1. Let’s create situation for BCNF non-satisfaction with **Favorites** schema

|  |  |  |
| --- | --- | --- |
| person | fav\_type | loves |
| Olzhas | Electronic | PS5 |
| Aibek | Movie | Avengers: Final |

Satisfies 1NF since all the data is atomatic

Satisfies 2NF since **{person, fav\_type} -> loves** depends on primary key

Satisfies 3NF since there is only one non-key attribute without transitive dependency

But **does not satisfy BCNF since part of a composite primary key depends on non-key attribute**

{loves} -> fav\_type, where attribute “**loves”** is not a super-key or has not trivial dependency

**Possible decomposition is {person} -> {loves} and {loves} -> {fav\_type}**

|  |  |
| --- | --- |
| person | loves |
| Olzhas | PS5 |
| Aibek | Avengers: Final |

|  |  |
| --- | --- |
| loves | fav\_type |
| PS5 | Electronic |
| Avengers: Final | Movie |

But clearly the dependency **{person, fav\_type} -> loves** is lost.

Proved.

**Why BCNF?**

Boyce Codd Normal Form is a slightly stronger version of the third normal form. It addresses certain types of anomalies not dealt with by 3NF. If a relational schema is in BCNF then all redundancy based on functional dependency has been removed.

1. **First Normal Form** (**1NF**):

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UnitID** | **StudentID** | **Date** | **TutorID** | **Topic** | **Room** | **Grade** | **Book** | **TutEmail** |
| U1 | St1 | 23.02.03 | Tut1 | GMT | 629 | 4.7 | Deumlich | tut1@fhbb.ch |
| U2 | St1 | 18.11.02 | Tut3 | Gln | 631 | 5.1 | Zehnder | tut3@fhbb.ch |
| U1 | St4 | 23.02.03 | Tut1 | GMT | 629 | 4.3 | Deumlich | tut1@fhbb.ch |
| U5 | St2 | 05.05.03 | Tut3 | PhF | 632 | 4.9 | Dümmlers | tut3@fhbb.ch |
| U4 | St2 | 04.07.03 | Tut5 | AVQ | 621 | 5.0 | SwissTopo | tut5@fhbb.ch |

**Second Normal Form**:

|  |  |  |
| --- | --- | --- |
| **UnitID** | **StudentID** | **Grade** |
| U1 | St1 | 4.7 |
| U2 | St1 | 5.1 |
| U1 | St4 | 4.3 |
| U5 | St2 | 4.9 |
| U4 | St2 | 5.0 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **UnitID** | **Date** | **TutorID** | **Topic** | **Room** | **Book** |
| U1 | 23.02.03 | Tut1 | GMT | 629 | Deumlich |
| U2 | 18.11.02 | Tut3 | Gln | 631 | Zehnder |
| U5 | 05.05.03 | Tut3 | PhF | 632 | Dümmlers |
| U4 | 04.07.03 | Tut5 | AVQ | 621 | SwissTopo |

**Third Normal Form**:

|  |  |
| --- | --- |
| **Topic** | **Book** |
| GMT | Deumlich |
| Gln | Zehnder |
| PhF | Dümmlers |
| AVQ | SwissTopo |

|  |  |
| --- | --- |
| **TutorID** | **TutEmail** |
| Tut1 | tut1@fhbb.ch |
| Tut3 | tut3@fhbb.ch |
| Tut5 | tut5@fhbb.ch |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **UnitID** | **Date** | **TutorID** | **Topic** | **Room** |
| U1 | 23.02.03 | Tut1 | GMT | 629 |
| U2 | 18.11.02 | Tut3 | Gln | 631 |
| U5 | 05.05.03 | Tut3 | PhF | 632 |
| U4 | 04.07.03 | Tut5 | AVQ | 621 |

|  |
| --- |
|  |

* All the blue tables are included as normalization to the 3NF

1. **First Normal Form** **(1NF)**:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ProjectName | ProjectManager | Position | Budget | TeamSize |
| Project1 | Manager1 | CTO | 1 kk $ | 15 |
| Project2 | Manager2 | CTO2 | 1.5 kk $ | 12 |

**Second Normal Form (2NF)**:

**First Solution**,

If Budget does not depends on Manager

|  |  |
| --- | --- |
| ProjectManager | Position |
| Manager1 | CTO |
| Manager2 | CTO2 |

|  |  |  |
| --- | --- | --- |
| ProjectName | Budget | TeamSize |
| Project1 | 1 kk $ | 15 |
| Project2 | 1.5 kk $ | 12 |

|  |  |
| --- | --- |
| ProjectName | ProjectManager |
| Project1 | Manager1 |
| Project2 | Manager2 |

1. Group -> Specialty -> Faculty

|  |  |
| --- | --- |
| Group | Specialty |
| Basic of IS | IS |
| FEE 2 | AC |

|  |  |
| --- | --- |
| Specialty | Faculty |
| IS | FIT |
| AC | FIT |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ProjectID | Department | Curator | TeamSize | ProjectGroupsNumber |
| 1 | IT | Asem | 100 | 5 |
| 2 | IT | Asem | 20 | 1 |
| 1 | Finance | Aisulu | 120 | 6 |
| 2 | Finance | Asem | 200 | 10 |

**BCNF:**

|  |  |
| --- | --- |
| TeamSize | ProjectGroupsNumber |
| 100 | 5 |
| 120 | 6 |

|  |  |  |
| --- | --- | --- |
| ProjectID | Department | Curator |
| p1 | d1 | e1 |
| p2 | d2 | e2 |

|  |  |
| --- | --- |
| ProjectID | TeamSize |
| p1 | 100 |
| p2 | 120 |



The three design goals are:

**1**. **Minimization of repetition of information.** Repetition is a bad because it increases the storage required for the relation and it makes updating the relation more difficult.

**2.** **Losslessness** (lossless-join decompositions) Loss is bad because certain questions cannot be answered using the reconstructed relation

**3.** **Dependency preservation** (dependency preserving decompositions)

They reach them so we can maintain an accurate result, data integrity. Moreover, we can check correctness of updates quickly, and consume as less space as possible.

**Pointless decomposition**

|  |  |  |  |
| --- | --- | --- | --- |
| **c\_id** | **p\_id** | **c\_name** | **c\_dob** |

|  |  |
| --- | --- |
| **c\_id** | **c\_dob** |

|  |  |  |
| --- | --- | --- |
| **c\_id** | **p\_id** | **c\_name** |

**Lossless-join decomposition**

|  |  |  |
| --- | --- | --- |
| **A** | **B** | **C** |
| 1731 | 43 | 10 |
| 1731 | 42 | 10 |
| 1414 | 43 | 10 |
| 3443 | 42 | 10 |

{A, B} {A, C} {B, C} **{A, B}** and **{B, C}** or **{A, B}** and **{A, C}** but not **{B, C} and {A, C}**

{B, A} {C, A} {C, B}

|  |  |
| --- | --- |
| **B** | **C** |
| 43 | 10 |
| 42 | 10 |

|  |  |  |
| --- | --- | --- |
| **A** | **B** | **C** |
| 1731 | 43 | 10 |
| 1731 | 42 | 10 |
| 1414 | 43 | 10 |
| 3443 | 42 | 10 |

|  |  |
| --- | --- |
| **A** | **B** |
| 1731 | 43 |
| 1731 | 42 |
| 1414 | 43 |
| 3443 | 42 |

|  |  |
| --- | --- |
| **A** | **C** |
| 1731 | 10 |
| 1414 | 10 |
| 3443 | 10 |

|  |  |
| --- | --- |
| **A** | **B** |
| 1731 | 43 |
| 1731 | 42 |
| 1414 | 43 |
| 3443 | 42 |

|  |  |  |
| --- | --- | --- |
| **A** | **B** | **C** |
| 1731 | 43 | 10 |
| 1731 | 42 | 10 |
| 1414 | 43 | 10 |
| 3443 | 42 | 10 |

|  |  |
| --- | --- |
| **A** | **C** |
| 1731 | 10 |
| 1414 | 10 |
| 3443 | 10 |

|  |  |
| --- | --- |
| **B** | **C** |
| 43 | 10 |
| 42 | 10 |

|  |  |  |
| --- | --- | --- |
| **A** | **B** | **C** |
| 1731 | 43 | 10 |
| 1731 | 42 | 10 |
| 1414 | 43 | 10 |
| ~~1414~~ | ~~42~~ | ~~10~~ |
| 3443 | 42 | 10 |
| ~~3443~~ | ~~43~~ | ~~10~~ |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| bank\_id | name | city | customer\_name | loan |

**Another Example:**

Lending schema

|  |  |  |
| --- | --- | --- |
| bank\_id | name | city |

|  |  |  |
| --- | --- | --- |
| bank\_id | customer\_name | loan |

Bank schema Loan schema