

# Relational Database Design Theory (I) [additional exercises]

Introduction to Database Management

CS348 Fall 2022

# 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

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

$PNum, Hours \rightarrow PLoc, Allowance$

# 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?) [Exercise]
    - Hint: check the attribute closure of its proper subset.

# 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
  - $FD_1: A \rightarrow B$
  - $FD_2: B \rightarrow C$
  - $FD_3: A \rightarrow C$
- $ComputeZ^+(\{A\}, F) = ?$ 
  - $\{A,B,C\}$
- $ComputeZ^+(\{B\}, F) = ?$ 
  - $\{B,C\}$
- $ComputeZ^+(\{A,B,C\}, F) = ?$ 
  - $\{A,B,C\}$
- 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  $R$ ?
  - $AC$