



FACULTAD DE MEDICINA
UNIVERSIDAD DE CHILE



Image Processing 2

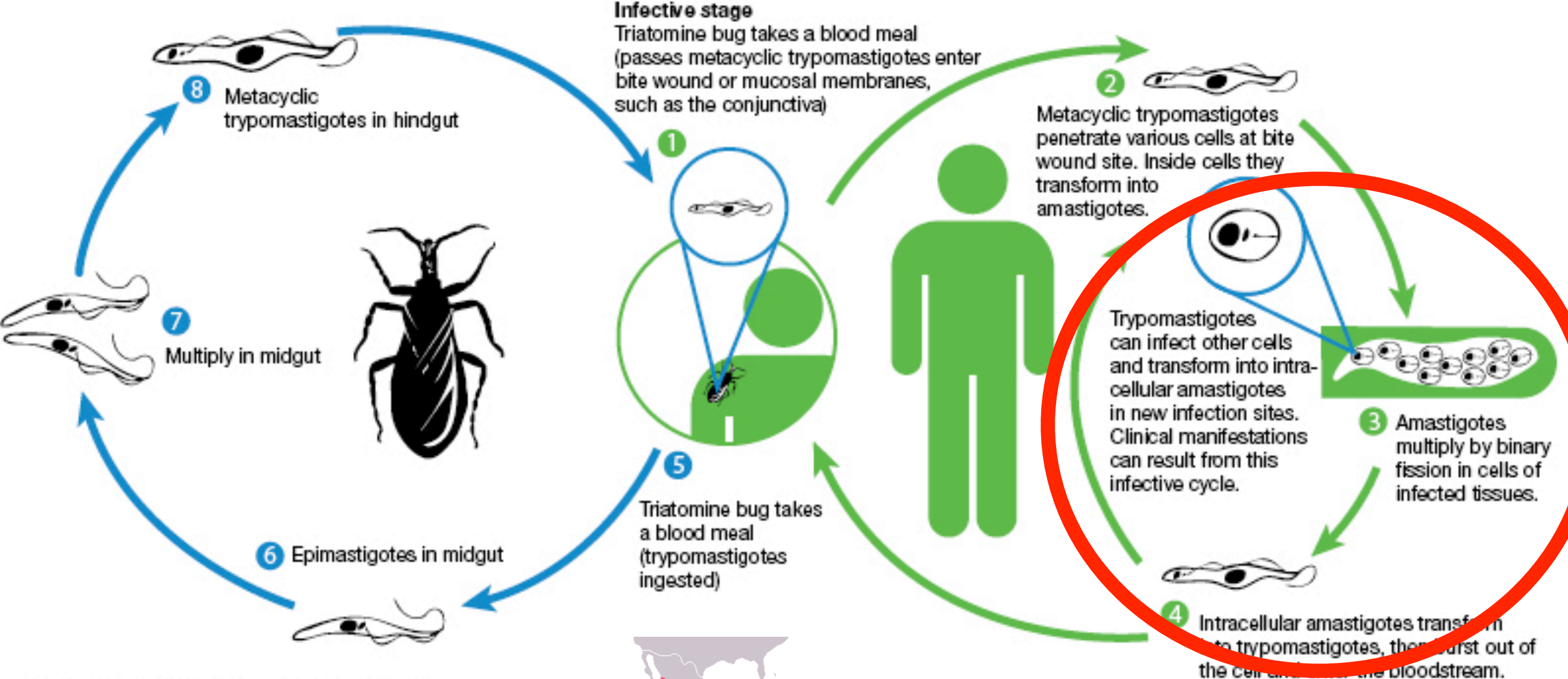
+ machine learning!

Mauricio Cerda
ICBM, CIMT, Faculty of Medicine
Universidad de Chile
mauriciocerda@med.uchile.cl
www.scian.cl

OUTLINE

- ▶ Segmentation (clustering)
- ▶ Segmentation (classification)

Infection cycles of Chagas disease



- Trypomastigoten = mobile pathogen
- Amastigoten = immobile pathogen
- Epimastigoten = divisible pathogen



Source: www.dpd-cdc.gov/dpdx



IMAGE PROCESSING: PARASITES

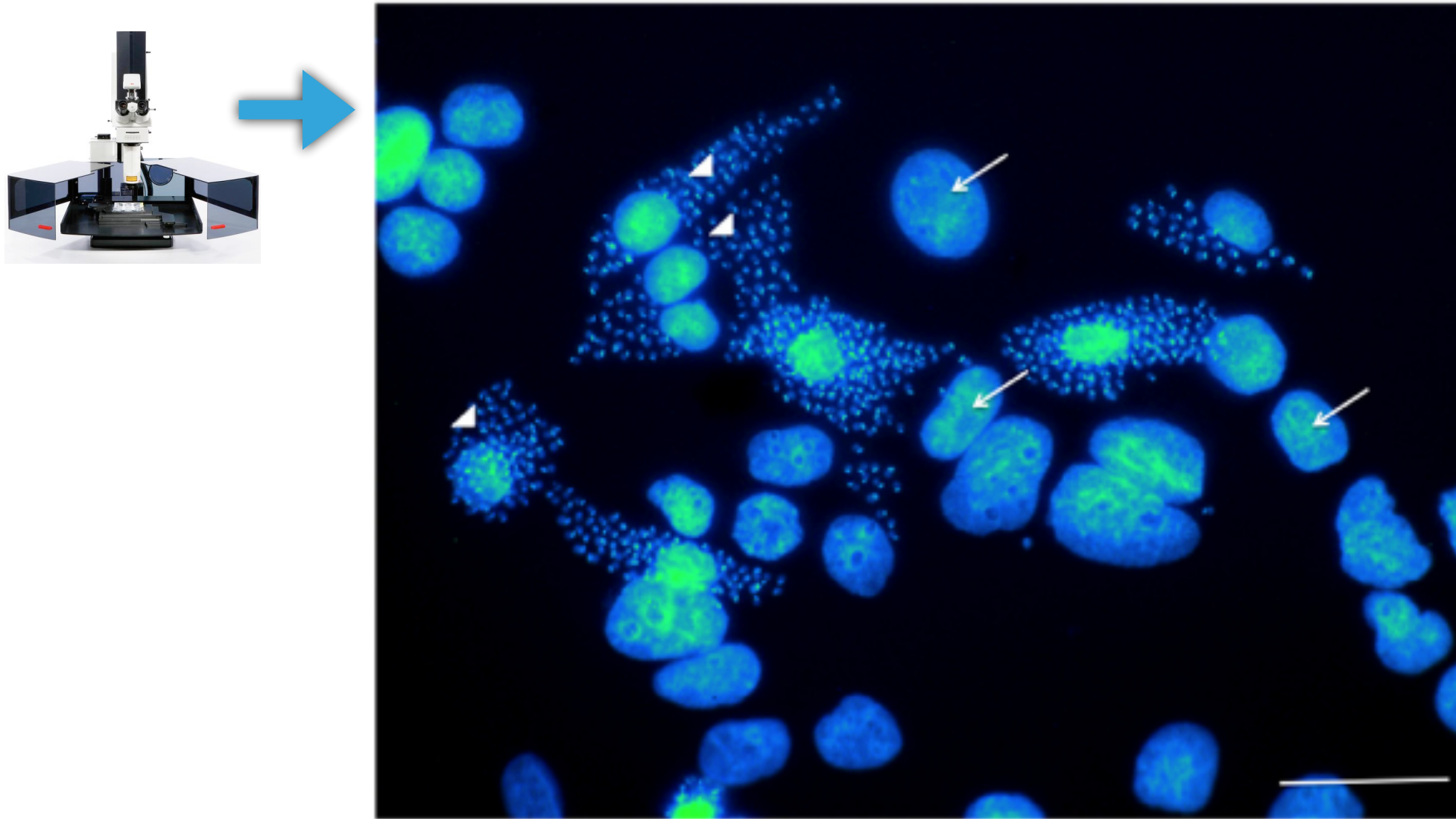
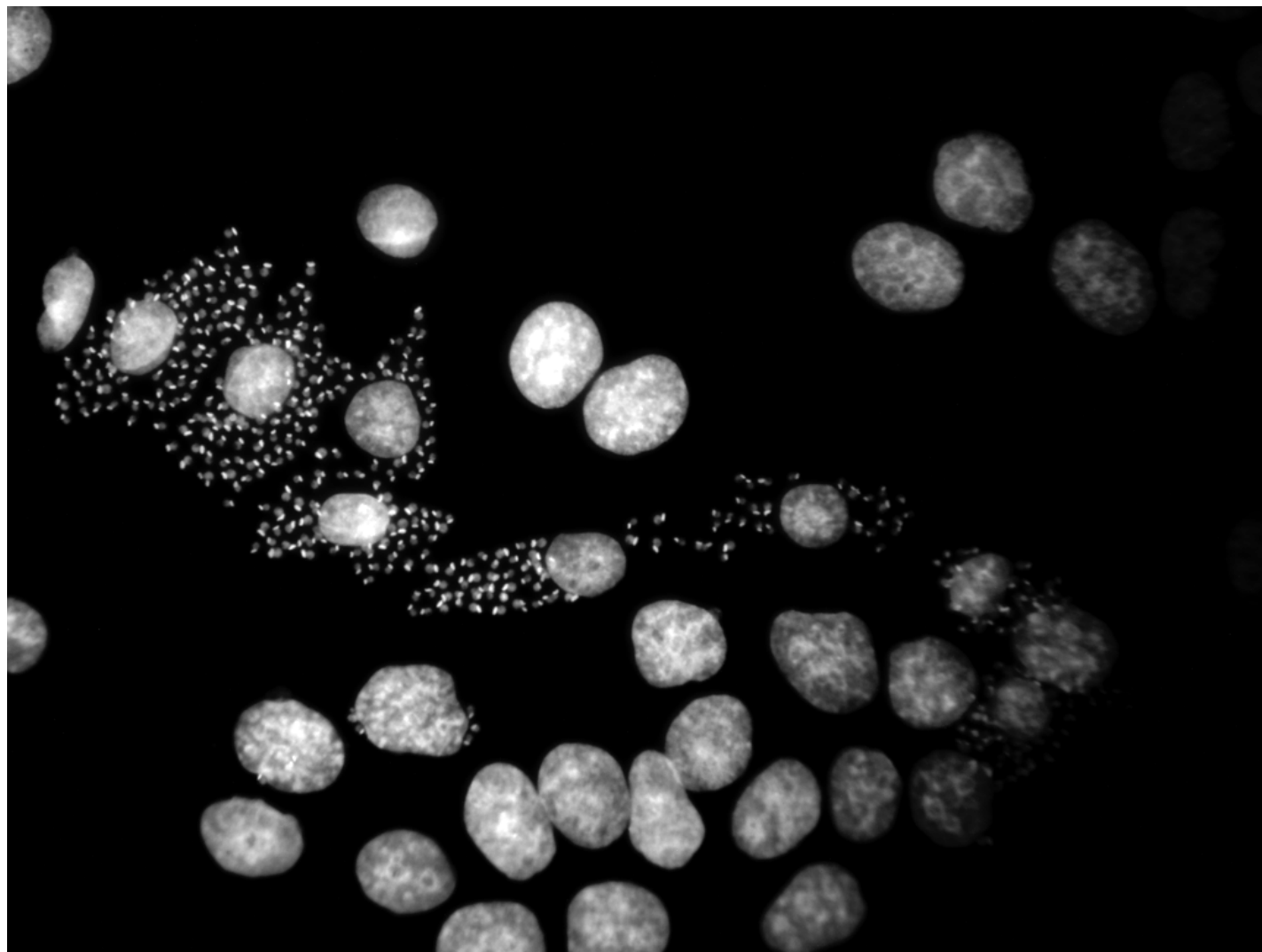


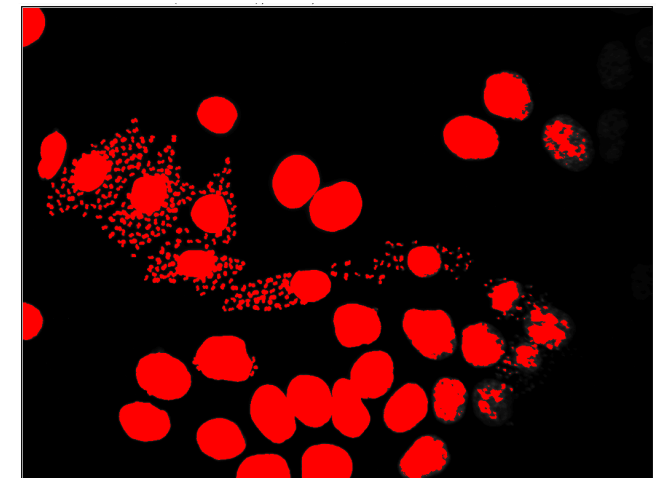
Fig. 1. Infection of BeWo cells with *T. cruzi* amastigotes. BeWo cells were challenged with *T. cruzi* Ypsilon strain trypomastigotes at a parasite:cell ratio of 1:1 for 24 h and were processed for DAPI staining after 48 h. The arrows show BeWo cell nuclei, and the arrowheads show intracellular amastigotes. Scale bar: 10 μm.

► Pregnancy?

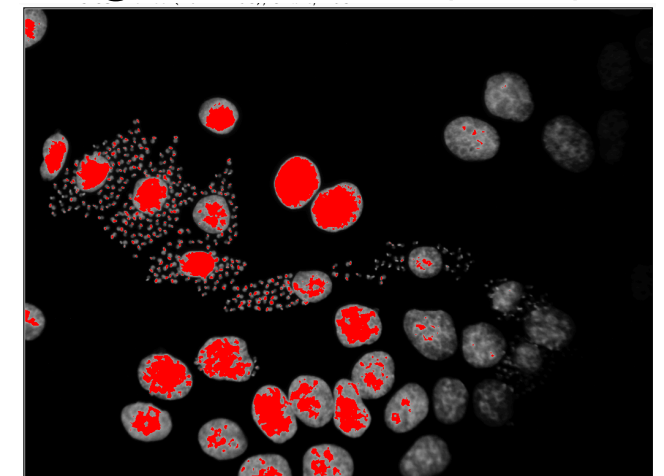
- ▶ The simplest segmentation... a manual global threshold



raw image



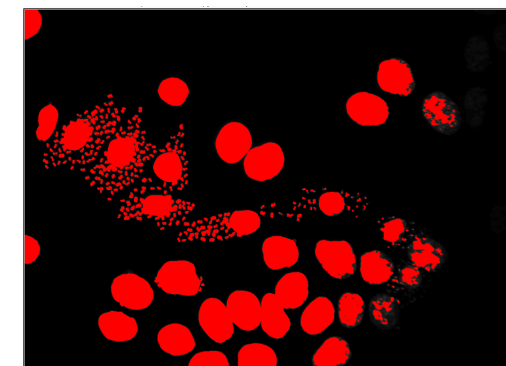
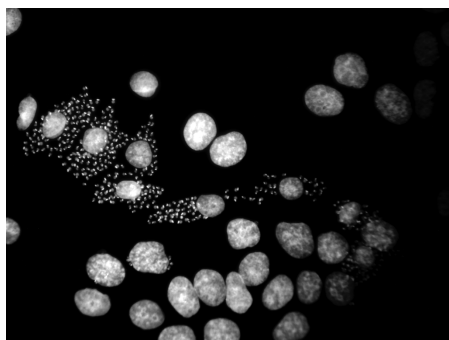
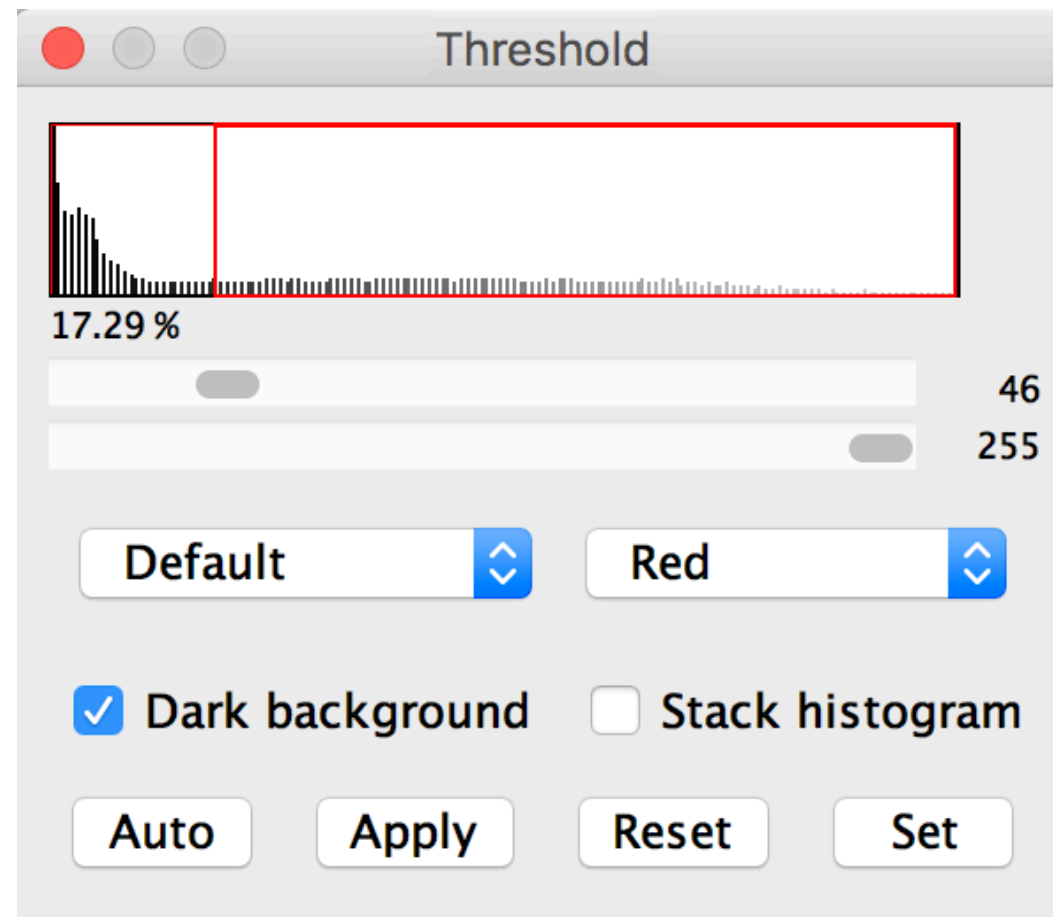
segmentation (>46)



segmentation (>158)

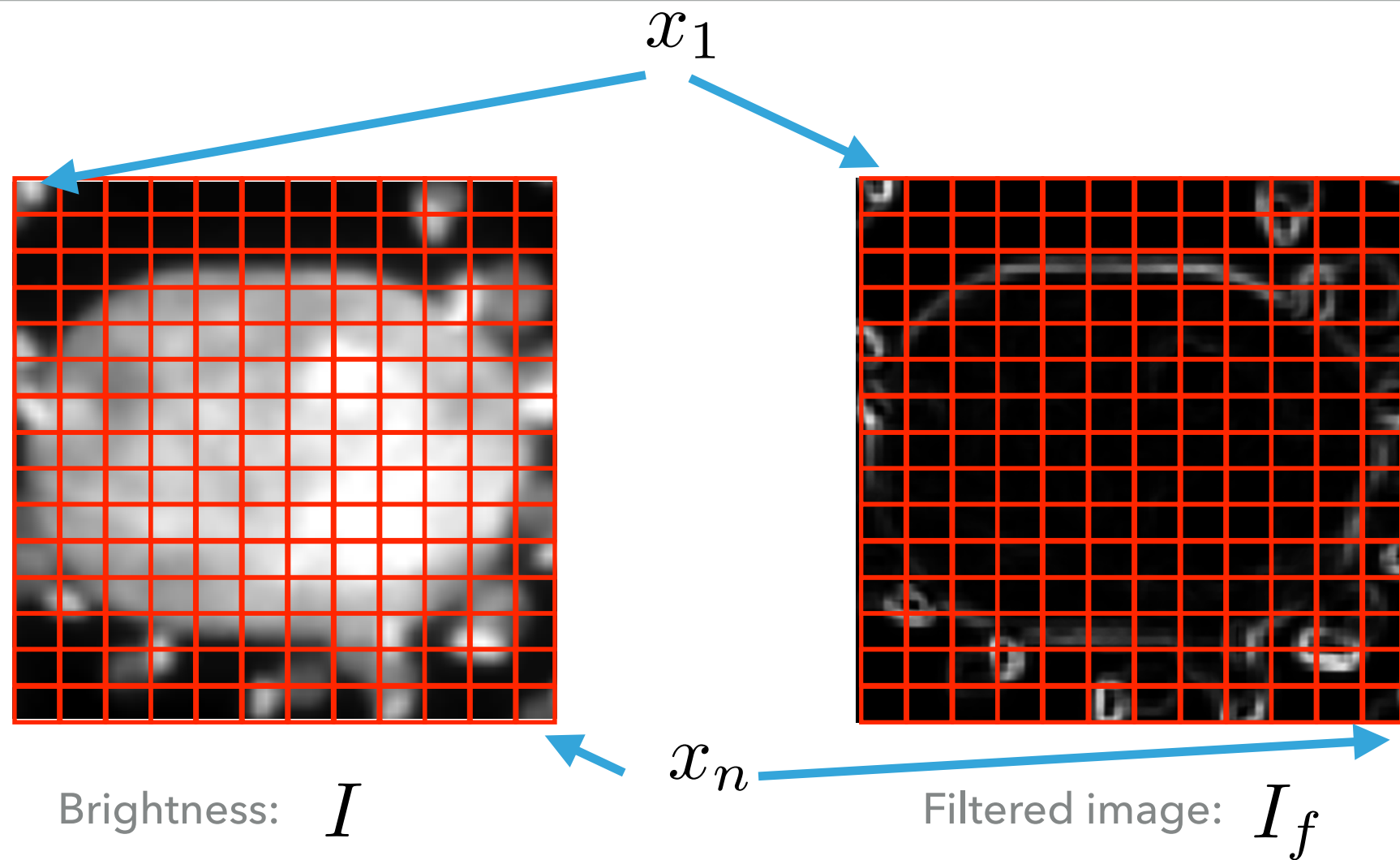
IMAGE SEGMENTATION

► How to define the threshold ? ...



- ▶ We know there are two groups (or three?): cells, and background.
- ▶ We don't have examples (!)
- ▶ Looks like a learning problem:
 - ▶ Unsupervised: **clustering**
 - ▶ Supervised: regression, **classification**

IMAGE PIXEL AS A VECTOR



- ▶ Brightness (**0**)
- ▶ Variance **3x3**
- ▶ Mean **3x3**
- ▶ Sobel **3x3**
- ▶ (any convolution)
- ▶ Others

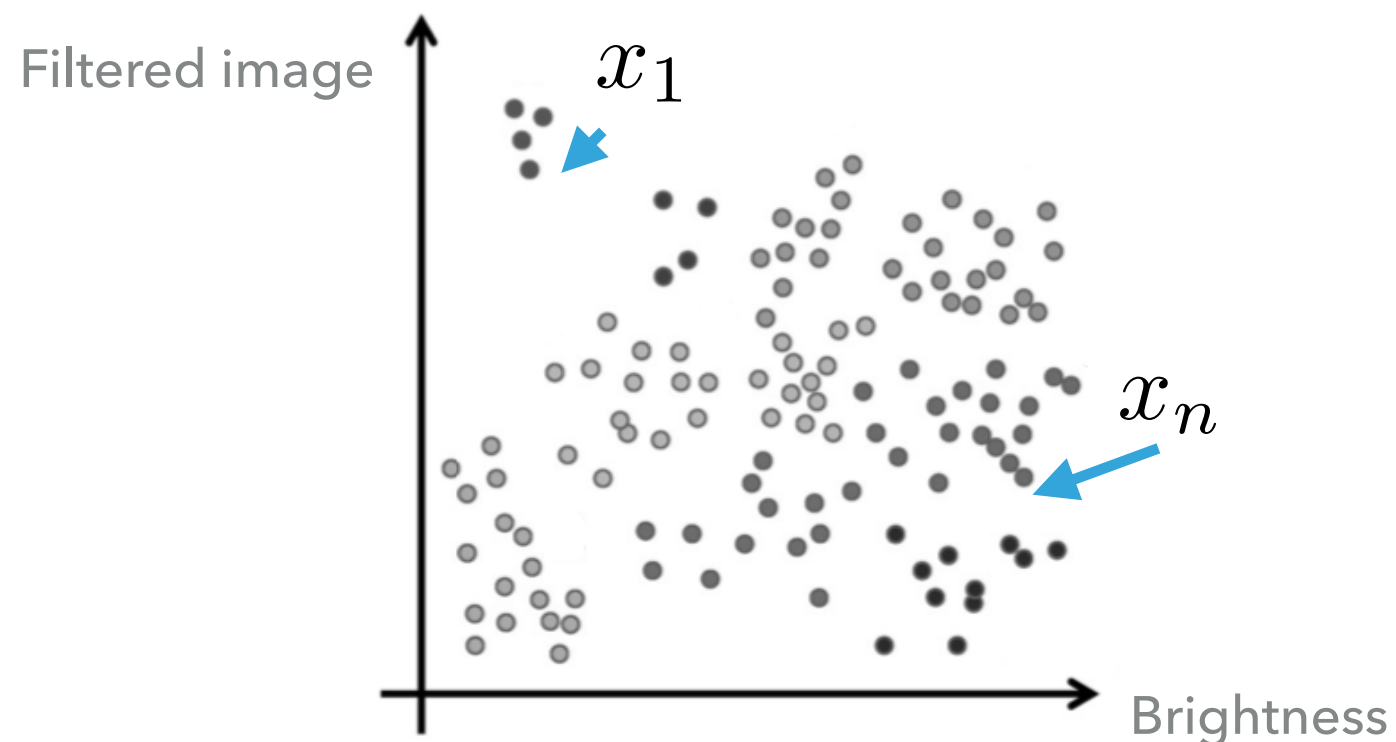
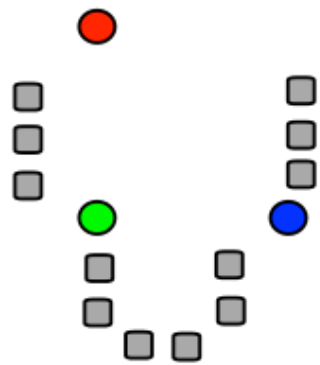
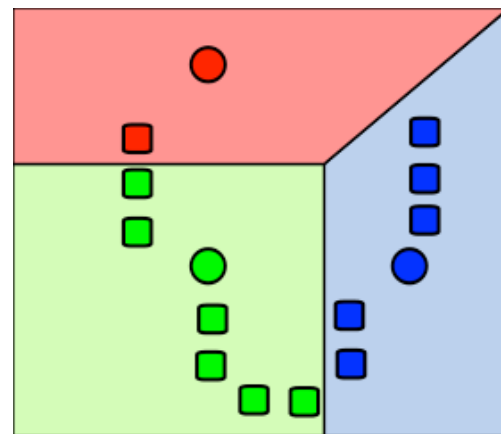


IMAGE SEGMENTATION: UNSUPERVISED APPROACH

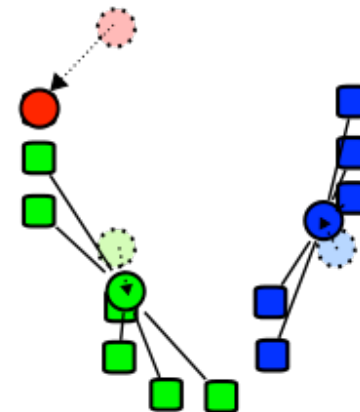
- ▶ We can model it as how to discover the best k groups or clusters at a pixel level.
- ▶ K-means clustering ($k=3$):



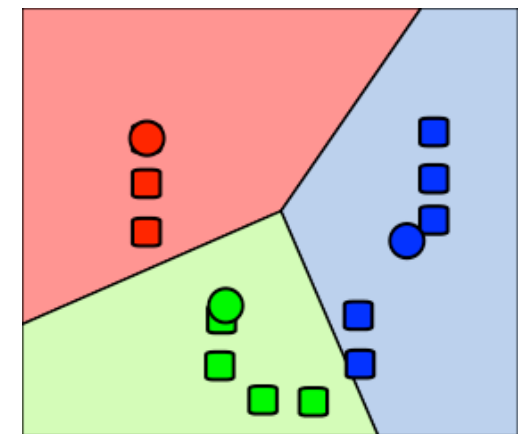
Random centroids



clusters assignation +
voronoi diagram



centroids re-computation

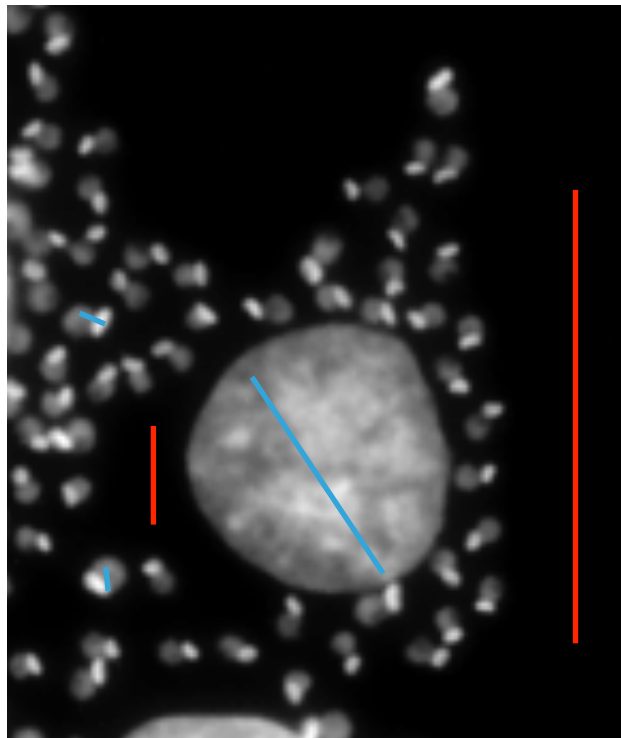


cluster assignation +
voronoi diagram



IMAGE SEGMENTATION: SUPERVISED APPROACH

- ▶ We can quickly build examples.
- ▶ Switch from unsupervised to supervised problem.



- ▶ Class A (background)
- ▶ Class B (objects)

Notebook

imageProcessing_1.ipynb

- ▶ EXERCISE 1: Color cells by size
- ▶ EXERCISE 2 (optional): Color cells by elongation
- ▶ EXERCISE 3 (optional): Get a data table (csv)

Notebook

imageProcessing_2.ipynb

- ▶ EXERCISE 1: Define a global threshold with k-means ($k=2$).
- ▶ EXERCISE 2: Use Random Forest to classify at pixel level (multiple features).