

Welcome!

CMPSC 305 – Database Systems



ALLEGHENY COLLEGE

Break-Out Groups



The year is 1823 and you and your associates are forming a package delivery service to move packages across the entire country. Assume that all you have is a paper-based system to record information. With your group, discuss the concerns on the next page and brainstorm to determine working solutions. Be creative! These solutions do not necessarily have to be practical if you cannot find any other way!

Break-Out Groups

A paper-based delivery service

- What kinds of information are necessary to deliver a package to an address?
- How would you record this information in an organized system?
- How do you update any of this information?
- What kinds of errors could happen when making updates to the information?
- How do you make this information available to anyone in the company who needs it?
- List two issues (not mentioned above) that require consideration when working with the information of a package? Please explain the concern and provide a creative solution.

What is the function of a database?



Database Management System (DBMS)



- Database Applications:
 - Banking: transactions
 - Airlines: reservations, schedules
 - Universities: registration, grades
 - Sales: customers, products, purchases
 - Online retailers: order tracking, customized recommendations
 - Manufacturing: production, inventory, orders, supply chain
 - Human resources: employee records, salaries, tax deductions

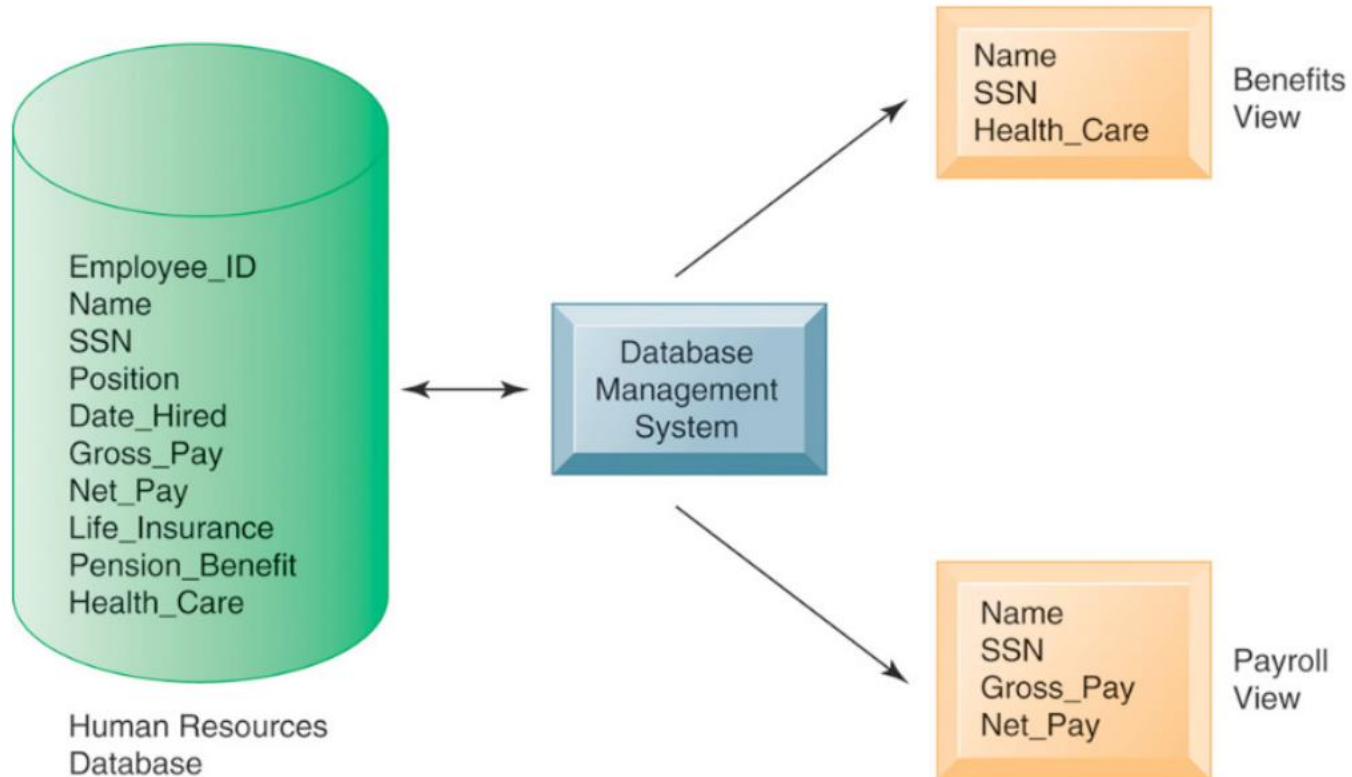
Databases at Our College!



Application:

- Adding new students, instructors, and courses
- Registering students for courses, and generate class rosters
- Assigning grades to students,
- Computing grade point averages (GPA)
- Generating transcripts

To connect data in some meaningful way



Database - A True Story (sort of)

*A long time ago
in a galaxy far,
far away...*

- Databases were not always used as they are today ...
- They were often disconnected systems
- Isolated from other systems that contained similar data.
- (Why would anyone use this configuration??)

Meanwhile at Batman and Associates



One database was working well...

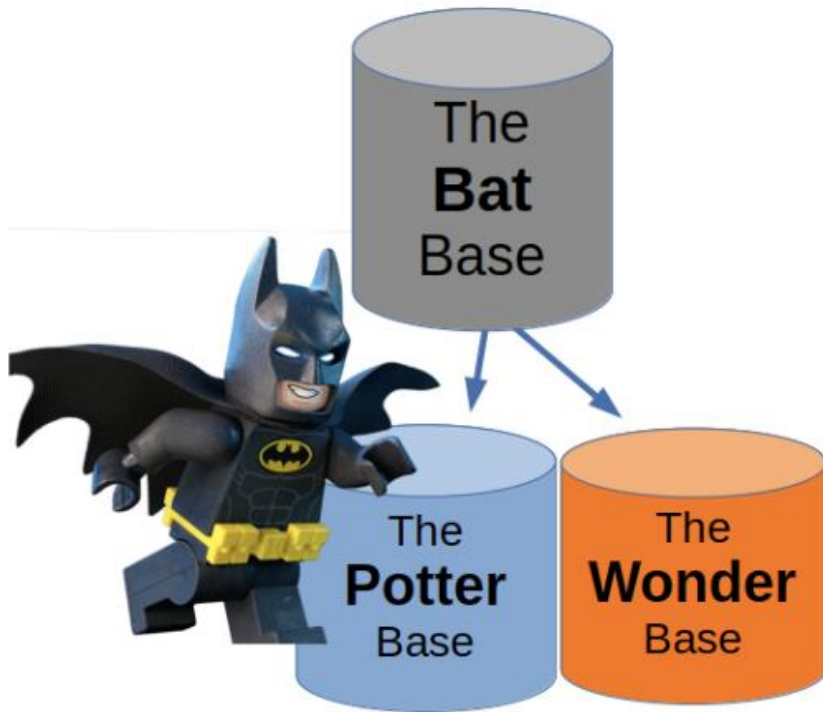
- One (simple) working database containing all company information.

Two teams join Batman and Associates...



Database Copies

Two identical
bases created from
a single base

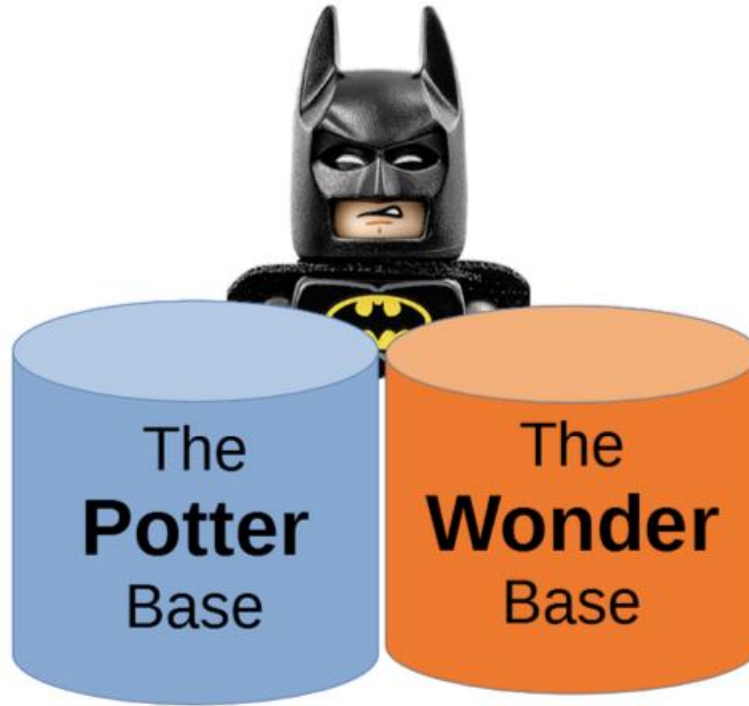


- The database is copied into two new identical bases for use by two different teams in the Bat Cave.

Each team gets own DB...



After a time, problems in the Bat Cave

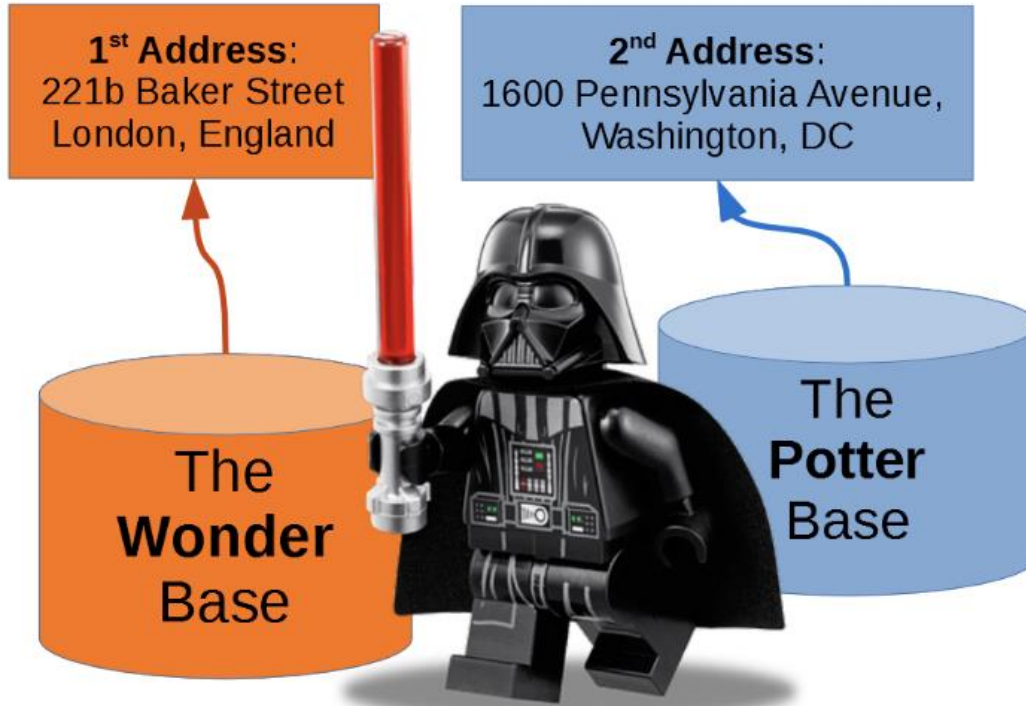


- Nearly identical: no equal updating of each base.
- Teams verbally communicate changes to each other

Batman and Associates confuses an address...

What went wrong?! :-)

Dr. Vader's actual address?

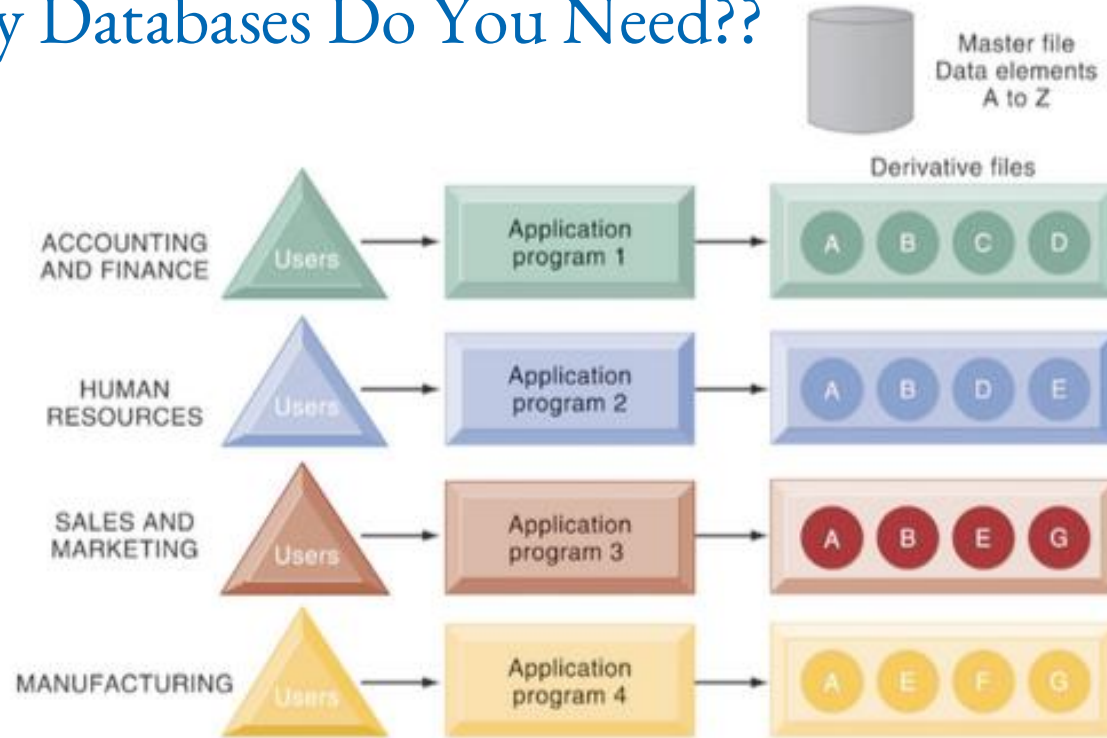


How Many Databases Do You Need??

Common Problems with Databases



How Many Databases Do You Need??



- Database applications were once built directly on top of file systems (i.e., permanent records of information in various spread-out files)
- A firm may have managed several information sources!
- Anything wrong with this picture?

Messy Data Storage?



- Drawbacks of using file systems to store data
 - **Data redundancy and inconsistency**
 - Multiple file formats, duplication of information in different files - hard to share
 - Difficulty in accessing data
 - Need to write a new program to carry out each new task
 - **Data redundancy and inconsistency**
 - Data isolation - multiple files and formats

Redundancy and Inconsistency

Is there an unnecessary copy of the data?

- Drawbacks of using file systems to store data, continued
 - Data redundancy and inconsistency
 - Integrity problems - The data is not accurate and consistently stored
 - Data redundancy and inconsistency
 - Integrity constraints (i.e., $\text{account balance} \geq 0$) become “buried” in program code rather than being stated explicitly
 - Hard to add new constraints or change existing ones
- How many times did you see, “Data redundancy and inconsistency”, here??
 - How many times should you see the same data in your DB??

Atomic Transactions

Does the DB complete two associated tasks simultaneously?

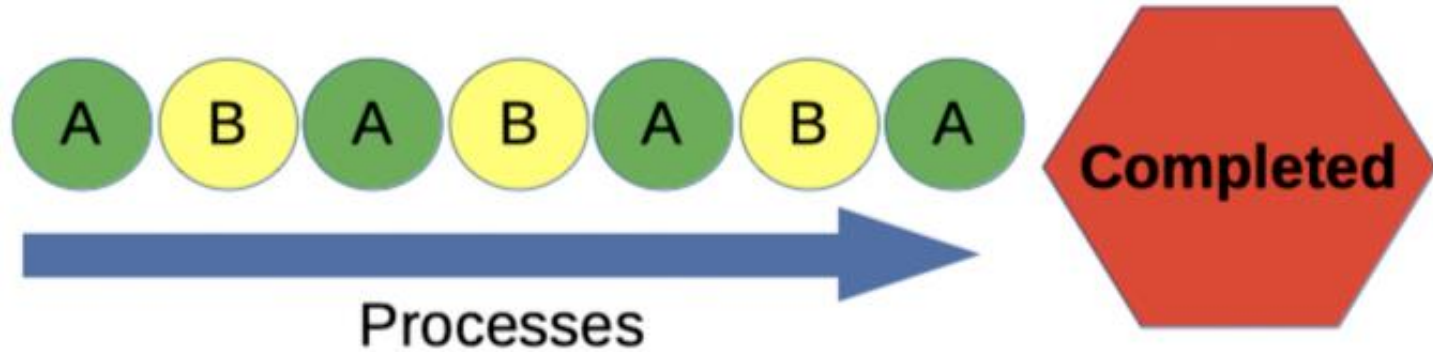
Atomicity of updates

- An atomic transaction is an indivisible and irreducible series of database operations such that either all occur, or nothing occurs.
- Failures may leave database in an inconsistent state with partial updates carried out
- Example: Transfer of funds from one account to another
- should either complete or not happen at all



Concurrency

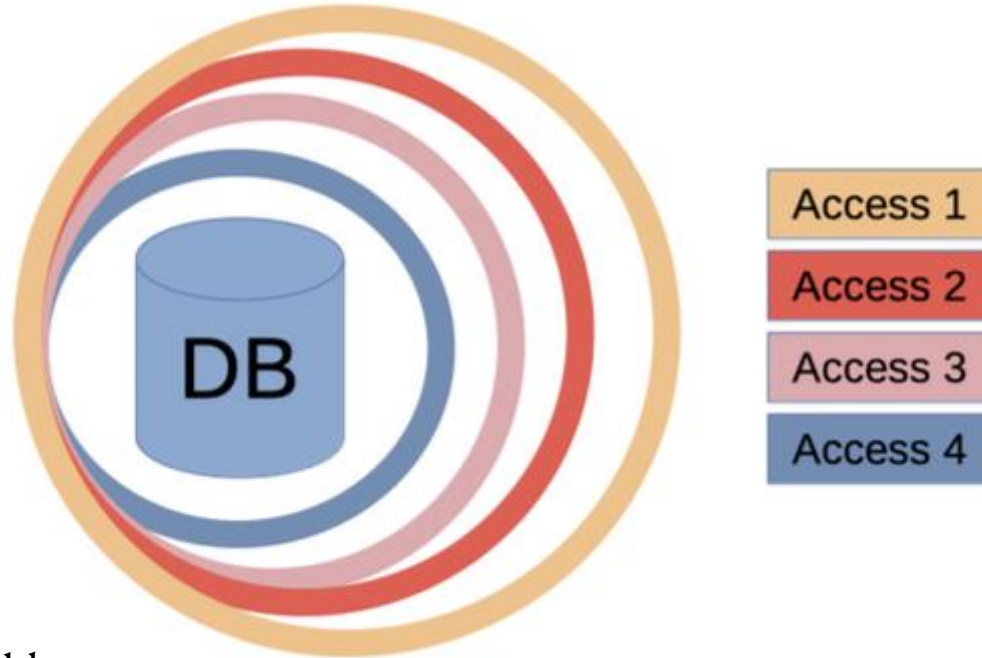
Can multiple users work with the DB at same time?



- Concurrency: transactions at same time
 - Multiple users, multiple tasks at the same time.
 - Banking: one person withdrawing money, the bank pushing the funds to account

Security?

Are there different authorizations?



- Security problems
 - Different users, Different types of access
- Database systems offer solutions to all the above problems

No Centralized DB at Batman and Associates ...



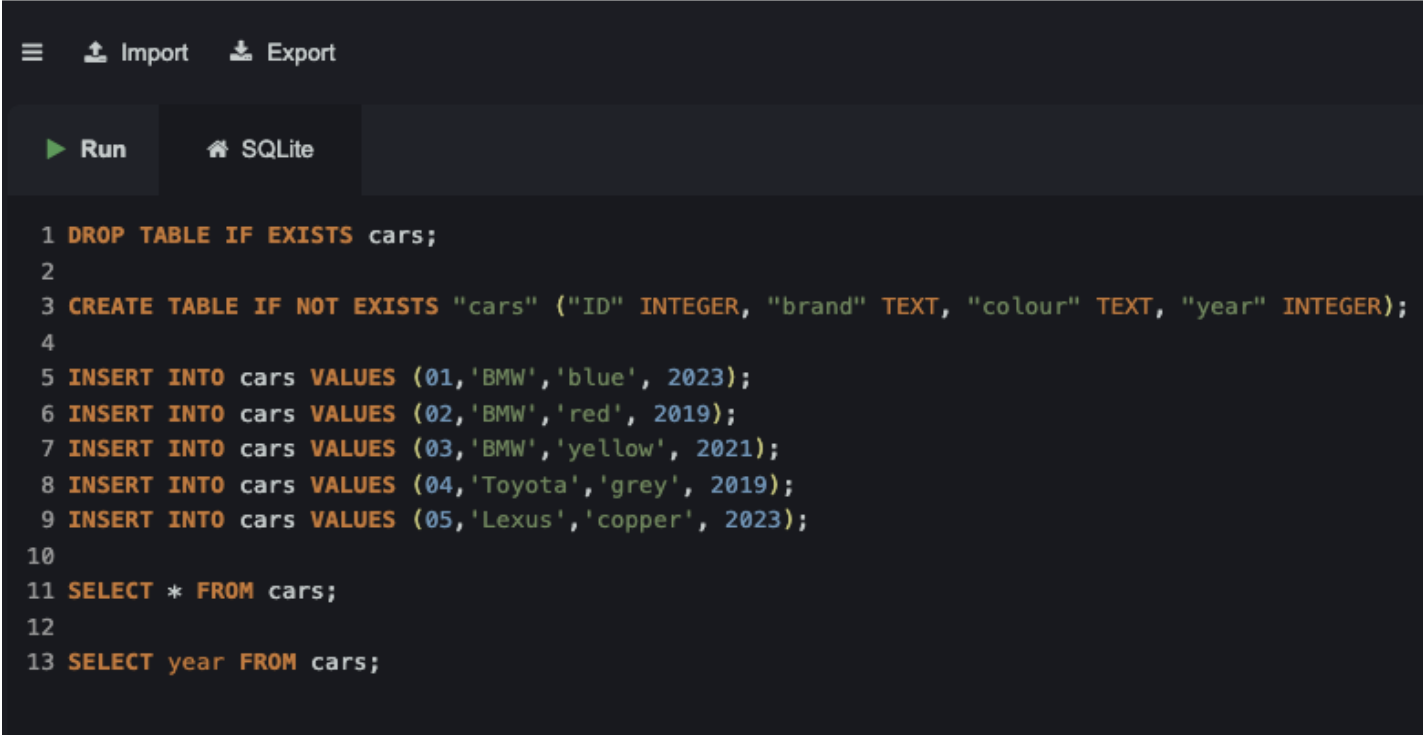
***Dr. Vader's
current address
remained a mystery!***

Let's Code Our First Database!!

Let's look at some SQL code!

Play with SQL Code Online!

Take a moment to think about what each line is doing!



The screenshot shows the SQLiteOnline web interface. At the top, there are icons for a menu, Import, and Export. Below these are buttons for 'Run' (with a green play icon) and 'SQLite' (with a database icon). The main area contains the following SQL code:

```
1 DROP TABLE IF EXISTS cars;
2
3 CREATE TABLE IF NOT EXISTS "cars" ("ID" INTEGER, "brand" TEXT, "colour" TEXT, "year" INTEGER);
4
5 INSERT INTO cars VALUES (01,'BMW','blue', 2023);
6 INSERT INTO cars VALUES (02,'BMW','red', 2019);
7 INSERT INTO cars VALUES (03,'BMW','yellow', 2021);
8 INSERT INTO cars VALUES (04,'Toyota','grey', 2019);
9 INSERT INTO cars VALUES (05,'Lexus','copper', 2023);
10
11 SELECT * FROM cars;
12
13 SELECT year FROM cars;
```

- Try it out at SQLiteOnline: <https://sqliteonline.com/>