



Introduction to Database Systems: CS305

Oliver Bonham-Carter
Hang Zhao

5 September 2023

Let's discuss...

Introduction
to Database
Systems:
CS305

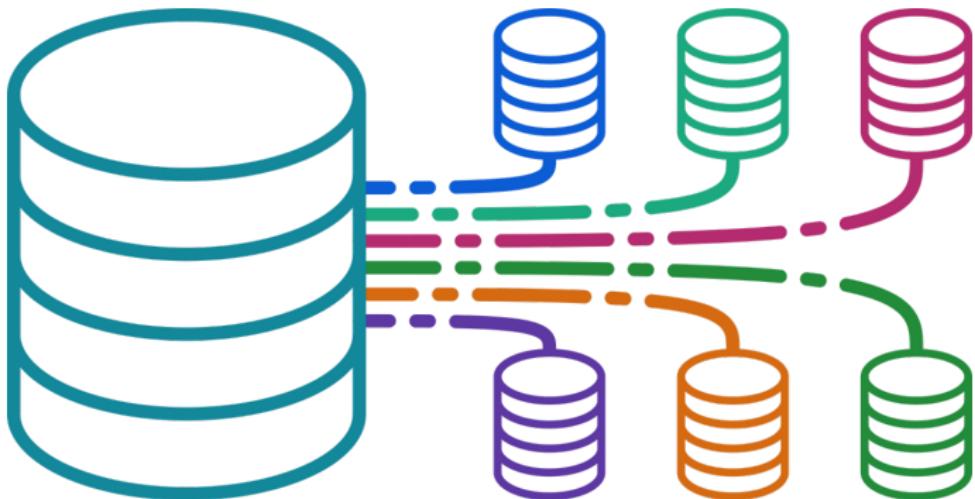
Oliver
Bonham-Carter
Hang Zhao

Database
applications

I have
connections

Common
problems

Play With
Code!



What is the function of a database?

Database Management System (DBMS)

Introduction
to Database
Systems:
CS305

Oliver
Bonham-
Carter
Hang Zhao

Database
applications

I have
connections

Common
problems

Play With
Code!



- 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!

Introduction
to Database
Systems:
CS305

Oliver
Bonham-
Carter
Hang Zhao

Database
applications

I have
connections

Common
problems

Play With
Code!



● 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

Introduction
to Database
Systems:
CS305

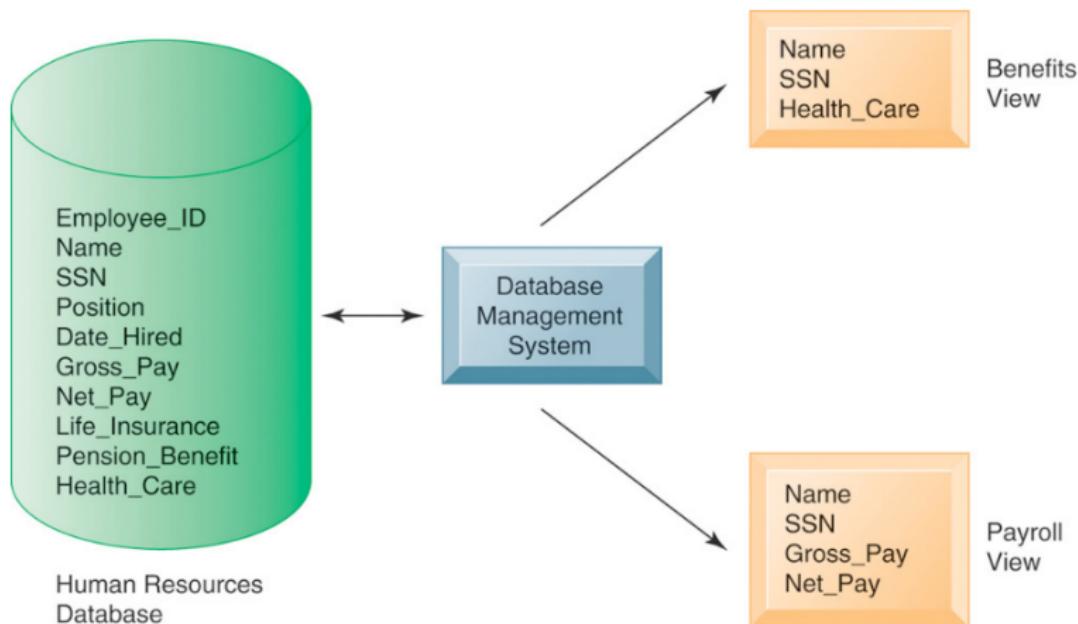
Oliver
Bonham-
Carter
Hang Zhao

Database
applications

I have
connections

Common
problems

Play With
Code!



Database - A *True Story* (sort of)

Introduction
to Database
Systems:
CS305

Oliver
Bonham-
Carter
Hang Zhao

Database
applications

I have
connections

Common
problems

Play With
Code!

*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...

Introduction
to Database
Systems:
CS305

Oliver
Bonham-
Carter
Hang Zhao

Database
applications

I have
connections

Common
problems

Play With
Code!



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

Two teams join *Batman and Associates...*

Introduction
to Database
Systems:
CS305

Oliver
Bonham-
Carter
Hang Zhao

Database
applications

I have
connections

Common
problems

Play With
Code!





Batman and Associates...

Two identical bases created from a single base

Introduction
to Database
Systems:
CS305

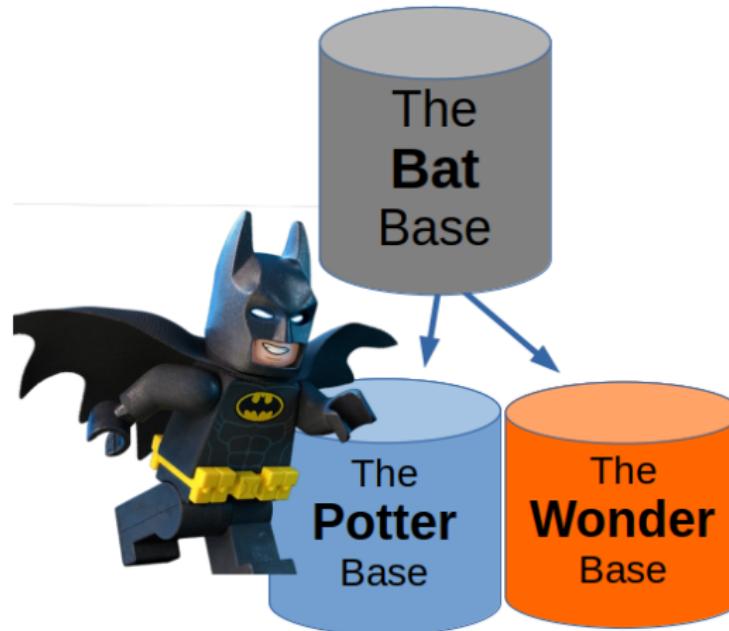
Oliver
Bonham-
Carter
Hang Zhao

Database
applications

I have
connections

Common
problems

Play With
Code!



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

Each team gets own DB...

Introduction
to Database
Systems:
CS305

Oliver
Bonham-
Carter
Hang Zhao

Database
applications

I have
connections

Common
problems

Play With
Code!



Batman and Associates...

After a time, problems in the Bat Cave

Introduction
to Database
Systems:
CS305

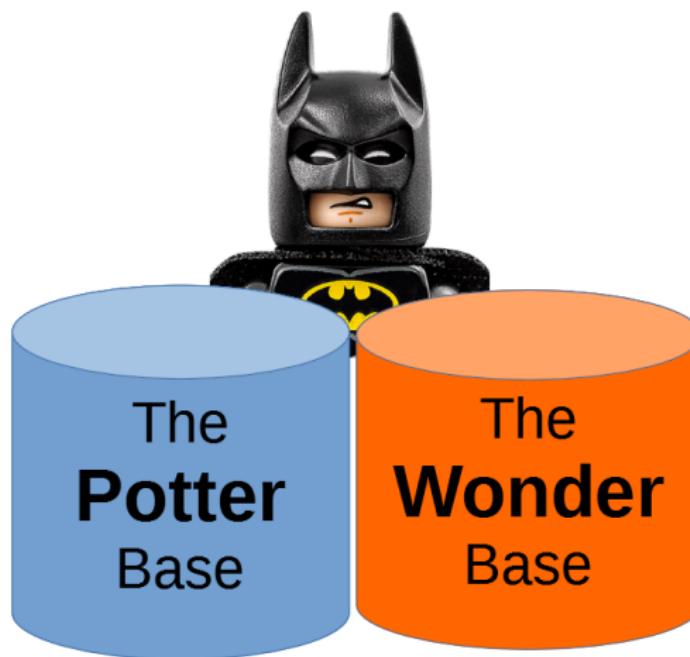
Oliver
Bonham-
Carter
Hang Zhao

Database
applications

I have
connections

Common
problems

Play With
Code!



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

*Batman and Associates confuses an address...
What went wrong?! :-)*

Introduction
to Database
Systems:
CS305

Oliver
Bonham-
Carter
Hang Zhao

Database
applications

I have
connections

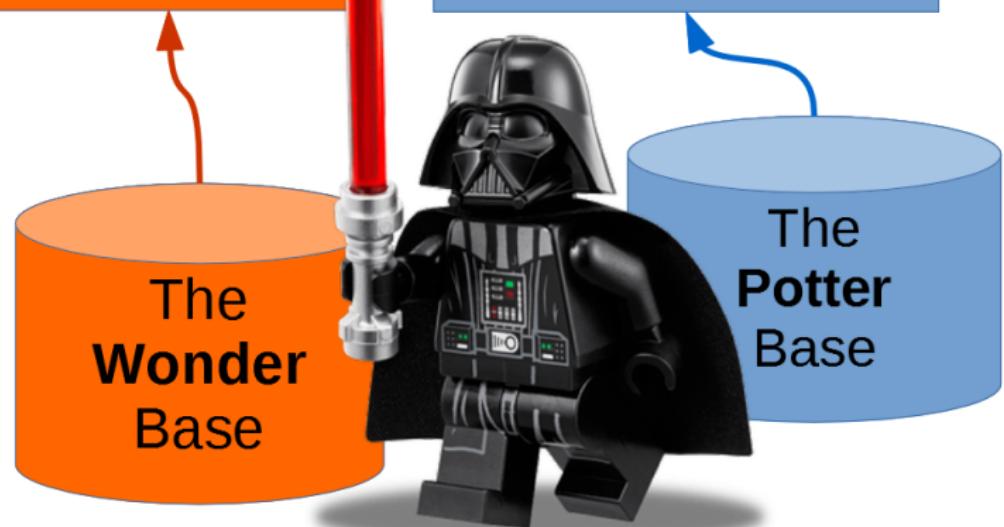
Common
problems

Play With
Code!

Dr. Vader's actual address?

1st Address:
221b Baker Street
London, England

2nd Address:
1600 Pennsylvania Avenue,
Washington, DC



How Many Databases Do You Need??

Common problems

Introduction
to Database
Systems:

CS305

Oliver
Bonham-
Carter
Hang Zhao

Database
applications

I have
connections

Common
problems

Play With
Code!

Let's talk about ...

Common Problems with Databases



How Many Databases Do You Need??

Common problems

Introduction
to Database
Systems:
CS305

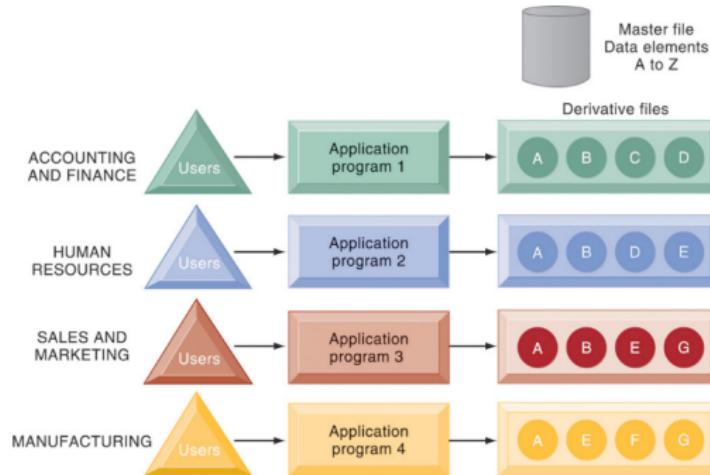
Oliver
Bonham-
Carter
Hang Zhao

Database
applications

I have
connections

Common
problems

Play With
Code!



- 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?

Risks of having several different DBs for same information

Introduction
to Database
Systems:
CS305

Oliver
Bonham-
Carter
Hang Zhao

Database
applications

I have
connections

Common
problems

Play With
Code!



- 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 a unnecessary copy of the data?

Introduction
to Database
Systems:
CS305

Oliver
Bonham-
Carter
Hang Zhao

Database
applications

I have
connections

Common
problems

Play With
Code!

- 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., account balance ≥ 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?

Introduction
to Database
Systems:
CS305

Oliver
Bonham-
Carter
Hang Zhao

Database
applications

I have
connections

Common
problems

Play With
Code!



● 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?

Introduction
to Database
Systems:
CS305

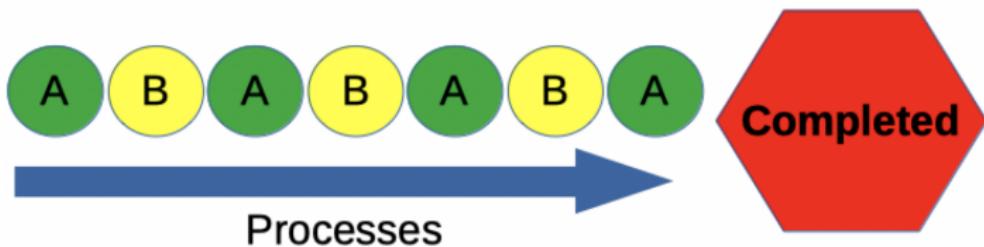
Oliver
Bonham-
Carter
Hang Zhao

Database
applications

I have
connections

Common
problems

Play With
Code!



- **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?

Introduction
to Database
Systems:
CS305

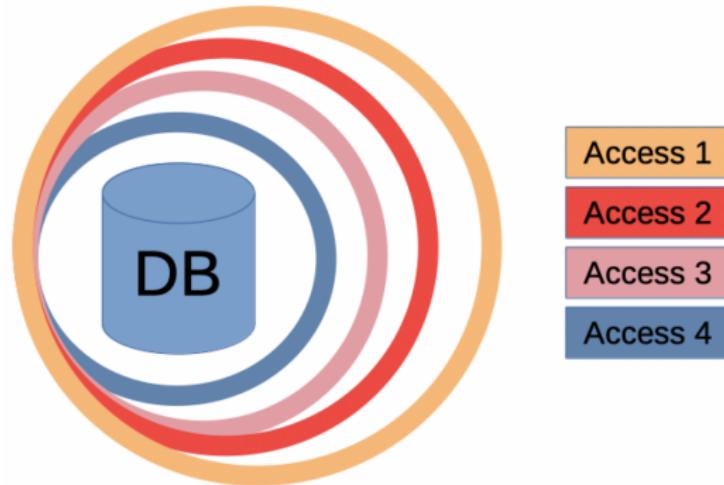
Oliver
Bonham-
Carter
Hang Zhao

Database
applications

I have
connections

Common
problems

Play With
Code!



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

No Centralized DB at *Batman and Associates* ...

Introduction
to Database
Systems:
CS305

Oliver
Bonham-
Carter
Hang Zhao

Database
applications

I have
connections

Common
problems

Play With
Code!



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

Let's Code Our First Database!!

Introduction
to Database
Systems:
CS305

Oliver
Bonham-
Carter
Hang Zhao

Database
applications

I have
connections

Common
problems

Play With
Code!



THINK

A large, bold, dark blue sans-serif font word "THINK" centered on a white rectangular background, which is itself centered on an orange rounded rectangular button.

Lets look at some SQL code!



Play with SQL Code Online!

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

Introduction
to Database
Systems:
CS305

Oliver
Bonham-
Carter
Hang Zhao

Database
applications

I have
connections

Common
problems

Play With
Code!

```
SQLite

1 DROP TABLE IF EXISTS cars;
2 CREATE TABLE IF NOT EXISTS "cars" (
3     "ID" INTEGER,
4     "brand" TEXT,
5     "colour" TEXT,
6     "year" INTEGER
7 );
8
9 INSERT INTO cars VALUES (01,"BMW","blue", 2023);
10 INSERT INTO cars VALUES (02,"BMW","red", 2019);
11 INSERT INTO cars VALUES (03,"BMW","yellow", 2021);
12 INSERT INTO cars VALUES (04,"Toyota","grey", 2019);
13 INSERT INTO cars VALUES (05,"Lexus","Copper", 2023);
14
15
16 SELECT * FROM cars;
17 SELECT year FROM cars;
```

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