CSC343 Worksheet 12 Solution

June 30, 2020

1. - Keys
     - {id of molecule}
     - {x position, y position, z position}
   - Functional Dependencies
     1. id of molecule → x position, y position, z position, x velocity, y velocity, z velocity
     2. x position, y position, z position → 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 → Name, Address, Birthdate

    Example 2:

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

       Example:

       Given relation

       R = Movies1(title, year, length, genre, studioName, starName)

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

ii. { year, starName } is not a key. Same star can be in multiple movies per year

- Superkeys
  - Means a a set of attributes that contains a key
  - Don't need to be minimal

    Example:
    Given relation

    $R =$ Movies1(title, year, length, genre, studioName, starName)

    · { title, year, starName } is a key and superkey

    · { title, year, starName, title, year, length} is a superkey

References:

1) OpenTextBC, Chapter 11 Functional Dependencies, link

2. a)
   1. $AB \rightarrow C$
   2. $AB \rightarrow D$
   3. $C \rightarrow A$
   4. $C \rightarrow B$
   5. $D \rightarrow B$
   6. $D \rightarrow C$
   7. $C \rightarrow D$
   8. $D \rightarrow A$

Second Attempt:

$\{A, B\}^+ = \{A, B, C, D\}$, so the following non-trivial FDs follows: $AB \rightarrow C$ and $AB \rightarrow D$.

$\{C\}^+ = \{D, A\}$, so the following non-trivial FDs follows $C \rightarrow D$ and $C \rightarrow A$.

$\{D\}^+ = \{A\}$, so the following non-trivial FDs follows: $D \rightarrow A$.

Notes:

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

Example:

Given

title year → length
title year → genre
title year → studioName

it's combined form is

title year → length genre studioName

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

Example:

Given

title year → length

It's splitted form is

title → length
year → length

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

Exmaple:

title year → title

Example 2:

title → title

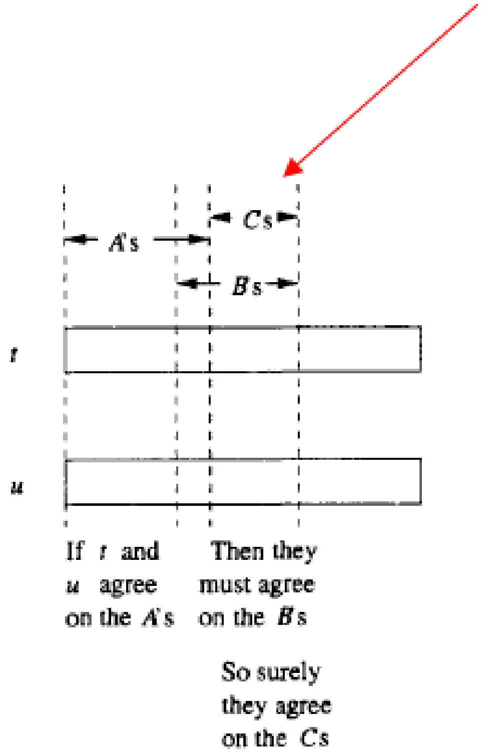
- Non-trivial Functional Dependencies
  - is a case where some but not all of the attributes on the R.H.S of an FD are also on L.H.S

Example:

title year → title movieLength

- Can be simplified using **tirivial-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.


Cs
A's
Bs
t
u
If t and u agree on the A's
Then they must agree on the Bs
So surely they agree on the Cs

the non-overlapping attribute

Figure 3.3: The trivial-dependency rule

- Computing the Clousre 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 $BCtoD$
       - ∗ 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 $\{A, B, C, D, E\}$ as our solution

- Why the Closure Algorithm Works
- Transitive Rule
  - Definition

    If $A_1 A_2 \cdots A_n \rightarrow B_1 B_2 \cdots B_m$ and $B_1 B_2 \cdots B_m \rightarrow C_1 C_2 \cdots C_k$ hold in relation R, $A_1 A_2 \cdots A_n \rightarrow C_1 C_2 \cdots C_k$ also holds in R.

    Example:

    Given

    title year → studioName
    studioName → studioAddr

    Transitive rule says the above is equal to the following

    title year → studioAddr
- Inference Rules
  - Is allso called **Armstrong's Axioms**
  - Has 3 axioms
    1. *Reflexivity*
       * If $\{B_1, B_2, ..., B_n\} \subseteq \{A_1, A_2, ..., A_n\}$ then $A_1 A_2 \cdots A_n \rightarrow B_1 B_2 \cdots B_m$
       * also called **trivial FDs**
    2. *Augmentation*
       * If $A_1 A_2 \cdots A_n \rightarrow B_1 B_2 \cdots B_m$ then $A_1 A_2 \cdots A_n C_1 C_2 \cdots C_k \rightarrow B_1 B_2 \cdots B_m C_1 C_2 \cdots C_k$
       * $C_1 C_2 \cdots C_k$ are any set of attributes
    3. *Transitivity*
       * If $A_1 A_2 \cdots A_n \rightarrow B_1 B_2 \cdots B_m$ and $B_1 B_2 \cdots B_m \rightarrow C_1 C_2 \cdots C_k$ then $A_1 A - 2 \cdots A_n \rightarrow C_1 C_2 \cdots C_k$

b) A, B is the only key of R.

Notes:

- Key of Attributes
  - **Definition:** A set of attributes $\{A_1, A_2, \cdots, A_n\}$ is a key for a relation R if
    1. Those attributes functionally determine all other attributes

2. No proper subset of $\{A_1, A_2, ..., A_n\}$ functionally determines all other attributes of R.

c) The superkeys that are not keys are: $\{A, B, C\}$, $\{A, B, D\}$, $\{A, B, C, D\}$

3. i) a) $\{A\}^+ = \{A, B, C, D\}$, so we have $A \to A$, $A \to B$, $A \to C$, $A \to D$

$\{B\}^+ = \{C, D\}$, so we have $B \to C$ and $B \to D$

b) $\{A\}$ is the key of S.