Discrete Inference and Learning

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Overview

- Course summary and organization
- Chapters overview

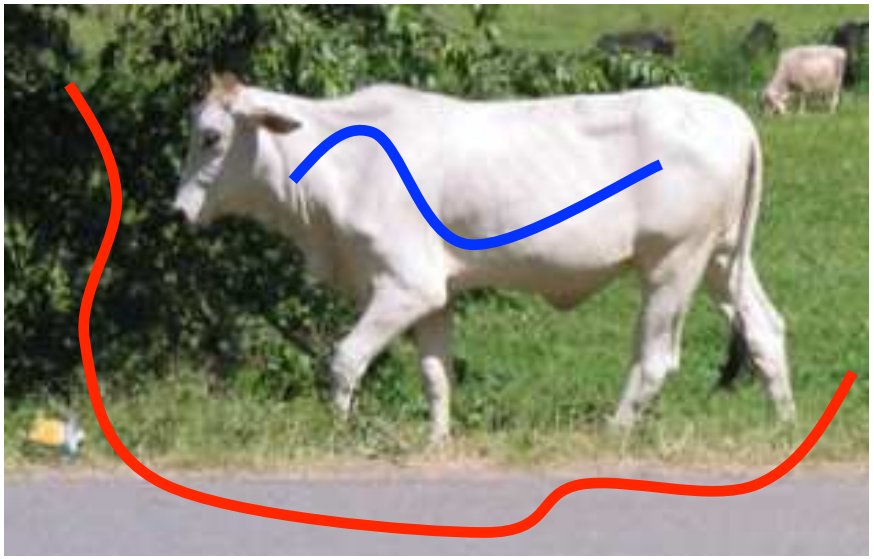
Context

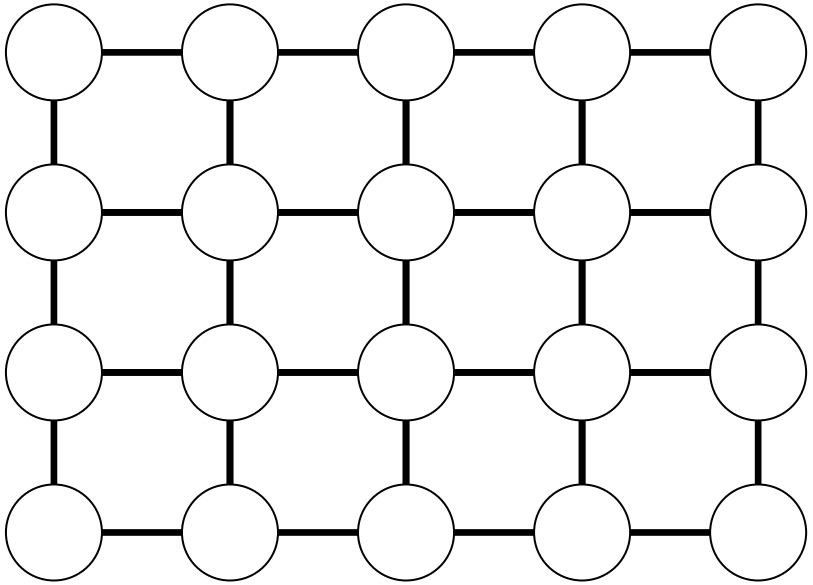
Graphical models (or probabilistic graphical models) provide a powerful paradigm to jointly exploit probability theory and graph theory for solving complex real-world problems. They form an indispensable component in several research areas, such as statistics, machine learning, computer vision, where a graph expresses the conditional (probabilistic) dependence among random variables.
This course will focus on discrete models, that is, cases where the random variables of the graphical models are discrete. After an introduction to the basics of graphical models, the course will then focus on problems in representation, inference, and learning of graphical models. We will cover classical as well as state of the art algorithms used for these problems. Several applications in machine learning and computer vision will be studied as part of the course.

TL;DR:

- modeling computer vision problems with graphs
- algorithms for discrete optimization on graphs

Interactive Binary Segmentation





Foreground histogram of RGB values FG

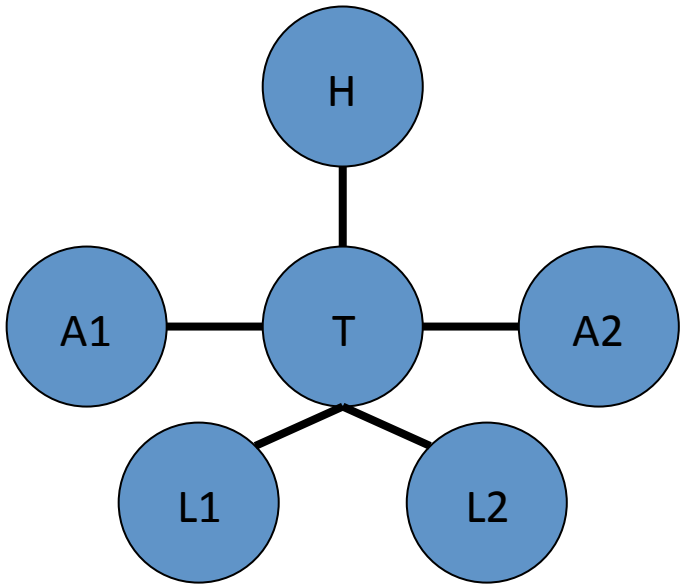
Background histogram of RGB values BG

‘1’ indicates foreground and ‘0’ indicates background

Results

Object Detection

Felzenszwalb and Huttenlocher, 2004



Labels - Poses of parts

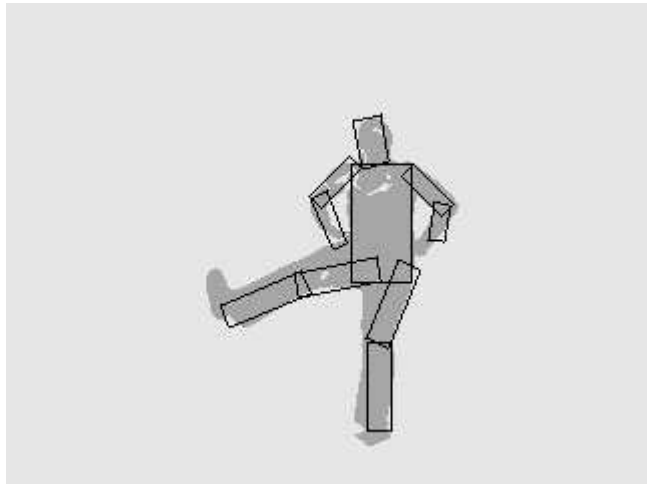
Unary Potentials:
Fraction of foreground pixels

Pairwise Potentials:
Favour Valid Configurations

Results

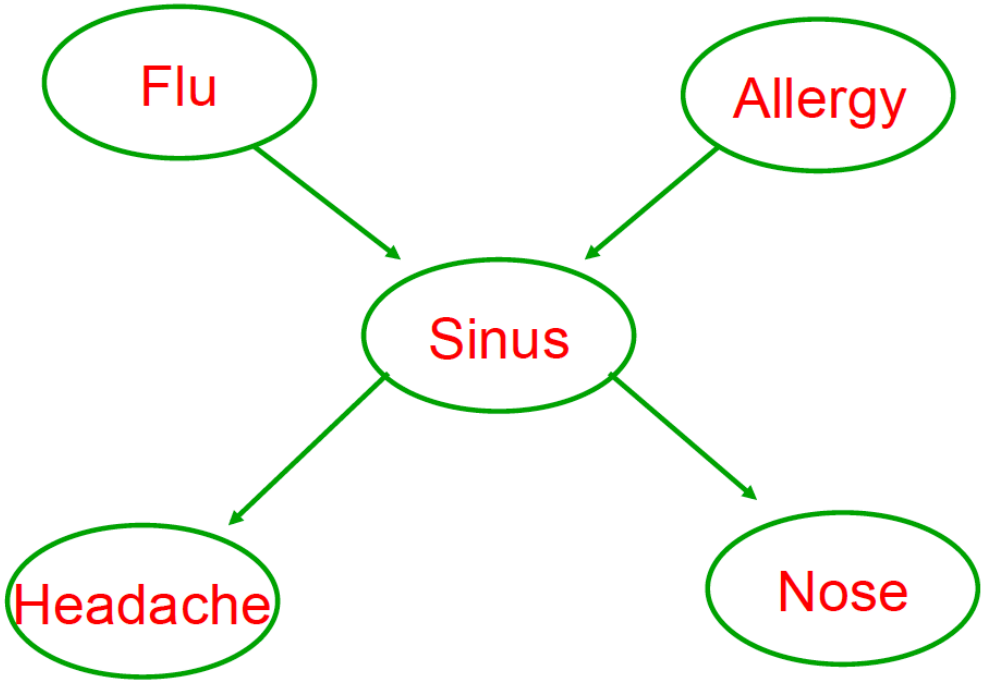
Object Detection

Felzenszwalb and Huttenlocher, 2004



Bayesian Networks

- Example



Slide courtesy: Dhruv Batra

Outline

Schedule

A bit tight: 7 sessions within a month! + project defenses 2 months later

- **Introduction and basics** [recorded] – **Jan. 5th** (K.A.)
  - graphical models
  - Markov Random Fields (MRF)
  - dynamic programming
- **Graph cuts** – **Jan. 11th** (G.C.)
  - binary energy minimization
  - extension to multi-label energies
  - application to computer vision (image grid graph: segmentation)
- **Message passing & Belief propagation** – **Jan. 12th** (K.A.)
- **Learning graphical models: CRF in dual form** – **Jan. 19th** (K.A.)
  - dual decomposition
  - Conditional Random Fields (CRF)

...

- **Primal-dual + further optimization on graphs** – **Jan. 22th** (G.C.)
  - Primal-dual formulations, Support Vector Machines (SVM)
  - Move-making algorithms, Ishikawa construction, Tree-ReWeighted message passing (TRW)
- **Bayesian networks** – **Jan. 26th** (K.A.)
  - Parameter learning
  - Structure learning
  - Inference
- **Causality** – **Feb. 2nd** (G.C.)
  - Correlation is not causality
  - Inferring the causality graph: hints from pairwise distributions
  - Causality as a machine learning task
  - Causality as model complexity

- Project defenses – **March 31st**

Organisation and evaluation

- Courses: lessons
- Validation: project

Schedule (irregular)
7 classes of 3 hours, most often on Tuesday afternoons (13h45 – 17h) but not always (check the webpage for details).

Webpage & mailing-list:
`https://lear.inrialpes.fr/people/alahari/disinflearn/index.html`

Prerequisite

- General maths (probabilities, Bayesian statistics, analysis, differential calculus...)

To attend the course

- Online; link on the website
- See you... last Tuesday [recorded]