

---

# Machine Learning Final

---

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

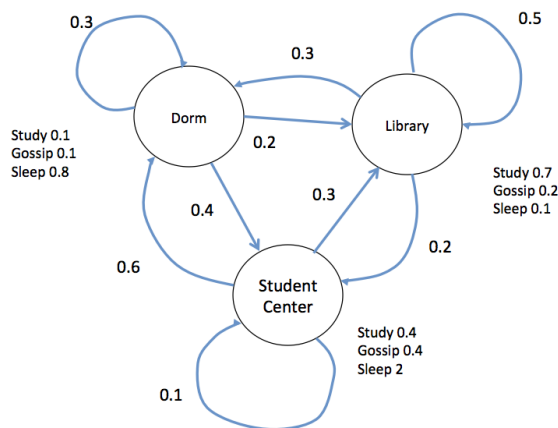
1. **Deep Learning** In a deep learning network that learned to play lots of games, the architecture had a convolution network at the initial stage followed by a conventional neural network. f

- (a) [10] *BRIEFLY* What is the purpose of convolution networks?. to achieve translation invariance in images
- (b) [15] Human eyes have a fovea. In the center of gaze, there are 10,000 times more cells so that the optical resolution goes up by a factor of 100 along each axis. One strategy could be to identify the X and Y coordinates of an area of interest and center a second Deep Network there.

How would you identify this spot from a conventional N-layer deep CNN network? After applying the image input, start at the top of the CNN and identify the maximum cell. Follow the links to the cells below and identify the maximum there. Keep going until the first layer is reached and report the center coordinates of the winning convolution

## 2. HMMs

You have watched your roommate's behavior and built the following graph:



- (a) [10] Draw the three-day HMM
- (b) [15] Your roommate reports in via text messages every day. Over the course of three days you receive *Gossip*, *Study*, *Gossip*. If in day one

you know that  $p(Dorm, Library, Centr) = (0.3, 0.4, 0.3)$ , what is the most likely sequence of locales?

### 3. Graphical Models

Consider the following 5-node graph:



- (a) [10] What argument can you make to show that  $x_2 \perp\!\!\!\perp x_5 | x_3$ ? **two ways to do this: 1) use the definition for undirected graphs, or 2) add unidirectional arrows and use the blocked definition for that graph**
4. [25] **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. Any emails that contain any of  $\{Believe, hide, losses, lawyer\}$  are suspicious. How would you set up a Markov random process to identify the guilty collaborators? Show all notification that you come up with.
- Let 1 be guilty and -1 be innocent and use the setup for the de-noising example with the modification that  $x$  cells are neighbors if they exchanged emails. Next define  $E(f(y))$  in some way. One way could be  $f(y)=1$  if any of the key words are in the email else  $f(y)=-1$ .**