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9. Sheet: Conjunctive Query Minimization

Exercise 1 (Containment & Minimization)
Consider the following four Conjunctive Queries, where c denotes a constant.

- $q_1 : ans(X, Y) \leftarrow R(X, A), R(A, B), R(B, Y)$
- $q_2 : ans(X, Y) \leftarrow R(X, A), R(A, B), R(B, C), R(C, Y)$
- $q_3 : ans(X, Y) \leftarrow R(X, A), R(B, C), R(D, Y), R(X, B), R(A, C), R(C, Y)$
- $q_4 : ans(X, Y) \leftarrow R(X, A), R(A, c), R(c, B), R(B, Y)$

a) Find all equivalences and containment relationships between the above queries.

b) Minimize all queries.

Exercise 2 (CQ Minimization)
Instead of eliminating subgoals, query minimization can also be achieved by eliminating variables. Write an algorithm which minimizes queries by eliminating each time at least one variable. Prove that your algorithm generates a minimal query.

Exercise 3 (Acyclic CQ)
Apply GYO Algorithm to the following queries and decide whether they are acyclic.

$q(X, T) \leftarrow R1(X, Y, Z), R2(Y, V), R3(Y, Z, U), R4(Z, U, W), R5(U, W, T).$

$q(X, W) \leftarrow R1(X, Y, Z), R3(Y, Z, U), R4(Z, U, W), R5(U, W, X).$