CS240A: Homework 1

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8.1)
allSuppliersBasicPart(SUPPLIER) <- part_cost(BASIC_PART,_,_,_),
part_cost(_,SUPPLIER,_,_), ¬supplies(BASIC_PART,SUPPLIER).
supplies(BASIC_PART,SUPPLIER) <- part_cost(BASIC_PART,SUPPLIER,_,_).

Another approach for this problem is:
allSuppliersBasicPart(SUPPLIER) <- part_cost(_,SUPPLIER,_,_), ¬missing(SUPPLIER).
missing(SUPPLIER) <- part_cost(BASIC_PART,_,_,_), ¬supplies(BASIC_PART,SUPPLIER).
supplies(BASIC_PART,SUPPLIER) <- part_cost(BASIC_PART,SUPPLIER,_,_).

8.2)
satisfy(Name) <- took(Name,Course1,_),took(Name,Course2,_),Course1~=Course2,
¬isNotHighest(Name).
isNotHighest(Name) <- took(Name,C,G1),took(Name2,C,G2),Name1~=Name2,G1<G2.

8.5) a)
<u>To Prove:</u> The expressive power of RA does not change if we drop set intersection.
<u>Proof:</u>
In order to show that the expressive power of RA does not change even if we drop the set intersection, we need to show that set intersection can be accomplished with the use of some operators other than ∩.
Let's consider two relations R and S. We now have to find the intersection between the two without using the intersection operator ∩.
Now, we know that **R∩S=R-(R-S).** Thus, intersection of these two relations R and S can be computed by R-(R-S).
This can also be accomplished by taking out the equijoin of the two relations R and S in every column and then projecting out the duplicate columns.
Thus, the above two methods give us the intersection of R and S without using the intersection operator ∩.
Hence, we have proved that the expressive power of RA does not change if we drop set intersection.

b) The monotonic operators of RA are as follows:

- Set Union
- Set Intersection
- Cartesian Product
- Selection
- Projection

Set difference is not a monotonic operator. Let's consider the set difference between two relations R and S i.e. **R-S.** Now, if size of S increases, the set difference R-S decreases (or remains the same). Which means set difference is non-monotonic.
All the remaining aforementioned operators are monotonic.

c) <u>To Prove:</u> There is a loss in expressive power of RA if we drop set difference from the RA.

Proof:
From 8.5 – b. we understand that set difference is the only non-monotonic operator of RA. All other operators (mentioned above in part b) are monotonic. We cannot use any other operator of RA to accomplish the task of set difference. And we know that the expressive power is not lost if and only if the same operation can be accomplished by some other operator. Since this is not possible for the set difference operator, there is a loss in expressive power of RA if we drop set difference from the RA. Hence proved.

8.7) We have:
r1: p(X,Y) <- b2(Y,Y,a), b1(X), X>Y.
r2: q(X,Y) <- p(X,Z), p(Z,Y).
r3: s(X) <- b2(Y,Y,a), X>Y, ¬b1(X).

Out of all the above three rules, r1 and r2 are safe while r3 is not safe. All variables of r1 and r2 are safe since all of them appear in some positive goal. The variable X of r3 appears in a negative goal and there is no equality goal X=Y such that Y is safe. Therefore variable X in r3 is unsafe which makes the rule r3 unsafe.

Relational Algebra:

- $Body_{r1} = \pi_{\$4,\$4}\ \sigma_{\$1=\$2,\ \$3=a,\ \$4>\$1}$ (B2 X B1)
- $Body_{r2} = \pi_{\$1,\$4}\ \sigma_{\$2=\$3}$ (P X P)