

**1. (4 %) Complete the following sentences:**

- (a) Logic programming systems are also called deductive databases.
- (b) The process of pattern matching to make statements identical is called unification.

**2. (12%) Give a concise answer to each question below:**

- (a) What are the differences between procedural programming and logic programming?

Procedural programming	Logic programming
Architecture: Von Neumann machine (sequential steps)	Abstract model (dealing with objects and their relationships)
Syntax: Sequence of statements (a, s, I)	Logic formulas (Horn Clauses)
Computation: Sequential statements execution	Deduction of the clauses
Control: Logic and control is mixed together	Logic and control can be separated

- (b) What are the deficiencies of Prolog?

- Resolution order control  
Ordering of pattern matching during resolution  
Cut operator
- Closed world assumption  
It has only the knowledge of its database  
A true/fail system rather than a true/false
- The negation Problem  
Prolog not operator is not equivalent to logical NOT operator

- (c) What are the motivations for Logic programming?

- Logic is used to represent program
- Deductions are used as computation
- A higher-level language does more automatically – we can concentrate more on what is to be done and less on how to do it
- Ideal: Algorithm = logic (what) + Control (how) – only specify logic and let system take care of control

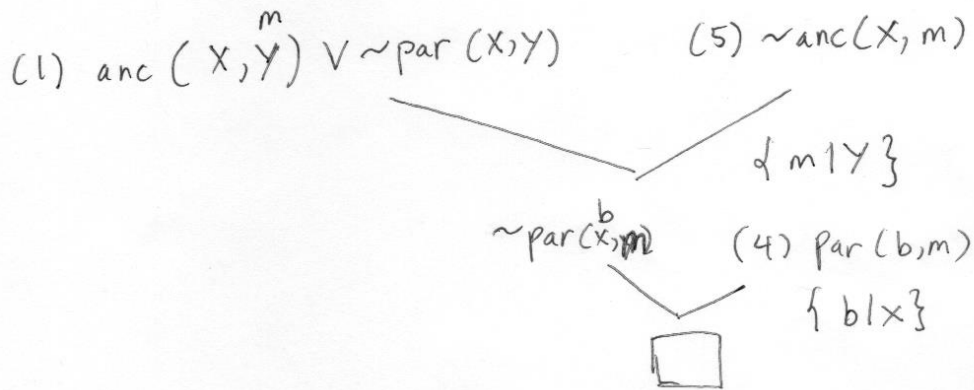
**3. (9%) Use the set notation to describe resolution as a refutation system.**

- Given two clauses, we can infer a new clause by taking the disjunction of the two clause & eliminating the complementary pair of literals
- Given a set of clauses  $S$  & and goal  $G$ ,  
Negate the goal  $G$   
 $\{S\} \cup \{\neg G\}$   
Existence of contradiction  $\Rightarrow$  derivation of empty clause
- Based on  $\{S\} \cup \{\neg G\}$  is inconsistent if  $\{S\} \cup \{G\}$  is consistent

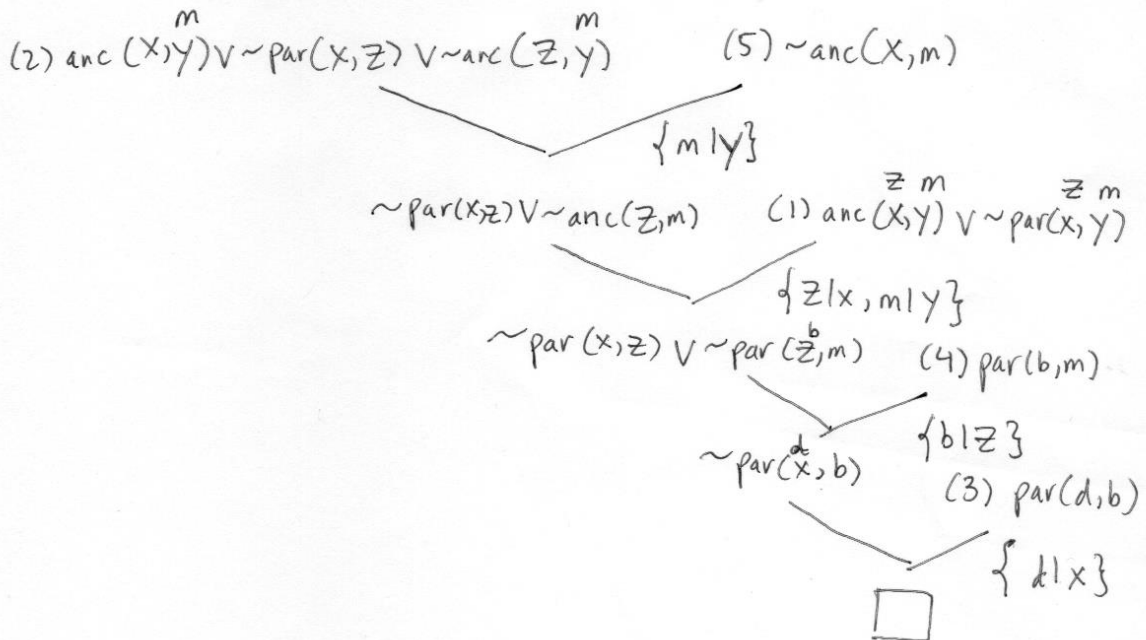
**4. (25%) Give deduction trees of resolution** (a) using (1) and (5); (b) using (2) and (5)

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(a) (1) and (5)



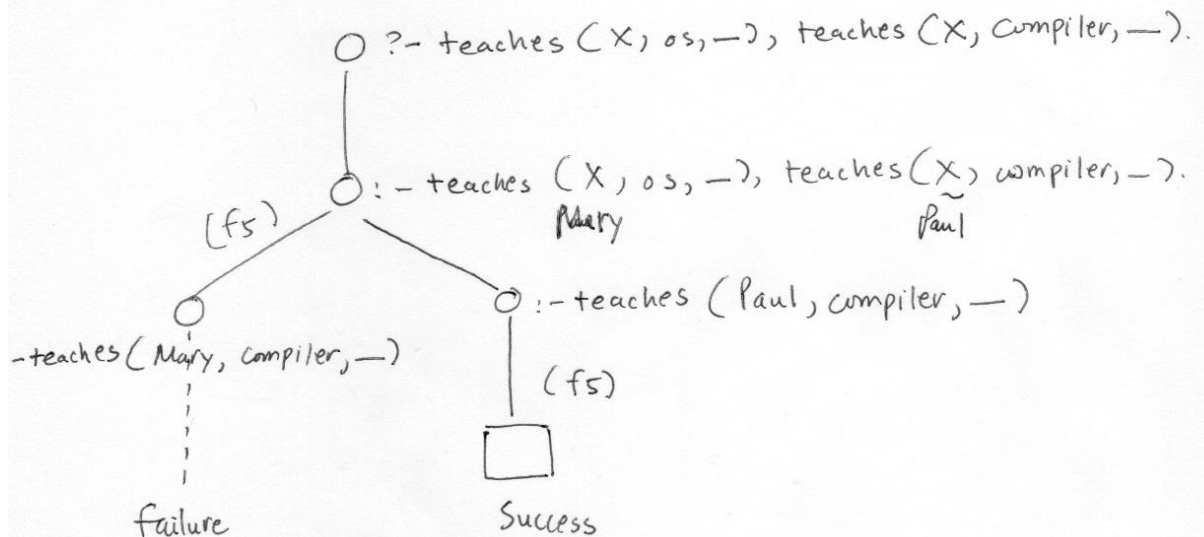
b) using (2) and (5)



5. (20%) a) Try to trace through search process for Query 2

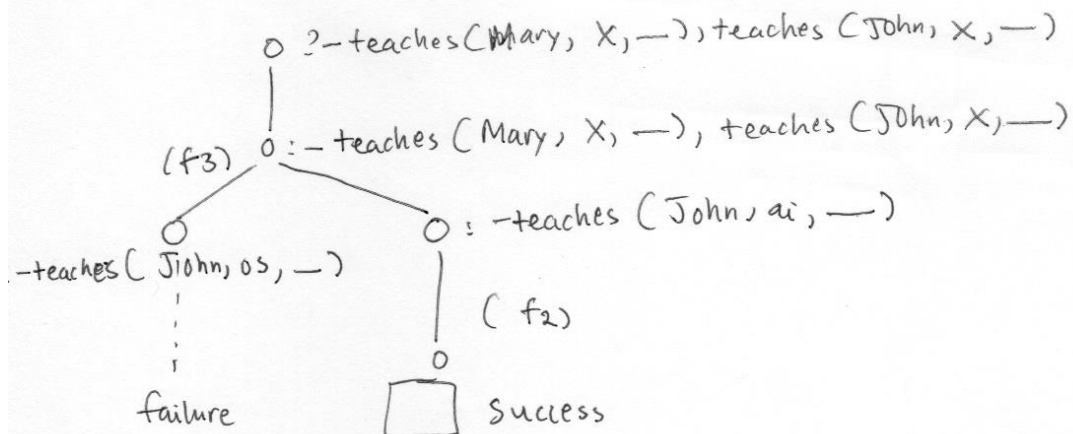
Query 2: who teaches both os and compiler?

?- teaches(X, os, -), teaches(X, compiler, -).



b) Try to trace through query 1, but with sub-goals reversed

Query 1 with sub goals reversed:  $?- \text{teaches}(\text{Mary}, X, -), \text{teaches}(\text{John}, X, -).$



6. (30%) **Exam problem contribution.** Using the Example "Every scientist is logician" (see Canvas ExecofProlog example) as a guide, to create a problem with following 4 parts and then give solution to your own problem. **Post your problem ((a) - (c)) and solution ((d) - (e)) at your website** to share with your classmates. (Note: You may scan/take a picture of hand drawn deduction tree or draw it with a tool digitally)

(a) (5%) Write a PROLOG representation of the following facts: (your at least 5 facts in English);

```
/* 7 FACTS */
studies(jason, sacstate).
studies(jackson, sacstate).
studies(jamie, ucdavis).
studies(jack, ucdavis).
junior(jason).
junior(jack).
senior(jackson).
```

(b) (6%) Write a PROLOG representation of the following rule: (your at least 3 rules in English);

```
/* 5 RULES */
hornetalumni(X):- studies(X, sacstate).
gunrockalumni(X):- studies(X, ucdavis).
collegestudent(X, Y):- studies(X, sacstate), studies(Y, ucdavis).
smartperson(X):- studies(X, sacstate).
friends(X, Y):- hornetalumni(X), gunrockalumni(Y).
```

(c) (4%) Write two PROLOG goal statements to search for answers: (also give 2 W questions in English), and at least one of your goal statements should be a conjunction of two subgoals;

```
?- hornetalumni(X).
?- gunrockalumni(X).
?- collegestudent(X, Y).
?- smartperson(X).
?- friends(X, Y).
```

(d) (10%) Run each given query in (c) using Prolog and then **post the interactive sessions as part of your solution at your website**;

```

?- hornetalumni(X).
X = jason ;
X = jackson.

?- gunrockalumni(X).
X = jamie ;
X = jack.

?- collegestudent(X, Y).
X = jason,
Y = jamie ;
X = jason,
Y = jack ;
X = jackson,
Y = jamie ;
X = jackson,
Y = jack.

?- smartperson(X).
X = jason ;
X = jackson.

?- friends(X, Y).
X = jason,
Y = jamie ;
X = jason,
Y = jack ;
X = jackson,
Y = jamie ;
X = jackson,
Y = jack.

```

(e) (5%) Show deduction tree that deducing the answer for one of the W questions above according to Prolog search strategy (**a picture to post**).

