Computer Science 108

Fall 2006

Final Exam

15 December 2006

Question	Points	Score	Description
1	16		Logic
2	14		Path Planning & Search
3	10		Learning
4	15		Natural Language
5	10		Vision
6	10		IC Programming
7	10		IC Debugging
8	15		Essay
total	100		

This exam is "open book and open notes." You may use the Cawsey text, the reading packet, your own class notes, and your solutions to the problem sets. The only other source you may use is me (for clarification of questions). *Do not discuss any aspect of the exam with anyone other than me*. Even giving another student your impression of the difficulty of a problem is to be avoided. You have 2.5 hours to complete the exam.

Your Name (Please print) ______________________________

I have neither given nor received aid on this examination

____

1) (16%) Knowledge Representation and Inference in First Order Logic

Consider the following statements.

Animals can outrun any animals that they can eat.

Carnivores are animals that can eat certain other animals.

Outrunning is transitive: If x can outrun y and y can outrun z, then x can outrun z.

Any lion can eat any zebra.

Any zebra can outrun any dog.

Lions are animals.

Zebras are animals.

Dogs are animals.

The first two above can be represented in First Order Logic as follows:

Animals can outrun any animals that they eat.
$\forall x\ \forall y\ \text{Animal}(x) \land \text{Animal}(y) \land \text{CanEat}(x, y) \Rightarrow \text{CanOutrun}(x, y)$

Carnivores are animals that can eat certain other animals.
$\forall x\ \text{Carnivore}(x) \Rightarrow \text{Animal}(x) \land (\exists y\ \text{CanEat}(x,y) \land \text{Animal}(y))$

a) Represent the remaining English sentences above in First Order Logic.

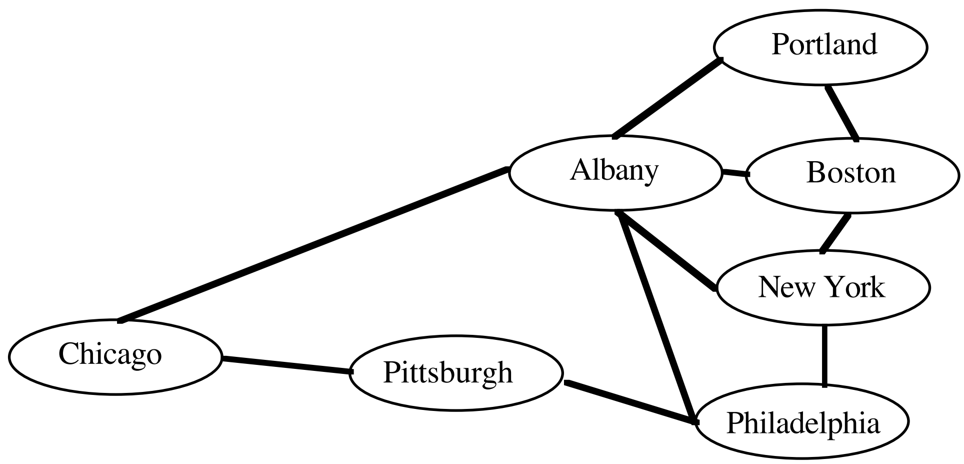
b) Say that you are given the following information:

Zebra(Zeke)	*Zeke is a zebra.*
Lion(Lizzy)	*Lizzy is a lion.*
Dog(Dizzy)	*Dizzy is a dog.*

Use the rules of inference for First Order Logic to show CanOutrun(Lizzy, Dizzy) , i.e., that Lizzy can outrun Dizzy.

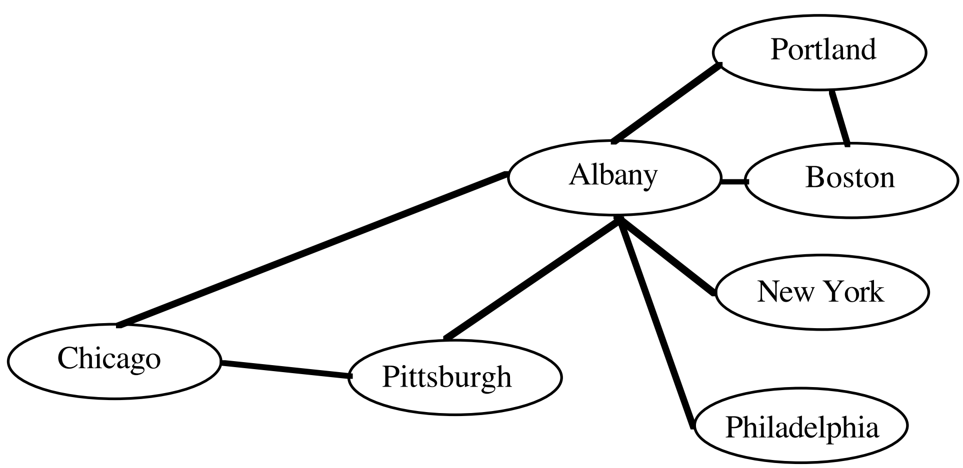
2) (14%) Path Planning and Search

Consider the following robot path-planning problem: “Visit every city in the figure below, starting and ending in New York. With the exception of New York, every city must be visited *exactly once*. In order to move from one city to another, there must be a direct connection between those two cities.”



One solution to the problem might be the following route: New York, Philadelphia, Pittsburgh, Chicago, Albany, Portland, Boston, New York.

Not every such problem will have a solution that meets the criteria given. For instance, the following configuration of cities has no solution:



a) Formulate this problem as state space search. That is, given a figure like one of those above, the search procedure should find a legal path from New York to New York, if one exists.

Describe the information contained in a state.

What does the initial state look like?

b) Imagine that you are doing breadth-first search on the first figure given above. Draw the search tree after two full levels have been expanded. (The expansion of the initial state is the expansion of the first level, so you'll just have to give one level beyond that.)

c) Does your formulation of the problem (i.e., the way you've designed states) help you to generate only legal solutions? Or is it possible that you will generate illegal solutions? How can you guarantee that only legal solutions are generated?

d) If you had the option of applying either breadth-first or depth-first search to this problem, which would you choose? Why?

3) (10%) Decision Tree Learning

This question asks you to simulate the process of building a decision tree from data. In this case, the decision tree will help a student decide whether they can consider a restaurant to be a dinner option.

Assume the decision tree-learning algorithm is given the following set of training examples.

Access to car?	Restaurant on Spring St?	Classification (Restaurant is viable option)
Yes	Yes	Yes
Yes	No	Yes
No	Yes	Yes
No	No	No

a) What is the entropy of this collection of training examples with respect to the target classification? (i.e., *Restaurant is viable option*)

b) What is the information gain of *Access to car?*

c) What is the information gain of *Restaurant on Spring Street?*

d) Which attribute will be chosen as the first test at the root of the decision tree? Why?

e) Sketch the complete decision tree.

4) (15%) Natural Language Processing

This question asks you to consider two words (squash and seat) in the context of example sentences. Specifically, you will argue whether their meanings can be determined primarily by a syntactic analysis or whether a deeper semantic analysis is required.

You will need to use the following simple grammar:

S → NP VP
NP → det noun
NP → noun
NP → noun noun (this is a noun-noun phrase – for example, "Mathematics class" or "doughnut hole" or "photocopy machine".)
NP → NP PP
PP → prep NP
VP → verb adj
VP → verb NP

The meanings of the symbols and abbreviations in the grammar are as follows:
S = sentence
NP = noun phrase
VP = verb phrase
PP = prepositional phrase
det = determiner
prep = preposition
adj = adjective

a) Consider the three sentences below. First show the parse tree for each sentence. Then, for each sentence argue whether the meaning of "squash" can be determined primarily by syntactic analysis or not.

Squash racquets are light.

Squash soup is tasty.

School children squash bugs.

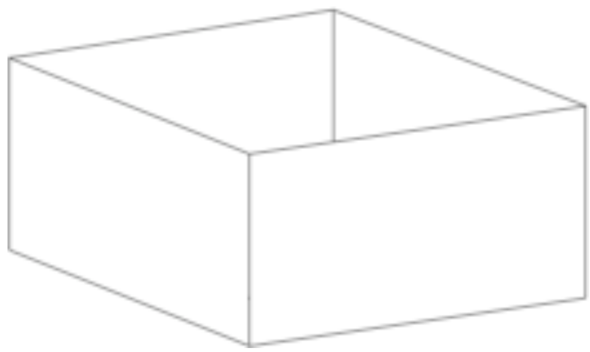
b) Now consider the following two sentences. Show the parse tree for each. Argue whether the meaning of “seat” can be determined primarily by syntactic analysis or not.

Hostesses seat people at restaurants.

Seat cushions cover the chairs in the library.

5) (10%) <u>Vision</u>

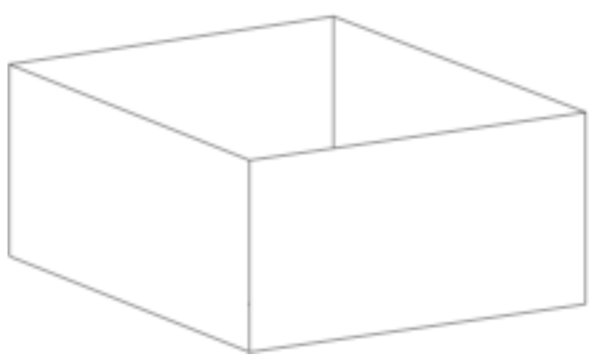
Imagine that a vision system is processing the following line drawing. In particular, imagine that the system needs to determine the orientation of the object.



a) Use the constraint propagation algorithm discussed in class to label each of the edges in the diagram above. Recall that the label choices are as follows:

- +
- –
- <
- >

b) Label the edges again, this time giving the orientation *you believe each to have*. A copy of the line drawing is given below:



c) Does your set of labels match the labels assigned by the algorithm? Why or why not?

6) (10%) Interactive C Programming

Fill in the details of the function `calcSpeed` below.

The function takes two values as parameters. The first, `currSpeed`, gives the current power level of the motors. The second, `currLight`, gives the current light reading. If the light value is dark (i.e., greater than 125), then the function should return a new speed that is 20 less than the current speed. If the value is bright, (i.e., not dark), then the function should return a value of 100.
The function should never return a value less than 0. If a value less than 0 is calculated, the function should return 0.

```
int calcSpeed(int currSpeed, int currLight) {









}
```

7) (10%) Interactive C Debugging

A new semester has begun and a new group of CS 108 students is learning Interactive C. You've been hired as a TA for the course, since you did so well when you took it.

This week in lab, the students have been asked to write a program that will do light sensing. There are four photocell light sensors on each robot vehicle. The vehicle should behave as follows. If there is "enough" light on the right side of the vehicle, the speed of the right motor should be 50. If it is fairly dark on the right side of the vehicle, the speed should be 100. Similarly for the left side. You may assume that if sum of the readings of the sensors on one side of a vehicle is less than 100, then there is "enough" light on that side.

The vehicle should not start until the start button is pressed. It should stop when the stop button is pressed.

Unfortunately, the program below doesn't work. Please help the group who wrote it find the bugs.

```
int RIGHT_MOTOR = 1;
int LEFT_MOTOR = 3;

int LEFT_FRONT_LIGHT = 3;
int RIGHT_FRONT_LIGHT = 4;
int LEFT_BACK_LIGHT = 5;
int RIGHT_BACK_LIGHT = 6;

main(){
  start_press();

  while (!stop_press()) {
    if ((analog(LEFT_FRONT_LIGHT) + analog(LEFT_BACK_LIGHT))<=100){
      motor(LEFT_MOTOR, 50);
    } else {
      motor(LEFT_MOTOR, 100);
    }
    if ((analog(RIGHT_FRONT_LIGHT) + analog(RIGHT_BACK_LIGHT))<=100){
      motor(RIGHT_MOTOR, 50);
    } else {
      motor(RIGHT_MOTOR, 100);
    }
  }
}
```

8) (15%) Essay: The nature of thought

In his paper "Computing Machinery and Intelligence," Alan Turing itemizes and discusses opinions opposed to his own. These are given in Section 6 ('Contrary views on the main question'). Into which category would Turing place John Searle? Into the group with theological objections? Heads in the sand? Those with mathematical objections? Etc?

Summarize (briefly) Turing's reaction to the group of objectors in which you classified Searle.

(Briefly – i.e., 1 paragraph) explain what you think Searle would say to Turing in response.