Practice Endterm Examination 3

CSCI 561: Foundations of
Artificial Intelligence
Spring 2015

Student ID: _____
Last Name: _____
First Name: _____
USC email: _____

Instructions:

1. Date: Thursday 4/30/2015 from 5:05pm – 6:20 pm
2. Maximum credits/points for this midterm: 100 points.
3. Credits/points for each question is indicated before the question.
4. No books (or any other material) are allowed.
5. Write down name, student ID and USC email address.
6. Your exam will be scanned and uploaded online.
7. Do NOT write on the 2D barcode. You could lose all the points for that page!
8. Do NOT write within a 1" margin of the edges of the page. You could lose points if the scanner cuts off the margins slightly.
9. No questions during the exam. If something is unclear to you, write that in your exam.
10. Be brief: a few words are often enough if they are precise and use the correct vocabulary studied in class.
11. When finished raise completed exam sheets until approached by proctor.
12. Adhere to the Academic Integrity code.

Planning (20pts)

"2 jugs problem" as planning problem

You have a well, and two water jugs of size 3 gallons and 5 gallons. The goal is to get 4 gallons in one of the jugs. In doing so, you are allowed to:

1. Fill up either jug completely
2. Empty either jug completely.
3. Pour water from one jug to the other, until the poured jug is empty, or the other jug is full.

Specify:

a. The initial state

0 0

b. The operators. For each operator, give the preconditions and effects.

(x,y) is the state

(x,y) to (3,y)

(x,y) to (x,5)

(x,y) to (0,y)

(x,y) to (x,0)

(x,y) to (0,x+y) if (x+y)<5

(x,y) to (x-5+y, 5) if (x+y)>5

(x,y) to (x+y, 0) if (x+y)<3

(x,y) to (3, x+y-3) if (x+y)>3

c. what is the correct plan?

1) Fill up Jug A with 5 litres and Fill jug B from A - there are 2 litres left in Jug A.

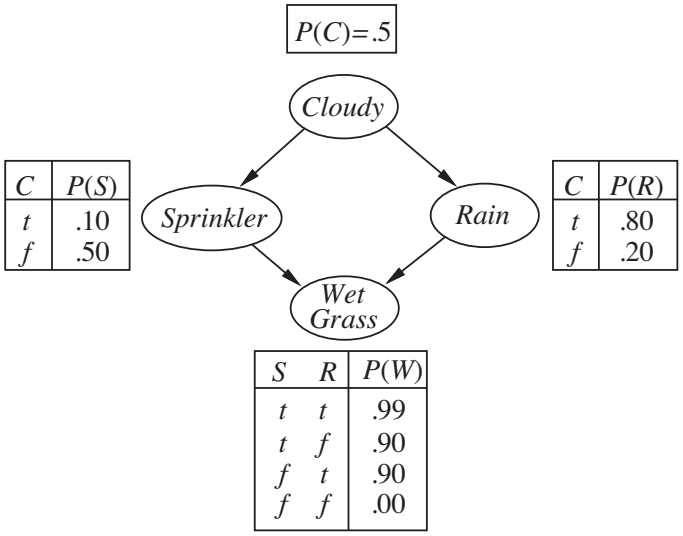
2) Empty Jug B and then tip the remaining 2 litres from Jug A into Jug B.

3) Re-Fill Jug A with 5 litres and then fill Jug B again from it. As Jug B already has 2 litres in it,

only 1 litre is taken out of Jug A. i.e. Jug A now has 4 litres left in it.

Reasoning about Uncertainty (30pts)

a. Given the Belief network for the wet grass problem, answer the questions below



1. Calculate the probability of P(*w, s, ¬c*). Give both the formula and calculations with values.

$P(x_1, \ldots, x_n) = \pi_{i=1} P(x_i \mid parents(X_i))$

P(w | s. r) P(s| ¬c) P(r| ¬c) P(¬c) + P(w | s. ¬r) P(s| ¬c) P(¬r| ¬c) P(¬c)

2. Calculate the probability of P(*w, s, c*). Give both the formula and calculations.

P(w | s, r) P(s| c) P(r| c) P(c) + P(w | s, ¬r) P(s| c) P(¬r| c) P(c)

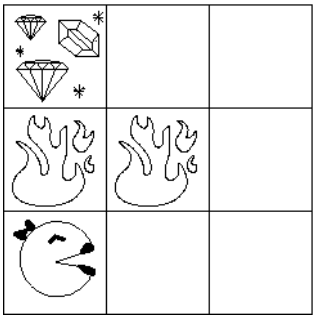
3. Calculate the probability of P(***S*** |*w*). Give both the formula and calculations with values.

$$\Pr(S=1|W=1) = \frac{\Pr(S=1, W=1)}{\Pr(W=1)} = \frac{\sum_{c,r} \Pr(C=c, S=1, R=r, W=1)}{\Pr(W=1)} = 0.2781/0.6471 = 0.430$$

$$\Pr(W=1) = \sum_{c,r,s} \Pr(C=c, S=s, R=r, W=1) = 0.6471$$

b. MDP - Treasure Hunting

While Pacman is out collecting all the dots from mediumClassic, Ms. Pacman takes some time to go treasure hunting in the Gridworld island. Ever prepared, she has a map that shows where all the hazards are, and where the treasure is. From any unmarked square, Ms. Pacman can take the standard actions (N, S, E, W), but she is surefooted enough that her actions always succeed (i.e. there is no movement noise). If she lands in a hazard (H) square or a treasure (T) square, her only action is to call for an airlift (X), which takes her to the terminal 'Done' state; this results in a reward of -64 if she's escaping a hazard, but +128 if she's running off with the treasure. There is no "living reward."



1. What are the optimal values, V^* of each state in the above grid if $\gamma = 0.5$?

128	64	32
-64	-64	16
2	4	8

2. What are the Q-values for the last square on the second row (i.e., the one without fire)?

Q((1, 2), N) = 16
Q((1, 2), W) = –32
Q((1, 2), S) = 4

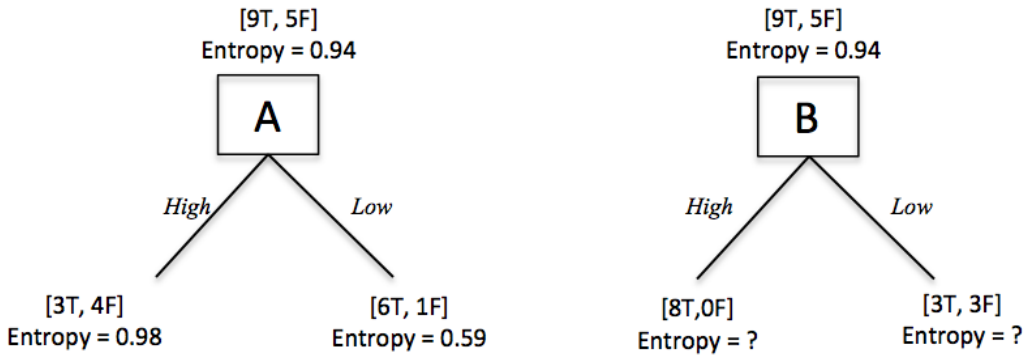
3. What's the optimal policy?

X	W	W
X	X	N
E	E	N

Machine Learning (30pts)

a. Decision Tree Learning

Consider the following decision trees for attributes A and B. At each node of the tree, [mT,nF] specifies that there are *m* 'True' and *n* 'False' examples. Entropy values are in bits.



1. Fill in the missing entropy values, in bits, for attribute B. 0 1

2. Calculate the information gain (or change in entropy), in bits, for each attribute.

Please show the steps clearly. You do not need to compute a final numerical result, just write down a formula that uses some of the numbers in the diagram above.

$$I(\frac{p}{p+n},\frac{n}{p+n}) = -\frac{p}{p+n}\log_2\frac{p}{p+n} - \frac{n}{p+n}\log_2\frac{n}{p+n}$$

$$IG(A) = I(\frac{p}{p+n},\frac{n}{p+n}) - remainder(A)$$

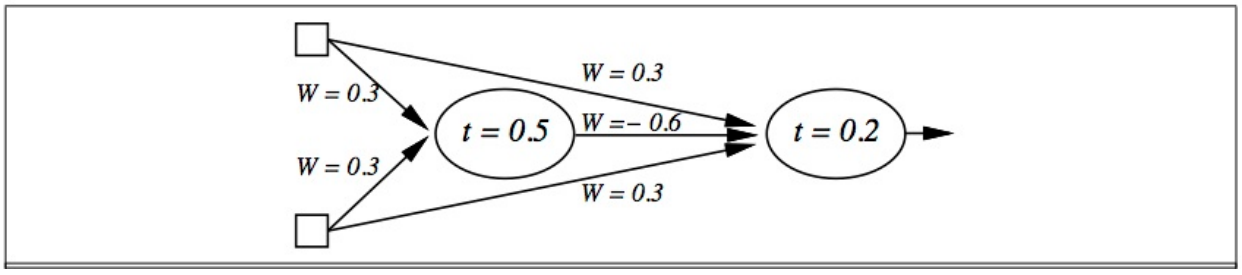
$$remainder(A) = \sum_{i=1}^{v}\frac{p_i+n_i}{p+n}I(\frac{p_i}{p_i+n_i},\frac{n_i}{p_i+n_i})$$

IG(A) = .94 – (7/14 I(3/7,4/7) + 7/14 I(6/7,1/7)) = .94 -.5(.98+.59)

IG(B) = .94 – (8/14 I(8/8,0/8) + 6/14 I(3/6,3/6)) = .94 – 3/7

3. Which one of the two attributes A and B is a better classifier according to the decision tree learning (DTL) algorithm? B

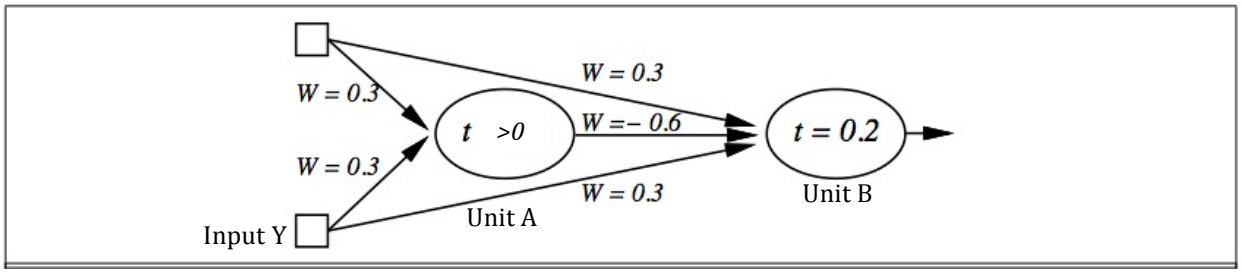
b. Draw the neural network to solve the XOR function for two inputs. Specify what type of unit you are using.



c. Circle each learning technique that is a **supervised** learning technique. For what types of problems would you apply each of the following learning techniques?

- Decision Tree
- Neural Net
- Bayesian Learning
- Example-based Learning
- Reinforcement Learning
- Support Vector Machine

d. Given this diagram of a Neural Network with two perceptron units A and B, answer the questions below.



- When input X = 0 and input Y = 0, what does the Unit A output? What does the Unit B output? 0 0

- When input X = 0 and input Y = 1, what does the Unit A output? What does the Unit B output? 1 0

- When input X = 1 and input Y = 0, what does the Unit A output? What does the Unit B output? 1 0

- When input X = 1 and input Y = 1, what does the Unit A output? What does the Unit B output? 1 0

- What Boolean function does this Neural Network compute? Always 0

Short Answer (20pts)

Keep your answers brief, one or two sentences.

1. [3pts] List 3 reasons **WHY** machine learning is needed?

Unknown environments
Adaptability
Lazy
Autonomous

2. [3pts] What is Ockham's razor? How is it used in neural net learning?

Bias for simplest hypothesis

Prefer fewer hidden units

3. [14pts] For the questions below choose any 2 topics from the guest lectures:

a. Describe how each topic relates to search, knowledge representation, reasoning about uncertainty, learning
b. Describe the limitations/pitfalls and future directions of each topic
c. Compare and contrast the two research topics

See lecture videos/slides