

Database Design

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Presentation Outline

- Database Fundamentals
- Relational Model
- Modification Anomalies
- Normal Forms
- Forming Relationships

Database Fundamentals

- Data: Meaningful facts
- Database: An organized collection of logically related data. Databases arise from:
 1. Existing data
 2. Development of new information systems projects
 3. The need to redesign an existing database to adopt to changing requirements

Database Fundamentals

- Database Management System (DBMS):
Software package for defining and managing a database.
 - Microsoft Access
 - Microsoft SQL Server
 - Oracle
 - MySQL

Relational Model

- Was introduced in 1970 by Dr. E. F. Codd in his paper "A Relational Model of Data for Large Shared Data Banks" in 1970."
- Why study the relational model?
- A relational data model is based on a collection of tables, and the model has three components
 - Data Structures: Data are organised in the form of tables
 - Data Manipulation: SQL language
 - Data Integrity: Specify business rules

Relational Keys

- Relational modeling uses primary keys and foreign keys to maintain relationships
- Primary Key: A column (or combination of columns) that uniquely identifies each row in a table
- Foreign Key: A column (or combination of columns) that is the primary key of another table

Modification Anomalies

- Insertion Anomaly: Occurs when extra data beyond the desired data must be added to a table.
- Example of an Insert Anomaly

Student_ID	CLASS_ID	CLASS_TITLE	INSTRUCTOR
562321124	IST-189	BASIC COMPUTER PROCESSING	SAMUAL MOORE
562321124	IST-189	BASIC COMPUTER PROCESSING	ADRIAN JONES
769017832	IST-250	ADVANCED COMPUTER PROCESSING	JAMES WILSON
989832423	OST-223	DATA PROCESSING	SAMUEL MOORE
908769987	IST-289	PROGRAMMING METHODS	NORMAN YOUNG
179077643	IST-220	BASIC PROGRAMMING	TAMMY GREEN

Modification Anomalies

- Deletion Anomaly: Occurs when deleting a row causes other data to be deleted
- Example of a Deletion Anomaly

Student_ID	CLASS_ID	CLASS_TITLE	INSTRUCTOR
562321124	IST-189	BASIC COMPUTER PROCESSING	SAMUAL MOORE
562321124	IST-189	BASIC COMPUTER PROCESSING	ADRIAN JONES
769017832	IST-250	ADVANCED COMPUTER PROCESSING	JAMES WILSON
989832423	OST-223	DATA PROCESSING	SAMUEL MOORE
908769987	IST-289	PROGRAMMING METHODS	NORMAN YOUNG
179077643	IST-220	BASIC PROGRAMMING	TAMMY GREEN

Modification Anomalies

- Update Anomaly: Occurs when it is necessary to change multiple rows to modify only a single fact
- Example of an update anomaly

Student_ID	CLASS_ID	CLASS_TITLE	INSTRUCTOR
562321124	IST-189	BASIC COMPUTER PROCESSING	SAMUAL MORE
562321124	IST-189	BASIC COMPUTER PROCESSING	ADRIAN JONES
769017832	IST-250	ADVANCED COMPUTER PROCESSING	JAMES WILSON
989832423	OST-223	DATA PROCESSING	SAMUEL MORE
908769987	IST-289	PROGRAMMING METHODS	NORMAN YOUNG
179077643	IST-220	BASIC PROGRAMMING	TAMMY GREEN

Normal Forms

- The requirements to satisfy the 1st NF:
 - Each table has a primary key: minimal set of attributes which can uniquely identify a record
 - The values in each column of a table are atomic (no multi-value attributes are allowed)
 - There are no repeating groups

1st Normal Form Example

Un-normalized table:

<u>MANAGER</u>	EMPLOYEES
James	Jerry, Mary
Smith	Tom, Richard

Is it 1NF?

<u>MANAGER</u>	EMPLOYEE1	EMPLOYEE2
James	Jerry	Mary
Smith	Tom	Richard

1st Normal Form Example

- Normalized table

<u>EMPLOYEE</u>	MANAGER
Jerry	James
Mary	James
Tom	Smith
Richard	Smith

Moving to 2nd Normal Form

- The requirements to satisfy the 2nd NF:
 - All requirements for 1st NF must be met.
 - Redundant data across multiple rows of a table must be moved to a separate table.
 - The resulting tables must be related to each other by use of foreign key.

2nd Normal Form Example

<u>CUSTOMERID</u>	FIRSTNAME	LASTNAME	ADDRESS	CITY	STATE	ZIPCODE
1	Bob	Smith	123 Main St.	Tucson	AZ	12345
2	John	Brown	555 2 nd Ave.	St. Paul	MN	54355
3	Sandy	Jessop	4256 James St.	Chicago	IL	43555
4	Gameil	Hintz	569 Summit St.	St. Paul	MN	54355
5	Shiela	Green	12 Michigan Ave.	Chicago	IL	43555

This table is in 1NF: all fields are atomic and the CustomerID serves as the primary key

2nd Normal Form Example

Customer Table

<u>CUSTOMERID</u>	FIRSTNAME	LASTNAME	ADDRESS	ZIPCODE
1	Bob	Smith	123 Main St.	12345
2	John	Brown	555 2 nd Ave.	54355
3	Sandy	Jessop	4256 James St.	43555
4	Gameil	Hintz	569 Summit St.	54355
5	Shiela	Green	12 Michigan Ave.	43555

ZipCode Table

<u>ZIPCODE</u>	CITY	STATE
12345	Tucson	AZ
54355	St. Paul	MN
43555	Chicago	IL

Summary of 1NF and 2NF

- 1NF:
 - Each table has a primary key
 - The values in each column of a table are atomic
 - There are no repeating groups
- 2NF:
 - All requirements for 1NF must be met
 - Repeating data of a table must be moved to a separate table

Moving to 3rd Normal Form

- The requirements to satisfy the 3rd NF:
 - All requirements for 2nd NF must be met.
 - All columns in a table must depend only on the primary key and not on any other field in the table
 - Any field which is dependent not only on the primary key but also on another field is moved out to a separate table.

3rd Normal Form Example

<u>ORDERID</u>	CUSTOMERID	PRODUCTID	PRICE	QUANTITY	TOTAL
1	1001	AB-111	50	1000	50000
2	1002	AB-111	60	500	30000
3	1001	ZA-245	35	100	3500
4	1003	MB-153	82	25	2050
5	1004	ZA-245	42	10	420
6	1002	ZA-245	40	50	2000
7	1001	AB-111	75	100	7500

3rd Normal Form Example

Order Table

<u>ORDERID</u>	CUSTOMERID	PRODUCTID	QUANTITY
1	1001	AB-111	1000
2	1002	AB-111	500
3	1001	ZA-245	100
4	1003	MB-153	25
5	1004	ZA-245	10
6	1002	ZA-245	50
7	1001	AB-111	100

Pricing List Table

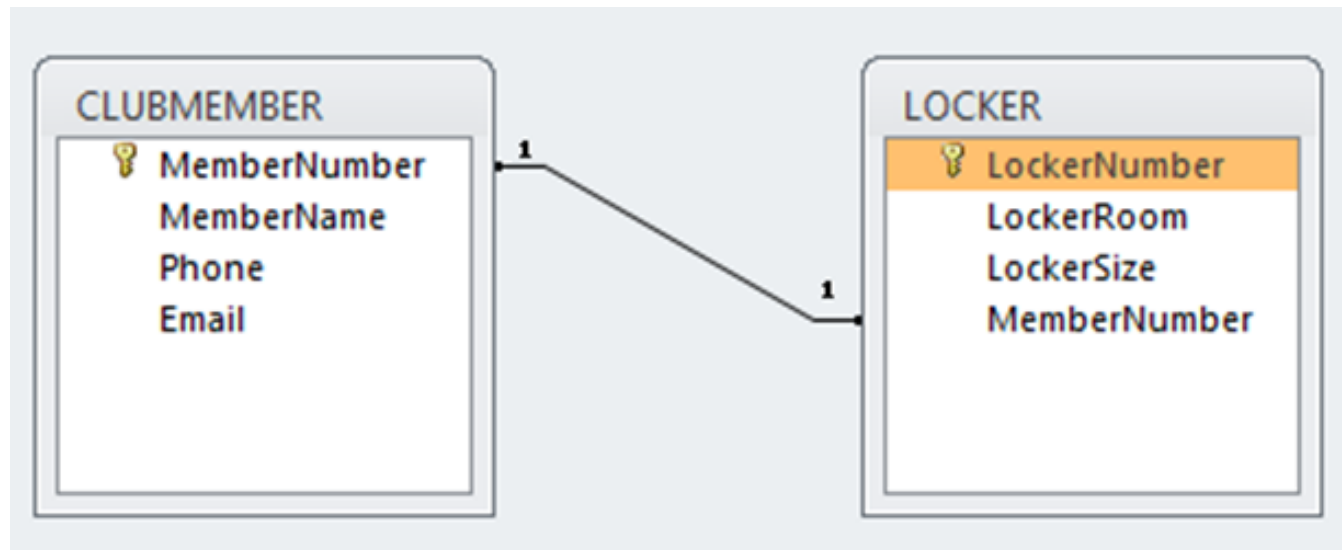
<u>PRODUCTID</u>	<u>QUANTITY</u>	PRICE
AB-111	1	75
AB-111	101	60
AB-111	501	50
ZA-245	1	42
ZA-245	11	40
ZA-245	51	35
MB-153	1	82

Summary of 1NF, 2NF, and 3NF

- A database is in 3NF if:
 - It is in 2NF
 - It has no transitive dependencies
- A database is in 2NF if:
 - It is in 1NF
 - There is no repeating data in its tables
- A database is in 1NF if:
 - All rows have a unique primary key
 - The values in each column of a table are atomic
 - There are no repeating groups (e.g., EMPLOYEE1, EMPLOYEE2...)

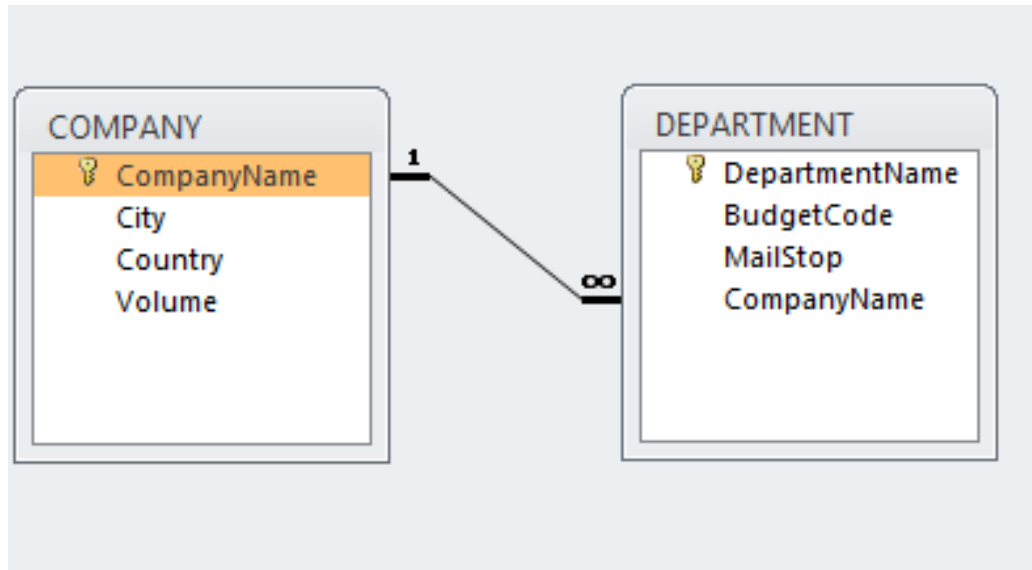
Forming Relationships

- One to One Relationship: Occur when each entry in the first table has one, and only one, counterpart in the second table.



Forming Relationships

- One to Many Relationship: Occurs when one row in the first table corresponds to many rows in the second table



Forming Relationships

- Many to Many Relationship: Occurs when multiple rows from table A correspond to multiple rows in table B

