

Presentation

Probabilistic Graphical Models

Jerónimo Hernández-González

About me

- ▶ Lecturer at UB
- ▶ Previously at UPV-EHU, AEPIA, IIIA-CSIC
- ▶ PhD in Machine Learning (University of the Basque Country, 2015)
Learning PGMs for weakly supervised classification
- ▶ Research lines:
 - ▶ Weakly supervised learning
(Crowd learning)
 - ▶ PGMs (Bayesian networks) for classification
 - ▶ Approximate inference in PGMs
 - ▶ Applied research: embryo selection, software defect, citizen science, etc.

By the end of the semester...

you will know...

- ▶ what probabilistic graphical models (PGMs) are
 - ▶ The probabilistic approach to machine learning
 - ▶ Types of PGMs
- ▶ which types of queries we can ask to them
i.e., how to make a query...
 - ▶ when it can be answered in polynomial time (exact)
 - ▶ when it **cannot** be answered efficiently (approximate)
- ▶ how a PGM can be inferred from data

By the end of the semester...

you will know...

- ▶ what probabilistic graphical models (PGMs) are
 - ▶ The probabilistic approach to machine learning
 - ▶ Types of PGMs
- ▶ which types of queries we can ask to them
i.e., how to make a query...
 - ▶ when it can be answered in polynomial time (exact)
 - ▶ when it **cannot** be answered efficiently (approximate)
- ▶ how a PGM can be inferred from data

you will be able to...

- ▶ apply the studied algorithms to problems of your interest
- ▶ translate PGMs and algorithms into code

Content

- ▶ Introduction
- ▶ Representation
 - ▶ Markov networks (Undirected)
 - ▶ Bayesian networks (Directed)
 - ▶ Temporal and plate models
- ▶ Inference
 - ▶ Exact (Variable elimination)
 - ▶ Approximate (Belief propagation / Sampling / Variational)
- ▶ Learning
 - ▶ Parametric learning
 - ▶ Structural learning
 - ▶ (In)complete data
- ▶ Real-world examples

Evaluation

30 % Participation

Dairy work, Problem/Programming assignments, Forums**

30 % Presentation

40 % Test

**You need to initiate at least 1 debate; you need to engage in at least 2 debates initiated by your classmates

Test

What: Show the acquisition of the subject's contents

How: Development/multiple-choice questions

When: May 17th

Presentation

What: (i) Present a state-of-the-art work

A paper of your choice from PGM conference:

<https://dblp.org/db/conf/pgm/>

(ii) carry out your own work with PGMs

Some practical work using some of the techniques seen in class

(iii) explain in depth a PGM topic

- How:**
- ▶ Choose a classmate and prepare a presentation for your colleagues (~ 15 min.)
 - ▶ Notify in the forum's thread your choice before May 17th!
 - ▶ No topic-paper-work can be presented more than once

When: May 24th

Examples of topics (iii) for your presentation

- ▶ Explain, in terms of PGMs, a classical model such a GMMs, HMMs, Kalman Filters, ...
- ▶ Log-linear models
- ▶ Conditional Random Fields
- ▶ Learning Markov Networks
- ▶ Structural learning based on conditional independence tests
- ▶ Structural learning with the K2 algorithm
- ▶ k-dependence Bayesian classifier
- ▶ Causality

Calendar

Apr. 5 <i>Intro</i>	Apr. 7	May 3	May 5
Apr. 12 No class	Apr. 14 No class	May 10	May 12
Apr. 19	Apr. 21	May 17	May 19 Test
Apr. 26	Apr. 28	May 24	May 26 Presentations

Bibliography

- ▶ Koller, D., and Friedman, N. (2009). Probabilistic Graphical Models: Principles and Techniques. The MIT Press.
- ▶ Murphy, K.P. (2012). Machine Learning. A Probabilistic Perspective. The MIT press.
- ▶ Castillo, E., Gutiérrez, J.M., and Hadi, A.S. (1997). Expert Systems and Probabilistic Network Models. Monographs in Computer Science, Springer.

- ▶ Daphne Köller (Stanford University) teaches a PGM course in Coursera
- ▶ Specialization (3 courses)
(Video lectures, Questions, Programming assignments)
<https://www.coursera.org/specializations/probabilistic-graphical-models>
- ▶ A lot of her material is used in these lessons
- ▶ You might be interested in enrolling (partially free)

Strongly recommended

About you

Please, answer this survey:

<https://forms.gle/ZWiXjwgcWfVb32rt7>



Presentation

Probabilistic Graphical Models

Jerónimo Hernández-González