresholding the image using the threshold for that iteration.



How to find the threshold(s)? Otsus method

- More used : Otsus method. Expect the background and foreground to have different μ AND different σ)
- Minimize within-class variance, $\sigma_w^2(t)$ AND maximize between-class variance, $\sigma_b^2(t)$, as function of threshold t.

- Can be shown: $\boxed{\sigma^2 = \sigma_w^2(t) + \sigma_b^2(t)}$

-> enough to look at one of them. We can maximize the between-class variance.