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. $AB \to C$
   2. $AB \to D$
   3. $C \to A$
   4. $C \to B$
   5. $D \to B$
   6. $D \to C$
   7. $C \to D$
   8. $D \to A$

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

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

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

Notes:

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

Example:

Given

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

it's combined form is

title year → length genre studioName

- Splitting Rule
  -
  - $A_1, A_2, \cdots A_n \to B_1, B_2, \cdots B_m$
    to
    $A_1, A_2, \cdots, A_n \to B_i$ 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 $FD : X \to Y$ 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 $A_1A_2 \cdots A_n \to B_1B_2 \cdots B_m$ is equivalent to $A_1A_2 \cdots A_n \to C_1C_2 \cdots C_k$

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

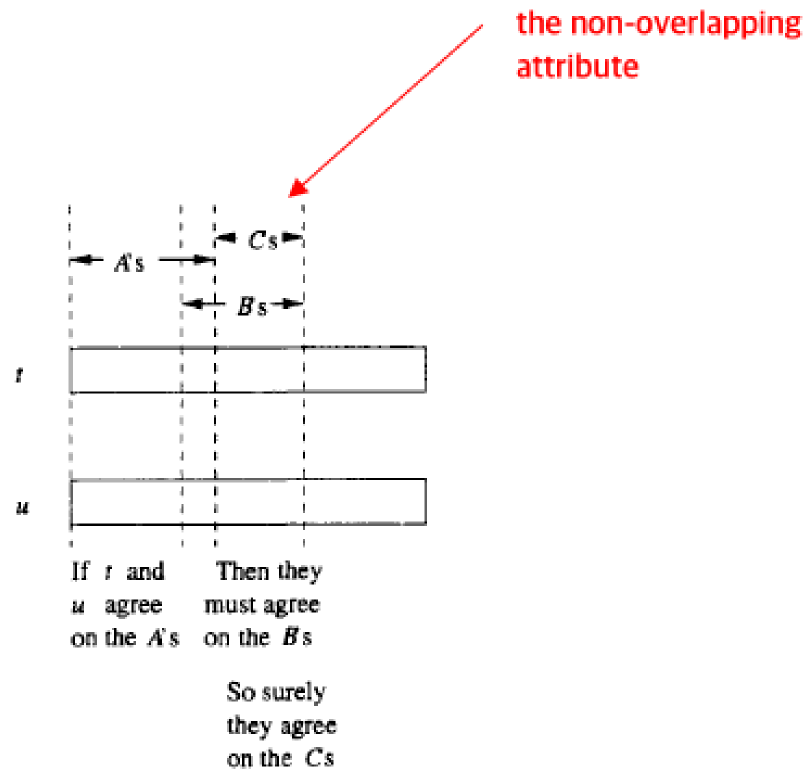

Figure 3.3: The trivial-dependency rule

- Computing the 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 $A \to B$

    Example:

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

    1. Start with $\{A, B\}$.
    2. Split $BC \to AD$
       * We have $BC \to A$ 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 $A_1A_2 \cdots A_n \rightarrow B_1B_2 \cdots B_m$ 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 $\{B_1, B_2, ..., B_n\} \subseteq \{A_1, A_2, ..., A_n\}$ 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 $A_1A - 2 \cdots A_n \rightarrow C_1C_2 \cdots C_k$