Module 11 - Databases

General Notes

Data

Data in Information Systems

- **Data:** Facts or observations about people, places, things, and events
- **Databases:** Store, organize, and use data

Types of Data

- **Audio** (captured, interpreted, and saved using microphones and voice recognition systems)
- **Music** (downloaded from the Internet and saved on various devices)
- **Photographs** (captured by digital cameras, edited by image editing software,
  and shared over the Internet)
- **Video** (captured by digital video cameras, TV tuner cards, and webcams)

Perspectives on Data

1. **Physical view**:
    - Focuses on actual format and location of the data
    - Data recorded as digital bits grouped into bytes representing characters using a coding scheme like Unicode
    - Mostly concerns specialized computer professionals
2. **Logical view**:
    - Focuses on meaning, content, and context of the data
    - Relevant to end users and most computer professionals
    - Involves using data with application programs
    - This chapter discusses the logical view of data and its storage in databases

Concept Check

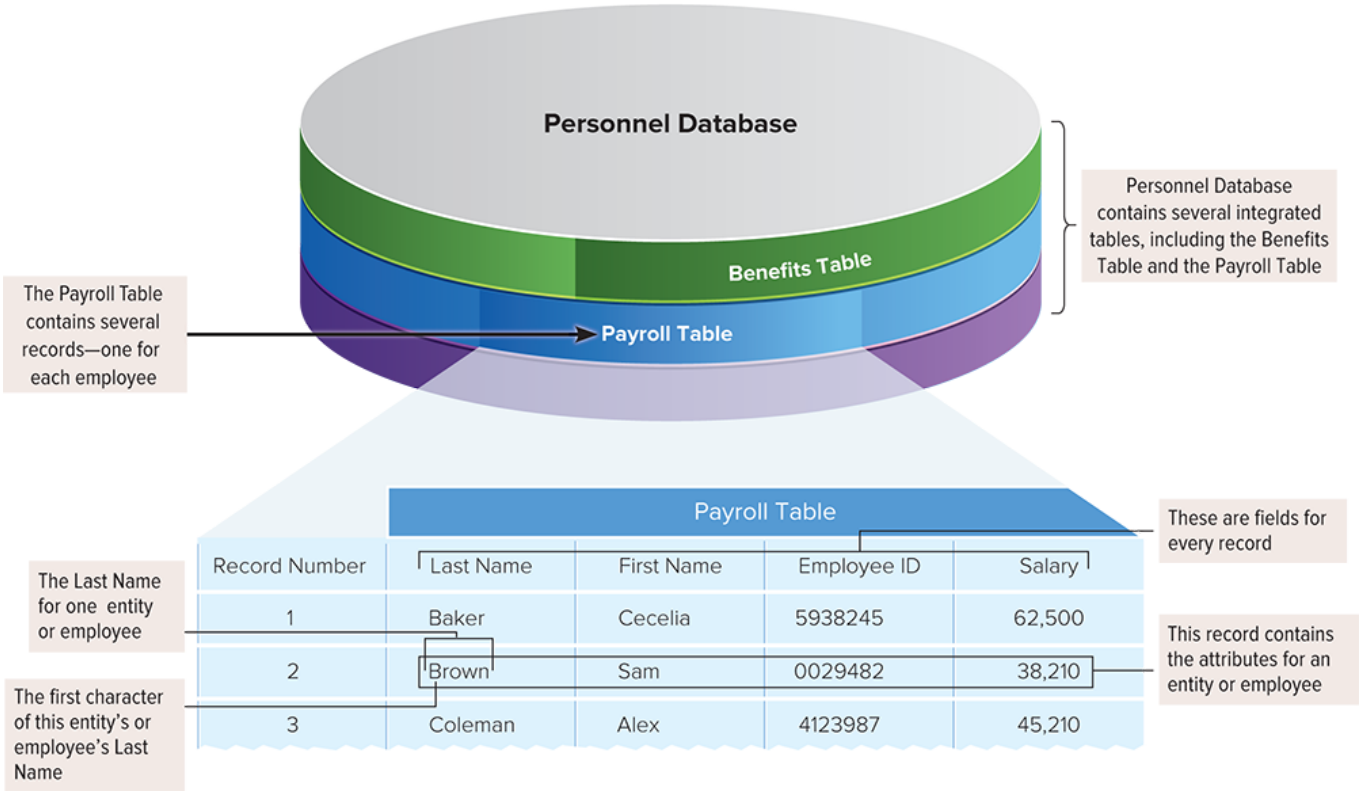
- **Different types of data:** audio, music, photographs, video
- **Physical view of data:** focuses on the actual format and location of the data
- **Logical view of data:** focuses on the meaning, content, and context of the data

Conclusion

Data is a crucial component of information systems and can be stored, organized, and used through databases. Data comes in various forms, such as audio, music, photographs, and video. **It can be viewed from two perspectives:** physical view (
format and location) and logical view (meaning, content, and context). This chapter mainly discusses the logical view of data and how it is stored in databases.

Data Organization

Logical Data Organization



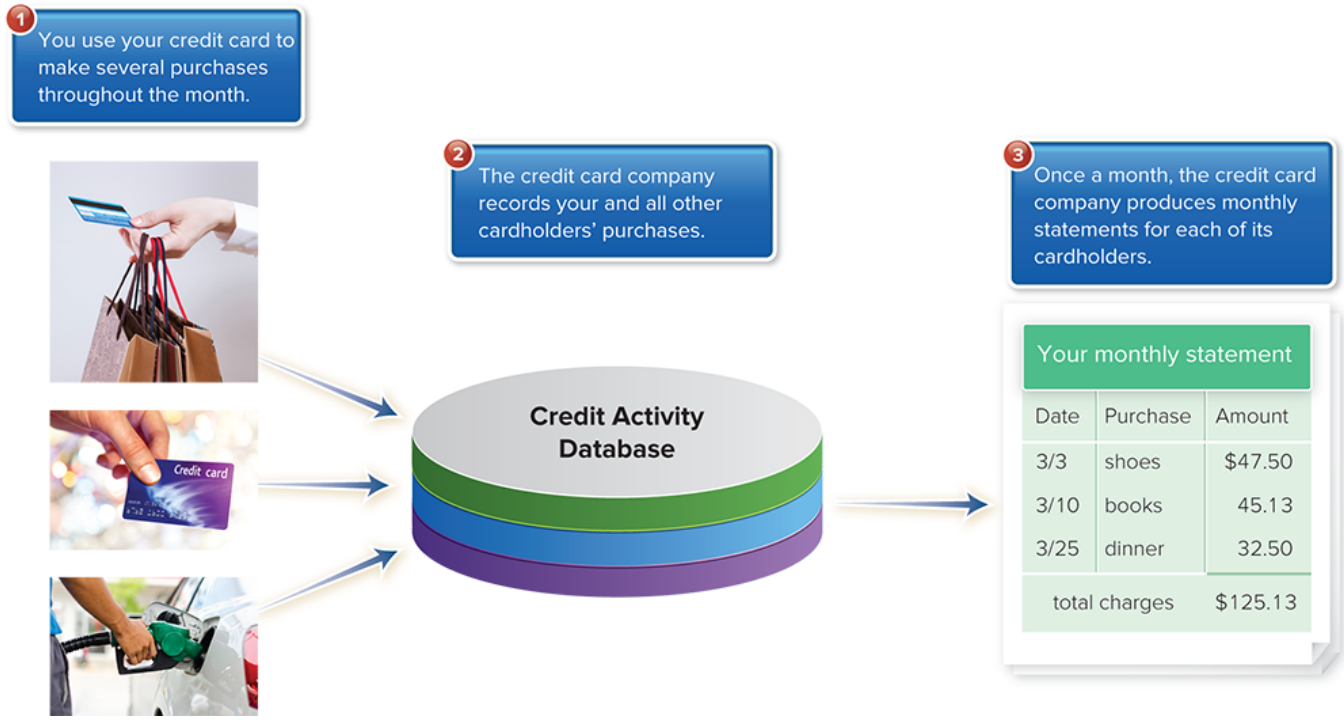
- **Character:** Single letter, number, or special character.
- **Field:** Group of related characters, represents an attribute of an entity.
- **Record:** Collection of related fields, describes an entity.
- **Table:** Collection of related records.
- **Database:** Integrated collection of logically related tables.

Key Field

- Distinctive field in a record, called **primary key**.
- Uniquely identifies the record.
- Used to relate tables by common key fields.
- Key fields in different tables can be used to integrate the data in a database.
    - For example, in the Personnel Database, both the Payroll and the Benefits tables include the field Employee ID. Data from the two tables could be related by combining all records with the same key field (Employee ID).

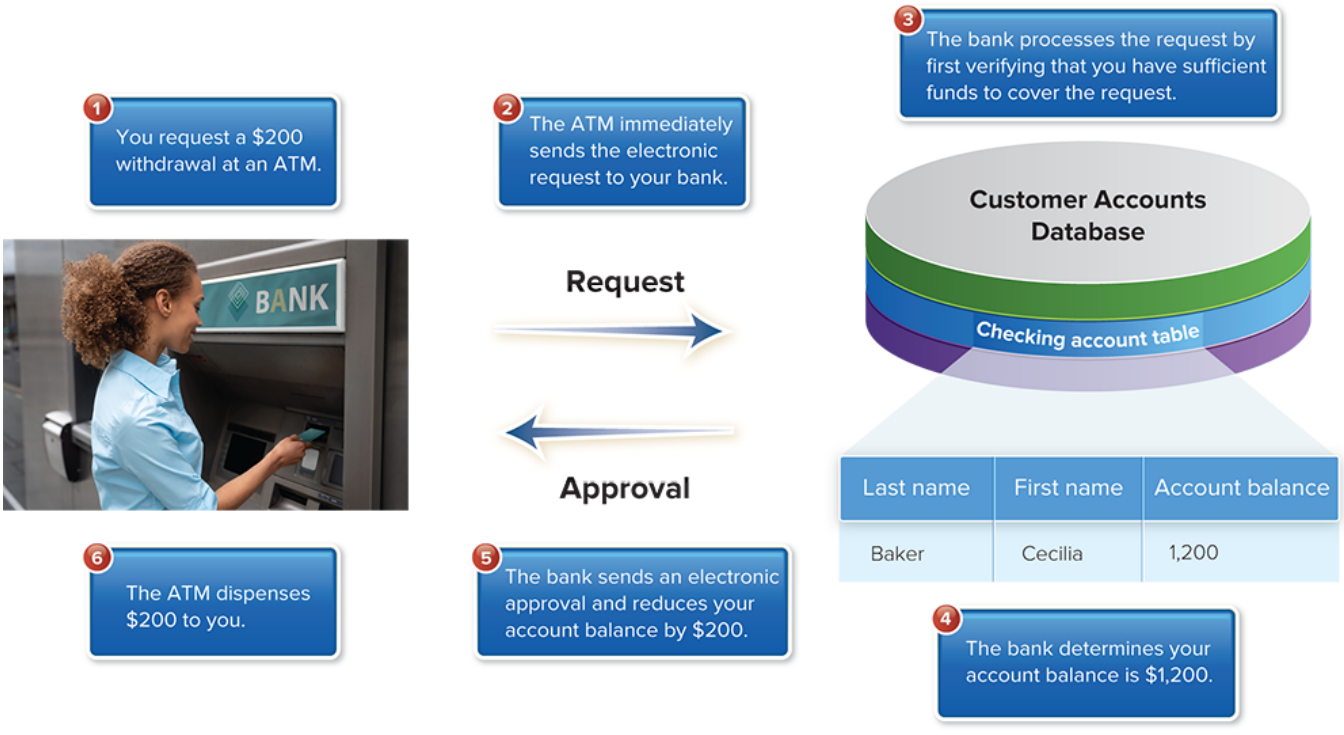
Batch vs Real-Time Processing

Batch Processing



- Data collected over a period and processed all at once.
- **_Example:** Monthly credit card statements._

Real-time Processing



- Data processed at the same time the transaction occurs.

- Also known as **online processing**.
- **_Example:** ATM withdrawal._

Conclusion

- Data in databases is organized logically into characters, fields, records, tables, and databases.
- Key fields uniquely identify records and are used to relate tables.
- Batch processing processes data in large groups, while real-time-processing processes data immediately as transactions occur.

Databases

Data Redundancy and Data Integrity

- **Data redundancy:** Multiple files containing the same information, leading to storage inefficiency and data maintenance problems.
- **Data integrity:** Ensuring accuracy and consistency of data across different sources.

Advantages of Databases

1. **Sharing:** Easy exchange of information across departments.
2. **Security:** Access control with passwords and selective permissions.
3. **Less data redundancy:** Reduced storage space and data maintenance issues.
4. **Data integrity:** Consistent and accurate data across different sources.
    - *Example: A customer's address may be listed as "Main Street" in one system and "Main St." in another. With discrepancies like these, it is probable that the customer would be treated as two separate people.*

Database Management System (DBMS)

- Software to create, modify, and access databases.
- *Example: Microsoft Access for personal computers, specialized database servers.*

DBMS Subsystems

1. **DBMS engine:** Bridge between logical and physical view of data.
    - Handles the details of actually locating the data (physical perspective).
2. **Data definition subsystem:** Defines database's logical structure using **data dictionary** or **schema**.
    - This dictionary contains a description of the structure of data in the database.
3. **Data manipulation subsystem:** Tools for data maintenance (adding, deleting, editing) and analysis (viewing, querying, reporting).
    - Maintaining data is known as **data maintenance**.
    - Specific tools include **query-by-example** and a specialized programming language called **structured query language (SQL)**.
4. **Application generation subsystem:** Tools to create data entry forms and interface with programming languages.
5. **Data administration subsystem:** Manages overall database, including security, disaster recovery, and performance monitoring.

Database Administration

- Database administrators (DBAs): Specialists managing databases and determining processing rights (who has access to what data).

Conclusion

Databases provide significant advantages to organizations, such as sharing, security, less data redundancy, and data integrity. Database management systems (DBMS) facilitate creating, modifying, and accessing databases through various subsystems. Database administrators (DBAs) play a crucial role in managing and securing access to the database.

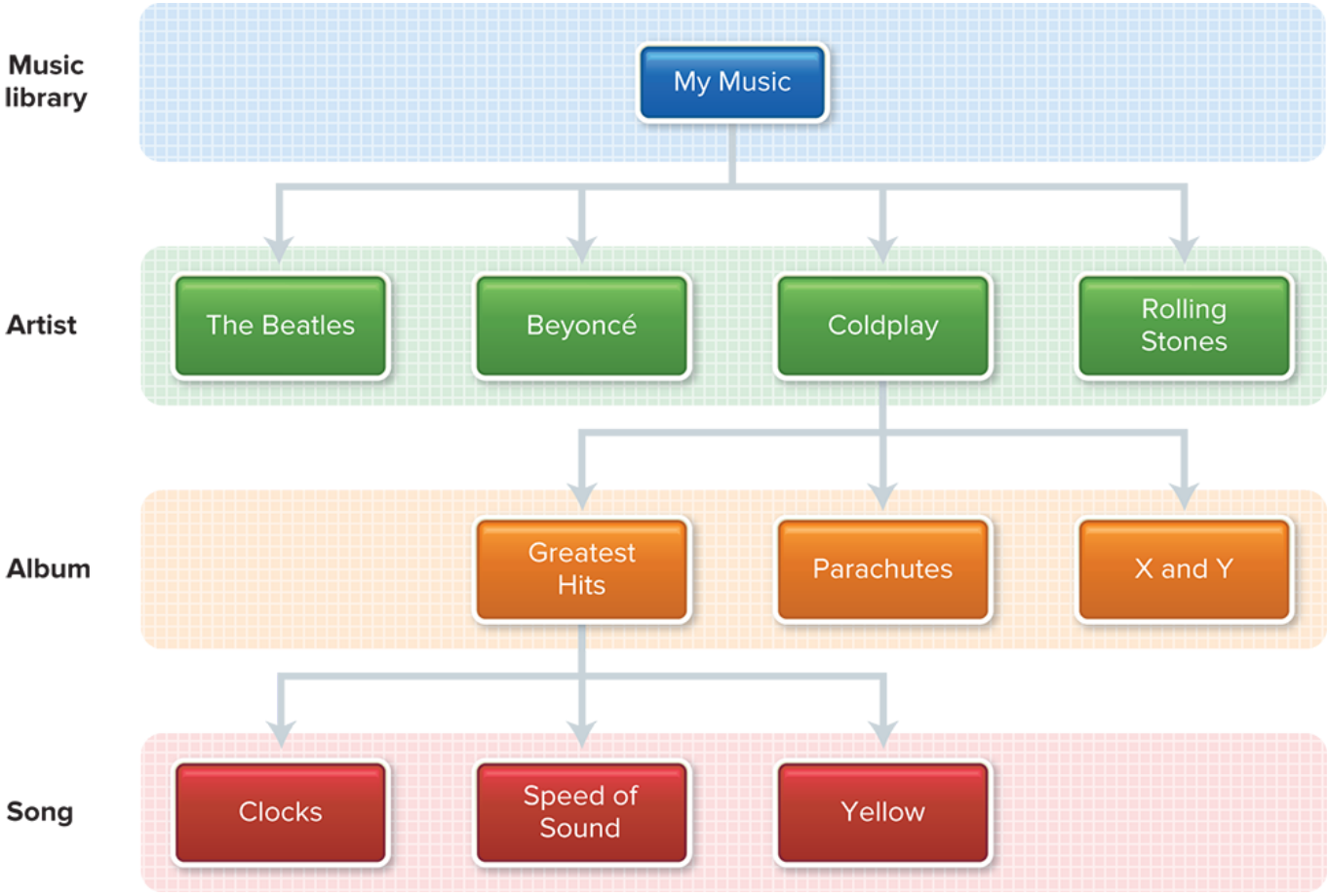
DBMS Structure

Database Models

- DBMS programs work with logically structured data, known as a **database model**.

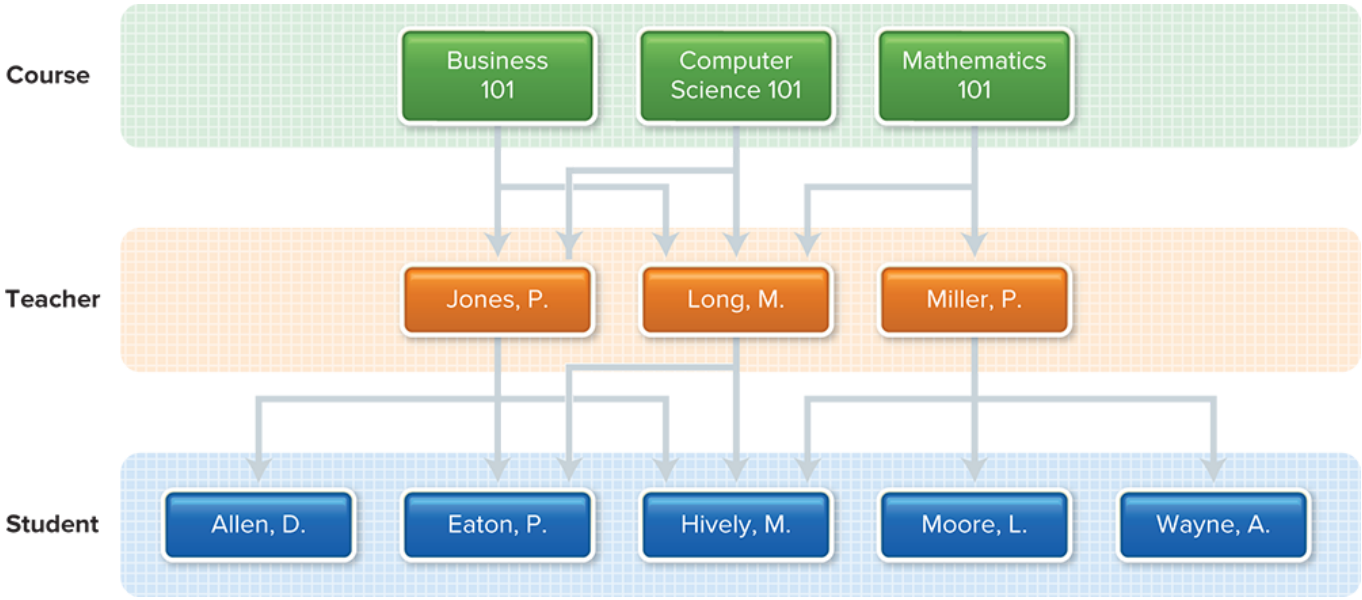
- Database models define rules and standards for all the data in a database.
- Microsoft Access is designed to work with databases using the relational data model.
- There are five common database models:
    - **Hierarchical**
    - **Network**
    - **Relational**
    - **Multidimensional**
    - **Object-oriented**

Hierarchical Database



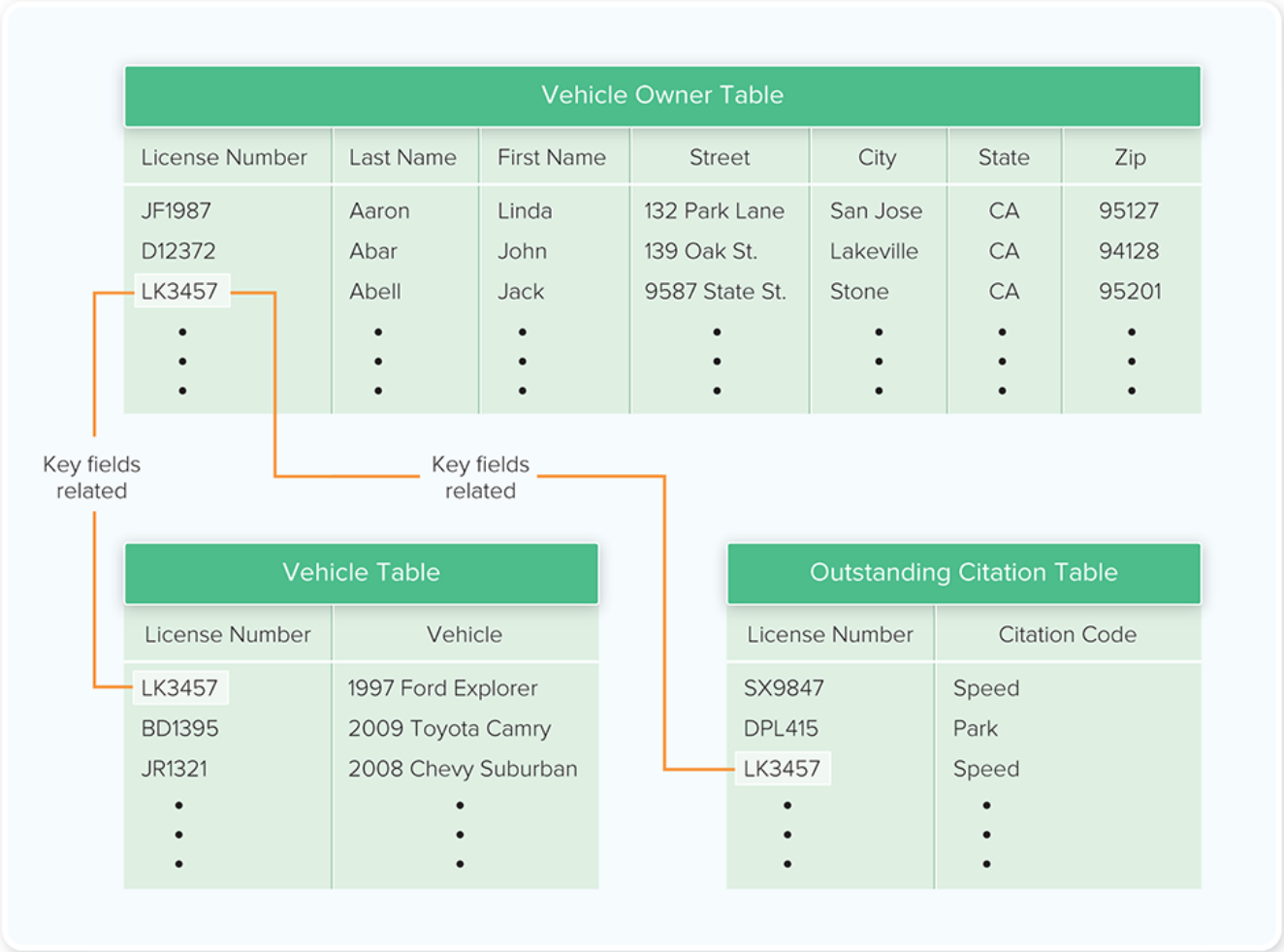
- Hierarchical data model used in mainframe DBMS
- Fields or records structured in nodes
- Parent nodes have one-to-many relationships with child nodes
- Rigid structure; deleting a parent node removes all child nodes
    - A child node cannot be added unless a parent node is added first.
    - One parent only per child, and no relationships or connections between the child nodes themselves.

Network Database



- Developed in response to hierarchical model limitations
- Each child node can have multiple parent nodes
  - **Many-to-many relationships**
- Increased flexibility and efficiency
- There are additional connections—called **pointers**—between parent nodes and child nodes.

Relational Database



- Most common database model
- Data elements stored in tables with rows and columns
- Tables and data called **relations**
- Requires **common data item** or shared key field in related tables
- Simplicity; easy addition, deletion, and modification of entries
- Used in personal computer DBMSs and mainframe/midrange systems

Multidimensional Database

- Variation and extension of relational model
- Uses **data cubes** with multiple dimensions
- Represents complex relationships between data

Advantages of Multidimensional Databases

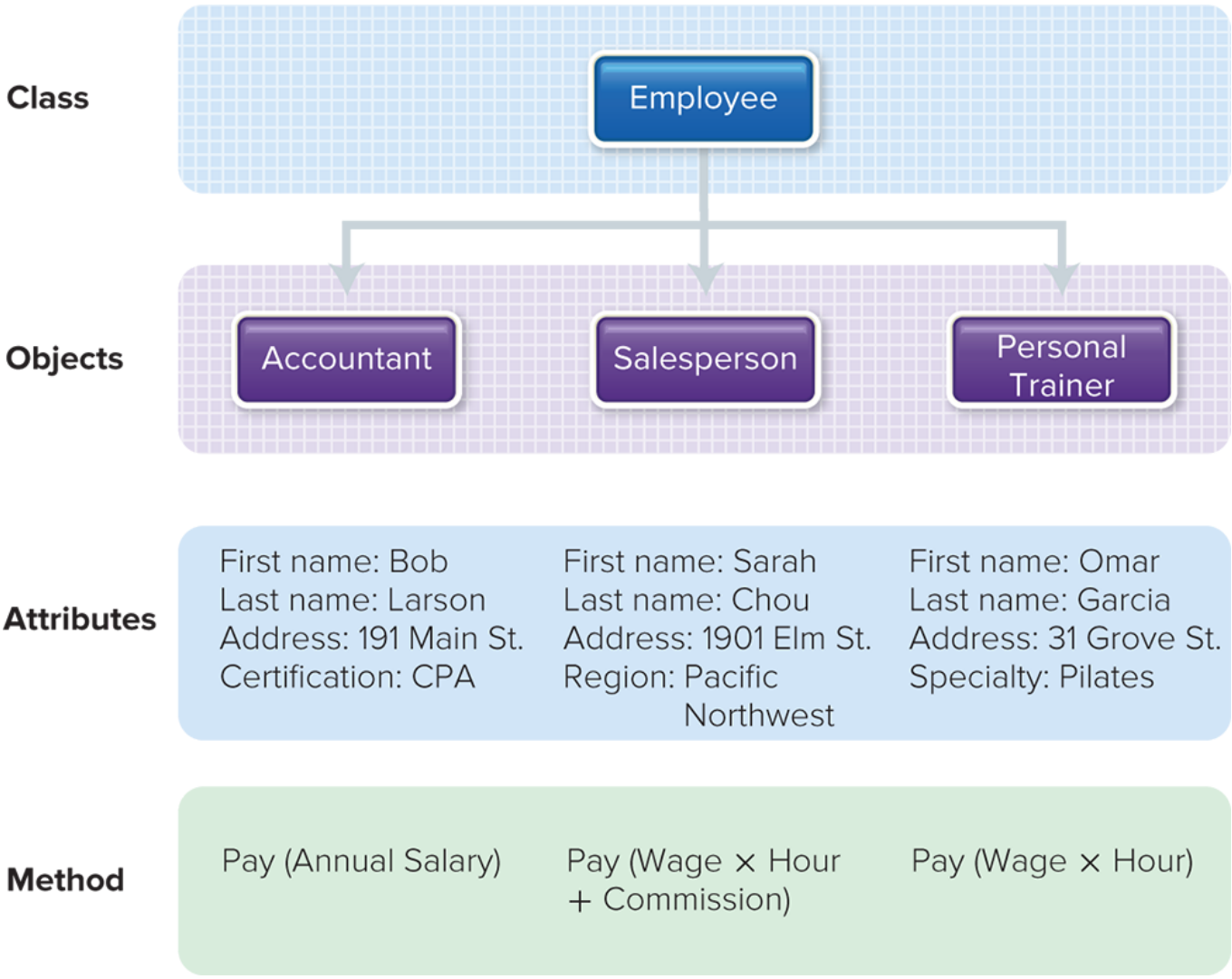
- **Conceptualization:** Users can analyze complex data and relationships without specialized database programming knowledge.

- **Processing Speed:** Analyzing and querying a large multidimensional database can be much faster than a relational database.

A query requiring just a few seconds on a multidimensional database could take minutes or hours to perform on a relational database.

Object-Oriented Database

Object-oriented databases are designed to store data as well as instructions to manipulate the data. They are more flexible than other data structures and ideally designed to provide input for object-oriented software development.



Classes, Objects, Attributes, and Methods

- **Classes**: General definitions.
- **Objects**: Specific instances of a class that can contain both data and instructions to manipulate the data.
- **Attributes**: Data fields an object possesses.

- **Methods**: Instructions for retrieving or manipulating attribute values.

Table of Databases

Organization	Description
Hierarchical	Data structured in nodes organized like an upside-down tree; each parent node can have several children; each child node can have only one parent
Network	Like hierarchical except that each child can have several parents
Relational	Data stored in tables consisting of rows and columns
Multidimensional	Data stored in data cubes with three or more dimensions
Object-oriented	Organizes data using classes, objects, attributes, and methods

Conclusion

Database models dictate the structure and organization of data in a database. There are various models available, each with their own advantages and limitations. Hierarchical and network databases are more rigid in structure, while relational databases are more common and offer simplicity. Multidimensional databases provide a more intuitive model and faster processing, and object-oriented databases offer flexibility and compatibility with object-oriented software development.

Although hierarchical and network databases are still widely used, relational and multidimensional databases are the most popular today. Object-oriented databases are becoming more widely used and are part of a new category of databases known as **NoSQL**.

Types of Databases

Types of Databases	Description
Individual	Databases that are created and maintained by individuals for personal use or for small projects.
Company	Databases that are created and maintained by organizations for their own use, such as managing customer information or inventory.
Distributed	Databases that are spread across multiple computers or locations and can be accessed by multiple users simultaneously.
Commercial	Databases that are created and maintained by companies specifically for commercial purposes, such as selling to other companies or providing data services.

1. Individual

- Also known as a **personal computer database**
- Used primarily by one person
- Data and DBMS under direct control of the user
- Stored on user's hard-disk drive or LAN file server
- *Example: A salesperson keeping track of their customers*

2. Company

- Created for internal use within a company
- Stored on a central database server and managed by a database administrator
- Accessible to users within the company via personal computers and networks
- Foundation for management information systems
- *Example: A department store recording all sales transactions*

3. Distributed

- Data stored in multiple locations, accessible through various communication networks
- Not all data physically located in one place
- Database servers on client/server networks link the data

- *Example: Sales figures for a chain of department stores located at various* stores, accessible by executives at district offices or headquarters

4. Commercial

- Large databases covering specific subjects
- Accessible to the public or selected individuals for a fee
- Also called **information utilities** or **data banks**
- *Example: Factiva, offering information-gathering and reporting services*
- **Widely used commercial databases:** ProQuest Dialog, Dow Jones Factiva, and LexisNexis

Table of Different Database Types

Table Summary: A table divided into 2 columns summarizes four types of databases. Column 1 shows the Type and column 2 shows the Description.

Type	Description
Individual	Integrated files used by just one person
Company	Common operational or commonly used files shared in an organization
Distributed	Database spread geographically and accessed using database server
Commercial	Information utilities or data banks available to users on a wide range of topics

Conclusion

Databases can be categorized into four types: individual, company, distributed,
and commercial. Individual databases are used by one person, while company databases are used internally within an organization. Distributed databases store data in multiple locations, and commercial databases offer access to specific subjects for a fee. Each type of database serves different purposes and has varying levels of accessibility.

- Databases can be classified according to their size and accessibility.

Database Uses and Issues

Strategic Uses

1. Databases are essential for productivity and planning, often more valuable than books and journals in corporate libraries.
2. Data warehouses store data from internal and external sources for managers and business professionals.
3. Data mining techniques search databases for related information and patterns.
4. Types of databases include:
    - Business directories
        - Providing addresses, financial and marketing information, products, and trade and brand names.
    - Demographic data
        - Such as county and city statistics, current estimates on population and income, employment statistics, census data, and so on.
    - Business statistical information
        - Such as financial information on publicly traded companies, market potential of certain retail stores, and other business data and information.
    - Text databases
        - Providing articles from business publications, press releases, reviews on companies and products, and so on.
    - Web databases
        - Covering a wide range of topics, including all of those previously mentioned. As mentioned earlier, web search sites like Google maintain extensive databases of available Internet content.

Security

1. Database security is critical due to the value of information stored.
2. **Security concerns:**
    - Misuse of personal and private information
    - Unauthorized users accessing databases
    - Computer viruses launched into databases or networks
3. **Security measures:**
    - Guards in computer rooms

- Identification checks
- Electronic fingerprint scanners
- Firewalls for controlling access to internal networks

Conclusion

Databases play a crucial role in businesses for maintaining productivity and strategic planning. Data warehouses and data mining techniques enable organizations to analyze data and find patterns. As databases hold valuable information, security measures such as identification checks, fingerprint scanners, and firewalls are necessary to protect against unauthorized access and potential misuse of information.

Careers in IT

Database Administrators

- **Role**: Determine efficient organization and access of company data, maintain security, and perform backups.
- **Industry**: Fast-growing, substantial job growth expected.
- **Requirements**:
  - Bachelor's degree in computer science or information systems.
  - Technical experience.
  - Internships and prior experience with the latest technology are advantageous.
- **Salary**: $47,000 to 111,000 annually.
- **Advancement**: Chief technology officer or managerial positions.

Crime Databases and Predictive Policing

- **Current databases**: Focus on individuals who have committed crimes.
  - Contain basic information, fingerprints, photos, and DNA samples.
- **Predicting criminal behavior**:
  - Research on patterns and factors leading to violent crime.
  - Studies on human DNA for connections to antisocial or violent behavior.
- **Expanding criminal databases**:
  - Collection of DNA samples from every person in a country.

    - Access to databases from schools, businesses, insurance companies, and medical practices.
    - Potentially monitor or intervene with psychological or medical assistance for identified individuals.
- **Challenges**:
    - Legal challenges to data collection.
    - Balancing privacy and crime reduction.
    - Trust in the government.

Conclusion

Database administrators play a crucial role in managing and securing company data, with the potential for career advancement. In the context of crime databases, the focus is shifting towards predicting criminal behavior by analyzing patterns and expanding data collection. However, challenges arise in balancing privacy, crime reduction, and trust in the government.