Lecture 30: Segmentation

Announcements

• Project 4 due Friday
Consumer face application: Apple iPhoto

http://www.apple.com/ilife/iphoto/

Consumer application: Apple iPhoto

Can be trained to recognize pets!

Consumer application: Apple iPhoto

Things iPhoto thinks are faces

Funny Nikon ads

"The Nikon S60 detects up to 12 faces."
Funny Nikon ads

"The Nikon S60 detects up to 12 faces."

Image segmentation
The goals of segmentation

• Group together similar-looking pixels for efficiency of further processing
  • "Bottom-up" process

“superpixels”


The goals of segmentation

• Separate image into coherent “objects”
  • “Bottom-up” or “top-down” process?

Berkeley segmentation database:
http://www.eecs.berkeley.edu/Research/Projects/CS/vision/grouping/segbench/
The Gestalt school

- Elements in a collection can have properties that result from relationships
  - “The whole is greater than the sum of its parts”

[Diagram showing subjective contours, occlusion, and familiar configuration]

http://en.wikipedia.org/wiki/Gestalt_psychology

Emergence

http://en.wikipedia.org/wiki/Gestalt_psychology
Gestalt factors

- These factors make intuitive sense, but are very difficult to translate into algorithms
Segmentation as clustering

• Cluster similar pixels (features) together

Source: K. Grauman

Segmentation as clustering

• K-means clustering based on intensity or color is essentially vector quantization of the image attributes
  • Clusters don’t have to be spatially coherent

Image | Intensity-based clusters | Color-based clusters
Segmentation as clustering

• Cluster similar pixels (features) together

Source: K. Grauman
K-Means for segmentation

- **Pros**
  - Very simple method
  - Converges to a local minimum of the error function

- **Cons**
  - Memory-intensive
  - Need to pick K
  - Sensitive to initialization
  - Sensitive to outliers
  - Only finds “spherical” clusters

Mean shift clustering and segmentation

- An advanced and versatile technique for clustering-based segmentation

http://www.caip.rutgers.edu/~comanici/MSPAMI/msPamiResults.html

Mean shift algorithm

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

http://www.caip.rutgers.edu/~comanici/MSPAMI/msPamiResults.html

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