

# **ECE 479/579**

Principles of Artificial Intelligence

Dr. M. Marefat

**Assignment # 3**

**Automated Deduction**

1. (20 pts.)

Prove the validity of the following wffs using the method of resolution refutation:

- (a)  $(\exists ?x) \{ [P(?x) \Rightarrow P(A)] \wedge [P(?x) \Rightarrow P(B)] \}$
- (b)  $(\forall ?z) [Q(?z) \Rightarrow P(?z)] \Rightarrow \{ (\exists ?x) \{ [Q(?x) \Rightarrow P(A)] \wedge [Q(?x) \Rightarrow P(B)] \} \}$
- (c)  $(\exists ?x)(\forall ?y) P(?x, ?y) \Rightarrow (\forall ?y)(\exists ?x)(P(?x, ?y))$

2. (20 pts.)

Show the steps required to put the following into clause form:

- (a)  $(\forall ?x)(\forall ?y) [On(?x, ?y) \Rightarrow Above(?x, ?y)]$
- (b)  $(\forall ?x)(\forall ?y)(\forall ?z) [Above(?x, ?y) \wedge Above(?y, ?z) \Rightarrow Above(?x, ?z)]$
- (c)  $(\forall ?x)(\forall ?y) [Above(?x, ?y) \wedge \neg On(?x, ?y) \Rightarrow (\exists ?z) [Above(?x, ?z) \wedge Above(?z, ?y)]]$

3. (20pts.) All people who are not poor and are smart are happy. The people who read are smart. John can read and is wealthy. Anyone who is wealthy is not poor. Happy people have exciting lives. Using resolution, find someone who has an exciting life.

Ontology:

Poor(?x) -> ?x is poor

Smart(?x) -> ?x is smart

Happy(?x) -> ?x is happy

Read(?x) -> ?x reads

Wealthy(?x) -> ?x is wealthy

Excitinglife(?x) -> ?x has exciting life

4. (20 pts.)

Consider the following piece of knowledge: Tony, Mike, and John belong to the Alpine Club. Every member of the Alpine club who is not a skier is a mountain climber.

Mountain climbers do not like rain, and anyone who does not like snow is not a skier.

Mike dislikes whatever Tony likes and likes whatever Tony dislikes. Tony likes rain and snow.

Represent this knowledge as a set of predicate calculus statements appropriate for a backward rule-based deduction system. Show how such a system would answer the

question. “Is there a member of the Alpine club who is a mountain climber but not a skier?”

5. (20 pts.)

A blocks-world situation is described by the following set of wffs:

ONTABLE(A)	CLEAR(E)
ONTABLE(C)	CLEAR(D)
ON(D,C)	HEAVY(D)
ON(B,A)	WOODEN(B)
HEAVY(B)	ON(E,B)

Draw a sketch of the situation that these wffs are intended to describe.

The following statements provide general knowledge about this blocks world:

Every big, blue block is on a green block.  
Each heavy, wooden block is big.  
All blocks with clear tops are blue.  
All wooden blocks are blue.

Represent these statements by a set of implications having single-literal consequents. Draw a consistent AND/OR solution tree (using B-rules) that solves the problem: “Which block is on a green block?”

**Extra Credit:**

6. (50 pts.)

Use resolution to solve the following puzzle problem from Wos et al. (1984). There are four people: Roberta, Thelma, Steve and Pete. The four hold eight different jobs. Each person has exactly two jobs. The jobs are, without sex bias, chef, guard, nurse, telephonist, police officer, teacher, actor and boxer. The nurse is a male. The husband of the chef is the telephonist. Roberta is not a boxer. Pete has no education past the ninth grade. Roberta, the chef and the police officer went golfing together. An actor is assumed to be a male, and an actress a female. Nurses, police officers and teachers should be high school graduates. Who holds which jobs?