Project P1 - Library management system

- ## DESCRIPTION OF THE PROJECT

The E-R model is used to get a high-level graphical, conceptual view of the essential components of the enterprise and how these components are related.
The enterprise is viewed as set of-

- Entities with their respective attributes
- Relationships among entities

Symbols used in E-R Diagram-

- **Entity** – rectangle
- **Attribute** – oval
- **Relationship** – diamond
- **Link** - line

We model the potential relationships. Not all entities from a set necessarily connect/relate to another entity in another set.

Cardinality is the number of entity instances to which another entity set can map under the relationship. This does not reflect a requirement that an entity has to participate in a relationship. Participation is another concept.

One-to-one: X-Y is 1:1 when each entity in X is associated with at most one entity in Y, and each entity in Y is associated with at most one entity in X.

One-to-many: X-Y is 1:M when each entity in X can be associated with many entities in Y, but each entity in Y is associated with at most one entity in X.

Many-to-many: X-Y is M: N if each entity in X can be associated with many entities in Y, and each entity in Y is associated with many entities in X ("many" =>one or more and sometimes zero)

This Library management system E-R model is made to maintain an efficient book lending system. It also helps in keeping check of funds, maintenance of library books, provides good staff management for the library and saves important information of various people/institutions both in and out of institution which can be used for future reference if needs.

- **LIST OF ENTITIES AND RELATED ATTRIBUTES**
  - **Staff Entity:** It has Name, Salary, Email_ID, Staff_ID, Phone_no, Designation, Account_no and Address as attributes. Here, **Staff_ID** is the **Primary Key**.
  - **Readers Entity:** It has Reader_ID, Email_ID, Phone_no, Name, Pincode and Address as attributes. **Reader_Id** is the **Primary Key** for Readers entity. Phone_no is a multivalued attribute.
  - **Publishers Entity:** It has Publisher_ID, Email_ID, Phone_no, Name, Account_no and Address as attributes. **Publisher_ID** is the **Primary Key**. Phone_no is a multivalued attribute.
  - **Books Entity:** It has Title, Genre, Book_ID, Author, Price, Units, Year_published, Publisher_ID and Edition as attributes. **Book_ID** is the **Primary Key**. **Publisher_ID** is **Foreign Key**.
  - **Authentication System Entity:** It has Staff_Id, Email_ID and Password attributes with **Staff_ID** is a **Foreign Key**. This entity is a **weak entity** and depends on **Staff Entity.**
  - **Reports Entity:** It has Book_ID, Reader_ID, Fine_due, Date_of_issue, Date_of_return and Fine_remark as attributes. This entity is a **weak entity** and depends on **Readers Entity** and **Books Entity**. It has **Book_ID** and **Reader_Id** as **Foreign keys**.

- **Monetary donations Entity:** It has Donor_name, Email_ID, Account_no, Donation, Address and Phone_no as attributes with **Account_no** as **Primary Key**.

- **Expenditure Entity:** It has attributes as Account_no, Address, Money_given, Email_ID, Receiver_name, Remark and Phone_no with **Account_no** as **Primary Key**.

- **RELATIONSHIP BETWEEN ENTITIES AND CARDINALITY**
  - Staff and Authentication system have a relationship of 1: 1.
  - Staff and Readers have a relationship of M: N.
  - Staff and Publishers have a relationship of M: N.
  - Staff and Books have a relationship of M: N.
  - Staff and Reports have a relationship of M: N.
  - Staff and Expenditure have a relationship of M: N.
  - Staff and Monetary donations have a relationship of M: N.
  - Publishers and Books have a 1: M relationship.
  - Readers and Books have a 1: M relationship.
  - Readers and Reports have a M: N relationship.
  - Books and Reports have a M: N relationship.
  - Monetary donations and Expenditure have a M: N relationship.
  - Expenditure and Books have a 1: M relationship.

NOTE - Total participation is shown by double line (=) in ER diagram which means each entity in the entity set **must participate** in the relationship is signified in the E-R diagram, rest of the single lined (-) relationships signifies **Partial Participation** i.e., that the entity in the entity set **may or may NOT participate** in the relationship.

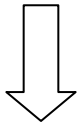
NORMAL FORMS

- **PERFORMING 1NF**

  First normal form (1NF) disallows the multi-valued attribute, composite attribute, and their combinations. Hence, a relation will be 1NF if it contains an atomic value.

  Since, **Phone_no** attribute in both **Readers** and **Publishers** entities is multivalued hence can have non-atomic values, our database is not in 1NF form. To resolve it we have to decompose as follows (for e.g., in **Readers** table)-

Reader_ID	Name	Phone_no	Email_ID	Address
2001056	Ankit Mishra	9890456322, 9432789432	am12@gmail.com	7, Sadar Street, Bhopal (M.P.)
2001189	Mani Kumar	9291763004	Mani35@gmail.com	119, Paradise Apt, Hemant Nagar, Bhopal (M.P.)



Reader_ID	Name	Phone_no	Email_ID	Address
2001056	Ankit Mishra	9890456322	am12@gmail.com	7, Sadar Street, Bhopal (M.P.)
2001056	Ankit Mishra	9432789432	am12@gmail.com	7, Sadar Street, Bhopal (M.P.)
2001189	Mani Kumar	9291763004	Mani35@gmail.com	119, Paradise Apt, Hemant Nagar, Bhopal (M.P.)

- **FUNCTIONAL DEPENDENCIES**

  Candidate key is a single key or a group of minimum number of multiple keys that uniquely identify rows in a table. A **Candidate key** is a subset of **Super keys** and is devoid of any unnecessary attributes that are not important for uniquely identifying tuples.

  A → B has trivial functional dependency if B is a subset of A.

  - **Staff Entity:**
    Candidate key – {Staff_ID , Account_no}

  - **Readers Entity:**
    Candidate key – {Reader_ID}

  - **Publishers Entity:**
    Candidate key – {Publisher_ID, Account_no}

  - **Books Entity:**
    Candidate key – {Book_ID, Publisher_ID}

  - **Authentication System Entity:**
    Candidate key – {Staff_ID, Account_no}

  - **Reports Entity:**
    Candidate key – {Book_ID, Reader_ID}

  - **Monetary donations Entity:**
    Candidate key – {Account_no}

  - **Expenditure Entity:**
    Candidate key – {Account_no}

  So super key can be any set of key(s) which will have Candidate keys in it because closure of all such sets will have all the keys.

- **PERFORMING 2NF**

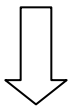
In the 2NF, relational must be in 1NF. All non-key attributes must be fully functionally dependent on only one candidate key alone.

1) In **Reports** table, **Book_ID** and **Reader_ID** both are **Candidate keys** and the table contains non-candidate attributes of which some depend on **Book_ID** whereas others depend on **Reader_ID**.

2) Also, in **Books** table, **Books_ID** and **Publisher_ID** are **Candidate keys** that have other non-key attributes have sharing dependency on both of them.

Hence, the table is not in Second normal form. To resolve it we have to decompose as follows-

Book_ID	Reader_ID	Date_of_issue	Date_of_return	Fine_due	Fine_remark
134567	200189	01/11/2021	1/02/2022	2000	Late_return
128905	200101	01/11/2021	10/11/2021	0	No fine



Reader_ID	Date_of_issue	Date_of_return	Fine_due	Fine_remark
200189	01/11/2021	1/02/2022	2000	Late_return
200101	01/11/2021	10/11/2021	0	No fine

and

Reader_ID	Book_ID
200189	134567
200101	128905

- **PERFORMING 3NF**

A relation will be in 3NF if it is in 2NF and does not contain any transitive partial dependency. If there is no transitive dependency for non-prime attributes, then the relation must be in third normal form.

1) In **Readers** table, Reader_ID is the **Candidate key** but there is a transitive relationship between Reader_ID and non-candidate attributes of **Address** and **Pincode.**

2) In **Reports** table, with **Reader_ID** as the **Candidate key** there is a transition from it to **Fine** to **Remark.**

3) Similarly in **Staff** table, with **Staff_ID** as the **Candidate key** there is a transition from it to **Designation** to **Salary**.

Therefore, it fails in Third normal form requirement. To resolve the issue, we do as follow-

Reader_ID	Name	Phone_no	Email_ID	Address	Pincode
190387	Urvi Dengra	6789456334	urvi2@gmail.com	2, Gomti ganj, Bhopal (M.P.)	540064
180675	Yash Yadav	5643219843	yy55@gmail.com	403, Ravi Tower, pench road, Bhopal (M.P)	456345

Reader_ID	Name	Phone_no	Email_ID	Address
190387	Urvi Dengra	6789456334	urvi2@gmail.com	2, Gomti ganj, Bhopal (M.P.)
180675	Yash Yadav	5643219843	yy55@gmail.com	403, Ravi Tower, pench road, Bhopal (M.P)

and

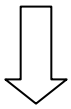
Address	Pincode
2, Gomti ganj, Bhopal (M.P.)	540064
403, Ravi Tower, pench road, Bhopal (M.P)	456345

- **PERFORMING BCNF (Boyce Codd Normal Form)**

  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 that table. A relation is in BCNF if every determinant is a candidate key. Here, this case can be possible in **Books** entity.

  Here, **Author** is a non-key attribute whereas **Title** and **Book_ID** are candidate key attributes, but we can create the following table which can convert **Author** to a candidate key when a reader wants to find more books written by same authors through the key attribute of name of book.

Book_ID	Title	Author	Price	Genre	Edition	Year_published	Units
234	Time Machine First part	A. Rose	500	Sci-fiction	1	2018	2
235	Time Machine Second part	A. Rose	500	Sci-fiction	1	2018	3
123	The flower world	R. Verma	400	Fiction	3	2007	1



Book_ID	Title	Price	Genre	Edition	Year_published	Units
234	Time Machine First part	500	Sci-fiction	1	2018	2
235	Time Machine Second part	500	Sci-fiction	1	2018	3
123	The flower world	400	Fiction	3	2007	1

and

Title	Author
Time Machine First part	A. Rose
Time Machine Second part	A. Rose
The flower world	R. Verma

BCNF is not able to preserve functional dependency because every non-prime attribute should be functionally dependent on any of super key in relation. If there exists any FD (functional dependence), which don't follow this, then for that case we have to separate it into new relation. Now if any of other FD uses previous FD, then this creates non preservation of FD in BCNF.