Master in
Computer Vision
Barcelona

Module: Optimization methods in CV
Inference algorithms: Guided problems
Lecturer: O. Ramos Terrades

Goals & Tools of this Lecture

Goal

- Model a simple examples
- build PGMs using public libraries
- applied available inference algorithms

Tools

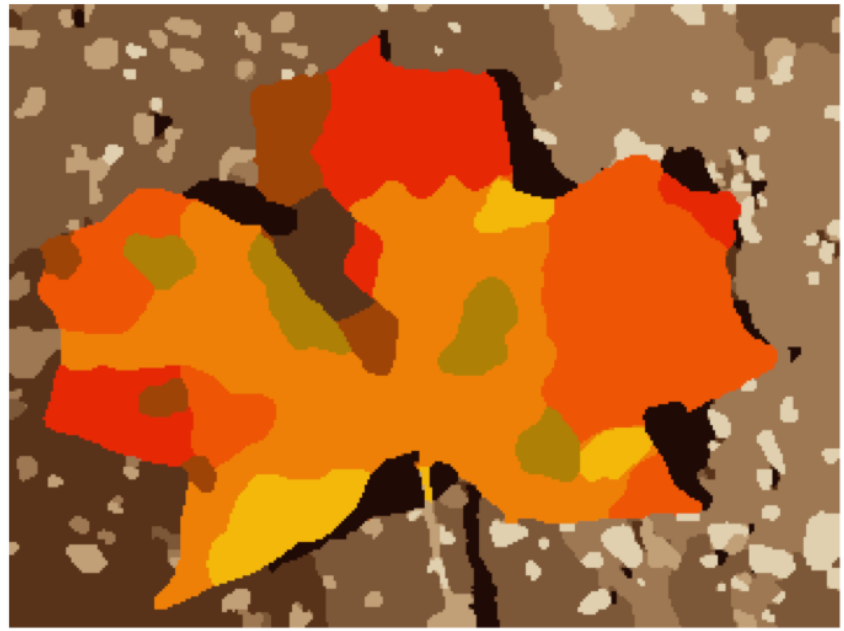
- UGM: Undirected Graphical Models
- Matlab and Python

Outline

Low level segmentation

Low level segmentation

Original Image



Segmented image by color

Definition

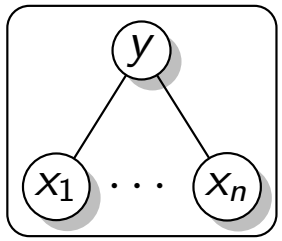
- x_p RGB vector at pixel p
- Assign to p the most *similar* color

Question

How to define each group of colors?

Definition of Unary potentials: Gaussian mixture model

$\{x_p\} \in V$



Main idea:

- Define $y \in \{1, \ldots, K\}$ Hidden (not observed) variable.
- $x_p = (x_1, \ldots, x_n)$ random vector of observed variables
- Get k

$$\hat{k}_p = \underset{k \in \{1,\ldots,K\}}{\text{argmax}} \; P(k|x_p)$$

```
%Preparing data for GMM fiting
%
im=double(im);
x=reshape(im,[size(im,1)*size(im,2)
size(im,3)]);
gmm_color = gmdistribution.fit(x,K);
mu_color=gmm_color.mu;
```

Join pdf

$$P(y,x) = \sum_{k=1}^{K} \frac{1}{(2\pi)^{n/2}|\Sigma_k|} \exp\{(x-\mu_k)^t \Sigma_k^{-1}(x-\mu_k)\} P(k) \mathbb{1}_k(y)$$

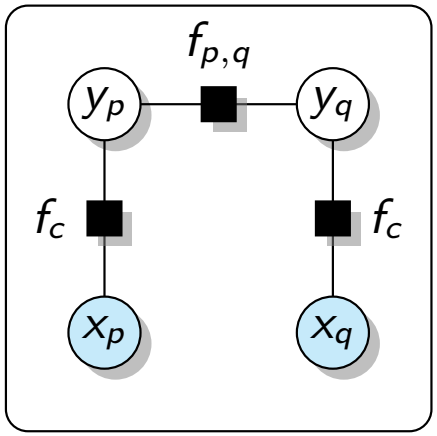
Definition of CRF

$pq \in \mathcal{E}$

Main idea:

- Unary potential: GMM
- Pair-wise potential: Potts model

$$f_{p,q}(k, k') = \theta_{p,q} \mathbb{1}_{\{y_p \neq y_q\}}(k, k')$$



CRF

$$P(y|x) = \prod_p P(y_p|x_p) \prod_{p,q} P(y_p, y_q)$$

```
% Estimate Unary potentials
data_term=gmm_color.posterior(x);
[~,c] = max(data_term,[],2);
```

$$f_c(y_p = k, x_p) = (x_p - \mu_k)^t \Sigma_k^{-1} (x_p - \mu_k)$$

Implementation of CRF

With UGM:

- Fix a number of color clusters, K, and estimate a *gmm* as Unary factors
- Fix parameter for a Potts model.
- Implement function CreateGridUGMModel.m
  - Define Grid
  - Define *Edge* structure
- Call inference algorithms
- **optional 1**: add an extra inference algorithm
- **optional 2**: change the pairwise potential