

# CSC343 Worksheet 12 Solution

June 30, 2020

1.
  - Keys
    - {id of molecule}
    - {x position, y position, z position}
  - Functional Dependencies
    - 1. id of molecule  $\rightarrow$  x position, y position, z position, x velocity, y velocity, z velocity
    - 2. x position, y position, z position  $\rightarrow$  id of molecule, x velocity, y velocity, z velocity

## Notes:

- Function Dependencies
  - *Functional Dependency* is a relationship between two attributes typically between the key and other non-key attributes within a table.

### Example:

SIN  $\rightarrow$  Name, Address, Birthdate

### Example 2:

ISBN  $\rightarrow$  Title

- Key of Relations
  - One or more attributes  $\{A_1, A_2, \dots, A_n\}$  is a key for a relation R if
    1. Those attributes functionally determine all other attributes of the relation
    2. No proper subset of  $\{A_1, A_2, \dots, A_n\}$  functionally determines all other attributes of R

### Example:

Given relation

$R = \text{Movies1}(\text{title, year, length, genre, studioName, starName})$

- i. {title, year, starName } form a key for the relation **Movies1**

- ii.  $\{ \text{year}, \text{starName} \}$  is not a key. Same star can be in multiple movies per year
- Superkeys
  - \* Means a set of attributes that contains a key
  - \* Don't need to be minimal

**Example:**

Given relation

$R = \text{Movies1}(\text{title}, \text{year}, \text{length}, \text{genre}, \text{studioName}, \text{starName})$

- $\{ \text{title}, \text{year}, \text{starName} \}$  is a key and superkey
- $\{ \text{title}, \text{year}, \text{starName}, \text{length} \}$  is a superkey

**References:**

1) OpenTextBC, Chapter 11 Functional Dependencies, link

2. a) **Notes:**

- The Splitting / Combining Rule
  - Combining Rule
    - \*  $A_1, A_2, \dots, A_n \rightarrow B_i$  for  $i = 1, 2, \dots, m$
    - to
    - $A_1, A_2, \dots, A_n \rightarrow B_1, B_2, \dots, B_m$

**Example:**

Given

$\text{title year} \rightarrow \text{length}$   
 $\text{title year} \rightarrow \text{genre}$   
 $\text{title year} \rightarrow \text{studioName}$

it's combined form is

$\text{title year} \rightarrow \text{length genre studioName}$

- Splitting Rule
  - \*
  - \*  $A_1, A_2, \dots, A_n \rightarrow B_1, B_2, \dots, B_m$
  - to
  - $A_1, A_2, \dots, A_n \rightarrow B_i$  for  $i = 1, 2, \dots, m$

**Example:**

Given

title year  $\rightarrow$  length

It's splitted form is

title  $\rightarrow$  length

year  $\rightarrow$  length

- Trivial Functional Dependencies

- A functional dependency  $FD : X \rightarrow Y$  is **trivial** if  $Y$  is a subset of  $X$

**Exmample:**

title year  $\rightarrow$  title

**Example 2:**

title  $\rightarrow$  title

- Non-trivial Functional Dependencies

- is a case where some but not all of the attributes on the R.H.S of an FD are also on L.H.S

**Example:**

title year  $\rightarrow$  title movieLength

- Can be simplified using **trivial-dependency rule**
  - \* The  $FD A_1A_2 \cdots A_n \rightarrow B_1B_2 \cdots B_m$  is equivalent to  $A_1A_2 \cdots A_n \rightarrow C_1C_2 \cdots C_k$

where  $C$ 's are all those  $B$ 's that are not in  $A$ 's.

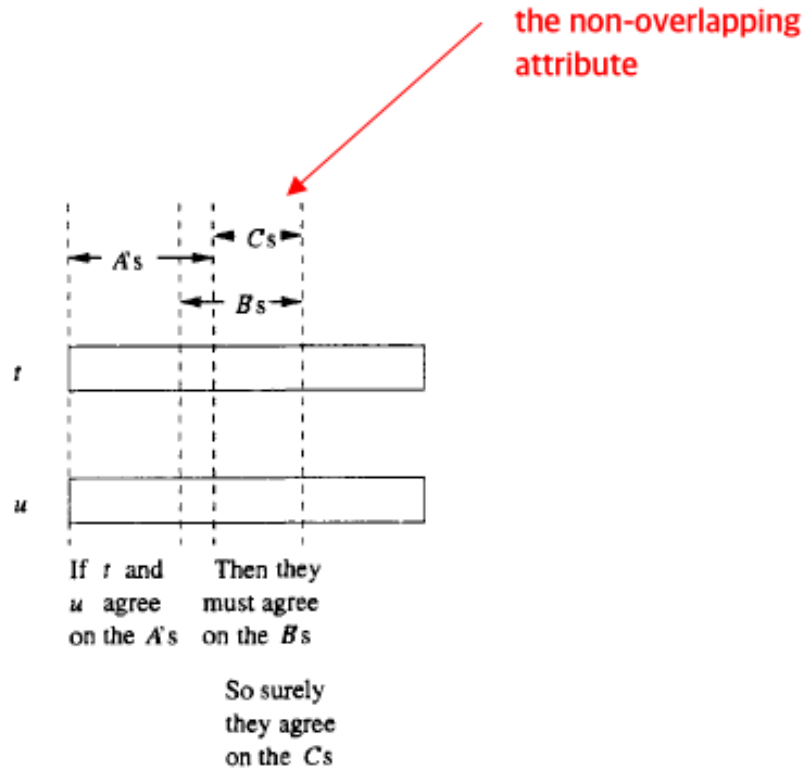


Figure 3.3: The trivial-dependency rule

- Computing the Closure of Attributes
  - Closure of attribute set  $\{X\}$  is denoted as  $\{X\}^+$ .
  - The closure means a given set of attributes  $A$  satisfying FD, are a sets of all attributes  $B$  such that  $A \rightarrow B$

**Example:**

Given attributes  $A, B, C, D, E, F$  and FDs  $AB \rightarrow C$ ,  $BC \rightarrow AD$ ,  $D \rightarrow E$  and  $CF \rightarrow B$ , What is the closure of  $\{A, B\}$  or  $\{A, B\}^+$

1. Start with  $\{A, B\}$ .
2. Split  $BC \rightarrow AD$ 
  - \* We have  $BC \rightarrow A$  and  $BC \rightarrow D$
  - \* Since  $A$  is in  $\{A, B\}$ , this is not included
  - \* Since  $D$  is not in  $\{A, B\}$ , this IS included

So, we have  $\{A, B, D\}$
3. Since  $C$  in  $AB \rightarrow C$  is NOT in  $\{A, B, C, D\}$ ,  $C$  is included and we have  $\{A, B, C, D\}$
4. Since  $A$  in  $BC \rightarrow A$  is in  $\{A, B, C, D\}$ , this is skipped
5. Since  $E$  is not in  $D \rightarrow E$ ,  $E$  is included and we have  $\{A, B, C, D, E\}$

- Why the Closure Algorithm Works
- Transitive Rule
  - Definition

If  $A_1A_2 \cdots A_n \rightarrow B_1B_2 \cdots B_m$  and  $B_1B_2 \cdots B_m \rightarrow C_1C_2 \cdots C_k$  hold in relation  $R$ ,  $A_1A_2 \cdots A_n \rightarrow C_1C_2 \cdots C_k$  also holds in  $R$ .

**Example:**

Given

title year  $\rightarrow$  studioName

studioName  $\rightarrow$  studioAddr

Transitive rule says the above is equal to the following

title year  $\rightarrow$  studioAddr

- Inference Rules
  - Is allso called **Armstrong's Axioms**
  - Has 3 axioms
    1. *Reflexivity*
      - \* If  $\{B_1, B_2, \dots, B_n\} \subseteq \{A_1, A_2, \dots, A_n\}$  then  $A_1A_2 \cdots A_n \rightarrow B_1B_2 \cdots B_m$
      - \* also called **trivial FDs**
    2. *Augmentation*
      - \* If  $A_1A_2 \cdots A_n \rightarrow B_1B_2 \cdots B_m$  then  $A_1A_2 \cdots A_nC_1C_2 \cdots C_k \rightarrow B_1B_2 \cdots B_mC_1C_2 \cdots C_k$
      - \*  $C_1C_2 \cdots C_k$  are any set of attributes
    3. *Transitivity*
      - \* If  $A_1A_2 \cdots A_n \rightarrow B_1B_2 \cdots B_m$  and  $B_1B_2 \cdots B_m \rightarrow C_1C_2 \cdots C_k$  then  $A_1A_2 \cdots A_n \rightarrow C_1C_2 \cdots C_k$
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