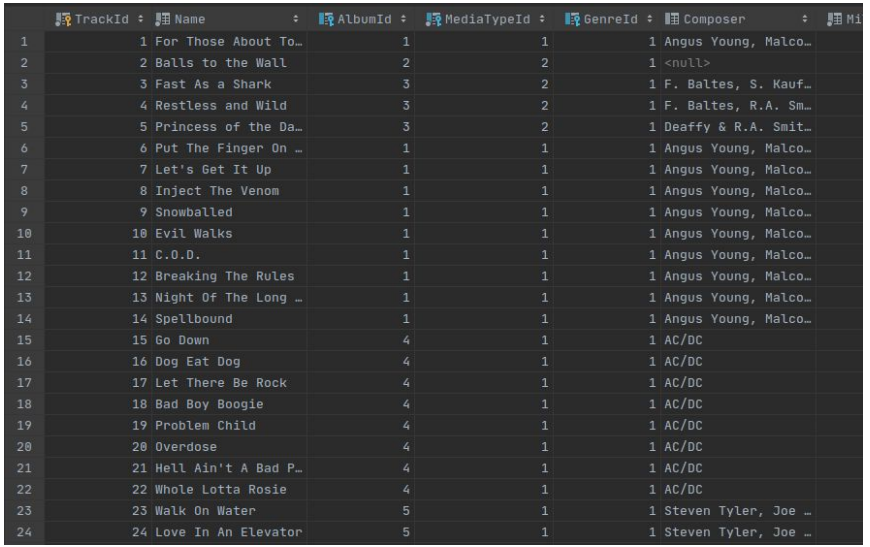
MONTANA
STATE UNIVERSITY

# Database Systems

History & Context

# What is a Database?

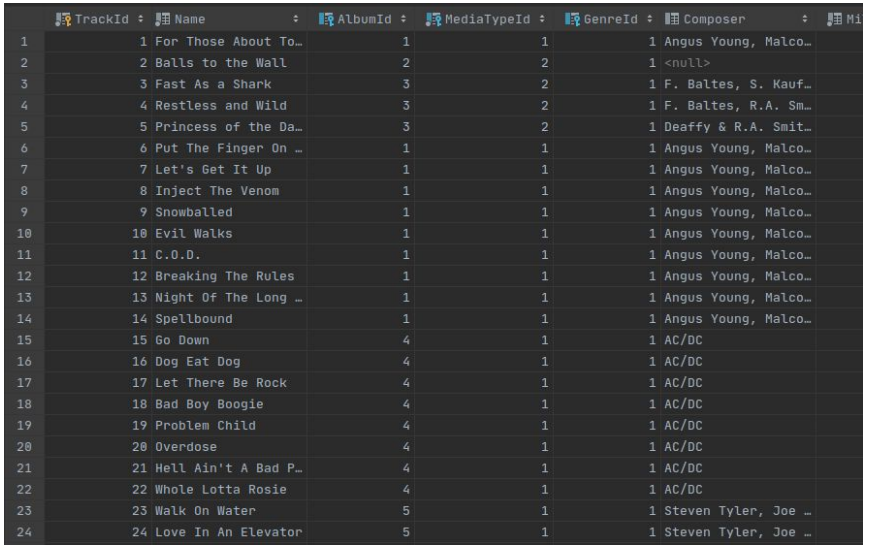
- A database is an organized collection of structured information, or data, typically stored electronically in a computer system
- A database is usually controlled by a database management system (DBMS)



| | TrackId | Name | AlbumId | MediaTypeId | GenreId | Composer | Mi |
|---|---|---|---|---|---|---|---|
| 1 | 1 | For Those About To… | 1 | 1 | 1 | Angus Young, Malco… | |
| 2 | 2 | Balls to the Wall | 2 | 2 | 1 | <null> | |
| 3 | 3 | Fast As a Shark | 3 | 2 | 1 | F. Baltes, S. Kauf… | |
| 4 | 4 | Restless and Wild | 3 | 2 | 1 | F. Baltes, R.A. Sm… | |
| 5 | 5 | Princess of the Da… | 3 | 2 | 1 | Deaffy & R.A. Smit… | |
| 6 | 6 | Put The Finger On … | 1 | 1 | 1 | Angus Young, Malco… | |
| 7 | 7 | Let's Get It Up | 1 | 1 | 1 | Angus Young, Malco… | |
| 8 | 8 | Inject The Venom | 1 | 1 | 1 | Angus Young, Malco… | |
| 9 | 9 | Snowballed | 1 | 1 | 1 | Angus Young, Malco… | |
| 10 | 10 | Evil Walks | 1 | 1 | 1 | Angus Young, Malco… | |
| 11 | 11 | C.O.D. | 1 | 1 | 1 | Angus Young, Malco… | |
| 12 | 12 | Breaking The Rules | 1 | 1 | 1 | Angus Young, Malco… | |
| 13 | 13 | Night Of The Long … | 1 | 1 | 1 | Angus Young, Malco… | |
| 14 | 14 | Spellbound | 1 | 1 | 1 | Angus Young, Malco… | |
| 15 | 15 | Go Down | 4 | 1 | 1 | AC/DC | |
| 16 | 16 | Dog Eat Dog | 4 | 1 | 1 | AC/DC | |
| 17 | 17 | Let There Be Rock | 4 | 1 | 1 | AC/DC | |
| 18 | 18 | Bad Boy Boogie | 4 | 1 | 1 | AC/DC | |
| 19 | 19 | Problem Child | 4 | 1 | 1 | AC/DC | |
| 20 | 20 | Overdose | 4 | 1 | 1 | AC/DC | |
| 21 | 21 | Hell Ain't A Bad P… | 4 | 1 | 1 | AC/DC | |
| 22 | 22 | Whole Lotta Rosie | 4 | 1 | 1 | AC/DC | |
| 23 | 23 | Walk On Water | 5 | 1 | 1 | Steven Tyler, Joe … | |
| 24 | 24 | Love In An Elevator | 5 | 1 | 1 | Steven Tyler, Joe … | |

# DBMS

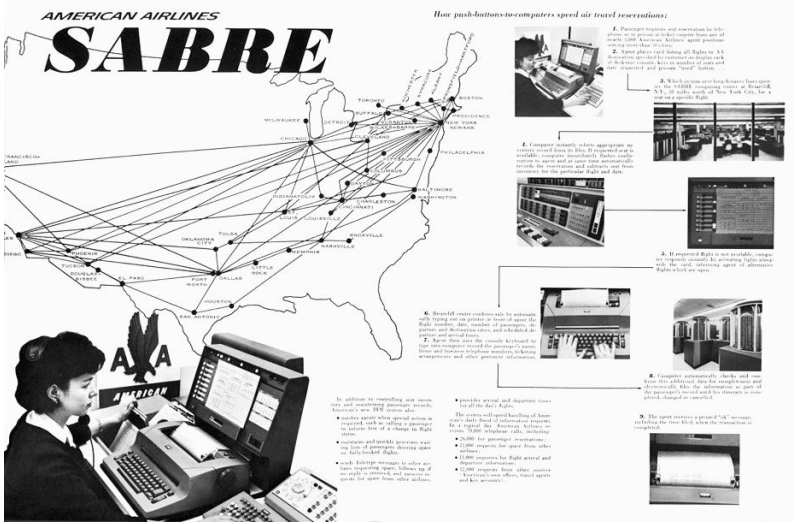
- Provides security
- Handles schema modification
- Provides isolation
- Supports a multi-user environment that allows parallel data access and manipulation



| | TrackId | Name | AlbumId | MediaTypeId | GenreId | Composer | Mi |
|---|---|---|---|---|---|---|---|
| 1 | 1 | For Those About To… | 1 | 1 | 1 | Angus Young, Malco… | |
| 2 | 2 | Balls to the Wall | 2 | 2 | 1 | <null> | |
| 3 | 3 | Fast As a Shark | 3 | 2 | 1 | F. Baltes, S. Kauf… | |
| 4 | 4 | Restless and Wild | 3 | 2 | 1 | F. Baltes, R.A. Sm… | |
| 5 | 5 | Princess of the Da… | 3 | 2 | 1 | Deaffy & R.A. Smit… | |
| 6 | 6 | Put The Finger On … | 1 | 1 | 1 | Angus Young, Malco… | |
| 7 | 7 | Let's Get It Up | 1 | 1 | 1 | Angus Young, Malco… | |
| 8 | 8 | Inject The Venom | 1 | 1 | 1 | Angus Young, Malco… | |
| 9 | 9 | Snowballed | 1 | 1 | 1 | Angus Young, Malco… | |
| 10 | 10 | Evil Walks | 1 | 1 | 1 | Angus Young, Malco… | |
| 11 | 11 | C.O.D. | 1 | 1 | 1 | Angus Young, Malco… | |
| 12 | 12 | Breaking The Rules | 1 | 1 | 1 | Angus Young, Malco… | |
| 13 | 13 | Night Of The Long … | 1 | 1 | 1 | Angus Young, Malco… | |
| 14 | 14 | Spellbound | 1 | 1 | 1 | Angus Young, Malco… | |
| 15 | 15 | Go Down | 4 | 1 | 1 | AC/DC | |
| 16 | 16 | Dog Eat Dog | 4 | 1 | 1 | AC/DC | |
| 17 | 17 | Let There Be Rock | 4 | 1 | 1 | AC/DC | |
| 18 | 18 | Bad Boy Boogie | 4 | 1 | 1 | AC/DC | |
| 19 | 19 | Problem Child | 4 | 1 | 1 | AC/DC | |
| 20 | 20 | Overdose | 4 | 1 | 1 | AC/DC | |
| 21 | 21 | Hell Ain't A Bad P… | 4 | 1 | 1 | AC/DC | |
| 22 | 22 | Whole Lotta Rosie | 4 | 1 | 1 | AC/DC | |
| 23 | 23 | Walk On Water | 5 | 1 | 1 | Steven Tyler, Joe … | |
| 24 | 24 | Love In An Elevator | 5 | 1 | 1 | Steven Tyler, Joe … | |

# History

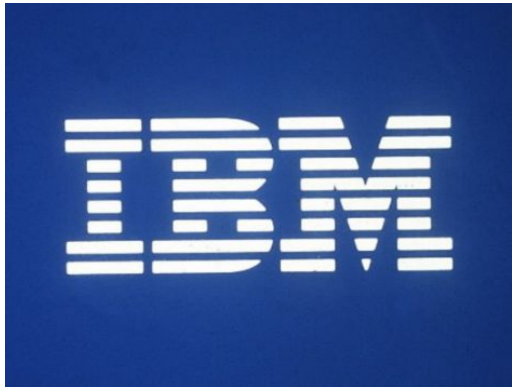
- 1960s - The first databases began to appear
- Databases evolved from flat files
- IBM SABRE system for airlines
  - Helped American Airlines handle reservations



# History

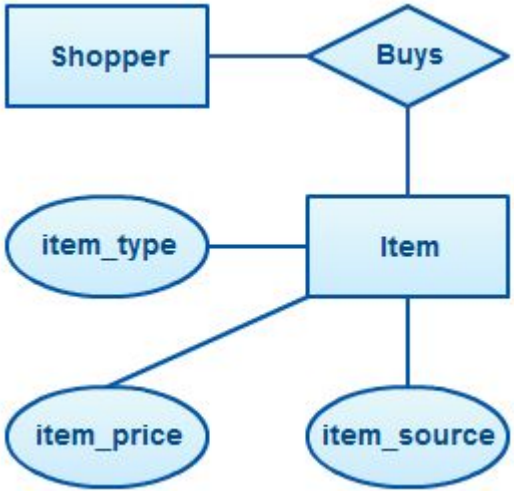
- 1970s - E.F. Cobb proposes the relational database model
- Ingres
  - QUEL query language
- System R
  - SEQUEL query language

INGRES



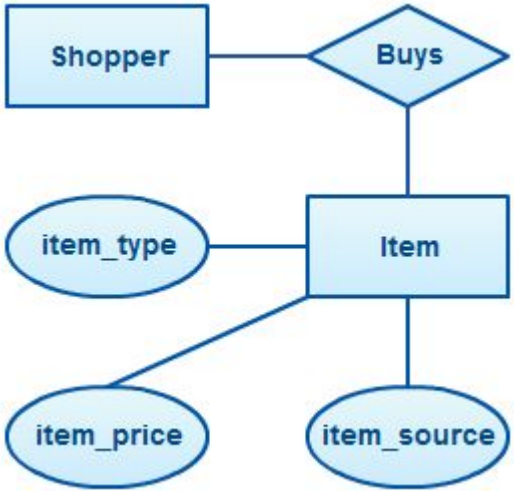
# History

- 1970s - E/R Diagrams are proposed
- Application designers could abstract away from table design



# History

- 1970s - E/R Diagrams are proposed
- Application designers could abstract away from table design…
  - *Is this a good thing?*



# History

- 1980s to early 1990s:
  *The Golden Age of Databases*
- SQL becomes a standard
- Many new players
- *Lots* of money was made

# History

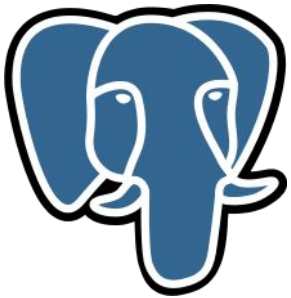
- Early 1990s: Big Shakeout
- Many vendors went bankrupt or became bit players
- Even **Oracle** came close to bankruptcy in 1990
  - Accounting shenanigans
  - "an incredible business mistake"

# History

- Late 1990s: Internet Boom
- A resurgence in vendors, Oracle and DB2 dominant
- Microsoft started making inroads with a fork of Sybase called SQLServer
- Today these are the three dominant commercial players

# History

- Late 1990s: Open Source Databases
- 1995 MySQL
  - Bought by oracle
- 1996 Postgresql
  - Based on Ingres at Berkeley
  - Go Bears
- 2000 SQLite
  - Super lightweight database
  - We are going to use it!



# History

- Post 2000 - Maturity
- Three major commercial vendors
- Two major open source options
- Rise of NoSQL
  - We will look at two
    - MongoDB
    - Redis

# Today

- Todays Database Rankings:

  https://db-engines.com/en/ranking

- Rankings are pretty stable
- Oracle continues to lead
- SQLite is becoming more popular

| Rank | | | DBMS |
|---|---|---|---|
| Jul 2020 | Jun 2020 | Jul 2019 | |
| 1. | 1. | 1. | Oracle |
| 2. | 2. | 2. | MySQL |
| 3. | 3. | 3. | Microsoft SQL Server |
| 4. | 4. | 4. | PostgreSQL |
| 5. | 5. | 5. | MongoDB |
| 6. | 6. | 6. | IBM Db2 |
| 7. | 7. | 7. | Elasticsearch |
| 8. | 8. | 8. | Redis |
| 9. | 9. | ↑ 11. | SQLite |
| 10. | 10. | 10. | Cassandra |

# What is a Database?

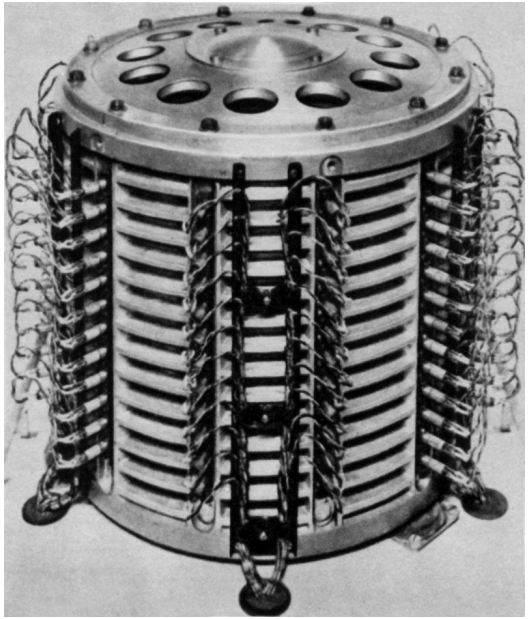
- A system that stores and retrieves data
- A query processor
- Some sort of data definition language (DDL)
- Typically provides network access
  - Not always! SQLite doesn't!
- Makes some guarantees about data

# Sidebar: Why A Cylinder?

- Probably due to the original appearance of hard disks

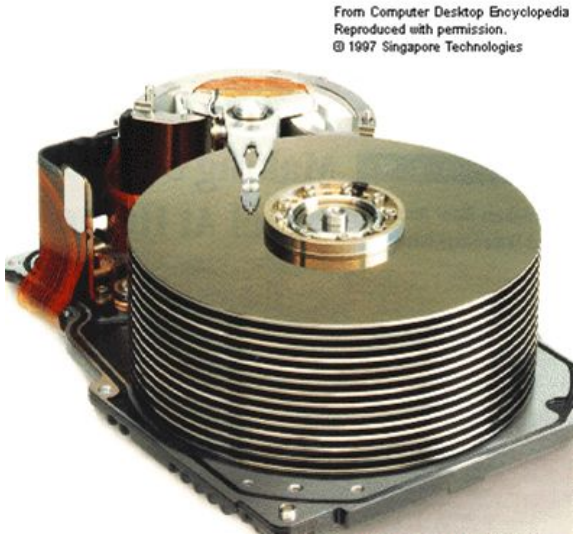
# Sidebar: Why A Cylinder?

- Probably due to the original appearance of hard disks



# Sidebar: Why A Cylinder?

- Probably due to the original appearance of hard disks



# Sidebar: Why A Cylinder?

- Probably due to the original appearance of hard disks
- Oracle Headquarters...

# Anyway, So, Back to Data

- DBMS Guarantees = Transactions (mostly)
- ACID
  - Atomicity - All completes or all fails
  - Consistency - Data consistency constraints are enforced
  - Isolation - Transactions complete as if no other transaction occurred
  - Durability - Data won't be lost

# ACID, Who needs it?

- NoSQL stores often relax or more of these constraints for performance reasons
- Very popular in the early 2010s!
- Since then the industry has shown some regrets
- A return to standard SQL systems or mixed systems

# End of Course Goals

- Be comfortable with the following:
  - Designing database schemas
  - Writing queries
  - Doing so from the web
  - Tuning queries for performance
  - Discussing general database architecture in a local and cloud context
- Be employable

**Vlad Mihalcea**
@vlad_mihalcea

Some companies have tech interviews that validate whether you can send a rocket to the moon, when, in fact, their day-to-day applications just fetch data from a database and display it on the UI.

9:20 PM · Jul 20, 2020 · Twitter for Android

**232** Retweets and comments **1K** Likes

MONTANA
STATE UNIVERSITY