

Relational Database Design Theory (I) [additional exercises]

CS348 Spring 2023

Exercises for Attribute closure

- The **closure of attributes Z** in a relation R (denoted Z^+) with respect to a set of FDs, \mathcal{F} , is the set of **all attributes $\{A_1, A_2, \dots\}$ functionally determined by Z** (that is, $Z \rightarrow A_1 A_2 \dots$)
- Algorithm for computing the closure
Compute $Z^+(Z, \mathcal{F})$:
 - Start with closure = Z
 - If $X \rightarrow Y$ is in \mathcal{F} and X is already in the closure, then also add Y to the closure
 - Repeat until no new attributes can be added

Example for computing attribute closure

Consider the schema of a table EmpProj and the FDs:

EmpProj

<u>SIN</u>	<u>PNum</u>	Hours	ENAME	PName	PLoc	Allowance
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\mathcal{F} includes:

$SIN, PNum \rightarrow Hours$

$SIN \rightarrow ENAME$

$PNum \rightarrow PName, PLoc$

$PLoc, Hours \rightarrow Allowance$

Example for computing attribute closure

Compute $Z^+ (\{PNum, Hours\}, \mathcal{F})$:

\mathcal{F} includes:

$SIN, PNum \rightarrow Hours$

$SIN \rightarrow EName$

$PNum \rightarrow PName, PLoc$

$PLoc, Hours \rightarrow Allowance$

FD	Z^+
initial	$PNum, Hours$
$PNum \rightarrow PName, PLoc$	$PNum, Hours, PName, PLoc$
$PLoc, Hours \rightarrow Allowance$	$PNum, Hours, PName, PLoc, Allowance$

$PNum, Hours \rightarrow PName, PLoc, Allowance$

Using attribute closure

Given a relation R and set of FD's \mathcal{F}

- Does another FD $X \rightarrow Y$ follow from \mathcal{F} ?
 - Compute X^+ with respect to \mathcal{F}
 - If $Y \subseteq X^+$, then $X \rightarrow Y$ follows from \mathcal{F}
- Is K a key of R ?
 - Compute K^+ with respect to \mathcal{F}
 - If K^+ contains all the attributes of R , K is a super key
 - Still need to verify that K is *minimal* (how?)
 - Hint: check the attribute closure of its proper subset.
 - i.e., Check that for no set X formed by removing attributes from K is X^+ the set of all attributes

Exercise I

Compute $Z^+(\{SIN, PNum\}, \mathcal{F})$:

\mathcal{F} includes:

$SIN, PNum \rightarrow Hours$

$SIN \rightarrow EName$

$PNum \rightarrow PName, PLoc$

$PLoc, Hours \rightarrow Allowance$

FD	Z^+
initial	$SIN, PNum$
$SIN \rightarrow EName$	$SIN, PNum, EName$
$PNum \rightarrow PName, PLoc$	$SIN, PNum, EName, PName, PLoc$

Compute $Z^+(\{SIN, PNum, Hours\}, \mathcal{F})$?

$\{SIN, PNum, Hours, EName, PName, PLoc, Allowance\}$

→ A candidate key (why?)

Exercise II

- $R(A,B,C)$
- F includes
 - $FD_1: A \rightarrow B$
 - $FD_2: B \rightarrow C$
 - $FD_3: A \rightarrow C$
- $Compute Z^+(\{A\}, F) = ?$
 - $\{A,B,C\}$
- $Compute Z^+(\{B\}, F) = ?$
 - $\{B,C\}$
- $Compute Z^+(\{A,B,C\}, F) = ?$
 - $\{A,B,C\}$
- Super keys for R ?
 - A, AB, AC, ABC
- Candidate keys for R ?
 - A

Exercise III

- $R(A,B,C)$
- F includes
 - $FD_1: A \rightarrow B$
- *Compute* $Z^+(\{A\}, F) = ?$
 - $\{A,B\}$
- Super keys for R ?
 - AC, ABC
- Candidate keys for R ?
 - AC