Welcome to the CoGrammar Databases

The session will start shortly...

Questions? Drop them in the chat. We'll have dedicated moderators answering questions.

Software Engineering Session Housekeeping

- The use of disrespectful language is prohibited in the questions, this is a supportive, learning environment for all - please engage accordingly. **(Fundamental British Values: Mutual Respect and Tolerance)**
- No question is daft or silly - **ask them!**
- There are **Q&A sessions** throughout this session, should you wish to ask any follow-up questions.
- If you have any questions outside of this lecture, or that are not answered during this lecture, please do submit these for upcoming Academic Sessions. You can submit these questions here: Questions

Software Engineering Session Housekeeping cont.

- For all **non-academic questions**, please submit a query: www.hyperiondev.com/support
- Report a **safeguarding** incident: www.hyperiondev.com/safeguardreporting
- We would love your **feedback** on lectures: Feedback on Lectures

Enhancing Accessibility: Activate Browser Captions

Why Enable Browser Captions?

- Captions provide **real-time text for spoken content**, ensuring inclusivity.
- Ideal for individuals in noisy or quiet environments or for those with **hearing impairments**.

How to Activate Captions:

1. **YouTube or Video Players:**
   - Look for the CC (Closed Captions) icon and click to enable.
2. **Browser Settings:**
   - Google Chrome: Go to *Settings > Accessibility > Live Captions* and toggle ON.
   - Edge: Enable captions in *Settings > Accessibility*.

Safeguarding & Welfare

We are committed to all our students and staff feeling safe and happy; we want to make sure there is always someone you can turn to if you are worried about anything.

If you are feeling upset or unsafe, are worried about a friend, student or family member, or you feel like something isn't right, speak to our safeguarding team:

Ian Wyles
Designated Safeguarding Lead

Simone Botes

Nurhaan Snyman

Rafiq Manan

Ronald Munodawafa

Tevin Pitts

Scan to report a safeguarding concern

or email the Designated Safeguarding Lead:
Ian Wyles
safeguarding@hyperiondev.com

CoGrammar HyperionDev

Skills Bootcamp Progression Overview

✓ Criterion 3 – End-Course Progress

Showcasing students' progress nearing the completion of the course.

To meet this criterion, students should:

- **Guided Learning Hours** (GLH): Complete the total minimum required GLH, by the support end date.
- **Task Completion** : Complete all mandatory tasks, including any necessary resubmissions, by the end of the bootcamp, 09 March 2025 (C11) or 30 March 2025 (C12).

✓ Criterion 4 - Employability

Demonstrating progress to find employment.

To meet this criterion, students should:

- **Record an Interview Invite:** Students are required to record proof of invitation to an interview by 30 March 2025 (C11) or 04 May 2025 (C12).
  - **South Holland Students** are required to proof and interview by 17 March 2025.
- **Record a Final Job Outcome** : Within 12 weeks post-graduation, students are required to record a job outcome.

CoGrammar

Stay Safe Series:

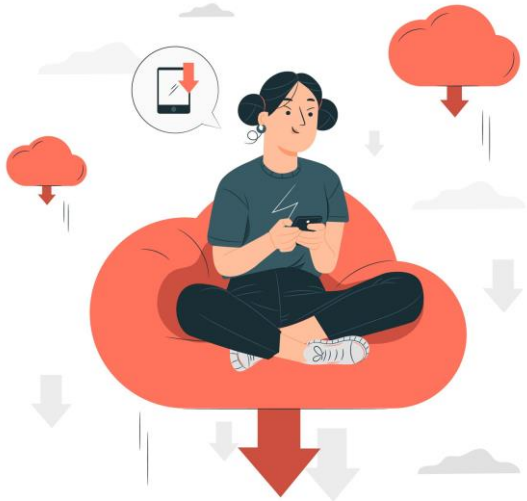
Mastering Online Safety One Week or Step at a Time

While the digital world can be a wonderful place to make education and learning accessible to all, it is unfortunately also a space where harmful threats like online radicalisation, extremist propaganda, phishing scams, online blackmail and hackers can flourish.

As a component of this BootCamp the *Stay Safe Series* is designed to guide you through essential measures in order to protect yourself & your community from online dangers, whether they target your privacy, personal information or even attempt to manipulate your beliefs.

Download with Caution: Avoiding Dangerous Files

- Use Trusted Sources Only
- Look for HTTPS
- Avoid Clicking on Pop-ups
- Scan Downloads with Antivirus
- Keep Software Updated
- Beware of Free Downloads
- Check File Extensions




SKILLS FOR LIFE
SKILLS BOOTCAMPS
Department for Education
CoGrammar
Databases

Polls

CoGrammar

Poll

1. On a scale of 1 to 5, how would you rate your understanding of the course material so far?
    1. Poor - I'm having difficulty grasping some concepts
    2. Average - I understand some parts but not all.
    3. Very Poor - I'm struggling to understand the material.
    4. Good - I feel confident about most of the material.
    5. Excellent - I have a strong grasp of the course material.

Poll

2. How comfortable are you with the concepts of databases and Database Management Systems (DBMS)?
   A. Not comfortable at all
   B. Somewhat uncomfortable
   C. Neutral
   D. Somewhat comfortable
   E. Very comfortable

Poll

3. In the context of managing data, what's the primary responsibility of a Database Management System (DBMS)?

   A. Organising, storing, and retrieving data in a structured and efficient manner.

   B. Processing complex algorithms for data analysis.

   C. Providing a user interface for interacting with various data sources.

Poll

4. Database Normalisation: When designing a database, what's the main objective of data normalisation?

   A. To compress the data size and save storage space.

   B. To eliminate data redundancy and improve data integrity

   C. To define relationships between different data sets.

Learning Outcomes

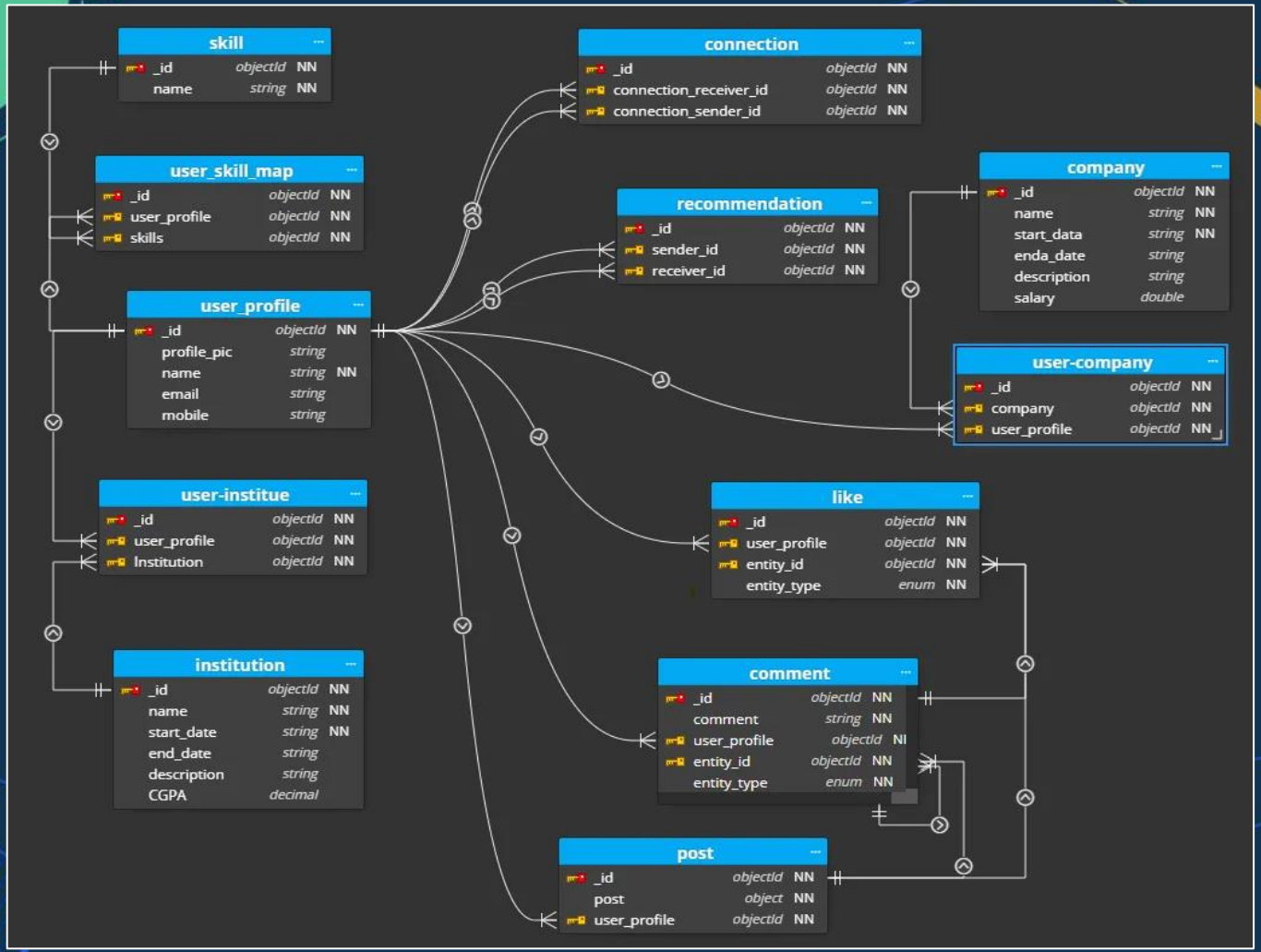
- Explain and describe the concept of a **database** and its role in software development.
- Identify **different types of databases** and how they are used.
- Learn basic database **terminology and concepts** (tables, columns, rows, keys, etc.).
- Explain the importance of **database normalisation** and apply it to simple database designs.
- Gain **practical experience** using MariaDB and/or SQLite/MySQL to interact with databases.

Learning Outcomes

- Introduce the concept of **Object-Relational Mappers** (ORMs).
- Describe the role and importance of **ACID** principles in database transactions.
- Recognise the role of **data lakes**, **data warehouses**, and **data marts** in modern cloud data management.
- Introduce the concept of **data modelling layers** in a cloud environment.
- Interact with SQL for **basic database** interaction

Introduction

CoGrammar


skill
_id objectId NN
name string NN
connection
_id objectId NN
connection_receiver_id objectId NN
connection_sender_id objectId NN
user_skill_map
_id objectId NN
user_profile objectId NN
skills objectId NN
recommendation
_id objectId NN
sender_id objectId NN
receiver_id objectId NN
company
_id objectId NN
name string NN
start_data string NN
enda_date string
description string
salary double
user_profile
_id objectId NN
profile_pic string
name string NN
email string
mobile string
user-company
_id objectId NN
company objectId NN
user_profile objectId NN
user-institue
_id objectId NN
user_profile objectId NN
Institution objectId NN
like
_id objectId NN
user_profile objectId NN
entity_id objectId NN
entity_type enum NN
institution
_id objectId NN
name string NN
start_date string NN
end_date string
description string
CGPA decimal
comment
_id objectId NN
comment string NN
user_profile objectId NI
entity_id objectId NN
entity_type enum NN
post
_id objectId NN
post object NN
user_profile objectId NN

CoGrammar

Databases

- Picture a clothing store in a bustling mall. Keeping track of hundreds of different items, various sizes and colours, along with customer purchases and loyalty program information using manual methods can be a nightmare.
- A database can streamline this process by storing detailed information about each clothing item (type, size, colour, price), managing inventory levels, and recording customer purchases with loyalty points.
- This allows the store to analyse trends, identify popular items and sizes, target promotions effectively, and personalise the shopping experience for loyal customers – all contributing to increased sales and better customer satisfaction.

The Power of Data

- Data is the raw information that we collect and store.
- It can include numbers, text, images, videos, and more.
- Data is everywhere!
- From our online activity to scientific research, data plays a crucial role.

Introducing Databases

- A database is a structured **collection** of **data** organised for easy **access**, **retrieval**, and **management**.
- Picture a well-organised library, but with information you can search and access in seconds.

Introducing Databases

- Databases offer many benefits:
  - Organisation: Keeps data organised and easy to find.
  - Efficiency: Saves time and effort compared to manual data management.
  - Accuracy: Reduces errors and inconsistencies in data.
  - Sharing: Allows multiple users to access and share data securely.
- There are different types of databases, but today we'll focus on Relational Databases, a popular and widely used type. Non Relationals include raw files like csv, or more complex systems like NoSQL

Database Fundamentals

CoGrammar

Unveiling the Database Toolbox

- **Databases** are like powerful digital toolboxes for **storing** and **managing information**.
- Let's explore the essential components that make them work:

- Schema
- Tables
- Columns
- Rows
- Data Types
- Keys
- Relationships
- View
- Index
- Join
- CRUD

Unveiling the Database Toolbox

Schema

The structure that defines the organisation of data in a database, including tables, columns, relationships, constraints, and other properties, providing a blueprint for how data is stored and accessed.

vehicle_id	customer_name	customer_contact	sale_amount	sale_location
1	Kwame Mensah	+225 01 23 45 67	25000.00	Abidjan
2	Laurent Dubois	+33 6 12 34 56 78	30000.00	Paris
3	Anna Müller	+49 151 12345678	28000.00	Berlin
4	Sofia Mabunda	+258 82 123 45671	22000.00	Maputo
5	Raj Patel	+91 98765 43210	35000.00	Mumbai

Unveiling the Database Toolbox

Tables

Single type of data within a **table**, such as a person's name or age, and is organised vertically within the table structure. (e.g., "Customer Name," "Product Price").

vehicle_id	customer_name	customer_contact	sale_amount	sale_location
1	Kwame Mensah	+225 01 23 45 67	25000.00	Abidjan
2	Laurent Dubois	+33 6 12 34 56 78	30000.00	Paris
3	Anna Müller	+49 151 12345678	28000.00	Berlin
4	Sofia Mabunda	+258 82 123 45671	22000.00	Maputo
5	Raj Patel	+91 98765 43210	35000.00	Mumbai

Unveiling the Database Toolbox

Columns

Structured collection of data organised into rows and columns, where each row represents a unique record and each column represents a different attribute or piece of information. (e.g., "Customers," "Products").

	vehicle_id	customer_name	customer_contact	sale_amount	sale_location
▶	1	Kwame Mensah	+225 01 23 45 67	25000.00	Abidjan
	2	Laurent Dubois	+33 6 12 34 56 78	30000.00	Paris
	3	Anna Müller	+49 151 12345678	28000.00	Berlin
	4	Sofia Mabunda	+258 82 123 45671	22000.00	Maputo
	5	Raj Patel	+91 98765 43210	35000.00	Mumbai

Unveiling the Database Toolbox

Rows

Also known as a record, represents a single instance of data within a table, containing specific values corresponding to each column of the table. (e.g., a customer's name and address).

vehicle_id	customer_name	customer_contact	sale_amount	sale_location
1	Kwame Mensah	+225 01 23 45 67	25000.00	Abidjan
2	Laurent Dubois	+33 6 12 34 56 78	30000.00	Paris
3	Anna Müller	+49 151 12345678	28000.00	Berlin
4	Sofia Mabunda	+258 82 123 4567	22000.00	Maputo
5	Raj Patel	+91 98765 43210	35000.00	Mumbai

Unveiling the Database Toolbox

Data Types

Specifies the kind of data a column can hold, such as **text** (VARCHAR, TEXT), **numbers** (INT, DECIMAL), **dates** (DATE, TIMESTAMP), or **binary data** (BIT), ensuring consistency and facilitating efficient storage and retrieval of information.

	vehicle_id	customer_name	customer_contact	sale_amount	sale_location
▶	1	Kwame Mensah	+225 01 23 45 67	25000.00	Abidjan
	2	Laurent Dubois	+33 6 12 34 56 78	30000.00	Paris
	3	Anna Müller	+49 151 12345678	28000.00	Berlin
	4	Sofia Mabunda	+258 82 123 45671	22000.00	Maputo
	5	Raj Patel	+91 98765 43210	35000.00	Mumbai

Keys, Relationships, and CRUD

Primary Keys

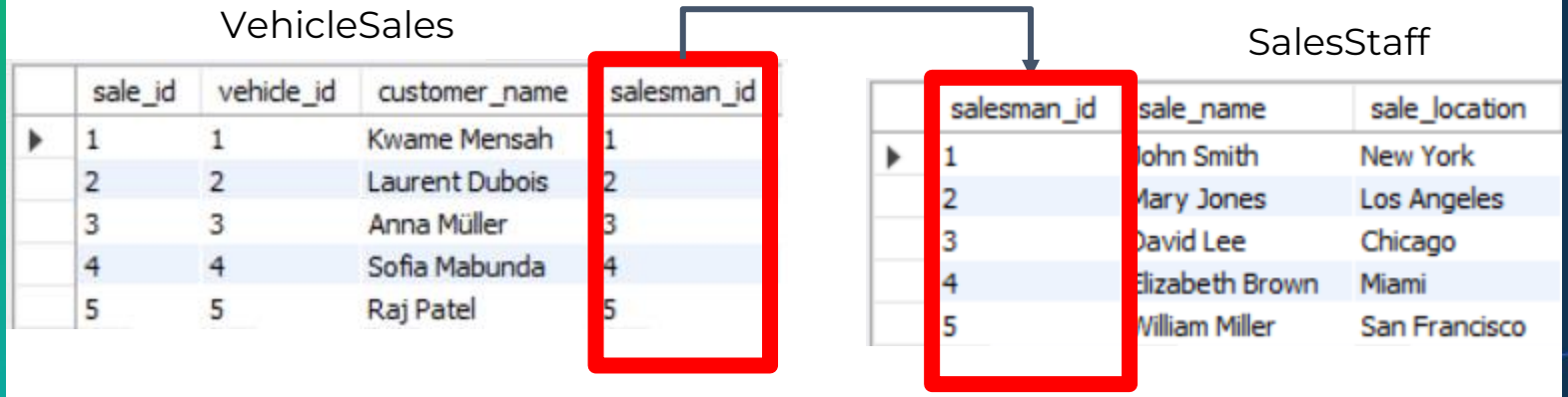
A unique identifier for each record within that table, ensuring that each row is uniquely identifiable. It serves as a reference point for other tables and is used to enforce data integrity and facilitate efficient data retrieval.

vehicle_id	customer_name	customer_contact	sale_amount	sale_location
1	Kwame Mensah	+225 01 23 45 67	25000.00	Abidjan
2	Laurent Dubois	+33 6 12 34 56 78	30000.00	Paris
3	Anna Müller	+49 151 12345678	28000.00	Berlin
4	Sofia Mabunda	+258 82 123 45671	22000.00	Maputo
5	Raj Patel	+91 98765 43210	35000.00	Mumbai

Keys, Relationships, and CRUD

Relationships

Foreign keys in a database are columns that establish a relationship between tables by referencing the primary key of another table.



Unveiling the Database Toolbox

Views

It is a virtual table that represents the result set of a pre-defined query. It acts as a stored SQL query that can be queried like a regular table, simplifying complex queries, providing security by restricting access to certain columns or rows, and encapsulating business logic.

View

	salesman_id	sale_name	sale_location
▶	1	John Smith	New York
	2	Mary Jones	Los Angeles
	3	David Lee	Chicago
	4	Elizabeth Brown	Miami
	5	William Miller	San Francisco
*	NULL	NULL	NULL

	salesman_id	sale_name	sale_location
▶	1	John Smith	New York
	2	Mary Jones	Los Angeles
	3	David Lee	Chicago
	4	Elizabeth Brown	Miami
	5	William Miller	San Francisco
*	NULL	NULL	NULL

Unveiling the Database Toolbox

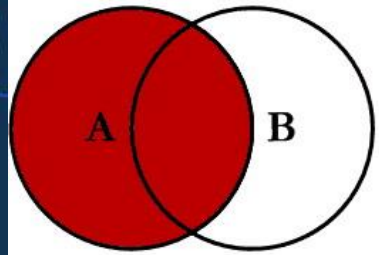
Indexes

Data structures that improve the performance of queries by allowing the database system to quickly locate rows based on the values of one or more columns, which is an essential component of the query execution plan.

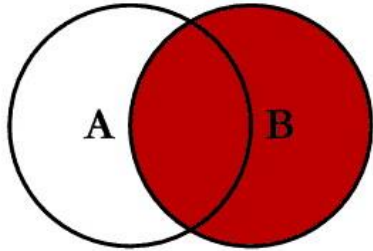
JOINS

CoGrammar

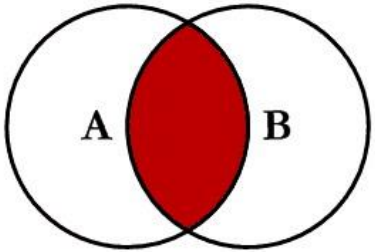
SQL JOINS



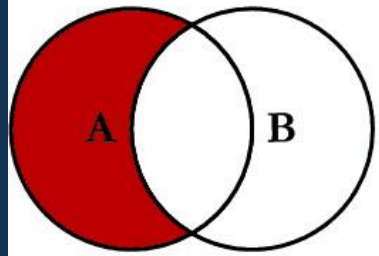

```
SELECT <select_list>
FROM TableA A
LEFT JOIN TableB B
ON A.Key = B.Key
```



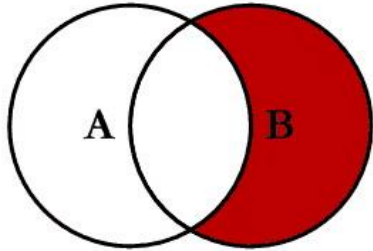

```
SELECT <select_list>
FROM TableA A
RIGHT JOIN TableB B
ON A.Key = B.Key
```



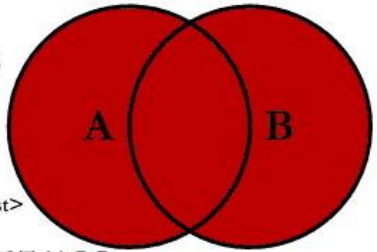

```
SELECT <select_list>
FROM TableA A
INNER JOIN TableB B
ON A.Key = B.Key
```



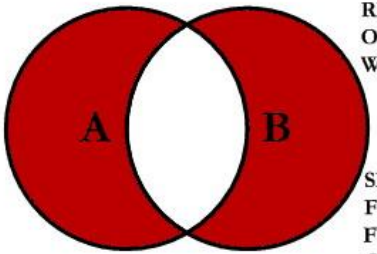

```
SELECT <select_list>
FROM TableA A
LEFT JOIN TableB B
ON A.Key = B.Key
WHERE B.Key IS NULL
```




```
SELECT <select_list>
FROM TableA A
RIGHT JOIN TableB B
ON A.Key = B.Key
WHERE A.Key IS NULL
```




```
SELECT <select_list>
FROM TableA A
FULL OUTER JOIN TableB B
ON A.Key = B.Key
```




```
SELECT <select_list>
FROM TableA A
FULL OUTER JOIN TableB B
ON A.Key = B.Key
WHERE A.Key IS NULL
OR B.Key IS NULL
```

Let’s take a short break

CoGrammar

Types of Databases

CoGrammar

Unveiling the Database Landscape

Relational Databases

- Structured data in tables with rows and columns.
- Enforces data integrity with constraints like primary and foreign keys.
- Supports relationships between tables through foreign keys.
- Utilises SQL for querying and manipulation.
- Adheres to ACID properties for transactional reliability and consistency.
- Examples: MySQL, MariaDB, SQLite, PostgreSQL

Unveiling the Database Landscape

Non Relational Databases (NoSQL)

- Flexible database schema.
- Various data models (document-oriented, key-value, etc.).
- Ability to handle unstructured and semi-structured data.
- Support for distributed transactions.
- Handle big data or large volumes of data and real-time analytics.
- Examples: MongoDB, Cassandra

Data Organisation and Processing

Row-Oriented Databases

- Data for each record (row) is stored together.
- This structure is efficient for retrieving complete records and often used for:
    - OLTP (Online Transaction Processing): Frequent updates and retrieval of individual records (e.g., processing sales transactions, managing customer accounts).
- **Examples**: MySQL, SQLite, Amazon Aurora

Data Organisation and Processing

Column-Oriented Databases

- Data for each column is stored together.
- Think of a library filing books by genre (all history books together, all novels together).
- This is an advanced topic, but offers benefits for:
    - OLAP (Online Analytical Processing): Analysing large datasets and identifying trends (e.g., customer buying patterns, market analysis).
- **Examples**: PostgreSQL, Amazon Redshift, Apache Cassandra

Database Properties

CoGrammar

Transactions and Data Reliability

- Transactions: A series of database operations treated as a single unit.
- Imagine withdrawing money from your bank account
- All or nothing: either all operations succeed or none of them happen.

Transactions and Data Reliability

ACID Compliance

Ensures data consistency and reliability in transactions (ACID stands for):

- Atomicity: All operations are indivisible (all succeed or none happen).
- Consistency: Maintains data integrity (transforms database from one valid state to another).
- Isolation: Concurrent transactions are isolated from each other (prevents data inconsistencies).
- Durability: Committed changes are permanent (ensures data is not lost).

MySQL and MariaDB are ACID-compliant DBMS.

Speaking the Database Language

- Clear and consistent naming conventions are crucial for databases.
- Use descriptive and easy-to-understand names:
  - customer_name is better than cust_nm
  - order_date is clearer than ord_dt
- Consistency is key: choose a convention (e.g., lowercase_with_underscores) and stick to it.

Database Normalisation

CoGrammar

Streamlining Your DB: Normalisation

- Imagine storing a customer's address multiple times in a database instead of maintaining it in a separate table, that will lead to duplicate information.
- Data normalisation involves organising data in a database to minimise redundancy and dependency.
- Redundancy: Repeated data across tables, which can lead to:
  - Errors: Updating one value in multiple places can lead to inconsistencies.
  - Wasted Storage: Duplicate data takes up unnecessary space.
  - Inefficiency: Queries become slower with redundant data to search through.

Normalisation Forms: Step-by-Step Approach

Normalisation Form	Description
1NF (First Normal Form)	Eliminates repeating groups of data within a table. Each record (row) should be unique and identifiable by a primary key.
2NF (Second Normal Form)	Meets 1NF requirements and eliminates partial dependencies. All non-key attributes must depend on the entire primary key, not just a part of it.
3NF (Third Normal Form)	Meets 2NF requirements and eliminates transitive dependencies. No non-key attribute should depend on another non-key attribute.

Example

Unnormalised

EMPLOYEE	JOB	STATE_CODE	HOME_STATE
E001, Alice, J01	Chef	26	Michigan
E001, Alice, J02	Waiter	26	Michigan
E002, Bob, J02	Waiter	56	Wyoming

Example

1 NF

EMPLOYEE_ID	NAME	JOB_CODE	JOB	STATE_CODE	HOME_STATE
E001	Alice	J01	Chef	26	Michigan
E001	Alice	J02	Waiter	26	Michigan
E002	Bob	J02	Waiter	56	Wyoming

Example

2 NF

roles table

EMPLOYEE_ID	JOB_CODE
E001	J01
E001	J02
E002	J02
E002	J03
E003	J01

employees table

EMPLOYEE_ID	NAME	STATE_CODE	HOME_STATE
E001	Alice	26	Michigan
E002	Bob	56	Wyoming
E003	Alice	56	Wyoming

jobs table

JOB_CODE	JOB
J01	Chef
J02	Waiter
J03	Bartender

Example

3 NF

employees table

EMPLOYEE_ID	NAME	STATE_CODE
E001	Alice	26
E002	Bob	56
E003	Alice	56

states table

STATE_CODE	HOME_STATE
26	Michigan
56	Wyoming

The Benefits of Normalisation

Normalisation is a powerful tool for:

- Data Integrity: Minimises errors and inconsistencies.
- Efficiency: Improves query performance and reduces storage requirements.
- Maintainability: Makes databases easier to manage and update.

Let’s take a short break

CoGrammar

SQL Fundamentals

CoGrammar

Unveiling the Database Language

- Imagine a vast vault holding valuable information.
- SQL (Structured Query Language) is the key to accessing that data.
- SQL is a standardised language for interacting with **relational databases**.
- We use SQL statements to:
  - **Create** and **manage** database structures (tables).
  - **Retrieve**, **update**, and **delete** data within those structures.

The Building Blocks of SQL

Category	Description	Example
DDL (Data Definition Language)	Creates and modifies the structure of a database (tables, views, indexes).	* **CREATE** TABLE Customers (CustomerID INT PRIMARY KEY, Name VARCHAR(255), Email VARCHAR(255))
DML (Data Manipulation Language)	Manages data within the database (insert, update, delete).	* **INSERT** INTO Customers (Name, Email) VALUES ('John Doe', 'john.doe@email.com')
DCL (Data Control Language)	Controls access privileges for users within the database (grant, revoke).	* **GRANT** SELECT ON Customers TO reports_user

Unveiling Your Data: SELECT Query

Clause	Description	Example
SELECT	Specifies the columns you want to retrieve.	SELECT Name, Email
FROM	Identifies the table containing the data.	FROM Customers
WHERE (Optional)	Filters data based on a specific condition.	WHERE Email LIKE '%@gmail.com'
ORDER BY (Optional)	Sorts the results based on a specified column.	ORDER BY Name ASC
GROUP BY (Optional)	Groups rows based on a shared value in one or more columns.	GROUP BY Country
HAVING (Optional)	Filters groups based on a condition applied to aggregate functions.	HAVING COUNT(*) > 10

In Organised projects

CoGrammar

Storage Solutions

- The amount of data organisations generate is exploding.
- We need efficient ways to store and manage this data.
- Different storage solutions cater to various data needs.

Data Lakes

A Reservoir for All Your Data

- Data lakes are large, central repositories for storing raw, unstructured, and semi-structured data.
- They offer high scalability and flexibility, accommodating diverse data sources (sensor data, social media feeds, etc.).
- Ideal for exploratory analysis and uncovering hidden patterns within the data.

Data Warehouses

The Organised Analyst's Haven

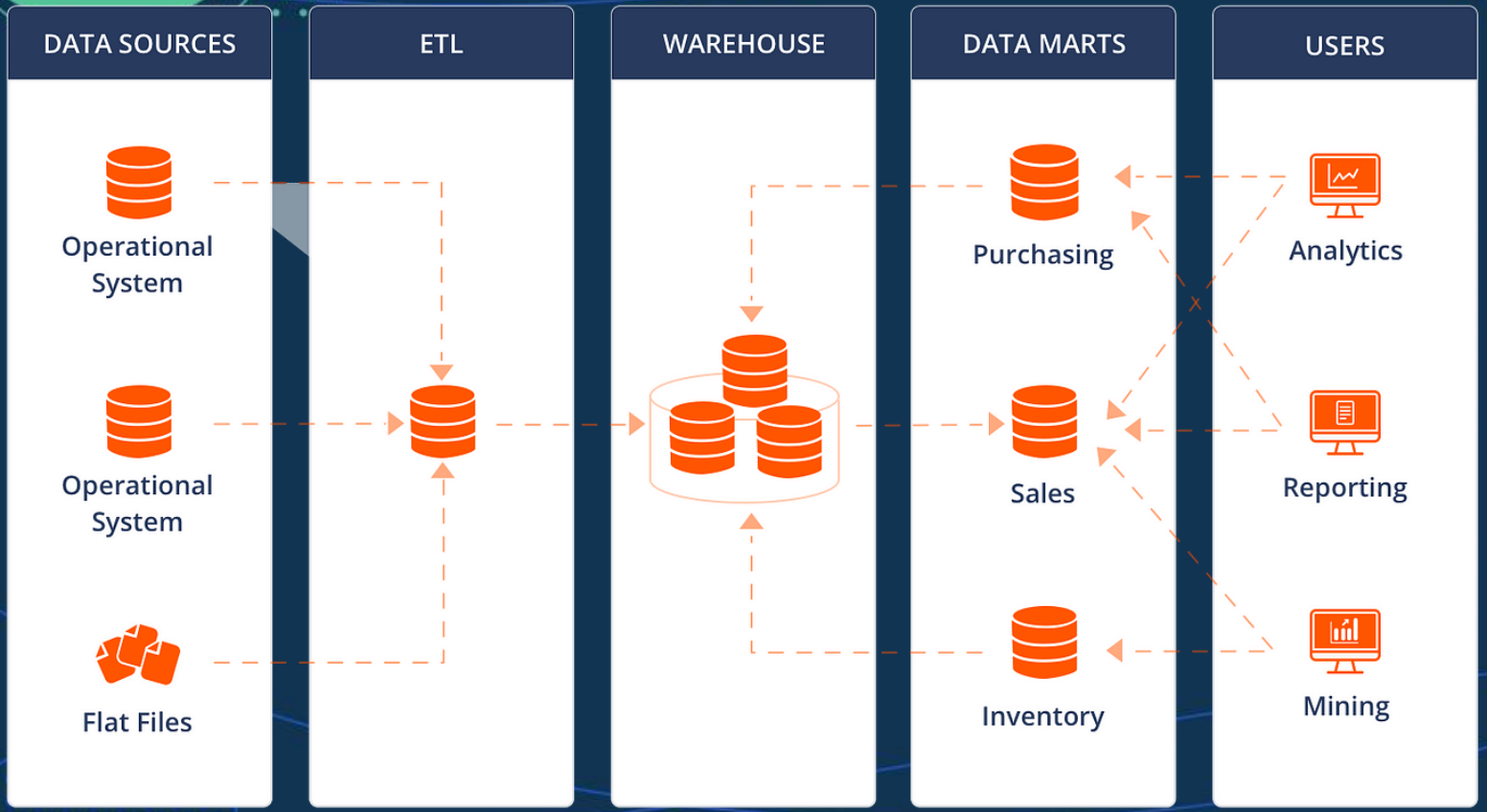
- Data warehouses are subject-oriented, centrally managed repositories designed for analytical workloads.
- Data is pre-processed, cleaned, and transformed into a consistent, structured format.
- Optimised for querying, reporting, and data analysis (often integrated with data lakes).

Data Marts

A Tailored Approach to Data Analysis

- Data marts are focused subsets of data warehouses, tailored for specific business needs (e.g., marketing, sales).
- Offer a smaller, more manageable data footprint compared to data warehouses.
- Can be deployed more quickly and are often less expensive to maintain.

Example of Data Architecture



CoGrammar

Final Assessment

CoGrammar

Poll

1. SQL (Structured Query Language): SQL is primarily used for what purpose in a relational database?

   A. To design and define the structure of the database
   B. To Create, Read, Update and Delete data within the database
   C. To manage user access permissions for the database

Poll

2. Data Warehouses: How do data warehouses typically differ from operational databases like OLTP systems?

   A. Data warehouses are designed for real-time transaction processing, while OLTP systems focus on historical data analysis.
   B. Data warehouses store detailed and integrated data from various sources, while OLTP systems manage current operational data.
   C. Data warehouses are more scalable and handle larger datasets compared to OLTP systems.

Lesson Conclusion and Recap

CoGrammar

Lesson Conclusion and Recap

- Databases store data in a structured format using tables with rows and columns.
- SQL (Structured Query Language) is the standard language for interacting with relational databases.
- Data Modelling defines the structure of a database to represent real-world entities and relationships.
- Database Normalisation is a process of reducing data redundancy within a database, improving efficiency and data integrity.
- We explored the basics of SQL categories: DDL (Data Definition Language) and DML (Data Manipulation Language).

Homework or Follow-up Activities

CoGrammar

Homework or Follow-up Activities

Objective: Practise writing basic SQL queries to retrieve, filter, and sort data.

- **Web-based SQL editor:** We'll be using a web-based SQL editor called "DB Fiddle" (or any other preferred platform you choose). This eliminates the need for Docker or local installations.
- **Sample Database:** A pre-populated sample database relevant to your field (e.g., library management system, e-commerce store) will be provided within the DB Fiddle environment.

Homework or Follow-up Activities

Instructions:

1. **Access DB Fiddle**: Visit **https://www.db-fiddle.com/** (or your chosen web-based SQL editor).
2. **Select Sample Database**: You'll be provided with a link or instructions to access the pre-populated sample database within DB Fiddle.
3. **Write SQL Queries**: Start by writing simple SELECT queries to retrieve specific data from the tables.
4. **Filter and Sort Results**: Experiment with WHERE and ORDER BY clauses to filter the retrieved data based on specific criteria and sort the results in various ways

References

- Database Design and Relational Theory, by C. J. Date
- FUNDAMENTALS OF Fourth Edition DATABASE SYSTEMS Ramez Elmasri
- Database Design for Mere Mortals, by Michael J Hernandez
- https://www.codeproject.com/KB/database/Visual_SQL_Joins/Visual_SQL_JOINS_orig.jpg

Thank you for attending

SKILLS FOR LIFE
SKILLS BOOTCAMPS

Department for Education

CoGrammar