

## CS5421 Assignment 2

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### Question 2b

Requirement: Return all minimal covers reachable from the functional dependencies of a given schema R and functional dependencies F.

#### Explanation of algorithm:

1. Remove trivial functional dependencies
  - a. In this step, I remove all trivial FDs and deduct the left hand side from the right hand side. For example,  $A \rightarrow A, B, C$  will become  $A \rightarrow B, C$  and  $D \rightarrow D$  will be removed from FD list. This step can help to reduce the input for next step.
2. Produce functional dependencies that right hand side are singleton
  - a. In this step, I loop through all FDs to produce FDs with one attribute on right hand side. For example,  $A \rightarrow BC$  will become  $A \rightarrow B$  and  $A \rightarrow C$
3. Reduce left hand side of each functional dependency
  - a. Firstly, all subsets of left hand side is first generated, and for each subset, check if rest attributes are included in closure of the subset. For example, for left hand side = ABC, we will generate subsets as A, B, C, AB, BC, AC. Then we will check if ABC is included in closure of A, C ... etc. If the subset is not a superset of existing result, we will add the subset to result set.
  - b. Secondly, expand the left hand side combinations to different FDs. For example.  $ABC \rightarrow D$  will become  $AC \rightarrow D$  and  $BC \rightarrow D$  (if B and A is reducible)
  - c. Thirdly, transform all FDs to string. For example,  $[[A, B], [C]]$  will be transformed to 'AB-C'. This step is to remove FDs that has exactly same LHS and RHS with another.
4. Generate all minimal covers
  - a. In this step, I use BFS algorithm to generate all minimal covers.
    - i. Use a queue to store covers
    - ii. Pop out a cover, continue if it has been visited
    - iii. For a cover, generated reduced\_cover by remove each FD from the cover
    - iv. If the reduced\_cover has not been visited, and the reduced\_cover can reach the removed FD, append it to the queue
    - v. If no reduced\_cover can reach the removed FD, the cover is a minimal cover, save it to result
    - vi. Continue until the queue is empty

### Question 2c

Requirement: Return all minimal covers of a given schema R and functional dependencies F.

#### Explanation of algorithm:

1. Generate all closures
2. Reduce all closures
  - a. Firstly, we remove all closure that left == right. E.g.,  $A+=\{A\}$
  - b. Secondly, we remove the left side from closure. E.g.,  $A+=\{ABC\} \Rightarrow A+=\{BC\}$
  - c. Thirdly, we remove closure that left-hand side is a superset of another equality left-hand-side and its right-hand side is a subset of the right-hand side
3. Generate all possible functional dependencies
  - a. For each closure, transform it to a FD. E.g.  $AC+=\{BD\} \Rightarrow AC \rightarrow BD$
4. Generate all minimal covers
  - a. In this step, use all FDs from the previous step to generate all minimal cover following steps in Question 2b