Database Systems

The Relational Model
A Simplified Introduction

Topics

- Brief Background
- SQL vs Model Terms
- Common Terminology
  - Tables, Columns, Rows
  - Primary Keys
  - Foreign Keys
  - Relationships / Referential Integrity
  - Normalization - SKIP for the time being

Background

A Relational Model of Data for Large Shared Data Banks

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Future users of large data banks must be protected from having to know how the data is organized in the machine (the internal representation). A prompting service which supplies such information is not a satisfactory solution. Activities of users at terminals and most application programs should remain unaffected when the internal representation of data is changed

Background

- Set Theory : foundation of the relational model
- Think in terms of sets of data rather than individual items or rows of data
- Relational algebraic operations (e.g. union, intersect, product, join, etc)
- Tables are analogues of sets: collection of distinct elements having common properties

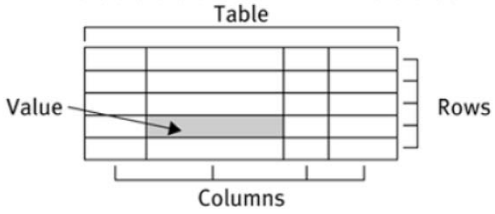
SQL vs Model Terms

Equivalent Terms

SQL	Model	~~Files~~
Table	Relation	~~File~~
Column	Attribute	~~Field~~
Row	Tuple	~~Record~~

Tables

- Each value is atomic (only 1 single value) or unknown (NULL)



Tables

- Example of an actual table

id	fname	lname
A01	Sarah	Buchman
A02	Wendy	Heydemark
A03	Hallie	Hull
A04	Klee	Hull
A05	Keith	Tang
A06		Johnson
A07	John	Doe
.		
.		

Tables

- Database is a collection of >=1 tables
- Uniquely named database structure that holds data as a collection of values
- Contains data about one entity type (e.g. student, course, enrollment, etc)
- 2-dimensional: columns and rows
- >= 1 columns
- >= 0 rows (0 row = empty table)
- **Columns and rows are unordered**

Columns

- Each column represents a specific attribute (or property) of the table's entity type
- Each column has a domain that restricts the set of values allowed - constraints
- Entries in columns are single-valued (atomic)
- Order of columns (left to right) is unimportant
- Each column is uniquely named

Rows

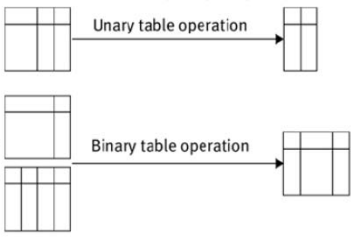
- Each row describes a fact about an entity (i.e. unique instance of an entity type)
- Each row contains a value or NULL for each of the table's columns
- Order of rows are unimportant
- No two rows in a table can be identical (model requirement, but not SQL)
- Each row is uniquely identified by its primary key

Tips - Relevant Facts

- DBMS uses 2 types of tables:
  User tables - for user data
  System tables - for metadata
- System Catalog = all the system tables
- **Closure** property of tables
- SQL Standard defines a hierarchy of RDB structures : catalog.schema.objects
- DBMSes use other terms for the same concepts, and vice versa

Closure Property of Tables

- Guarantees that result is always a table -> allows nesting of operations



Hierarchy of RDB Structures

Object References	
Platform	**Address**
Standard SQL	catalog.schema.object
Access	database.object
SQL Server 2008	server.database.schema.object
Oracle 11g	schema.object
DB2	schema.object
MySQL	Database.object
PostgreSQL	Database.schema.object

Primary Key – Entity Integrity

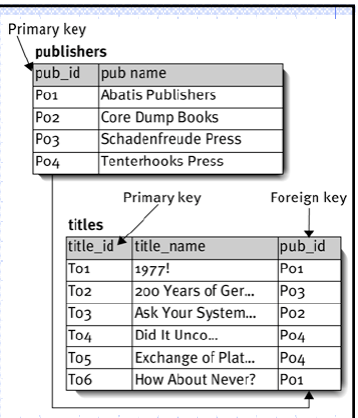
- A primary key is required for each table to access one single row and its column values
- **Entity Integrity** : Each table has at most **one** primary key [PK]
  - **Unique** : no 2 rows can have the same primary key value
  - **Not null**
- Key : Simple (1 column) or composite (>1)
- Minimal : minimum number of columns as necessary for uniqueness

Tips - Relevant Facts

- Use of artificial keys instead of common unique identifiers
- Candidate keys : multiple choices of unique identifiers in a table
- One of the candidate keys is designated as primary key
- Alternate keys : all the remaining candidate keys
- e.g. identifying a book in the library

Foreign Keys [FK]

- Mechanism in Relational DB to associate tables
- Relationship
- **Referential Integrity**



Foreign Keys [FK]

- Column(s) in one table which values, if any, relate to or reference the primary key or unique key values in other table(s) or its own table
- Child table - contains FK column(s)
  Parent table - has PK or unique column
- FK values generally are not unique in their own table
- A table can have 1 PK and >= 0 FKs

Referential Integrity

- Foreign key values in child table must correspond to existing value in parent table, or NULL
- PK (parent) and FK (child) columns can have different names, but must have the same domain
- Self-referencing table:
  FK in one table references PK of same table

Relationships

- Association established between common columns in two tables
- Can be self-referencing
- Relationship between tables can be:
  - One-to-One
  - One-to-Many
  - Many-to-Many
- The One / Many refers to the possible maximum number of rows allowed to exist in that table

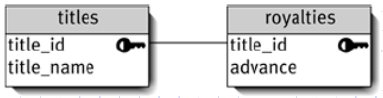
One-to-One

titles

title_id	title_name
T01	1977!
T02	200 Years of Ger...
T03	Ask Your System...
T04	But I Did It Unco...

royalties

title_id	advance
T01	10000
T02	1000
T04	20000



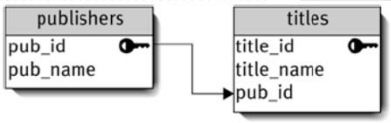
One-to-Many

publishers

pub_id	pub name
P01	Abatis Publishers
P02	Core Dump Books
P03	Schadenfreude Press
P04	Tenterhooks Press

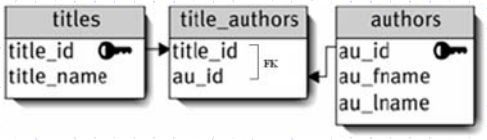
titles

title_id	title_name	pub_id
T01	1977!	P01
T02	200 Years of Ger...	P03
T03	Ask Your System...	P02
T04	But I Did It Unco...	P04
T05	Exchange of Plati...	P04

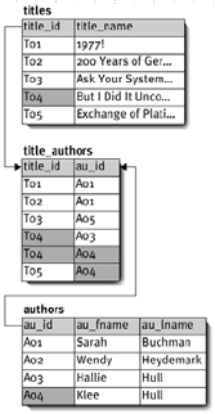


Many-to-Many

- Cannot be implemented directly in the relational model
- Need to be implemented with a pair of one-to-many relationships by adding a Junction or Associating table



Many-to-Many



titles

title_id	title_name
T01	1977!
T02	200 Years of Ger...
T03	Ask Your System...
T04	But I Did It Unco...
T05	Exchange of Plati...

title_authors

title_id	au_id
T01	A01
T02	A01
T03	A05
T04	A03
T04	A04
T05	A04

authors

au_id	au_fname	au_lname
A01	Sarah	Buchman
A02	Wendy	Heydemark
A03	Hallie	Hull
A04	Klee	Hull

Normalization

- Defer detail discussion in this topic until the second half of this term when we will be discussing Database Design
- Can pre-read these pages