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Normalizing Book relations (BCNF)

Attributes: (PhysicalBook_ID, Title, Edition, ISBN, language, publisher, Date of publish, prequels,sequels, Author, Genre, Damage)
We have the functional dependency
PhysicalBook_ID => Title, Edition, ISBN, language, publisher, Date of publish, prequels,sequels, Author, Genre, Damage.
To avoid redundancy we can have a FD PhysicalBook_ID,Title => prequel , sequel where PhysicalBook_ID and Title act as a primary key to determine the prequels and sequels of a book

-1NF : we need to ensure that there are no multivalued or composed attributes in the relation. Since the same copy of a book with a certain PhysicalBook_ID may have more than one author and more than one genre. That's why we decided to decompose the Book relation into 4 different function dependencies as following:

(FD1) : (PK) PhysicalBook_ID => Title, Edition, ISBN, language, publisher, Date of publish, Damage.
(FD2) PhysicalBook_ID,Title => prequel , sequel
(FD3) : (FK) PhysicalBook_ID => Author
(FD4) : (FK) PhysicalBook_ID => Genre
Observe that, even though a book may have different language, Edition, publisher, yet a copy of that book would always have still a certain language, Edition and publisher. That is, PhysicalBook_ID uniquety still can hold.

2NF: Now that we have the tables in first normal form , we need to ensure that there are no partial dependencies, that is, we cannot have a non-prime attribute that is functionally dependent on any proper subset of any candidate key of the relation. Since we have only PhysicalBook_Id as a key. After examining we found out that date of publish and publisher are partially dependent on the combination of title and edition, so we need to make some adjustment to not violate 2NF and cause redundancy :
(FD1) : (PK) PhysicalBook_ID => Title, Edition, ISBN, language, Damage.

(FD2): (PK) Title, Edition => publisher, Date of publish

(FD3) PhysicalBook_ID,Title => prequel , sequel

(FD4) : (FK) PhysicalBook_ID => Author

(FD5) : (FK) PhysicalBook_ID => Genre

3NF : to decompose a second normal form table into a third normal form we need to ensure that the table has no transitive functional dependencies . After examining the tables we couldn't find any transitive functional dependencies with the assumption that ISBN isn't provided for all the books. Therefor, we still have the following function dependencies:

(FD1) : (PK) PhysicalBook_ID => Title, Edition, ISBN, language, Damage.

(FD2): (PK) Title, Edition => publisher, Date of publish

(FD3): PhysicalBook_ID,Title => prequel , sequel

(FD4) : (FK) PhysicalBook_ID => Author

(FD5) : (FK) PhysicalBook_ID => Genre

-After applying BCNF algorithm we get the following relations:

(S1) : (PK) PhysicalBook_ID => Title, Edition, ISBN, language, Damage.

(S2) : (PK)Title, Edition => publisher, Date of publish

(S3) PhysicalBook_ID,Title => prequel , sequel

(S4) : (FK) PhysicalBook_ID => Author

(S5) : (FK) PhysicalBook_ID => Genre

Normalizing Student user relations (3NF)

Attributers: (StudentUser_ID, FirstName, LastName, Email, Program, Address)

- The only function dependency we have her is :

(FD1) : StudentUser_ID => FirstName, LastName, Email, Program, Address

- 1NF: The table is in first normal form as there is no attribute that contains multivalues.

- 2NF: The table is in the second normal form since there isn’t a non-prime key which is functionally dependent on a subset of a candidate key.

-3NF: The table is the third normal form since there are no transitive functional dependencies.

-BCNF: The super key StudentUser_ID uniquely identifies all the columns, hence the relation is in BCNF.

Normalizing Borrowed book relations (BCNF)

Attributers: (Borrowing_ID, Date Of Borrowing, Expiring Date, ReturnDate, PhysicalBook_ID, StudentUser_ID)

We have only one function dependency here which is:

- (FD1): Borrowing_ID => Date Of Borrowing, Expiring Date, ReturnDate, PhysicalBook_ID, StudentUser_ID.

-1NF: The function dependency is in first normal form since there are no multivalued attributes.

-2NF: The function dependency is in the second normal form since there is no non-prime attribute that is dependent on a subset of a candidate key.

-3NF: The function dependency is in the third normal form since there are no transitive dependencies.

-BCNF: The super key Borrowing_ID uniquely identifies all the columns, hence the relation is in BCNF.

(PK): Borrowing_ID

(FK): PhysicalBook_ID and StudentUser_ID

Normalizing admin user relations (BCNF)

Attributers: (AdmintUser_ID, FirstName, LastName, Email, Department, Address, PhoneNumber)

- The only function dependency we have here is :

(FD1) AdmintUser_ID => FirstName, LastName, Email, Department, Address, PhoneNumber

- 1NF: The table is in first normal form as there is no attribute that contains multivalues.

- 2NF: The table is in the second normal form since there isn't a non-prime key which is functionally dependent on a subset of a candidate key.

-3NF: The table is the third normal form since there are no transitive functional dependencies.

-BCNF: The super key AdmintUser_ID uniquely identifies all the columns, hence the relation is in BCNF.

(PK)AdmintUser_ID

Normalizing transaction relations (BCNF)

Attributes : (Transaction_ID, Borrowing_ID, date of payment, payment method)

- The only function dependency we have here is :

(FD1) Transaction_ID => Borrowing_ID, date of payment, payment method

-1NF: The function dependency is in first normal form since there are no multivalued attributes.

-2NF: The function dependency is in the second normal form since there is no non-prime attribute that is dependent on a subset of a candidate key.

-3NF: The function dependency is in the third normal form since there are no transitive dependencies.

-BCNF: The super key Transaction_ID uniquely identifies all the columns, hence the relation is in BCNF.

(PK): Transaction_ID

(FK): Borrowing_ID

Normalizing fines relations (BCNF)

Attributes : (Borrowing_ID, Amount)

- The only function dependency we have here is :

(FD1) Borrowing_ID => Amount

- 1NF: The table is in first normal form as there is no attribute that contains multivalues.

- 2NF: The table is in the second normal form since there isn't a non-prime key which is functionally dependent on a subset of a candidate key.

-3NF: The table is the third normal form since there are no transitive functional dependencies.

-BCNF: The super key Borrowing_ID uniquely identifies all the columns, hence the relation is in BCNF.

(FK): Borrowing_ID

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Our actual database model

1. Published_Books (Title: String, Edition: String, publisher: String, DateOfPublish: Date)

2- Book(PhysicalBook_ID: Integer, Title: String, Edition: String, ISBN: String, language: String)

3- Damaged_Book(PhysicalBook_ID: integer, Damage: string)

4- Prequel_And_Sequel(PhysicalBook_ID: Integer,Title : String , prequel : String , sequel: String)

5- Book_Author(PhysicalBook_ID: integer, Author: string)

6- Book_Genre(PhysicalBook_ID: integer, Genre: string)

7- Student(StudentID : Integer,FirstName: string, LastName: string , Email: string, Program: string, Address: string)

8- Admin(AdminID: integer, FirstName: string, LastName: string, Email: string, Adress: string, Department: string, PhoneNumber: string)

9- Borrowed_Book(Borrowing_ID: Integer, DateOfBorrowing: Date, ExpiringDate: Date, ReturnDate: Date, PysicalBook_ID: integer, Student_ID: integer)

10- Fines(Borrowing_ID: integer, FineAmount: double)

11- Transaction_Information(Transaction_ID: integer, DateOFPayment: Date, PaymentMethod: string, Borrowing_ID)