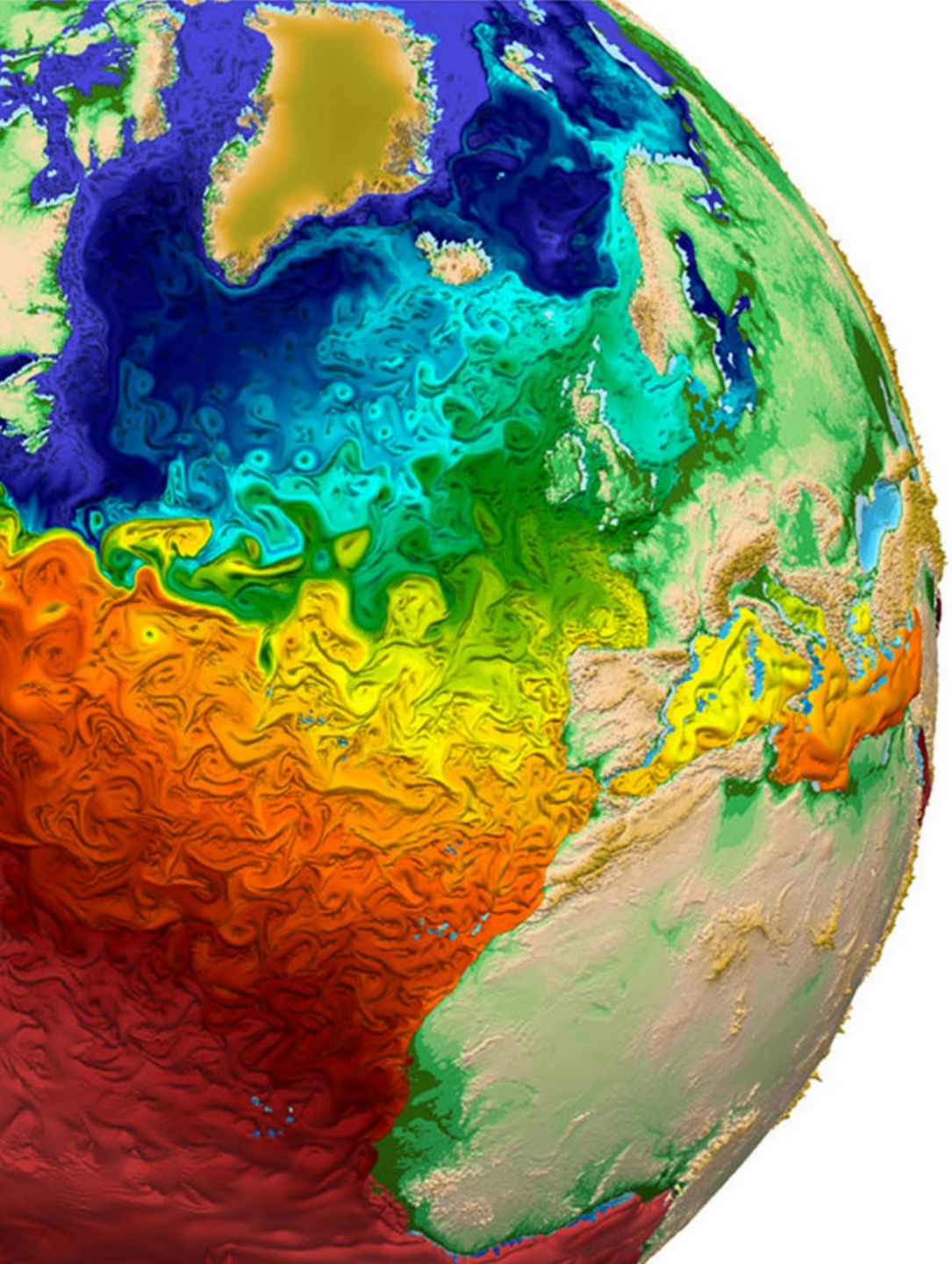


Image Segmentation

Segmenting Multiple Objects

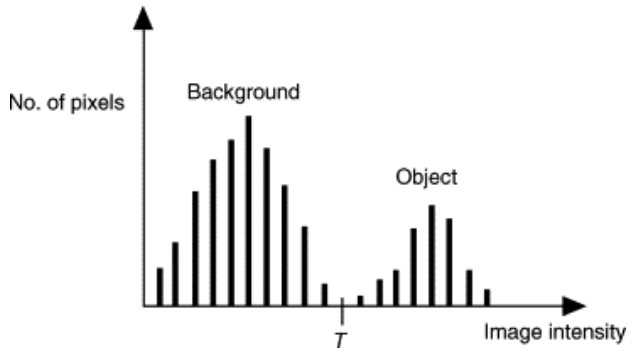
Scientific Visualization
Professor Eric Shaffer

Review: Segmentation by Thresholding

Classical thresholding results in a binary labeling

- Otsu's method

- Good approach for segmenting single object or all objects of given type
- Supports notion of object(s)/foreground vs. background
- Will not be effective distinguishing multiple objects

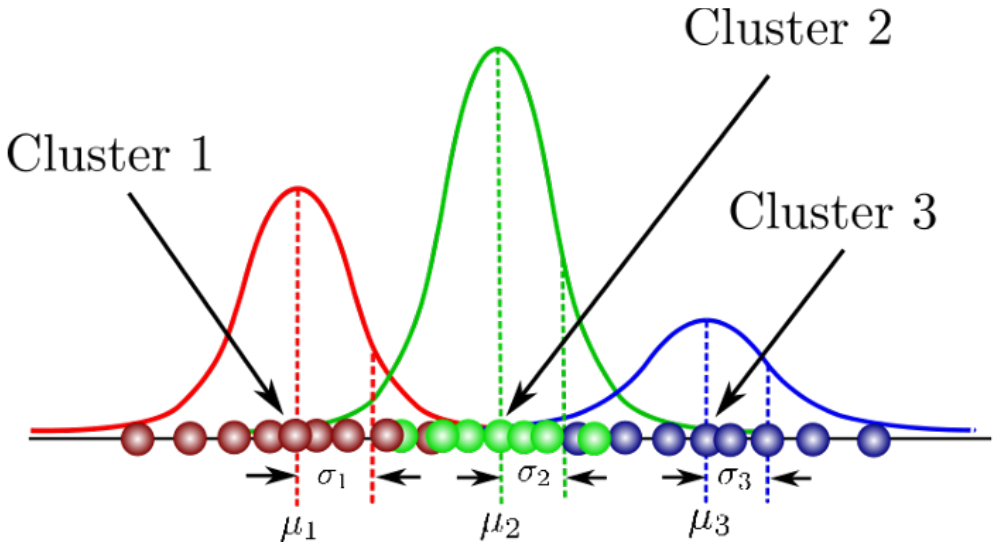


ILLINOIS

Other Approaches to Thresholding

Expectation Maximization (EM) to fit Gaussians

- More powerful and flexible than Otsu's method
- EM can infer the parameters of multiple Gaussian distributions
- Usually more computationally expensive
- You must separately compute the thresholds after the GMM has been inferred
  - GMM is Gaussian mixture model
- General EM of GMM can easily model multiple classes of pixels



ILLINOIS

Thresholding with Non-Binary Labels

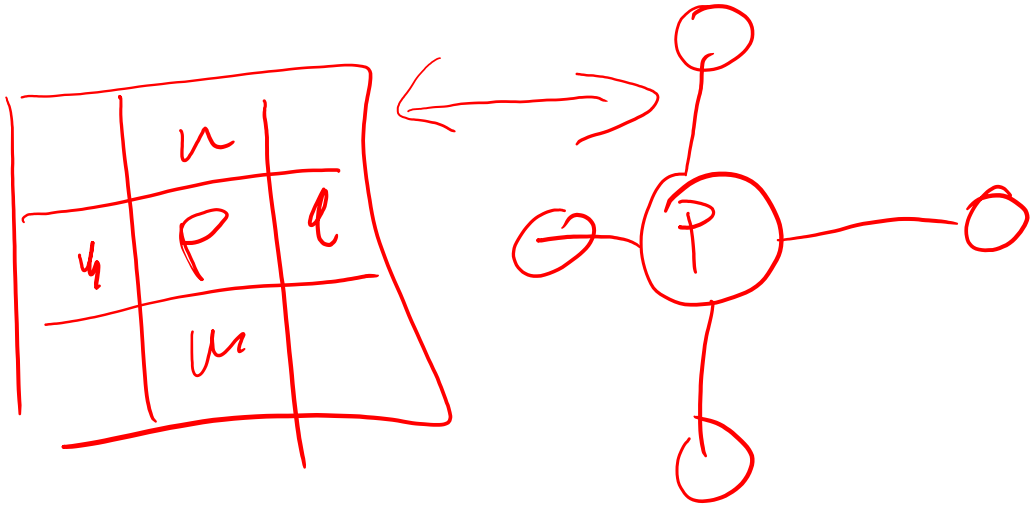
- Recall that thresholding produces a binary segmentation
- What if thresholding detects multiple objects
  …but we need to analyze each of them separately?
  - e.g. multiple bones in a CT scan
  - Multiple fiducial markers.
- We need to give a different label to each detected object

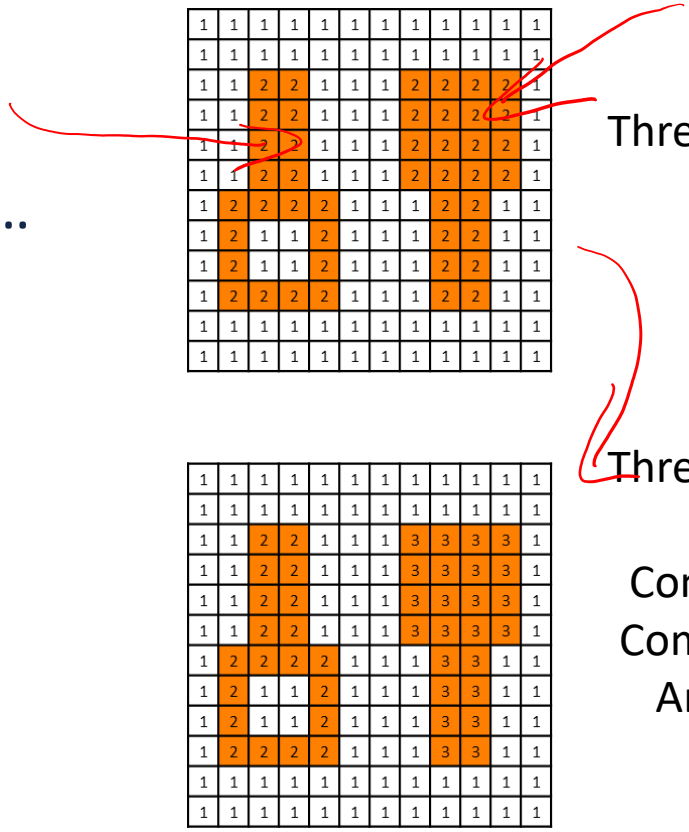
Graph-Theoretic Image Segmentation

Can use a graph-theoretic approach to extend binary thresholding

Connected component analysis lets us:

- Assign a different label to each (disconnected) object…
- from the (binary) set of segmented objects





Recursive Region Growing

One method of doing connected component analysis

Algorithm

Input: A threshold segmentation with object pixels as black in f

1. Search for an unlabeled black pixel; that is, $L(x, y) = 0$
   If you find one, choose a new label number for this region, call it N
   If all pixels have been labeled, stop
2. $L(x, y) \leftarrow N$
3. Push unlabeled neighboring object pixels onto the stack
   - If $f(x\text{-}1, y)$ is black push $(x\text{-}1, y)$ onto the stack.
   - If $f(x\text{+}1, y)$ is black push $(x\text{+}1, y)$ onto the stack.
   - If $f(x, y\text{-}1)$ is black push $(x, y\text{-}1)$ onto the stack.
   - If $f(x, y\text{+}1)$ is black push $(x, y\text{+}1)$ onto the stack.
4. If the stack is empty, go to 1
5. Else choose a new (x, y) by popping the stack and go to 2.