Relational Databases

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Temporary Storage

- Information is stored in memory
  - *e.g. an inverted index*
  - *e.g. loading a file into memory*

- Provides fast access to information

- Disappears when program exits or system powered off

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Persistent Storage

- Information is stored on disk (may be distributed)
  - *e.g. a file saved on a hard drive*
  - *e.g. a file saved on a USB flash drive*

- Provides slower access to information

- Persists when program exits or system powered off

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Flat Files

- Several disconnected tables stored as text
  - *e.g. comma-separated values (csv)*

- Time consuming to find data

- Complex to manage consistency across files

- Complex to manage concurrency within a file

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Flat Files

Customer File

Customer ID	Company Name	Contact First Name	Contact Last Name	Job Title	City	State
6	Company F	Francisco	Pérez-Olaeta	Purchasing Manager	Milwaukee	WI
26	Company Z	Run	Liu	Accounting Assistant	Miami	FL

Employee File

Employee ID	First Name	Last Name	Title
2	Andrew	Cencini	Vice President, Sales
5	Steven	Thrope	Sales Manager
9	Anne	Hellung-Larsen	Sales Representative

Product File

Product ID	Product Code	Product Name	Category	Quantity Per Unit	List Price
5	NWTO-5	Northwind Traders Olive Oil	Oil	36 boxes	$21.35
7	NWTDFN-7	Northwind Traders Dried Pears	Dried Fruit & Nuts	12 - 1 lb pkgs	$30.00

"Databases A Beginner's Guide" by Andy Oppel, McGraw-Hill, 2009

Flat Files

Order File

Order ID	Customer ID	Employee ID	Order Date	Shipped Date	Shipping Fee
51	26	9	4/5/2006	4/5/2006	$60.00
56	6	2	4/3/2006	4/3/2006	$0.00
79	6	2	6/23/2006	6/23/2006	$0.00

Order Detail File

Order ID	Product ID	Unit Price	Quantity
51	5	$21.35	15
51	41	$9.65	21
51	40	$18.40	2
56	48	$12.75	20
79	7	$30.00	14
79	51	$53.00	8

"Databases A Beginner's Guide" by Andy Oppel, McGraw-Hill, 2009

Relational Tables

Customer Table

Customer ID	Company Name	Contact First Name	Contact Last Name	Job Title	City	State
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Order Table

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Database Management System

- Handles data storage, maintenance, and retrieval

- Manages concurrent data access

- Transactions are atomic (all-or-nothing)

- Often separate physical, logical, and external layers
  - *e.g. how data is stored separate from how it is viewed*

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Relational DBMS

- Supports relationships between tables
  - *e.g. one-to-one, one-to-many, many-to-many*

- Able to join data across tables together using queries

- Stable and mature with many providers
  - *e.g. MySQL or MariaDB, PostgreSQL, SQL Server, Oracle, IBM DB2, SQLite, ...*

https://docs.oracle.com/javase/tutorial/jdbc/overview/database.html

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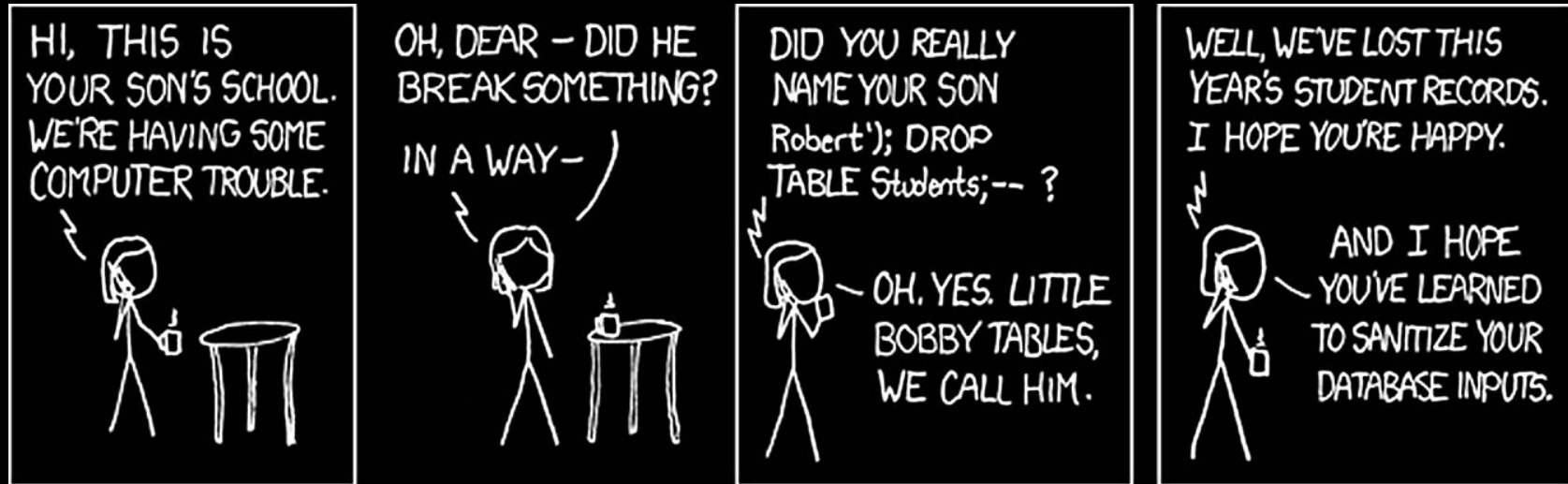
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Top 10 Security Flaws

1. Broken Access Control
2. Cryptographic Failures
3. Injection (XSS, SQL, ...)
4. Insecure Design
5. Security Misconfig

6. Vulnerable and Outdated Components
7. Identification/Authentication Failures
8. Software/Data Integrity Failures
9. Security Logging/Monitoring Failures
10. Server-Side Request Forgery (SSRF)

https://owasp.org/www-project-top-ten/

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Bobby Tables

https://xkcd.com/327/

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Sweden Election Hack

https://www.wired.co.uk/article/sweden-election-hack

Traffic Cameras

https://gizmodo.com/sql-injection-license-plate-hopes-to-foil-euro-traffic-5498412

Other Considerations

- Database design, optimization, theory, implementation
  - *e.g. CS 333 Introduction to Database Systems*

- Non-Relational (NoSQL) Databases
  - *e.g. column/distributed (e.g. Cassandra), document (MongoDB), graph (Neo4j), key/value (Dynamo), …*

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CS Database Accounts

- Lookup username on course website

- Log into a CS la computer
  - ssh user###@stargate.cs.usfca.edu
  - ssh user###@g12##.cs.usfca.edu

- Log into database server
  - mysql -h sql -u user### -D user### -p

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Questions?

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16