Week 7 Assignment - James Gray

Sunday, May 4, 2014 9:07 AM

Using the functional dependencies provided, normalize each of the relations, R1, R2, and R3 to the third normal form. You should assume that there are no duplicate rows present and that all values are atomic. A separate solution is required for each relation that must clearly identify the steps required to normalize the relation to 3NF and demonstrate that it is lossless and preserves all functional dependencies.

R1 (ABCDEFGH)
FDs: AB --> D, B --> C, B --> E, B --> F, A --> H, H --> G
R2 (ABCDEFGH)
FDs: ABC --> DE, BC --> G, G --> HF
R3 (ABCDEFGH)
FDs: BC --> DE, C --> F, F --> GH

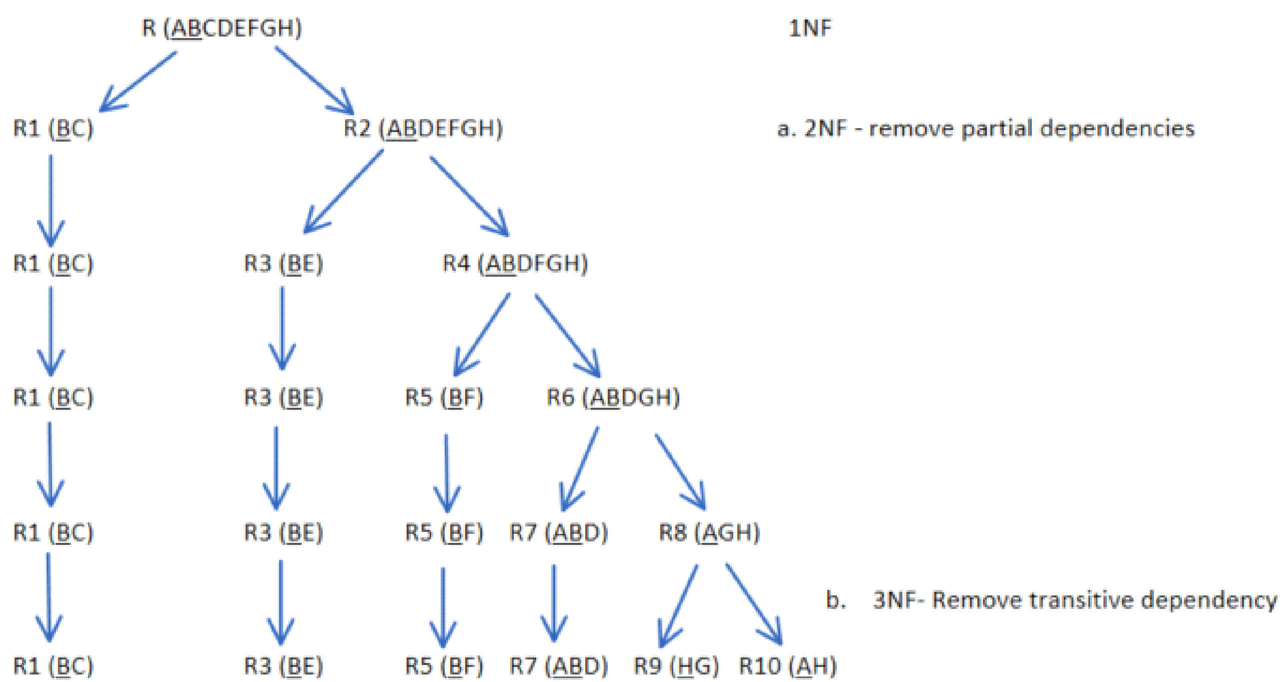
Relation R1 Normalization

Step 1 - Find the minimal cover for R (ABCDEFGH).

FD1: AB --> D (Full)
FD2: B --> C (Partial)
FD3: B --> E (Partial)
FD4: B --> F (Partial)
FD5: A --> H (Partial)
FD6: H --> G (Transitive)
Key: AB

Step 2 - Decompose R to normalize to 3NF

We will decompose R into 2NF given that there are non-key attributes that are partially dependent on the AB key.



Step 3 - Confirm that each step of the decomposition process is lossless and there is preservation of the functional dependencies.

A. Natural join of relations R1, R3, R5, R7, R8, R9 and R10 produce the original R

Decomposing R	R1 ∩ R2 = R1 - R2	B -> C	Lossless
Decomposing R2	R3 ∩ R4 = R3 - R4	B -> E	Lossless
Decomposing R4	R5 ∩ R6 = R5 - R6	B -> F	Lossless
Decomposing R6	R8 ∩ R7 = R8 - R7	A -> H	Lossless
Decomposing R8	R9 ∩ R10 = R9 - R10	H -> G	Lossless

B. We will now check to confirm this decomposition is FD preserving

R7 preserves FD1
R1 preserves FD2
R3 preserves FD3
R5 preserves FD4
R10 preserves FD5
R9 preserves FD6

Relation R2 Normalization

R (ABCDEFGH)
FDs: ABC --> DE, BC --> G, G --> HF

Step1 - Determine Minimal Cover

Step 1a - Split the right hand side of all FDs using the Union rule

- FD1: ABC -> D
- FD2: ABC -> E
- FD3: BC -> G
- FD4: G -> H
- FD5: G -> F

Step 1b - attempt to reduce the left hand side using the Pseudo transitivity rule.

We will examine each FD where there are multiple attributes on the left hand side and use pseudo transitivity to determine if the dependency can be reduced.

- FD1: ABC -> D
  - A -> B? No
  - B -> A ? No
  - A -> C ? No
  - C -> A? No
  - AB -> C? No
  - C -> AB? No
- FD2: ABC -> E
- FD3: BC -> H
  - B -> C ? No

- C -> B ? No
- FD4: BC -> F

Eliminate redundant FDs. We will remove each FD and attempt to see if it can be represented by the remaining FDs.

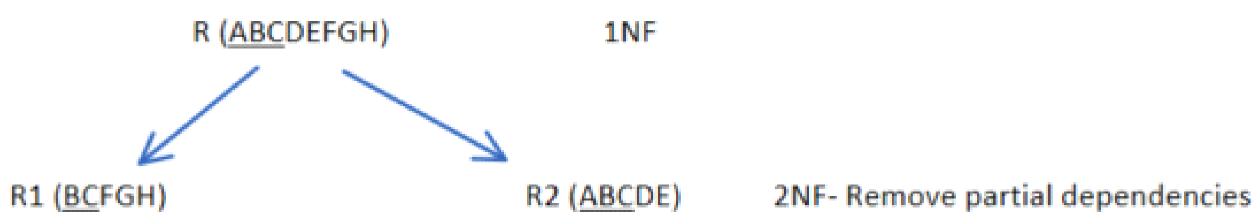
- FD1: ABC -> D (not redundant since there is not a way to get to D from the other FDs)
- FD2: ABC -> E (not redundant since there is not a way to get to E from the other FDs)
- FD3: BC -> G (not redundant since there is not a way to get to G from the other FDs)
- FD4: G -> H (this is the only way to get to H)
- FD5: G -> F (this is the only way to get to F)

BC -> HF given that BC -> G -> HF

Therefore the minimal cover for R is:

R (ABCDEFGH)
FD1: ABC -> DE (Full)
FD2: BC -> G (Partial)
FD2: BC -> HF (Partial)
Key: ABC

Step 2 - Decompose R to normalize to 3NF. In this case there are no transitive dependencies so 2NF is 3NF



Step 3 - Confirm that each step of the decomposition process is lossless and there is preservation of the functional dependencies.

A. Natural joins R1 and R2 produce the original R

Decomposing R	R1 ∩ R2 = R1 - R2	BC -> G	Lossless

B. We will now check to confirm this decomposition is FD preserving

R2 preserves FD1 (ABC -> DE)
R1 preserves BC -> F and G -> HF

<u>Relation R3 Normalization</u>

R3 (ABCDEFGH)
FDs: BC --> DE, C --> F, F --> GH

Step 1 - Find the minimal cover for R by analyzing the FD's.

Step 1a - Split the right hand side of all FDs using the Union rule

FD1: BC -> D
FD2: BC -> E

FD3: C -> F
FD4: F -> G
FD5: F -> H

Step 1b - Reduce the left hand side using the Pseudo transitivity rule.

- BC -> D
    - B -> C ? No
    - C -> B ? No

Therefore there are no reductions that can be made to the LHS

Step 1c - Eliminate redundant FDs. We will remove each FD and attempt to see if it can be represented by the remaining FDs.

FD1: BC -> D (Not redundant as this is the only way to get to D)
FD2: BC -> E (Not redundant as this is the only way to get to E)
FD3: C -> F (Not redundant as this is the only way to get to F)
FD4: F -> G (Not redundant as this is the only way to get to G)
FD5: F -> H (Not redundant as this is the only way to get to H)

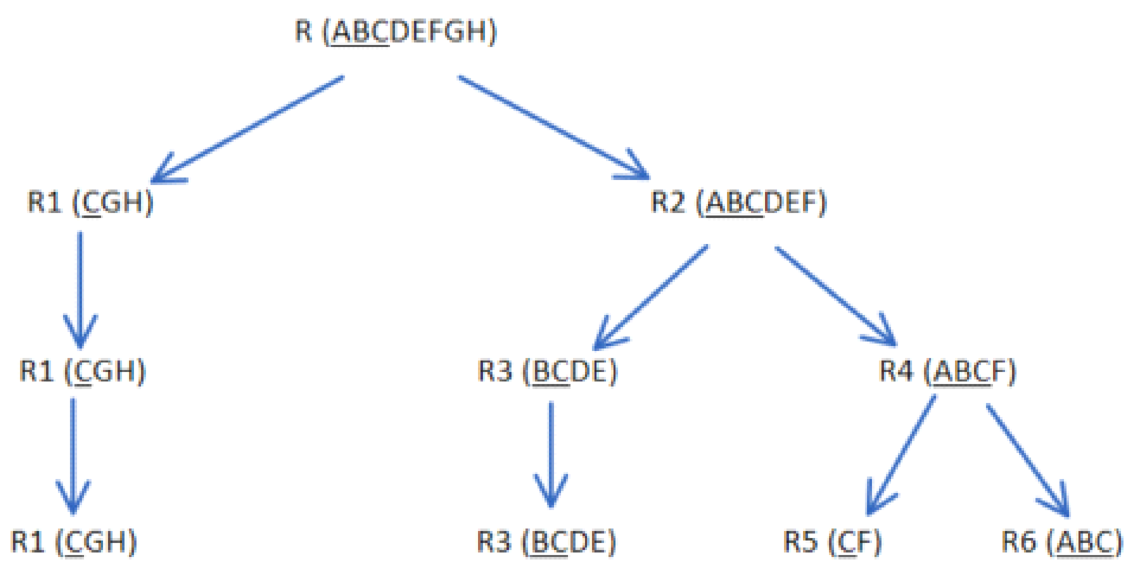
C -> GH given that C -> F -> G and C -> F -> H

Therefore the minimal cover is:

FD1: BC -> DE (partial)
FD2: C -> F (partial)
FD2: C -> GH (partial)
Key: ABC

I will assume that the key is "ABC" for R(ABCDEFGH) since A does not appear in the FD's and through ABC this enables BC -> DE, C -> F, F -> G, F -> H.

Step 2 - Decompose R to normalize to 3NF by removing partial dependencies



Step 3 - Confirm that each step of the decomposition process is lossless and there is preservation of the functional dependencies.

A. Natural join of relations R1, R3, R5 and R6 produces the original R

Decomposing R	R1 ∩ R2 = R1 - R2	C -> G	Lossless
Decomposing R2	R3 ∩ R4 = R3 - R4	BC -> DE	Lossless
Decomposing R4	R5 ∩ R6 = R5 - R6	C -> F	Lossless

B. We will now check to confirm this decomposition is FD preserving

R3 preserves BC -> DE
R1 and R5 join preserves C -> F and F -> GH