

CSE473/573 Final Project - Mean Shift and Hough Circles

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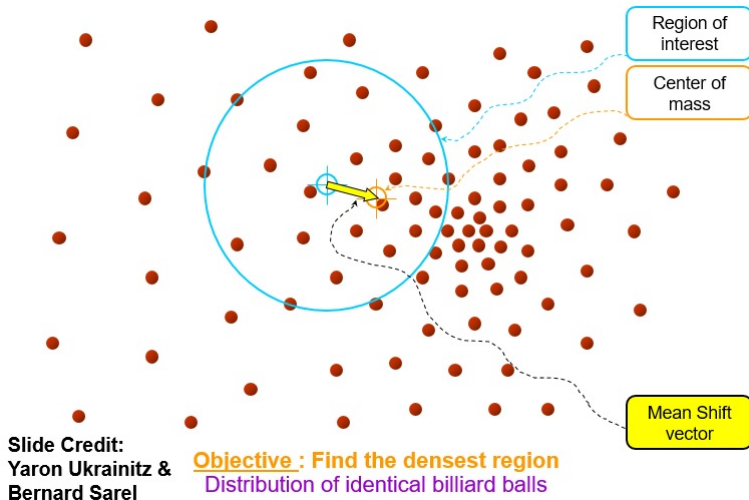
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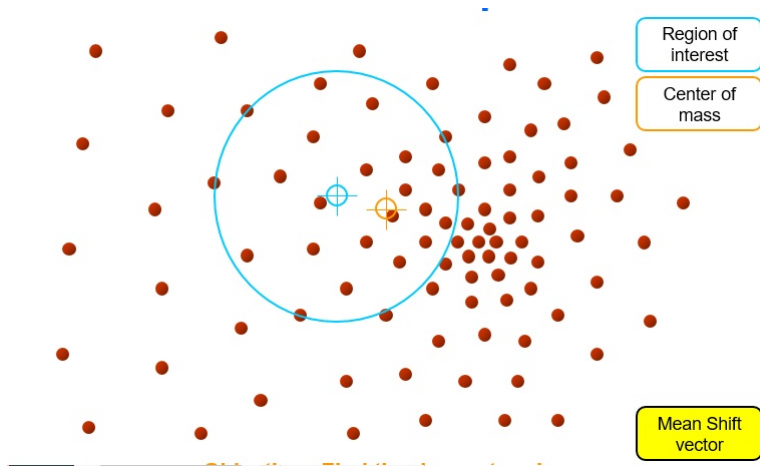
Mean Shift Segmentation

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.

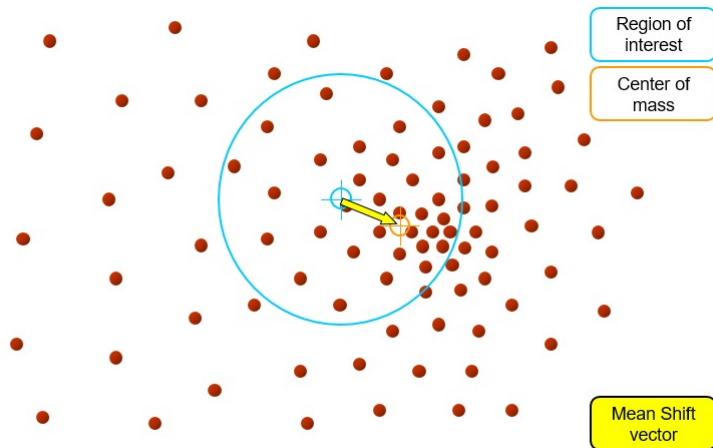
Mean Shift Segmentation - intuition



Mean Shift Segmentation - intuition

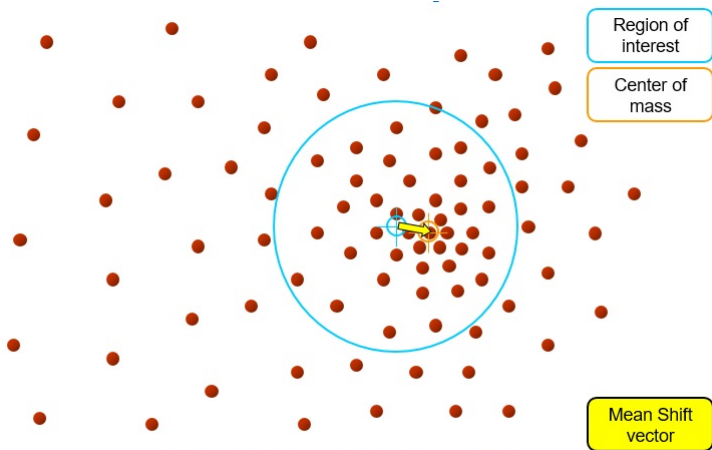


Mean Shift Segmentation - intuition



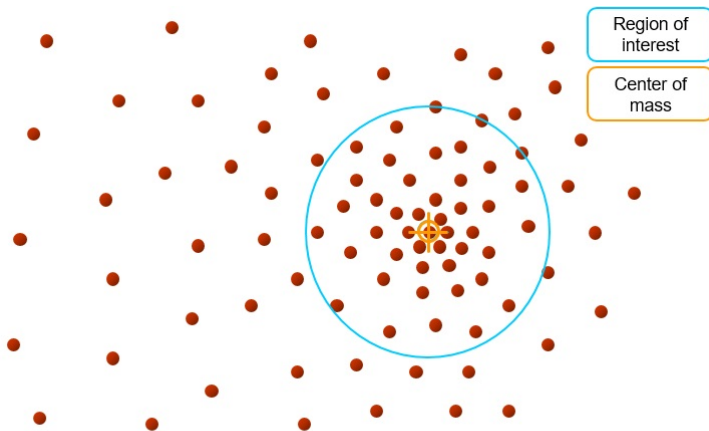
Objective : Find the densest region
Distribution of identical billiard balls

Mean Shift Segmentation - intuition



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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 - $(2/3 \text{ W}, 1/3 \text{ B})$, $(1/3 \text{ W}, 1/3 \text{ B}, 1/3 \text{ W})$ 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 - $200 \times 200 \times 3$ image becomes 40000×5 , 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 euclidian 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

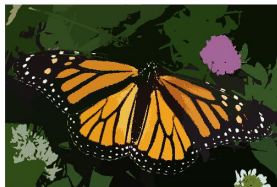
Important points

- 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

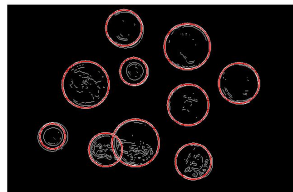
- We have used uniform weighted kernel earlier. Try to use the kernels mentioned in textbook (normal or epanechnikov)
- You will use two thresholds h_s and h_r with the kernels and apply the meanshift edge preserving filter and store all the converged mean points
- Show segmentation boundaries over original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



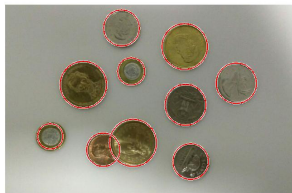
Hough Circles Results



(a) canny edge 1



(b) canny edge 2



(c) final result

Figure: Hough Circle results

- You can use external libraries to perform smoothing and edge detection
- Every aspect of hough circle detector should be written from scratch
- Use external libraries of hough circle detectors as a validation step

- Pick a range of circle radii
- Each edge pixel will correspond to a circle in accumulator array
- circle pixels accumulator array will be incremented by one (voting)
- You should carefully pick the maxima regions in the accumulator array (a region of 3 or more adjacent pixels combined having the largest number of votes)