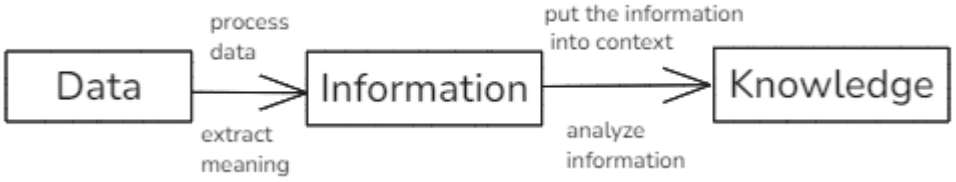
IS Course 2 - Components of Information Systems - Databases, Network, People

1- Data, Information, and Knowledge

- **Data**:
  - Data is the raw material of information systems.
  - Data can be quantitative or qualitative.
  - Data is raw facts, without context or purpose.
  - Example: A computer sales order. A spreadsheet.
- **Information**
  - Information is obtained by processing data to extract meaning.
  - Processed data that has context, relevance, and purpose.
  - Example: Monthly sales calculated from daily sales data collected over the previous year.
- **Knowledge**:
  - Human beliefs or perceptions about the relationships between facts or concepts relevant to a given domain.
  - Knowledge is obtained by contextualizing and analyzing information.
  - Knowledge can be explicit (easy to communicate) or tacit (difficult to communicate).
  - Knowledge is essential for making informed decisions and solving problems.
  - Example: the conceived relationship between product quality and sales.



2- Databases

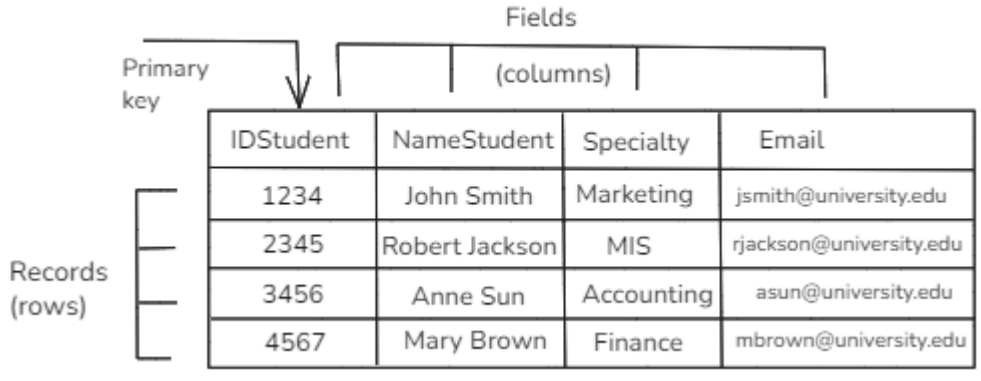
- **Definition**
  - A database is an organized collection of related data.
  - It is designed to store and manipulate data efficiently and reliably.
- **Database Examples**
  - A student database can store the following information for each student: first name, last name, student ID, major, grades, etc.
  - A product database can store the following information for each product: name, description, price, quantity in stock, etc.

    - A customer database can store the following information for each customer: first name, last name, address, phone number, email, purchase history, etc.
- **The Benefits of Using Databases**
    - The advantages of databases over non-specialized tools such as Excel spreadsheets or Word documents are:
        - Elimination of data redundancy:
            - Databases allow data to be stored only once, reducing the risk of inconsistency and data corruption.
        - Maintenance of data integrity:
            - Databases can apply validation rules to ensure the consistency of stored data.
        - Facilitate data search and analysis:
            - Databases provide powerful tools for searching and analyzing large and complex data.

3- Relational Databases

3-1 Definitions

- *a data model*
    - A data model is the logical structure of the data stored in a database. It defines data types, relationships between different data types, and data integrity rules.
- *A relational database*
    - A relational database is a database that uses the relational data model.
- Data in a relational database is organized into tables, which are linked together by relationships.



3-2 Designing a Relational Database

- To design a database, you must first identify the tables and the relationships between them.
- Once the entities and relationships have been identified, you must create tables for each entity and define the relationships between the tables.

- *For example:*
  - A university wants to create a database to track student data. After interviewing several people, the design team learns that the goal of implementing the system is to:
    - better understand student performance and academic resources.
    - From this, the team decides that the system should track students, their grades, courses, and classrooms.
  - Using this information, the design team determines that the following tables should be created:
    - **STUDENT**: Student name, major, and email address.
    - **COURSE**: Course title, capacity.
    - **NOTE**: This table will correlate STUDENT with COURSE, allowing us to have a given student enroll in multiple courses and receive a grade for each course.
    - **CLASSROOM**: Classroom location, classroom type, and classroom capacity.
  - Once the design team has determined which tables to create, they must define the specific data elements each table will contain.
    This requires identifying the fields that will be in each table. For example, the course title would be one of the fields in the COURSE table.
  - Finally, since this will be a relational database, each table must have a field in common with at least one other table (in other words, they must have relationships with each other).

3-3 Normalization

- Normalizing a database means designing it to reduce data redundancy and ensure its integrity.
- To reduce data redundancy, avoid storing the same information in multiple locations within the database.
- To ensure data integrity, ensure that data is stored consistently and can be modified and deleted without error.

3-3-1 Example:

A school's database needs to track student grades. A simple (and poor) solution would be to create a "Student" field in the "Courses" table and list all student names in it. However, this design would mean that if a student takes two or more courses, their data would have to be entered twice or more. This means that the data is redundant.

- To solve this problem, the "Grade" table is introduced.
- In this design, when a student enrolls in the school system before taking a course, they must first be added to the "Student" table, where their ID, name, major, and email address are entered.

- Next, a new entry must be added to indicate that the student is taking a specific course. To do this, a record with the student ID and course ID must be added to the "Grade" table.
- If this student is taking a second course, there's no need to duplicate the student's name, major, and email address. Simply create another entry in the "Grade" table with the second course ID and the student's ID.
- The school's database design also allows for easy design modifications without major changes to the existing structure.
- For example, if the design team were to add functionality to the system to track the instructors who teach the courses, they would simply add a "PROFESSOR" table (similar to the "Student" table) and add a new field to the "Course" table to contain the instructor IDs.

3-4 Data Types

- When defining fields in a database table, each field must be associated with a data type.
- Examples of common data types:
  - **Text:** To store concise, non-numeric data, typically less than 256 characters. The maximum length can be set by the database designer.
  - **Number:** To store numbers. Several number types are usually available depending on the size of the largest number.
  - **Boolean:** A data type with only two possible values, such as 0 or 1, "true" or "false," "yes" or "no."
  - **Date/Time:** A special form of the number data type that can be interpreted as a number or a time.
  - **Currency:** A special form of the number data type that formats all values with a currency indicator and two decimal places. - **Paragraph Text:** Allows you to store text longer than 256 characters.
  - **Object:** Allows you to store data that cannot be entered using the keyboard, such as an image or music file.

3-4-1 Reasons for Proper Data Type Definition

- First, the data type informs the database about possible operations with the data. For example, to perform mathematical operations, the data type must be defined correctly.
- Second, defining the data type ensures proper storage space allocation. For example, if the Student Name field is defined as a Text(50) data type, this means that 50 characters are allocated for each name to be stored, and any longer names will be truncated.

3-5 Metadata

- Metadata can be understood as "data about data."
- Examples of database metadata:

    - **number of records**
    - **field data type**
    - **field size**
    - **field description**
    - **field default value**
    - **usage rules**
- When designing a database, a "data dictionary" is created to contain the metadata, defining the fields and structure of the database.

4 Database Management System

4-1 Definition

- DBMSs are software applications that allow the creation, management, and analysis of databases. For example, they allow users to access, read, modify, add, or delete data in a database.
- DBMSs also provide an interface for viewing and modifying the database design, creating queries, and generating reports.
- **Examples**
    - Various software programs, such as iTunes or mobile apps, can interact with a database to provide playlists, play songs, or manage contacts.
    - DBMSs, such as Oracle, Microsoft SQL Server, and IBM Db2, are used in businesses for relational databases.
    - Some personal DBMSs, such as Microsoft Access and Open Office Base, are intended for databases used by a single user.

4-2 SQL Language

- SQL (Structured Query Language) is the primary way to work with relational databases.
- Used to analyze and manipulate data, SQL is integrated into many database applications.
- Examples of SQL queries include retrieving specific information and counting the total records in a table.

4-3 Other Types of Databases

- Besides the relational model, other database models exist, such as the hierarchical model and the document-centric model.
- The concept of NoSQL (not only SQL) emerged to address the needs of large databases distributed across multiple servers, providing a less structured environment.

4-4 Developments in Databases

- Relational models have scalability limitations, leading to the emergence of NoSQL solutions for large databases.
- NoSQL enables a more flexible environment, suitable for large-scale databases such as those from Google and Amazon.
- Services such as Google App Engine Datastore (NoSQL) and Amazon RDS (relational) offer diverse solutions to meet the needs of developers and businesses.

5- Networks

5.1 Evolution of the Internet

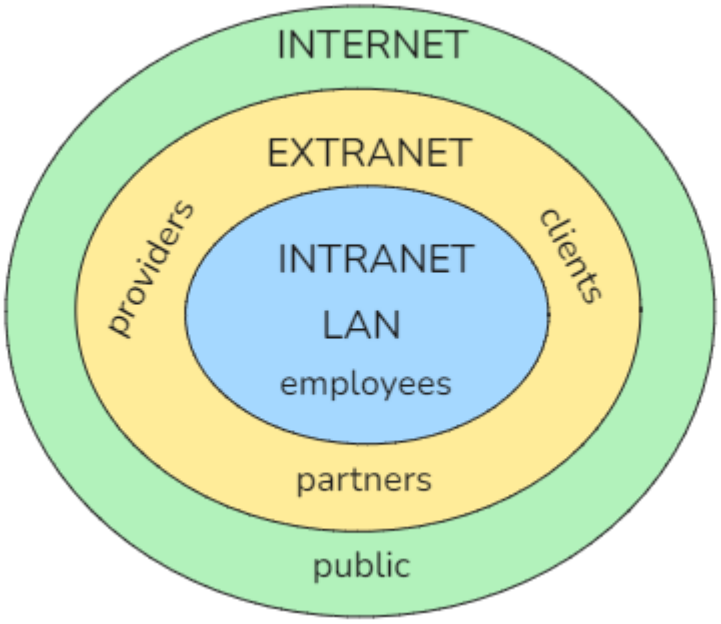
- **ARPANET:**
  - The Internet was born from ARPA (the Advanced Research Projects Agency (ARPA), now called DARPA (Defense Advanced Research Projects Agency).
  - In the 1960s, ARPA had a problem: many computers couldn't communicate with each other. The creation of a communications technology that would integrate different computers located across the country into a single network: the ARPANET.
  - The first four nodes of the ARPANET were located at UCLA, the University of California, Stanford, and the University of Utah.
- **The Internet and the World Wide Web**
  - In the 1970s, other networks were created, but they couldn't communicate with each other.
  - The invention of TCP/IP (Transmission Control Protocol/Internet Protocol) allowed networks to communicate with each other ⇒ the *internet* was born. Which can be simply defined as an interconnected network of networks.
  - In 1980, the World Wide Web project was launched. This can be simply defined as a hypertext system that allows easy navigation on the internet.
  - hypertext: "Hypertext is text that contains links to other text."
  - E-commerce companies must develop business models adapted to the online environment to succeed.
- **Web 2.0:**
  - This is a period that describes the change in internet usage, and is characterized by the following points:
  - Universal access to applications
  - Value is found in the content, not in the display software
  - Data can be easily shared
  - Distribution is bottom-up, not top-down
  - Employees and customers can use and access tools on their own
  - Informal networks are encouraged (because a larger number of contributors leads to a Best Content)
  - Social tools encourage people to share information

5.2 Wireless Networks

Different wireless connection technologies exist, including:

- **Wi-Fi:**
  - Wi-Fi converts an internet signal into radio waves that can be picked up by devices equipped with a wireless adapter.
  - Several Wi-Fi specifications have been developed over the years to improve Wi-Fi speed and range, enabling new uses.
- **Mobile Network:**
  - Data networks have been incorporated into the mobile phone network.
  - In 2011, mobile phone operators began offering 4G data speeds, giving cellular networks the same speeds customers were used to with their home connection.
- **Bluetooth:**
  - Bluetooth is a wireless technology that allows nearby devices to be connected wirelessly. - Some applications of Bluetooth:
  - connecting a printer to a personal computer
  - connecting a cell phone and headset
  - connecting a wireless keyboard and mouse to a computer

5.3 Networking



5-3-1 Organizational Networks (LANs and WANs)

- A LAN (Local Area Network) is a local area network, usually operated within the same building or on the same campus.
- It allows computers to connect to each other and to peripheral devices.

- A WAN (Wide Area Network) connects networks located in different geographical areas, such as an organization's locations in different cities or states.

5-3-2 Client-Server Model

- The client-server model allows standalone devices, such as personal computers, printers, and file servers, to work together.
- Within a LAN, more powerful computers are installed as servers, and LAN users can run applications and share information between departments and organizations.

5-3-3 Intranet

- An intranet is an internal network that provides web-based resources to an organization's users.
- These web pages are not accessible to people outside the company.
- The pages typically contain information useful to employees, such as policies and procedures.
- In an academic context, the intranet provides an interface to learning resources for students.

5-3-4 Extranet

- An extranet is a part of the company's network that can be securely made available to people outside the company.
- Extranets can be used to allow customers to log in and place orders, or for suppliers to check their customers' stock levels.

5-3-5 VPN (Virtual Private Network)

- A VPN allows a person who is not physically located on an organization's internal network to securely access the intranet.

6 People

- They can be classified into the following categories:
  - Information system creators:
    - Systems analyst
    - Programmer/Developer
    - IT engineer
      - Hardware, software, systems, and networks
  - Information systems operations and administration
    - Computer operator
    - Database administrator

        - Technical support analyst
        - Trainer
- Information systems management
    - Information systems director
    - Functional manager
    - ERP management: "Enterprise Resource Planning"
    - Project managers
    - IT security manager
    - New roles
- Information systems users
    - Types of users based on technology adoption:
        - Innovators
        - Early adopters
        - Early majority
        - Late majority
        - Laggards

Bibliographic References

Bourgeois, David T., James L. Smith, Shouhong Wang, and Joseph Mortati. *Information systems for business and beyond*. Saylor Academy, 2019