Functional Dependencies
- summary

pm jat @ daiict

Functional Dependencies - summary

- A dependencies among attributes in database
  - Comes from semantics of attributes
  - FDs capture database constraints
  - Basically mapping from attribute(s) to attribute(s)
  - FDs are used for detecting "redundancies in a relations"
- Understood as
  - Function: $f: x \rightarrow y$
    - In FDs function is lookup function rather than computation function that might the case in math
  - Lookup: SELECT distinct Y FROM R WHERE X=xval;

Functional Dependencies - summary

- Suppose there is a relation r, and

  $t1 \in r$

  $t2 \in r$

- Then if we have t1[X] = t2[X] and then we also have t1[Y] = t2[Y], then we say that there is a FD $X \rightarrow Y$!

Key Defined in terms of FDs

- Key is set of attributes that irreducibly determines rest of attributes of a relation.

- A relation can have multiple keys

FD Inference Rules

- From a given sett of FDs, other FDs can be implied or inferred.
- There are certain inference rules that can be used for computing inferred or implied FDs.
- Following are three basic inference rules, known as "Armstrong's axioms"-

  (1) Reflexive Rule: if $Y \subseteq X$ then $X \to Y$; basically trivial FD rule.
  (2) Augmentation Rule: $\{X \to Y\} \models XZ \to YZ$
  (3) Transitive Rule: $\{X \to Y, Y \to Z\} \models X \to Z$
- Three more rules, derived from "Armstrong's axioms"-

  (4) Union Rule: $\{X \to Y, X \to Z\} \models X \to YZ$
  (5) Decomposition Rule: $\{X \to YZ\} \models X \to Y$, and $X \to Z$
  (6) Pseudo-transitivity Rule: If $X \to Y$ and $WY \to Z$, then $WX \to Z$

Where do we use inference rules

- Determining if a FD is implied from a given FD set
- Computation of closure F^+ of F
- Determining if two FD sets are equivalent
- Computing minimal FD set

Some terms

- F^+, closure of FD set F – is set of all FDs that are inferred from F.
- A FD set G said to cover another FD set F, if closure of both are same.
- Two FD set F and G are said to be equivalent when the cover each other.
- F_{min} (for FD set F) is a minimal subset of F that still equivalent to F.
  – Minimal FD set is also referred as "canonical cover" in some texts.
- Attribute closure: X^+ of attribute X – is set of all attributes that are functionally determined by X.

Computation of Attribute Closure

Given

F = {

AB → C,

BC → AD,

D → E

CF → B

}

Compute $\{A,B\}^+$ using this Algorithm

Input: X, F

Output: X^+

X^+:= X;

repeat

oldX^+ := X^+

for each fd YZ in F do

if X^+ is superset of Y then

X^+ := X^+U Z;

until (X^+= oldX^+);

Computation of Minimal FD set

- Drop all trivial FDs
- Write the FDs in following (canonical) form-
  - Have only one attribute in right hand side and
  - Make left side “irreducible”
- Remove redundant FDs if any (i.e. No inferred FDs)
  - Should be easy to notice duplicate and trivial FD when written in canonical form
  - See if there are any transitively inferred FDs
  - See still there are some inferred FDs; remove them.

Exercise: Compute Minimal Set

studid→ name

studid→ cpi

studid→ progid

studid→ pname

studid→ intake

studid→ did

studid→ dname

progid→ pname

progid→ did

progid→ intake

progid→ dname

did → dname

Exercise: Compute Minimal Set

studid→ name	
studid→ cpi	
studid→ progid	studid→ name
studid→ pname	studid→ cpi
studid→ intake	studid→ progid
studid→ did	progid→ pname
studid→ dname	progid→ did
progid→ pname	progid→ intake
progid→ did	did → dname
progid→ intake	
progid→ dname	
did → dname	

Exercise: Compute Minimal Set

- $F = \{A \rightarrow C, AC \rightarrow D, E \rightarrow AD, E \rightarrow H\}$

- $F = \{AB \rightarrow CD, A \rightarrow E, E \rightarrow C\}$

Exercise: Compute Minimal Set

- $F = \{A \rightarrow C, AC \rightarrow D, E \rightarrow AD, E \rightarrow H\}$

$A \rightarrow C$	$A \rightarrow C$	$A \rightarrow C$	$A \rightarrow C$	
$AC \rightarrow D$	$AC \rightarrow D$	$A \rightarrow D$	$A \rightarrow D$	$A \rightarrow CD$
$E \rightarrow AD$	$E \rightarrow A$	$E \rightarrow A$	$E \rightarrow A$	$E \rightarrow AH$
$E \rightarrow H$	$E \rightarrow D$	$E \rightarrow D$	$E \rightarrow H$	
	$E \rightarrow H$	$E \rightarrow H$		

- $F = \{AB \rightarrow CD, A \rightarrow E, E \rightarrow C\}$

$AB \rightarrow C$	$AB \rightarrow C$	$A \rightarrow C$	
$AB \rightarrow D$	$AB \rightarrow D$	$AB \rightarrow D$	$AB \rightarrow D$
$A \rightarrow E$	$A \rightarrow E$	$A \rightarrow E$	$A \rightarrow E$
$E \rightarrow C$	$E \rightarrow C$	$E \rightarrow C$	$E \rightarrow C$
	$A \rightarrow C$	$A \rightarrow C$	

Computation of Key

- For a relation R, and given set of FDs F, you can compute key for R as following-
  - Pick one possible minimum set of attributes, X, and compute closure, if closure includes all attributes of R, then X is key.
  - <u>Ensure X is minimal</u>, if so, it is Key; X is minimal if closure of none of its subset contains all attributes of relation R.
  - A relation might have multiple key, you should also see if there is some other attribute(s) Y, is a key.