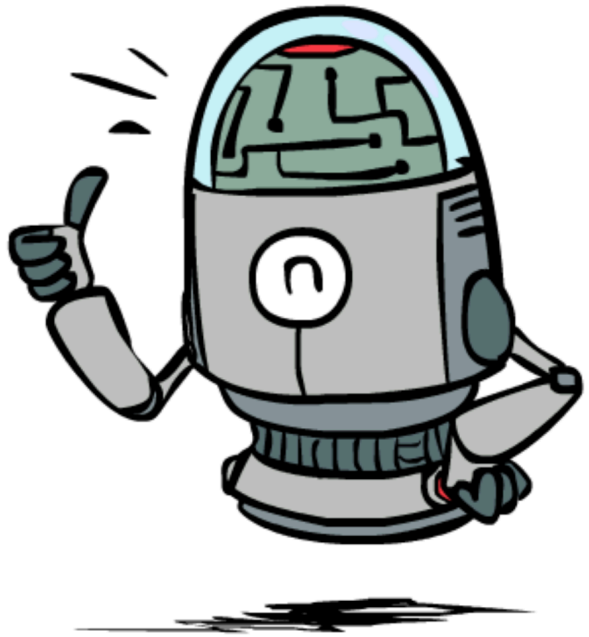
CS 5522: Artificial Intelligence II

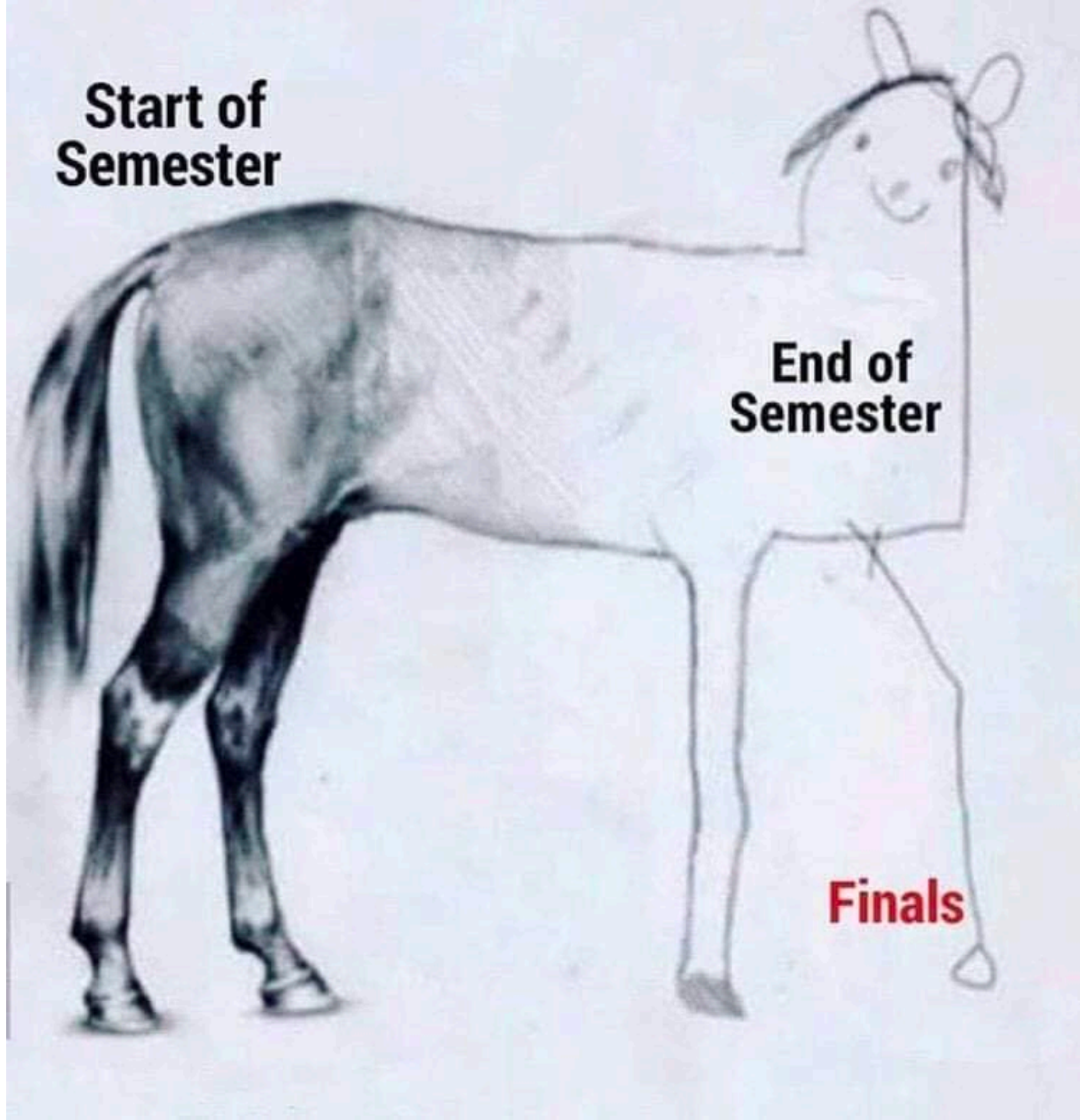
Final Review



Instructor: Wei Xu

Ohio State University

[Cartoons were adapted from CS188 Intro to AI at UC Berkeley.]


Start of Semester
End of Semester
Finals

Final Exam

- The final exam will be closed notes, books, laptops, and people. (You will be given an instructor-provided “cheat sheet”)

- 105 minutes. 12/12 Wednesday 12:00-1:45pm. This room.

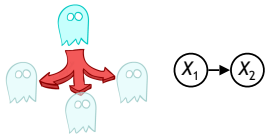
- Preparation:
  - Lecture Slides
  - Written Homework
  - Example Exam
  - Project 4: Ghostbusters

Instructor provided “cheat sheet”

Inference: Base Cases

$$P(X_1|e_1)$$

$$P(x_1|e_1) = P(x_1, e_1)/P(e_1)$$
$$\propto_{X_1} P(x_1, e_1)$$
$$= P(x_1)P(e_1|x_1)$$



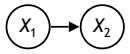
$$P(X_2)$$

$$P(x_2) = \sum_{x_1} P(x_1, x_2)$$
$$= \sum_{x_1} P(x_1)P(x_2|x_1)$$

Passage of Time

- Assume we have current belief P(X | evidence to date)

$$B(X_t) = P(X_t|e_{1:t})$$



- Then, after one time step passes:

$$P(X_{t+1}|e_{1:t}) = \sum_{x_t} P(X_{t+1}, x_t|e_{1:t})$$
$$= \sum_{x_t} P(X_{t+1}|x_t, e_{1:t})P(x_t|e_{1:t})$$
$$= \sum_{x_t} P(X_{t+1}|x_t)P(x_t|e_{1:t})$$

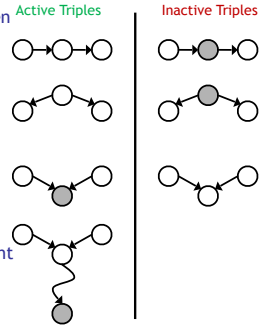
- Or compactly:

$$B'(X_{t+1}) = \sum_{x_t} P(X'|x_t)B(x_t)$$

- Basic idea: beliefs get “pushed” through the transitions
  - With the “B” notation, we have to be careful about what time step t the belief is about, and what evidence it includes

Active / Inactive Paths

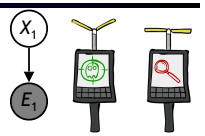
- Question: Are X and Y conditionally independent given evidence variables {Z}?
  - Yes, if X and Y “d-separated” by Z
  - Consider all (undirected) paths from X to Y
  - No active paths = independence!
- A path is active if each triple is active:
  - Causal chain A → B → C where B is unobserved (either direction)
  - Common cause A ← B → C where B is unobserved
  - Common effect (aka v-structure)
    A → B ← C where B *or one of its descendents* is observed
- All it takes to block a path is a single inactive segment



Observation

- Assume we have current belief P(X | previous evidence):

$$B'(X_{t+1}) = P(X_{t+1}|e_{1:t})$$



- Then, after evidence comes in:

$$P(X_{t+1}|e_{1:t+1}) = P(X_{t+1}, e_{t+1}|e_{1:t})/P(e_{t+1}|e_{1:t})$$
$$\propto_{X_{t+1}} P(X_{t+1}, e_{t+1}|e_{1:t})$$
$$= P(e_{t+1}|e_{1:t}, X_{t+1})P(X_{t+1}|e_{1:t})$$
$$= P(e_{t+1}|X_{t+1})P(X_{t+1}|e_{1:t})$$

- Basic idea: beliefs “reweighted” by likelihood of evidence
- Unlike passage of time, we have to renormalize
- Or, compactly:

$$B(X_{t+1}) \propto_{X_{t+1}} P(e_{t+1}|X_{t+1})B'(X_{t+1})$$

The Forward Algorithm

- We are given evidence at each time and want to know

$$B_t(X) = P(X_t|e_{1:t})$$

- We can derive the following updates

$$P(x_t|e_{1:t}) \propto_X P(x_t, e_{1:t})$$
$$= \sum_{x_{t-1}} P(x_{t-1}, x_t, e_{1:t})$$
$$= \sum_{x_{t-1}} P(x_{t-1}, e_{1:t-1})P(x_t|x_{t-1})P(e_t|x_t)$$
$$= P(e_t|x_t) \sum_{x_{t-1}} P(x_t|x_{t-1})P(x_{t-1}, e_{1:t-1})$$

We can normalize as we go if we want to have P(x|e) at each time step, or just once at the end…

- Forward Algorithm
- D-Seperation

Final Exam

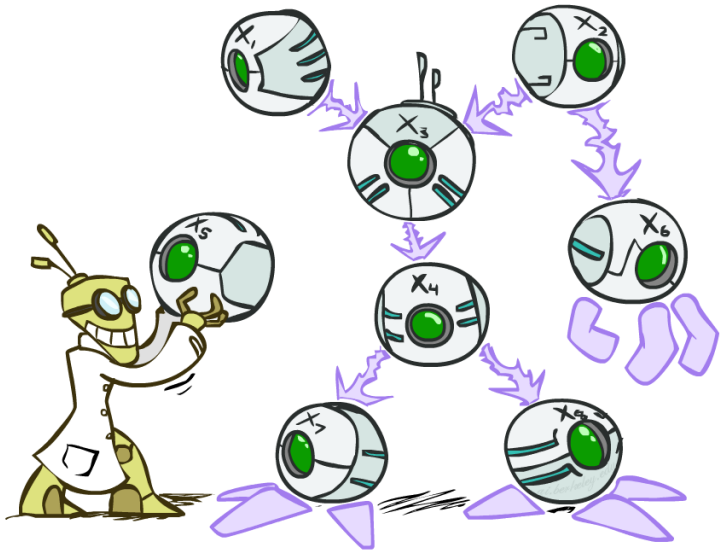
- Make sure you **understand** the fundamentals in addition to being able to procedurally execute algorithms.

- The exam will not test your knowledge of Python, however questions may assume **familiarity with the projects** and test ability of **writing pseudocode**.

- See **written homework** and **example exam** for examples

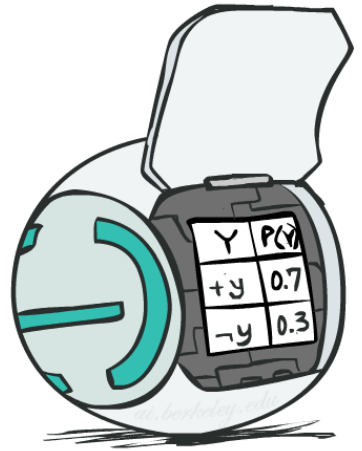
Possible Final Exam Topics

- Markov Models and HMMs:
  - Markov Model and HMM definition
  - Observation and Time Elapse
  - Exact Inference
  - Approximate Inference
  - Particle Filtering
  - Most Likely Explanation



- Bayes Nets:
  - Probabilistic Representations
  - D-Seperation
  - Inference
  - Variable Elimination

- Naive Bayes:
  - Classification
  - Prediction
  - Parameter Estimation
  - Smoothing



Possible Final Exam Topics

- Will **not** cover the follows:
  - Search
  - Reinforcement Learning
  - Neural Networks
  - Speech Recognition
  - Computer Vision
  - Natural Language Processing

Office Hours

- Office Hour - Wednesday, 12/5 4-5pm (DL 495)
- Office Hour - Friday, 12/7 4-5pm (DL 495)

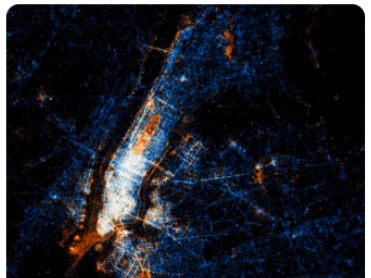
- Will also answer questions on Piazza

CSE AI Courses at OSU

- CSE 3521/5521: Intro to AI 1
- CSE 3522/5522: Advanced AI 2
- CSE 5523: Machine Learning
- CSE 5524: Computer Vision
- CSE 5525: Speech & Language Processing
- CSE 5526: Neural Networks
- Several special topic courses:
  - CSE 5539-0010: Social Media & Text Analysis.

http://socialmedia-class.org/

Social Media & Text Analytics Syllabus Twitter API Tutorial Homework



Social media provides a massive amount of valuable information and shows us how language is actually used by lots of people. This course will give an overview of prominent research findings on language use in social media. The course will also cover several machine learning algorithms and the core natural language processing techniques for obtaining and processing Twitter data.

Instructor

Wei Xu is an assistant professor in the Department of Computer Science and Engineering at the Ohio State University. Her research interests lie at the intersection of machine learning, natural language processing, and social media. She holds a PhD in Computer Science from New York University. Prior