CS345A PROBLEM SET #1

Due in class, Monday, April 11, 1994
6 Questions, 90 pts.

1) (10 points) Consider the rule

```
q(X) :- e(A,B,X) & p(A) & p(B).
```

Suppose the relation P for p contains the (unary) tuples $\{(1), (2), (3)\}$, and the tuples in the relation E for e are $\{(1,2,4),\ (3,4,5),\ (2,3,4),\ (3,1,6)\}$. What is the value of the relation Q for q? For each tuple of Q, give a substitution of constants for variables that explains why that tuple is in Q.

2) (15 points) (Exercise 3.5 from PDKS-I) The following is a simplification of a calculation that must be performed in an optimizing compiler. We shall assume that all procedures of the hypothetical language being compiled have a single parameter, and an EDB relation $param(P, X)$ says that X is the formal parameter of procedure P. Another EDB predicate $calls(P, Q, Y)$ says that procedure P calls procedure Q with actual parameter Y. It is possible that Y is a local variable of P, the formal parameter of P, or a constant. For example, the procedures in Figure A are characterized by the EDB facts

$param(p, x)$	$calls(p, q, a)$
$param(q, y)$	$calls(p, q, x)$
	$calls(q, p, y)$
	$calls(q, q, 3)$

Write Datalog rules that compute the "transitive closure" of $calls$, that is, an IDB predicate $calls\_star(P, Q, Z)$ that says when procedure P executes, it results in a call to Q with argument Z, perhaps through a sequence of calls to procedures. For example, in the procedures of Figure A, $calls\_star(p, p, a)$ is true, because p calls q with argument a, and q calls p with its own formal parameter as argument.

```
procedure p(x);
    local a;
    call q(a);
    call q(x);
end

procedure q(y);
    call p(y);
    call q(3);
end
```

Fig. A. Example program for Problem 2.

3) (10 points) (Exercise 3.6 of PDKS-I) Suppose we have EDB relations

$$frequents(Drinker, Bar)$$
$$serves(Bar, Beer)$$
$$likes(Drinker, Beer)$$

The first indicates the bars a drinker visits; the second tells what beers each bar serves, and the last indicates which beers each drinker likes to drink. Define the following predicates using safe Datalog rules.

a) $happy(D)$ that is true if drinker D frequents at least one bar that serves a beer he or she likes.

b) $shouldVisit(D, B)$ if bar B serves a beer drinker D likes.

4) (30 points) Write each of the queries:

a) $veryHappy(D)$ if every bar that drinker D frequents serves at least one beer he or she likes. You may assume that every drinker frequents at least one bar.

b) $sad(D)$ if drinker D frequents no bar that serves a beer he or she likes.

In (i) domain relational calculus and (ii) tuple relational calculus. For each of (a) and (b), 10 points is awarded for "getting the idea," and 5 points for rendering the idea correctly in DRC and TRC.

5) (25 points) (Exercise 3.25 from PDKS-I):

Consider the rules:

```
p(X,Y) :- q(X,Y) & not r(X).
r(X) :- s(X,Y) & not t(Y).
r(X) :- s(X,Y) & r(Y).
```

a) Determine the stratum of each predicate. Is the program stratified?

b) Suppose the relations for the EDB predicates s, t, and q are, respectively, $S = \{ab, bc, ca\}$, $T = \{a, b, c\}$, and $Q = \{ab, bc, cd, de\}$. Find the stratified (perfect) model for the IDB predicates p and r, given this EDB.

c) Find another minimal model for the rules and the EDB given in (b).