Introduction to Databases

Database Foundations

Author: Eng. Carlos Andrés Sierra, M.Sc.
cavirguezs@udistrital.edu.co

Lecturer
Computer Engineer
School of Engineering
Universidad Distrital Francisco José de Caldas

2024-III

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Outline

1. Software Components and Applications
2. Glosary
3. DataBase Classification
4. Relational Database Design
5. Entity-Relation Model (MER)
6. DataBase Management Systems — DBMS
7. DataBases Infrastructure
8. DevOps
9. Data Engineering

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Outline

1. Software Components and Applications
2. Glosary
3. DataBase Classification
4. Relational Database Design
5. Entity-Relation Model (MER)
6. DataBase Management Systems — DBMS
7. DataBases Infrastructure
8. DevOps
9. Data Engineering

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Modular Software Components

- **Software Components** are the building blocks of software systems.
- **Modular Software** is a software design technique that emphasizes separating the functionality of a program into independent, interchangeable **modules**.
- **Software Applications** are the final product of software development.
- **Software Development** is the process of creating software applications.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Modular Software Components

- **Software Components** are the building blocks of software systems.
- **Modular Software** is a software `design technique` that emphasizes separating the functionality of a program into independent, interchangeable **modules**.
- **Software Applications** are the final product of software development.
- **Software Development** is the process of creating software applications.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Modular Software Components

- **Software Components** are the building blocks of software systems.
- **Modular Software** is a software `design technique` that emphasizes separating the functionality of a program into independent, interchangeable **modules**.
- **Software Applications** are the final product of software development.
- **Software Development** is the process of creating software applications.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Modular Software Components

- **Software Components** are the building blocks of software systems.
- **Modular Software** is a software `design technique` that emphasizes separating the functionality of a program into independent, interchangeable **modules**.
- **Software Applications** are the final product of software development.
- **Software Development** is the process of creating software applications.

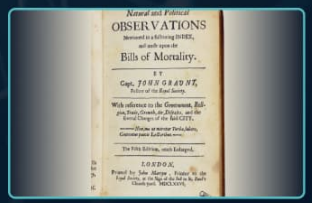
UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

History of Data

HISTORY OF DATA

19,000 BC — 1600s — 1800s — 1900s — 1990s

The Ishango bone holds the first evidence of data collection and storage.



John Graunt introduces the concept of data analysis in 1663.

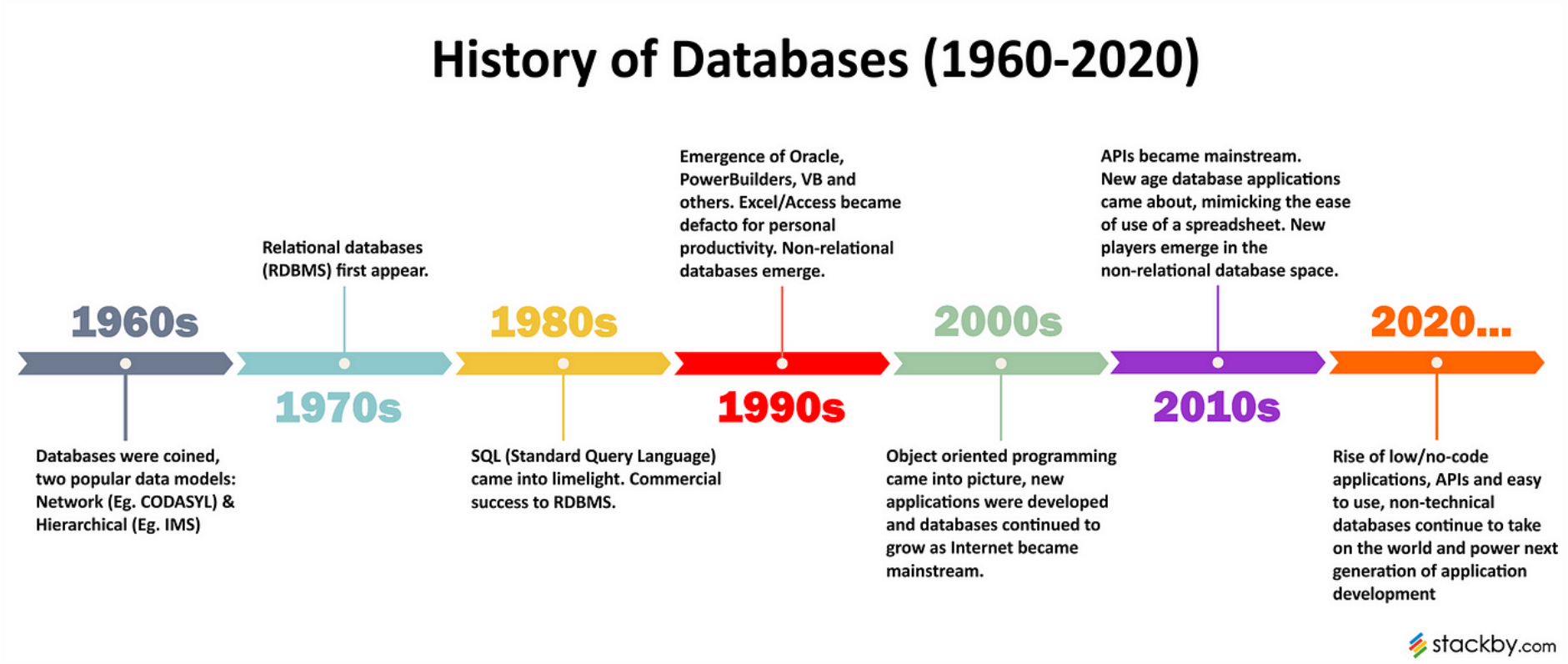
Herman Hollerith designs a machine that helped complete the US census in 1890.

Fritz Pfleumer invents the magnetic tape which later inspired the invention of floppy disks and hard disk drives.

Sir Tim Berners Lee invents the World Wide Web.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

History of DataBases



Applications

- Are software based on **layers** of abstraction and modularity lets implement different database strategies.
- Database Systems are fundamental for **data management**.
- Data analysis, data mining, data visualization, and data interpretation are **applications** of **database systems**.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Applications

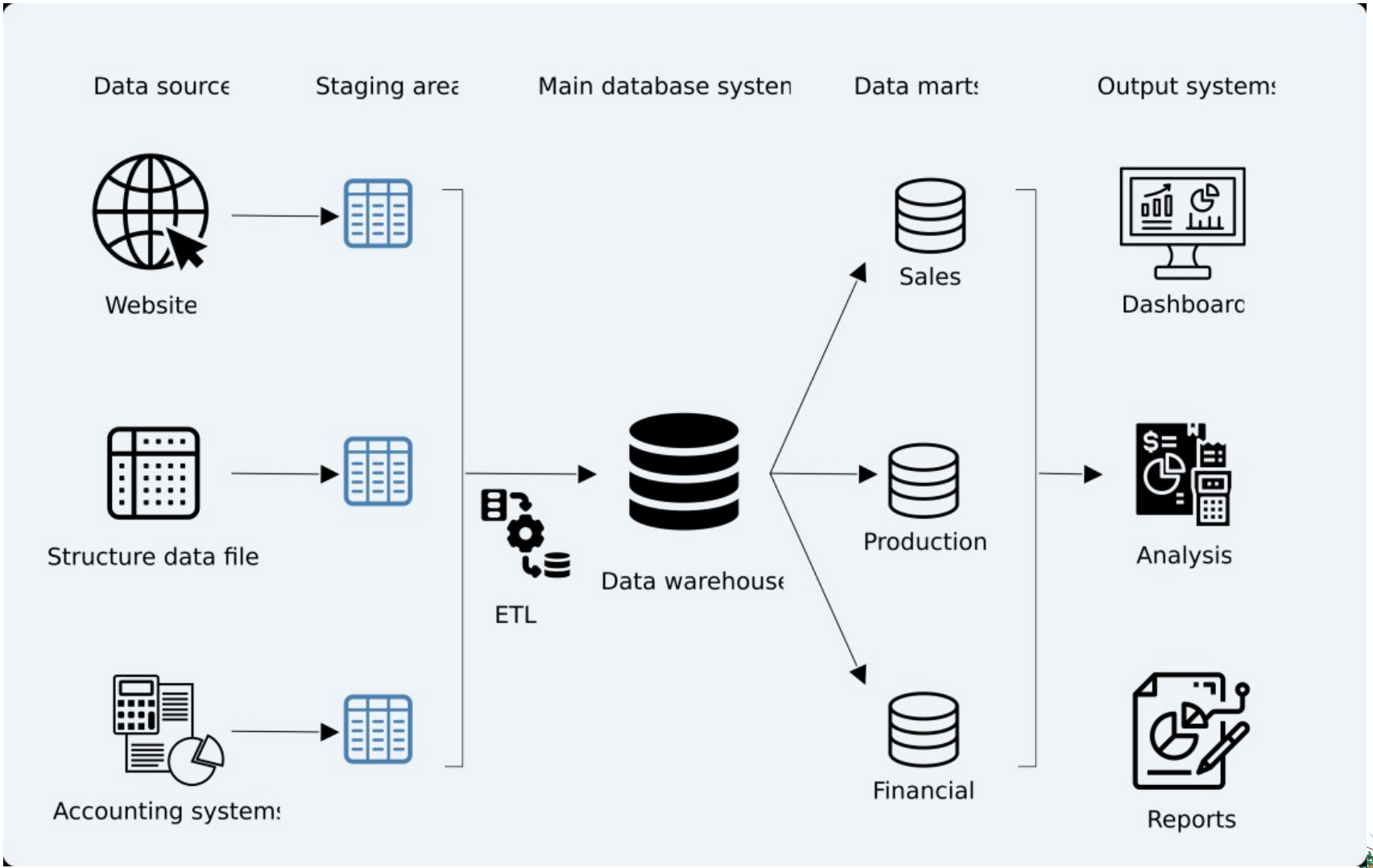
- Are software based on **layers** of abstraction and modularity lets implement different database strategies.
- Database Systems are fundamental for **data management**.
- Data analysis, data mining, data visualization, and data interpretation are **applications** of **database systems**.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Applications

- Are software based on **layers** of abstraction and modularity lets implement different database strategies.
- Database Systems are fundamental for **data management**.
- Data analysis, data mining, data visualization, and data interpretation are **applications** of **database systems**.

Case of Study: DataBase System



Outline

1. Software Components and Applications
2. Glosary
3. DataBase Classification
4. Relational Database Design
5. Entity-Relation Model (MER)
6. DataBase Management Systems — DBMS
7. DataBases Infrastructure
8. DevOps
9. Data Engineering

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

From Data to Information

- Data: is a set of **values** of **qualitative** or **quantitative** variables.
- Data Management: is the process of **collecting**, **storing**, **processing**, and **analyzing** data.
- Data Analysis: is a process of **inspecting**, **cleansing**, **transforming**, and **modeling** data with the goal of **discovering** useful **information**, informing **conclusions**, and supporting **decision-making**.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

From Data to Information

- Data: is a set of **values** of **qualitative** or **quantitative** variables.
- Data Management: is the process of **collecting**, **storing**, **processing**, and **analyzing** data.
- Data Analysis: is a process of **inspecting**, **cleansing**, **transforming**, and **modeling** data with the goal of **discovering** useful **information**, informing **conclusions**, and supporting **decision-making**.

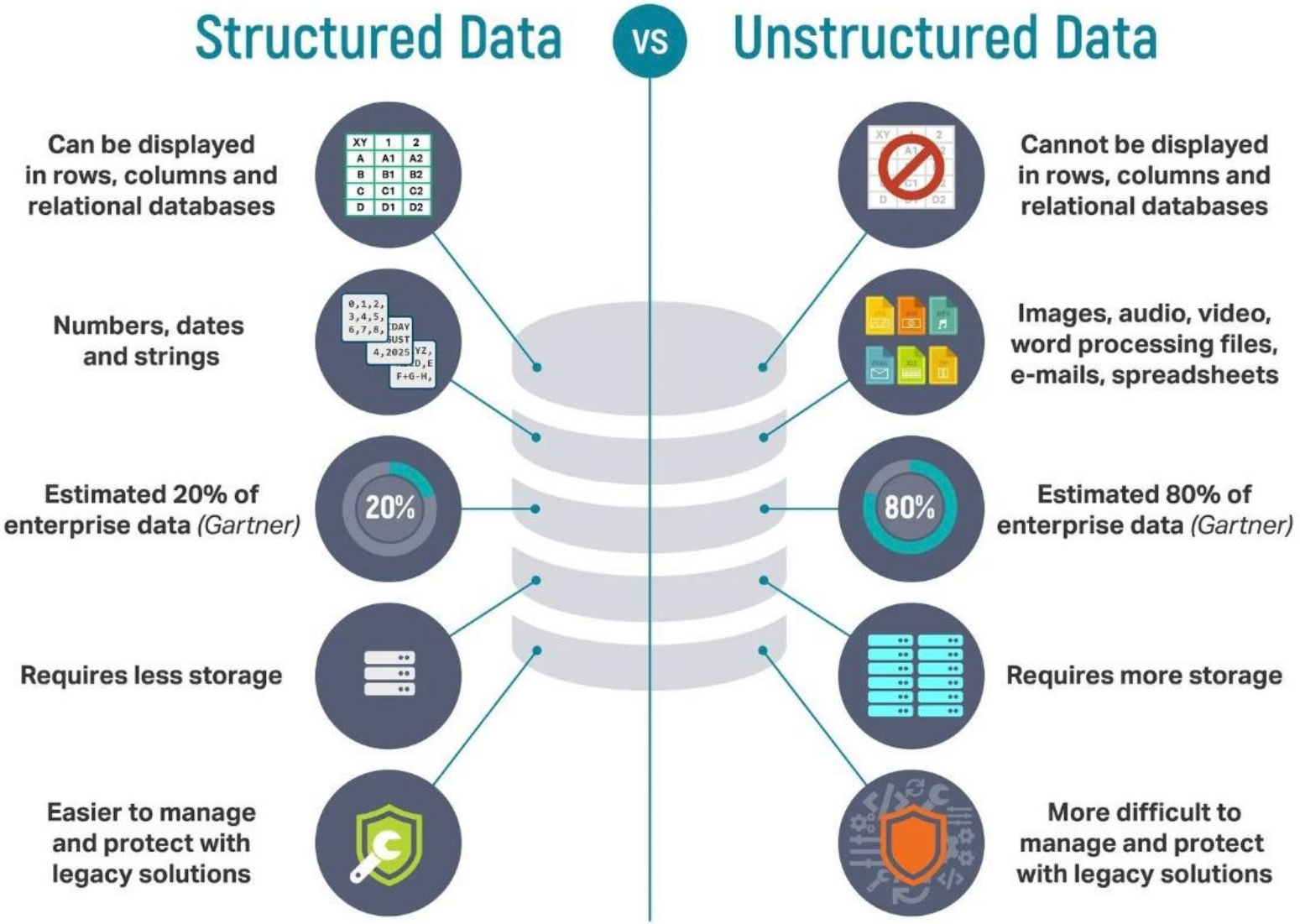
UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

From Data to Information

- Data: is a set of **values** of **qualitative** or **quantitative** variables.
- Data Management: is the process of **collecting**, **storing**, **processing**, and **analyzing** data.
- Data Analysis: is a process of **inspecting**, **cleansing**, **transforming**, and **modeling** data with the goal of **discovering** useful **information**, informing **conclusions**, and supporting **decision-making**.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Structured and Unstructured Data



Tables, Columns and Rows

- **Table** is a collection of related data held in a structured format within a database.
- **Column** is a set of data values of a particular simple type, one for each row of the table.
- **Row** is a set of data values of a particular relationship, one for each column of the table.

Primary and Foreign Keys

- **Primary Key** is a unique identifier for a record in a data set.
- **Foreign Key** is a column or group of columns in a table that links to a primary key in another table.

Key-Value Data Structures

- **Key-Value Data Structures** are a type of data structure that can map keys to values.
- **Key** is a unique identifier for a record in a data fragment. **Value** is the data that is associated with the key.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

CRUD Operations

- CRUD is an acronym for **Create**, **Read**, **Update**, and **Delete**.
- Create is the process of **adding** new **records** to a **data set**.
- Read is the process of **retrieving records** from a **data set**.
- Update is the process of **modifying records** in a **data set**.
- Delete is the process of **removing records** from a **data set**.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Outline

1. Software Components and Applications
2. Glosary
3. DataBase Classification
4. Relational Database Design
5. Entity-Relation Model (MER)
6. DataBase Management Systems — DBMS
7. DataBases Infrastructure
8. DevOps
9. Data Engineering

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

DataBase Classification

- DataBase is a collection of **data** that is **organized** so that it can be **easily accessed**, **managed**, and **updated**.
- Relational DataBase is a type of **database** that stores and provides access to **data points** that are **related** to one another.
- NoSQL DataBase is a type of **database** that provides a mechanism for **storage** and **retrieval** of **data** that is **modeled** in **means** other than the **tabular relations** used in **relational databases**.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

DataBase Classification

- DataBase is a collection of **data** that is **organized** so that it can be **easily accessed**, **managed**, and **updated**.
- Relational DataBase is a type of **database** that stores and provides access to **data points** that are **related** to one another.
- NoSQL DataBase is a type of **database** that provides a mechanism for **storage** and **retrieval** of **data** that is **modeled** in **means** other than the **tabular relations** used in **relational databases**.

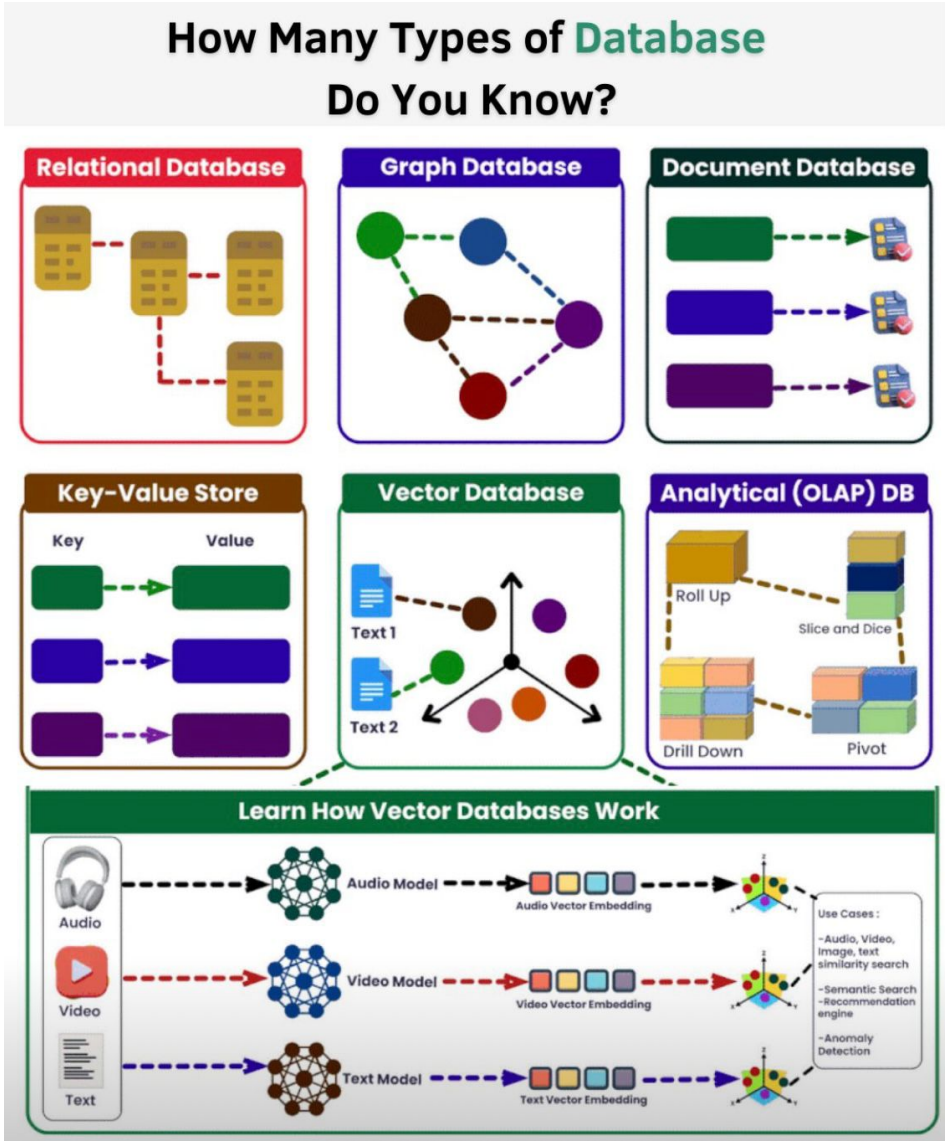
UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

DataBase Classification

- DataBase is a collection of **data** that is **organized** so that it can be **easily accessed**, **managed**, and **updated**.
- Relational DataBase is a type of **database** that stores and provides access to **data points** that are **related** to one another.
- NoSQL DataBase is a type of **database** that provides a mechanism for **storage** and **retrieval** of **data** that is **modeled** in **means** other than the **tabular relations** used in **relational databases**.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Types of Database



DataBases Models

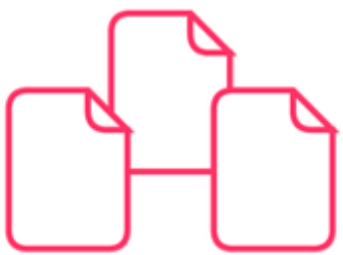
DataBases Models are the way to organize and store data in a database.

There are some common models:

- Hierarchical
- Network
- Relational
- Object-Oriented
- Document-Based
- Graph-Based
- ...

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Semi-Structured Data



Unstructured	Semi-structured	Structured
PDFs, JPEGs, MP3, Movies, ...	CSV, JSON, XML, MongoDB, ...	Oracle, MSSQL, MySQL, DB2, ...

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Relational Model

- The **relational model** is the most common and widely used model today.
- It is based on the concept of relations. A **relation** is a table with rows and columns.
- The relational model is based on the concept of **keys**, which leads to *strong relationships* in `structured data`.
- It also incorporates the concepts of integrity constraints and **normalization**.

Relational Model

- The **relational model** is the most common and widely used model today.
- It is based on the concept of relations. A **relation** is a table with rows and columns.
- The relational model is based on the concept of **keys**, which leads to *strong relationships* in `structured data`.
- It also incorporates the concepts of integrity constraints and **normalization**.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Relational Model

- The **relational model** is the most common and widely used model today.
- It is based on the concept of relations. A **relation** is a table with rows and columns.
- The relational model is based on the concept of **keys**, which leads to *strong relationships* in `structured data`.
- It also incorporates the concepts of integrity constraints and **normalization**.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Relational Model

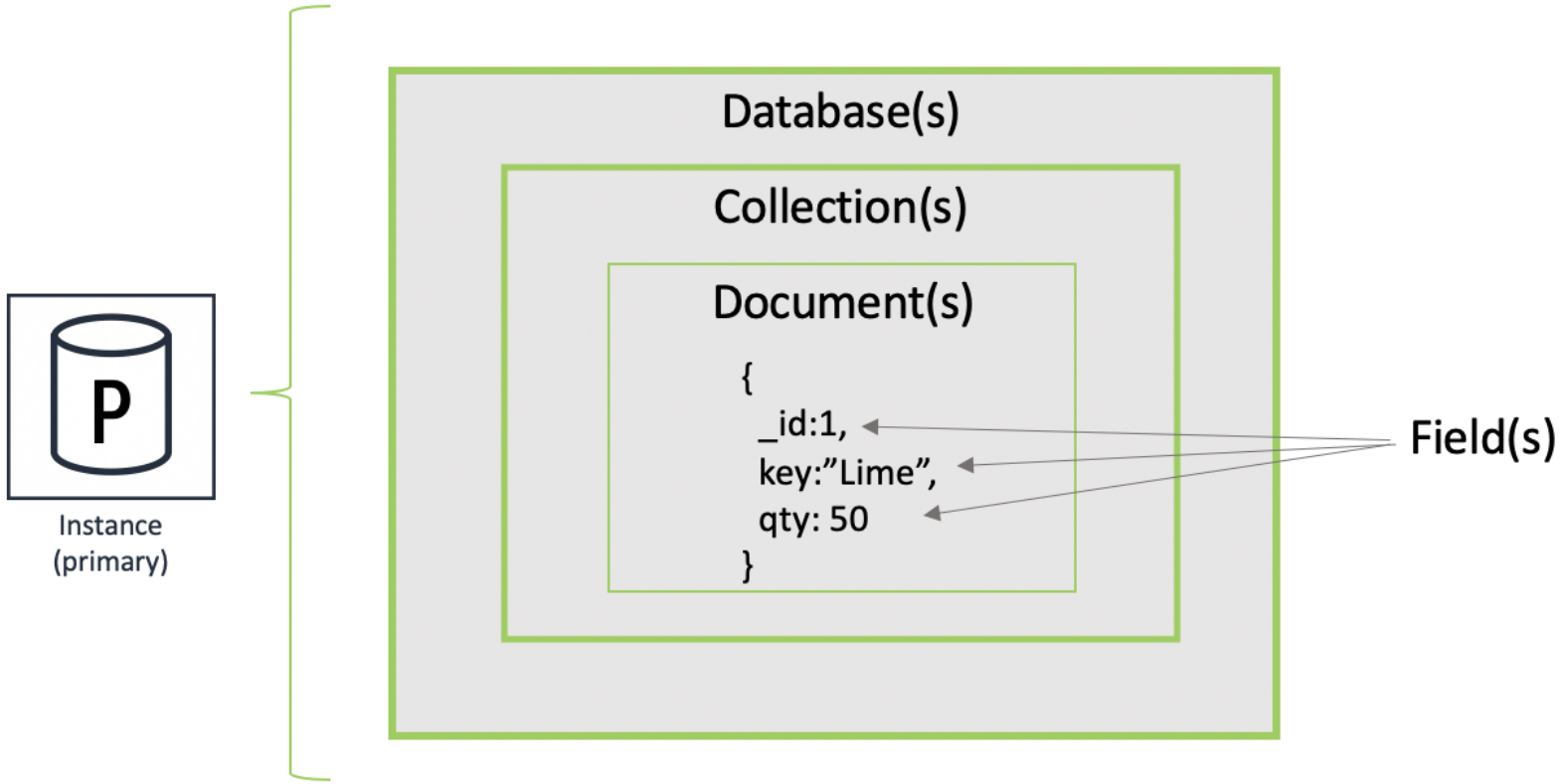
- The **relational model** is the most common and widely used model today.
- It is based on the concept of relations. A **relation** is a table with rows and columns.
- The relational model is based on the concept of **keys**, which leads to *strong relationships* in `structured data`.
- It also incorporates the concepts of integrity constraints and **normalization**.

Hierarchical Model

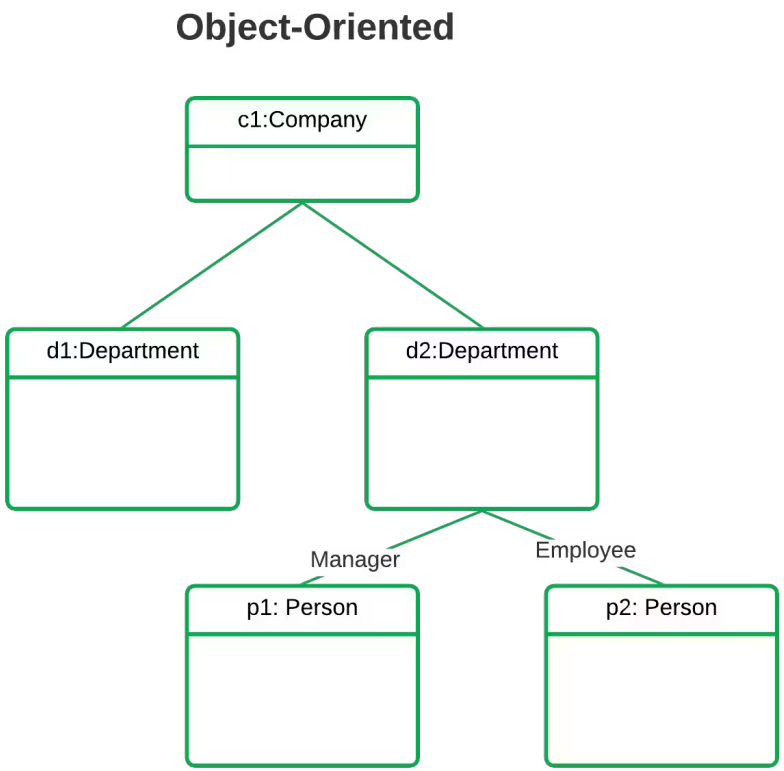
- The **hierarchical model** organizes data in a tree-like structure.
- It is based on the concept of parent-child relationships, meaning **one-to-many** relationships.
- An example of a hierarchical model is the `XML format`.

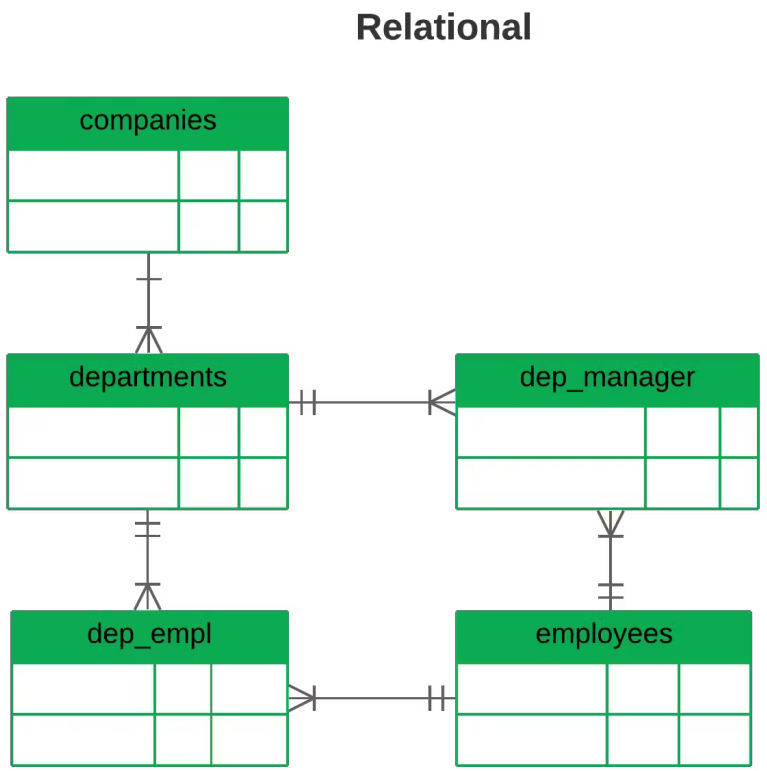
UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Document-Based Model

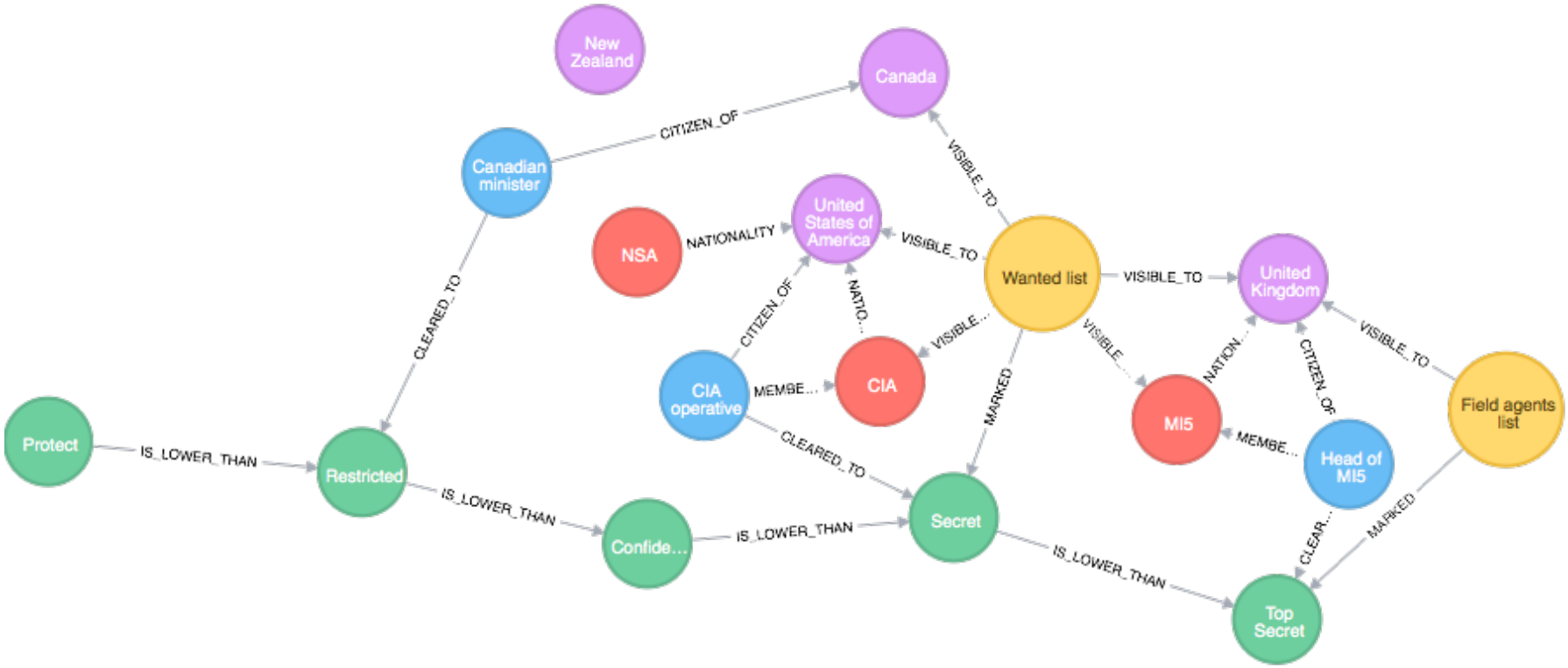


Object-Oriented Model

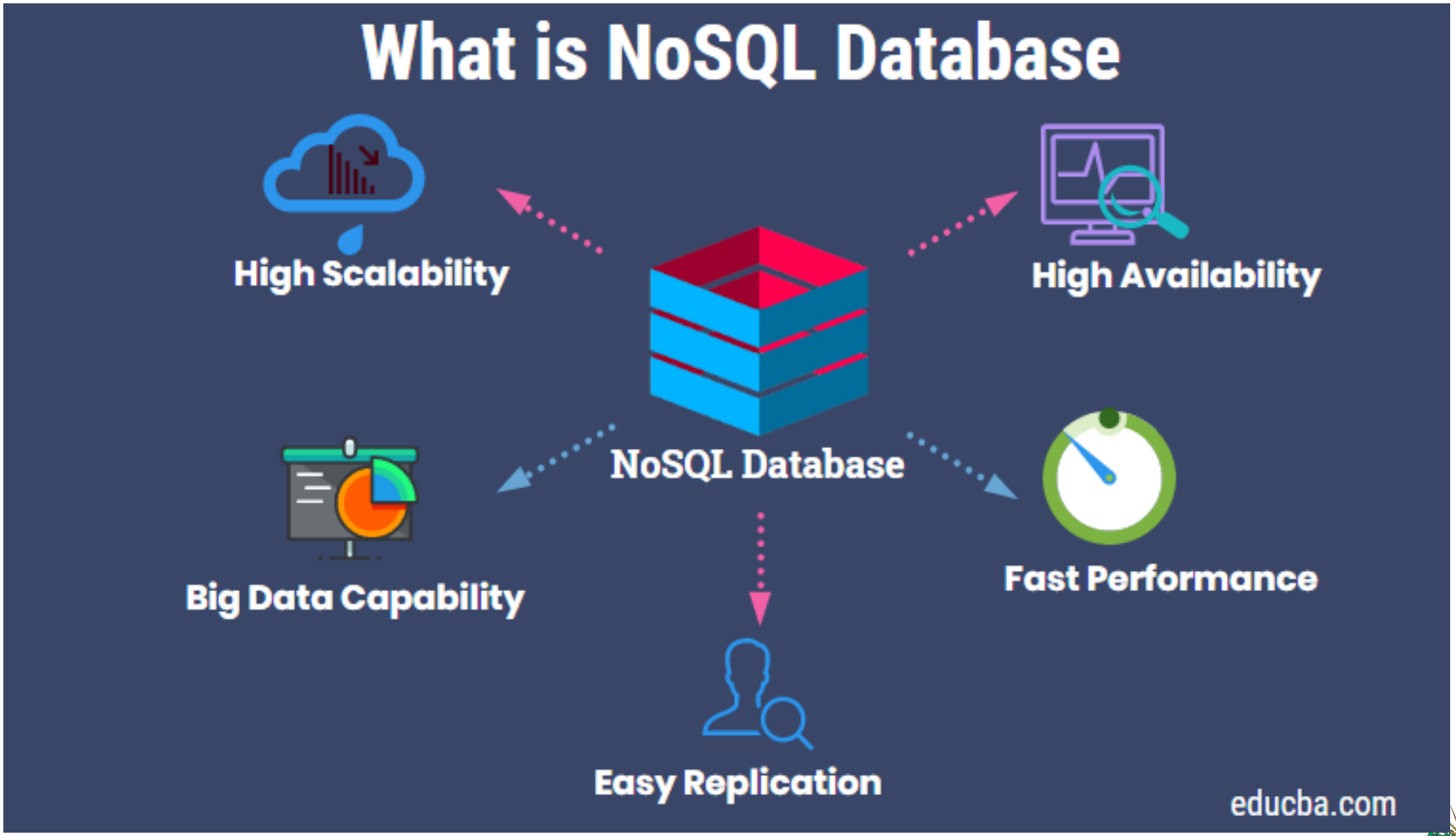




Graph-Based Model



NoSQL Model


What is NoSQL Database
High Scalability
High Availability
NoSQL Database
Big Data Capability
Fast Performance
Easy Replication
educba.com

Outline

1. Software Components and Applications
2. Glosary
3. DataBase Classification
4. Relational Database Design
5. Entity-Relation Model (MER)
6. DataBase Management Systems — DBMS
7. DataBases Infrastructure
8. DevOps
9. Data Engineering

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Database Design Foundations

- In the context of **databases**, designing a database is the process of producing a **detailed** data model.
- This **data model** encompasses all the required logical and physical design **decisions**, as well as physical storage parameters, to generate a design in a *data definition language* that can subsequently be used to create the database.
- A fully attributed data model contains detailed attributes for **each entity**.
- **Relational data models** avoid redundancy and inconsistency by ensuring that data is **normalized**.

Database Design Foundations

- In the context of **databases**, designing a database is the process of producing a **detailed** data model.
- This **data model** encompasses all the required logical and physical design **decisions**, as well as physical storage parameters, to generate a design in a *data definition language* that can subsequently be used to create the database.
- A fully attributed data model contains detailed attributes for **each entity**.
- **Relational data models** avoid redundancy and inconsistency by ensuring that data is **normalized**.

Database Design Foundations

- In the context of **databases**, designing a database is the process of producing a **detailed** data model.
- This **data model** encompasses all the required logical and physical design **decisions**, as well as physical storage parameters, to generate a design in a *data definition language* that can subsequently be used to create the database.
- A fully attributed data model contains detailed attributes for **each entity**.
- **Relational data models** avoid redundancy and inconsistency by ensuring that data is **normalized**.

Database Design Foundations

- In the context of **databases**, designing a database is the process of producing a **detailed** data model.
- This **data model** encompasses all the required logical and physical design **decisions**, as well as physical storage parameters, to generate a design in a *data definition language* that can subsequently be used to create the database.
- A fully attributed data model contains detailed attributes for **each entity**.
- **Relational data models** avoid redundancy and inconsistency by ensuring that data is **normalized**.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Set Theory in Databases

- The **set theory** is a branch of mathematical logic that studies sets, which are collections of objects.
- The **set theory** is applied in databases to define the relational model and the relational algebra.
- The **relational model** is a mathematical model of data for large shared data banks and it has a **solid theoretical foundation**.
- The **relational algebra** is a procedural query language, which takes relations as input and produces relations as output.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Set Theory in Databases

- The **set theory** is a branch of mathematical logic that studies sets, which are collections of objects.
- The **set theory** is applied in databases to define the relational model and the relational algebra.
- The **relational model** is a mathematical model of data for large shared data banks and it has a **solid theoretical foundation**.
- The **relational algebra** is a procedural query language, which takes relations as input and produces relations as output.

Normalization in Databases

- **Normalization** is the process of organizing the columns (attributes) and tables (relations) of a relational database to **minimize data redundancy**.
- **Normalization** involves decomposing a table into **smaller tables** and defining relationships between them.
- The objective is to **isolate data** so that additions, deletions, and modifications of a field can be made in just **one table** and then **propagated** through the rest of the database using the defined relationships.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Normalization in Databases

- **Normalization** is the process of organizing the columns (attributes) and tables (relations) of a relational database to **minimize data redundancy**.
- **Normalization** involves decomposing a table into **smaller tables** and defining relationships between them.
- The objective is to **isolate data** so that additions, deletions, and modifications of a field can be made in just **one table** and then **propagated** through the rest of the database using the defined relationships.

Normalization in Databases

- **Normalization** is the process of organizing the columns (attributes) and tables (relations) of a relational database to **minimize data redundancy**.
- **Normalization** involves decomposing a table into **smaller tables** and defining relationships between them.
- The objective is to **isolate data** so that additions, deletions, and modifications of a field can be made in just **one table** and then **propagated** through the rest of the database using the defined relationships.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

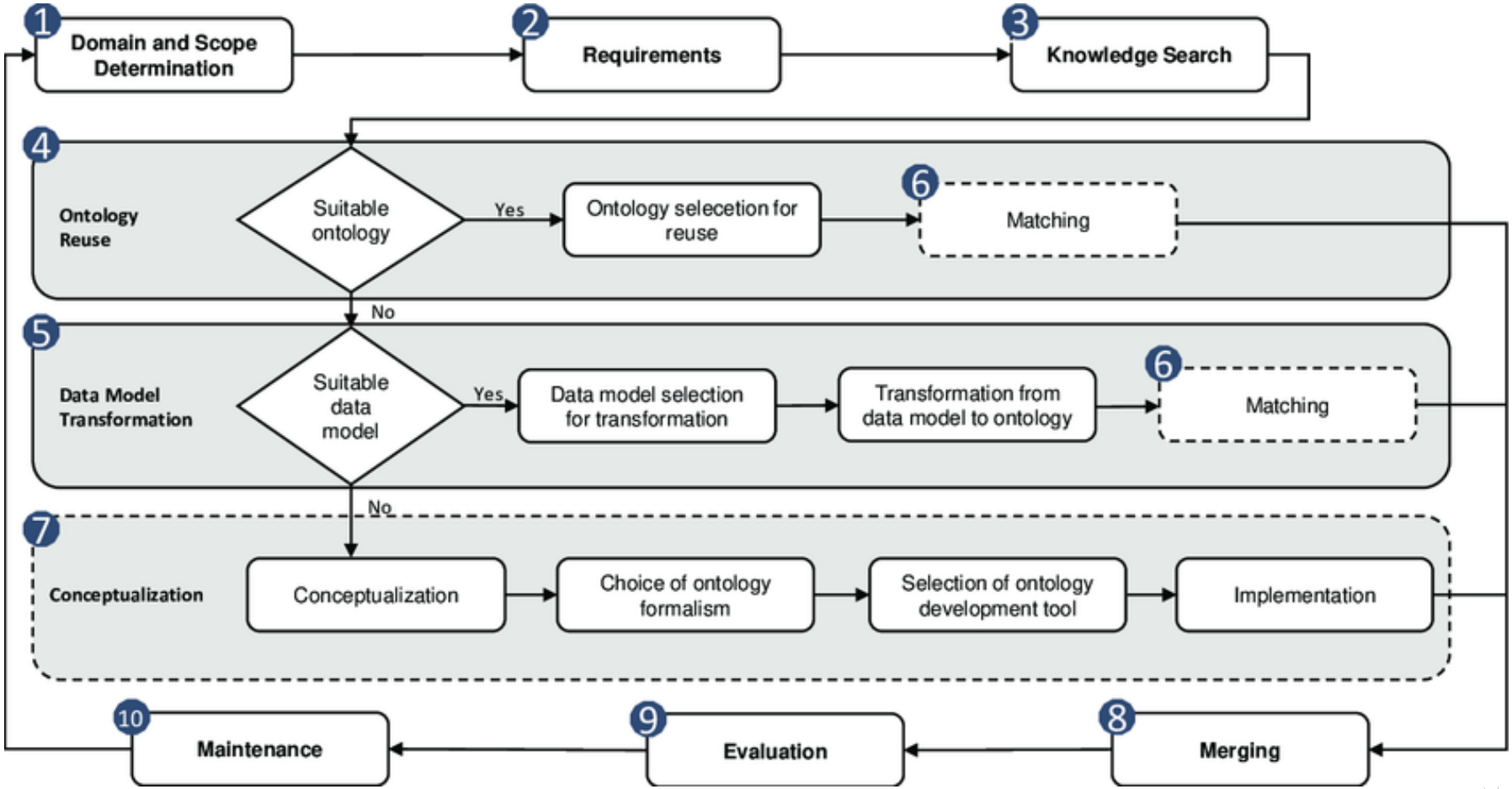
Normal Levels

1. **First normal form (1NF)**: The table is a two-dimensional table with rows and columns. Each column contains **atomic values**, and there are no repeating groups or arrays.
2. **Second normal form (2NF)**: The table is in first normal form and all the non-key attributes are fully functionally dependent on the primary key.
3. **Third normal form (3NF)**: The table is in second normal form and all the non-key attributes are non-transitively dependent on the primary key.
4. **Fourth normal form (4NF)**: The table is in third normal form and there are no multi-valued dependencies.

Ontologies

- An **ontology** is a formal naming and definition of the types, properties, and interrelationships of the **entities** that really or fundamentally exist for a particular domain of discourse.
- **Ontologies** are used in databases to define the schema of the database.
- The **schema** of a database is a formal definition of the structure of the database: the `types of data` that are stored, the `relationships` between the data, and the `constraints` on the data.

Ontology Workflow



Outline

1. Software Components and Applications
2. Glosary
3. DataBase Classification
4. Relational Database Design
5. Entity-Relation Model (MER)
6. DataBase Management Systems — DBMS
7. DataBases Infrastructure
8. DevOps
9. Data Engineering

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Definitions

- **Entity**: A thing or object in the real world that is distinguishable from other objects.
- **Attribute**: A property or characteristic of an entity.
- **Relationship**: An association between entities.
- **Cardinality**: The number of instances of an entity that can be associated with another entity.
- **Degree**: The number of entities that participate in a relationship.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Definitions

- **Entity**: A thing or object in the real world that is distinguishable from other objects.
- **Attribute**: A property or characteristic of an entity.
- **Relationship**: An association between entities.
- **Cardinality**: The number of instances of an entity that can be associated with another entity.
- **Degree**: The number of entities that participate in a relationship.

Definitions

- **Entity**: A thing or object in the real world that is distinguishable from other objects.
- **Attribute**: A property or characteristic of an entity.
- **Relationship**: An association between entities.
- **Cardinality**: The number of instances of an entity that can be associated with another entity.
- **Degree**: The number of entities that participate in a relationship.

Definitions

- **Entity**: A thing or object in the real world that is distinguishable from other objects.
- **Attribute**: A property or characteristic of an entity.
- **Relationship**: An association between entities.
- **Cardinality**: The number of instances of an entity that can be associated with another entity.
- **Degree**: The number of entities that participate in a relationship.

Definitions

- **Entity**: A thing or object in the real world that is distinguishable from other objects.
- **Attribute**: A property or characteristic of an entity.
- **Relationship**: An association between entities.
- **Cardinality**: The number of instances of an entity that can be associated with another entity.
- **Degree**: The number of entities that participate in a relationship.

Entity-Relation Model

- The **Entity-Relation Model** is a graphical representation of the entities and their relationships in a database.
- The **Entity-Relation Model** is used to design the schema of a database and to communicate the design to stakeholders.
- Following a process based on a **ontology** it is easy to define the entities, attributes, and relationships of the database.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Entity-Relation Model

- The **Entity-Relation Model** is a graphical representation of the entities and their relationships in a database.
- The **Entity-Relation Model** is used to design the schema of a database and to communicate the design to stakeholders.
- Following a process based on a **ontology** it is easy to define the entities, attributes, and relationships of the database.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Entity-Relation Model

- The **Entity-Relation Model** is a graphical representation of the entities and their relationships in a database.
- The **Entity-Relation Model** is used to design the schema of a database and to communicate the design to stakeholders.
- Following a process based on a **ontology** it is easy to define the entities, attributes, and relationships of the database.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Step 1. Define Components

Step 2. Define Entities

Step 3. Define Attributes per Entity

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Step 4. Define Relationships

Step 5. Define Relationships Types

Step 6. First Entity-Relationship Model Draw

Step 7. Split Many-to-Many Relationships

Step 8. Second Entity-Relationship Model Draw

Step 9. Get Data-Structure Entity-Relationship Model

Step 10. Define Constraints and Properties of Data

Outline

1. Software Components and Applications
2. Glosary
3. DataBase Classification
4. Relational Database Design
5. Entity-Relation Model (MER)
6. DataBase Management Systems — DBMS
7. DataBases Infrastructure
8. DevOps
9. Data Engineering

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

What is a DBMS?

- A **Database Management System** (DBMS) is a software system that uses a standard method to store and organize data.
- A **DBMS** is a software system that allows users to define, create, maintain, and control access to the database.
- A **DBMS** is a software package designed to manipulate, retrieve, and manage data in a database.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

What is a DBMS?

- A **Database Management System** (DBMS) is a software system that uses a standard method to store and organize data.
- A **DBMS** is a software system that allows users to define, create, maintain, and control access to the database.
- A **DBMS** is a software package designed to manipulate, retrieve, and manage data in a database.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

What is a DBMS?

- A **Database Management System** (DBMS) is a software system that uses a standard method to store and organize data.
- A **DBMS** is a software system that allows users to define, create, maintain, and control access to the database.
- A **DBMS** is a software package designed to manipulate, retrieve, and manage data in a database.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Pros & Cons of DBMS

- **Pros**:
  - **Data Independence**: Data is stored independently of the applications that use it.
  - **Data Integrity**: Data is consistent and accurate.
  - **Data Security**: Data is protected from unauthorized access.
  - **Data Recovery**: Data can be recovered in case of failure.
- **Cons**:
  - **Complexity**: DBMS are complex systems.
  - **Cost**: DBMS are expensive for bigger data volumes.
  - **Performance**: DBMS can be slow.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Pros & Cons of DBMS

- **Pros**:
  - **Data Independence**: Data is stored independently of the applications that use it.
  - **Data Integrity**: Data is consistent and accurate.
  - **Data Security**: Data is protected from unauthorized access.
  - **Data Recovery**: Data can be recovered in case of failure.
- **Cons**:
  - **Complexity**: DBMS are complex systems.
  - **Cost**: DBMS are expensive for bigger data volumes.
  - **Performance**: DBMS can be slow.

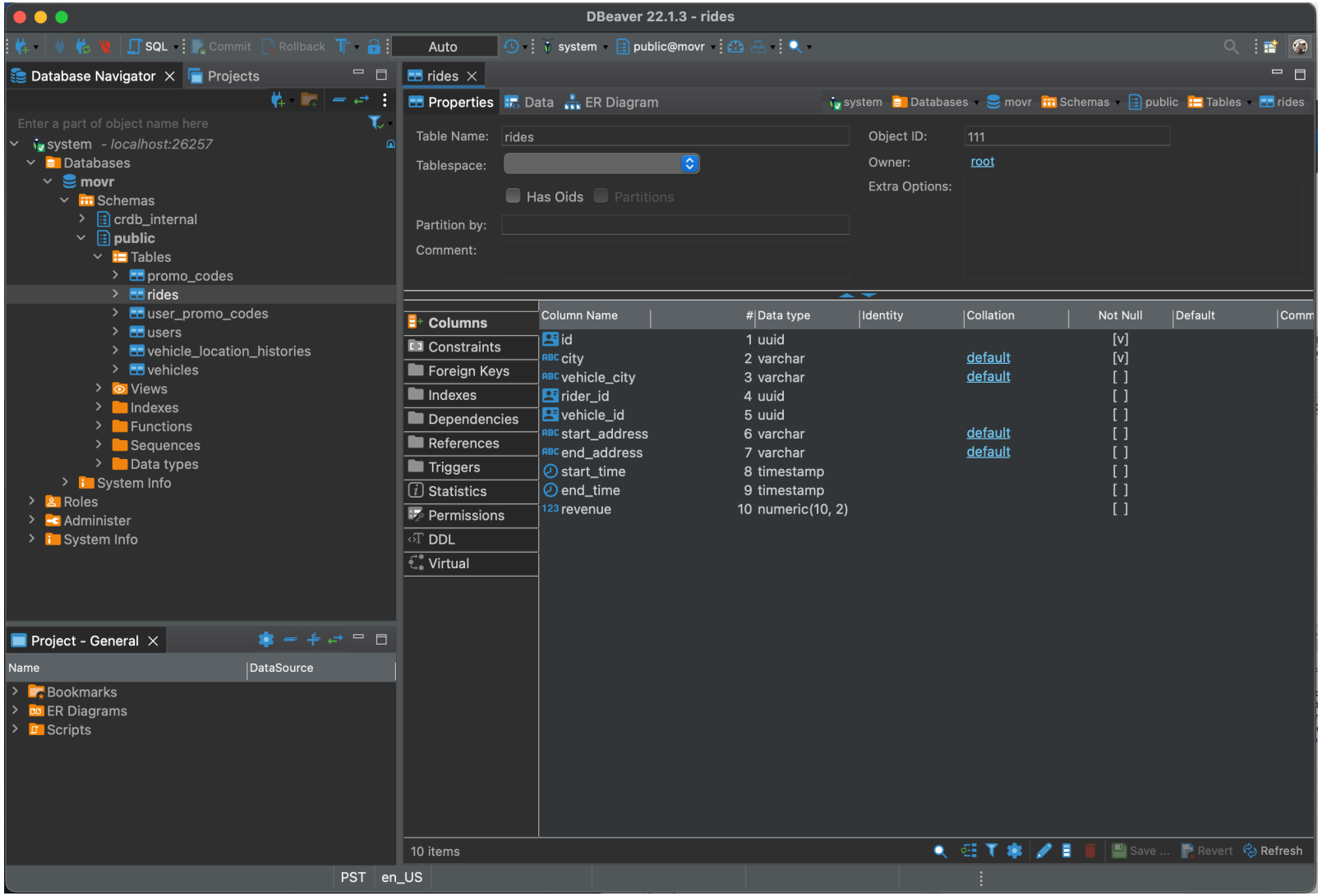
UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

GUI Assistants

- A **Graphical User Interface** (`GUI`) is a type of user interface that allows users to interact with electronic devices using graphical icons and visual indicators.
- `GUIs` are easier to use than `Command Line Interfaces` (CLI) because they allow users to interact with the system using visual elements such as windows, buttons, and menus.
- `GUIs` are more intuitive and user-friendly than `CLIs`, which makes them ideal for users who are not familiar with the system.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Case of Study: DBeaver



Command Line

- A **Command Line Interface** (`CLI`) is a type of user interface that allows users to interact with electronic devices using text-based commands.
- `CLIs` are more powerful and flexible than `GUIs` because they allow users to perform complex tasks using simple commands.
- `CLIs` are more efficient than `GUIs` because they do not require users to navigate through menus and windows to perform tasks.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Case of Study: MariaDB CLI

```
arnel@arnel.com [~]# mysql -u arnel_test2 -p
Enter password:
Welcome to the MariaDB monitor.  Commands end with ; or \g.
Your MariaDB connection id is 8643
Server version: 10.1.25-MariaDB MariaDB Server

Copyright (c) 2000, 2017, Oracle, MariaDB Corporation Ab and others.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.

MariaDB [(none)]> show databases;
+--------------------+
| Database           |
+--------------------+
| arnel_test1        |
| arnel_test2        |
| information_schema |
+--------------------+
3 rows in set (0.00 sec)

MariaDB [(none)]> use arnel_test1
Reading table information for completion of table and column names
You can turn off this feature to get a quicker startup with -A

Database changed
MariaDB [arnel_test1]>
```

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Why use an agnostic tool?

- An **agnostic tool** is a tool that is not tied to a specific technology or platform.
- **Agnostic tools** are useful because they allow users to work with multiple databases without having to learn different tools.
- **Agnostic tools** are also useful because they allow users to work with multiple databases without having to switch between different tools.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Outline

1. Software Components and Applications
2. Glosary
3. DataBase Classification
4. Relational Database Design
5. Entity-Relation Model (MER)
6. DataBase Management Systems — DBMS
7. DataBases Infrastructure
8. DevOps
9. Data Engineering

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

What is the Cloud Computing?

- **Cloud computing** is the delivery of computing services over the internet.
- **Cloud computing** allows users to access computing resources such as servers, storage, and databases **on demand**.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

What is the Cloud Computing?

- **Cloud computing** is the delivery of computing services over the internet.
- **Cloud computing** allows users to access computing resources such as servers, storage, and databases **on demand**.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

What is On-Premises Computing?

- **On-premises computing** is the traditional way of accessing computing resources.
- **On-premises computing** requires users to purchase and maintain their own computing resources such as servers, storage, and databases.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

What is On-Premises Computing?

- **On-premises computing** is the traditional way of accessing computing resources.
- **On-premises computing** requires users to purchase and maintain their own computing resources such as servers, storage, and databases.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Pros & Cons of Cloud Computing

- **Pros**:
  - **Cost-Effective**: Cloud computing is a cost-effective way to access computing resources.
  - **Scalable**: Cloud computing is a scalable way to access computing resources.
  - **Flexible**: Cloud computing is a flexible way to access computing resources.
- **Cons**:
  - **Security**: Cloud computing can be less secure than on-premises computing.
  - **Performance**: Cloud computing can be slower than on-premises computing.
  - **Reliability**: Cloud computing can be less reliable than on-premises computing.

Pros & Cons of Cloud Computing

- **Pros**:
  - **Cost-Effective**: Cloud computing is a cost-effective way to access computing resources.
  - **Scalable**: Cloud computing is a scalable way to access computing resources.
  - **Flexible**: Cloud computing is a flexible way to access computing resources.
- **Cons**:
  - **Security**: Cloud computing can be less secure than on-premises computing.
  - **Performance**: Cloud computing can be slower than on-premises computing.
  - **Reliability**: Cloud computing can be less reliable than on-premises computing.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Pros & Cons of Cloud Computing

- **Pros**:
  - **Cost-Effective**: Cloud computing is a cost-effective way to access computing resources.
  - **Scalable**: Cloud computing is a scalable way to access computing resources.
  - **Flexible**: Cloud computing is a flexible way to access computing resources.
- **Cons**:
  - **Security**: Cloud computing can be less secure than on-premises computing.
  - **Performance**: Cloud computing can be slower than on-premises computing.
  - **Reliability**: Cloud computing can be less reliable than on-premises computing.

Pros & Cons of Cloud Computing

- **Pros**:
  - **Cost-Effective**: Cloud computing is a cost-effective way to access computing resources.
  - **Scalable**: Cloud computing is a scalable way to access computing resources.
  - **Flexible**: Cloud computing is a flexible way to access computing resources.
- **Cons**:
  - **Security**: Cloud computing can be less secure than on-premises computing.
  - **Performance**: Cloud computing can be slower than on-premises computing.
  - **Reliability**: Cloud computing can be less reliable than on-premises computing.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Pros & Cons of Cloud Computing

- **Pros**:
  - **Cost-Effective**: Cloud computing is a cost-effective way to access computing resources.
  - **Scalable**: Cloud computing is a scalable way to access computing resources.
  - **Flexible**: Cloud computing is a flexible way to access computing resources.
- **Cons**:
  - **Security**: Cloud computing can be less secure than on-premises computing.
  - **Performance**: Cloud computing can be slower than on-premises computing.
  - **Reliability**: Cloud computing can be less reliable than on-premises computing.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Pros & Cons of Cloud Computing

- **Pros**:
  - **Cost-Effective**: Cloud computing is a cost-effective way to access computing resources.
  - **Scalable**: Cloud computing is a scalable way to access computing resources.
  - **Flexible**: Cloud computing is a flexible way to access computing resources.
- **Cons**:
  - **Security**: Cloud computing can be less secure than on-premises computing.
  - **Performance**: Cloud computing can be slower than on-premises computing.
  - **Reliability**: Cloud computing can be less reliable than on-premises computing.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

SaaS Vs. IaaS Vs. PaaS

- **Software as a Service** (*SaaS*) is a software distribution model in which a third-party provider hosts applications and makes them available to customers over the internet.
- **Infrastructure as a Service** (*IaaS*) is a cloud computing model that provides virtualized computing resources over the internet.
- **Platform as a Service** (*PaaS*) is a cloud computing model that provides a platform for developers to build, deploy, and manage applications over the internet.

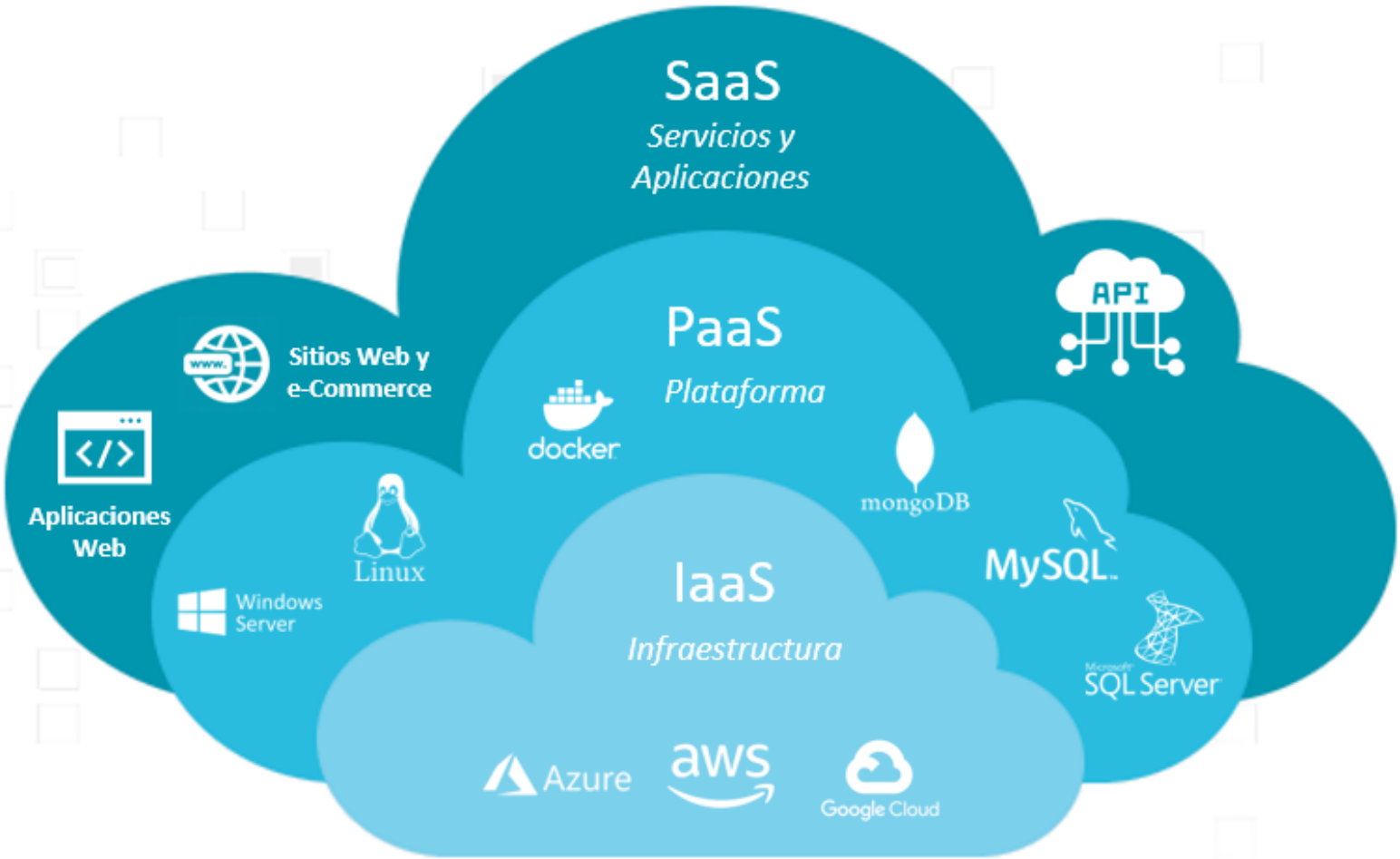
SaaS Vs. IaaS Vs. PaaS

- **Software as a Service** (*SaaS*) is a software distribution model in which a third-party provider hosts applications and makes them available to customers over the internet.
- **Infrastructure as a Service** (*IaaS*) is a cloud computing model that provides virtualized computing resources over the internet.
- **Platform as a Service** (*PaaS*) is a cloud computing model that provides a platform for developers to build, deploy, and manage applications over the internet.

SaaS Vs. IaaS Vs. PaaS

- **Software as a Service** (*SaaS*) is a software distribution model in which a third-party provider hosts applications and makes them available to customers over the internet.
- **Infrastructure as a Service** (*IaaS*) is a cloud computing model that provides virtualized computing resources over the internet.
- **Platform as a Service** (*PaaS*) is a cloud computing model that provides a platform for developers to build, deploy, and manage applications over the internet.

Cloud Levels

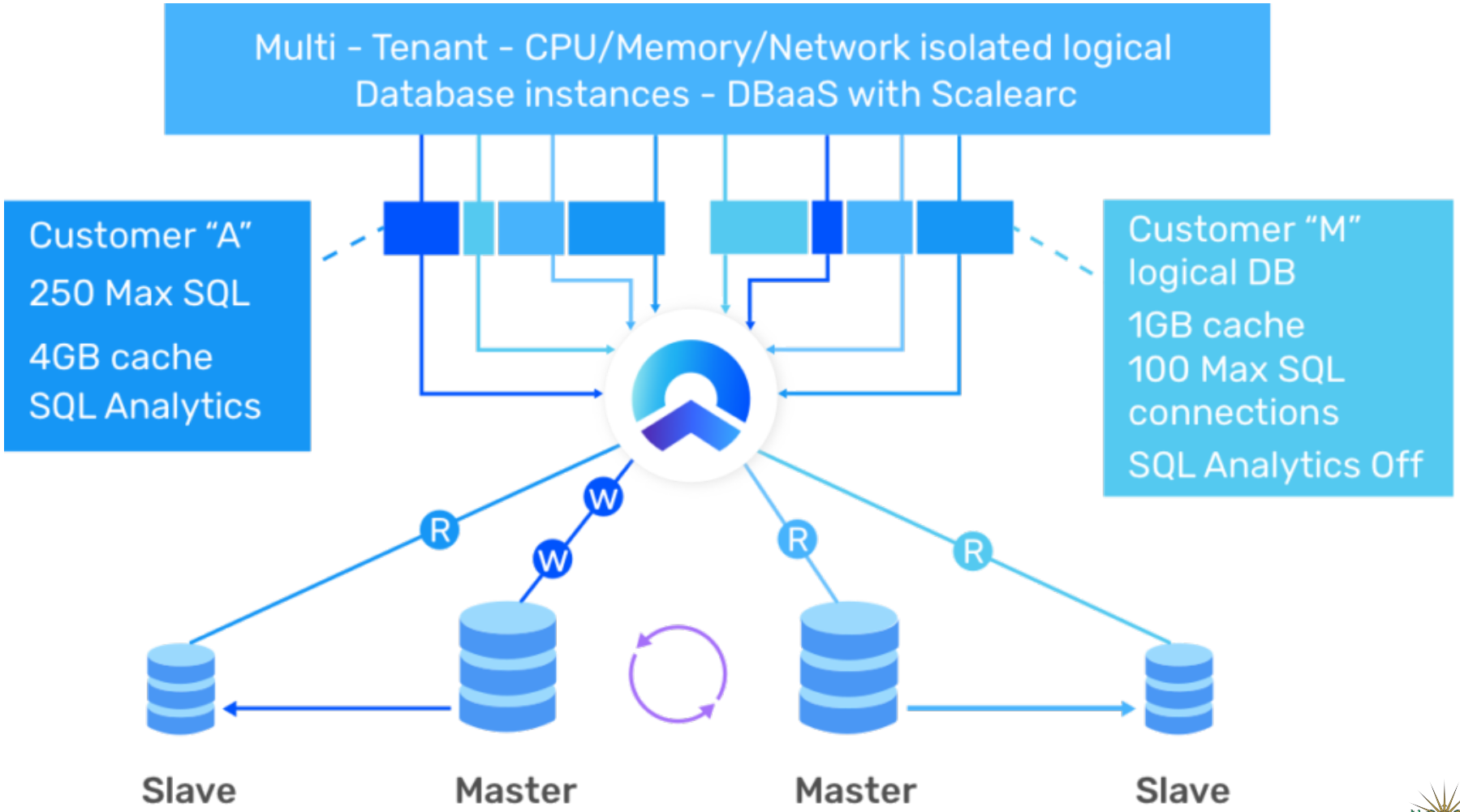


DataBases as a Service

Database as a Service (DBaaS) is a cloud computing model that provides database services over the internet.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Case of Study: DBaaS Custom for Clients



Localhost

- **Localhost** is a hostname that refers to the local computer that a program is running on.
- **Localhost** is used to access the services that are running on the local computer.
- **Localhost** is used to access the database services that are running on the local computer.
- **Localhost** is used to access the web services that are running on the local computer.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Localhost

- **Localhost** is a hostname that refers to the local computer that a program is running on.
- **Localhost** is used to access the services that are running on the local computer.
- **Localhost** is used to access the database services that are running on the local computer.
- **Localhost** is used to access the web services that are running on the local computer.

Localhost

- **Localhost** is a hostname that refers to the local computer that a program is running on.
- **Localhost** is used to access the services that are running on the local computer.
- **Localhost** is used to access the database services that are running on the local computer.
- **Localhost** is used to access the web services that are running on the local computer.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Monolithic Architecture

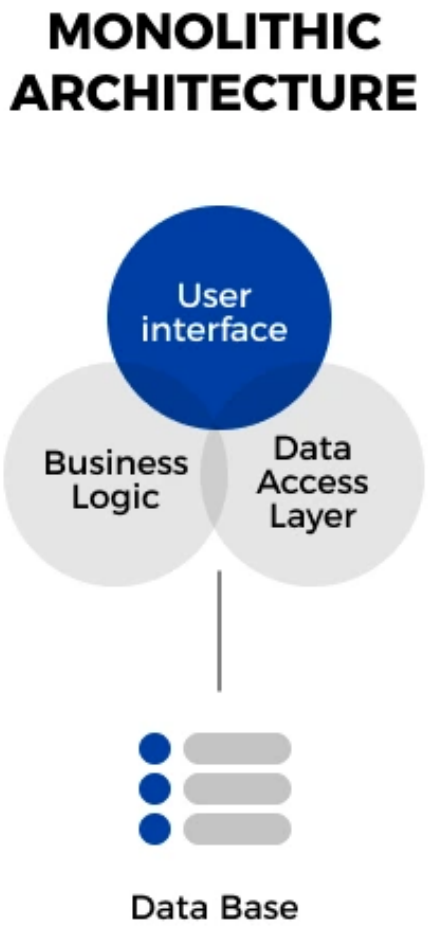
- **Monolithic Architecture** is a software architecture in which all the components of the software are combined into a single program.
- **Monolithic Architecture** is a traditional software architecture that was used to build large and complex software systems.
- **Monolithic Architecture** is a simple and easy-to-understand software architecture that is used to build software systems that do not require high scalability and flexibility.

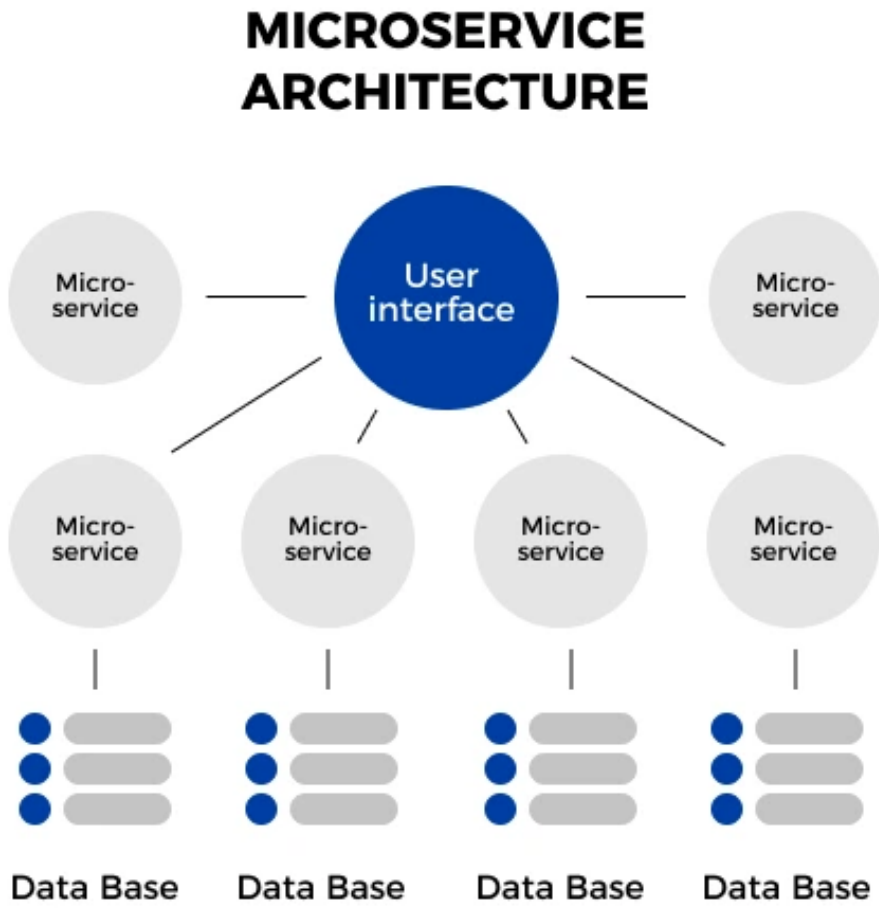
UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Microservices Architecture

- **Microservices Architecture** is a software architecture in which the components of the software are broken down into small, independent services.
- **Microservices Architecture** is a modern software architecture that is used to build large and complex software systems.
- **Microservices Architecture** is a flexible and scalable software architecture that is used to build software systems that require high scalability and flexibility.

Monolithic Architecture Schema





Outline

1. Software Components and Applications
2. Glosary
3. DataBase Classification
4. Relational Database Design
5. Entity-Relation Model (MER)
6. DataBase Management Systems — DBMS
7. DataBases Infrastructure
8. DevOps
9. Data Engineering

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Continuous Integration

- **Continuous Integration** is a software development practice in which developers integrate code into a shared repository frequently.
- **Continuous Integration** is a software development practice that helps developers to detect and fix integration errors early.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Continuous Integration

- **Continuous Integration** is a software development practice in which developers integrate code into a shared repository frequently.
- **Continuous Integration** is a software development practice that helps developers to detect and fix integration errors early.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Continuous Deployment

- Developers deploy code into production frequently.
- **Continuous Deployment** is a software development practice that helps developers deliver new features to customers quickly.
- **Continuous Deployment** is also a practice that helps developers improve the quality of the software.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Continuous Deployment

- Developers deploy code into production frequently.
- **Continuous Deployment** is a software development practice that helps developers deliver new features to customers quickly.
- **Continuous Deployment** is also a practice that helps developers improve the quality of the software.

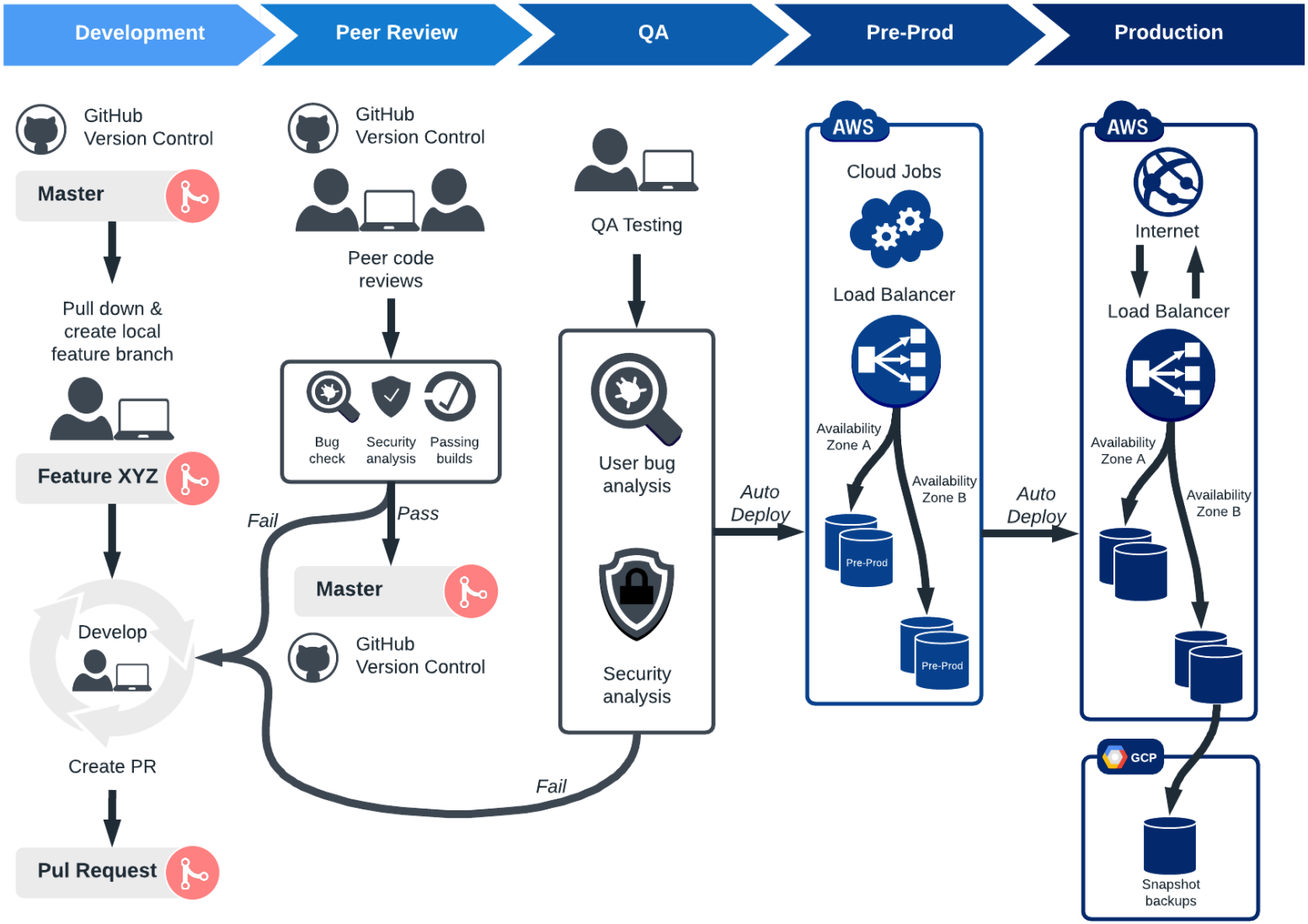
UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Continuous Deployment

- Developers deploy code into production frequently.
- **Continuous Deployment** is a software development practice that helps developers deliver new features to customers quickly.
- **Continuous Deployment** is also a practice that helps developers improve the quality of the software.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Development Workflow using CI/CD



Containers and Docker

- **Containers** are a lightweight and portable way to package software.
- **Containers** are a method to isolate applications from the underlying system.
- **Docker** is a platform that allows developers to build, ship, and run containers.

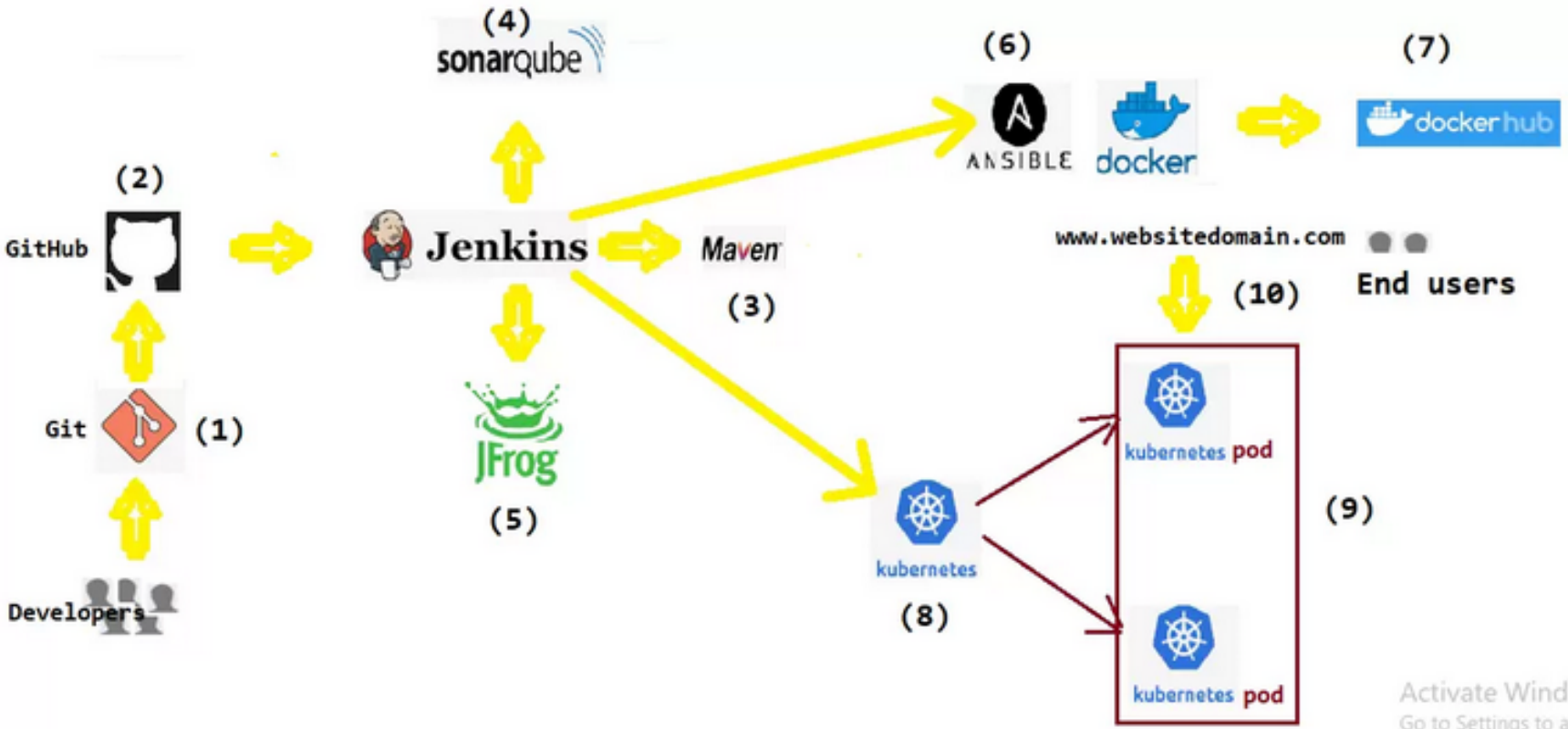
UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Containers and Docker

- **Containers** are a lightweight and portable way to package software.
- **Containers** are a method to isolate applications from the underlying system.
- **Docker** is a platform that allows developers to build, ship, and run containers.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

From Code to Docker



Outline

1. Software Components and Applications
2. Glosary
3. DataBase Classification
4. Relational Database Design
5. Entity-Relation Model (MER)
6. DataBase Management Systems — DBMS
7. DataBases Infrastructure
8. DevOps
9. Data Engineering

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

What is Data Engineering?

- **Data Engineering** is the aspect of data science that focuses on practical applications of data collection and analysis.
- **Data Engineers** are responsible for building and maintaining the architecture that allows data scientists to perform their work.
- **Data Engineering** is a set of operations aimed at creating interfaces and mechanisms for the flow and access of data.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

What is Data Engineering?

- **Data Engineering** is the aspect of data science that focuses on practical applications of data collection and analysis.
- **Data Engineers** are responsible for building and maintaining the architecture that allows data scientists to perform their work.
- **Data Engineering** is a set of operations aimed at creating interfaces and mechanisms for the flow and access of data.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

What is Data Engineering?

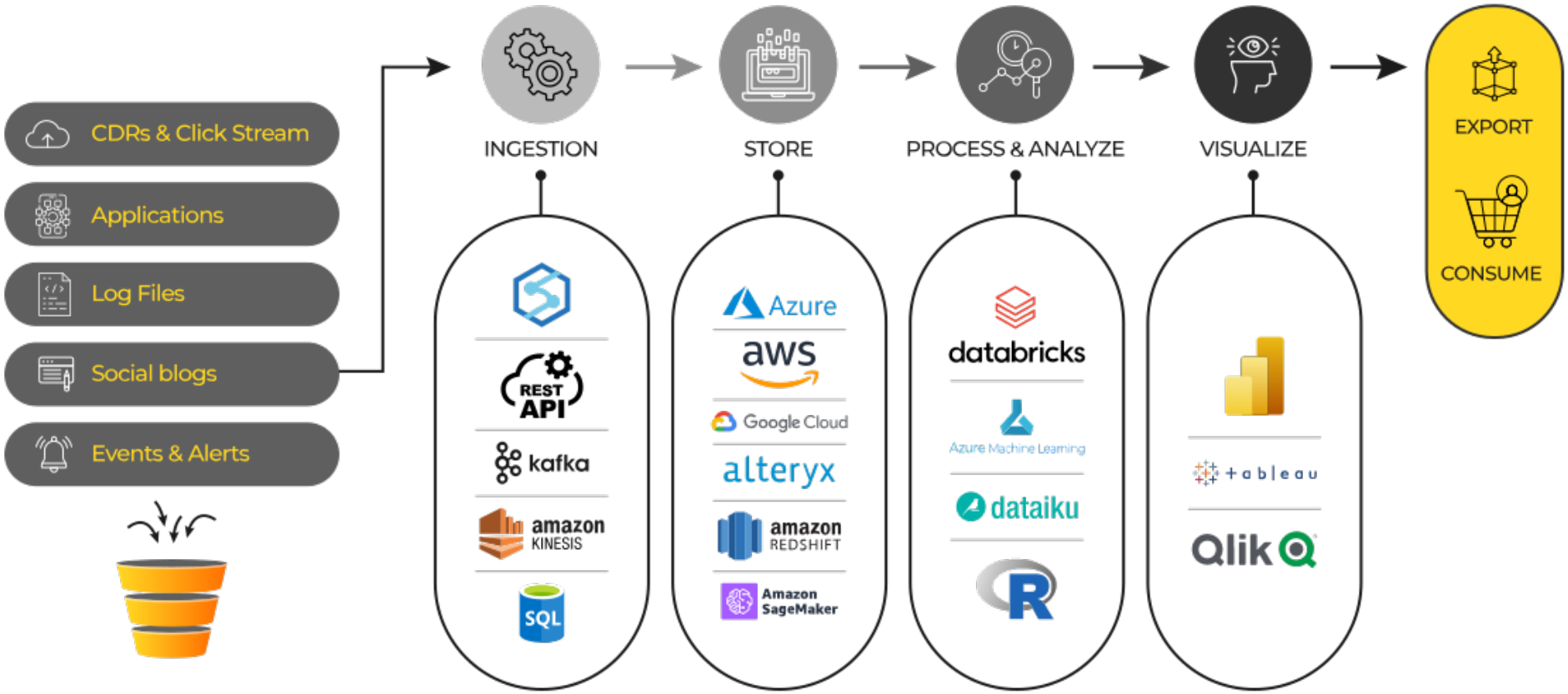
- **Data Engineering** is the aspect of data science that focuses on practical applications of data collection and analysis.
- **Data Engineers** are responsible for building and maintaining the architecture that allows data scientists to perform their work.
- **Data Engineering** is a set of operations aimed at creating interfaces and mechanisms for the flow and access of data.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

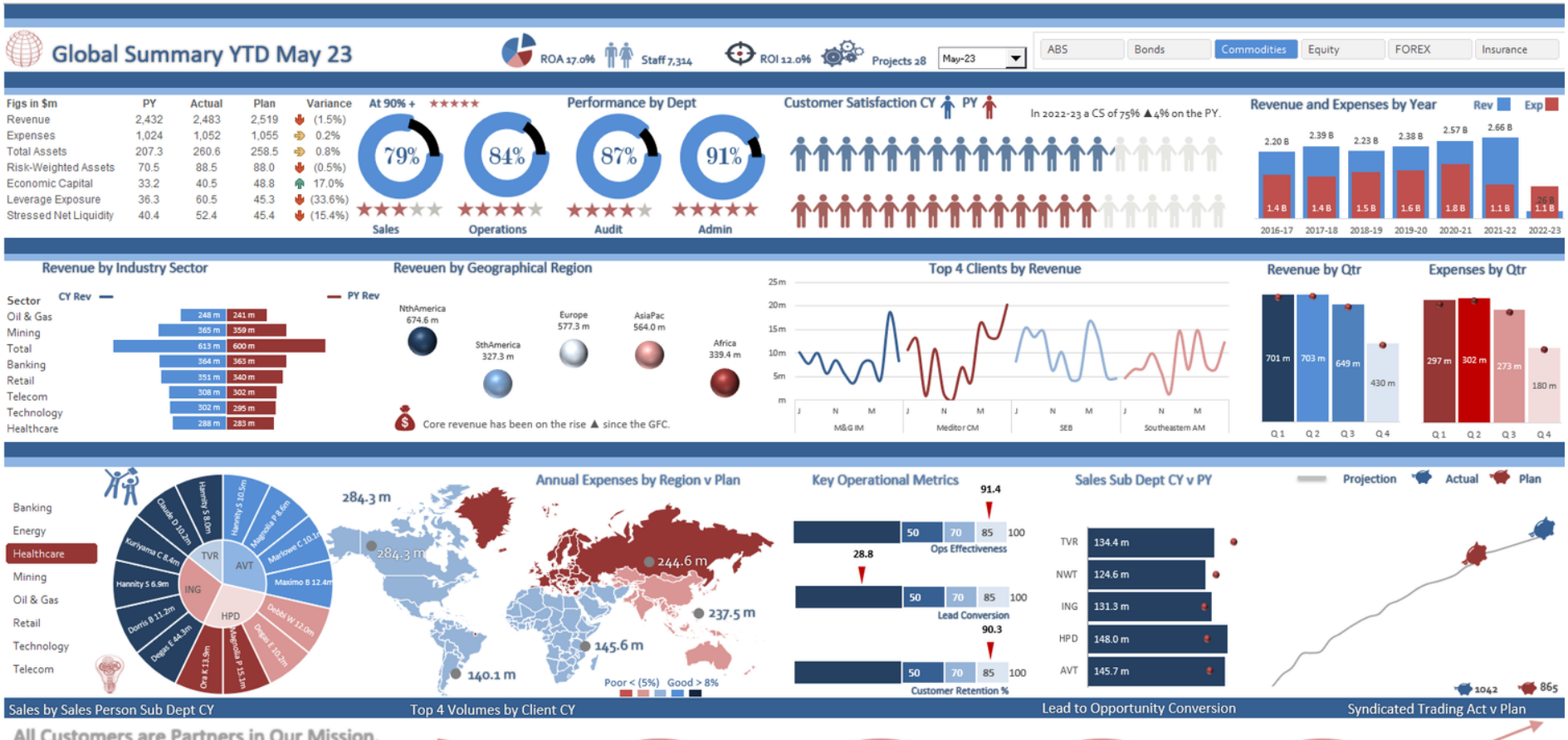
Why is important Data Engineering?

- **Data Engineering** is the foundation of the high-quality data that is necessary for effective data science.
- **Data Engineering** is the process of collecting, transforming, and storing data in a way that's accessible and easy to analyze.

Data Engineering Architecture



Case of Study: Dashboards



Data Science

- **Data Science** is the process of extracting knowledge from data.
- **Data Science** is the process of analyzing and interpreting complex digital data.
- **Data Science** is the process of creating models that can predict future outcomes.
- **Data Science** is the process of creating visualizations to help understand data.

Data Science

- **Data Science** is the process of extracting knowledge from data.
- **Data Science** is the process of analyzing and interpreting complex digital data.
- **Data Science** is the process of creating models that can predict future outcomes.
- **Data Science** is the process of creating visualizations to help understand data.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

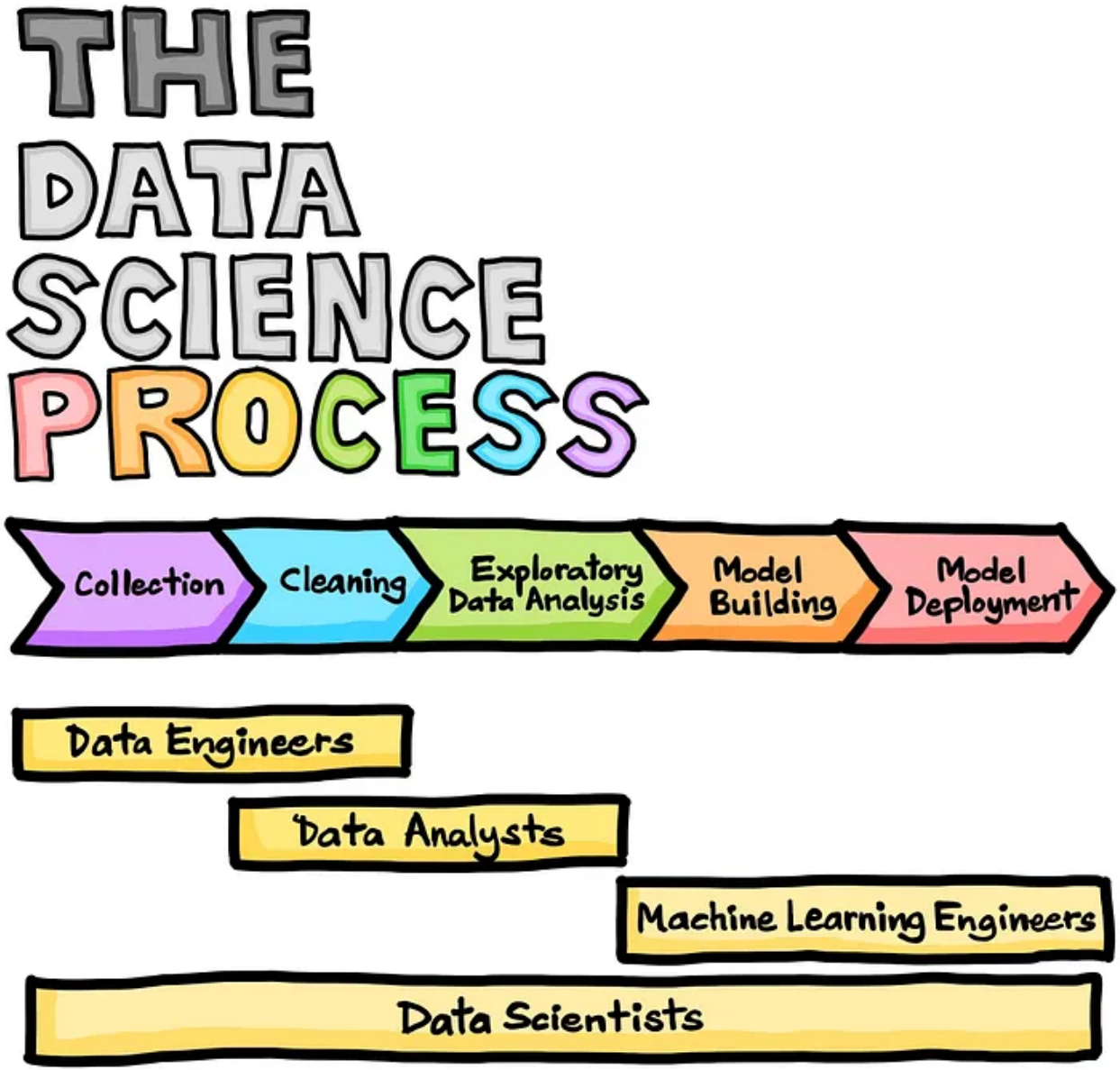
Data Science

- **Data Science** is the process of extracting knowledge from data.
- **Data Science** is the process of analyzing and interpreting complex digital data.
- **Data Science** is the process of creating models that can predict future outcomes.
- **Data Science** is the process of creating visualizations to help understand data.

Data Science

- **Data Science** is the process of extracting knowledge from data.
- **Data Science** is the process of analyzing and interpreting complex digital data.
- **Data Science** is the process of creating models that can predict future outcomes.
- **Data Science** is the process of creating visualizations to help understand data.

Data Science Workflow



DBOps vs Data Engineer

- **DBOps** is responsible for the operation of the database.
- **DBOps** is responsible for the performance of the database.
- **DBOps** is responsible for the security of the database.
- **Data Engineer** is responsible for the data architecture.
- **Data Engineer** is responsible for the data quality.
- **Data Engineer** is responsible for the data flow.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

DBOps vs Data Engineer

- **DBOps** is responsible for the operation of the database.
- **DBOps** is responsible for the performance of the database.
- **DBOps** is responsible for the security of the database.
- **Data Engineer** is responsible for the data architecture.
- **Data Engineer** is responsible for the data quality.
- **Data Engineer** is responsible for the data flow.

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

How to improve data quality?

- **Data Quality** is the process of ensuring that data is accurate, complete, and reliable.
- **Data Quality** is the process of ensuring that data is consistent and up-to-date.
- **Data Quality** is the process of ensuring that data is free from errors and inconsistencies.
- **Data Quality** is the process of ensuring that data is of high quality and can be trusted.
- **Data Quality** is the process of ensuring that data is fit for purpose and can be used effectively.

Outline

1. Software Components and Applications
2. Glosary
3. DataBase Classification
4. Relational Database Design
5. Entity-Relation Model (MER)
6. DataBase Management Systems — DBMS
7. DataBases Infrastructure
8. DevOps
9. Data Engineering

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS

Thanks!

Questions?

Repo: `https://github.com/EngAndres/ud-public/tree/main/courses/databases-ii`

UNIVERSIDAD DISTRITAL
FRANCISCO JOSÉ DE CALDAS