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Advanced Databases and Information Systems
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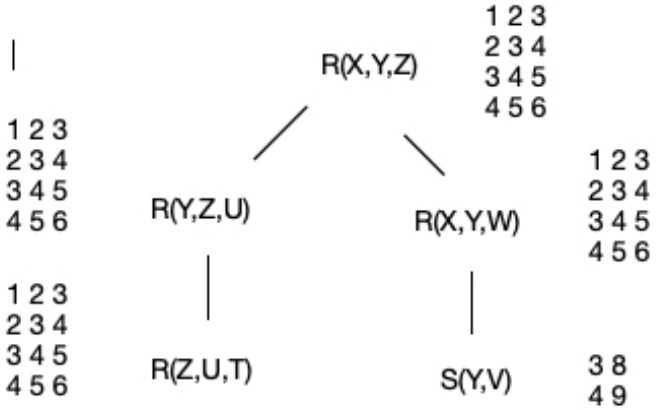
10. Sheet: Conjunctive Query Minimization

Exercise 1 (Acyclic CQ)
Given the following CQ with the database instance $R(1,2,3)$, $R(2,3,4)$, $R(3,4,5)$, $R(4,5,6)$, $S(3,8)$, $S(4,9)$.

$q(X,T) \leftarrow R(X,Y,Z), S(Y,V), R(Y,Z,U), R(Z,U,T), R(X,Y,W)$.

- Apply GYO Algorithm to show the query is acyclic.
  Removing sequence as follows:
  - S(Y,V) witness R(X,Y,W)
  - R(X,Y,W) witness R(X,Y,Z)
  - R(Z,U,T) witness R(Y,Z,U)
  - R(Y,Z,U) witness R(X,Y,Z)
  - R(X,Y,Z)
- Give the join tree of the query.



- Apply the semi-join algorithm over the join tree on the given database and obtain the query answer.

Exercise 2 (Datalog)
Consider a directed graph which is given by $E(X,Y)$ (edges). Give a Datalog program which computes the following relations:

- $Odd(X, Y)$, which holds if there is a path with odd length from X to Y.
  $Odd(X, Y) \leftarrow E(X, Y))$.
  $Even(X, Y) \leftarrow Odd(X, Z), Odd(Z, Y)$.
  $Even(X, Y) \leftarrow Even(X, Z), Even(Z, Y)$.
  $Odd(X, Y) \leftarrow Odd(X, Z), Even(Z, Y)$.
- $Oddcycle(X)$, there is a cycle with odd length through X.
  $Oddcycle(X,) \leftarrow Odd(X, X)$.
- $Evencycle(X)$, there is cycle with even length through X.
  $Evencycle(X) \leftarrow Even(X, X)$.
- $Bothcycles(X)$, there are cycles with even length and cycles with odd length through X.
  $Bothcycle(X, X) \leftarrow Oddcycle(X), Evencycle(X)$.

Exercise 3 (Datalog)
$parent(X, Y)$ is a family tree with root p. Please give a Datalog program, which computes the predicates $samegeneration(X, Y)$, $sibling(X, Y)$ and $cousin(X, Y)$. ($samegeneration(X, Y)$ holds, if the distance between X and p is the same as the distance between Y and p; $sibling(X, Y)$ is true, if X and Y have the same parent; $cousin(X, Y)$ holds, if X and Y belong to the same generation but are not siblings). Hint: You may use negation in your programs.

$sibling(X, Y) \leftarrow parent(Z, X), parent(Z, Y)$.

$samegeneration(X, Y) \leftarrow sibling(X, Y)$.

$samegeneration(X, Y) \leftarrow parent(Z, X), parent(W, Y), samegeneration(Z, W)$.

$cousin(X, Y) \leftarrow samegeneration(X, Y), \neg sibling(X, Y)$.