- Database languages
    - Data-definition language
    - Data-manipulation language
        - Procedural DML
        - Declarative DML
        - nonprocedural DML
    - Query language
- Data-definition language
    - Domain Constraints
    - Referential Integrity
    - Authorization
        - Read authorization
        - Insert authorization
        - Update authorization
        - Delete authorization
- Metadata
- Application program
- Database design
    - Conceptual design
    - Normalization
    - Specification of functional re-quirements
    - Physical-design phase
- Database Engine
    - Storage manager
        - Authorization and integrity manager

- Transaction manager
- File manager
- Buffer manager
- Data files
- Data dictionary
- Indices

- Query processor
    - DDL interpreter
    - DML compiler
    - Query optimization
    - Query evaluation engine
- Transactions
    - Atomicity
    - Consistency
    - Durability
    - Recovery manager
    - Failure recovery
    - Concurrency-control manager

- Database Architecture
    - Centralized
    - Parallel
    - Distributed
- Database Application Architecture
    - Two-tier
    - Three-tier
    - Application server
- Database administrator (DBA)

Practice Exercises

1.1 This chapter has described several major advantages of a database system. What are two disadvantages?

1.2 List five ways in which the type declaration system of a language such as Java or C++ differs from the data definition language used in a database.

1.3   List six major steps that you would take in setting up a database for a particular enterprise.

1.4   Suppose you want to build a video site similar to YouTube. Consider each of the points listed in Section 1.2 as disadvantages of keeping data in a file-processing system. Discuss the relevance of each of these points to the storage of actual video data, and to metadata about the video, such as title, the user who uploaded it, tags, and which users viewed it.

1.5   Keyword queries used in web search are quite different from database queries. List key differences between the two, in terms of the way the queries are specified and in terms of what is the result of a query.

Exercises

1.6   List four applications you have used that most likely employed a database system to store persistent data.

1.7   List four significant differences between a file-processing system and a DBMS.

1.8   Explain the concept of physical data independence and its importance in database systems.

1.9   List five responsibilities of a database-management system. For each responsibility, explain the problems that would arise if the responsibility were not discharged.

1.10   List at least two reasons why database systems support data manipulation using a declarative query language such as SQL, instead of just providing a library of C or C++ functions to carry out data manipulation.

1.11   Assume that two students are trying to register for a course in which there is only one open seat. What component of a database system prevents both students from being given that last seat?

1.12   Explain the difference between two-tier and three-tier application architectures. Which is better suited for web applications? Why?

1.13   List two features developed in the 2000s and that help database systems handle data-analytics workloads.

1.14   Explain why NoSQL systems emerged in the 2000s, and briefly contrast their features with traditional database systems.

1.15   Describe at least three tables that might be used to store information in a social-networking system such as Facebook.