CS 540-1: Introduction to Artificial Intelligence

Exam 1: 11am-12:15pm, October 19, 1994

CLOSED BOOK

(one page of notes allowed)

Write your answers on these pages and show your work. If you feel that a question is not fully specified, state any assumptions you need to make in order to solve the problem. You may use the backs of these sheets for scratch work.

Write your name on this and all other pages of this exam. Make sure your exam contains four problems on eight pages.

Name _____

Student ID _____

Problem	Score	Max Score
1	_____	35
2	_____	20
3	_____	30
4	_____	15
Total	_____	100

PROBLEM 1 - First-Order Predicate Calculus (35 points)

a) Give *one* (1) predicate calculus representation for each of these English sentences. If you feel a sentence is ambiguous, provide a more detailed sentence that better captures the version represented by your FOPC. Choose reasonable constants, predicates and functions - the predicate *dogs-chase-cats* is *not* an acceptable answer to the first question.

i) Dogs chase cats.

ii) Some computers are cheap.

iii) Every book is valuable.

iv) Some chess pieces move diagonally, or my name isn't Bobby Fischer.

v) All pianists and conductors know a piece written by Mozart.

b) For the English-FOPC pairs below, provide an *interpretation* that shows that the FOPC on the right does *not* represent the English on the left. Briefly explain your answers.

i) *All movie stars are envied.* $\forall X [movie\_star(X) \wedge envied(X)]$

ii) *All children, when healthy, like ice cream.* $\forall X [child(X) \rightarrow [healthy(X) \vee \neg likes(X,ice\_cream)]]$

PROBLEM 2 - Other Forms of Knowledge Representation (20 points)

a) Draw a simple *ISA hierarchy* that (partially) represents the classes offered at the University of Wisconsin - Madison. Do not, of course, draw the entire hierarchy, but do meet the following constraints:

- your hierarchy must be at least three (3) levels deep,
- your hierarchy must contain at least one (1) *inheritable property*
- your hierarchy must contain at least one (1) *overridden default*

b) Represent the following in *conceptual dependency*.

i) *Ali punched Frazier.*

ii) *Bill told Sue that Mary told John to visit Sue.*

PROBLEM 3 - Deduction (30 points)

a) Use *binary resolution* to solve the problem below.

GIVEN:	(1)	$\forall$ X [p(X) $\rightarrow$ q(X)]
	(2)	$\forall$ X [p(X) $\rightarrow$ [$\exists$ Y w(Y)]]
	(3)	$\forall$ X $\forall$ Y [[q(X) $\wedge$ w(Y)] $\rightarrow$ s(X)]
	(4)	p(mary)
SHOW:		s(mary)

The givens in clausal form:

The negated query in clausal form:

The resolution proof:

b) Show how *putting FOPC wff's in clausal form and then doing binary resolution* can produce the same new wff as the following *natural deduction* inference rules produce. You can show this by producing one concrete example, using P's and Q's, for each case; you do not have to show this for the general case.

i) modus tolens

ii) and elimination

PROBLEM 4 - Common Lisp (15 points)

Write a car-cdr recursive Common Lisp function `(contained-in? item sexpr)`. This function should return non-nil (i.e., ‘‘true’’) if `item` is *anywhere* in `sexpr`. For example,

```
> (contained-in? 3 '(1 2 3 4 5))
t  ;;; actually, anything other than NIL is an acceptable result

> (contained-in? '(a b) '(a b (c d) (a) (b)))
nil

> (contained-in? '(a b) '(1 2 ((((a b) c))) 6))
t

> (contained-in? '(a b) '(a b))
t
```

```
(defun contained-in? (item sexpr)
       "Is ITEM contained anywhere in SEXPR?"
```