# Multi-scale automatic (MSA) segmentation for live cell movies

- Ensemble idea in supervised learning
  - Combining multiple (weak) classifiers to build a better classifier

- Scale-space idea in computer vision
  - Patterns in an image may be exposed at different (smoothing) scales

- MSA method
  1. Combine multiple (42) segmentation outcomes
     1. Gaussian filter sigma = [0, 0.5, 1, 1.5, 2, 2.5, 3] pixels (7 different sigmas)
     2. Minmax, Rosin, Otsu (3 thresholding methods)
     3. Mask Refinement (`imclose.m`) radius = [1, 3] (2 different radii)
  2. Compute votes for each pixel
     1. Mask score = the number of masks that classified the pixel into the foreground
  3. Thresholding based on the votes

Mask scores

Histogram of mask scores
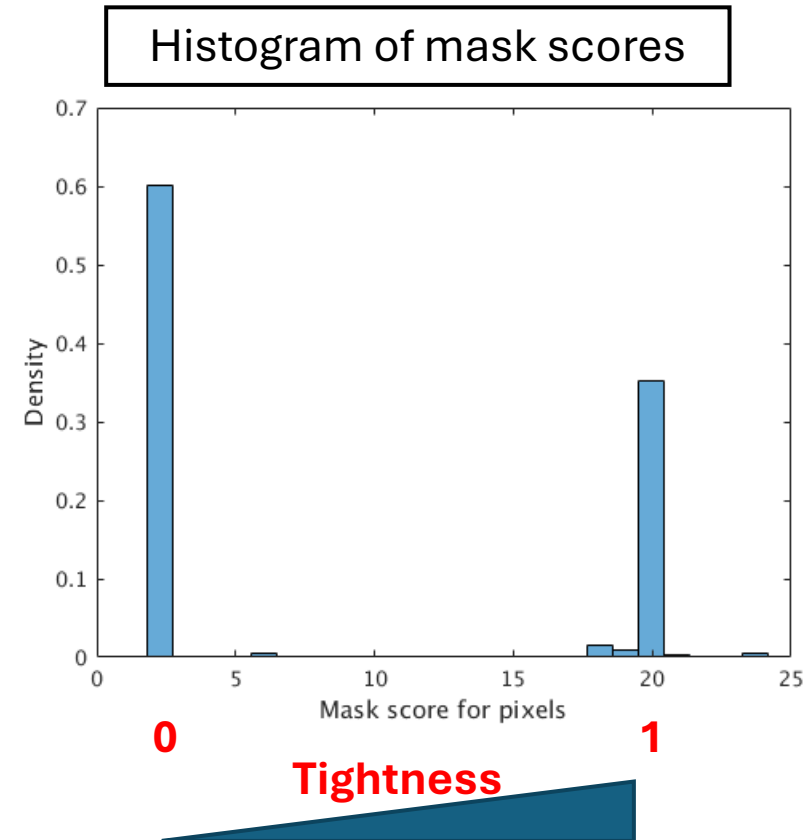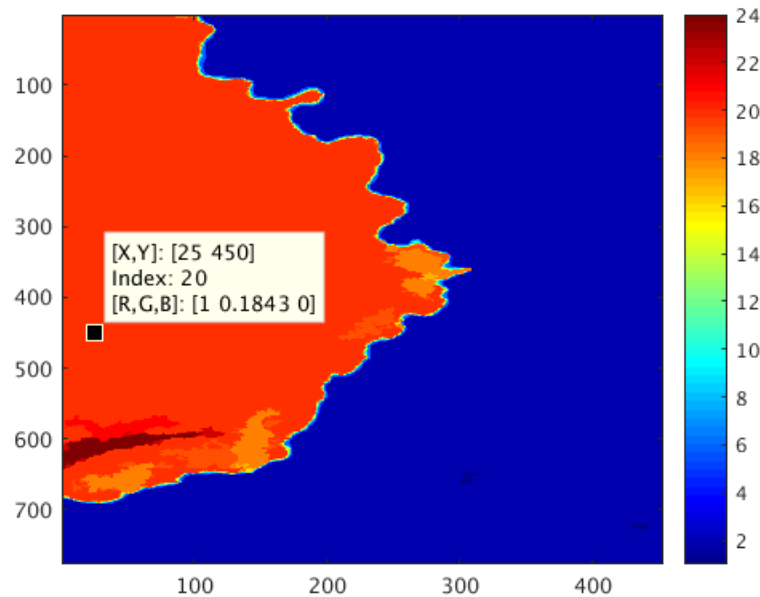
- Distribution of mask scores over pixels showed prominent two peaks, which correspond to the foreground and background.

- Mask scores for foreground and background may be different across frames according to noise level.

- 'Tightness' is a normalized mask score, which varies [0, 1] between the two peaks.

- A single or default parameter can work for all the movies imaged under the same condition.
  - 'Tightness' = 0.5 commonly works well.
  - Or specifying a cut-off of votes or mask scores works well (e.g., number of votes = 20).