CS 440 Final Instructions

This is a closed book exam. No notes are allowed. Electronic devices must be put out of sight/reach, ideally in a bag.

You have 2 hours of working time.

When you finish, turn in your exam at the front, show your ID to the proctor, and then quickly collect your stuff and leave the room.

We will be grading scanned copies of the exams using a tool that automatically separates out answers for each question.

> **Your answer to each question must be written inside the box provided.**
>
> **The backs of sheets will not be scanned.**

Overlong answers may be continued in the box on the last page. You may use the backs of sheets for scratch work.

You may remove this instruction sheet to use as scratch paper. Other than that do not take the exam apart. (If the sheets come apart accidentally, put your name on any loose sheets and warn the proctors when you turn it in.)

Points may be deducted for solutions which are correct but excessively complicated, hard to understand, poorly explained, or excessively hard to read.

Assume that answers require brief justification/work, unless there is clear indication to the contrary (e.g. it's a multiple choice question, it's asking you to repeat back a standard formula).

Please bring any apparent bugs to the attention of the proctors.

Cheating (e.g. looking at another student's exam) is obviously not allowed. Also, you may not do things that look like cheating, such as talking to your neighbor even if the topic is innocent. If your behavior is suspicious, we may take actions such as issuing warnings, reseating you, or having you take a makeup for the exam.

If you have to do something that could be misinterpreted, e.g. pick up a dropped eraser or silence a ringing cell phone, please do it conspicuously so everyone can easily understand what you're doing.

If you must leave the room during the exam (e.g. need the restroom), check in with the proctors when you leave and when you return.

CS 440, Fall 19 Final Exam

Name:_____ **NetID:**_____

1. (5 points) Why is it safe to use DFS when solving a constraint satisfaction problem?

2. (5 points) What is the difference between a MAP and an MLE estimate of $P(C \mid E)$.
   (C is an underlying cause and E an observable effect.)

Name:_____ NetID:_____

3. (5 points) Give the equation for the softmax of a set of classifier outputs $v_1, \ldots, v_n$

4. (5 points) How does a recurrent neural net differ from a standard (feedforward) network?

Name:_____ NetID:_____

5. (5 points) In the context of neural nets, what is "weight regularization"? What is it useful for?

6. (5 points) Why does a neural net have a non-linear activation function between its linear layers?

Name:_____ NetID:_____

7. (5 points) Suppose that we have computed a correct utility value U(s) for each state in our MDP. Give an equation defining the corresponding optimal policy π.

8. (5 points) In the cart-pole problem, the agent tries to keep the pole balanced as long as possible. To learn this, our reinforcement learning algorithm was given a positive reward at each non-final state, and then zero reward in the final state (i.e. when it has dropped the pole). How would its behavior change if the non-final rewards were negative?

9. (5 points) How does a situation space planner differ from a plan space (aka partial order) planner?

10. (5 points) Suppose that we are estimating probabilities of words in English text. Let count(w) be the number of times we have seen the word w in our training data. Give the equations for computing probabilities using Laplace smoothing. (Be sure to define any variables used in your equations.)

Name:_____ NetID:_____

11. (5 points) Suppose I have a circular robot of radius 2 moving in a 2D environment that contains a single circular obstacle of radius 1. What does the configuration space look like?

12. (5 points) How does word2vec prevent very frequent words from having too much influence on the embeddings?

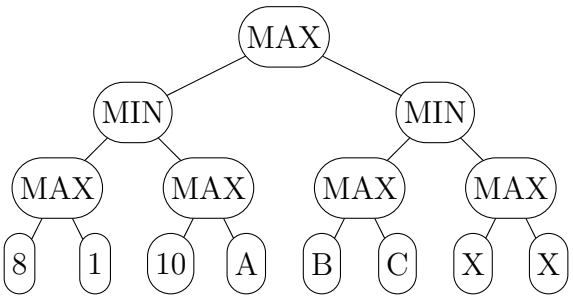
13. (5 points) Why do discussions of vector semantics algorithms sometimes talk about "cosine similarity" and sometimes "dot product"?

14. (5 points) In discussions of word meanings, what is the "principle of contrast"?

Name:_____ **NetID:**_____

15. (5 points) Minimax game search descends the game tree recursively. When does the recursion halt? How does it compute a node value before returning up the tree?

16. (5 points) For the minimax tree below, give integer values for A, B, and C that will prevent α-β pruning from examining the values in the two nodes labelled X.



Name:_____ **NetID:**_____

This box is additional answer space. Clearly indicate the problem number.