Relational Database Design

DBC340

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Difficulties of Managing Data

- Data are scattered and collected by many individuals using various methods and devices.
- Data come from many sources including internal sources, personal sources and external sources.
- Vast amounts of data can be collected and processed
  - e.g., Amazon.com collecting clickstream data.

What is a relational database?

- You have all heard of the major players in the RDBMS (relational database mgmt system) market
  - E.g., Oracle, MySQL, Microsoft SQL-Server
- What makes a database relational?
  - Relational db's are organized around _____
  - Earlier database systems ("hierarchical", "network") were harder to use, and never developed the popularity of relational systems

Database Design terminology

- Entity is a kind of thing you want to store information about (e.g., students, courses, buildings, etc.).
- Attribute is a characteristic or quality of a particular entity
  - Note: same idea as a class attribute in programming – a piece of information aut an object
- Primary key is a field that uniquely identifies that record.
- Foreign keys are fields that have reflect identifying information from another entity (allowing you to "look up" the associated entity).

What are relationships between entities?

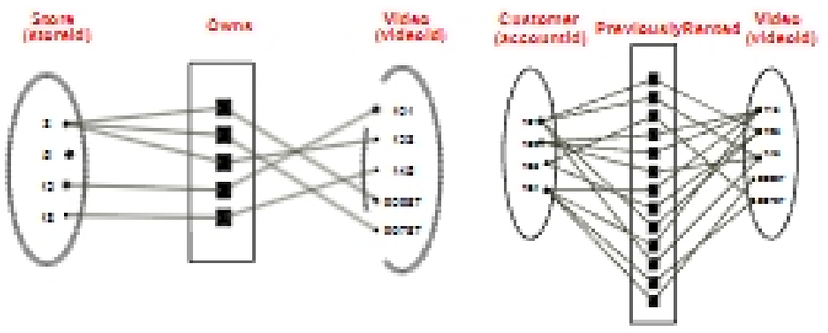
- A relationship between 2 database entities represents the possibility that two entities may be associated with each other
  - E.g., a customer may rent a video
- There are 3 basic types of relationships:
  - 1-to-1
  - 1-to-Many
  - Many-to-Many

Relationship types

- One-to-one
  - when a single instance (row) in the first table can be related to at most one row in the second table, and vice versa
- One-to-many
  - when a single instance (row) in the first table can be related to many rows in the second table, AND
  - when a single instance (row) in the second table can be related to at most one row in the first table
- Many-to-many
  - when a single instance (row) in the first table can be related to multiple rows in the second table, and vice versa

Relationship types

- Examples below for one-to-many and many-to-many



The database design process

- A good order in which to ask yourself some questions…
  - What real-world entities ("things") am I collecting information about? Each entity will become a table (think of a table as a list of things)
  - What pieces of information (attributes) about those entities do I wish to store?
    - Also, what subset of that information will be used to identify the things (e.g., SSN would be a common choice for a table containing people things)
  - How are the entities related?

We need a key (an "identifier") for the things in each table (list)

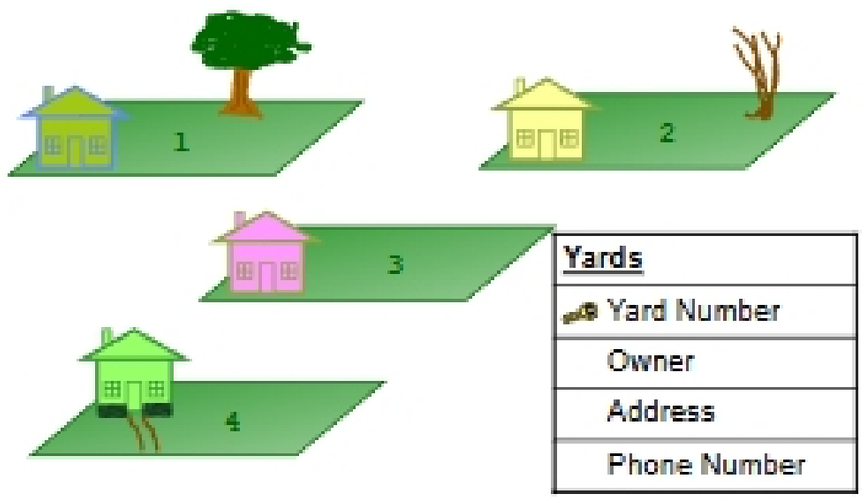
Table	Plausible identifier (a "key")
Customer of brick-and-mortar video store	account ID
Online customer of video store	e-mail address
Working person in the United States	Social Security number
DVD video	12-digit UPC bar code number

In the last case (books), you might need to track specific copies.

A simple design example

- You and several of your bird-loving neighbors want to keep track of the birds that come to feed in the various yards in the neighborhood.
- What things are we collecting information about?
  - Each implies a separate database table
  - What entities are in the bird-study problem?
    - Birds
    - Birdfeeders
    - Yards

List (table) of Yards



List (table) of Birdfeeders

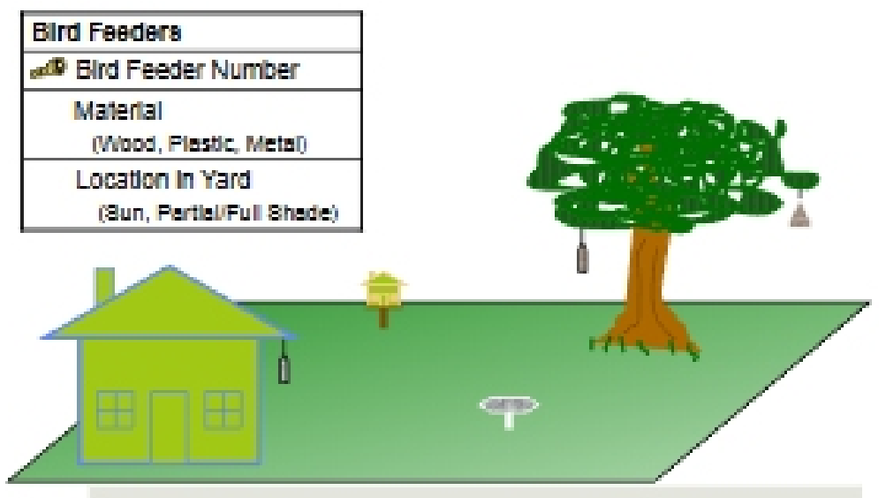


Table of Birds

Bird Data
Data Number
Date
Time
Bird Type
# of this type

Relationship: One Yard, Many Feeders

Bird Feeders
Bird Feeder Number
Material
Location in Yard
Yard Number

There must be one field in both tables that is the same, so that the database knows how the tables connect. In this case, we need to know which yard each bird feeder is located.

Each **Yard** can have many **Birdfeeders**, but each **Birdfeeder** can only be in one **Yard**. This is called a one to many (1 - ∞) Relationship.

Yards
Yard Number
Owner
Address
Phone Number

Relationship: One Birdfeeder, Many Birds

Bird Data
Data Number
Date
Time
Bird Type
Bird Feeder Number

Again, there must be one field in both tables that is the same, so that the database knows how the tables connect. In this case one birdfeeder can be visited by many birds.

Most relationships in the world (of data) turn out to be One-to-Many.

Bird Feeders
Bird Feeder Number
Material
Location in Yard
Yard Number

More details on Implementing relationships

- One-to-one
  - Add a foreign key column to one of the tables
  - E.g., consider a university where each faculty member has one office, and each office holds one faculty member
    - Two design option: (1) include an "Room Num" foreign key column in the faculty table, or (2) include a "Fac SSN" foreign key column in the rooms table

These two tables show the first design option:

Faculty

Fac SSN	Fac Name	Fac Phone	Room Num
000-00-0001	John Roon	229-0000	302
100-00-0002	Bill Hill	229-0002	3010
100-00-1002	Klafer Zorn	229-0027	102
070-00-0003	Pinar Mehan	229-0000	1001

Foreign key column

Rooms

Room Num	Building	Type
102	Water Hall	Office
302	Condon Hall	Office
1001	High Tower	Office
3010	Gun Building	Office
3040	Gun Building	Class

More details on Implementing relationships

- One-to-many
  - Add a foreign key column to the table on the "many" side
  - E.g., painter and paintings exhibit a 1-to-many relationship
    - To capture the relationship, we add a "painter Id" column to the painting table

Painter

ID	Name	Deceased	Sex
1	Tore Rasmussen	No	M
3	Rachel Hill	Yes	F
4	Jon Smyth	Yes	M
5	Phil's Georges	No	F

Painting

Code	Title	Est. Value	Type	PID
100	A Sense of Space	$2000	Water	3
101	The Road to Nowhere	$3000	Water	3
103	Reflections	$40,000	Oil	3
103	A Journey's End	$20,000	Oil	4
104	Fisherman's Catch	$10,000	Oil	4
105	Reflections	$45,000	Oil	4
106	Treescape	$2000	Oil	5
107	Veiled Visions	$4000	Oil	5

Foreign Key column

More details on Implementing relationships

- Many-to-many
  - Add a bridge table "between" the two table which keeps track of all row combinations
  - E.g., at a university, the relationship between Students and Classes is many-to-many
    - *One student can enroll in multiple classes*
    - *One class will have multiple students*

Students

Student SSN	Student Name	Student Phone
000-00-0001	Cosmo Pinker	321-345-9001
000-00-0002	Doogie Rugg	321-911-3578
070-00-0003	Wendy Kooper	321-270-0321
072-00-0001	Curtis Pencil	210-267-8772

Classes

Class Num	Term	Room Num	Time
750	F05	3010	MW 8am
750	F05	3010	MW 10am
800	S06	3010	TTh 8am
810	S06	3010	TTh 10am

Adding a column to either table (or both) will not be adequate to represent many students taking one course, and one course having many students, so we need to add a "bridge table"