

اصول پردازش تصویر

Principles of Image Processing

مصطفی کمالی تبریزی

۱۲ آبان ۱۳۹۹

جلسه سیزدهم

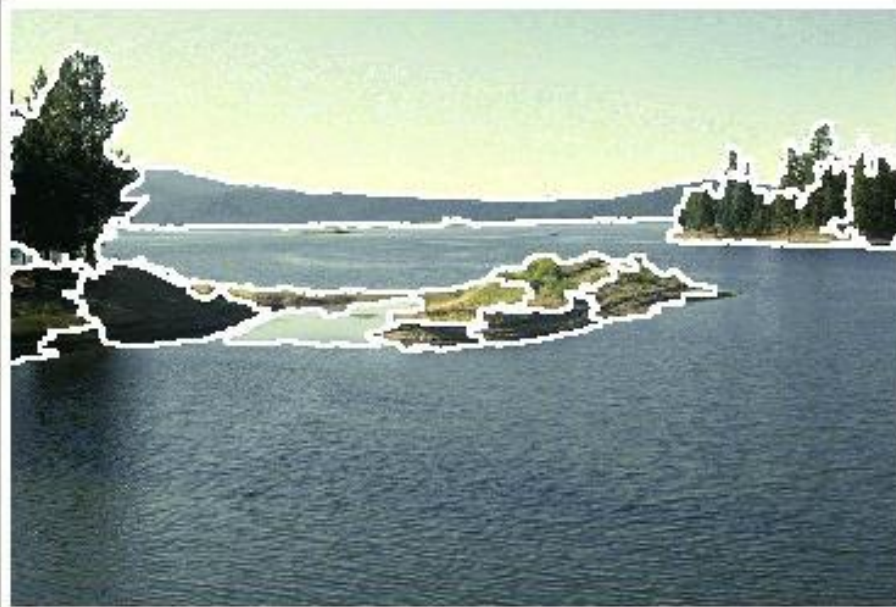
Mean-Shift

D. Comaniciu and P. Meer, [Mean Shift: A Robust Approach toward Feature Space Analysis](#), PAMI 2002.

Mean-Shift

- An advanced and versatile technique for clustering-based segmentation

Segmented "landscape 1"



Segmented "landscape 2"



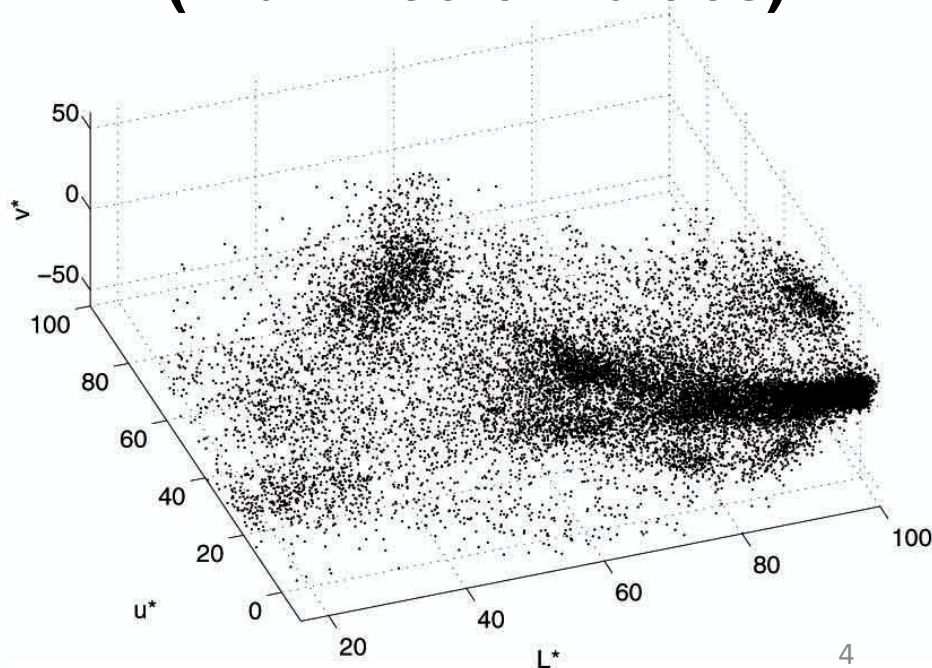
Mean-Shift Algorithm

- The mean-shift algorithm seeks *modes* or *local maxima* of density in the feature space

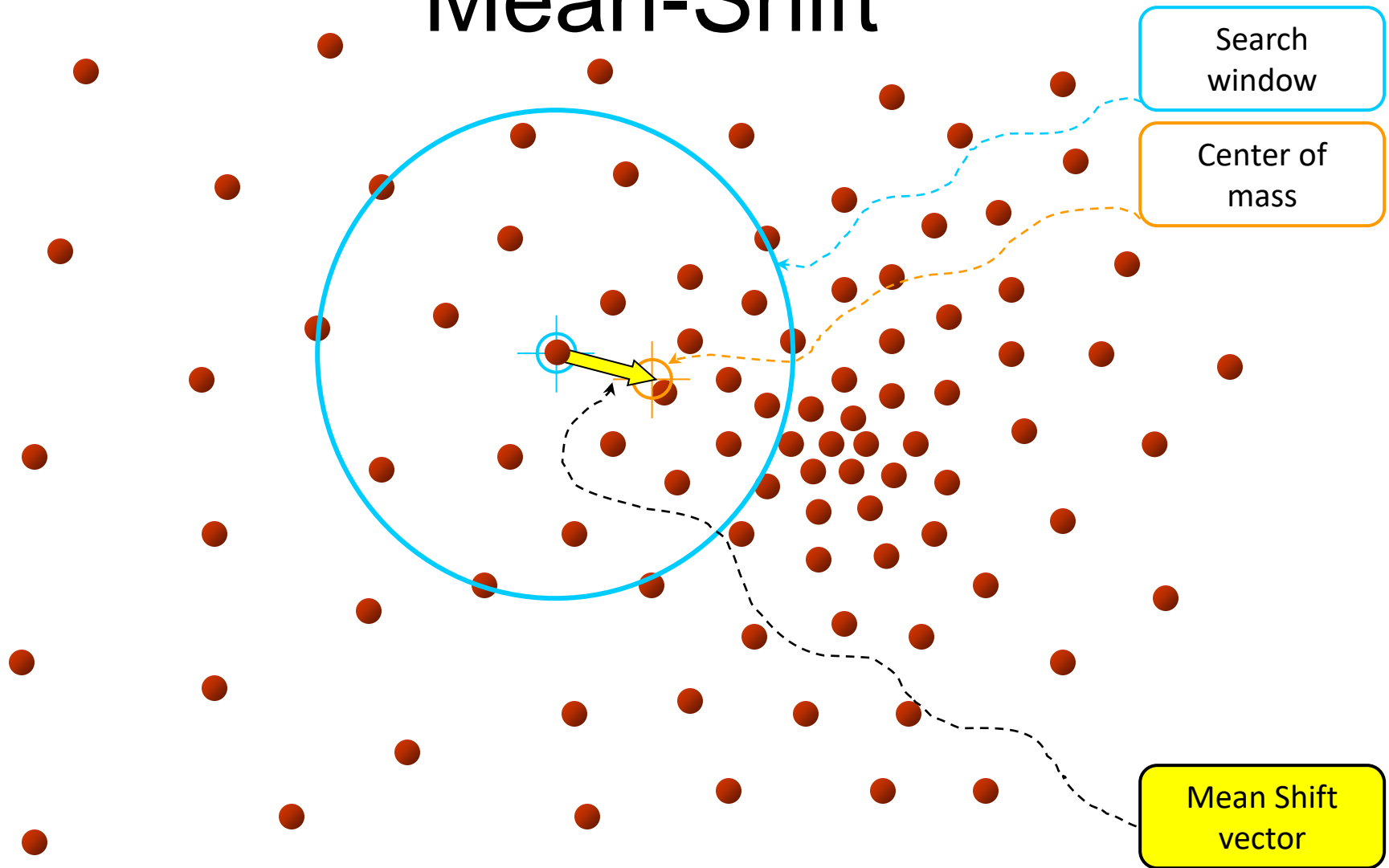
image



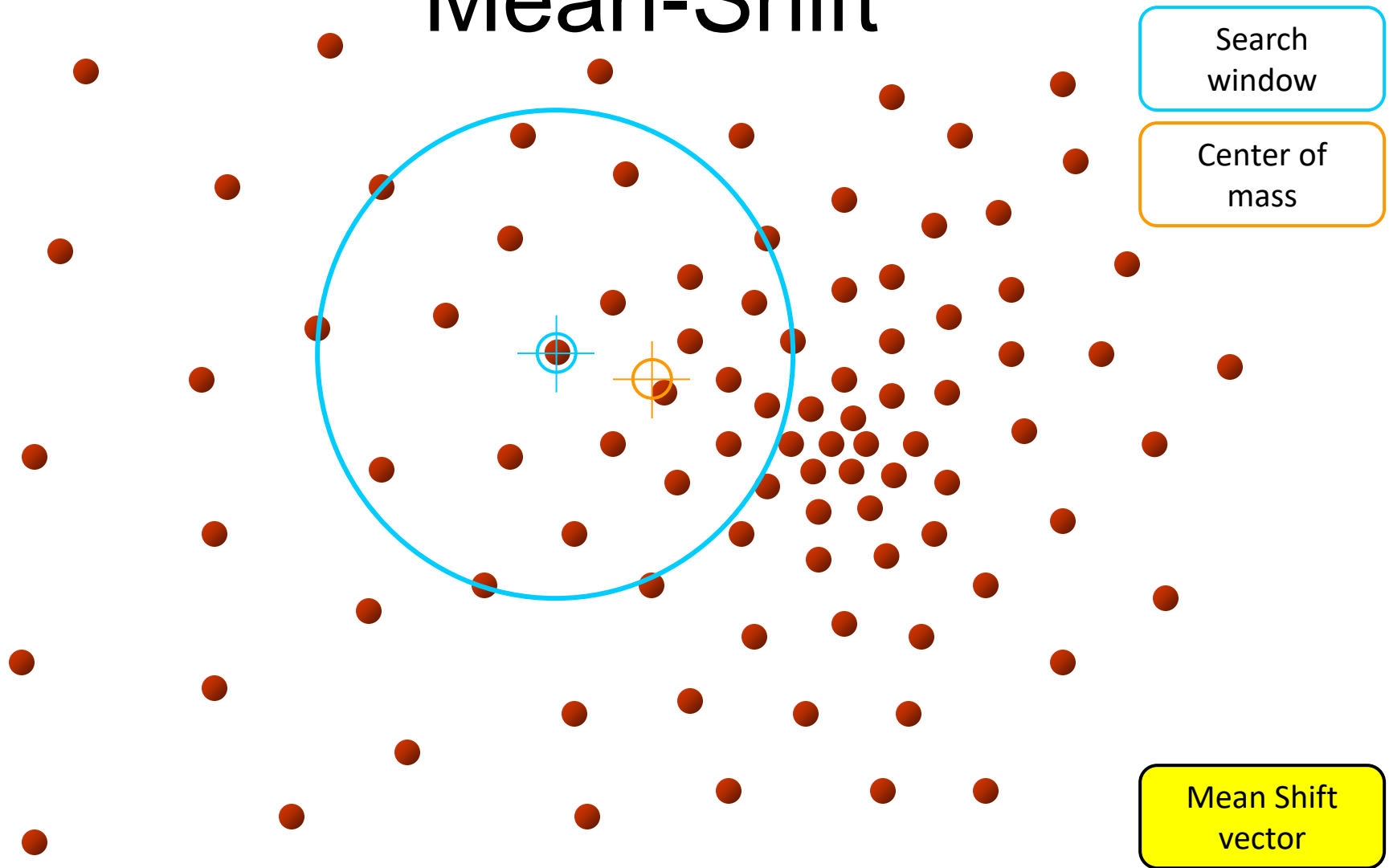
Feature space
($L^*u^*v^*$ color values)



Mean-Shift



Mean-Shift

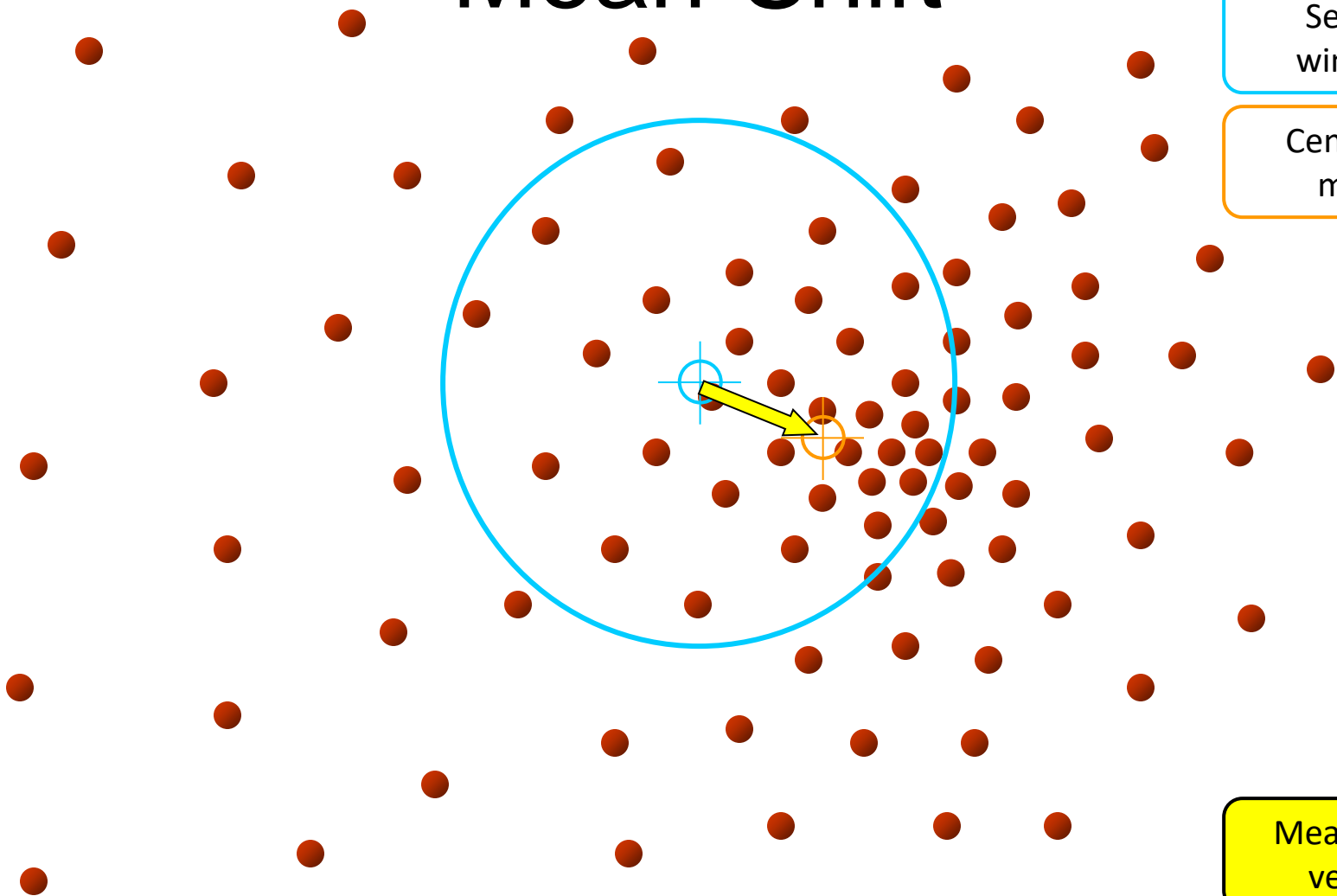


Mean-Shift

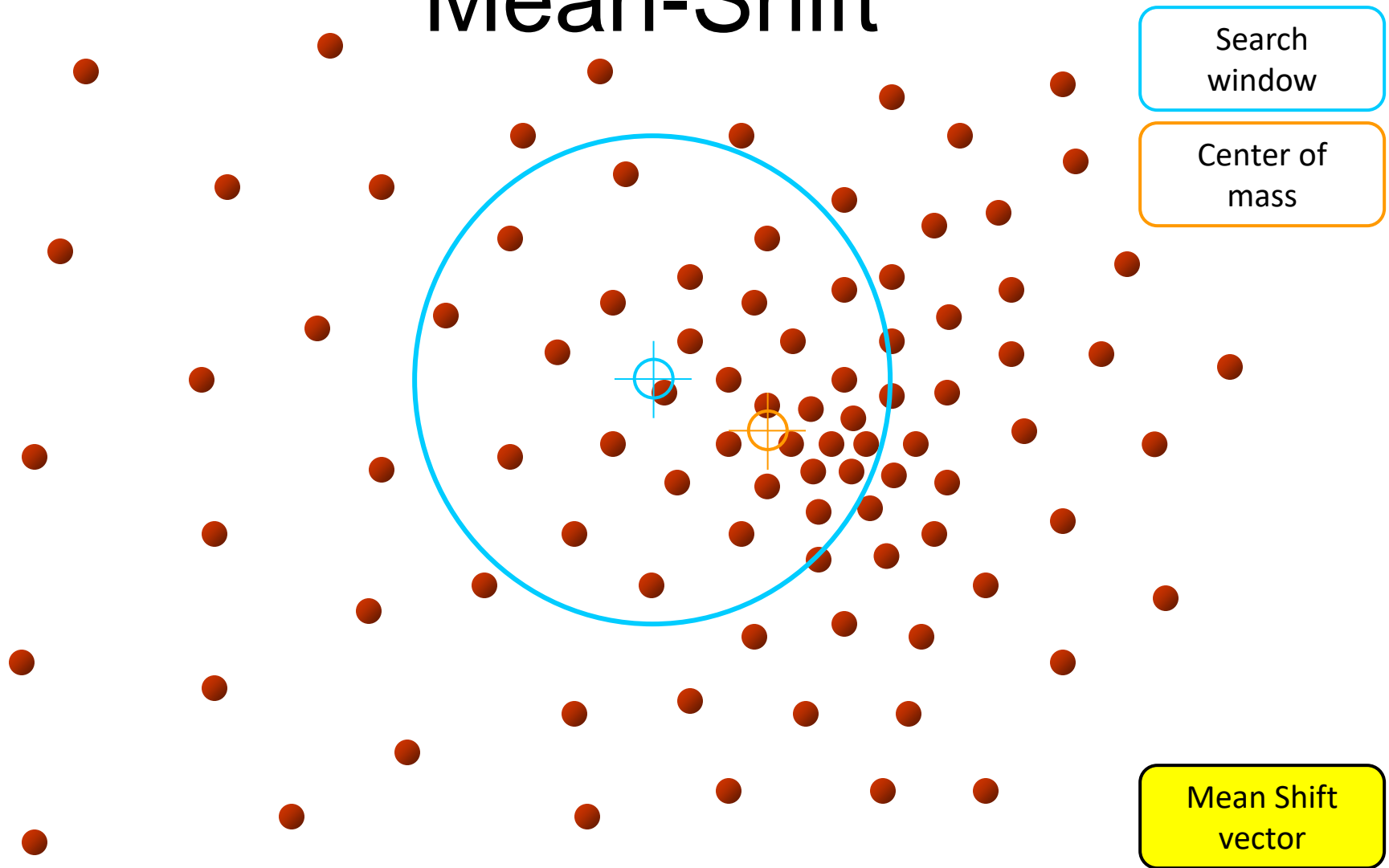
Search
window

Center of
mass

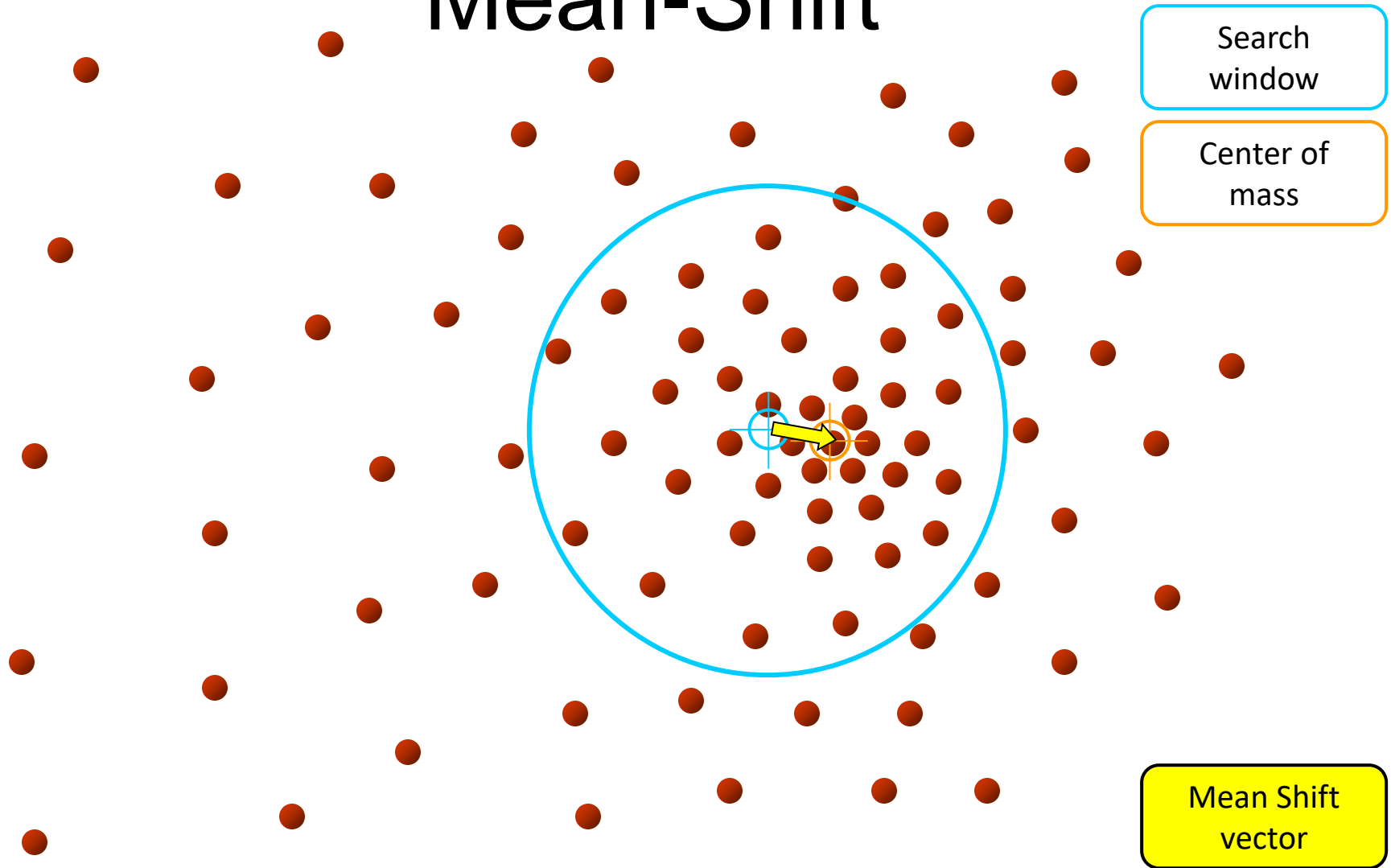
Mean Shift
vector



Mean-Shift



Mean-Shift

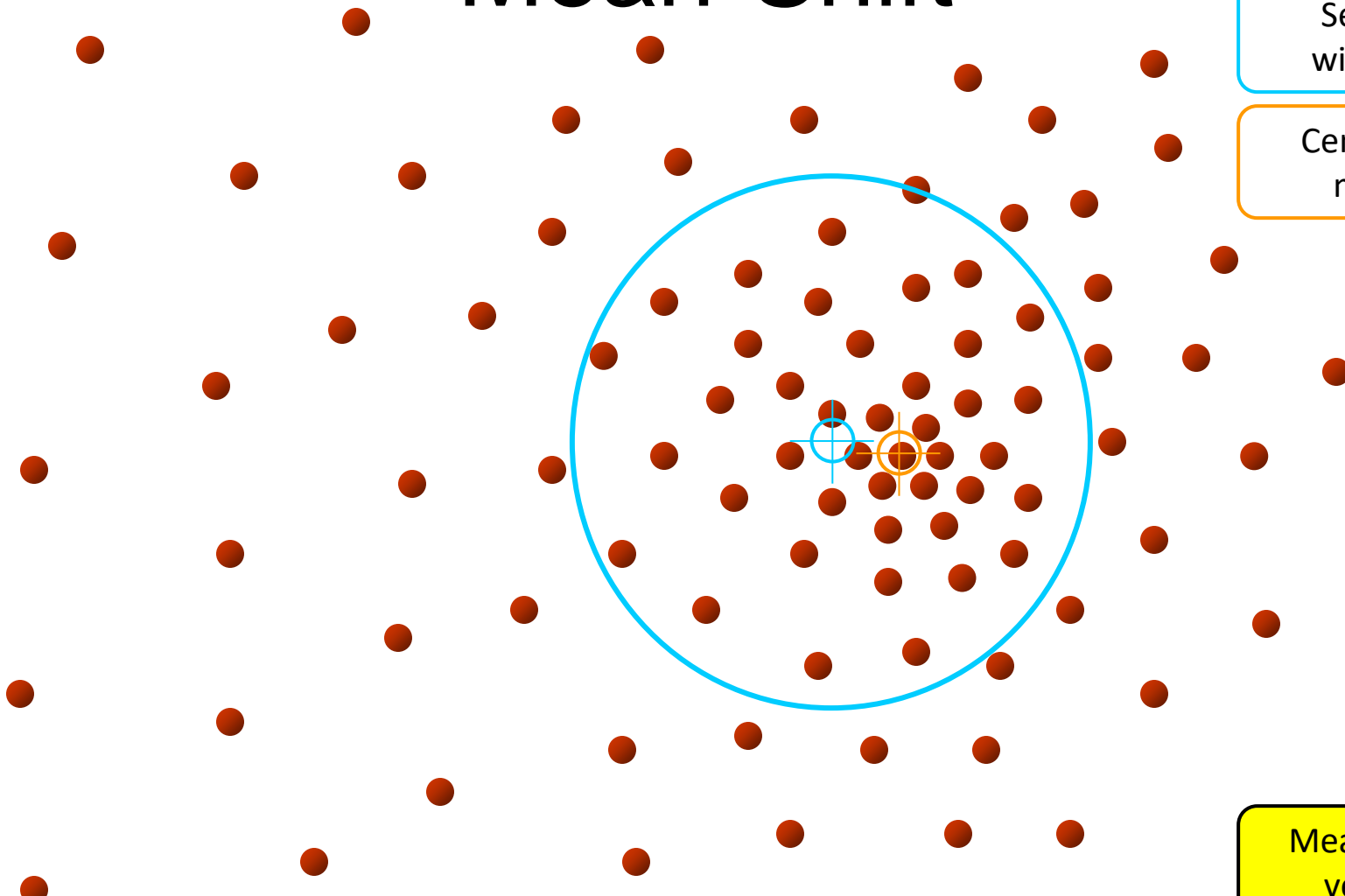


Mean-Shift

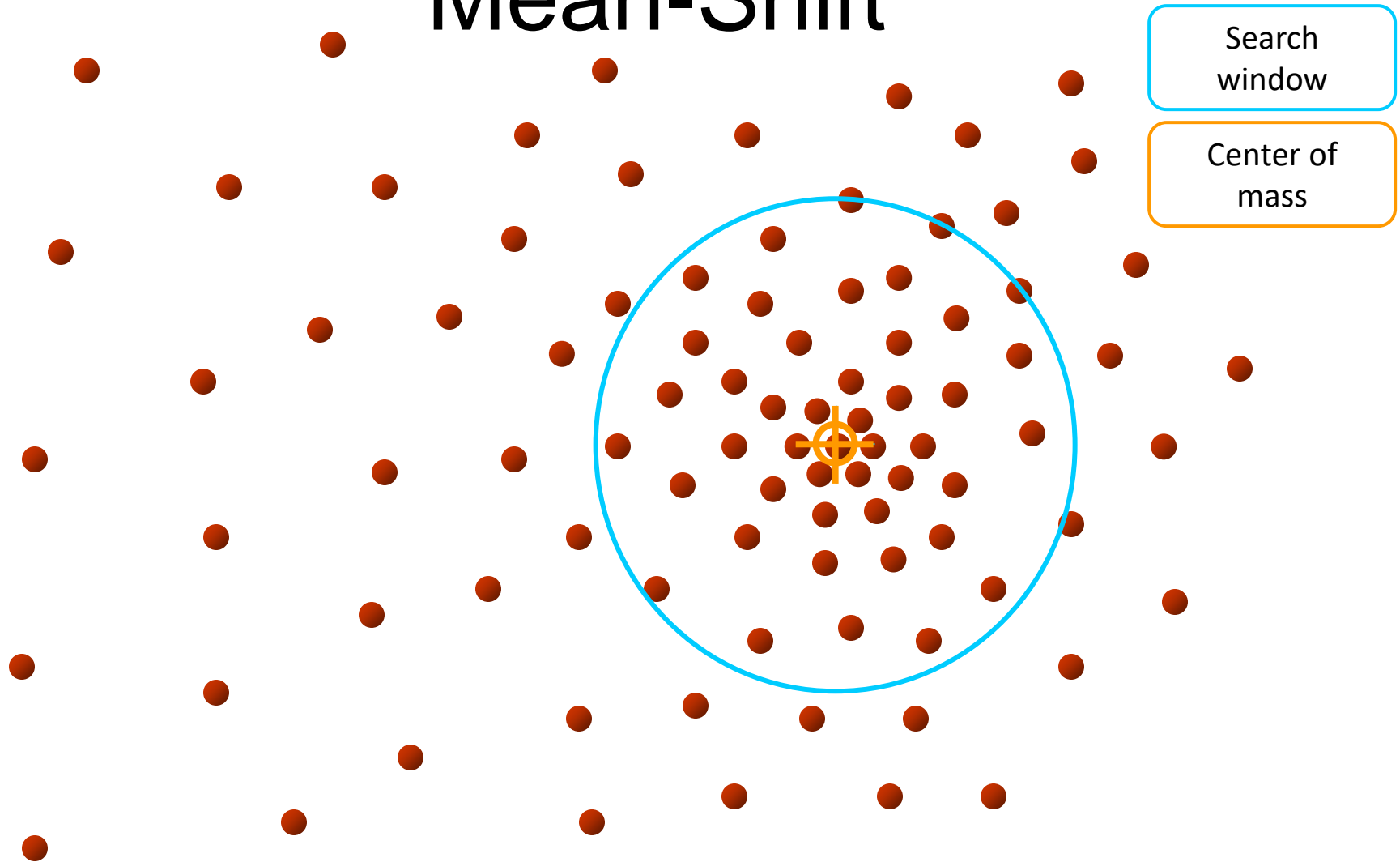
Search
window

Center of
mass

Mean Shift
vector

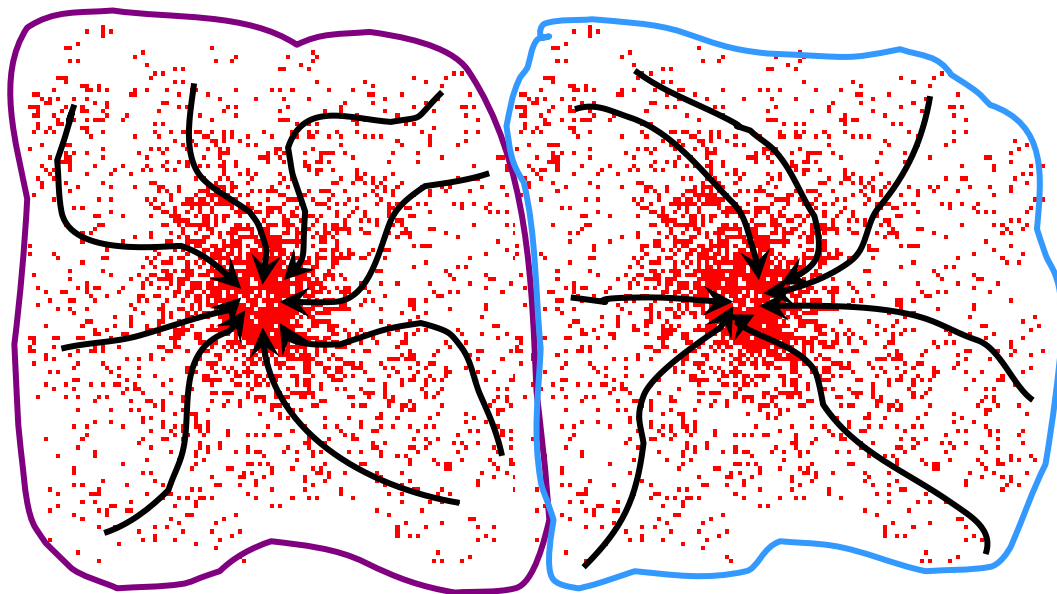


Mean-Shift



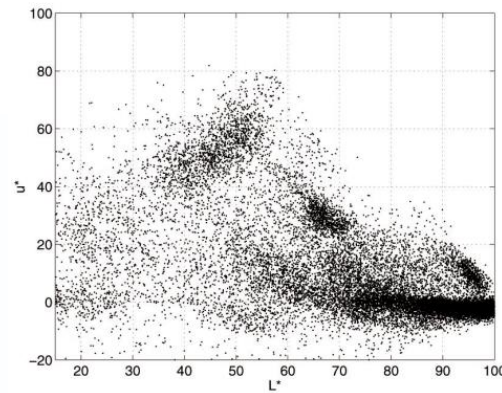
Mean-Shift Clustering

- Cluster: all data points in the attraction basin of a mode
- Attraction basin: the region for which all trajectories lead to the same mode

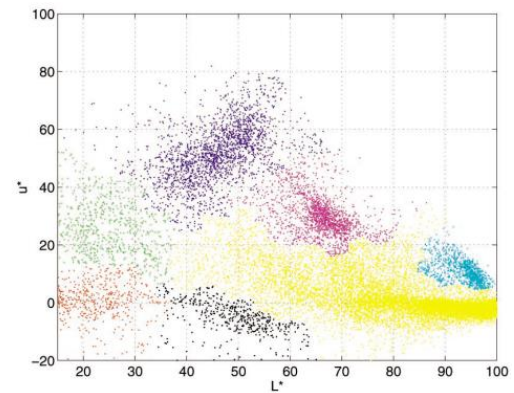


Mean-Shift Clustering/Segmentation

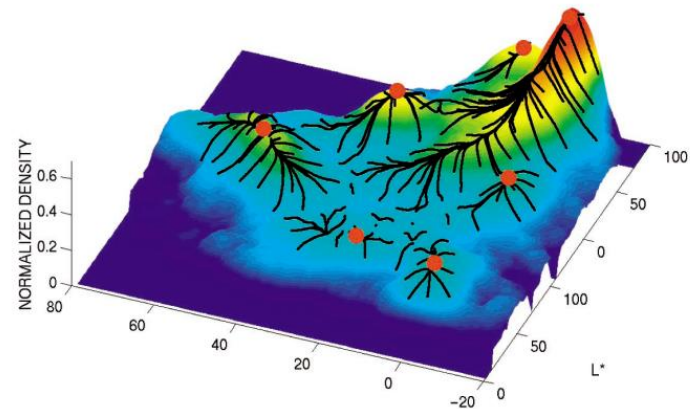
- Find features (color, gradients, texture, etc)
- Initialize windows at individual feature points
- Perform mean-shift for each window until convergence
- Merge windows that end up near the same “peak” or mode



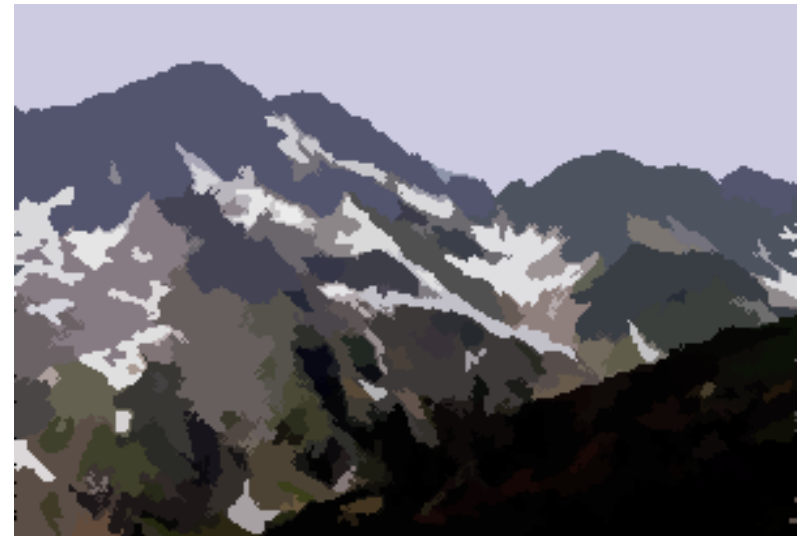
(a)



(b)



Mean-Shift Segmentation Results



More Results



More Results



Mean-Shift Pros and Cons

- Pros
 - Does not assume spherical clusters
 - Just a single parameter (window size)
 - Finds variable number of modes
 - Robust to outliers
- Cons
 - Output depends on window size
 - Computationally expensive
 - Does not scale well with dimension of feature space

References

- Mean-Shift

Paper: “Mean Shift: A Robust Approach toward Feature Space Analysis”, D. Comaniciu and P. Meer, PAMI 2002

Texture Based Segmentation

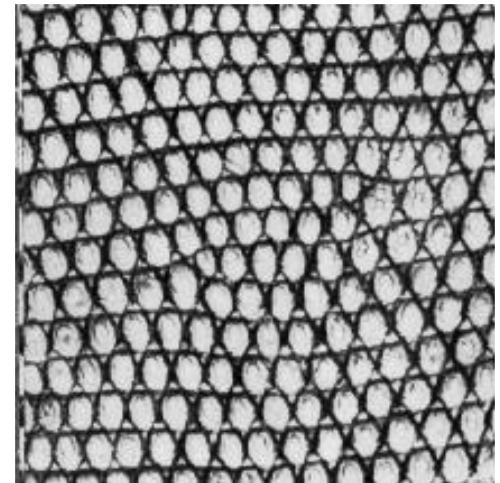
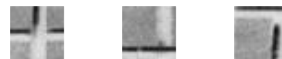
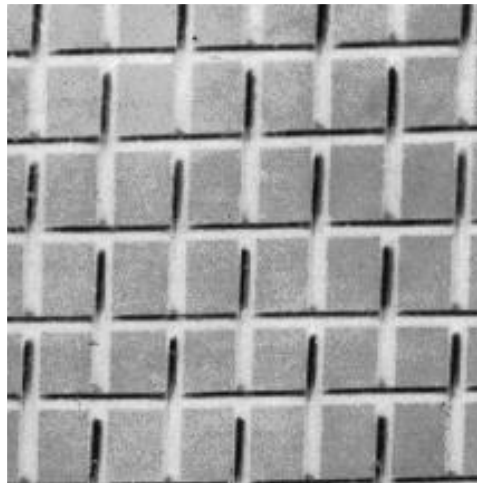
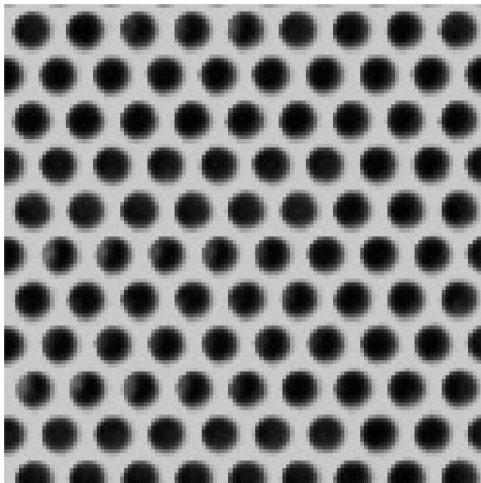
Jitendra Malik, Serge Belongie, Thomas Leung, and Jianbo Shi

Contour and Texture Analysis for Image Segmentation

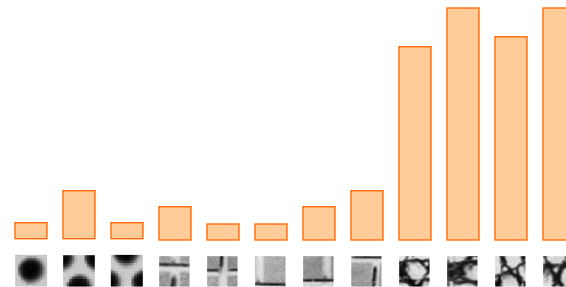
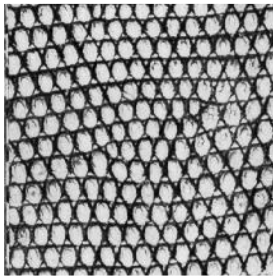
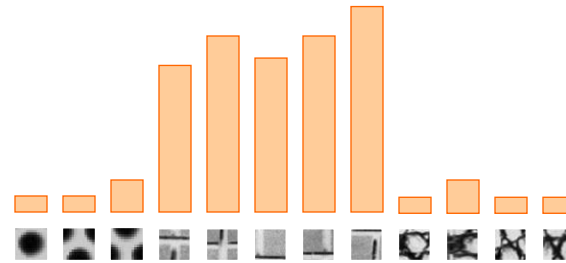
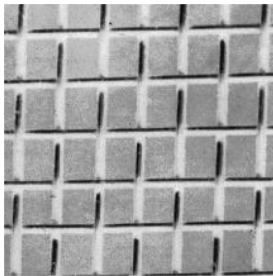
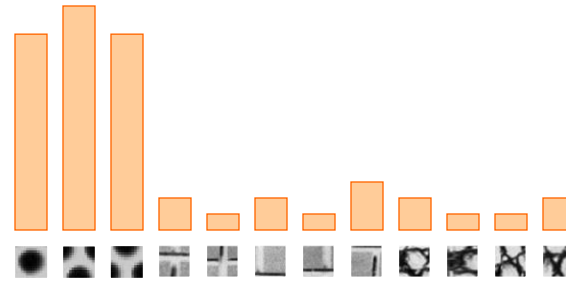
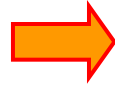
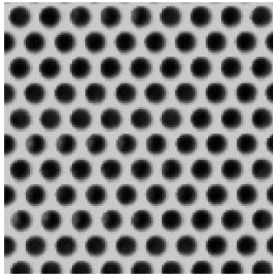
International Journal of Computer Vision (IJCV), 2001

Texture Recognition

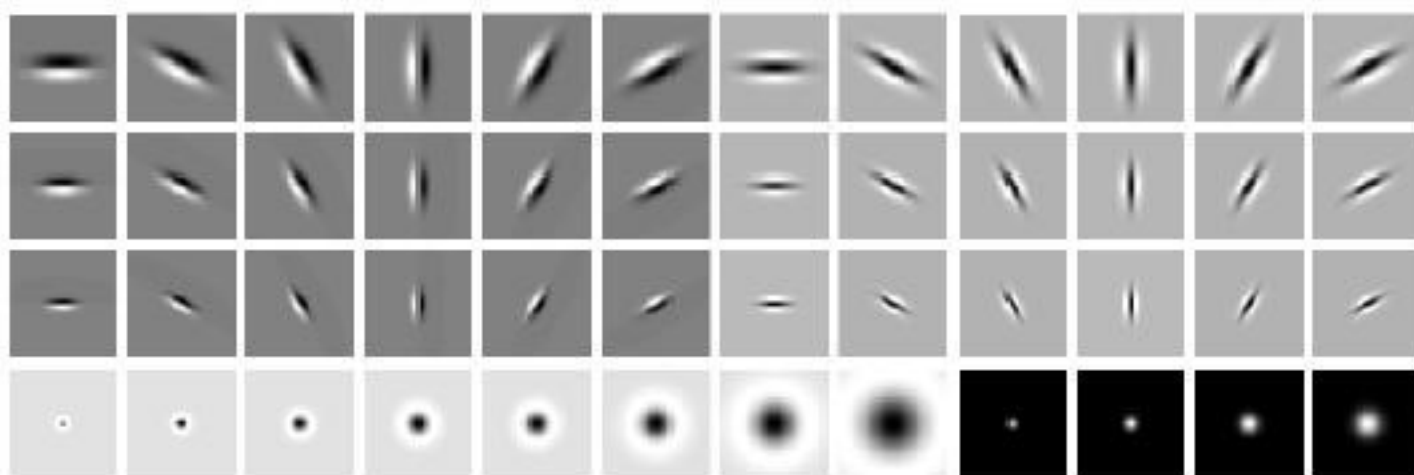
- Texture is characterized by the repetition of basic elements or *textons*
- For stochastic textures, it is the identity of the textons, not their spatial arrangement, that matters



Texture Recognition



Leung-Malik (LM) Filter Bank



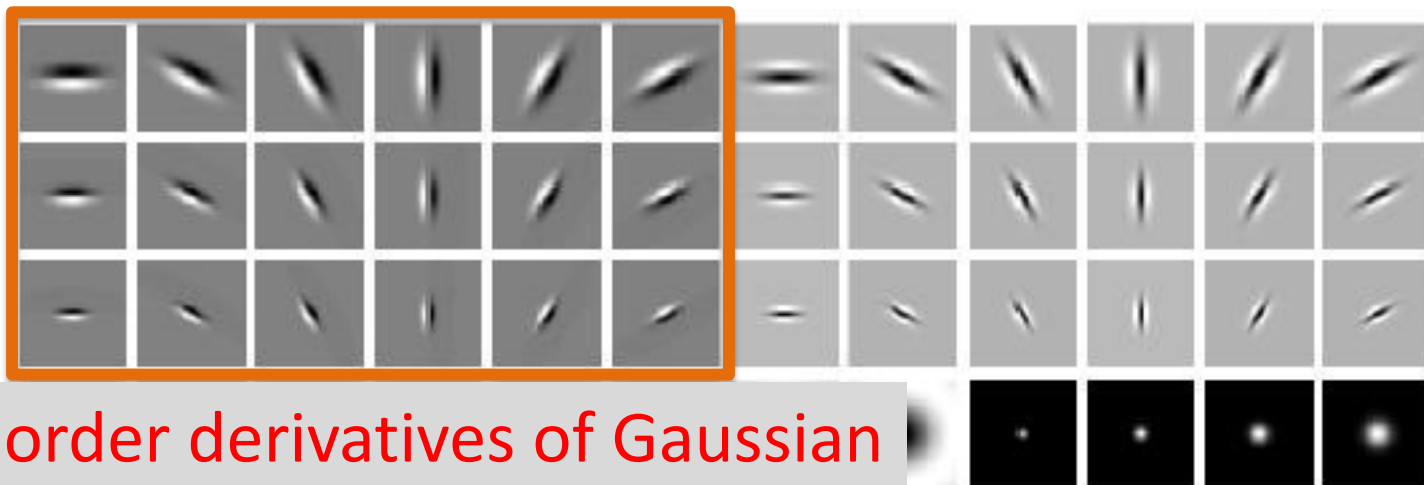
- What filters to put in the bank?
 - Typically we want a combination of scales and orientations, different types of patterns.

48 filters

MATLAB code available for these examples:

<http://www.robots.ox.ac.uk/~vgg/research/texclass/filters.html>

Leung-Malik (LM) Filter Bank



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Leung-Malik (LM) Filter Bank

Orientations

Scales

First order derivatives of Gaussian

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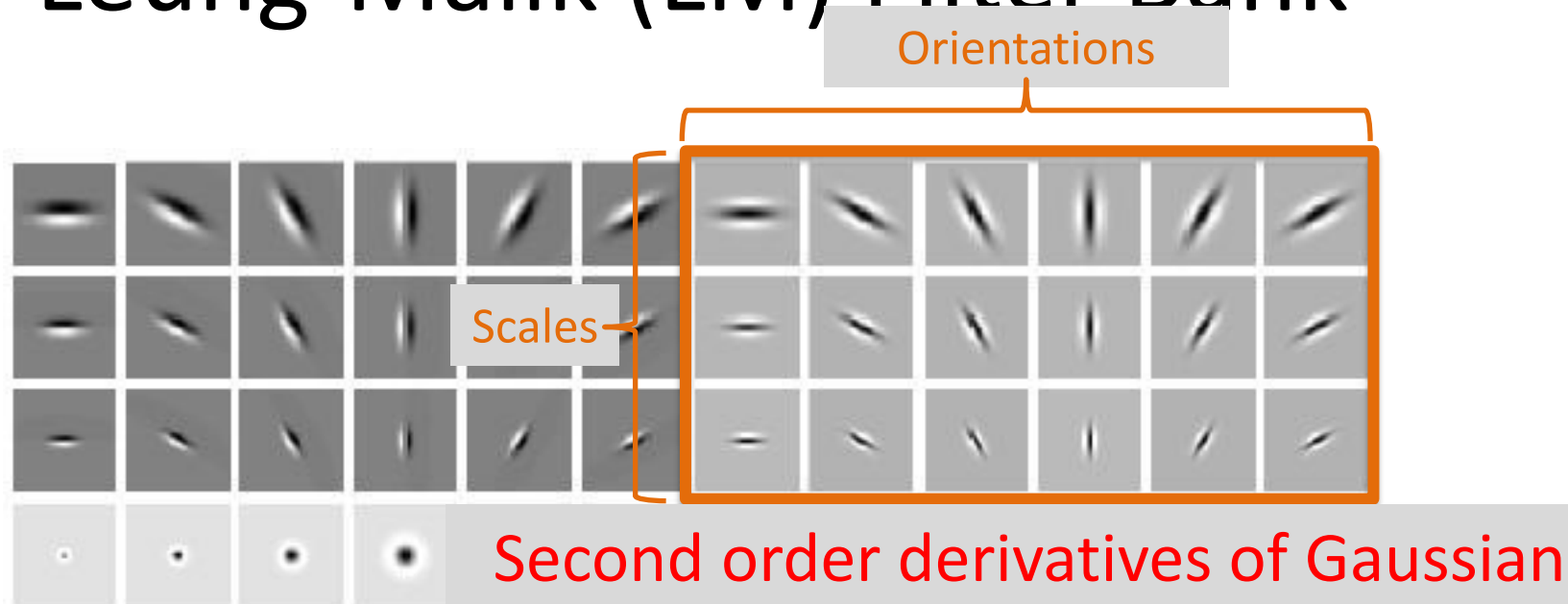
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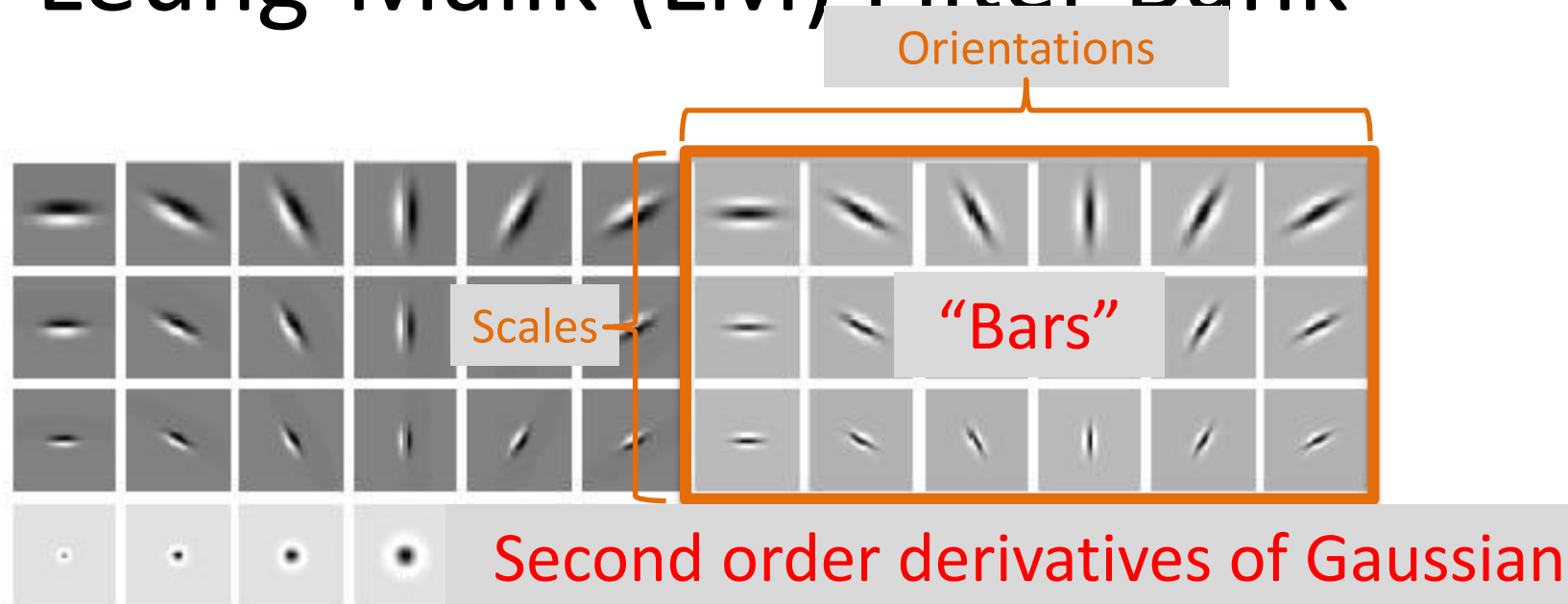
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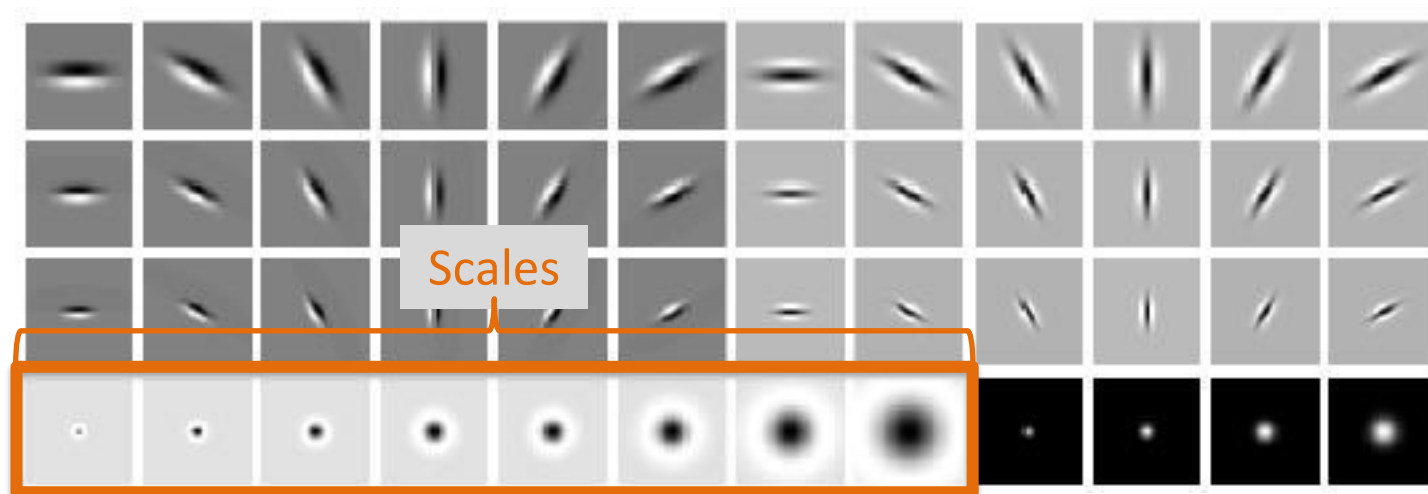
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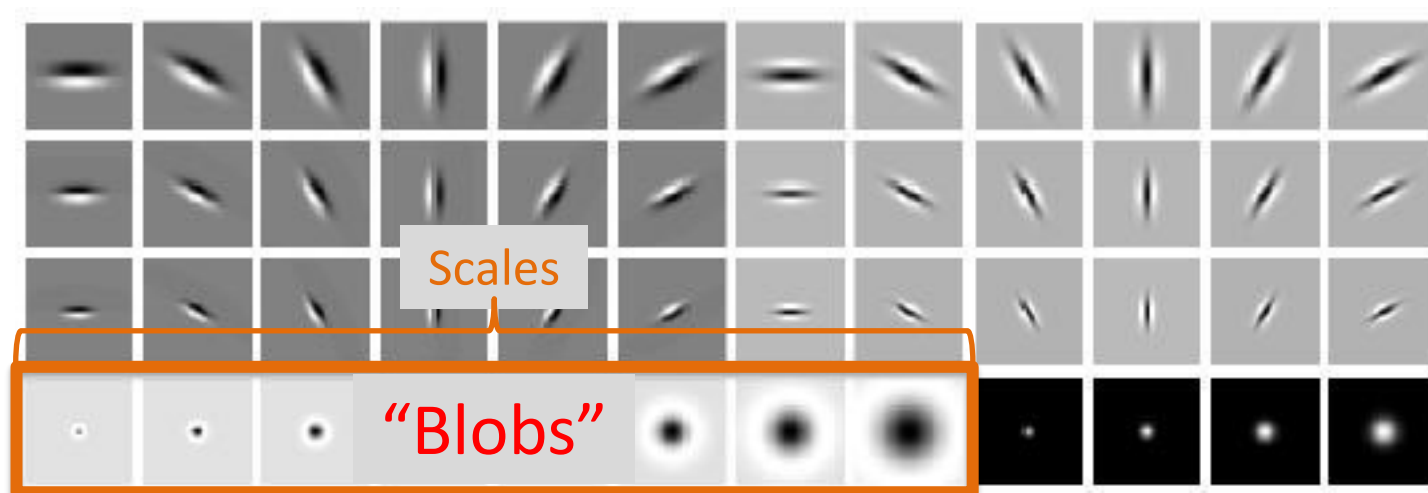
- What **Laplacian of Gaussian** bank?
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48 filters

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Leung-Malik (LM) Filter Bank



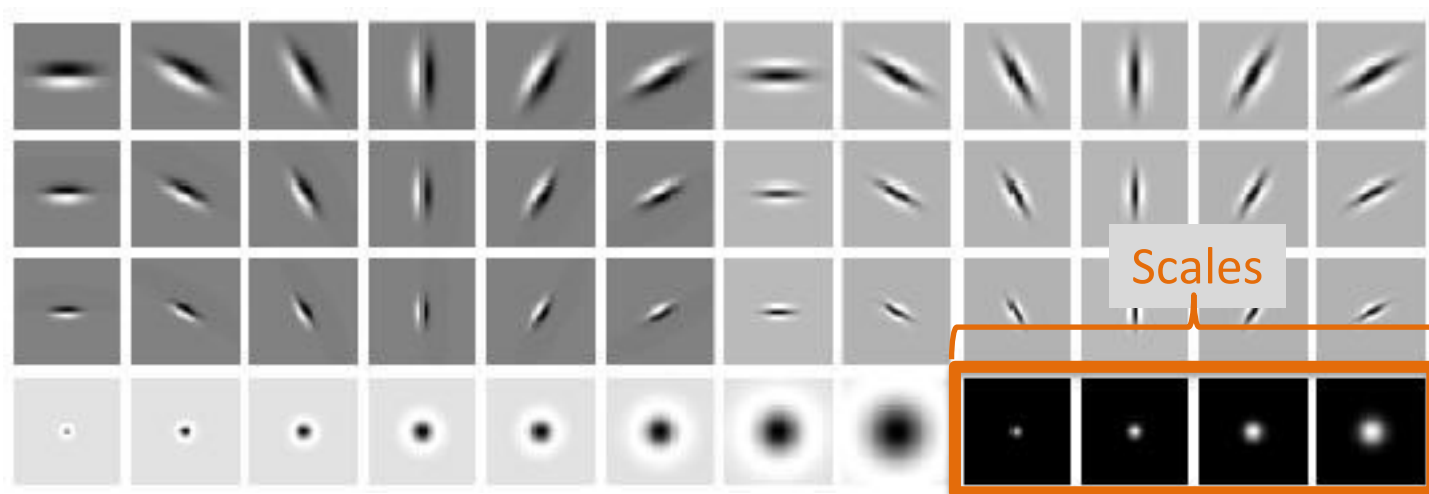
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48 filters

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Leung-Malik (LM) Filter Bank



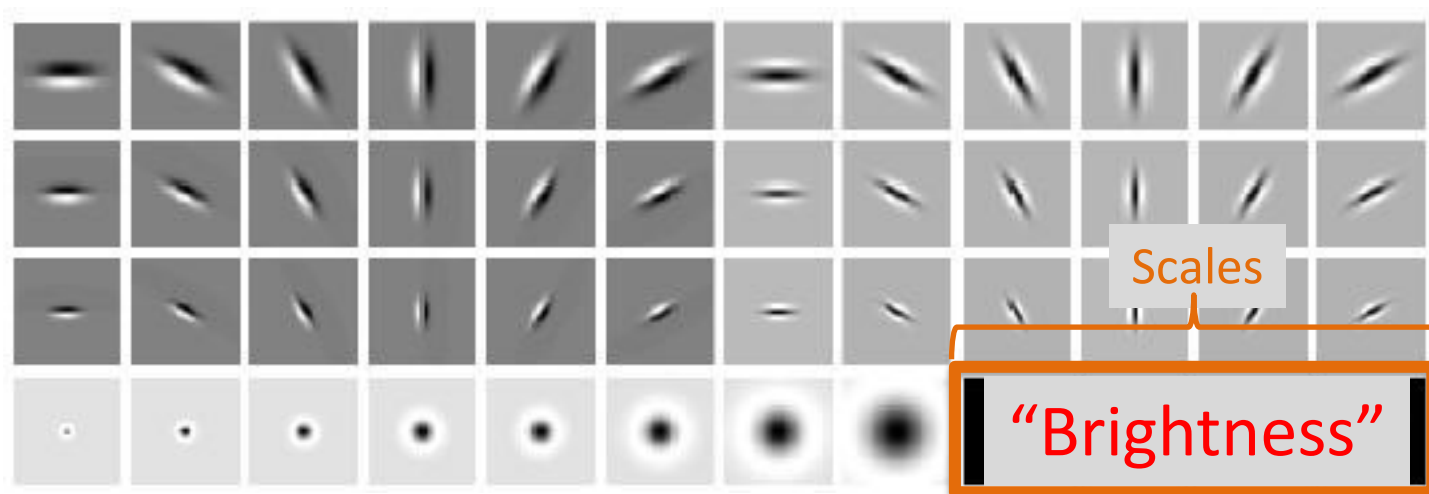
- What filters to put in the bank? **Gaussian**
 - Typically we want a combination of scales and orientations, different types of patterns.

48 filters

MATLAB code available for these examples:

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Leung-Malik (LM) Filter Bank



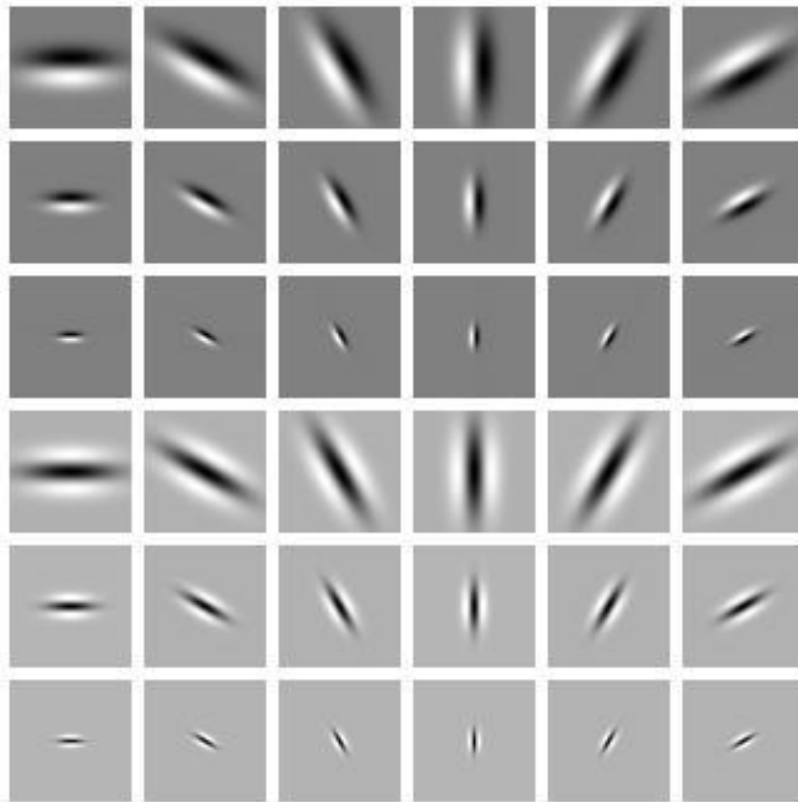
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 - Typically we want a combination of scales and orientations, different types of patterns.

48 filters

MATLAB code available for these examples:

<http://www.robots.ox.ac.uk/~vgg/research/texclass/filters.html>

Root Filter Set (RFS)

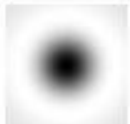


First Derivative of Gaussian (Edge)
3 scales $(\sigma_x, \sigma_y) \in \{(1,3), (2,6), (4,12)\}$
6 orientations

Second Derivative of Gaussian (Bar)
3 scales $(\sigma_x, \sigma_y) \in \{(1,3), (2,6), (4,12)\}$
6 orientations



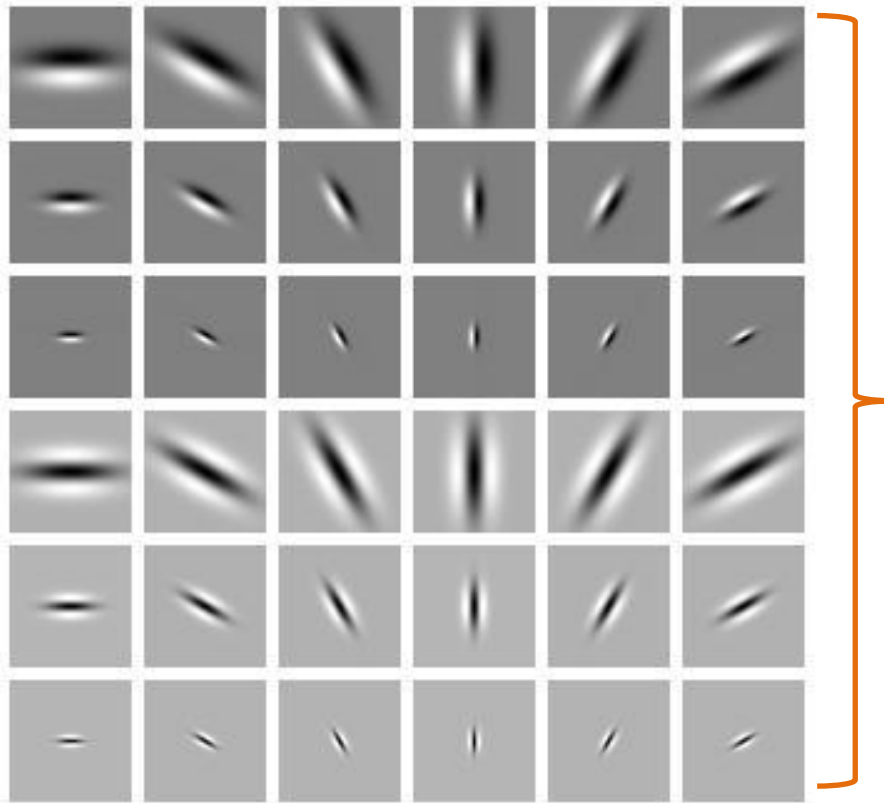
Gaussian ($\sigma = 10$)



Laplacian of Gaussian ($\sigma = 10$)

38 filters

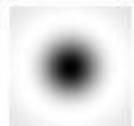
Maximum Response 8 (MR8)



*Maximum response
across all 6 orientations*



Gaussian ($\sigma = 10$)

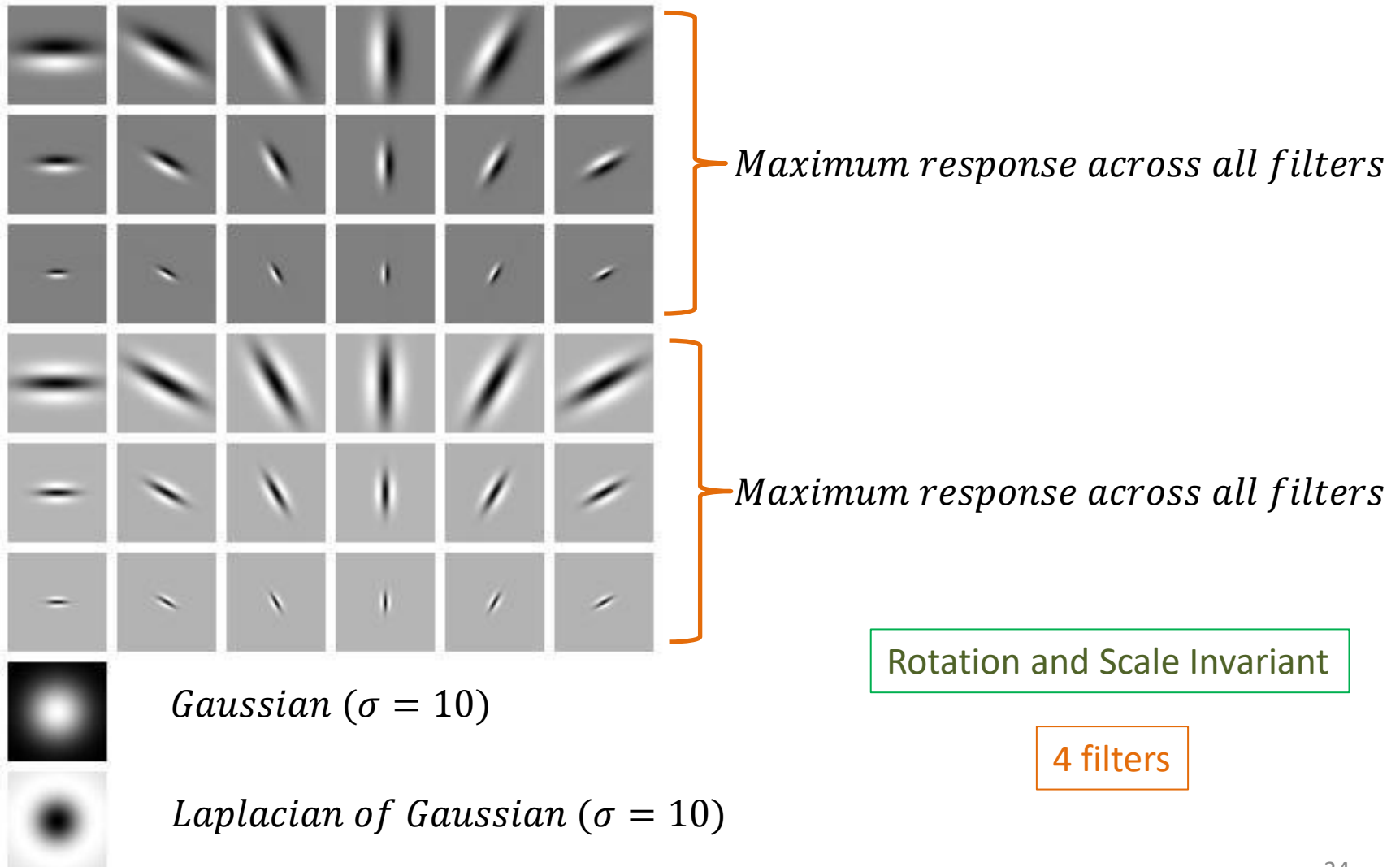


Laplacian of Gaussian ($\sigma = 10$)

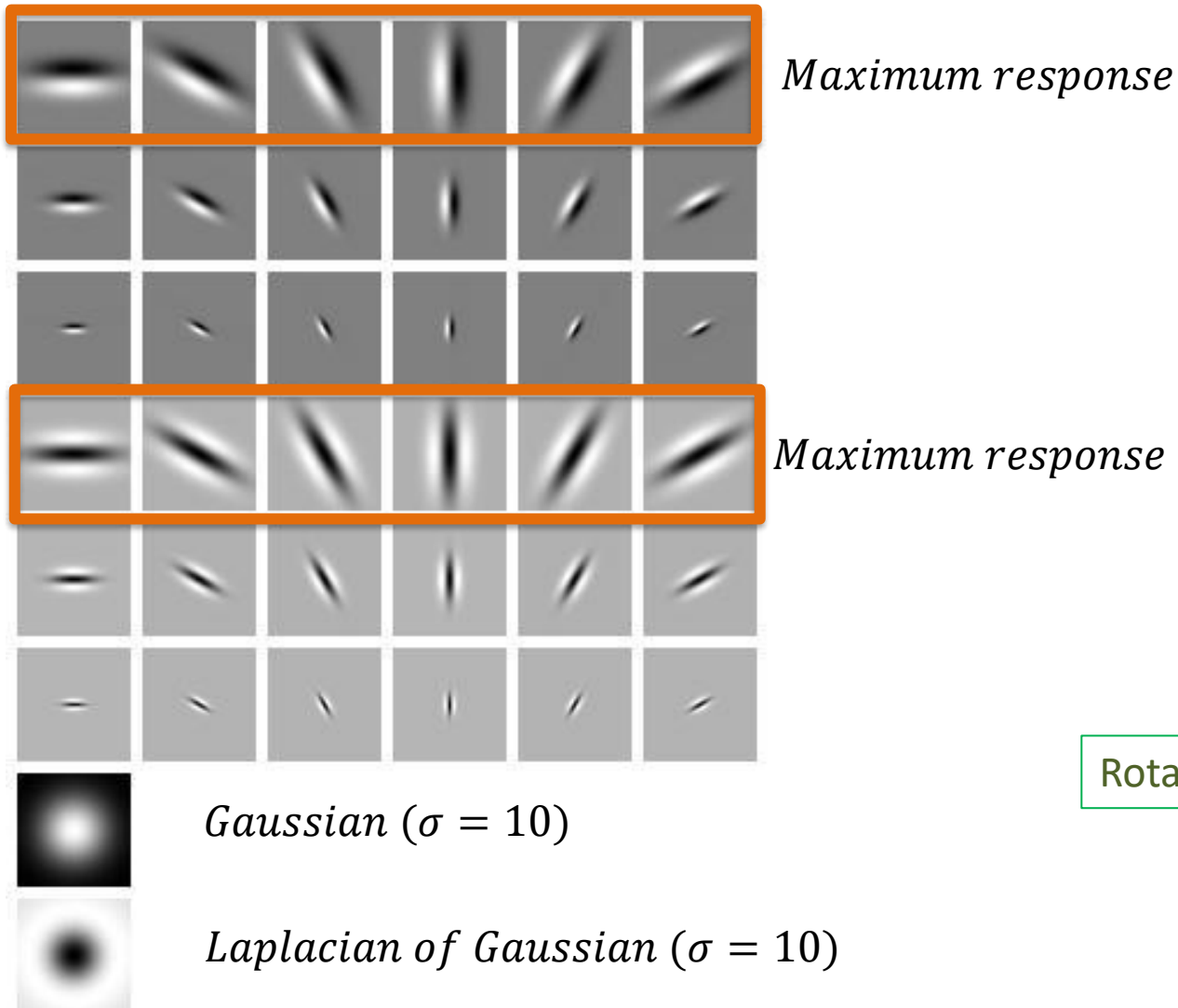
Rotation Invariant

8 filters

MRS4

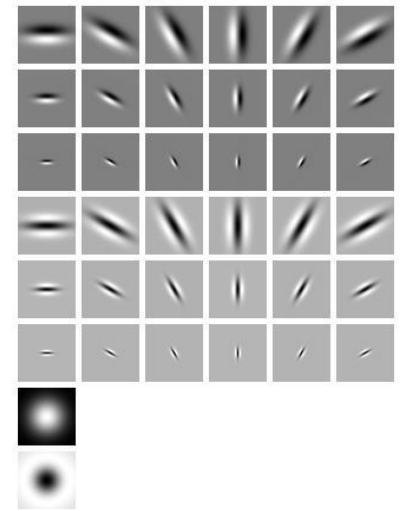
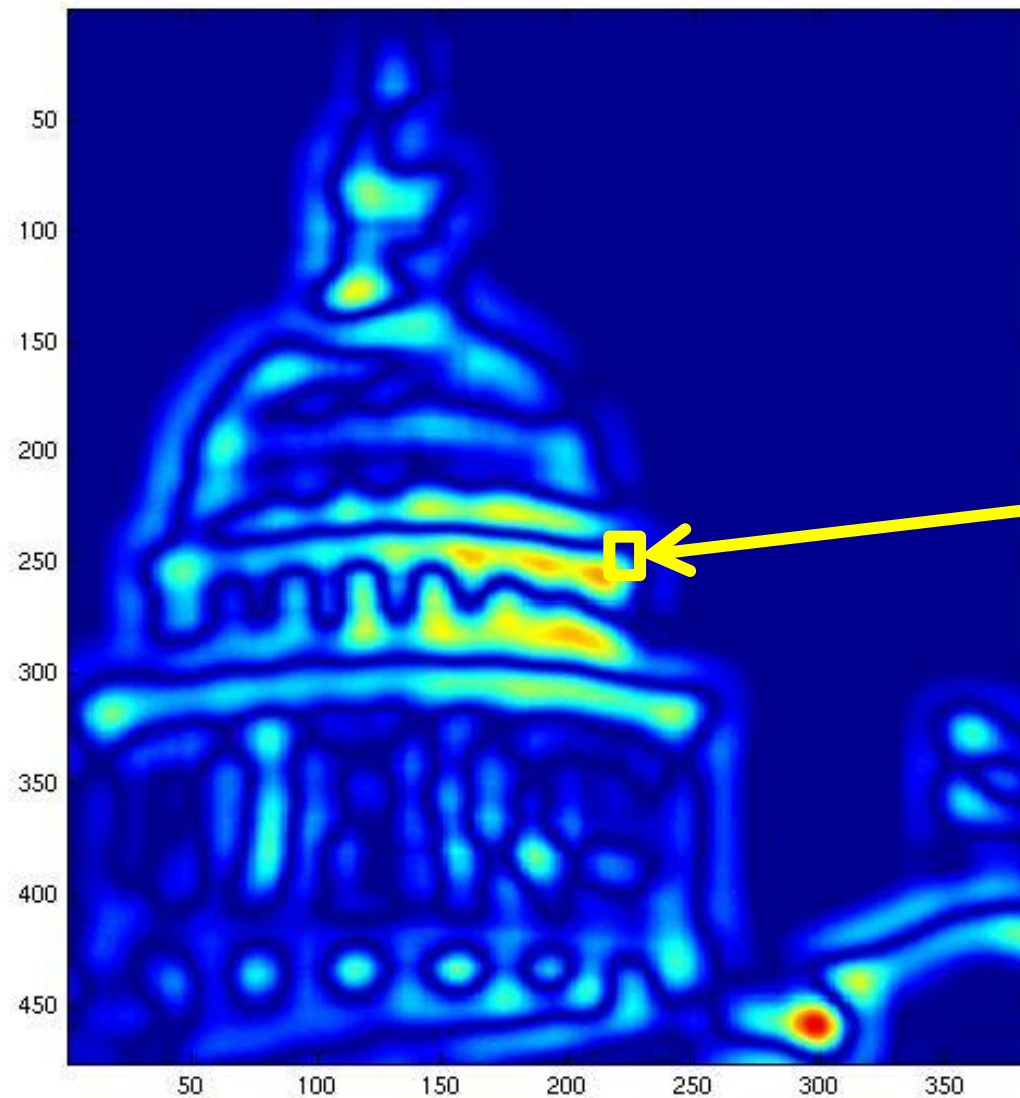


MR4



Rotation Invariant

4 filters



[r1, r2, ..., r38]

We can form a feature vector from the list of responses at each pixel.