CS 181 2018 Midterm 2 Topic List

The best way to prepare for the midterm is to review homeworks, section notes, the 2017 lecture slides, and the midterm practice questions. The midterm will be both conceptual and analytical and will not involve pseudocode. The midterm is non-cumulative (except where we built on concepts later in the semester). Deep learning and Deep RL are not on the exam.

Do not spend time memorizing PDFs or matrix derivatives. These will be given. You should be familiar with probability theory and the various models and methodologies weve studied in this course. Rather than memorize equations for things such as value iteration, Q-learning, or the recurrence for forward-backward in HMMs, we suggest that you are familiar enough that you would be able to work with them if provided with reminders. Here is a brief list of topics:

- Clustering:
  - Know the K-means objective, know Llyods algorithm, know HAC, know dendrograms.
  - Understand the typical kinds of applications of clustering.
- Mixture models:
  - Understand how to work with the Gaussian mixture model and models like topic models. No need to memorize their specific forms.
  - EM: understand expected complete-data likelihood, the E-step and the M-step, the relationship to the MLE problem. Know how to use EM, but no need to memorize specific algebraic forms of solutions to the E-step or M-step for particular models.
  - Understand the typical kinds of applications of mixture models.
- Directed Graphical Models:
  - Understand latent vs. observed variables, handling parameters as random variables, and plate notation.
- Dimensionality Reduction and PCA:
  - Understand motivations, typical applications; understand the PCA reconstruction loss function (no need to memorize).
  - Know how to use eigenvectors of the empirical covariance for PCA (but dont memorize how to solve for eigenvalues/vectors)
- Hidden Markov Models:
  - Know the form of the HMM, the distribution it defines, the conditional independence properties, and understand the typical kinds of applications
  - Learning: complete-information version, use of EM (no need to memorize the E or M step rules)

- Bayesian Networks:
  - Understand the distribution defined by a Bayesian Network (BN), the role of topological orderings, local conditional independence properties, and typical applications.
  - Know the rules of d-separation, and how to reason about conditional independence.
  - Can construct a BN for a given variable ordering, understand the effect of different orderings
  - how to learn parameters with complete data and known structure (incomplete data and unknown structure out of scope)
  - Know how to use variable elimination for exact inference
- Markov Decision Processes:
  - Know the form of the MDP model, can model problems via MDP, understand the typical kinds of applications of MDPs
  - Finite horizon planning: understand planning objective, the MDP value function and policy evaluation. No need to memorize formulas.
  - Infinite horizon: understand the planning objective, the MDP value function, policy evaluation, Bellman equations, value iteration (VI), policy iteration (PI), and how VI and PI compare. No need to memorize formulas.
  - Out of scope: specifics of any particular grid world model, expecti-max
- Reinforcement Learning:
  - Understand typical applications, exploration vs exploitation, difference between model-based and model-free RL.
  - Understand the Q-function and the alternate form of Bellman equations in terms of Q-functions.
  - Understand the meaning of SARSA, "temporal difference", and on-policy vs. off-policy learning.