Lecture 19
Mid-level Vision: Overview
ECEN 5283 Computer Vision

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Goals

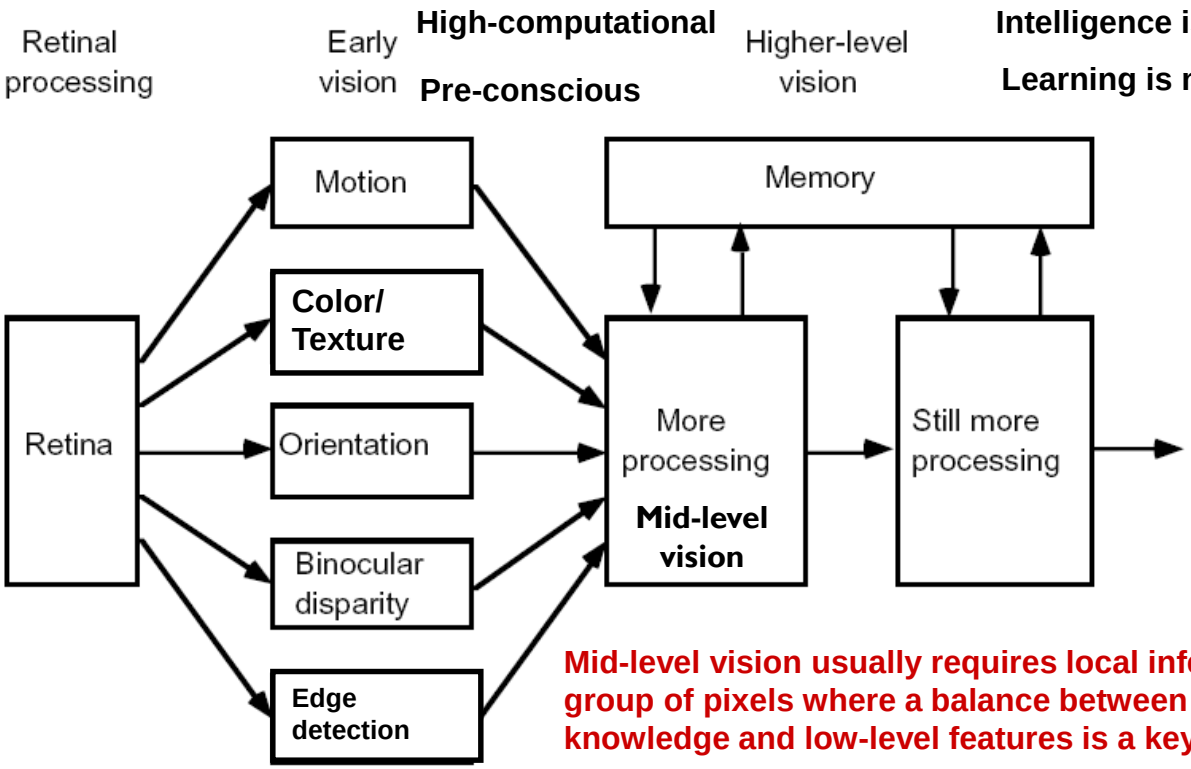
- To provide some feedbacks for Project 1.
- To give an overview of mid-level vision.

Some Observations from Project 1

- PPT Report
  - The value of ϵ should be -1 since the image plane and the scene are on different sides
  - Need to present the camera parameters collectively in a nice format
  - More experimental discussion is encouraged
  - New experiments to test robustness or limitation of the linear approach is welcomed.
  - Interesting videos are well received

- Advices for future submission
  - Zip all files into one package to upload
  - Make sure your Matlab code can be executed without additional operations
  - The PPT report should be detailed and include all meaningful results
  - The results should be presented nicely and easy to understand
  - The discussion should be personal and inspiring

Parallel pathways in early vision



Mid-level vision usually requires local inference on a group of pixels where a balance between high-level knowledge and low-level features is a key issue.

Fig. 1.1
A generic diagram for visual processing. In this approach, early vision consists of a set of parallel pathways, each analyzing some particular aspect of the visual stimulus.

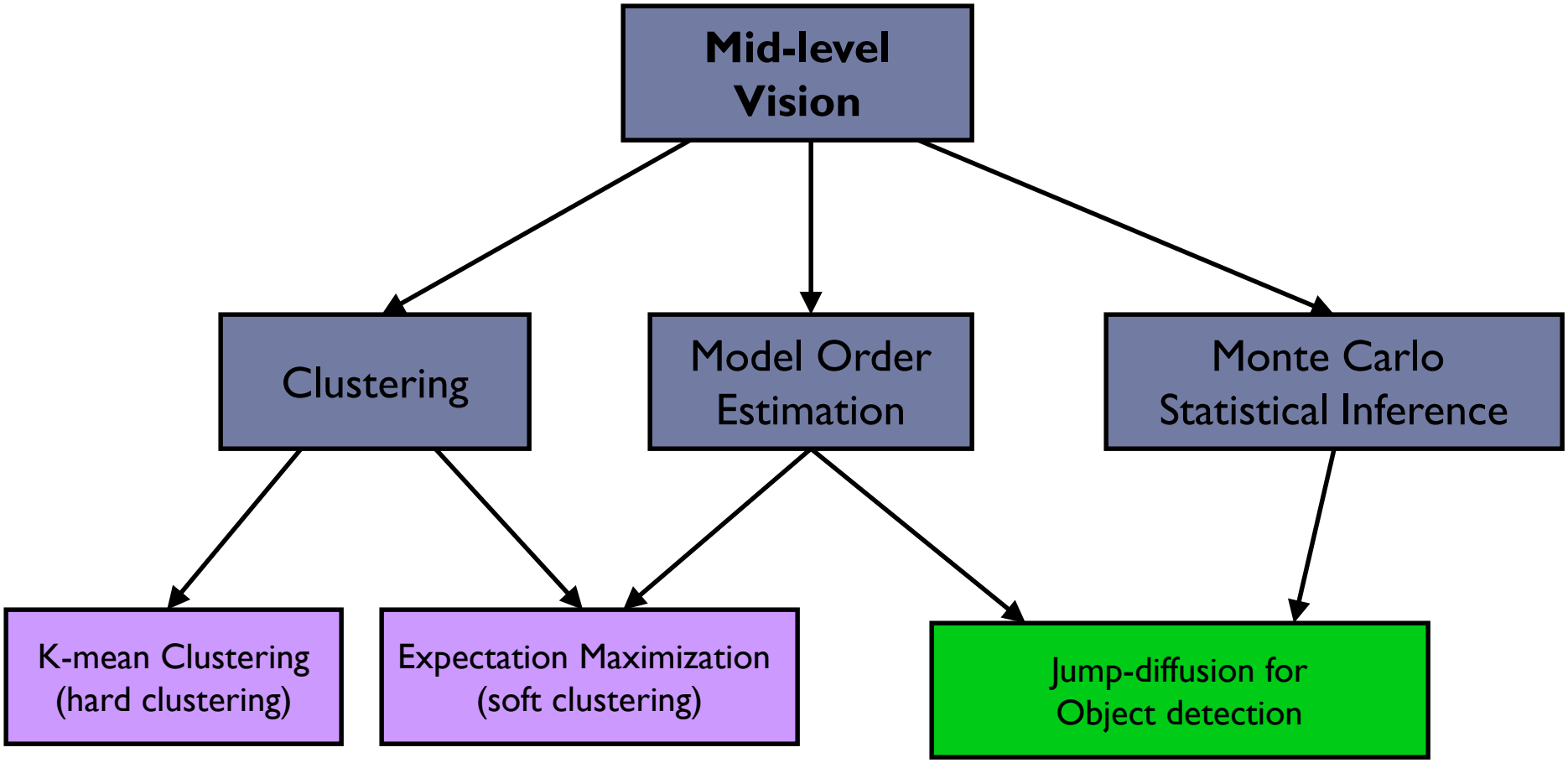
The Plenoptic Function and the Elements of Early Vision
web.mit.edu/persci/people/adelson/pub_pdfs/elements91.pdf

What is mid-level vision?

- Mid-level is the second stage of visual perception that involves inferring the structure of the world from the measurements of low-level vision.

	Low-level vision	Mid-level vision
Purpose	To extract a set of visual primitives at the pixel-level for further visual processing.	To bridge low-level vision and high-level vision with inference of the local structure by involving multiple pixels.
Computational model	Pixel-level linear filtering (convolution)	Region-level statistical Inference (clustering and grouping)
High-level knowledge involved	It is a pre-conscious process.	It is a process that requires some intelligence.
Bottom-up and Top-down flow	It is mainly a data-driven bottom-up process.	Both data-driven bottom-up and knowledge-driven top-down are involved.

Overview of Mid-level Vision



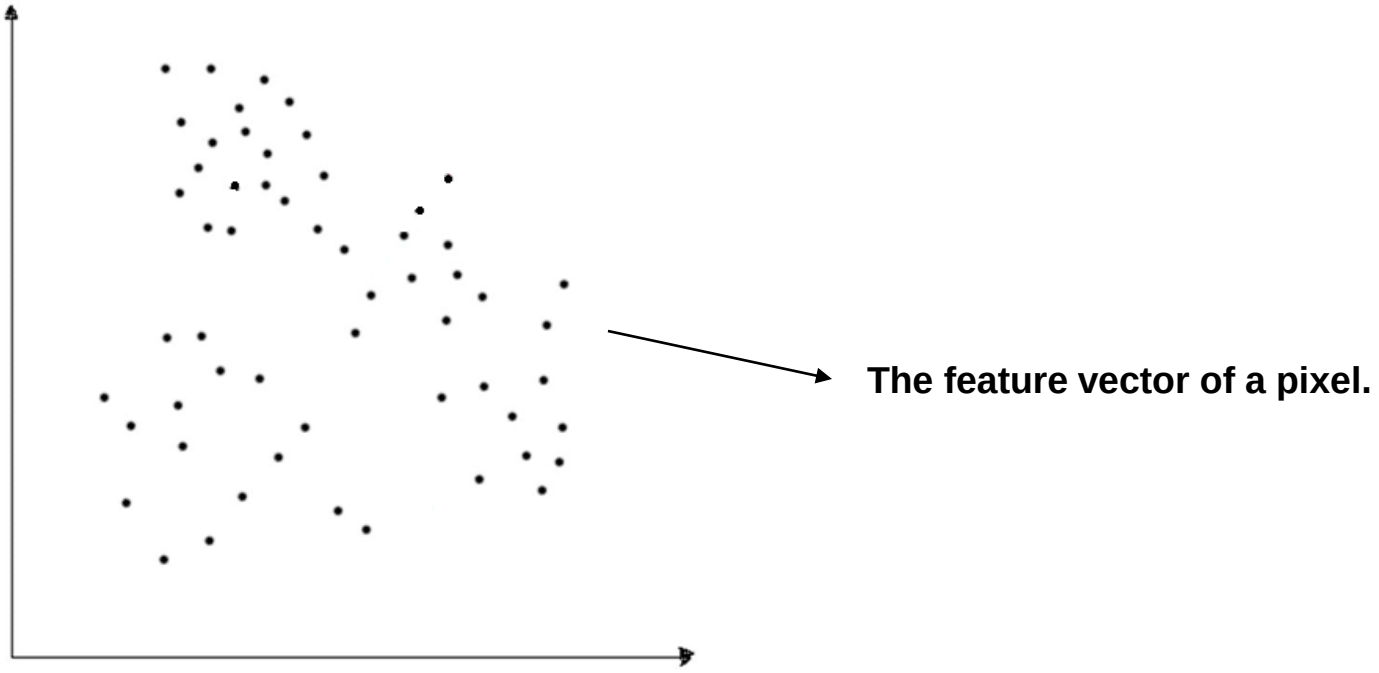
Clustering

- To segment an image into different regions based their colors, textures, motion and/or other low-level features.
  - It is usually done in a feature space where each point reflects the feature vector at a pixel.

http://www2.crl.go.jp/jt/a133/yamazaki/PAPERS/icips98.pdf

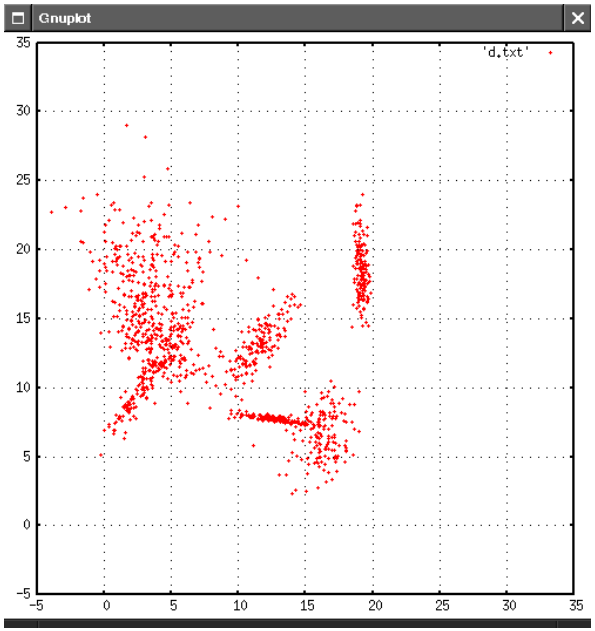
Hard Clustering: K-mean

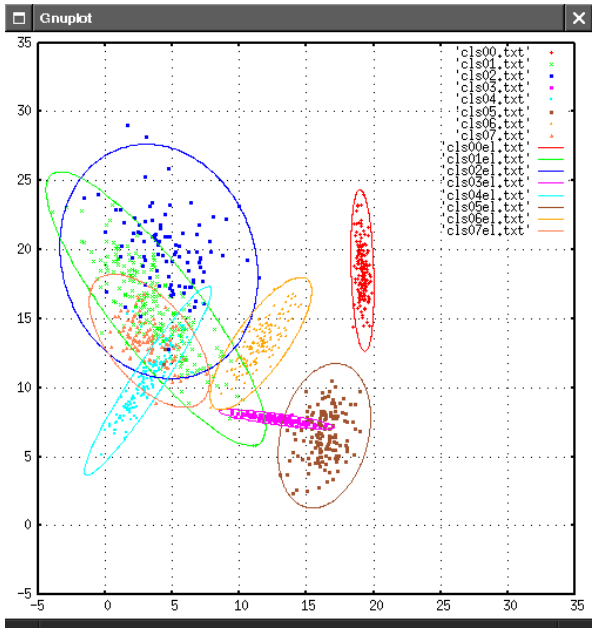
- It is a hard clustering method that classifies each sample with a deterministic label during the iteration.
  - The clustering result is a deterministic classification rule.



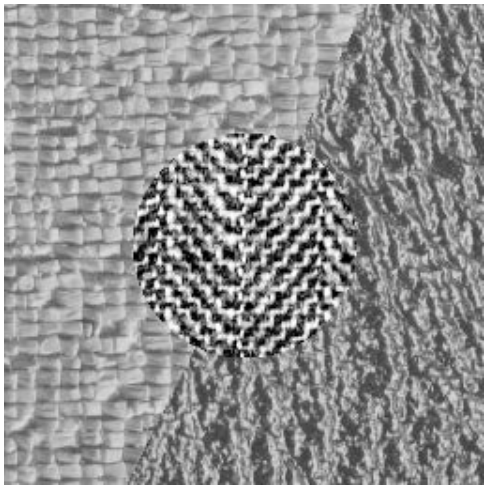
Soft Clustering: Expectation Maximization (EM)

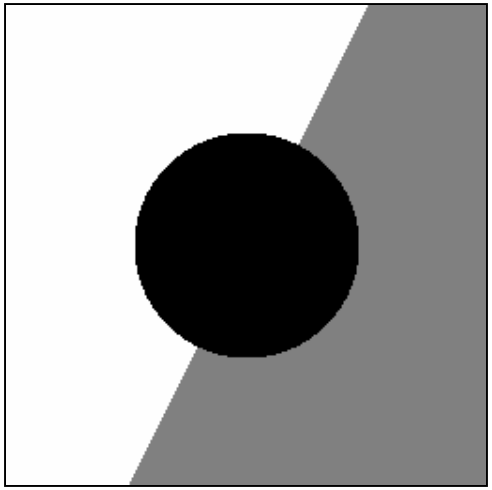
- A soft clustering method computes the probability of each sample belonging to each class label during the iteration.
  - The clustering result is a set of statistical models (Gaussian mixture model or GMM) showing the distribution of each class.

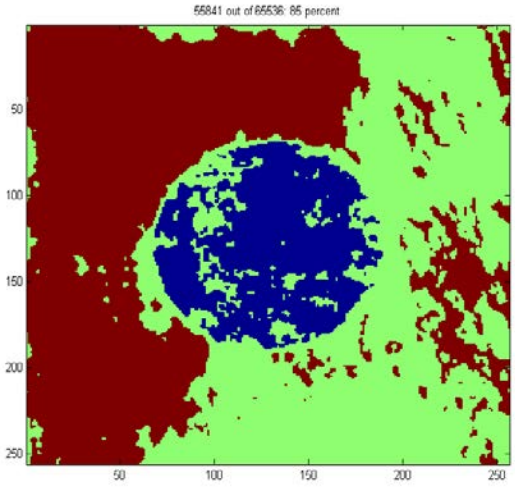


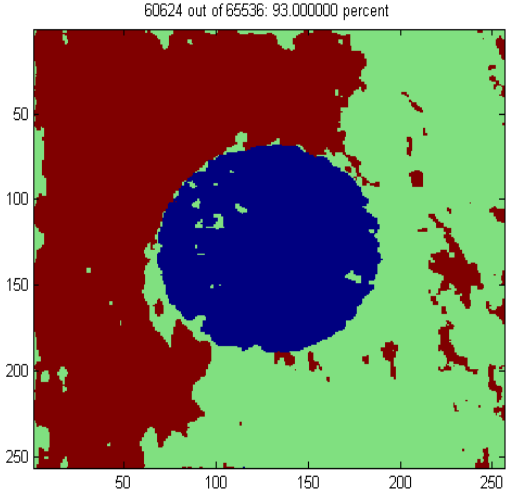


Project 4. Image Segmentation



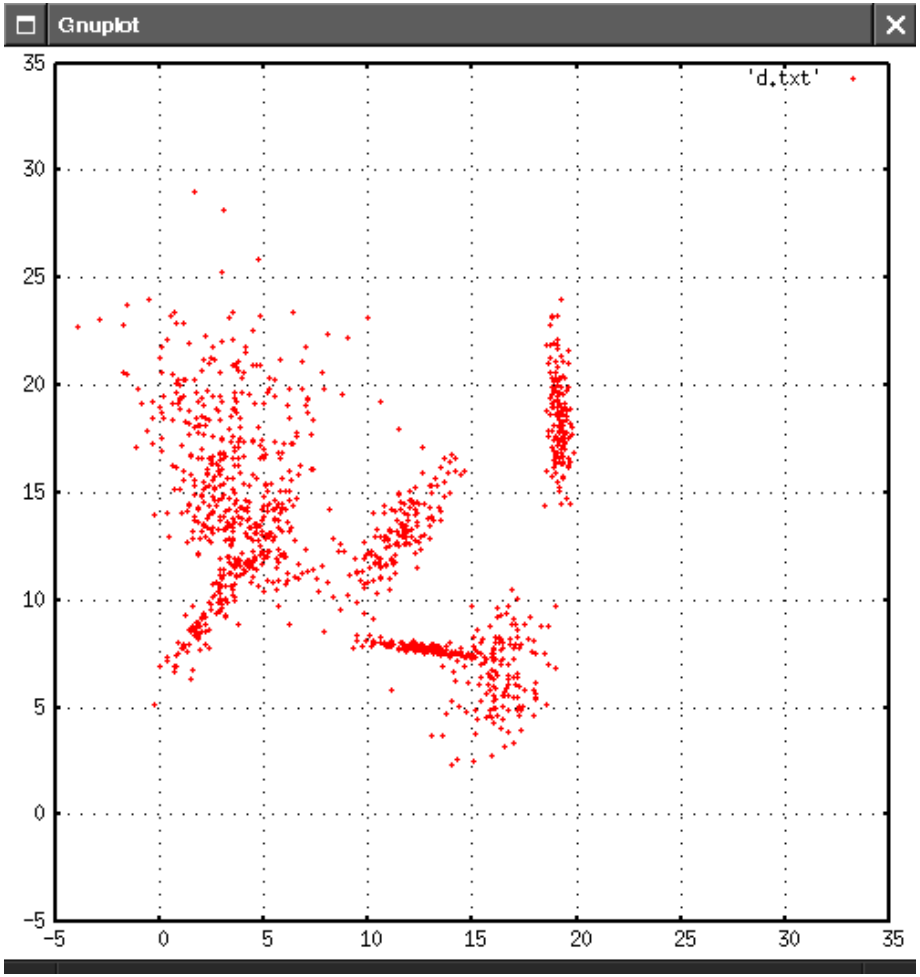






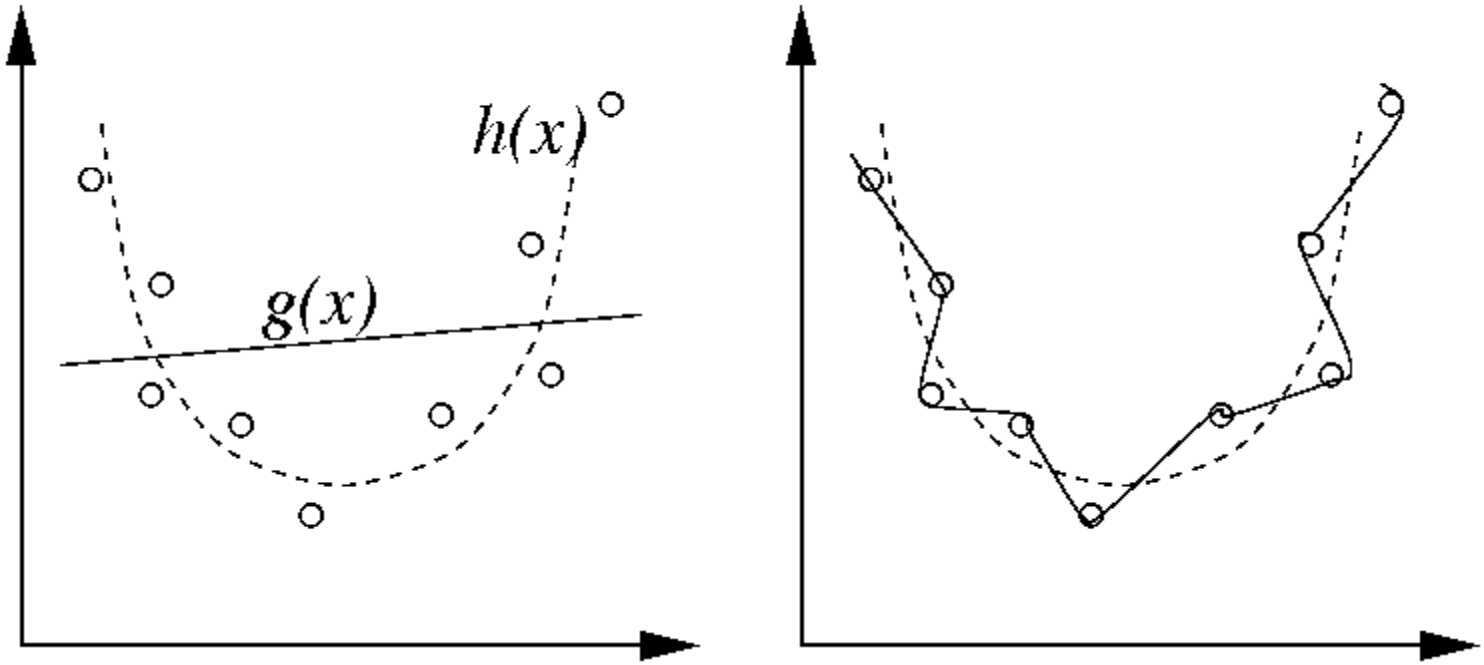
An important question to ask

- How many classes in the feature space?



Model Order Estimation

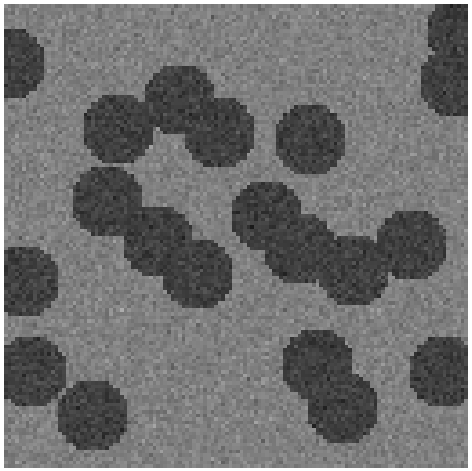
- We try to avoid both under-fitting and over-fitting problems and obtain an appropriate model.

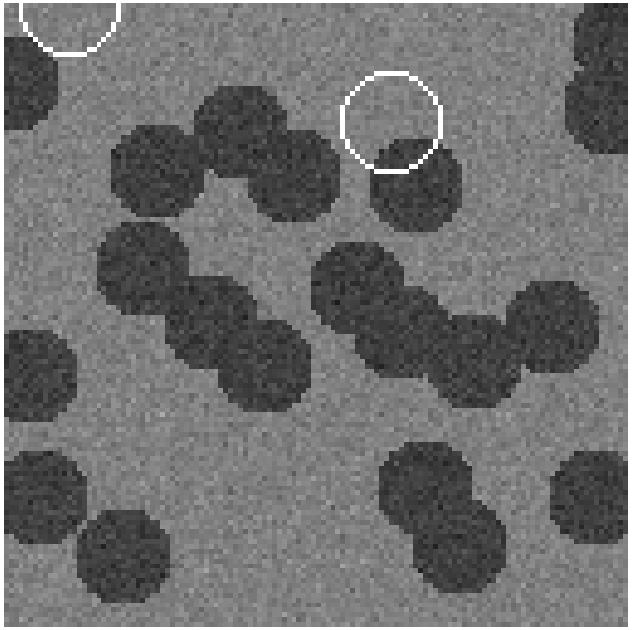


http://www.willamette.edu/~gorr/classes/cs449/figs/overfit.gif

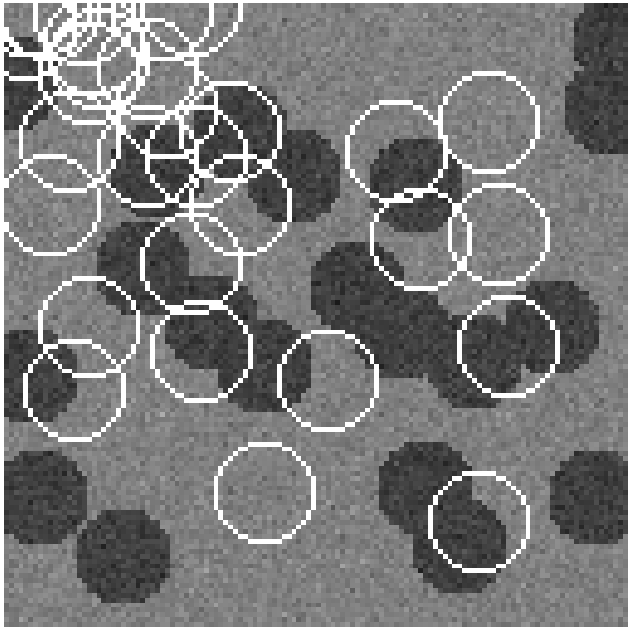
Project 5. Jump-diffusion MC for Object Detection

- Two questions to be answered in this project.
  - How many objects in the image?
  - Where are they?





$k_0 = 2$



$k_0 = 30$

Jump-Diffusion MCMC

- Jump-diffusion provide a mixed mechanism to draw samples from a disconnected state space where both discrete and continuous state variables exist.
  - Jump contributes in sampling over the parameter number.
    - Can be controlled by a probability
  - Diffusion contributes in sampling over the parameter values.
    - Can be managed by a random walk.