
THE UNIVERSITY
of ADELAIDE
Web and Database Computing
adelaide.edu.au
Intro to Relational Databases: Relational Database Fundamentals

Why Databases?

How to store data in a Web Application

Store on client using cookies

- Designed for a website to remember stateful information by storing user information in the user's web browser e.g.
  - Items added in a shopping cart
- Authentication cookies to know whether a user is logged in or not.
  - Data expires when the browser is closed
- Data is stored on client, so no control.

Store on the server using variables or sessions:

- Allow user information to be stored on the server instead of the client.
- Data is not persistent. The information is lost when the server is restarted.

What about information that needs to persist between restarts of the server?

We can store information in files

But! we will need to write code to:

- Check data integrity.
  - Make sure the values are valid
- Handle all the ways to access the data
  - Return different parts of the data as needed
- Manage concurrent access
  - What if a second functions reads the data before the first has written an update?
- Ensure that repeated data in multiple files is updated everywhere when changed.
- Control access to the data through permissions.

Database Management Systems (DBMS)

Databases are applications that are optimized for storing and accessing data efficiently.

Several database models exist:

- Flat file
- Network
- Object Oriented
- Document store
- Graph
- and more..

The most common model is by far the relational model (Codd 1970)

- Underpinned by a mathematical model (relational algebra)
- Most common implementations include Oracle, MySQL/MariaDB, Microsoft SQL server

What is a Relational Database?

Consider a store

The store wants to keep a record of all of their customers and the items they've purchased during ech shopping trip.

How do we store that data?

Keep the data in one big spreadsheet/table?

First Name	Family Name	Phone Number	Item	Price	Barcode	Date Purchased
Alice	Smith	0412 345 678	Cling Wrap	1.19	12345 78654	2019-03-30
Bob	James	0498 765 432	Detergent	12.34	48325 65404	2019-04-01
Bob	James	0498 765 432	Cling Wrap	1.19	12345 78654	2019-04-01
Bob	James	0498 765 432	Blanket	39.99	64597 15632	2019-04-01
Bob	James	0498 765 432	Mushrooms	9.99	85146 15647	2019-04-02
Carol	Parker	0411 222 333	Cling Wrap	1.19	12345 78654	2019-04-02

Save it in a single file, or store the rows as an array of objects

One big spreadsheet/table has problems

First Name	Family Name	Phone Number	Item	Price	Barcode	Date Purchased
Alice	Smith	0412 345 678	Cling Wrap	1.19	12345 78654	2019-03-30
Bob	James	0498 765 432	Detergent	12.34	48325 65404	2019-04-01
Bob	James	0498 765 432	Cling Wrap	1.19	12345 78654	2019-04-01
Bob	James	0498 765 432	Blanket	39.99	64597 15632	2019-04-01
Bob	James	0498 765 432	Mushrooms	9.99	85146 15647	2019-04-02
Carol	Parker	0411 222 333	Cling Wrap	1.19	12345 78654	2019-04-02

Data is duplicated.

What if we want to change things?

Split into multiple tables instead!

Customer

CustID	First Name	Family Name	Phone Number
1	Alice	Smith	0412 345 678
2	Bob	James	0498 765 432
3	Carol	Parker	0411 222 333

Shopping Trip Purchases

TripID	ItemID
1	1
2	2
2	1
2	3
3	4
4	1

Item

Scaling Up

Might seem overly complex,
BUT
when adding more data, relational tables quickly become more efficient!

~ Flattened ~

First Name	Family Name	Phone Number	Item	Price	Barcode	Date Purchased
Alice	Smith	0412 345 678	Cling Wrap	1.19	12345 78654	2019-03-30
Bob	James	0498 765 432	Detergent	12.34	48325 65404	2019-04-01
Bob	James	0498 765 432	Cling Wrap	1.19	12345 78654	2019-04-01
Bob	James	0498 765 432	Blanket	39.99	64597 15632	2019-04-01
Bob	James	0498 765 432	Toilet Paper	10.99	84569 13564	2019-04-01
Carol	Parker	0411 222 333	Cling Wrap	1.19	12345 78654	2019-04-02
Carol	Parker	0411 222 333	Blanket	39.99	64597 15632	2019-04-02
Carol	Parker	0411 222 333	Mushrooms	9.99	85146 15647	2019-04-02
Carol	Parker	0411 222 333	Cling Wrap	1.19	12345 78654	2019-04-02
Carol	Parker	0411 222 333	Detergent	12.34	48325 65404	2019-04-02
Carol	Parker	0411 222 333	Apples	2.58	14564 86542	2019-04-02
Alice	Smith	0412 345 678	Blanket	39.99	64597 15632	2019-04-02
Alice	Smith	0412 345 678	Toilet Paper	10.99	84569 13564	2019-04-02
Alice	Smith	0412 345 678	Cling Wrap	1.19	12345 78654	2019-04-02
Alice	Smith	0412 345 678	Detergent	12.34	48325 65404	2019-04-02
Alice	Smith	0412 345 678	Apples	2.58	14564 86542	2019-04-02
Bob	James	0498 765 432	Blanket	39.99	64597 15632	2019-04-05
Bob	James	0498 765 432	Mushrooms	9.99	85146 15647	2019-04-05
Bob	James	0498 765 432	Cling Wrap	1.19	12345 78654	2019-04-05
Bob	James	0498 765 432	Detergent	12.34	48325 65404	2019-04-05
Bob	James	0498 765 432	Apples	2.58	14564 86542	2019-04-05
Bob	James	0498 765 432	Toilet Paper	10.99	84569 13564	2019-04-05
Bob	James	0498 765 432	Toilet Paper	10.99	84569 13564	2019-04-05
Bob	James	0498 765 432	Toilet Paper	10.99	84569 13564	2019-04-05
Carol	Parker	0411 222 333	Mushrooms	9.99	85146 15647	2019-04-06
Carol	Parker	0411 222 333	Cling Wrap	1.19	12345 78654	2019-04-06
Carol	Parker	0411 222 333	Detergent	12.34	48325 65404	2019-04-06
Carol	Parker	0411 222 333	Apples	2.58	14564 86542	2019-04-06
Carol	Parker	0411 222 333	Apples	2.58	14564 86542	2019-04-06
Alice	Smith	0412 345 678	Mushrooms	9.99	85146 15647	2019-04-06
Alice	Smith	0412 345 678	Cling Wrap	1.19	12345 78654	2019-04-06
Alice	Smith	0412 345 678	Detergent	12.34	48325 65404	2019-04-06
Alice	Smith	0412 345 678	Apples	2.58	14564 86542	2019-04-06
Alice	Smith	0412 345 678	Toilet Paper	10.99	84569 13564	2019-04-06
Bob	James	0498 765 432	Mushrooms	9.99	85146 15647	2019-04-08
Bob	James	0498 765 432	Cling Wrap	1.19	12345 78654	2019-04-08
Bob	James	0498 765 432	Detergent	12.34	48325 65404	2019-04-08
Bob	James	0498 765 432	Apples	2.58	14564 86542	2019-04-08
Bob	James	0498 765 432	Toilet Paper	10.99	84569 13564	2019-04-08
Bob	James	0498 765 432	Toilet Paper	10.99	84569 13564	2019-04-08

~ Relational ~

CustID	First Name	Family Name	Phone Number
1	Alice	Smith	0412 345 678
2	Bob	James	0498 765 432
3	Carol	Parker	0411 222 333

ItemID	Item	Price	Barcode
1	Cling Wrap	1.19	12345 78654
2	Detergent	12.34	48325 65404
3	Blanket	39.99	64597 15632
4	Mushrooms	9.99	85146 15647
5	Apples	2.58	14564 86542
6	Toilet Paper	10.99	84569 13564

TripID	CustID	TripDate
1	1	2019-03-30
2	2	2019-04-01
3	3	2019-04-02
4	1	2019-04-02
5	2	2019-04-05
6	3	2019-04-06
7	1	2019-04-06
8	2	2019-04-08

TripID	ItemID
1	1
2	2
2	1
2	3
2	6
3	1
3	3
3	4
3	1
3	2
3	5
4	3
4	6
4	1
4	2
4	5
5	3
5	4
5	1
5	2
5	5
5	6
5	6
5	6
6	4
6	1
6	2
6	5
6	5
7	4
7	1
7	2
7	5
7	6
8	4
8	1
8	2
8	5
8	6
8	6

Relational databases

- Separate data into Entities; 2-dimensional tables that consist of
    - Attributes, i.e., column headers
    - Tuples, i.e., rows in a table.

      Entity Name

Attribute1	Attribute2
1st	Tuple
2nd	Tuple
3rd	Tuple

    - Where each tuple is unique.
- Logical connections between the Entities define Relationships between them.

The blueprint for a relational database is called the Database Schema

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