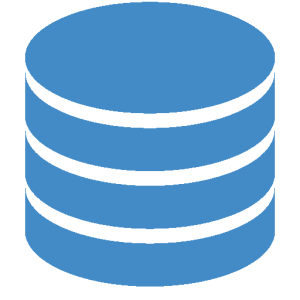
Normal Forms and Entity Relationship Diagram

CS 2203



By

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# Design view

The library has the following tables in its database;

1. **Library**(Title, Address and Contact Information)
2. **Books** (ISBN, Book\_Title, Author, Availability and Rental Fee)
3. **Borrower** (Borrower\_ID, Borrower Name, Borrower Contact, Book\_Title, Borrowed Date and Return Date)
4. **Librarian** (Staff\_ID, Staff name, Username and Contact Information)
5. **BookLended** (ISBN, Book\_Title, Borrower\_ID, Borrowed Date and Return Date)

Primary Keys are represented by \_\_\_\_\_\_\_ and Foreign keys are represented by \_ \_ \_ \_ \_ \_ .

# Normalization of Table

Why Normalization: Database normalization is the process of removing redundant data from your tables in order to improve storage efficiency, data integrity, and scalability. Normalization generally involves splitting existing tables into multiple ones, which must be re-joined or linked each time a query is issued.

**First Normal Form** Given table is converted to its 1NF as follows.

* Step number 1: elimination of duplicative columns from table 1.
* Step number 2: create separate table for each group of related data and identify each row with unique column (primary key).

**Second Normal Form**

A table is in first normal form and each non-key field is functionally dependent upon primary key. To decide what fields belong together in a table, think about which field determines the values in other fields. Create a table for those fields and enter the sample data. Think about what the primary key for each table would be and about the relationship between the tables. Mark the primary key for each table and make sure that you do not have repeated data in non-key fields.

**Third normal form (3NF)**

This requires that there are no functional dependencies of non-key attributes on something other than a candidate key. A table is in 3NF if all of the non-primary-key attributes are mutually independent. There should not be transitive dependencies.

# Normalizations of the Tables

**First Normal Form**

For each table to pass the first normal form the following must be met:

1. Each cell must have a single value
2. Entries in the columns must all be the same type
3. Rows must be uniquely identified. If they are not, then simply add a unique id or add a unique attribute (column)

1st NF Status: Pass

|  |  |  |
| --- | --- | --- |
| **Library** | | |
| **Title** (PK) | Address | Contact Information |
| John Booth Library | 1234, Mayland St. | 1-800-Mayland |

1st NF Status: Pass

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Books** | | | | |
| **ISBN** (PK) | Book\_Title | Author | Availability | Rental Fee |
| 2-226-05257-7 | My Little Pony | Phil Thomas | No | $2.00 |
| 8-335-09832-9 | Saving Grace | Ben Steven | No | $3.50 |
| 9-116-03453-1 | The Trip | Mary Phillip | No | $3.00 |
| 3-454-45456-2 | Life the Story | Mike Mil | No | $2.00 |

1st NF Status: Pass

|  |  |  |  |
| --- | --- | --- | --- |
| **Librarian** | | | |
| **Staff\_ID** (PK) | Staff Name | Username | Contact Information |
| ID234-678 | Faye Henry | FBweB | 555-456-2364 |

1st NF Status: Pass

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **BookLended** | | | | |
| ISBN | Book\_Title (PK) | **Borrower\_ID** | Borrowed Date | Return Date |
| 2-226-05257-7 | My Little Pony | 78990 | 12th May, 2016 | 12th Nov, 2016 |
| 8-335-09832-9 | Saving Grace | 23468 | 11th April, 2016 | 20th Dec, 2016 |
| 9-116-03453-1 | The Trip | 45690 | 24th March, 2016 | 15th Oct, 2016 |
| 3-454-45456-2 | Life the Story | 45690 | 24th March, 2016 | 15th Oct, 2016 |

**1st NF Status: Fail 🡪 Borrower 45690 has borrower Book and they are in the same column**.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Borrower\_ID** (PK) | Borrower Name | Borrower Contact | Book\_Title | Borrowed Date | Return Date |
| 78990 | Berry White | -------- | My Little Pony | 12th May, 2016 | 12th Nov, 2016 |
| 23468 | Bella King | --------- | Saving Grace | 11th April, 2016 | 20th Dec, 2016 |
| 45690 | Mel Johnson | --------- | The Trip  Life the Story | 24th March, 2016 | 15th Oct, 2016 |

**Solution: Add a new row to give the book title its own column.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Borrower\_ID** (PK) | Borrower Name | Borrower Contact | Book\_Title | Borrowed Date | Return Date |
| 78990 | Berry White | -------- | My Little Pony | 12th May, 2016 | 12th Nov, 2016 |
| 23468 | Bella King | --------- | Saving Grace | 11th April, 2016 | 20th Dec, 2016 |
| 45690 | Mel Johnson | --------- | The Trip | 24th March, 2016 | 15th Oct, 2016 |
| 45690 | Mel Johnson | --------- | Life the Story | 24th March, 2016 | 15th Oct, 2016 |

**Second Normal Form**

Rule: The rule of the 2nd normal form says that every attribute of a relation depends on the entire key not on part of it. So we will have to check to ensure that each attribute is fully dependent on the primary and foreign keys.

1st NF Status: Pass, 2nd NF: Pass (Address and Contact information attributes are fully dependent on the Title Primary Key)

|  |  |  |
| --- | --- | --- |
| **Library** | | |
| **Title** (PK) | Address | Contact Information |
| John Booth Library | 1234, Mayland St. | 1-800-Mayland |

1st NF Status: Pass, 2nd NF: Pass (Title, Author, Availability and Rental Fee all depend on the ISBN Primary Key)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Books** | | | | |
| **ISBN** (PK) | Book\_Title | Author | Availability | Rental Fee |
| 2-226-05257-7 | My Little Pony | Phil Thomas | No | $2.00 |
| 8-335-09832-9 | Saving Grace | Ben Steven | No | $3.50 |
| 9-116-03453-1 | The Trip | Mary Phillip | No | $3.00 |
| 3-454-45456-2 | Life the Story | Mike Mil | No | $2.00 |

1st NF Status: Pass, 2nd NF: Pass (Staff Name, Username and Contact Information attributes all depend on the Staff\_ID Primary Key)

|  |  |  |  |
| --- | --- | --- | --- |
| **Librarian** | | | |
| **Staff\_ID** (PK) | Staff Name | Username | Contact Information |
| ID234-678 | Faye Henry | FBweB | 555-456-2364 |

1st NF Status: Pass, 2nd NF: Pass

|  |  |
| --- | --- |
| **BookLended** | |
| Book\_Title (PK) | ISBN |
| My Little Pony | 2-226-05257-7 |
| Saving Grace | 8-335-09832-9 |
| The Trip | 9-116-03453-1 |
| Life the Story | 3-454-45456-2 |

For the two tables to both pass a new entity called Dates must be created. This entity will hold a composite key because for the Borrower table, Borrower Name and Borrower Contact both depend on the Borrower\_ID primary key. And for the BookLended Table, ISBN Depends on the Book\_Title Primary Key.

Borrowed Date and Return Date for both the Borrower Table and the BookLended table will depend on the composite key comprising of the Borrower\_ID key and Book\_Title key.

1st NF Status: Pass, 2nd NF: Pass

|  |  |  |
| --- | --- | --- |
| **Borrower** | | |
| **Borrower\_ID** (PK) | Borrower Name | Borrower Contact |
| 78990 | Berry White | -------- |
| 23468 | Bella King | --------- |
| 45690 | Mel Johnson | --------- |
| 45690 | Mel Johnson | --------- |

|  |  |  |  |
| --- | --- | --- | --- |
| **Dates** | | | |
| **Borrower\_ID** (PK) | Book\_Title (PK) | Borrowed Date | Return Date |
| 78990 | My Little Pony | 12th May, 2016 | 12th Nov, 2016 |
| 23468 | Saving Grace | 11th April, 2016 | 20th Dec, 2016 |
| 45690 | The Trip | 24th March, 2016 | 15th Oct, 2016 |
| 45690 | Life the Story | 24th March, 2016 | 15th Oct, 2016 |

**Third Normal Form**

1st NF Status: Pass, 2nd NF: Pass (Address and Contact information attributes are fully dependent on the Title Primary Key), 3rd NF: Pass (Address and Contact information are both non-key attributes and they both depend on a key attribute called Title)

|  |  |  |
| --- | --- | --- |
| **Library** | | |
| **Title** (PK) | Address | Contact Information |
| John Booth Library | 1234, Mayland St. | 1-800-Mayland |

1st NF Status: Pass, 2nd NF: Pass (Staff Name, Username and Contact Information attributes all depend on the Staff\_ID Primary Key), 3rd NF: Pass (Staff Name, Username and Contact Information are non-key attributes and they all depend on a key attribute called Staff\_ID)

|  |  |  |  |
| --- | --- | --- | --- |
| **Librarian** | | | |
| **Staff\_ID** (PK) | Staff Name | Username | Contact Information |
| ID234-678 | Faye Henry | FBweB | 555-456-2364 |

1st NF Status: Pass, 2nd NF: Pass, 3rd NF: Pass ( ISBN, Borrowed Date and Return Date are all non-key attributes that depend on the composite key combination of Book\_Title and Borrower\_ID)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **BookLended** | | | | |
| ISBN | Book\_Title (PK) | **Borrower\_ID** | Borrowed Date | Return Date |
| 2-226-05257-7 | My Little Pony | 78990 | 12th May, 2016 | 12th Nov, 2016 |
| 8-335-09832-9 | Saving Grace | 23468 | 11th April, 2016 | 20th Dec, 2016 |
| 9-116-03453-1 | The Trip | 45690 | 24th March, 2016 | 15th Oct, 2016 |
| 3-454-45456-2 | Life the Story | 45690 | 24th March, 2016 | 15th Oct, 2016 |

1st NF Status: Pass, 2nd NF: Pass, 3rd NF: Pass (Borrower Name, Borrower Contact, Borrowed Date and Return Date are all non-key attributes that depend on the composite key combination of Book\_Title and Borrower\_ID)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Borrower** | | | | | |
| **Borrower\_ID** (PK) | Borrower Name | Borrower Contact | Book\_Title | Borrowed Date | Return Date |
| 78990 | Berry White | -------- | My Little Pony | 12th May, 2016 | 12th Nov, 2016 |
| 23468 | Bella King | --------- | Saving Grace | 11th April, 2016 | 20th Dec, 2016 |
| 45690 | Mel Johnson | --------- | The Trip | 24th March, 2016 | 15th Oct, 2016 |
| 45690 | Mel Johnson | --------- | Life the Story | 24th March, 2016 | 15th Oct, 2016 |

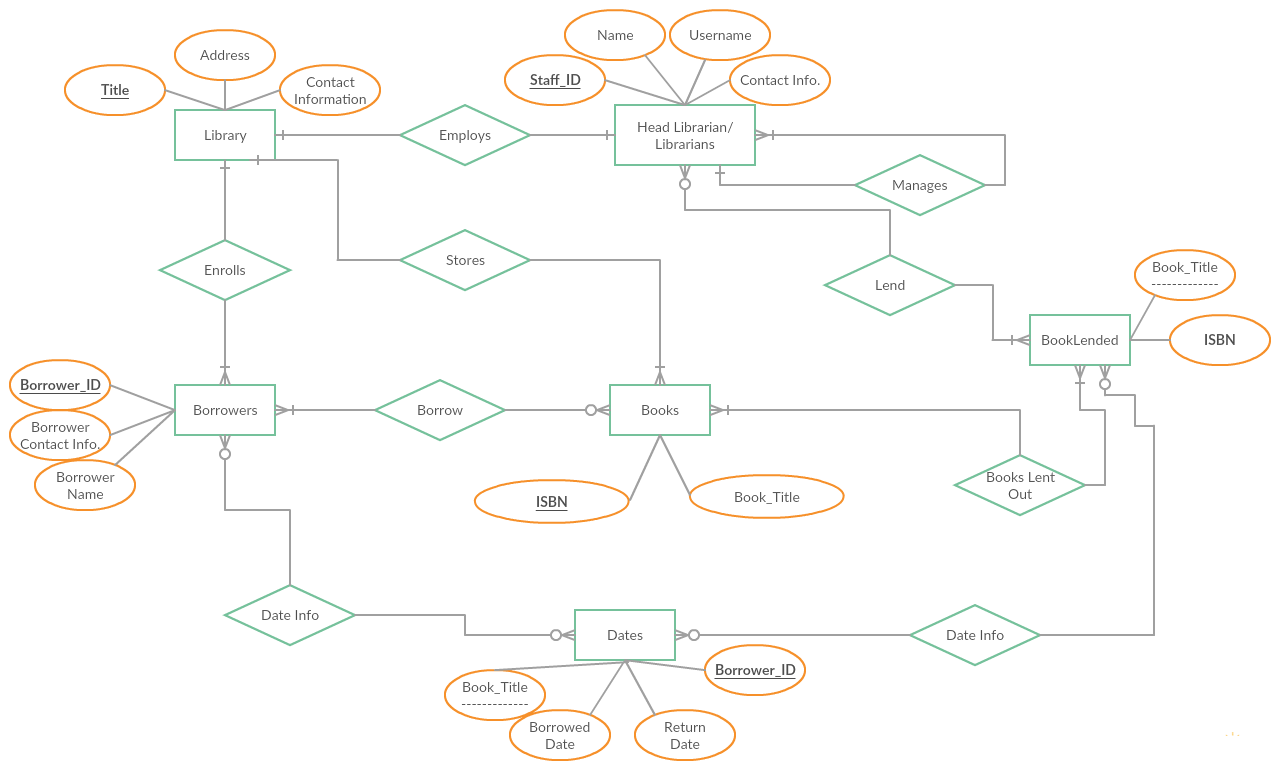
1st NF Status: Pass, 2nd NF: Pass (Title, Author, Availability and Rental Fee all depend on the ISBN Primary Key) 3rd NF: Fail (Author, Availability, and Rental Fee are all non-key attributes which depend on another non-key attribute called Book\_Title. In return, the non-key attribute called Book\_Title depends on the key attribute ISBN.) To fix this, we must remove the Author, Availability, and Rental Fee non-key attributes.)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Books** | | | | |
| **ISBN** (PK) | Book\_Title | Author | Availability | Rental Fee |
| 2-226-05257-7 | My Little Pony | Phil Thomas | No | $2.00 |
| 8-335-09832-9 | Saving Grace | Ben Steven | No | $3.50 |
| 9-116-03453-1 | The Trip | Mary Phillip | No | $3.00 |
| 3-454-45456-2 | Life the Story | Mike Mil | No | $2.00 |

**Solution for 3rd NF to Pass**

|  |  |
| --- | --- |
| **Books** | |
| **ISBN** (PK) | Book\_Title |
| 2-226-05257-7 | My Little Pony |
| 8-335-09832-9 | Saving Grace |
| 9-116-03453-1 | The Trip |
| 3-454-45456-2 | Life the Story |

**Third Normal Form ERD**

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