Database Management Systems

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Example - 01

Movies relation

- Let R be: `Movies(title, year, filmType, studioName, startName)`
- Let $r(R)$ be

title	year	length	filmType	studioName	starName
Star wars	1977	124	color	Fox	Carrie Fisher
Star wars	1977	124	color	Fox	Mark Hamill
Star wars	1977	124	color	Fox	Harrison Ford
Mighty Ducks	1991	104	color	Disney	Emilio Estevez
Wayne's world	1992	95	color	Paramount	Data Carvey
Wayne's world	1992	95	color	Paramount	Mike Meyers

Example - 02

Movies relation

The three FDs for the Movies relation are

- title year $\rightarrow$ length
- title year $\rightarrow$ filmType
- title year $\rightarrow$ studioName
- These three FDs satisfies every pair of $r(R)$
- title year $\rightarrow$ length filmType studioName

Example - 03

Movies relation

FD that do not satisfy every pair of tuples in $r(R)$ is `title year` $\rightarrow$ startName

Keys of Relations

Properties

Set of one or more attributes $\{A_1, A_2, \cdots, A_n\}$ is a key for relation R if the following holds

1. A_1 to A_n functionally determine all the other attributes of R
2. No proper subset of $\{A_1, A_2, \cdots, A_n\}$ functionally determines all other attributes of R. Satisfying minimal clause

Keys of Relations

Example Movies Relation

`(title, year, starName)` forms a key

1. First argue for functionally determines all other attributes
   - That is two tuples agrees on `(title, year, starName)`, those tuples agree on `(length, fileType, studioName)`
   - `title year` $\rightarrow$ `(length,filmType,studioName)`

Keys of Relations

Example Movies Relation

(title, year, starName) forms a key

1. Next argue for No proper subset
   - (title, year) do not determine startName
   - (year, starName) is not a key (first point violation)
   - (title, starName) is not a key (first point violation)

Super Keys

Definition

A set of attributes that contains a key is called a super key (super set of a key)

Discussion

- Every key is a super key
- However, some super keys are not (minimal) keys
- That is super key need not satisfy minimality

Discovering Keys for Relations

Thumb Rules

- If entity set is translated to a relation then key attributes of entity set are the key for the relation. Example: students
- (For binary relationships) If R is many-to-many, then keys of both connected entity sets are the key attributes of R. Example: grades(roll_number, cid, grd)
- If R is many-to-one from E_1 to E_2 then key attribute of E_1 are key attributes of R. Example: Employees works for department
- If R is one-to-one then the key attributes for either of the entity are key attributes of R

Rules About FD's - 01

Splitting & Combining

Given an FD of the form: $A_1 A_2 \cdots A_n \rightarrow B_1 B_2 \cdots B_m$

- Split the attributes on the right side so that only one attribute appears on right of every FD

$$
\begin{array}{cccccc}
A_1 & A_2 & \cdots & A_n & \rightarrow & B_1 \\
A_1 & A_2 & \cdots & A_n & \rightarrow & B_2 \\
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\
A_1 & A_2 & \cdots & A_n & \rightarrow & B_m
\end{array}
$$

- Likewise, replace a collection of FD's with common LHS by single FD

Rules About FD's - 02

Splitting & Combining - concise form

Splitting Rule Replace an FD of the form: $A_1A_2\cdots A_n \rightarrow B_1B_2\cdots B_m$ by $A_1A_2\cdots A_n \rightarrow B_i$ for $i = 1, 2, \cdots m$

Rules About FD's - 02

Splitting & Combining - concise form

Splitting Rule Replace an FD of the form: $A_1A_2\cdots A_n \rightarrow B_1B_2\cdots B_m$ by $A_1A_2\cdots A_n \rightarrow B_i$ for $i = 1, 2, \cdots m$

Combining Rule Replace set of FD's of the form $A_1A_2\cdots A_n \rightarrow B_i$ for $i = 1, 2, \cdots m$ by $A_1A_2\cdots A_n \rightarrow B_1B_2\cdots B_m$

Rules About FD's - 03

Classification

An FD $A_1A_2\cdots A_n \rightarrow B_1B_2\cdots B_m$ is

Trivial if B's are a subset of A's. title year $\rightarrow$ title

Rules About FD's - 03

Classification

An FD $A_1 A_2 \cdots A_n \rightarrow B_1 B_2 \cdots B_m$ is

- **Trivial** if B's are a subset of A's. title year $\rightarrow$ title
- **Non-trivial** if at least one of the B's is not among the A's. title year $\rightarrow$ year length

Rules About FD's - 03

Classification

An FD $A_1 A_2 \cdots A_n \rightarrow B_1 B_2 \cdots B_m$ is

Trivial if B's are a subset of A's. title year $\rightarrow$ title

Non-trivial if at least one of the B's is not among the A's. title year $\rightarrow$ year length

Completely non-trivial if none of the B's is also one of the A's. title year $\rightarrow$ length

Closure of Attributes

Definition

A general principle from which all rules follow

Closure of Attributes

Definition

Given a set F of FDs, we are interested in determining all the FDs that can be logically implied by F.

Closure of Attributes

Definition

The set of all FDs that are implied by a give set of FDs

Closure of Attributes

Definition

- Let $\{A_1, A_2, \cdots, A_n\}$ be set of attributes
- F be a set of FD's
- closure of $\{A_1, A_2, \cdots, A_n\}$ denoted as $\{A_1, A_2, \cdots, A_n\}^+$ under FD's in F is
  - set of attributes B such that
  - every relation that satisfies all the FDs in F also satisfies $A_1 A_2 \cdots A_n \rightarrow B$

Closure of Attributes

Definition

That is $A_1 A_2 \cdots A_n \rightarrow B$ follows from the FDs of F

Closure of Attributes

Computation

Closer of $\{A_1, A_2, \cdots, A_n\}$ w.r.t. set of FD's F

1. Let X be set of attributes that will be become the closure. Initialize $X = \{A_1, A_2, \cdots, A_n\}$
2. Repeatedly search for some FD $B_1 B_2 \cdots B_m \rightarrow C$ such that all of $B_1 B_2 \cdots B_m$ are in X and $C \notin X$. $X = X \cup \{C\}$
3. Repeat step 2 until no more attributes can be added to X
4. The resulting set X is the $\{A_1, A_2, \cdots, A_n\}^+$

Closure of Attributes

Computation

1. Let $R(A, B, C, D, E, F)$ be a relation
2. R satisfies the set of FDs
   $\{$AB $\rightarrow$ C, BC $\rightarrow$ AD,
   D $\rightarrow$ E, CF $\rightarrow$ B$\}$
3. Compute $\{A, B\}^+$

Closure of Attributes

Computation

1. X = {A, B}
2. {AB → C} satisfies step 2
3. Therefore add C to X. That is X = {A, B, C}
4. {BC → AD} satisfies step 2
5. Therefore add D to X. X = {A, B, C, D} (A is already present in X)
6. {D → E} satisfies step 2
7. Therefore add E to X. X = {A, B, C, D, E}
8. {CF → F} does not satisfies step 2
9. $\{A, B\}^{+}$ = {A, B, C, D, E}

Closing sets of FDs

About FDs

1. Given a set of FDs, we can infer some other FDs (trivial/non-trivial)
2. Distinction to be made between given FDs and derived FDs
3. And have a choice of which ones to use in relations

Basis FDs

Definition

Any set of given FDs from which we can infer all the FDs for a relation

Basis FDs

Example

- Let R(A, B, C) be a relation
- Property of this relation is that each attribute functionally determines the other two
- That is $\{A \rightarrow B, B \rightarrow A, B \rightarrow C, C \rightarrow B, A \rightarrow C, C \rightarrow A, AB \rightarrow C, AC \rightarrow B, BC \rightarrow A\}$
- This relation has a *minimal basis*: $\{ A \rightarrow B, B \rightarrow C, C \rightarrow A\}$

Several Relational Schemas

Flawed Relations

- Information about Staff and Branch
- Design 01: StaffBranch(staffNo, sName, position, salary, branchNo, bAddress)
- Design 02:
  - Staff(staffNo, sName, position, salary, branchNo)
  - Branch(branchNo, bAddress)

Data Redundancy

Anomalies

- Redundancy: information is repeated in several tuples.
- Leading to storage size
- In addition, Relations with redundancy will lead to Update Anomalies
  - Insertion Anomaly
  - Deletion Anomaly
  - Modifications Anomaly

Data Redundancy

Insertion Anomalies

- To insert new members of staff into `StaffBranch` relation, we must include details of branch - number and name
- Example: Correct branch number `B007` and branch address, identical to that of other tuples of `StaffBranch`
- No two rows corresponding to `B007` should have as 16 Argyll St, Aberdeen; Argyll Street, Aberdeen
- The above lead to inconsistency
- More serious issue: To insert details of a new branch that currently has no members of staff into the `StaffBranch` relation, null values must be entered into the Staff attributes
- However, `staffNo` is the primary key! Null values are not allowed for primary key constraint
- You may have to insert a dummy staff for a every new branch that is created

Data Redundancy

Deletion Anomalies

- Deleting SA9
- Only branch (B007) and assocaited address (16 Argyll St, Aberdeen) correspond to this employee are lost
- Now, any query pertaining to number of distinct branches will result in incorrect answer!

Data Redundancy

Modification Anomalies

- If address for branch number B003 need to be updated, it will lead to updating address at several places
- In this example, address at three records needs to be changed
- If these updates are not performed carefully, it will result in inconsistency in the data

Normalization - 01

Introduction

- Refers to a reversible step-by-step process in which a given relation is replaced by successive collections of relations
- The collection have a simpler and more regular structure
- Each step referred to as a normal form
- Normal forms define a criteria or normal form tests that need to be met by the different relations (tables)
- The process is reversible because the original relation can be recovered with no loss of information

Normalization - 02

Objectives

- To make it feaible to represent any relation in the database
- To obtain powerful relational retrieval algorithms based on collection of primitive relational operators
- To eliminate the undesirable insertion, update and deletion anomalies
- To reduce the need for restructing relations as new data types are introduced

Normalization - 03

Numbers

- Several normal forms exists.
- Identified with numbers: 1st normal form (1NF), 2NF, 3NF, BCNF, 4NF, 5NF, and 6NF
- Each of these allievate one or more of the identified anomalies

Normalization - 04

An example table

Proj-ID	Proj-Name	Proj-Mgr-ID	Emp-ID	Emp-Name	Emp-Dpt	Emp-Hrly-Rate	Total-Hrs
100	E-commerce	789487453	123423479 980808980 234809000 542298973	Heydary Jones Alexander Johnson	MIS TechSupport TechSupport TechDoc	65 45 35 30	10 6 6 12
110	Distance-Ed	820972445	432329700 689231199 712093093	Mantle Richardson Howard	MIS TechSupport TechDoc	50 35 30	5 12 8
120	Cyber	980212343	834920043 380802233 553208932 123423479	Lopez Harrison Olivier Heydary	Engineering TechSupport TechDoc MIS	80 35 30 65	4 11 12 07
130	Nitts	550227043	340783453	Shaw	MIS	65	07

Fig. 5-2. The PROJECT table.

Normalization - 05

Issues with the table

- Some attributes have multiple values
- Example: Emp-ID, Emp-Name, Emp-Dpt, Emp-Hrly-Rate & Total-Hrs
- Such a relation is known to be in unnormalized form
- To represent this table as relation and it is necessary to normalize the table.
- Need to convert the table into First Normal Form

1NF - 01

Definition

A relation r(R) is in first normal form if and only if every entry of the relation has at most a single value

1NF - 01

Definition

A relation r(R) is in first normal form if and only all its attribtues are based upon a simple domain

1NF - 01

Definition

Flatten the table by (i) removing repeating groups, (ii) filling the missing entries with copies of corresponding nonrepeating attributes

1NF - 02

An example table

Proj-ID	Proj-Name	Proj-Mgr-ID	Emp-ID	Emp-Name	Emp-Dpt	Emp-Hrly-Rate	Total-Hrs
100	E-commerce	789487453	123423479	Heydary	MIS	65	10
100	E-commerce	789487453	980808980	Jones	TechSupport	45	6
100	E-commerce	789487453	234809000	Alexander	TechSupport	35	6
100	E-commerce	789487453	542298973	Johnson	TechDoc	30	12
110	Distance-Ed	820972445	432329700	Mantle	MIS	50	5
110	Distance-Ed	820972445	689231199	Richardson	TechSupport	35	12
110	Distance-Ed	820972445	712093093	Howard	TechDoc	30	8
120	Cyber	980212343	834920043	Lopez	Engineering	80	4
120	Cyber	980212343	380802233	Harrison	TechSupport	35	11
120	Cyber	980212343	553208932	Olivier	TechDoc	30	12
120	Cyber	789487453	123423479	Heydary	MIS	65	10
130	Nitts	550227043	340783453	Shaw	Cabling	40	27

1NF - 03

Not a relation

- The above flattened table is not a relation
- It has no (primay) key
- It has redundancy

Decomposing relation

Process

- Given a relation R$(A_1, A_2, \cdots, A_n)$
- We may decompose R into two relations S and T
- S$(B_1, B_2, \cdots, B_m)$
- T$(C_1, C_2, \cdots, C_k)$
- Such that $\{A_1, A_2, \cdots, A_n\} = \{B_1, B_2, \cdots, B_m\} \cup \{C_1, C_2, \cdots, C_k\}$
- Tuples in R with attribute values $(B_1, B_2, \cdots, B_m)$ are placed in S
- Tuples in R with attribute values $(C_1, C_2, \cdots, C_k)$ are placed in T
- Duplicates are not included

Example - decomposing relation

R(title, year, length, filmType, studioName, starName)

title	year	length	filmType	studioName	starName
Star wars	1977	124	color	Fox	Carrie Fisher
Star wars	1977	124	color	Fox	Mark Hamill
Star wars	1977	124	color	Fox	Harrison Ford
Mighty Ducks	1991	104	color	Disney	Emilio Estevez
Wayne's world	1992	95	color	Paramount	Data Carvey
Wayne's world	1992	95	color	Paramount	Mike Meyers

S(title, year, length, fileType, studioName)

title	year	length	filmType	studioName
Star wars	1977	124	color	Fox
Mighty Ducks	1991	104	color	Disney
Wayne's world	1992	95	color	Paramount

Example - decomposing relation

R(title, year, length, filmType, studioName, starName)

title	year	length	filmType	studioName	starName
Star wars	1977	124	color	Fox	Carrie Fisher
Star wars	1977	124	color	Fox	Mark Hamill
Star wars	1977	124	color	Fox	Harrison Ford
Mighty Ducks	1991	104	color	Disney	Emilio Estevez
Wayne's world	1992	95	color	Paramount	Data Carvey
Wayne's world	1992	95	color	Paramount	Mike Meyers

T(title, year, starName)

title	year	starName
Star wars	1977	Carrie Fisher
Star wars	1977	Mark Hamill
Star wars	1977	Harrison Ford
Mighty Ducks	1991	Emilio Estevez
Wayne's world	1992	Data Carvey
Wayne's world	1992	Mike Meyers

1NF - 04

Convert table into - 1 NF

- Decompose the original table into two tables
- Such that each table is a relation with a (primary) key

1NF - 05

An example table

Proj-ID	Proj-Name	Proj-Mgr-ID	Emp-ID	Emp-Name	Emp-Dpt	Emp-Hrly-Rate	Total-Hrs
100	E-commerce	789487453	123423479	Heydary	MIS	65	10
100	E-commerce	789487453	980808980	Jones	TechSupport	45	6
100	E-commerce	789487453	234809000	Alexander	TechSupport	35	6
100	E-commerce	789487453	542298973	Johnson	TechDoc	30	12
110	Distance-Ed	820972445	432329700	Mantle	MIS	50	5
110	Distance-Ed	820972445	689231199	Richardson	TechSupport	35	12
110	Distance-Ed	820972445	712093093	Howard	TechDoc	30	8
120	Cyber	980212343	834920043	Lopez	Engineering	80	4
120	Cyber	980212343	380802233	Harrison	TechSupport	35	11
120	Cyber	980212343	553208932	Olivier	TechDoc	30	12
120	Cyber	789487453	123423479	Heydary	MIS	65	10
130	Nitts	550227043	340783453	Shaw	Cabling	40	27

Decomposed table in 1NF

PROJECT

Proj-ID	Proj-Name	Proj-Mgr-ID
100	E-commerce	789487453
110	Distance-Ed	820972445
120	Cyber	980212343
130	Nitts	550227043

1NF - 06

An example table

Proj-ID	Proj-Name	Proj-Mgr-ID	Emp-ID	Emp-Name	Emp-Dpt	Emp-Hrly-Rate	Total-Hrs
100	E-commerce	789487453	123423479	Heydary	MIS	65	10
100	E-commerce	789487453	980808980	Jones	TechSupport	45	6
100	E-commerce	789487453	234809000	Alexander	TechSupport	35	6
100	E-commerce	789487453	542298973	Johnson	TechDoc	30	12
110	Distance-Ed	820972445	432329700	Mantle	MIS	50	5
110	Distance-Ed	820972445	689231199	Richardson	TechSupport	35	12
110	Distance-Ed	820972445	712093093	Howard	TechDoc	30	8
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120	Cyber	980212343	553208932	Olivier	TechDoc	30	12
120	Cyber	789487453	123423479	Heydary	MIS	65	10
130	Nitts	550227043	340783453	Shaw	Cabling	40	27

Decomposed table in 1NF

PROJECT-EMPLOYEE

Proj-ID	Emp-ID	Emp-Name	Emp-Dpt	Emp-Hrly-Rate	Total-Hrs
100	123423479	Heydary	MIS	65	10
100	980808980	Jones	TechSupport	45	6
100	234809000	Alexander	TechSupport	45	6
100	542298973	Johnson	TechDoc	30	12
110	432329700	Mantle	MIS	65	5
110	689231199	Richardson	TechSupport	45	12
110	712093093	Howard	TechDoc	30	8
120	834920043	Lopez	Engineering	80	4
120	380802233	Harrison	TechSupport	45	11
120	553208932	Olivier	TechDoc	30	12
120	123423479	Heydary	MIS	65	10
130	340783453	Shaw	Cabling	40	27

1NF - 07

Anomalies in 1NF Tables

- Insertion into `project-employee` table
- The FD `EMP-ID` $\rightarrow$ `EMP-DPT`
- For a new employee, when department is not assigned yet, inserting this into `project-employee` result in issues
- Deletion from `project-employee` table
- When deleting employee, we loose employee-project information
- We also loose the employee department information
- Update Anomaly: We may miss updating one redundant row

Partial Dependencies

Discussion

- Let X, Y be set of attributes such that X $\subset$ R and Y $\subset$ R
- We also are given the FD: X $\rightarrow$ Y
- We say Y is fully dependent on X if and only if there no proper subset W of X such that W $\rightarrow$ Y
- We say Y is partially dependent on X if there a proper subset W of X such that W $\rightarrow$ Y
- Exmaple: $A_1 A_2 \cdots A_m \rightarrow B_1 B_2 \cdots B_n$
- Let $AcA_d \cdots A_k \subset A_1 A_2 \cdots A_m$ such that
- $AcA_d \cdots A_k \rightarrow B_1 B_2 \cdots B_n$

2NF - No partial dependency

Definition

A relation r(R) is in 2NF if and only if

- r(R) is already in 1NF
- No non-prime attribute is partially dependent on any key

2NF - No partial dependency

Definition

A relation r(R) is in 2NF if and only if

- r(R) is already in 1NF
- Each non-prime attribute is fully dependent on every key

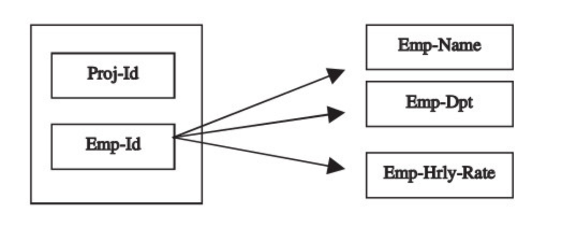
Non-prime attributes

Discussion

- To find non-prime attribute of R we need to identify all prime attributes of R
- That is we need to identify all possible keys of R
- non-prime attributes(R) = all attributes(R) - prime attribtues(R)

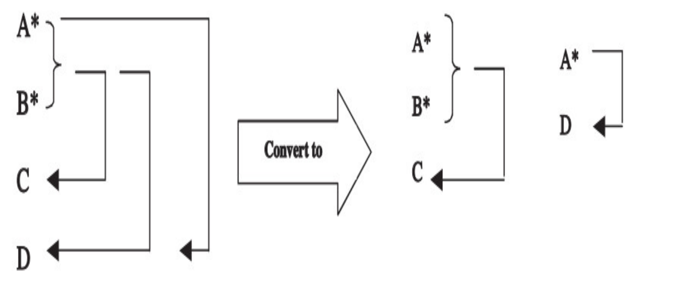
2NF - 01

An example table



2NF - 02

Decomposing Relation into 2NF



2NF - 03

Decomposing Relation into 2NF

- HOURS-ASSIGNED(Proj-ID, Emp-ID, Total-Hours)
- EMPLOYEE(Emp-ID, Emp-Name, Emp-Dpt, Emp-Hrly-Rate)

2NF - 04

Project-Employee Table split into 2 - Hours-Assigned

Proj-ID	Emp-ID	Total-Hrs
100	123423479	10
100	980808980	6
100	234809000	6
100	542298973	12
110	432329700	5
110	689231199	12
110	712093093	8
120	834920043	4
120	380802233	11
120	553208932	12
120	123423479	10
130	340783453	27

2NF - 04

Project-Employee Table split into 2 - Employee

Emp-ID	Emp-Name	Emp-Dpt	Emp-Hrly-Rate
123423479	Heydary	MIS	65
980808980	Jones	TechSupport	45
234809000	Alexander	TechSupport	45
542298973	Johnson	TechDoc	30
432329700	Mantle	MIS	65
689231199	Richardson	TechSupport	45
712093093	Howard	TechDoc	30
834920043	Leopez	Engineering	80
380802233	Harrison	TechSupport	45
553208932	Olivier	TechDoc	30
123423479	Heydary	MIS	65
340783453	Shaw	Cabling	40

2NF - 05

Data Anomalies in 2NF

- Relations in 2NF are still subject to data anomalies
- Consider the FD: `Emp-Dpt` $\rightarrow$ `Emp-Hrly-Rate`
- This fact was not considered perviously
- Insertion Anomaly Rate to be charged to be set before hand to employees of new department
- Deletion Anomaly The only employee in the department left there by loosing the information about that department charges
- Update Anomalies Employees of the same department working on different projects data need to be updated

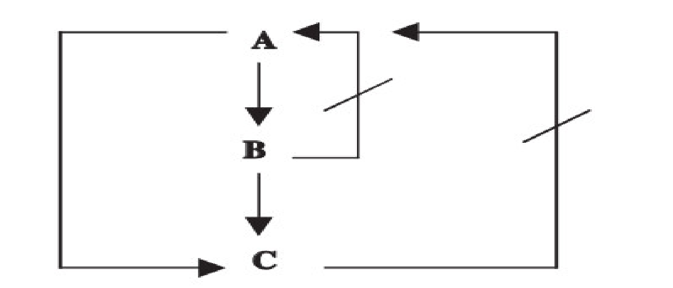
Transitive Dependencies - 01

Discussion

- Let A, B, C be set of attribute of r(R)
- Assum FDs $\{ A \rightarrow B, B \rightarrow C, A \rightarrow C, B \not\rightarrow A, C \not\rightarrow A \}$
- Then C is transitively dependent on A

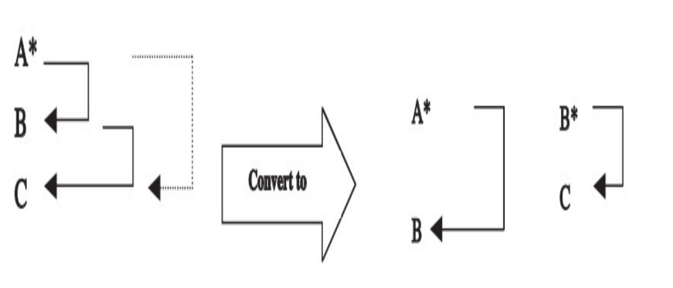
Transitive Dependencies - 02

Transitive Dependency - Diagram



3NF - 01

Decomposing Relation into 3NF



3NF - 02

Decompose Empoyee into two tables to get to 3NF

- `EMPLOYEE(Emp-ID, Emp-Name, Emp-Dpt)`
- `CHARGES(Emp-Dpt, Emp-Hrly-Rate)`

3NF - 03

Employee Table split into 2 - Employee

Emp-ID	Emp-Name	Emp-Dpt
123423479	Heydary	MIS
980808980	Jones	TechSupport
234809000	Alexander	TechSupport
542298973	Johnson	TechDoc
432329700	Mantle	MIS
689231199	Richardson	TechSupport
712093093	Howard	TechDoc
834920043	Leopez	Engineering
380802233	Harrison	TechSupport
553208932	Olivier	TechDoc
123423479	Heydary	MIS
340783453	Shaw	Cabling

3NF - 04

Employee Table split into 2 - Charges

Emp-Dpt	Emp-Hrly-Rate
MIS	65
TechSupport	45
TechDoc	30
MIS	65
Engineering	80
Cabling	40

Given table to 1NF, 2NF and 3NF

Given table

Proj-ID	Proj-Name	Proj-Mgr-ID	Emp-ID	Emp-Name	Emp-Dpt	Emp-Hrly-Rate	Total-Hrs
100	E-commerce	789487453	123423479 980808980 234809000 542298973	Heydary Jones Alexander Johnson	MIS TechSupport TechSupport TechDoc	65 45 35 30	10 6 6 12
110	Distance-Ed	820972445	432329700 689231199 712093093	Mantle Richardson Howard	MIS TechSupport TechDoc	50 35 30	5 12 8
120	Cyber	980212343	834920043 380802233 553208932 123423479	Lopez Harrison Olivier Heydary	Engineering TechSupport TechDoc MIS	80 35 30 65	4 11 12 07
130	Nitts	550227043	340783453	Shaw	MIS	65	07

Fig. 5-2. The PROJECT table.

Given table to 1NF, 2NF and 3NF

Convert to 1NF

PROJECT

Proj-ID	Proj-Name	Proj-Mgr-ID
100	E-commerce	789487453
110	Distance-Ed	820972445
120	Cyber	980212343
130	Nitts	550227043

Given table to 1NF, 2NF and 3NF

Convert to 1NF

PROJECT-EMPLOYEE

Proj-ID	Emp-ID	Emp-Name	Emp-Dpt	Emp-Hrly-Rate	Total-Hrs
100	123423479	Heydary	MIS	65	10
100	980808980	Jones	TechSupport	45	6
100	234809000	Alexander	TechSupport	45	6
100	542298973	Johnson	TechDoc	30	12
110	432329700	Mantle	MIS	65	5
110	689231199	Richardson	TechSupport	45	12
110	712093093	Howard	TechDoc	30	8
120	834920043	Lopez	Engineering	80	4
120	380802233	Harrison	TechSupport	45	11
120	553208932	Olivier	TechDoc	30	12
120	123423479	Heydary	MIS	65	10
130	340783453	Shaw	Cabling	40	27

Given table to 1NF, 2NF and 3NF

Convert to 2NF

Emp-ID	Emp-Name	Emp-Dpt	Emp-Hrly-Rate
123423479	Heydary	MIS	65
980808980	Jones	TechSupport	45
234809000	Alexander	TechSupport	45
542298973	Johnson	TechDoc	30
432329700	Mantle	MIS	65
689231199	Richardson	TechSupport	45
712093093	Howard	TechDoc	30
834920043	Leopez	Engineering	80
380802233	Harrison	TechSupport	45
553208932	Olivier	TechDoc	30
123423479	Heydary	MIS	65
340783453	Shaw	Cabling	40

Given table to 1NF, 2NF and 3NF

Project-Employee Table split into 2 - Hours-Assigned

Proj-ID	Emp-ID	Total-Hrs
100	123423479	10
100	980808980	6
100	234809000	6
100	542298973	12
110	432329700	5
110	689231199	12
110	712093093	8
120	834920043	4
120	380802233	11
120	553208932	12
120	123423479	10
130	340783453	27

Given table to 1NF, 2NF and 3NF

Employee Table split into 2 - Employee

Emp-ID	Emp-Name	Emp-Dpt
123423479	Heydary	MIS
980808980	Jones	TechSupport
234809000	Alexander	TechSupport
542298973	Johnson	TechDoc
432329700	Mantle	MIS
689231199	Richardson	TechSupport
712093093	Howard	TechDoc
834920043	Leopez	Engineering
380802233	Harrison	TechSupport
553208932	Olivier	TechDoc
123423479	Heydary	MIS
340783453	Shaw	Cabling

Given table to 1NF, 2NF and 3NF

Employee Table split into 2 - Charges

Emp-Dpt	Emp-Hrly-Rate
MIS	65
TechSupport	45
TechDoc	30
MIS	65
Engineering	80
Cabling	40