UBC MLRG (Summer 2016): Miscellaneous

Some images from this lecture are taken from Google Image Search.
Recent MLRG History

• Topics covered in recent MLRG terms:
  – Fall 2014: Deep learning and Bayesian optimization.
  – Summer 2015: Probabilistic graphical models.
  – Fall 2015: Convex optimization.

• Summer 2016 proposal: miscellaneous!
  – Major topics not previously covered in CPSC 540 or recently in the MLRG.
    • But that we don’t want to dedicate a semester to.
  – Plan is to spend 2 weeks on each topic.

• Today:
  – Overview of these topics, and getting people to choose topics/weeks.
Independent Component Analysis (ICA)

• 540 covers probabilistic PCA and factor analysis:
  – Latent factors follow an independent Gaussian distribution.

• Independent component analysis:
  – Latent factors follow and independent non-Gaussian distribution.

• Key advantage:
  – Latent factors become identifiable (up to label switching).

• Key applications:
  – Source separation.
  – Causality.
Changepoint Detection

• 540 covers hidden Markov models:
  – Finds latent “modes” and latent dynamics in time-series.

• Changepoint detection:
  – Task of finding breakpoints where time series distribution changes.

• Key advantage:
  – May be easier than fitting generative HMM.

• Key applications:
  – Bioinformatics.
  – Econometrics.
Sub-Modularity

• 540 covers convexity:
  – Class of continuous functions that is easy to minimize.

• Sub-modularity:
  – Class of discrete functions that is easy to minimize.
  – Algorithms also exist for approximate maximization.

• Key advantage:
  – Expands class of efficiently-solvable problems.

• Applications:
  – Computer vision.
  – Sensor networks.

• Related: QUBO.
Relational Models

- 540 covers Bayesian networks:
  - Describes relationships between variables.

- Probabilistic relational models and Markov logic networks:
  - We have “types” of variables and probabilities on logical statements.

- Key advantage:
  - More expressive language.

- Applications:
  - Adding probabilities to databases.

Continuous Graphical Models

• 540 covers discrete and Gaussian graphical models:
  – Convenient due to conjugacy.
• Nonparanormal and Gaussian-copulas models:
  – More flexible continuous distributions.
• Key advantage:
  – Gaussians are very restricted class.
• Applications:
Grammars

• 540 covers Markov models:
  – Useful for modeling sequence data with Markov assumption.
  – Can be generalized to Bayesian networks.

• Probabilistic context-free grammars:
  – Different generalization using “recursive” Markov assumption.

• Key advantage:
  – Dependencies at different scales.

• Applications:
  – Natural language processing.
  – RNA secondary structure.

• Related: And-Or trees, image grammars.
Topic Models

• 540 covers density estimation.
• Topic models:
  – Hierarchical density estimation.
• Key advantage:
  – Structure at different scales (document vs. word).
• Applications:
  – Document modeling/clustering/analysis.
• Related: more non-parametric Bayes.
Spectral Methods

• 540 covers expectation maximization:
  – Only finds global optimum.

• Spectral methods:
  – Consistent estimators.

• Key advantage:
  – No local minima if you have enough data.

• Applications:
  – All the usual HMM applications.
Large-Scale Kernels Methods

• 540 covers kernel methods:
  – Flexible universal approximators.
  – But $O(n^2)$ or worse cost/storage.

• Large-scale methods:
  – Tricks to get $O(n \log n)$.

• Big literature:
  – Nystrom.
  – Fast multipole.
  – Kronecker products.
  – Circulant matrices.
Topics/Schedule

• June 1: No meeting (UAI camera-ready deadline)
• June 8, 15: Spectral Methods (Sharan and Geoff)
• June 22: Relational Models (Chris)
• June 29: Submodularity (Saif)
• July 6: Grammars (Nasim)
• July 13, 20: Continuous graphical models (Eviatar, Steven, Kevin)
• July 27, August 3: Large-scale kernels methods (Issam, Julieta)
• August 10, 17: Changepoint detection (Mohamed, Alireza)
• August 24, 31: Independent component analysis (Julie, Ricky)