Midterm Study Guide

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1 Introduction

This is a study guide for the midterm exam in CS6741, spring 2020. It covers the following:

1. Specification of generative models through *generative processes* and directed graphical models.
2. Parameterization of distributions through features and *neural networks*.
3. Geometric representations of distributions through softmax and *simplex* representations.
4. Information-theoretic properties of discrete distributions, primarily *KL* but also entropy, cross-entropy.
5. Maximum-likelihood estimation (MLE) through *back-propagation* particularly chain-rule of log-softmax.
6. Familiarity with basic neural network structures, in particular *attention*.
7. Mastery of *Naive Bayes* and *Softmax regression* - parameterization, class-sizes, posterior inference, features, difference.
8. Comprehension of notation of *latent-variables* and their usage, including MLE in the presence of latent-variables.
9. Understanding the *variational* formulation of the MLE objective in terms of ELBO and posterior gap.
10. Writing down the *EM* steps for clustering and understanding what each step is doing.
11. Knowing the conditions under which EM is intractable and alternative variational approaches using simpler q.
12. Using variational auto-encoders with neural ρ as an alternative to EM.
13. Conditions under which REINFORCE is used for backpropagation and the reasoning.

2 Generative models

3 Parameterization of distributions

3.1 Features

3.2 Neural networks

4 Geometric representations of distributions

4.1 Softmax representations

4.2 Simplex representations

5 Information-theoretic properties of discrete distributions

5.1 Entropy & Perplexity

5.2 KL

5.3 Cross-entropy

6 MLE through backpropagation: chain-rule of log-softmax

7 Basic neural network structures, in particular attention

8 Naive Bayes and Softmax regression

Parameterization, class sizes, posterior inference, features, difference.