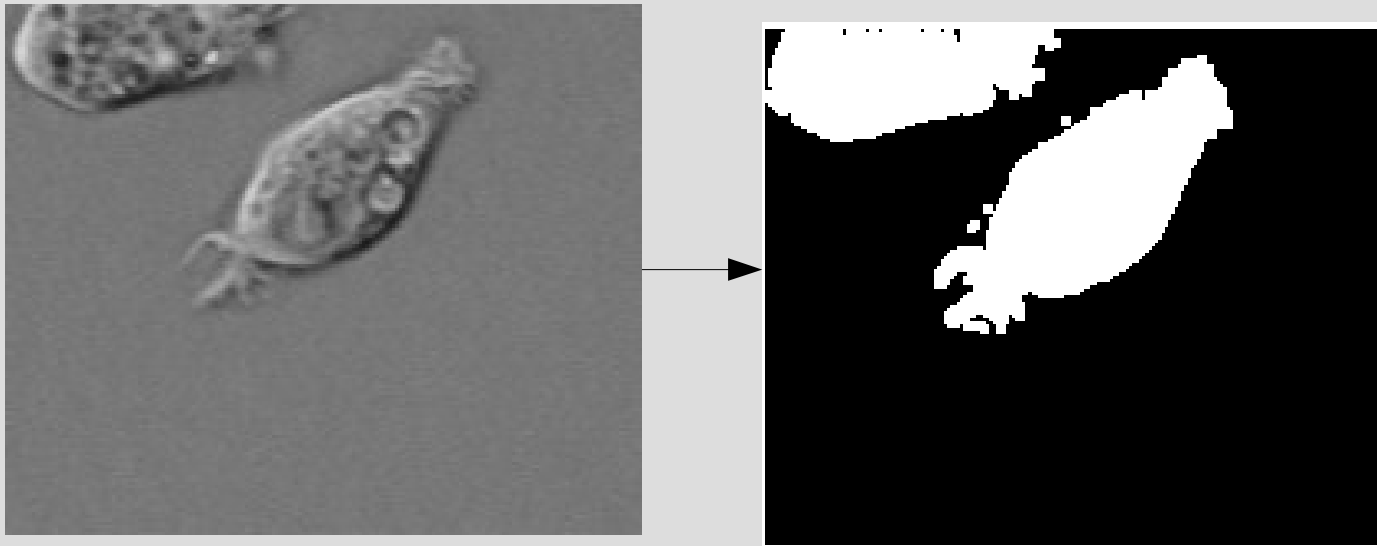


SYDE 575: Introduction to Image Processing

Segmentation

What is Segmentation?

- Underlying goal of image segmentation is to partition an image into multiple groups/regions



Why segment?

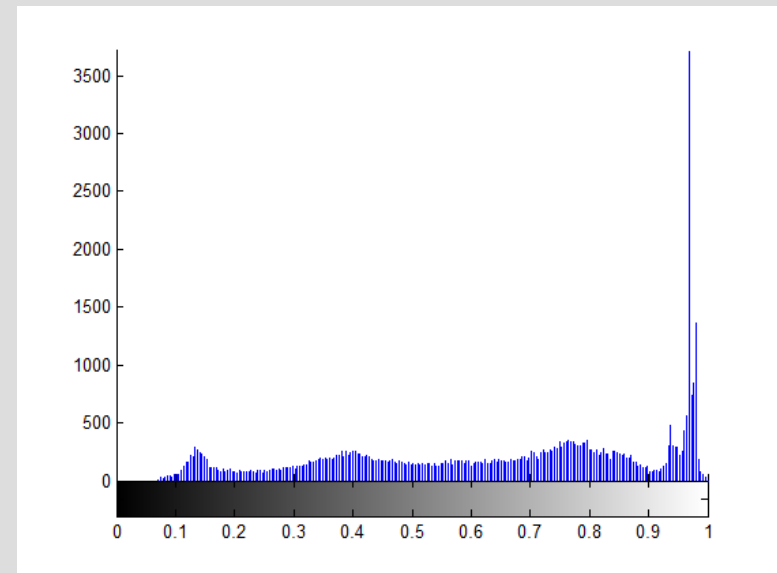
- Segmentation allows objects and regions to be analysed in a more meaningful manner.
- Some applications of segmentation:
 - Object tracking (e.g., people tracking for surveillance purposes)
 - Medical Image Analysis (e.g., tumor growth analysis)
 - Remote Sensing Analysis (e.g., determine the ratio of different types of sea-ice within a region)
 - Face recognition (e.g., partition face into individual parts for component recognition)

Types of Segmentation Algorithms

- Some of the most common groups of segmentation algorithms are:
 - Histogram based segmentation
 - Clustering based segmentation
 - Region growing segmentation
 - Active contour based segmentation
 - Watershed based segmentation
 - Morphology based segmentation

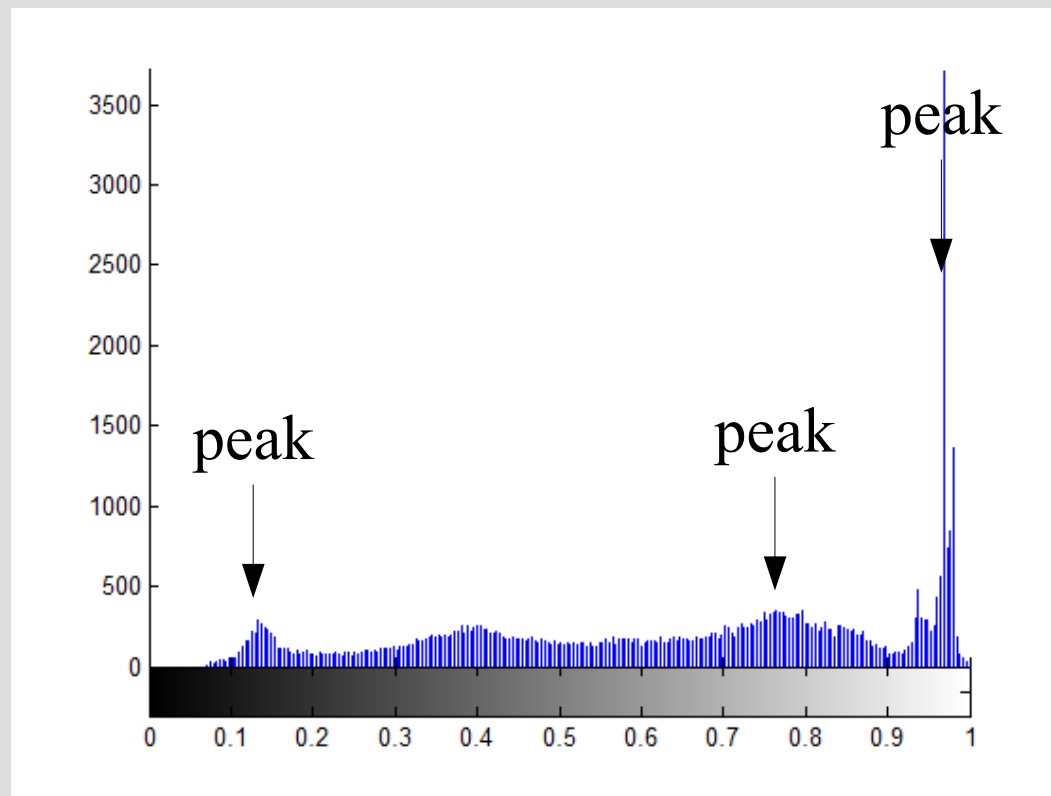
Histogram based Segmentation

- One of the simplest and most efficient form of segmentation
- Steps:
 - Compute the histogram of the image



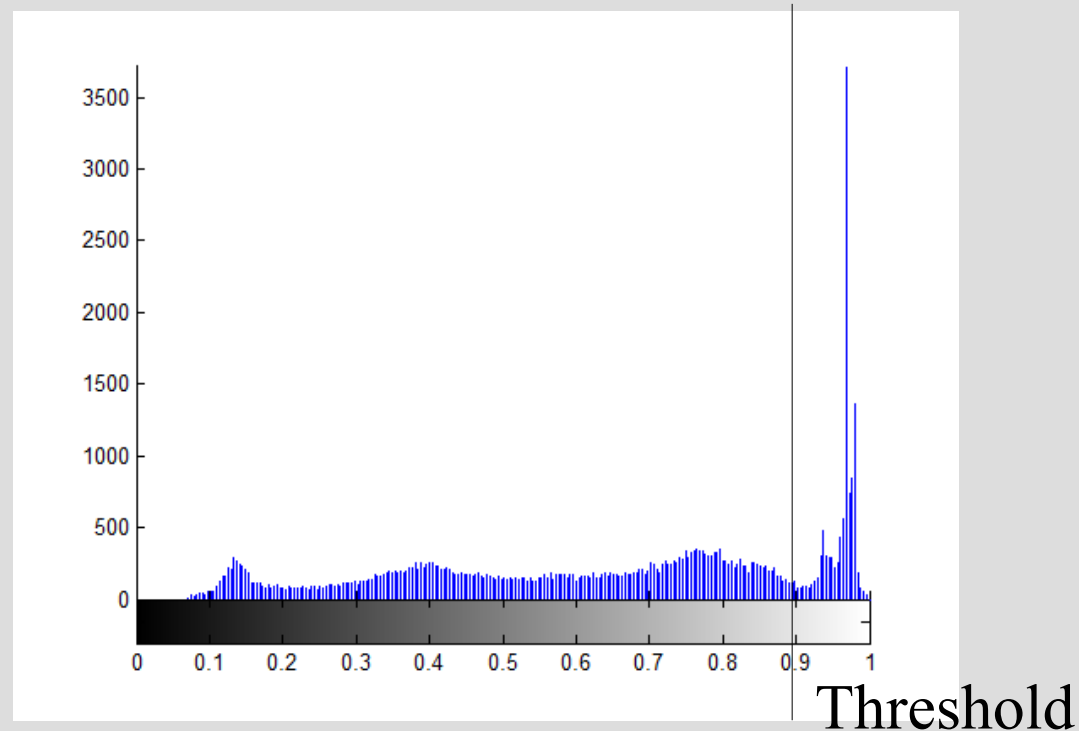
Histogram based Segmentation

- Steps:
 - Analyse peaks of the histogram and determine an appropriate point of thresholding



Histogram based Segmentation

- Steps:
 - Determine an appropriate point of thresholding based on what we want (e.g., segment foreground and background)



Histogram based Segmentation

- Steps:
 - Set all pixels to a set of fixed values based on threshold



Histogram based Segmentation

- Advantages:
 - Efficient (usually requires only one pass for simple segmentation cases)
- Disadvantages:
 - Often difficult to determine proper peaks in the histogram
 - Difficult in situations where intensity is not sufficient to distinguish between two partitions (e.g., textured regions containing different mixes of intensities)

Clustering based Segmentation

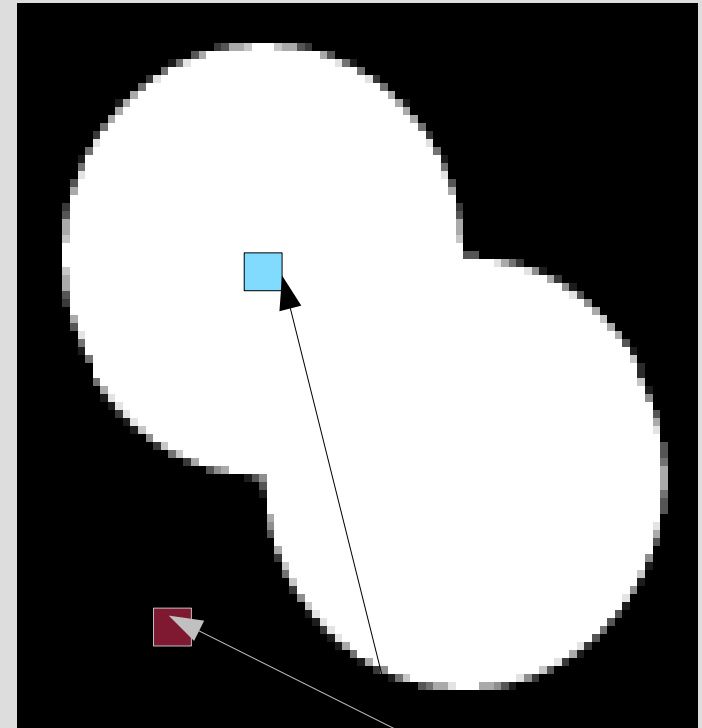
- Create partitions by grouping pixels into clusters
- Steps (for K-means clustering):
 - Pick k pixels in the image to act as the initial centers of the k clusters
 - For each pixel, find the cluster that minimizes your distance metric
 - Distance metric can be the differences in:
 - Pixel intensity
 - Location
 - Variance
 - Weighted combination of these differences

Clustering based Segmentation

- Steps:
 - For each cluster, recalculate the cluster center based on the pixel locations within the cluster
 - Re-do all previous steps until convergence
- Advantages:
 - Good for segmentation where there are multiple distinct partitions
- Disadvantages:
 - Performs poorly when the regions have irregular shapes that mix into each other

Region Growing Segmentation

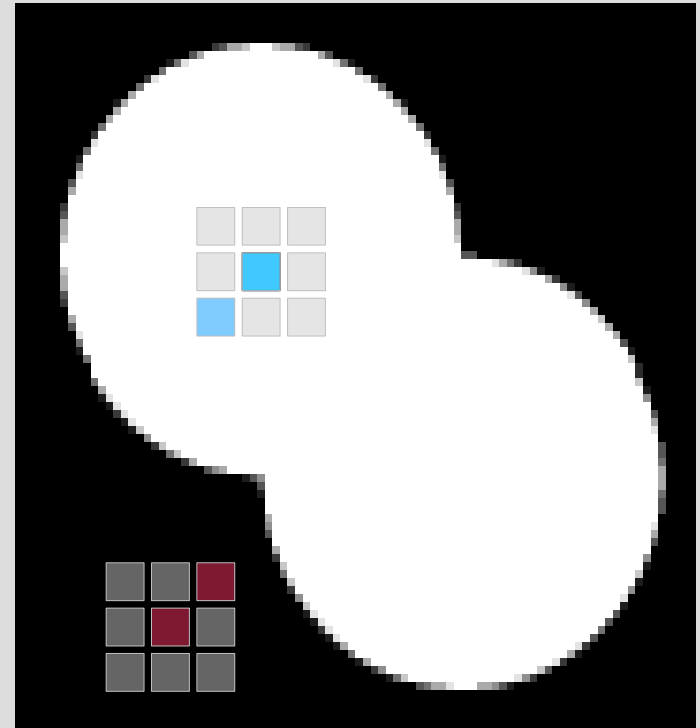
- Create partitions by continuously growing smaller regions until all pixels are accounted for.
- Steps:
 - Pick initial seeds that mark the individual regions who wish to segment



seeds

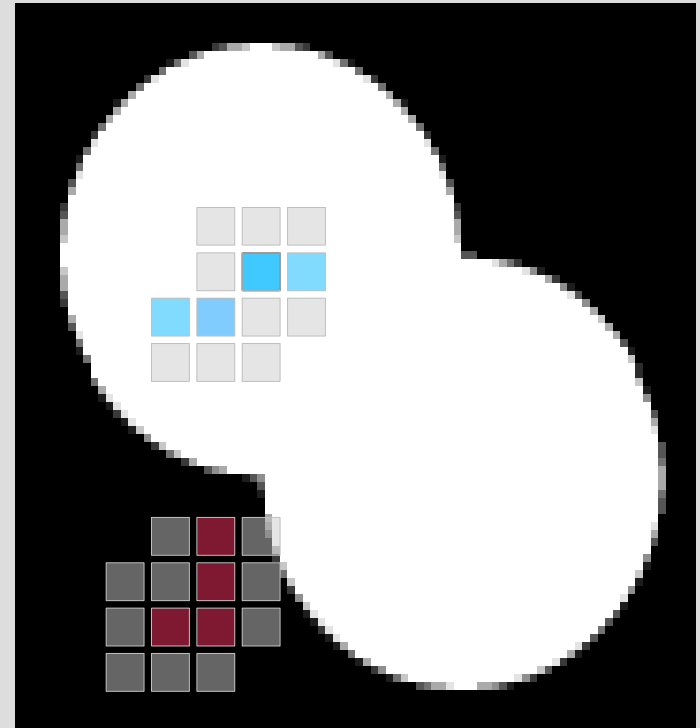
Region Growing Segmentation

- Steps:
 - For all neighboring pixels to the seed, compare the similarity between the seed and the pixel
 - The pixel with the highest similarity is added to the seed to form a small region



Region Growing Segmentation

- Steps:
 - For all neighboring pixels to the new regions, compare the similarity between the seed and the pixel
 - The pixel with the highest similarity is added to the small region to form a bigger region
 - Continue until all pixels in the image belong to a region

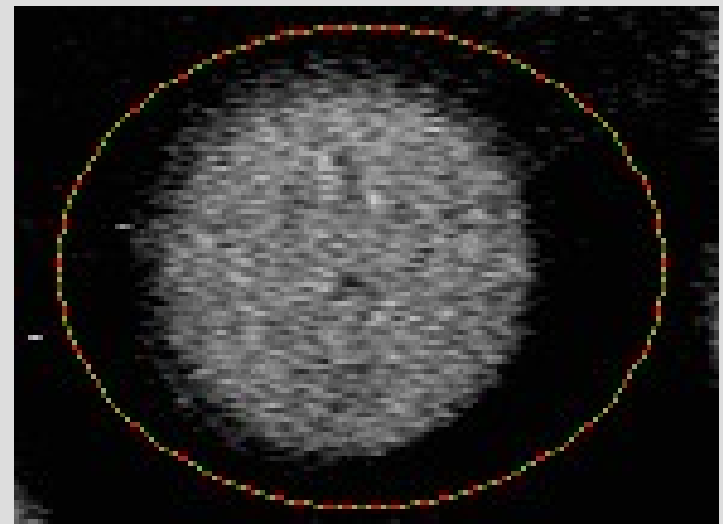


Region Growing Segmentation

- Advantages:
 - Good for segmentation with irregular shapes
- Disadvantages:
 - Slow

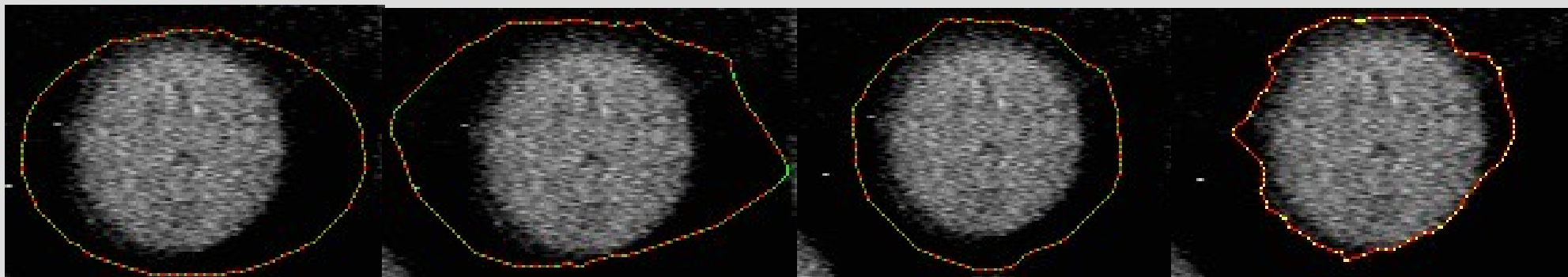
Active Contour Segmentation

- Create partitions by forming rough boundaries around regions/objects of interest and refining the boundaries until it matches the actual boundaries of the objects
- Steps:
 - Create rough boundary around the object



Active Contour Segmentation

- Steps:
 - Calculate energy gradient between the current location of the boundary and it's neighboring pixels
 - Expand or contract the boundary based on the gradient



i=1

i=5

i=20

i=50

Active Contour Segmentation

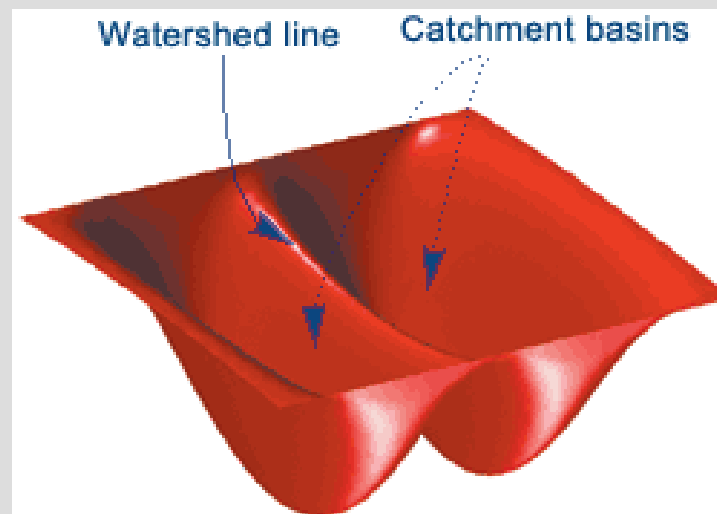
- Advantages:
 - Good for segmenting and tracking objects with deformable motion and clear boundaries
 - Motion information can be extracted from the contour
- Disadvantage:
 - Relatively slow
 - Ill-suited for situations where your regions do not have clearly defined boundaries

Watershed Segmentation

- What is a watershed?
 - A ridge that divides different areas that different rivers and streams drain into
- What is a catchment basin?
 - An area that collects water within an area and drains into a body of water (e.g., sea, ocean, river, etc.)
- What does this have to do with segmentation?!

Watershed Segmentation

- Idea:
 - Let's treat bright areas as having high elevation and dark areas as having low elevation
 - Let's treat boundaries between regions as watersheds and the local minimas of the regions as catchment basins



Source: The MathWorks

Watershed Segmentation

- Idea:
 - Suppose we took a water hose and pour water into the catchment basins until they are full of water
 - Each of these filled catchment basins become the individual regions that you wish to segment!
 - Small regions can be merged into larger regions by continuing to pour water into the basins and overflow the smaller basins until they form a larger basin

Watershed Segmentation

- Advantages:
 - Efficient
 - Simple conceptually
- Disadvantages:
 - How much water do I pour?
 - Too little water leads to over-segmentation (too many remaining regions)
 - Too much water leads to under-segmentation (keep pouring water and the whole image becomes one big region)