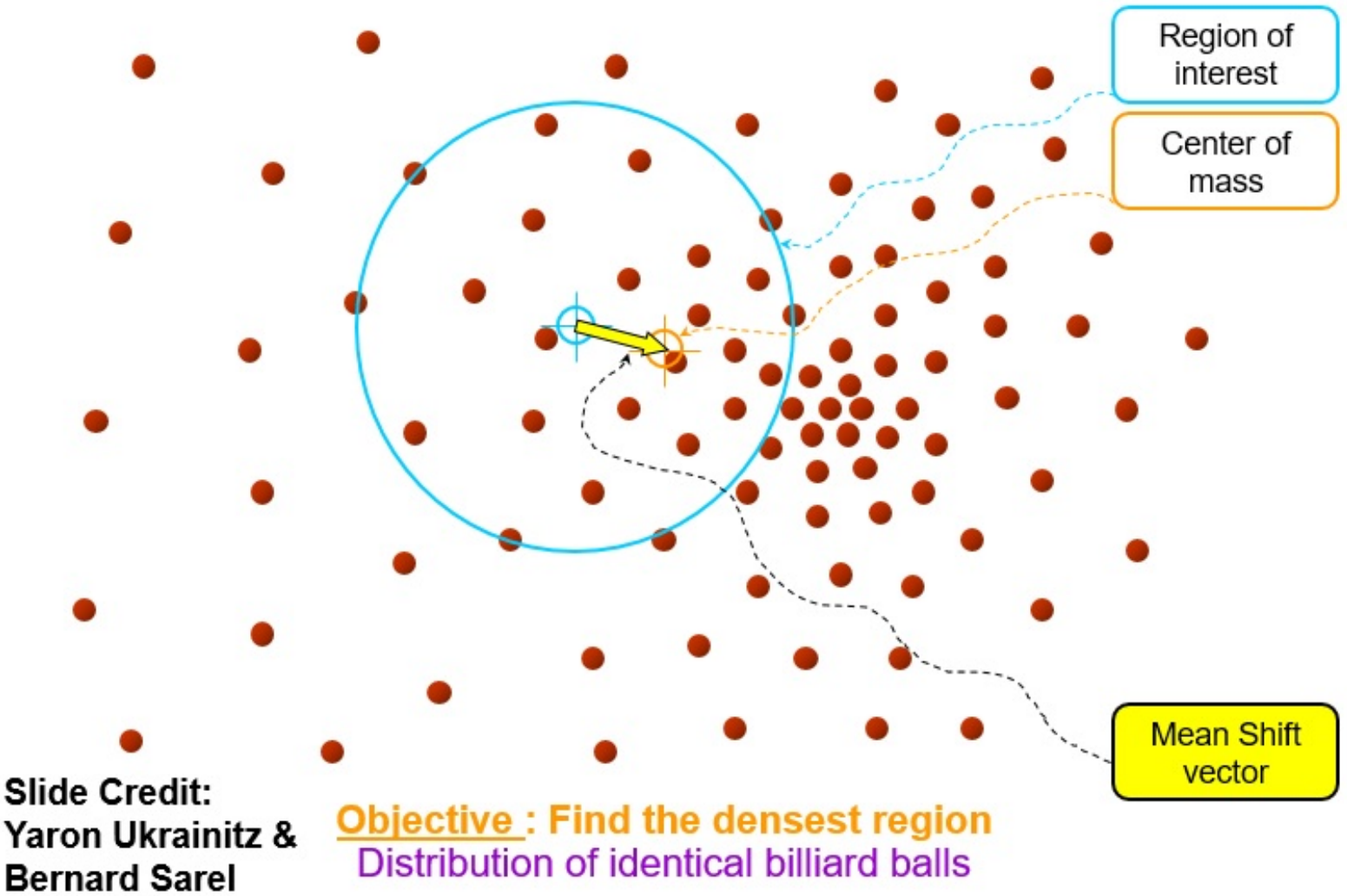
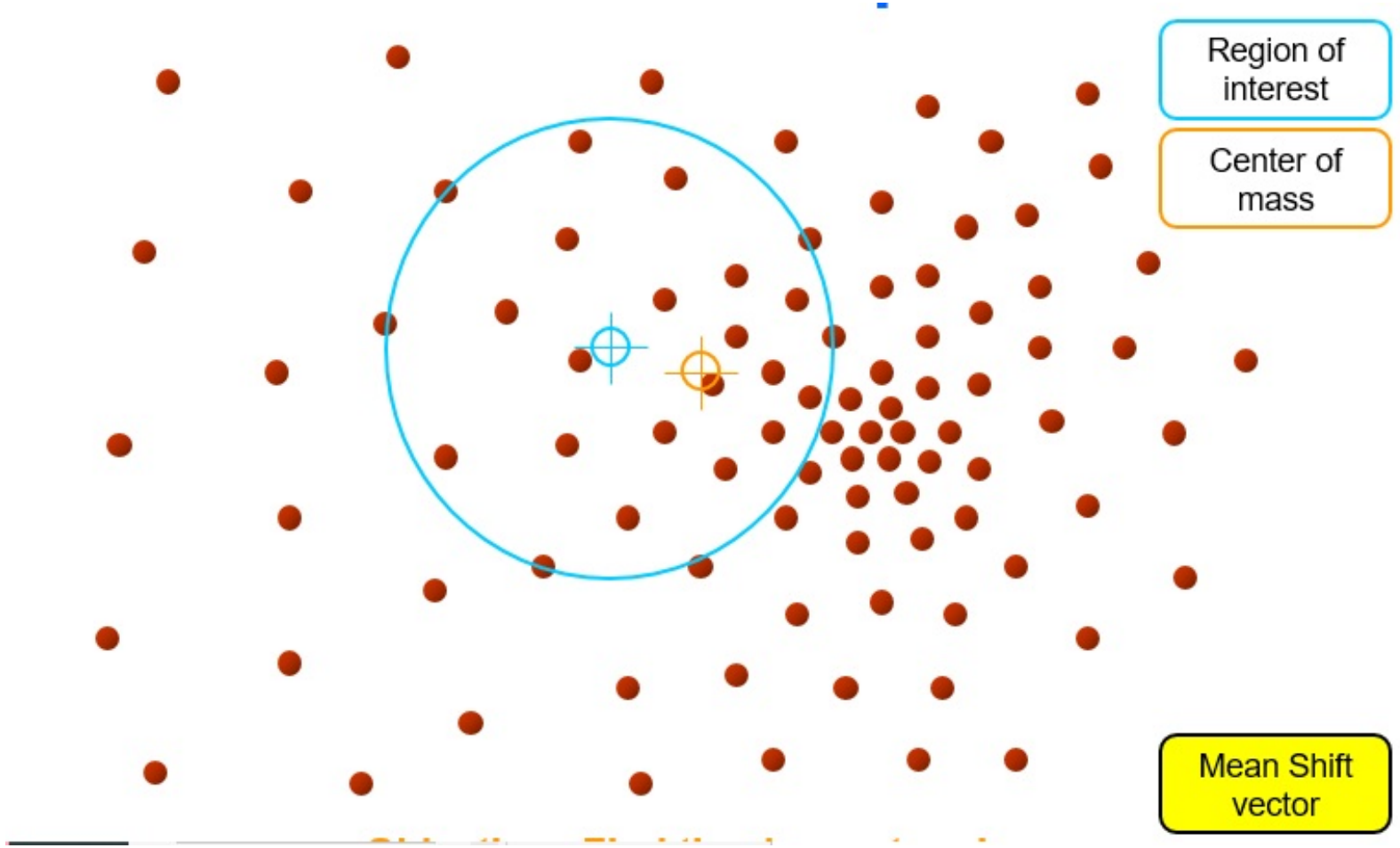
Mean Shift Segmentation

A non-parametric technique for analyzing complex multimodal feature spaces and estimating the stationary points (modes) of the underlying probability density function without explicitly estimating it.

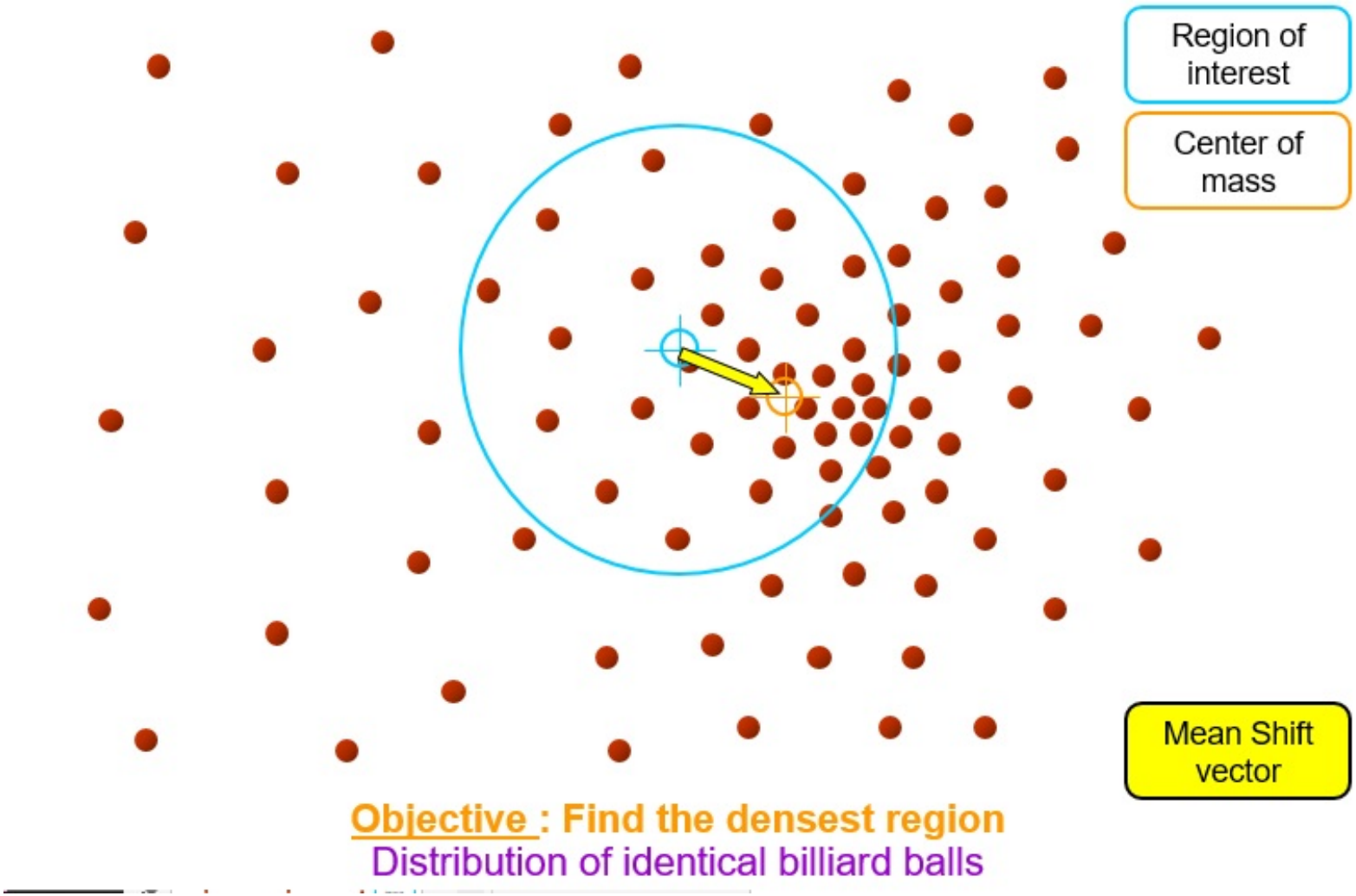
Mean Shift Segmentation - intuition



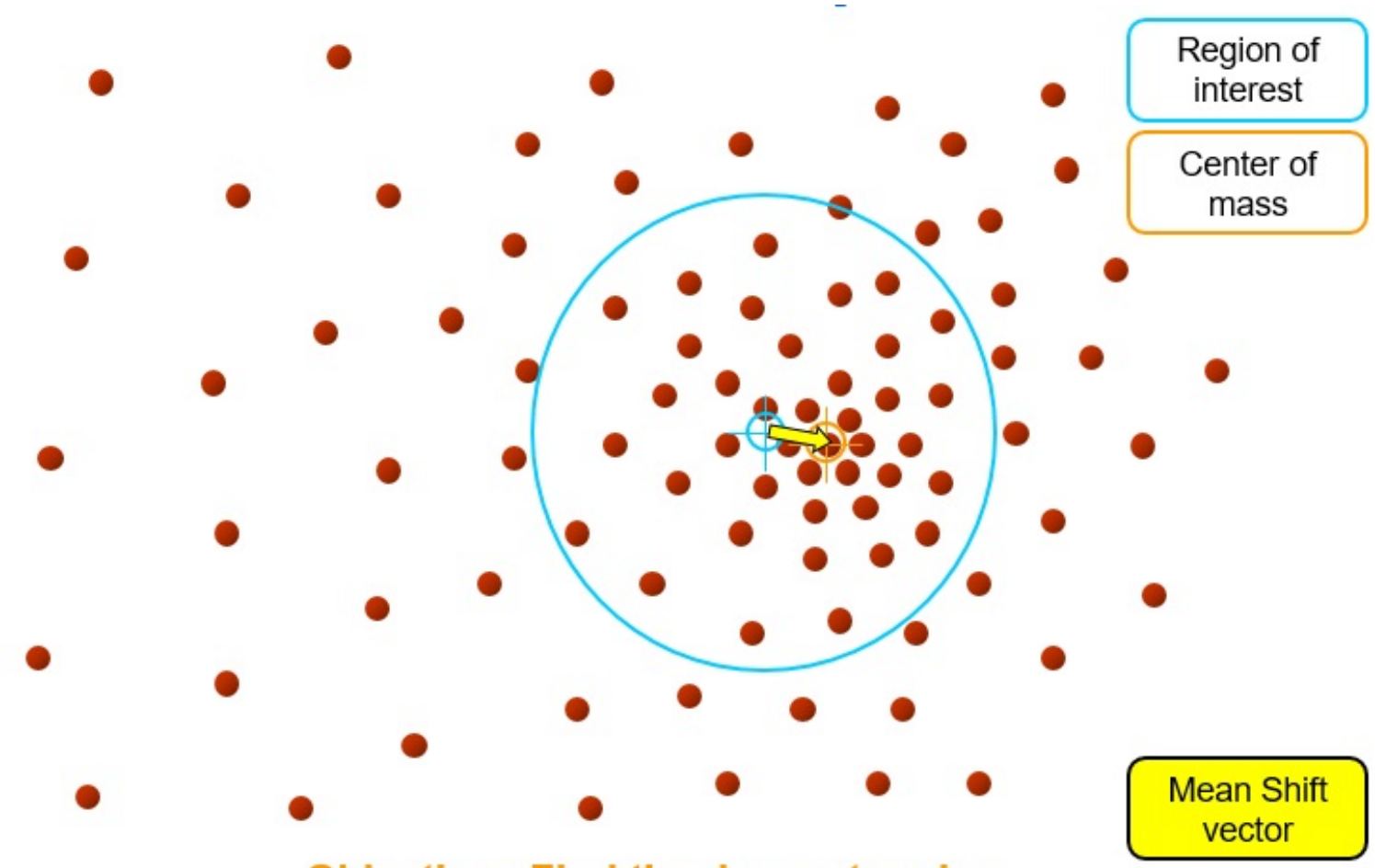
Mean Shift Segmentation - intuition



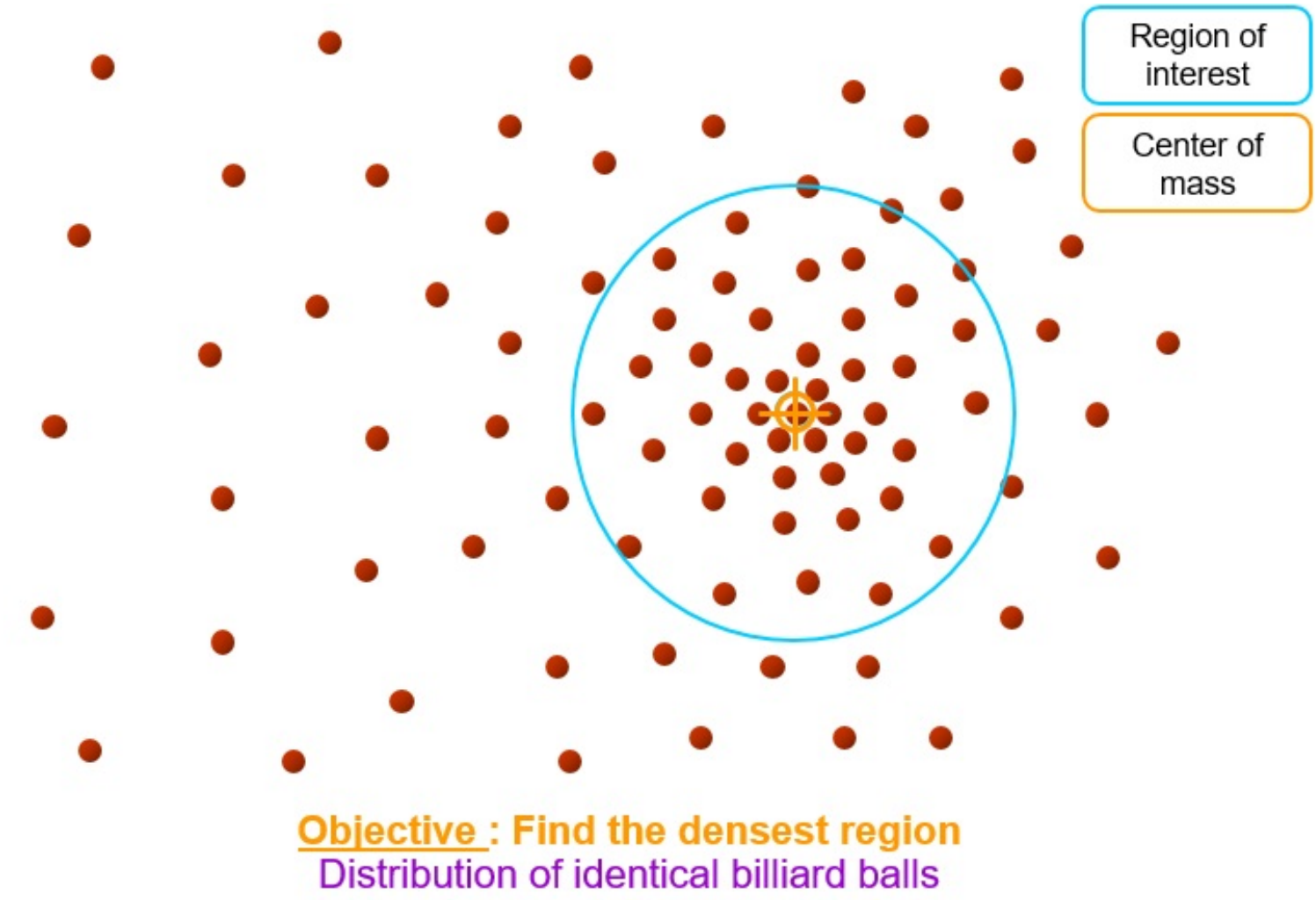
Mean Shift Segmentation - intuition



Mean Shift Segmentation - intuition



Mean Shift Segmentation - intuition



Mean Shift Segmentation - joint spatial and range intuition

- Different images can have same histograms
- Imagine a picture with 2/3 region white and 1/3 region black. There are many configurations possible - (2/3 W, 1/3 B) , (1/3 W, 1/3 B, 1/3 W) etc
- Our target is to label every region that is distinct from it's neighbors spatially

Mean-shift discontinuity preserving filter

Simplest way to implement this is to have a kernel that assigns weight of 1 to all the pixels that fall within the threshold. Follow the steps below to get a basic understanding of how it works (80% of credit if you can implement this successfully as this involves successful implementation of mean shift)

- Re-arrange the image into a feature vector matrix F containing both spatial and range information - 200x200x3 image becomes 40000x5, with two columns that represent pixel location
- The first row of this new feature vector matrix F looks like [240, 120, 100, 1, 1]

First iteration

Set a single threshold h for this spatial-range feature matrix and convergence criterion value *iter*

- Pick a random row from F as initial seed point which is current mean
- compute the eucledian distance of all the points in F with current mean
- store the indexes of all the points that are within threshold h
- Average out each column of these select points and find the new mean
- check if the mean shift value is below *iter*. If yes, mark all these pixels in the original image with the mean intensity value. If no, repeat this iteration all over again

Important points

- After the first convergence, you will eliminate indexes of all the points that are already marked
- you pick a random seed point from reduced search space
- This process continues till you exhaust all the points
- This method may yield regions with just a single pixel!

Results

(a) original

(b) h = 30

(c) h = 60

(d) h = 90

Figure: Mean shift segmentation results

Mean Shift Segmentation - full credit

- We have used uniform weighted kernel earlier. Try to use the kernels mentioned in textbook (normal or epanechnikov)
- You will use two thresholds h_s and h_r with the kernels and apply the meanshift edge preserving filter and store all the converged mean points
- Show segmentation boundaries over original image