DBMS - 1

Class Assignment 4

**SUBMITTED BY:**

**SHAHZANEER AHMED**

**REGISTRATION**

**NUMBER**

**:**

**SP21-BCS-087**

**SUBMITTED TO**

**:**

**Dr. Basit Raza**

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**OF**

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Consider the following four unnormalized tables. You are required to normalize each of them up to 1NF, 2NF, 3NF, BCNF, 4NF normal form whatever is applicable. Provide complete details about the normalization steps while converting from one normalize form to the next normal form. State all dependencies and anomalies if exists in each step.

1. **Employee/Department Data**

Table

Description automatically generated

First Normal Form (1NF):

* Eliminate all repeating groups from the table
* The table is now in 1st Normal Form

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Emp No** | **Emp Name** | **Time Card No** | **Time Card Date** | **Dept No** | **Dept Name** |
| 10 | Thomas Arquette | 106 | 11/02/2002 | 20 | Marketing |
| 10 | Thomas Arquette | 115 | 11/09/2002 | 20 | Marketing |
| 99 | Janice Smitty |  |  | 10 | Accounting |
| 500 | Alan Cook | 107 | 11/02/2002 | 50 | Shipping |
| 700 | Ernest Gold | 108 | 11/02/2002 | 50 | Shipping |
| 700 | Ernest Gold | 116 | 11/09/2002 | 50 | Shipping |

Second Normal Form (2NF):

* In the given table, non-prime attribute “Emp Name” is dependent on “Emp No” which is a proper subset of a candidate key. That's why it violates the rule for 2 NF
* To convert the given table into 2NF, we decompose it into two tables: Employee\_Details and Employee \_Department

**Employee\_Details**

|  |  |
| --- | --- |
| **Emp No** | **Emp Name** |
| 10 | Thomas Arquette |
| 99 | Janice Smitty |
| 500 | Alan Cook |
| 700 | Ernest Gold |

**Employee\_Department**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Emp No** | **Time Card No** | **Time Card Date** | **Dept No** | **Dept Name** |
| 10 | 106 | 11/02/2002 | 20 | Marketing |
| 10 | 115 | 11/09/2002 | 20 | Marketing |
| 99 |  |  | 10 | Accounting |
| 500 | 107 | 11/02/2002 | 50 | Shipping |
| 700 | 108 | 11/02/2002 | 50 | Shipping |
| 700 | 116 | 11/09/2002 | 50 | Shipping |

Third Normal Form (3NF):

* Here, “Dept Name” is dependent on “Dept No” and “Dept No” is dependent on “Emp No”. The non-prime attributes (”Dept Name” and “Dept No”) transitively dependent on super key (Emp No). It violates the rule of third normal form.
* That's why we need to move the ”Dept Name” and “Dept No” to the new Department table, with “Dept No” as a Primary key.

**Employee\_Details**

|  |  |
| --- | --- |
| **Emp No** | **Emp Name** |
| 10 | Thomas Arquette |
| 99 | Janice Smitty |
| 500 | Alan Cook |
| 700 | Ernest Gold |

**Employee\_Department**

|  |  |  |  |
| --- | --- | --- | --- |
| **Emp No** | **Time Card No** | **Time Card Date** | **Dept No** |
| 10 | 106 | 11/02/2002 | 20 |
| 10 | 115 | 11/09/2002 | 20 |
| 99 |  |  | 10 |
| 500 | 107 | 11/02/2002 | 50 |
| 700 | 108 | 11/02/2002 | 50 |
| 700 | 116 | 11/09/2002 | 50 |

**Department**

|  |  |
| --- | --- |
| **Dept No** | **Dept Name** |
| 20 | Marketing |
| 10 | Accounting |
| 50 | Shipping |

Boyce-Codd Form (BCNF):

* BCNF is the advance version of 3NF. It is stricter than 3NF.
* A table is in BCNF if every functional dependency X → Y, X is the super key of the table.
* The table is not in BCNF because neither “Emp No” nor “Dept No” alone are keys.
* To convert the given table into BCNF, we decompose it into four tables

**Employee\_Details**

|  |  |
| --- | --- |
| **Emp No** | **Emp Name** |
| 10 | Thomas Arquette |
| 99 | Janice Smitty |
| 500 | Alan Cook |
| 700 | Ernest Gold |

**Time\_Card**

|  |  |
| --- | --- |
| **Time Card No** | **Time Card Date** |
| 99 |  |
| 106 | 11/02/2002 |
| 107 | 11/02/2002 |
| 108 | 11/02/2002 |
| 115 | 11/09/2002 |
| 116 | 11/09/2002 |

**Department**

|  |  |
| --- | --- |
| **Dept No** | **Dept Name** |
| 20 | Marketing |
| 10 | Accounting |
| 50 | Shipping |

**Employee\_Department**

|  |  |  |
| --- | --- | --- |
| **Emp No** | **Time Card No** | **Dept No** |
| 10 | 106 | 20 |
| 10 | 115 | 20 |
| 99 |  | 10 |
| 500 | 107 | 50 |
| 700 | 108 | 50 |
| 700 | 116 | 50 |

Fourth Normal Form (4NF):

* A relation will be in 4NF if it is in Boyce Codd normal form and has no multi-valued dependency.
* In the “Employee\_Department” relation, an employee with “Emp No = 10” contains two “Card No”: 106 and 115. So there is a Multi-valued dependency on “Emp No”, which leads to unnecessary repetition of data.
* So to make the above table into 4NF, we can decompose the “Employee\_Department” into two tables

**Employee\_Details**

|  |  |
| --- | --- |
| **Emp No** | **Emp Name** |
| 10 | Thomas Arquette |
| 99 | Janice Smitty |
| 500 | Alan Cook |
| 700 | Ernest Gold |

**Time\_Card**

|  |  |
| --- | --- |
| **Time Card No** | **Time Card Date** |
| 99 |  |
| 106 | 11/02/2002 |
| 107 | 11/02/2002 |
| 108 | 11/02/2002 |
| 115 | 11/09/2002 |
| 116 | 11/09/2002 |

**Department**

|  |  |
| --- | --- |
| **Dept No** | **Dept Name** |
| 20 | Marketing |
| 10 | Accounting |
| 50 | Shipping |

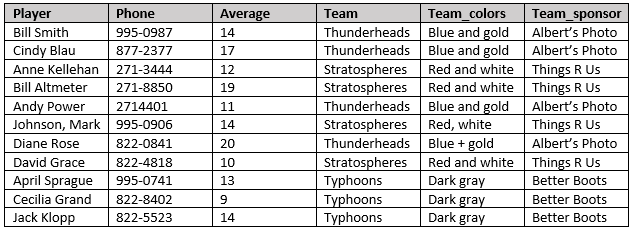
**Employee\_Card**

|  |  |
| --- | --- |
| **Emp No** | **Time Card No** |
| 10 | 106 |
| 10 | 115 |
| 99 |  |
| 500 | 107 |
| 700 | 108 |
| 700 | 116 |

**Employee\_Department**

|  |  |
| --- | --- |
| **Emp No** | **Dept No** |
| 10 | 20 |
| 99 | 10 |
| 500 | 50 |
| 700 | 50 |

1. **Player Data**



First Normal Form (1NF):   
If a relation contains a composite or multi-valued attribute, it violates the first normal form, or the relation is in first normal form if it does not contain any composite or multi-valued attribute. A relation is in first normal form if every attribute in that relation is singled valued attribute.

The field (team\_color) has multiple attributes so for separating them by making more rows so that the table is in 1NF.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Player** | **Phone** | **Average** | **Team** | **Team\_colors** | **Team\_sponsor** |
| Bill Smith | 995-0987 | 14 | Thunderheads | Blue | Albert’s Photo |
| Bill Smith | 995-0987 | 14 | Thunderheads | Gold | Albert’s Photo |
| Cindy Blau | 877-2377 | 17 | Thunderheads | Blue | Albert’s Photo |
| Cindy Blau | 877-2377 | 17 | Thunderheads | Gold | Albert’s Photo |
| Anne Kellehan | 271-3444 | 12 | Stratoshperes | Red | Things R Us |
| Anne Kellehan | 271-3444 | 12 | Stratoshperes | White | Things R Us |
| Bill Altmeter | 271-8850 | 19 | Stratoshperes | Red | Things R Us |
| Bill Altmeter | 271-8850 | 19 | Stratoshperes | White | Things R Us |
| Andy Power | 271-4401 | 11 | Thunderheads | Blue | Albert’s Photo |
| Andy Power | 271-4401 | 11 | Thunderheads | Gold | Albert’s Photo |
| Johnson Mark | 995-0906 | 14 | Stratoshperes | Red | Things R Us |
| Johnson Mark | 995-0906 | 14 | Stratoshperes | White | Things R Us |
| David Grace | 822-4818 | 10 | Stratoshperes | Red | Things R Us |
| David Grace | 822-4818 | 10 | Stratoshperes | White | Things R Us |
| Diane Rose | 822-0841 | 20 | Thunderheads | Red | Albert’s Photo |
| Diane Rose | 822-0841 | 20 | Thunderheads | White | Albert’s Photo |
| April Sprague | 955-0741 | 13 | Typhoons | Dark Grey | Better Boots |
| Cecilia Grand | 822-8402 | 9 | Typhoons | Dark Grey | Better Boots |
| Jack Klopp | 822-5523 | 14 | Typhoons | Dark Grey | Better Boots |

Second Normal Form (2NF):  
Second Normal Form (2NF) is based on the concept of full functional dependency. Second Normal Form applies to relations with composite keys, that is, relations with a primary key composed of two or more attributes. A relation with a single-attribute primary key is automatically in at least 2NF. A relation that is not in 2NF may suffer from the update anomalies.

* There can be made a separate table for team and (team\_color, team\_sponsor) can be identified using it.
* Player will have a separate table with attribute team.

|  |  |  |  |
| --- | --- | --- | --- |
| Player | Phone | Average | Team |
| Bill Smith | 995-0987 | 14 | Thunderheads |
| Cindy Blau | 877-2377 | 17 | Thunderheads |
| Anne Kellehan | 271-3444 | 12 | Stratoshperes |
| Bill Altmeter | 271-8850 | 19 | Stratoshperes |
| Andy Power | 271-4401 | 11 | Thunderheads |
| Johnson Mark | 995-0906 | 14 | Stratoshperes |
| David Grace | 822-4818 | 10 | Stratoshperes |
| Diane Rose | 822-0841 | 20 | Thunderheads |
| April Sprague | 955-0741 | 13 | Typhoons |
| Cecilia Grand | 822-8402 | 9 | Typhoons |
| Jack Klopp | 822-5523 | 14 | Typhoons |

|  |  |  |
| --- | --- | --- |
| Team | Team\_Color | Team\_Sponsor |
| Thunderheads | Blue | Albert’s Photo |
| Thunderheads | Gold | Albert’s Photo |
| Stratoshperes | Red | Things R Us |
| Stratoshperes | White | Things R Us |
| Typhoons | Dark Grey | Better Boots |

Third Normal Form (3NF):  
A relation is in third normal form if there is no transitive dependency for non-prime attributes as well as it is in second normal form.

* A relation is in 3NF if at least one of the following condition holds in every non-trivial function dependency X –> Y:
* X is a super key.
* Y is a prime attribute (each element of Y is part of some candidate key).

|  |  |
| --- | --- |
| Team | Team\_Sponsor |
| Thunderheads | Albert’s Photo |
| Stratoshperes | Things R Us |
| Typhoons | Better Boots |

Boyce-Codd Normal Form (BCNF):

BCNF (Boyce Codd Normal Form) is the advanced version of 3NF. A table is in BCNF if every functional dependency X->Y, X is the super key of the table. For BCNF, the table should be in 3NF, and for every FD. LHS is super key.

**The Tables cannot be further normalized.**

# Fourth normal form (4NF):

Fourth normal form (4NF) is a level of database normalization where there are no non-trivial multivalued dependencies other than a candidate key. It builds on the first three normal forms (1NF, 2NF and 3NF) and the Boyce-Codd Normal Form (BCNF). It states that, in addition to a database meeting the requirements of BCNF, it must not contain more than one multivalued dependency.

**The Tables cannot be further normalized.**

1. **Course/System utilization Data**

Table

Description automatically generated

# First normal form (1NF):

If a relation contains a composite or multi-valued attribute, it violates the first normal form, or the relation is in first normal form if it does not contain any composite or multi-valued attribute. A relation is in first normal form if every attribute in that relation is singled valued attribute.

* In, 1 NF, we eliminate all repeating groups from the table
* This table is already in 1st Normal Form

# Second normal form (2NF):

* In the given table, non-prime attribute “Hourly rate” is dependent on “System Used” which is a proper subset of a candidate key. That's why it violates the rule for 2 NF
* To convert the given table into 2NF, we decompose it into two tables: Course\_System and System

**System**

|  |  |
| --- | --- |
| **System used** | **Hourly rate** |
| P-I | 20 |
| P-II | 30 |
| Celeron | 10 |
| P-IV | 40 |
| P-III | 35 |
| Cyrix | 20 |

**Course**

|  |  |  |
| --- | --- | --- |
| **Course Code** | **Course name** | **Teacher Name** |
| **C1** | **Visual basic** | **ABC** |
| **C2** | **Oracle&Dev** | **DEF** |
| **C3** | **C++** | **KJP** |
| **C4** | **Java** | **Kumar** |

**Course\_System Utilization**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Course Code** | **Roll no** | **Name** | **System used** | **Total hours** |
| **C1** | **100** | **A1** | **P-I** | **7** |
| **C1** | **101** | **A2** | **P-II** | **3** |
| **C1** | **102** | **A3** | **Celeron** | **6** |
| **C1** | **103** | **A4** | **P-IV** | **1** |
| **C2** | **100** | **A5** | **P-I** | **7** |
| **C2** | **104** | **A6** | **P-III** | **3** |
| **C2** | **105** | **A2** | **P-II** | **1** |
| **C3** | **106** | **A7** | **P-II** | **2** |
| **C3** | **107** | **A8** | **P-IV** | **3** |
| **C3** | **108** | **A9** | **P-IV** | **2** |
| **C4** | **109** | **A10** | **P-I** | **1** |
|  |  |  | **Cyrix** | **2** |

# Third normal form (3NF):

* There is not functional dependency between “Roll no” and “Name” which should have been present as

“Roll No 🡪 Name”. For the “Roll No = 100”, there exists two names: “A1 and A5”

* The table is imbalanced as there are 11 rows for the first three columns whereas 12 rows for the last 2 columns
* Hence this table cannot be further normalized.

1. **Product/ vendor data**

Table

Description automatically generated

First Normal Form (1NF):   
If a relation contains a composite or multi-valued attribute, it violates the first normal form, or the relation is in first normal form if it does not contain any composite or multi-valued attribute. A relation is in first normal form if every attribute in that relation is singled valued attribute.

**The Tables are already in 1NF.**

**As there are no rows fully repeating and all atomic values.**

Second Normal Form (2NF):  
Second Normal Form (2NF) is based on the concept of full functional dependency. Second Normal Form applies to relations with composite keys, that is, relations with a primary key composed of two or more attributes. A relation with a single-attribute primary key is automatically in at least 2NF. A relation that is not in 2NF may suffer from the update anomalies.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Product Number** | **Product Name** | **Product Type ID** | **Product Type** | **Product Rating** | **Bore Diameter Inches** | **Unit Selling Price** | **Supplier ID** | **Supplier Name** | **Supplier On-Time Delivery** |
| 4ZZA11 | Disc Bearing | 1 | Round Bore | 4 stars | 1.125 | 78.23 | ROWT | Row Tem | 97.0 |
| 4ZZA41 | Disc Bearing | 1 | Round Bore | 5 stars | 1.125 | 81.15 | SFAB | Steel Fab | 90.0 |
| 4ZZA83 | Disc Bearing | 1 | Round Bore | 5 stars | 1.25 | 84.74 | SFAB | Steel Fab | 90.0 |
| 4ZYU10 | Disc Bearing | 1 | Round Bore | 4 stars | 1.25 | 83.50 | SPW | Spin Works | 85.0 |
| 4TZB30 | Disc Bearing | 2 | Square Bore | 4 stars | 1.125 | 97.25 | ROWT | Row Tem | 97.0 |
| 4TTA12 | Disc Bearing | 2 | Square Bore | 5 stars | 1.125 | 98.50 | SFAB | Steel Fab | 90.0 |
| 4TTA32 | Disc Bearing | 2 | Square Bore | 5 stars | 1.25 | 136.48 | SPW | Spin Works | 85.0 |
| 4TZC44 | Disc Bearing | 2 | Square Bore | 4.2 stars | 1.25 | 135.55 | BORE | Borelt | 97.0 |
| 4TZB35 | Disc Bearing | 2 | Square Bore | 4 stars | 1.50 | 150.89 | SPW | Spin Works | 85.0 |
| 4XXB52 | Disc Bearing | 3 | Hex Bore | 4 stars | 0.875 | 43.70 | ROWT | Row Tem | 97.0 |
| 4ZXB57 | Insert Bearing | 1 | Round Bore | 4.5 stars | 1.0 | 22.15 | SPW | Spin Works | 85.0 |
| 4XRG85 | Insert Bearing | 3 | Hex Bore | 4 stars | 0.875 | 45.00 | BTECH | Bore Tech | 91.0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Product Number** | **Product Type** | **Warehouse Number** | **Warehouse Phone no.** | **Product Location in Warehouse** | **Quantity in Stock** |
| 4ZZA11 | Round Bore | 1 | 555-6137 | Aisle 12 | 57 |
| 4ZZA41 | Square Bore | 1 | 555-6137 | Aisle 12 | 123 |
| 4ZZA41 | Round Bore | 2 | 555-8744 | Aisle 20 | 49 |
| 4ZZA83 | Round Bore | 1 | 555-6137 | Aisle 12 | 37 |
| 4ZZA83 | Round Bore | 2 | 555-8744 | Aisle 20 | 112 |
| 4ZYU10 | Round Bore | 2 | 555-8744 | Aisle 19 | 68 |
| 4TZB30 | Square Bore | 1 | 555-6137 | Aisle 15 | 61 |
| 4TTA12 | Square Bore | 1 | 555-6137 | Aisle 15 | 59 |
| 4TTA32 | Square Bore | 2 | 555-8744 | Aisle 17 | 27 |
| 4TZC44 | Square Bore | 1 | 555-6137 | Aisle 15 | 18 |
| 4TZB35 | Square Bore | 2 | 555-8744 | Aisle 17 | 25 |
| 4XXB52 | Hex Bore | 1 | 555-6137 | Aisle 20 | 135 |
| 4XXB52 | Hex Bore | 2 | 555-8744 | Aisle 20 | 115 |
| 4ZXB57 | Round Bore | 1 | 555-6137 | Aisle 18 | 97 |
| 4ZXB57 | Round Bore | 2 | 555-8744 | Aisle 21 | 45 |
| 4XRG85 | Hex Bore | 2 | 555-8744 | Aisle 20 | 101 |

Third Normal Form (3NF):  
A relation is in third normal form if there is no transitive dependency for non-prime attributes as well as it is in second normal form.

A relation is in 3NF if at least one of the following condition holds in every non-trivial function dependency X –> Y:

X is a super key.

Y is a prime attribute (each element of Y is part of some candidate key).

|  |  |  |
| --- | --- | --- |
| **Warehouse Number** | **Warehouse Phone no.** | **Product Location in Warehouse** |
| 1 | 555-6137 | Aisle 12 |
| 2 | 555-8744 | Aisle 20 |
| 2 | 555-8744 | Aisle 19 |
| 1 | 555-6137 | Aisle 15 |
| 2 | 555-8744 | Aisle 17 |
| 1 | 555-6137 | Aisle 18 |
| 2 | 555-8744 | Aisle 21 |

|  |  |  |
| --- | --- | --- |
| **Supplier ID** | **Supplier Name** | **Supplier On-Time Delivery** |
| ROWT | Row Tem | 97.0 |
| SFAB | Steel Fab | 90.0 |
| SPW | Spin Works | 85.0 |
| BORE | Borelt | 97.0 |
| BTECH | Bore Tech | 91.0 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Product Number** | **Product Name** | **Product Type ID** | **Product Type** | **Product Rating** | **Bore Diameter Inches** | **Unit Selling Price** |
| 4ZZA11 | Disc Bearing | 1 | Round Bore | 4 stars | 1.125 | 78.23 |
| 4ZZA41 | Disc Bearing | 1 | Round Bore | 5 stars | 1.125 | 81.15 |
| 4ZZA83 | Disc Bearing | 1 | Round Bore | 5 stars | 1.25 | 84.74 |
| 4ZYU10 | Disc Bearing | 1 | Round Bore | 4 stars | 1.25 | 83.50 |
| 4TZB30 | Disc Bearing | 2 | Square Bore | 4 stars | 1.125 | 97.25 |
| 4TTA12 | Disc Bearing | 2 | Square Bore | 5 stars | 1.125 | 98.50 |
| 4TTA32 | Disc Bearing | 2 | Square Bore | 5 stars | 1.25 | 136.48 |
| 4TZC44 | Disc Bearing | 2 | Square Bore | 4.2 stars | 1.25 | 135.55 |
| 4TZB35 | Disc Bearing | 2 | Square Bore | 4 stars | 1.50 | 150.89 |
| 4XXB52 | Disc Bearing | 3 | Hex Bore | 4 stars | 0.875 | 43.70 |
| 4ZXB57 | Insert Bearing | 1 | Round Bore | 4.5 stars | 1.0 | 22.15 |
| 4XRG85 | Insert Bearing | 3 | Hex Bore | 4 stars | 0.875 | 45.00 |

Boyce-Codd Normal Form (BCNF):

BCNF (Boyce Codd Normal Form) is the advanced version of 3NF. A table is in BCNF if every functional dependency X->Y, X is the super key of the table. For BCNF, the table should be in 3NF, and for every FD. LHS is super key.

|  |  |
| --- | --- |
| **Warehouse Number** | **Warehouse Phone no.** |
| 1 | 555-6137 |
| 2 | 555-8744 |

|  |  |  |
| --- | --- | --- |
| **Product Type ID** | **Product Type** | **Bore Diameter Inches** |
| 1 | Round Bore | 1.125 |
| 1 | Round Bore | 1.25 |
| 2 | Square Bore | 1.125 |
| 2 | Square Bore | 1.25 |
| 2 | Square Bore | 1.50 |
| 3 | Hex Bore | 0.875 |
| 1 | Round Bore | 1.0 |

|  |  |  |
| --- | --- | --- |
| **Supplier ID** | **Supplier Name** | **Supplier On-Time Delivery** |
| ROWT | Row Tem | 97.0 |
| SFAB | Steel Fab | 90.0 |
| SPW | Spin Works | 85.0 |
| BORE | Borelt | 97.0 |
| BTECH | Bore Tech | 91.0 |

# Fourth normal form (4NF):

Fourth normal form (4NF) is a level of database normalization where there are no non-trivial multivalued dependencies other than a candidate key. It builds on the first three normal forms (1NF, 2NF and 3NF) and the Boyce-Codd Normal Form (BCNF). It states that, in addition to a database meeting the requirements of BCNF, it must not contain more than one multivalued dependency.

|  |  |
| --- | --- |
| **Product Type ID** | **Product Type** |
| 1 | Round Bore |
| 2 | Square Bore |
| 3 | Hex Bore |

|  |  |
| --- | --- |
| **Supplier ID** | **Supplier Name** |
| ROWT | Row Tem |
| SFAB | Steel Fab |
| SPW | Spin Works |
| BORE | Borelt |
| BTECH | Bore Tech |

|  |  |
| --- | --- |
| **Warehouse Number** | **Warehouse Phone no.** |
| 1 | 555-6137 |
| 2 | 555-8744 |