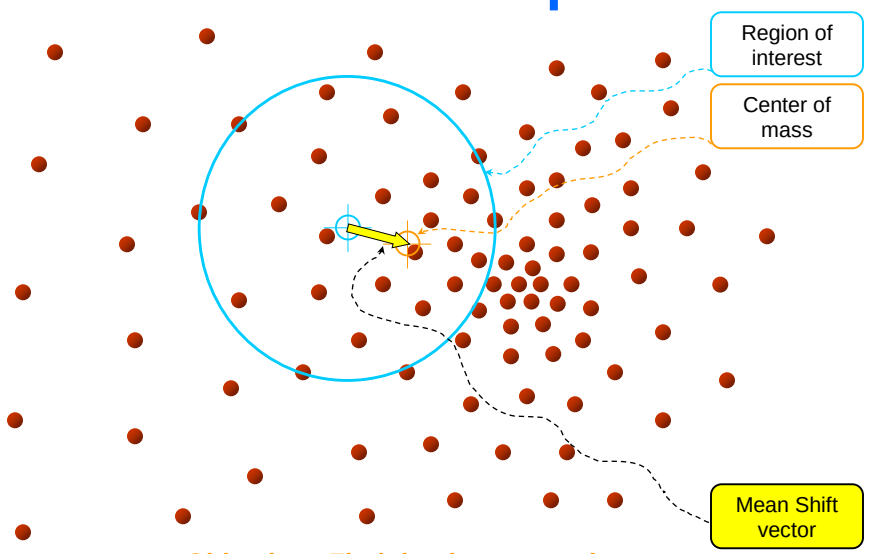
Mean Shift Theory

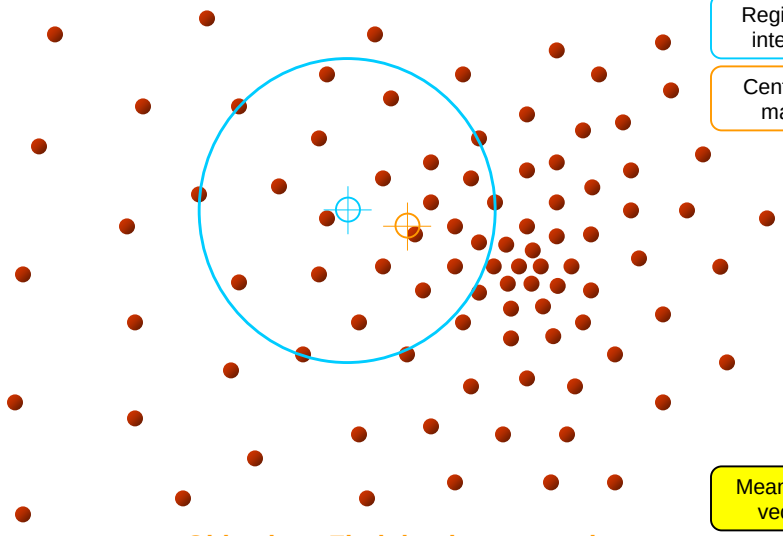
Slides from **Y. Ukrainitz & B. Sarel**

Intuitive Description



Objective : Find the densest region
Distribution of identical billiard balls

Intuitive Description



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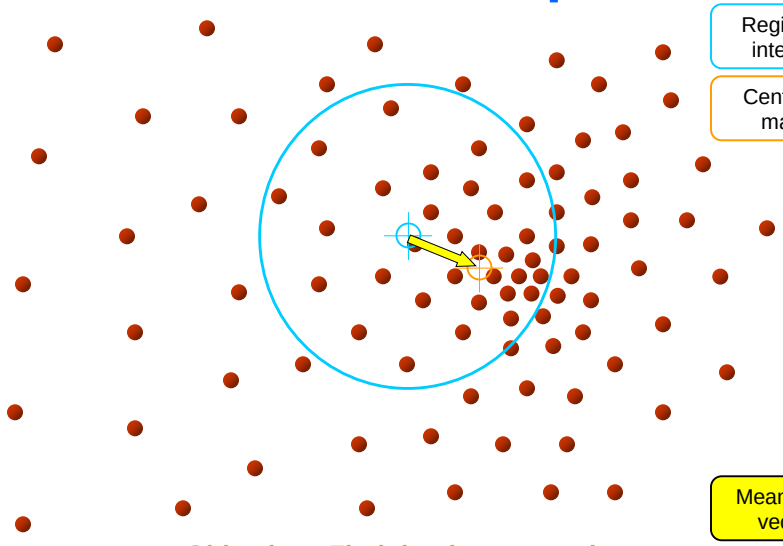

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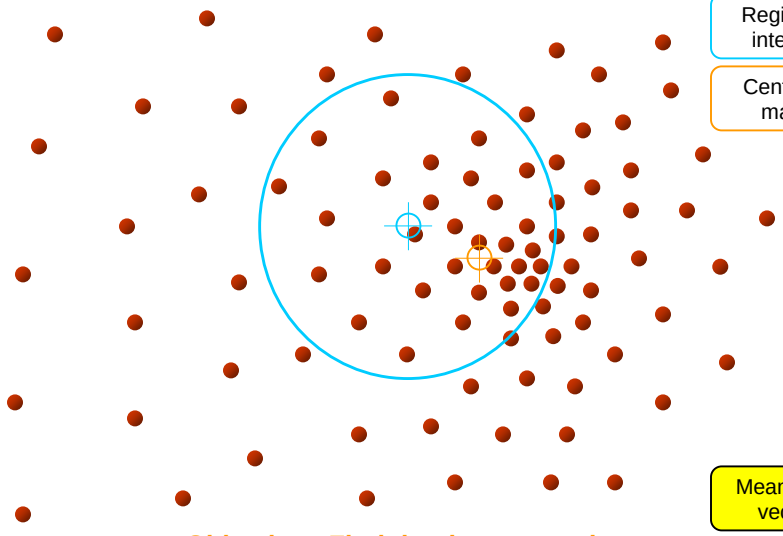

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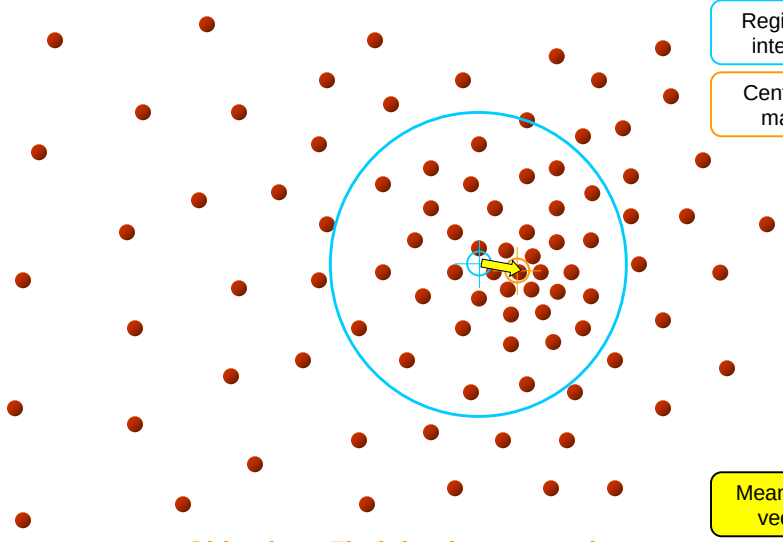

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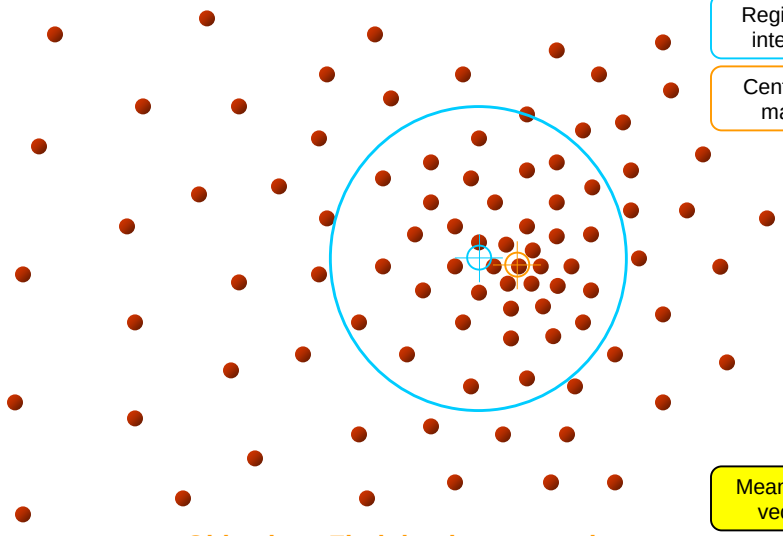

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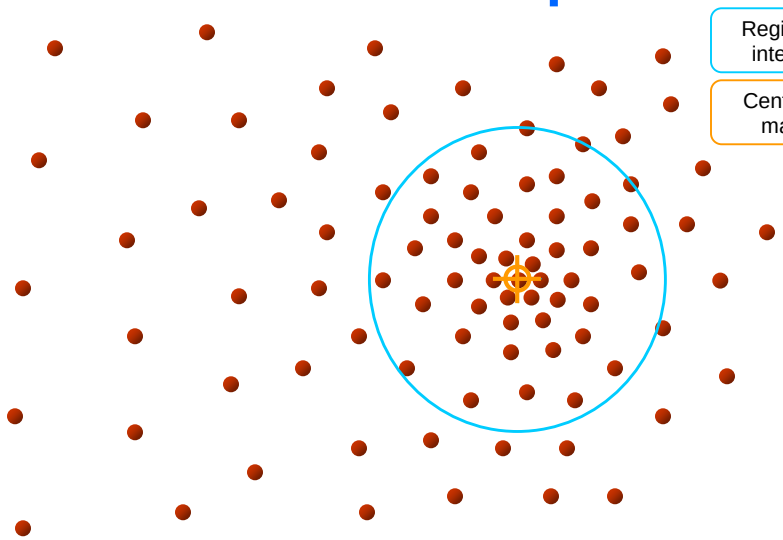

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What is Mean Shift ?

A tool for:
Finding modes in a set of data samples, manifesting an underlying probability density function (PDF) in R^N

PDF in feature space
• Color spac
• Scale spac
Actually an ou can conce
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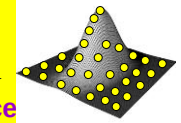
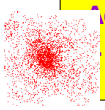
Non-parametric Density Estimation

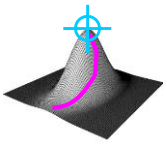


Discrete PDF Representation



Data

Non-parametric Density **GRADIENT** Estimation (Mean Shift)



PDF Analysis

Computing The Mean Shift

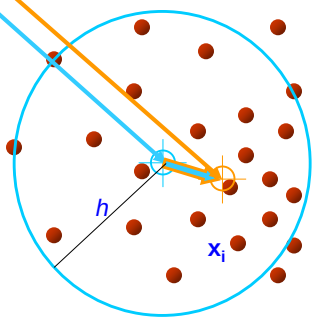
Simple Mean Shift procedure:
• Compute mean shift vector

$$\mathbf{m}(\mathbf{x}) = \left[\frac{\sum_{i=1}^{n} \mathbf{x}_i g\left(\frac{\|\mathbf{x} - \mathbf{x}_i\|^2}{h} \right)}{\sum_{i=1}^{n} g\left(\frac{\|\mathbf{x} - \mathbf{x}_i\|^2}{h} \right)} - \mathbf{x} \right]$$

•Translate the Kernel window by **m(x)**

If the weights $g(||x - x_i||^2/h)$ are equal to 1 for $||x - x_i|| < h$ (i.e. if the kernel is uniform) then:

$$\mathbf{m(x)} = \frac{1}{n} \sum_{i=1}^{n} \mathbf{x}_i - \mathbf{x}$$

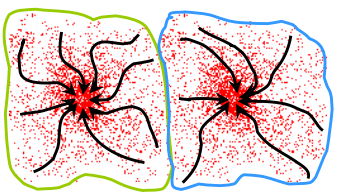


Mean Shift Applications

Clustering

Cluster : All data points in the ***attraction basin*** of a mode

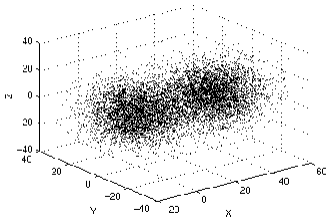
Attraction basin : the region for which all trajectories lead to the same mode



Mean Shift : A robust Approach Toward Feature Space Analysis, by Comaniciu, Meer

Clustering

Synthetic Examples

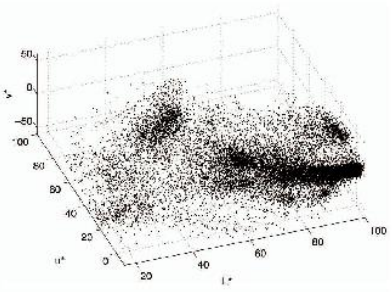


Simple Modal Structures

Complex Modal Structures

Clustering

Real Example

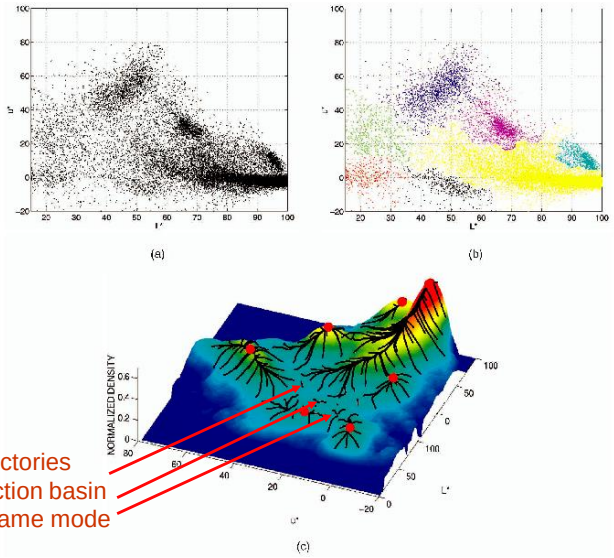


L*u*v space representation

Clustering

Real Example

2D (L*u) space representation



Final clusters

Not all trajectories in the attraction basin reach the same mode