Data structures

UNDERSTANDING DATA ENGINEERING



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Structured data

- Easy to search and organize
- Consistent model, rows and columns
- Defined types
- Can be grouped to form relations
- Stored in relational databases
- About 20% of the data is structured
- Created and queried using SQL

Employee table

index	last_name	first_name	role	team	full_time	office
0	Thien	Vivian	Data Engineer	Data Science	1	Belgium
1	Huong	Julian	Data Scientist	Data Science	1	Belgium
2	Duplantier	Norbert	Software Developer	Infrastructure	1	United Kingdom
3	McColgan	Jeff	Business Developer	Sales	1	United States
4	Sanchez	Rick	Support Agent	Customer Service	0	United States

Relational database

office	address	number	city	zipcode
Belgium	Martelarenlaan	38	Leuven	3010
UK	Old Street	207	London	EC1V 9NR
USA	5th Ave	350	New York	10118

Relational database

index	last_name	first_name	office	address	number	city	zipcode
0	Thien	Vivian	Belgium	Martelarenlaan	38	Leuven	3010
1	Huong	Julian	Belgium	Martelarenlaan	38	Leuven	3010
2	Duplantier	Norbert	UK	Old Street	207	London	EC1V 9NR
3	McColgan	Jeff	USA	5th Ave	350	New York	10118
4	Sanchez	Rick	USA	5th Ave	350	New York	10118

Semi-structured data

- Relatively easy to search and organize
- Consistent model, less-rigid implementation: different observations have different sizes
- Different types
- Can be grouped, but needs more work
- NoSQL databases: JSON, XML, YAML

Favorite artists JSON file

```
{
  {"user_1645156":
     "last_name": "Lacroix",
     "first_name: "Hadrien",
     "favorite_artists": ["Fools in Deed", "Gojira", "Pain", "Nanowar of Steel"]},
  {"user_5913764":
     "last_name": "Billen",
     "first_name: "Sara",
     "favorite_artists": ["Tamino", "Taylor Swift"]},
  {"user_8436791":
     "last_name": "Sulmont",
     "first_name: "Lis",
     "favorite_artists": ["Arctic Monkeys", "Rihanna", "Nina Simone"]},
  ...
}
```

Unstructured data

- Does not follow a model, can't be contained in rows and columns
- Difficult to search and organize
- Usually text, sound, pictures or videos
- Usually stored in data lakes, can appear in data warehouses or databases
- Most of the data is unstructured
- Can be extremely valuable

```
Una mattina mi son alzato
O bella ciao, bella ciao, bella ciao, ciao, ciao
Una mattina mi son alzato
E ho trovato l'invasor

O partigiano, portami via
O bella ciao, bella ciao, bella ciao, ciao, ciao
O partigiano, portami via
Ché mi sento di morir

E se io muoio da partigiano
O bella ciao, bella ciao, bella ciao, ciao, ciao
E se io muoio da partigiano
Tu mi devi seppellir

E seppellire lassù in montagna
O bella ciao, bella ciao, bella ciao, ciao, ciao
E seppellire lassù in montagna
Sotto l'ombra di un bel fior

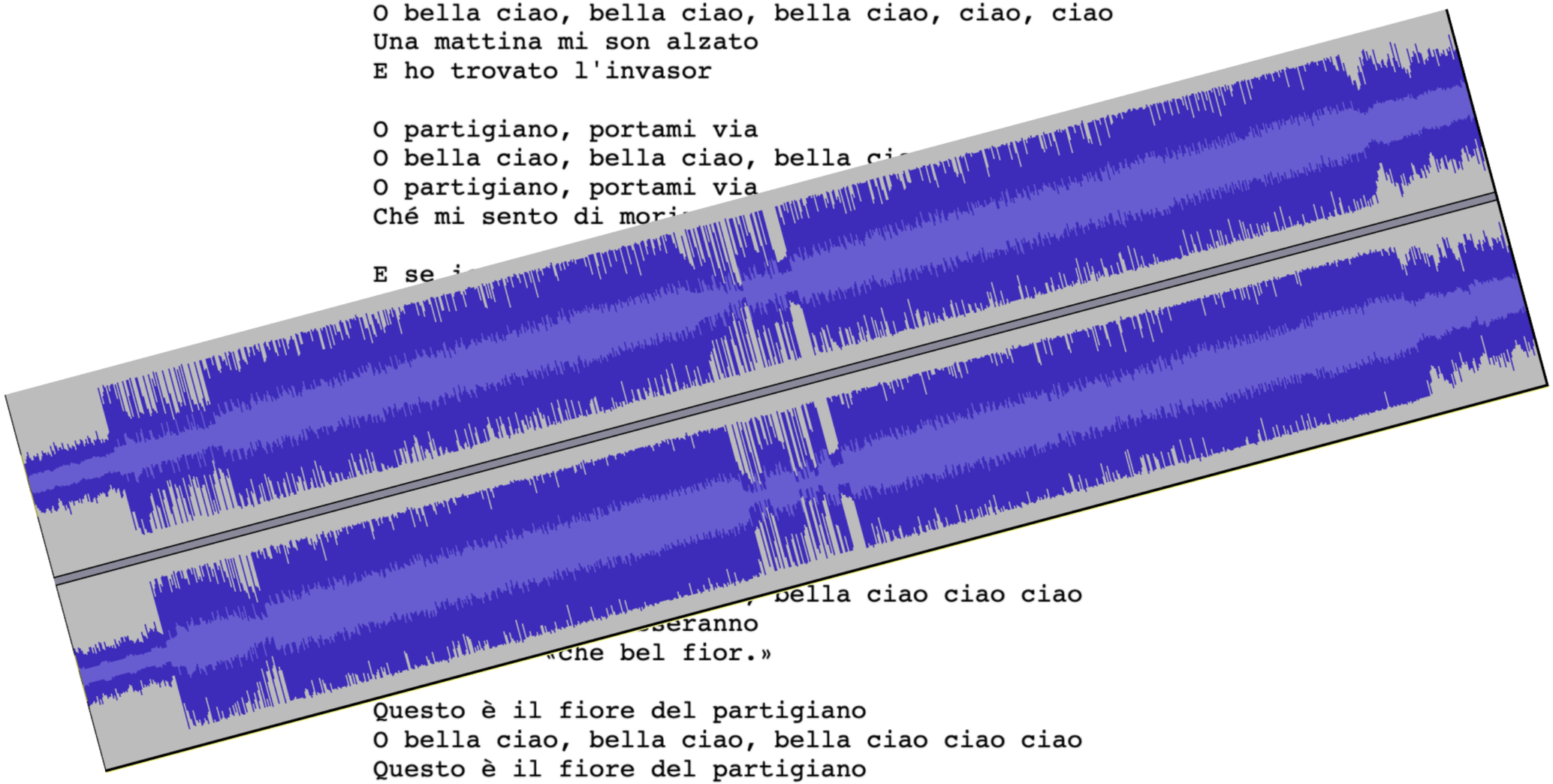
E le genti che passeranno
O bella ciao, bella ciao, bella ciao ciao ciao
E le genti che passeranno
Mi diranno «che bel fior.»

Questo è il fiore del partigiano
O bella ciao, bella ciao, bella ciao ciao ciao
Questo è il fiore del partigiano
Morto per la libertà
```

Una mattina mi son alzato
O bella ciao, bella ciao, bella ciao, ciao, ciao
Una mattina mi son alzato
E ho trovato l'invasor

O partigiano, portami via
O bella ciao, bella ciao, bella ci
O partigiano, portami via
Ché mi sento di mori

E se i



bella ciao ciao ciao
seranno
«che bel fior.»

Questo è il fiore del partigiano
O bella ciao, bella ciao, bella ciao ciao ciao
Questo è il fiore del partigiano
Morto per la libertà

Una mattina mi son alzato
O bella ciao, bella ciao, bella ciao, ciao, ciao
Una matti[illegible]n alzato
E ho tro[illegible]

O parti[illegible]
O bella[illegible]
O part[illegible]
Ché mi[illegible]

E se[illegible]



Questo è il fiore del[illegible]
O bella ciao, bella ciao, bel[illegible]
Questo è il fiore del partigiano
Morto per la libertà

Una mattina mi son alzato
O bella ciao, bella ciao, bella ciao, ciao, ciao
Una matti[illegible]n alzato
E ho tro[illegible]



[illegible]ciao, bella ciao, be[illegible]
Questo è il fiore del partigiano
Morto per la libertà

Adding some structure

- Use AI to search and organize unstructured data
- Add information to make it semi-structured

Summary

- Structured data
- Semi-structured data
- Unstructured data
- Differences between the three
- Give examples

Let's practice!

UNDERSTANDING DATA ENGINEERING

SQL databases

UNDERSTANDING DATA ENGINEERING



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SQL

- Structured Query Language
- Industry standard for Relational Database Management System (RDBMS)
- Allows you to access many records at once, and group, filter or aggregate them
- Close to written English, easy to write and understand
- Data engineers use SQL to create and maintain databases
- Data scientists use SQL to query (request information from) databases

Remember the employees table

index	last_name	first_name	role	team	full_time	office
0	Thien	Vivian	Data Engineer	Data Science	1	Belgium
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4	Sanchez	Rick	Support Agent	Customer Service	0	United States

SQL for data engineers

- Data engineers use SQL to create, maintain and update tables.

```
CREATE TABLE employees (
    employee_id INT,
    first_name VARCHAR(255),
    last_name VARCHAR(255),
    role VARCHAR(255),
    team VARCHAR(255),
    full_time BOOLEAN,
    office VARCHAR(255)
);
```

SQL for data scientists

- Data scientist use SQL to query, filter, group and aggregate data in tables.

```
SELECT first_name, last_name
FROM employees
WHERE role LIKE '%Data%'
```

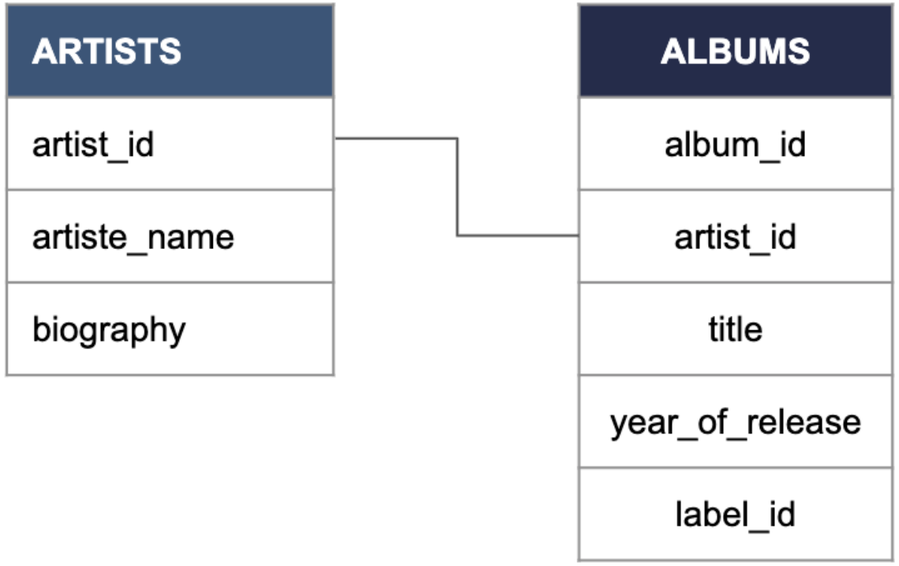
Database schema

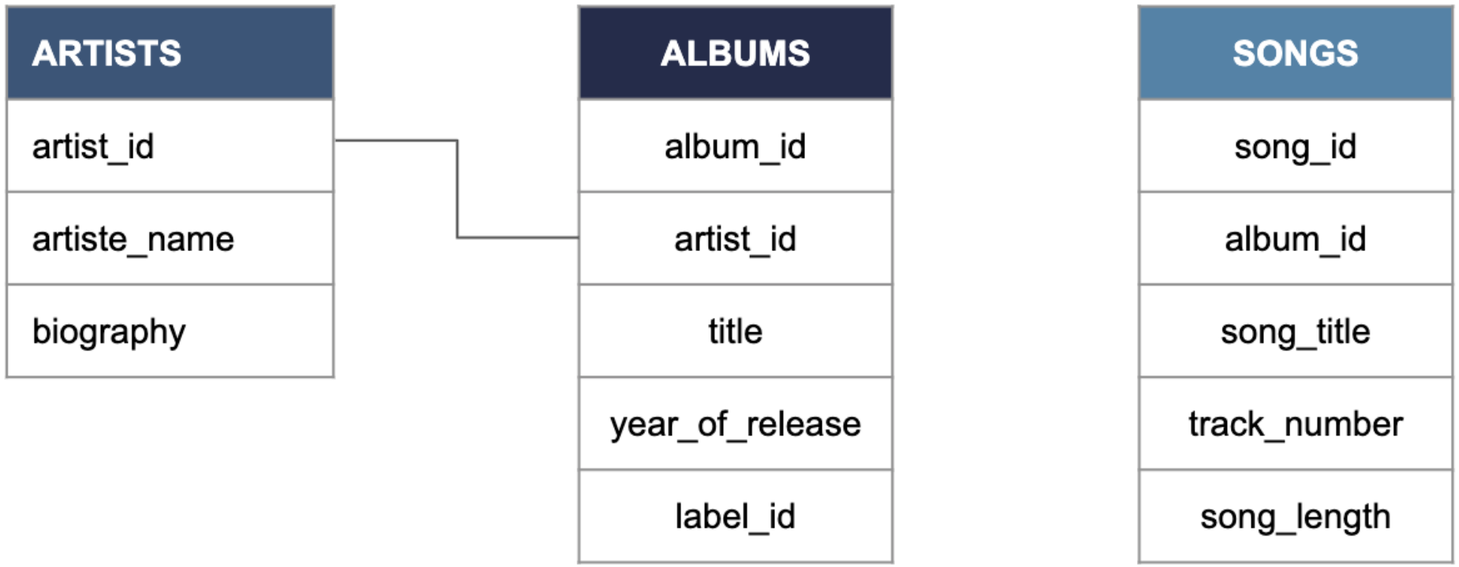
- Databases are made of tables
- The database schema governs how tables are related

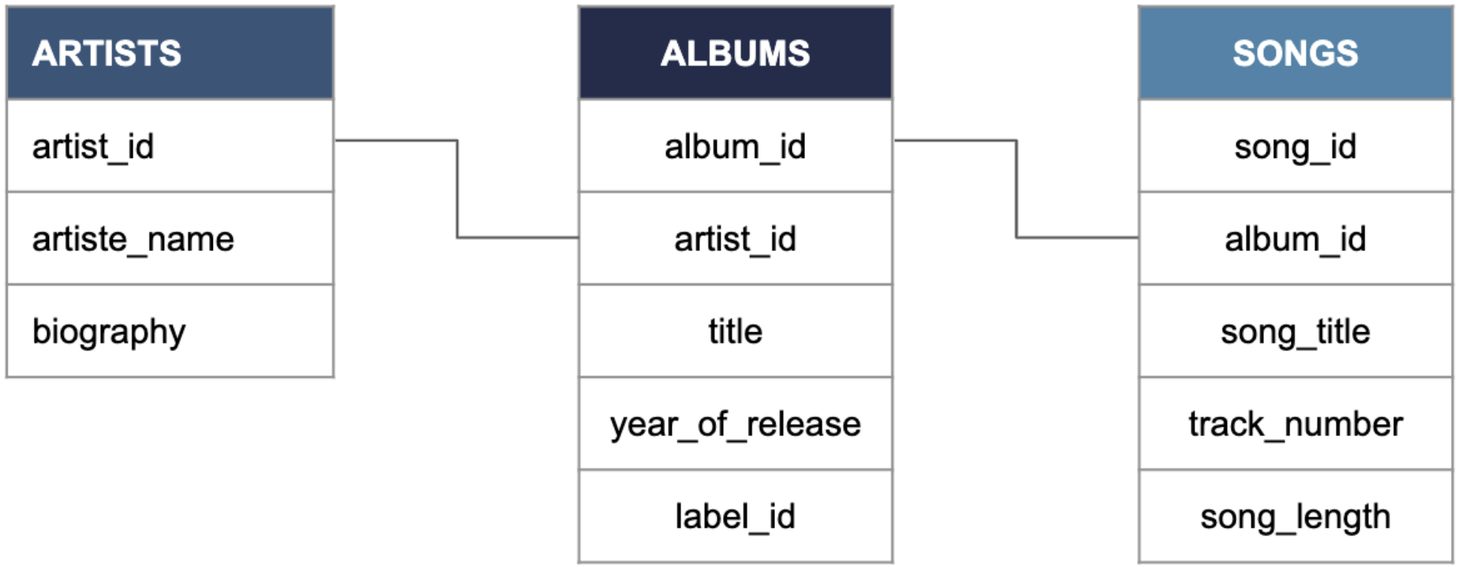
ALBUMS
album_id
artist_id
title
year_of_release
label_id

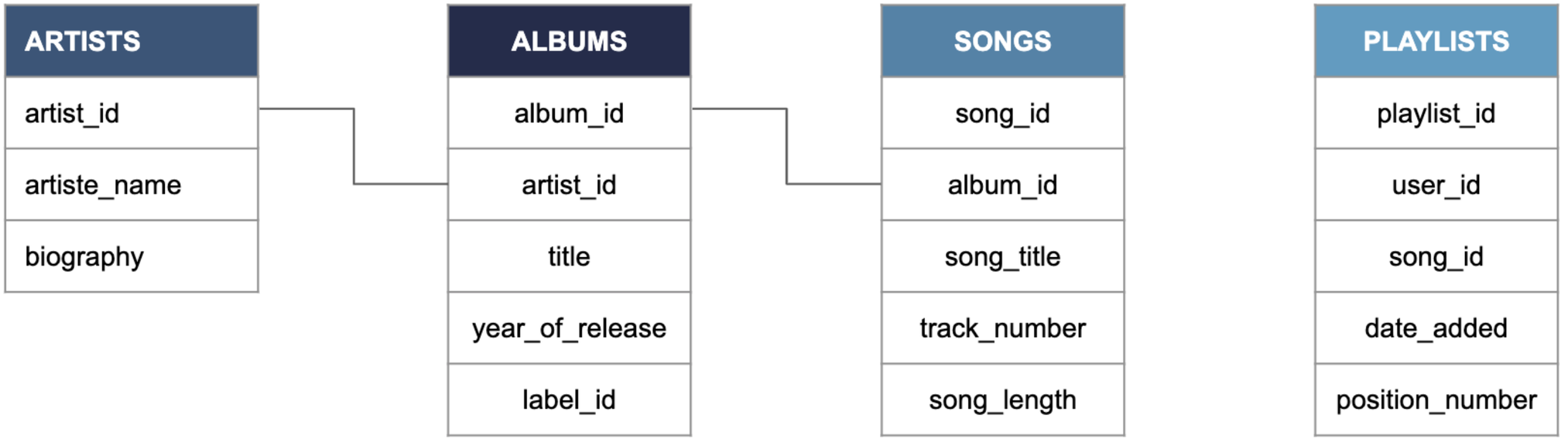
ARTISTS
artist_id
artiste_name
biography

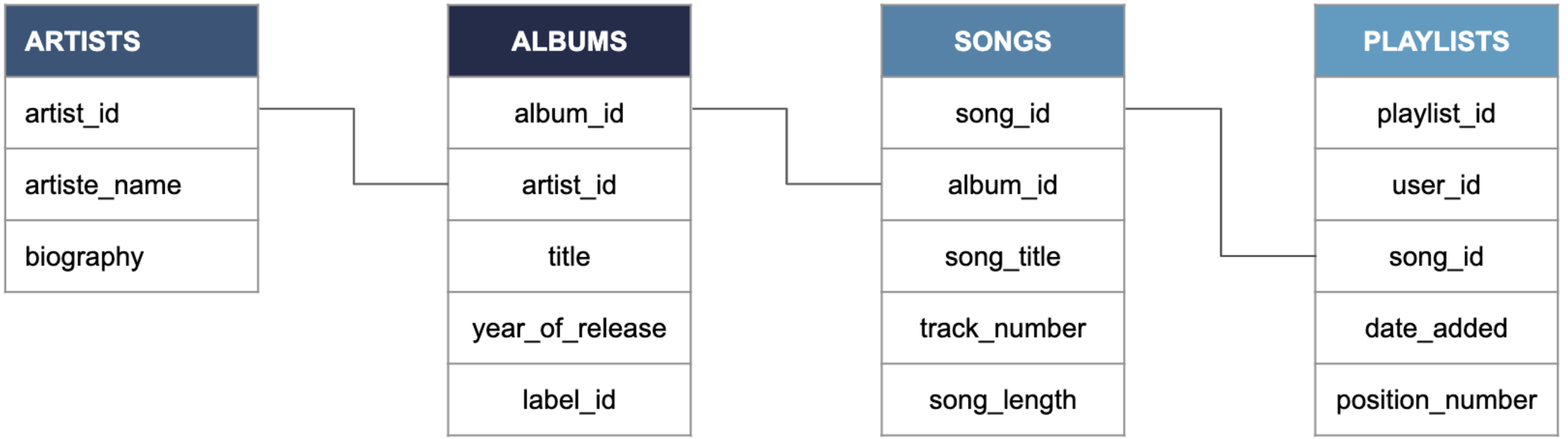
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song_id
album_id
song_title
track_number
song_length


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playlist_id
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song_id
date_added
position_number

Several implementations

- SQLite
- MySQL
- PostgreSQL
- Oracle SQL
- SQL Server

Summary

- SQL = industry standard
- Explain how Data engineers and Data scientists use it differently
- Database schema
- SQL implementations

Let's practice!

UNDERSTANDING DATA ENGINEERING

Data warehouses and data lakes

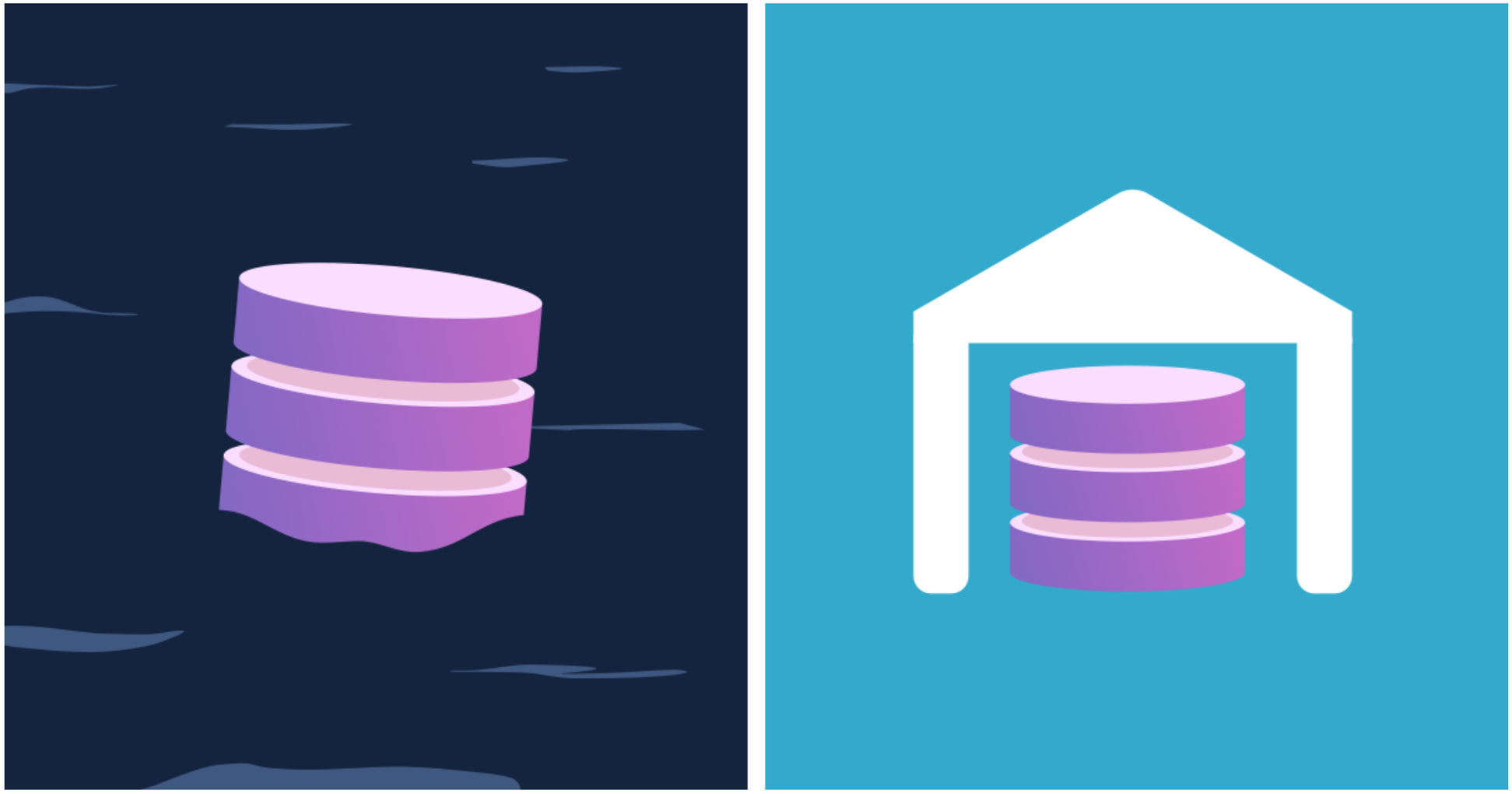
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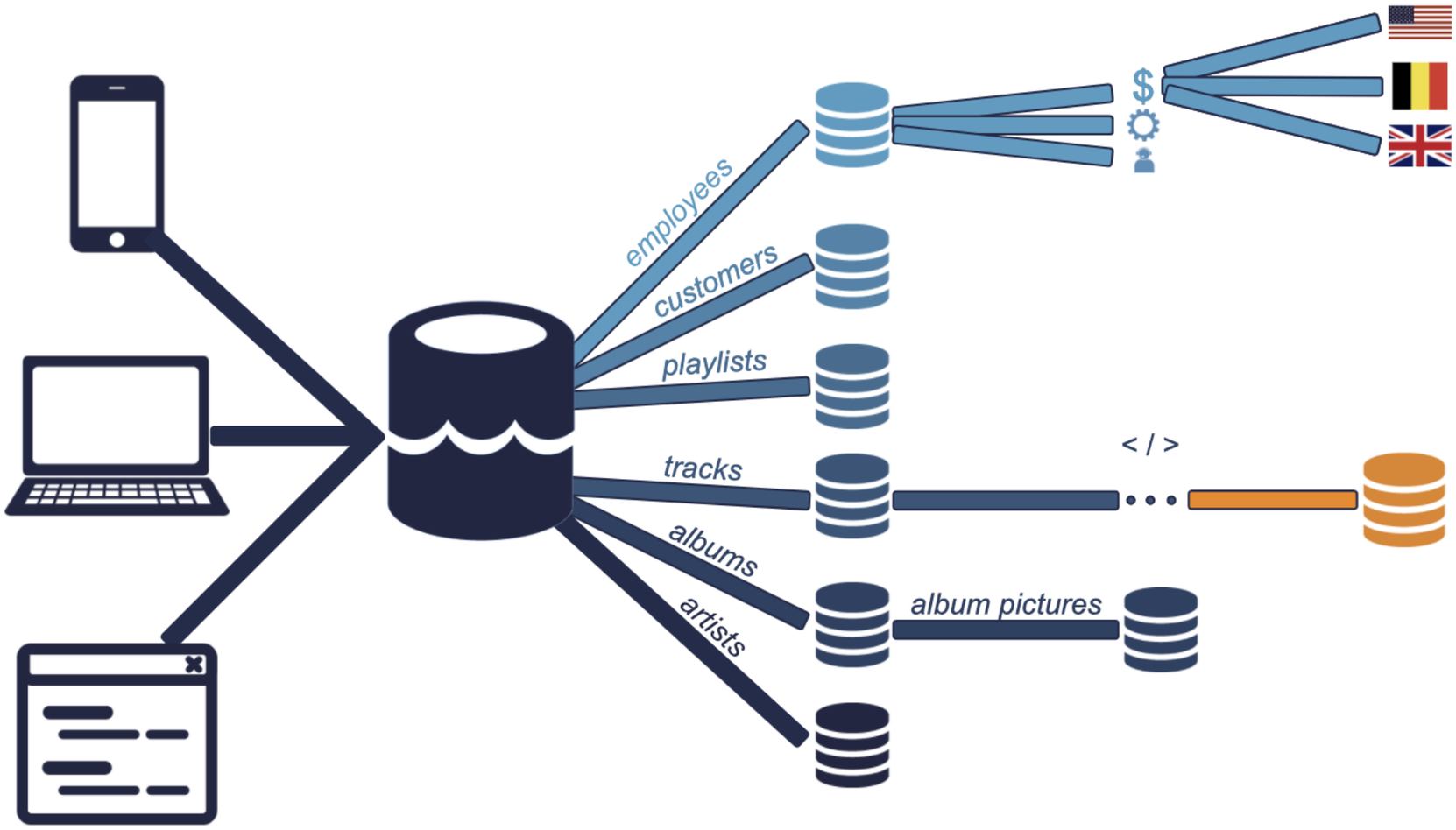


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Warehouses with stunning view on the lake




employees
customers
playlists
tracks
albums
artists
< / >
album pictures

Data lakes and data warehouses

Data lake

- Stores all the raw data
- Can be petabytes (1 million GBs)
- Stores all data structures
- Cost-effective
- Difficult to analyze
- Requires an up-to-date data catalog
- Used by data scientists
- Big data, real-time analytics

Data warehouse

- Specific data for specific use
- Relatively small
- Stores mainly structured data
- More costly to update
- Optimized for data analysis
- Also used by data analysts and business analysts
- Ad-hoc, read-only queries

Data catalog for data lakes

- What is the source of this data?
- Where is this data used?
- Who is the owner of the data?
- How often is this data updated?
- Good practice in terms of data governance
- Ensures reproducibility
- No catalog --> data swamp

- **Good practice for any data storage solution**
  - Reliability
  - Autonomy
  - Scalability
  - Speed

Database vs. data warehouse

- Database:
  - General term
  - Loosely defined as *organized data stored and accessed on a computer*
- Data warehouse is a type of database

Summary

- Data lakes
- Data warehouses
- Databases
- Data catalog

Let's practice!

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