**CS 540 Section 35-W Spring 2015 Exam 1**

**YOUR NAME \_\_\_\_\_\_\_\_\_\_\_\_Youli Zhou\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

/\* **You are to complete this exam under a honor system:**

\* **you shall not give or receive help in completing**

\* **the exam; the entire work must be your own.**

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\* DO NOT ASK ME ANYTHING ABOUT THE EXAM.

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\* JUST ANSWER THE QUESTIONS TO THE BEST OF YOUR

\* KNOWLEDGE.

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\* YOU MAY NOT SIMPLY COPY TEXTS FROM THE PAPER

\* AS YOUR ANSWERS. **USE YOUR OWN WORDS**.

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\* YOUR ANSWERS MUST BE BASED ON THE PAPER HOWEVER.

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**PART I General concept assimilation**

**1. (6 point)**  Consider 3 pitchers of respective sizes 10 quarts, 7 quarts and 4 quarts, with no

markings on them. Initially, the 10-quart pitcher is full of water, the other two pitchers empty.

Consider the problem of **getting 2 quarts of water into the 7-quart or the 4-quart pitcher**.

The rules are:

**(i)** there is no other source of water (in particular, no pump);

**(ii)** you may pour water from one pitcher into another;

**(iii)** you may not discard water (e.g. pour it onto the ground).

Think of the problem as a *state space search* problem. Assume that you are using the Python

***simpleai***framework for state space search. In particular, assume a class **ThreePitchersProblem**,

sub-classing **SearchProblem**.

1. How is a state represented in the Python code, for this problem?

**# coding=utf-8**

**from simpleai.search import SearchProblem**

**class ThreePitchersProblem(SearchProblem)**

**def \_\_init\_\_(self, j1, j2, j3):**

**super(WaterJugProblem, self).\_\_init\_\_(initial\_state=(10, 0, 0))**

**self.jug1=j1**

**self.jug2=j2**

**self.jug3=j3**

1. Show your complete Python code for the required ***is\_goal()*** method.

**def is\_goal(self, s):**

**return s[0] == (8, 2, 0) or (8, 0, 2) or (6, 2, 2)**

**(c)** You recall that you will need to write an ***actions()*** method that returns a list *actions*

(the list *actions* may of course be named differently) consisting of the allowed moves

from a given state.

An action appended to this list *actions* is usually a pair like

( 'Description', next state )

And one way of making a legal action is to write an appropriate *if condition* for

appending the action onto the list, instead of checking each state by a separate

method.

Anyway, write the Python code snippet (to be part of the ***actions()*** method) for

the action of

pouring everything in the 4-quart pitcher into the 10-quart pitcher.

**def actions(self, s):**

**‘ ‘ ‘ s[0] as 10-quart pitcher, s[1] as 7-quart pitcher, s[2] as 4-quart pitcher ’ ’ ’**

**Actions=[]**

**if (s[2]+s[0] <= 10) and (s[2] > 0):**

**actions.append(" pouring everything in the 4-quart pitcher into the 10-quart pitcher", (s[0]+s[2], 0, 0))**

**return actions**

**(d)** Likewise, write the Python code snippet for the action

"Pour water from the 7-quart pitcher into the 4-quart pitcher until the latter is full."

**def actions(self, s):**

**‘ ‘ ‘ s[0] as 10-quart pitcher, s[1] as 7-quart pitcher, s[2] as 4-quart pitcher ’ ’ ’**

**Actions=[]**

**if (s[1]+s[2] >= 4) and (s[1] > 0):**

**actions.append(" Pour water from the 7-quart pitcher into the 4-quart pitcher until the latter is full ", (10, s[1]-(4-s[2]), 4))**

**return actions**

**2. (6 points)** In a certain turn-based board game, one player uses 10 identical *blue* tokens and

the other player 10 identical *red* tokens, that they place and move on a 50-slot

one-dimensional board.

For this question, the exact rules of the games are *not* important. However, the rules state

that one end of the board must always contain a “blue” token, and the other end must

always contain a “red” token.

**(a)**  State very clearly how you would think of a state in this game.

**numRedToken = 10**

**numBlueToken = 10**

**numSlot = 50**

**redToken = 1**

**blueToken = 2**

**state = [0] \* numSlot**

**state[0] = redToken**

**state[-1] = blueToken**

**(b)** Write a Python code snippet to randomly replace a “blue” on the board (not the one

at the end point) with a “red”.

**import random**

**while True:**

**s = random.randint(1, numSlot-1)**

**if state[s] == blueToken:**

**state[s] = redToken**

**break**

**(c)** Write the complete code of a Python class method to count how many “reds” are

on the board (that is, at any given state s).

**def countReds(self, s):**

**cnt = 0**

**for item in s:**

**if item == self.redToken:**

**cnt += 1**

**return cnt**

**(d)** Write the complete code of a Python class method to reverse the contents of the

board (state) s, keeping the “blue” and “red” at the end points.

**def reverse(self, s):**

**return [s[0]] + s[1:-1][::-1] + [s[-1]]**

**3. (1 point)** Which of the following statements are true and which are false,

about (blind/un-informed) breadth-first search and depth-first search?

1. breadth-first is a good idea if nodes have a very small number of children**(true)**
2. depth-first is a good idea if you have long paths that never reach a goal or a dead end **(false)**
3. breadth-first uses a stack (queue with "enqueue-at-front") to store its frontier**(false)**
4. depth-first uses a regular queue (queue with "enqueue-at-end") to store its

Frontier.**(false)**

**4. (1 point)** When applying a genetic algorithm, it is important to “consolidate” what has

already been learned by the individuals in the current population.

What is the primary operation used for consolidation of knowledge in a genetic algorithm?

**EC-P = Evolutionary Computation and Population-based methods**

When applying a genetic algorithm, it is also important that “new aspects” of the problem

be considered. That is, innovation must be introduced into potential solutions to the

problem.

What is the most common operator used for innovation in genetic algorithms?

**The most common operator used for innovation in genetic algorithm is Mutation operator**

**5. (3 points)** Consider a relational database table of sale transactions (say at Walmart), one of

whose columns is totalAmount (of transaction).

**(a)** State, in your own words and as clearly as possible, how the **probability that a**

**transaction is more than 50 dollars**, may be estimated from the table.

**We can assume that sale transaction total number is N in one day, among these transactions, it has M number of totalAmount is more than 50 dollars, so we can assume the probability that a transaction is more than 50 dollars is P(X)= **

**(b)** Likewise, state in words how the **conditional probability**

**p( transaction is over 50 dollars | transaction contains diapers )**

may be estimated?

**It can be estimated as the probability of transactions is over 50 dollars if the transaction contains diapers. If we assume the probability of transaction is over 50 dollars is P(A), the probability of transaction contains diapers is P(B), so it is also can be wrote as**

**p( A | B )= It is easily to count the number p (transaction is over 50 dollars | transaction contains diapers)**

**(c)** More generally, how is a **conditional probability like**

**p( X1, X2, …, Xn | E1, E2, …, Ek )**

estimated?

**p( X1, X2, …, Xn | E1, E2, …, Ek )=**

**6. (2 points)** Give an argument that the following *Bayes* probability formula holds true:

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**We have ;**

**;**

**;**

**Hence  can be wrote as**

**;**

**7. (2 points)** Recall that the JPD (Joint Probability Distribution) of a system (e.g. a Bayesian belief

network) allows us to answer ***all*** relevant probability questions about the system.

**(a)** Why is it then that we do not just store the JPD of any system of interest?

**It is usually too large to create or use in its explicit form, the JPD is big (exponential in the number of variables), there is no way to store the entire JPD (and then search it) for most practical systems.**

1. Suppose you have a system consisting of 1022 nodes (variables) where half of the nodes are

*binary* (i.e. 2 possible values), and the other half are *ternary* (i.e. 3 possible states).

How many entries would be in the JPD?

**Assume A is number of nodes are binary**

**B is number of nodes are ternary**

**So we get A= B= 511 nodes**

**So the entries can be calculated as 2\*3\*511\*511+4\*= 201584901**

**8. (3 points)**

**(a)** Translate each of the following statements into an equality between two probabilities.

**(i)**  A is *conditionally independent* of B given C and D.

**(ii)** C is *conditionally independent* of D given B.

(i). P(A| B, C, D)= P (A| C,D)

(ii). P(C| D,B)=P(C| B)

**(b)** Assume now that both conditions **(i)** and **(ii)** above hold true. Give an argument that the

following also holds true:

p( A, C | B, D ) = p( A | C, D ) p( C | B )

P(A, C | B, D)=

And (i) and (ii) hold true which means

P( A | C, D ) P( C | B )=P(A| B, C, D)P(C| D,B)=

==P(A, C | B, D)

QED ( proved )

**PART II Paper review and comprehension**

The paper (in PDF) to read is

**The singularity and the state of the art in artificial intelligence**

Read the paper and answer the following questions. Remember that your answers must

be based on the contents of the paper, not something you just make up.

Write complete sentences in your answers. We are hit hard by accreditation agencies for

not insisting on students’ making efforts to write properly. **I will take points off for**

**not making sentences.**

**1.** **(1 point)** State, in your own words and as clearly as possible, what you believe to be

the main conclusion drawn by the author, from his analysis of the current

state of artificial intelligence.

**2.** (**1 point)** What are the two areas of artificial intelligence on which the author is

basing much of his analysis?

**3.** **(1 point)** According to the author, which kind of reasoning is the most difficult

to automate with a computer?

**4.** **(1 point)** According to the paper, which English text processing tasks would be the

most successfully automated?

**5.** **(1 point)** According to the paper, what makes automated video processing (by

computers) very difficult?

**6.** **(1 point)** According to the paper, which commercial product, allowing English

queries, is unable to correctly answer simple questions that most scientists

would find rather trivial?