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# Machine Learning Final

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This TWO-SIDED exam is open book. You may bring in your homework, class notes and text- books to help you. You will have 1 hour and 15 minutes. Write all answers in your blue book. Please make sure YOUR NAME is on each of your blue books. Square brackets [] denote the points for a question. ANSWER ALL FOUR QUESTIONS FOR FULL CREDIT

## 1. Deep Learning

A standard deep learning network the architecture has a convolution network at the initial stage followed by a conventional neural network.

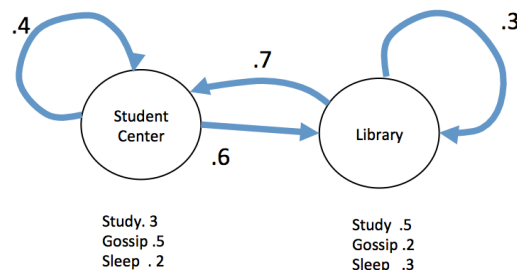
- (a) [10] *BRIEFLY* What is the purpose of convolution networks?.
- (b) [15] Human eyes have a central fovea of one degree wide. In the fovea, the optical resolution goes up by a factor of 100 along each axis. To use deep learning to mimic the functionality of the human system, one strategy would be to have one CNN network identify the  $(x, y)$  coordinates of a peripheral area of interest and center a second, high-resolution deep network there. How would you identify the peripheral location from the first network's conventional n-layer deep CNN network?

## 2. HMMs

You are in charge of mentoring your roommate, who has big exam coming up. She reports that she may have gossiped on the last day but she has been studying on the other two and has been in the library for the last three days. To help you keep track, you have built the following Markov model of her behavior that has initial probabilities:

$$p(\text{Library, Center}) = (.6, .4)$$

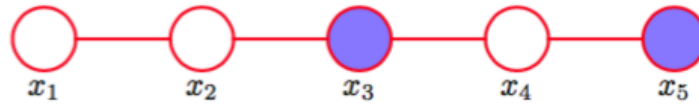
and structure given by:



- (a) [5] Draw the three-day HMM
- (b) [20] Is your roommate's report the most likely scenario? Show all steps you use to solve this problem

### 3. Graphical Models

Consider the following 5-node graph:



- (a) [10] What argument can you make to show that  $x_2 \perp\!\!\!\perp x_5 | x_3$ ?
- (b) [15] In a  $\mu$  notation, write down the factors that would be used in computing  $p(x_2)$ , keeping in mind that  $x_3$  is observed.

4. **Markov Random Fields** A certain corrupt company has engaged in illegal activity by altering their accounts records. You have been assigned to separate the guilty employees on the basis of the content of their email records including who they sent them to. Emails that contain any of  $\{ \textit{Belieze}, \textit{hide}, \textit{losses}, \textit{lawyer} \}$  are suspicious.

How would you set up a Markov Random Field process to identify the potential collaborators? Show all notation that you come up with.

- [10] What would the energy functions look like?
- [15] What would the network look like?