Database Management System

Instructor

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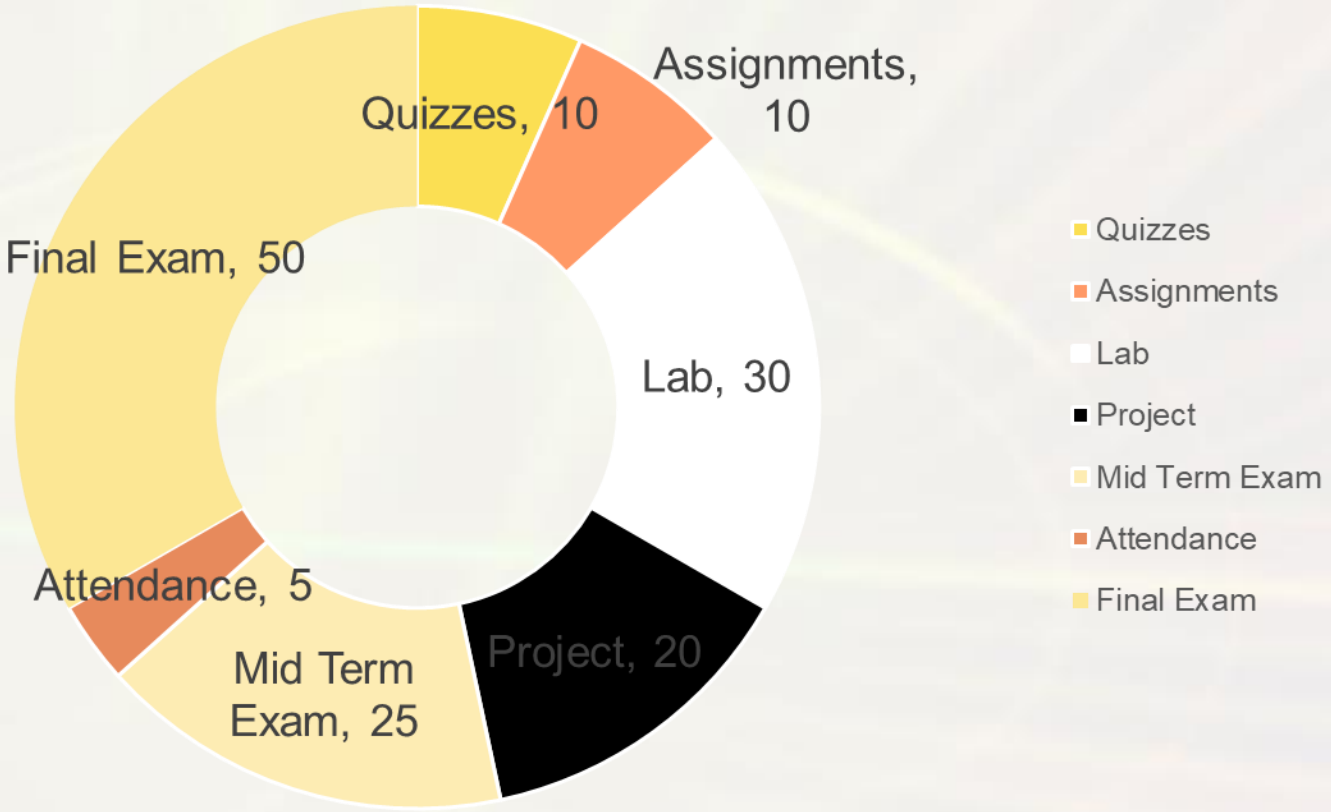
Course Outlines

- Introduction
- Data Models
- Relational Model
- Structure Query Language
- Relational Database Design and Normalization
- Database Security
- Query Processing
- Filing and file Structure
- Concurrency Control
- Database Recovery
- Advanced Database Models

Evaluation Breakdowns

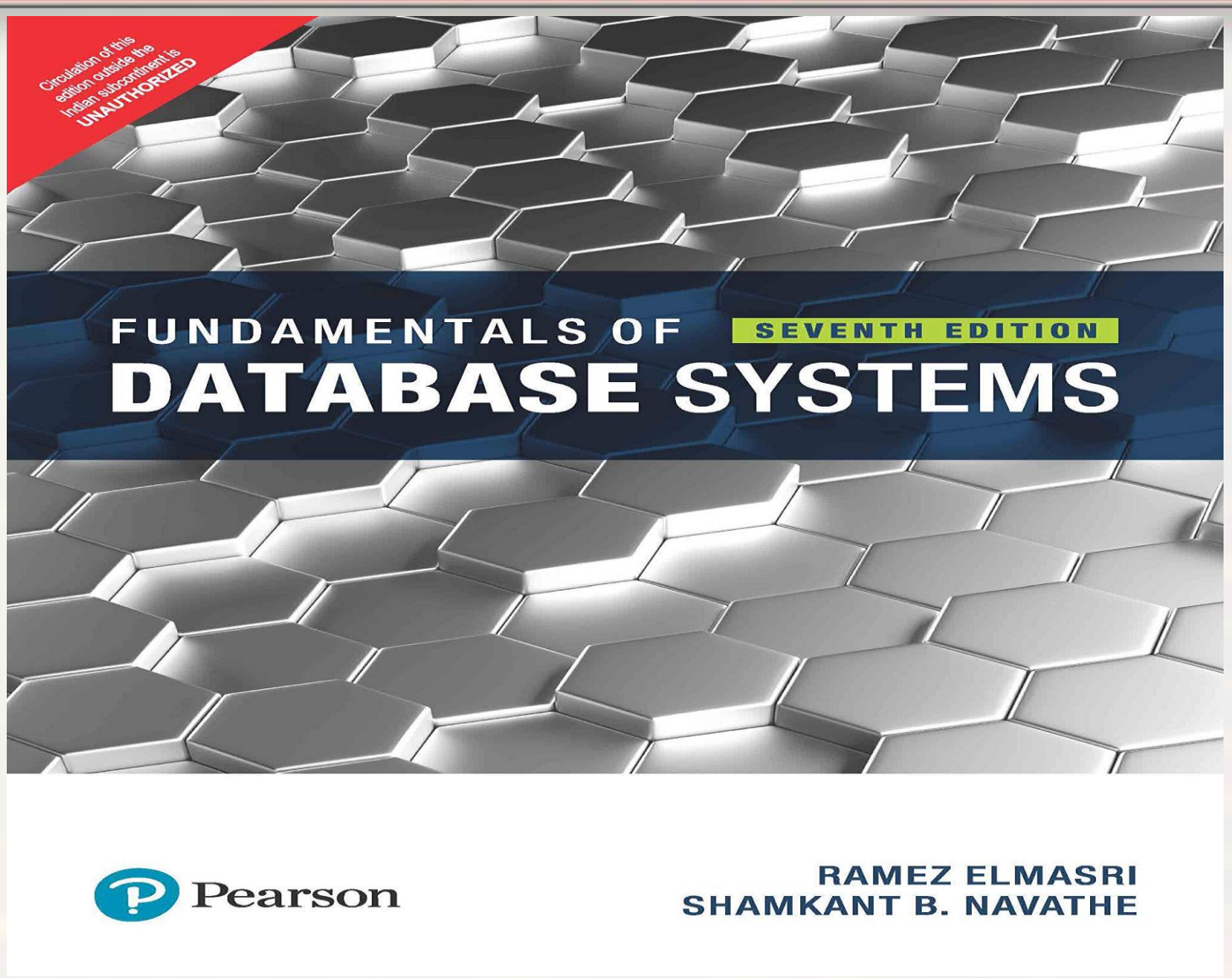


- It may be adjustable.
- Total Marks 150
- 12 Labs

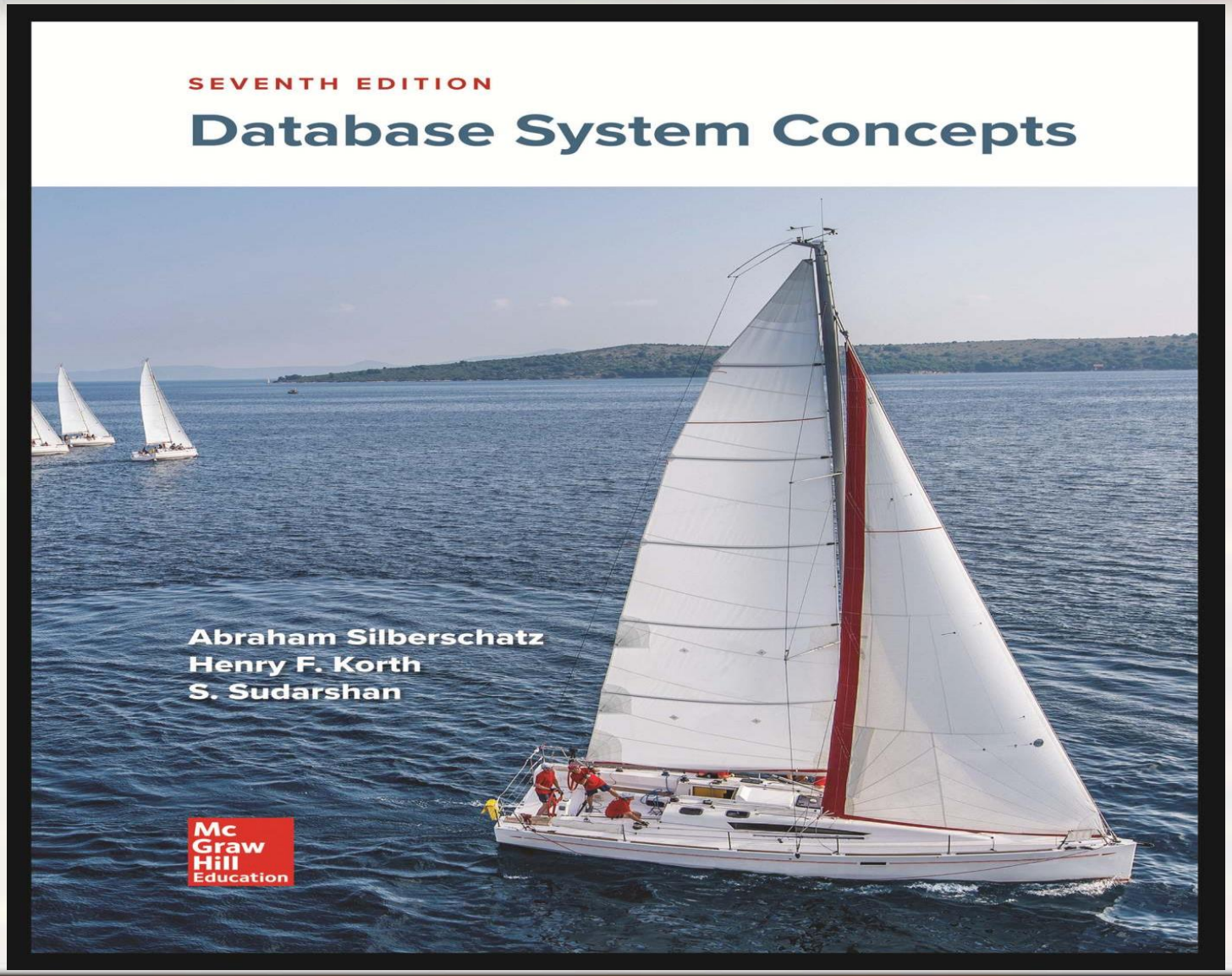
Policies / Administrivia

- Class Discipline
  - No noise/shouting/rumor
- Mobile phones and Laptops
  - Mute mic
- Attendance policy
  - Greater than or equal to 80% get full 5 mark
- Assignment Policy
  - Individual, No plagiarism
- Quizzes
  - Announced/Unannounced
- Project
  - Group (2-3 person) or Individual project for semester
- Print version of ppt will be provided by end of each lecture.

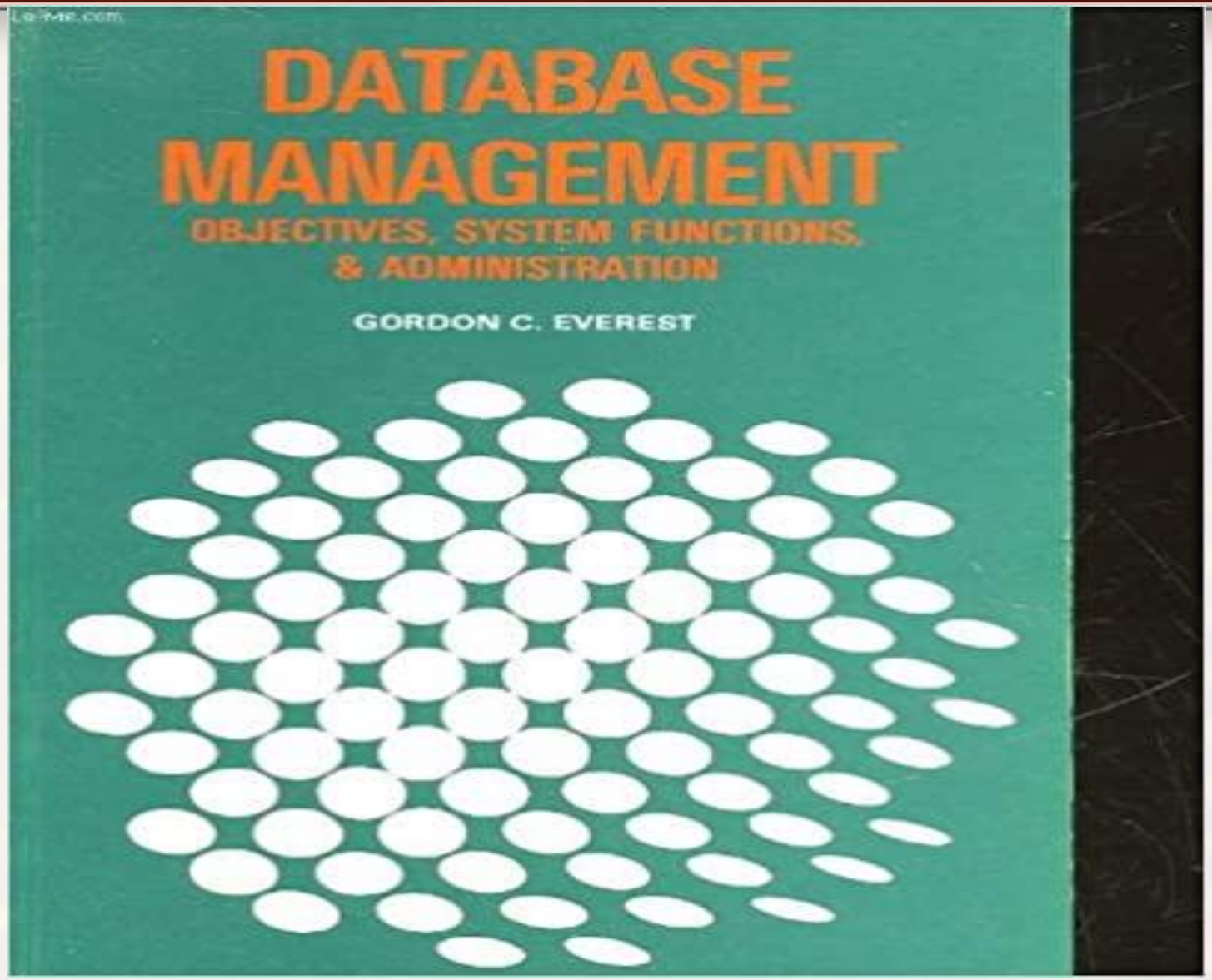
Text Books


Circulation of this edition outside the Indian subcontinent is UNAUTHORIZED
FUNDAMENTALS OF
SEVENTH EDITION
DATABASE SYSTEMS
Pearson
RAMEZ ELMASRI
SHAMKANT B. NAVATHE

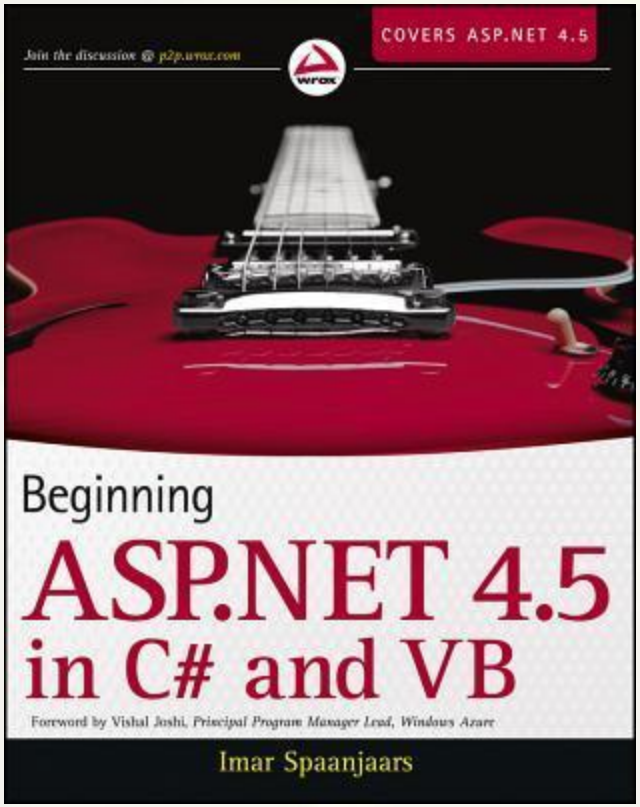
References Text Books

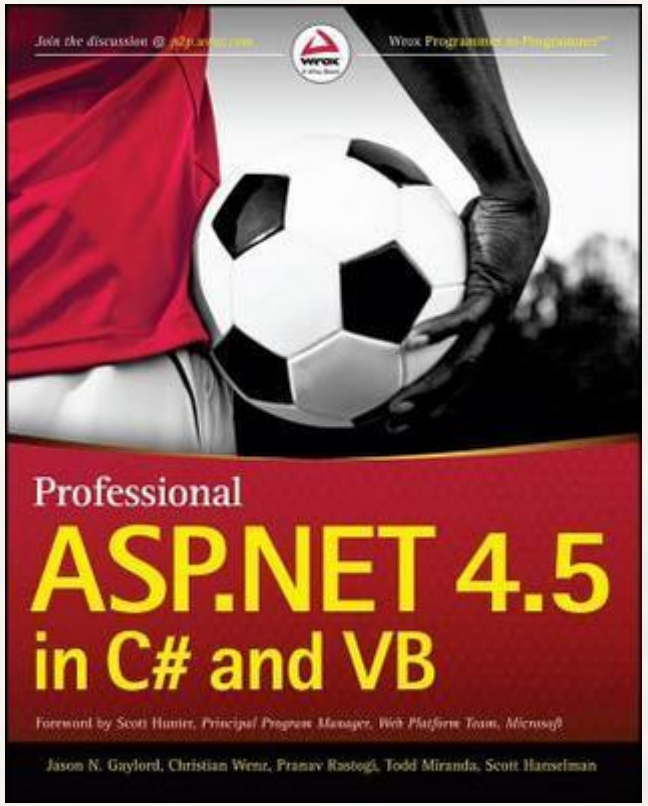


References Text Books

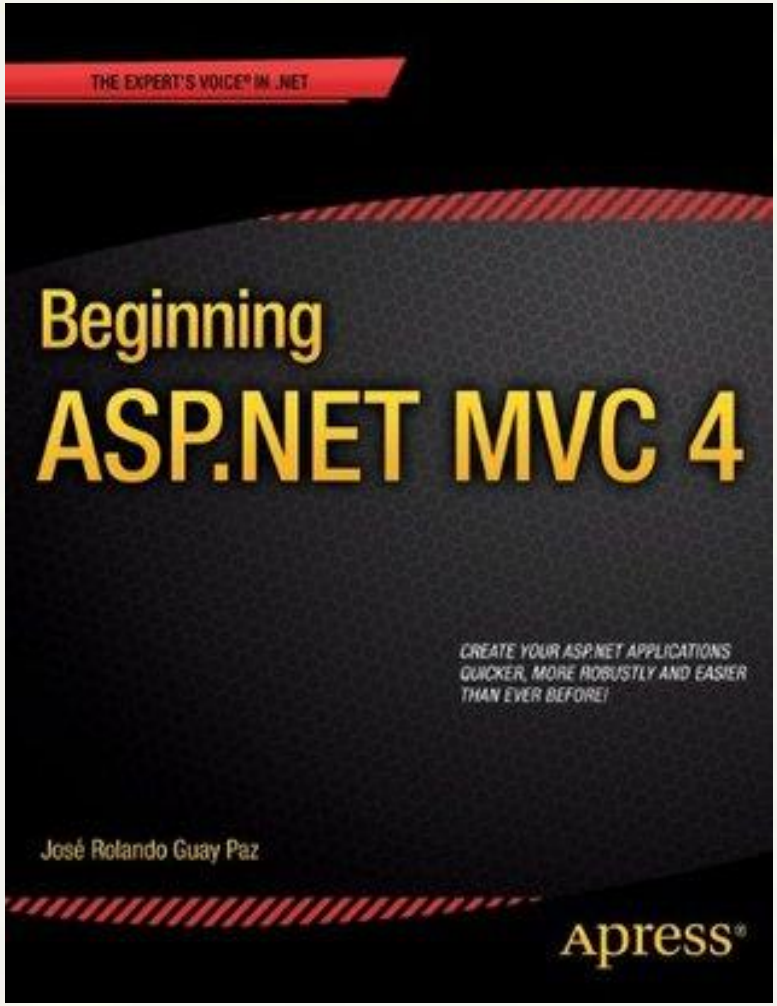


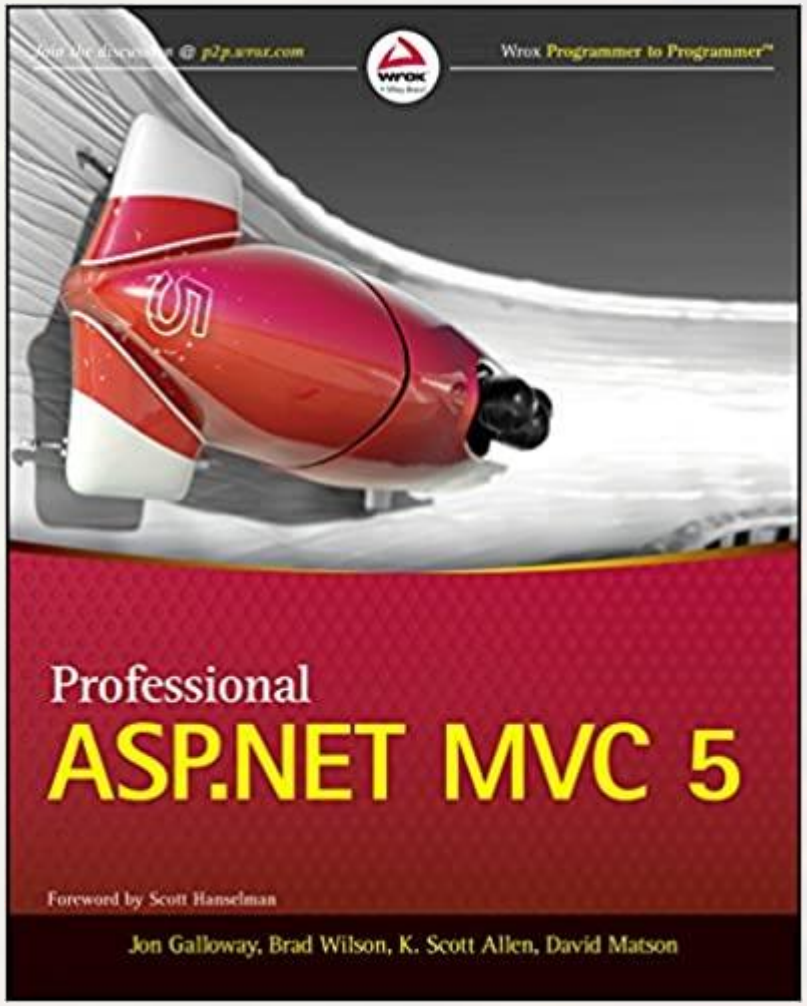
ASP. Net Text Books for Projects



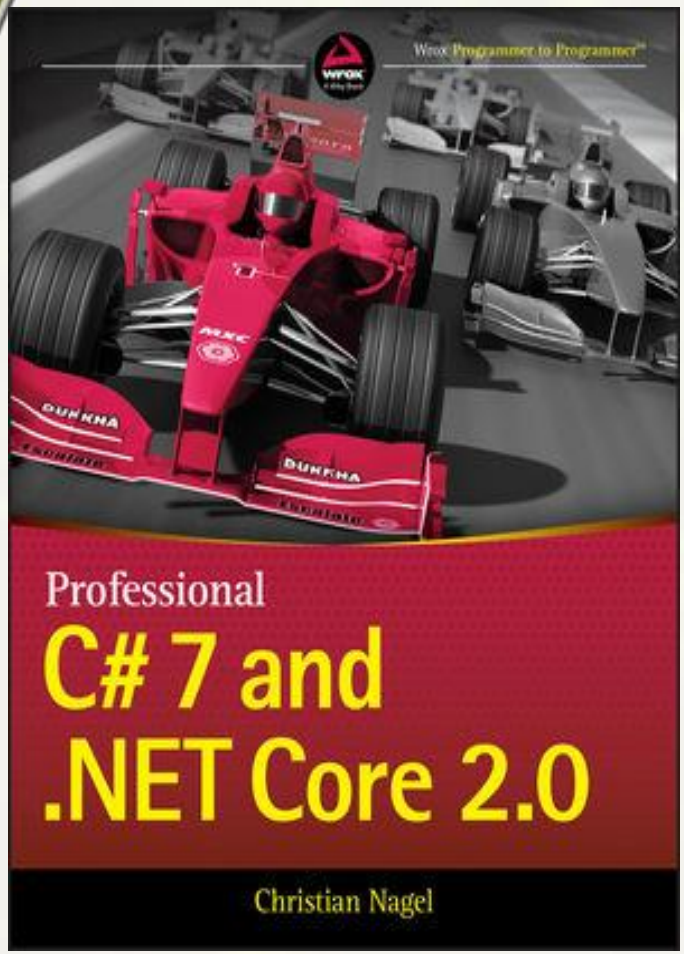


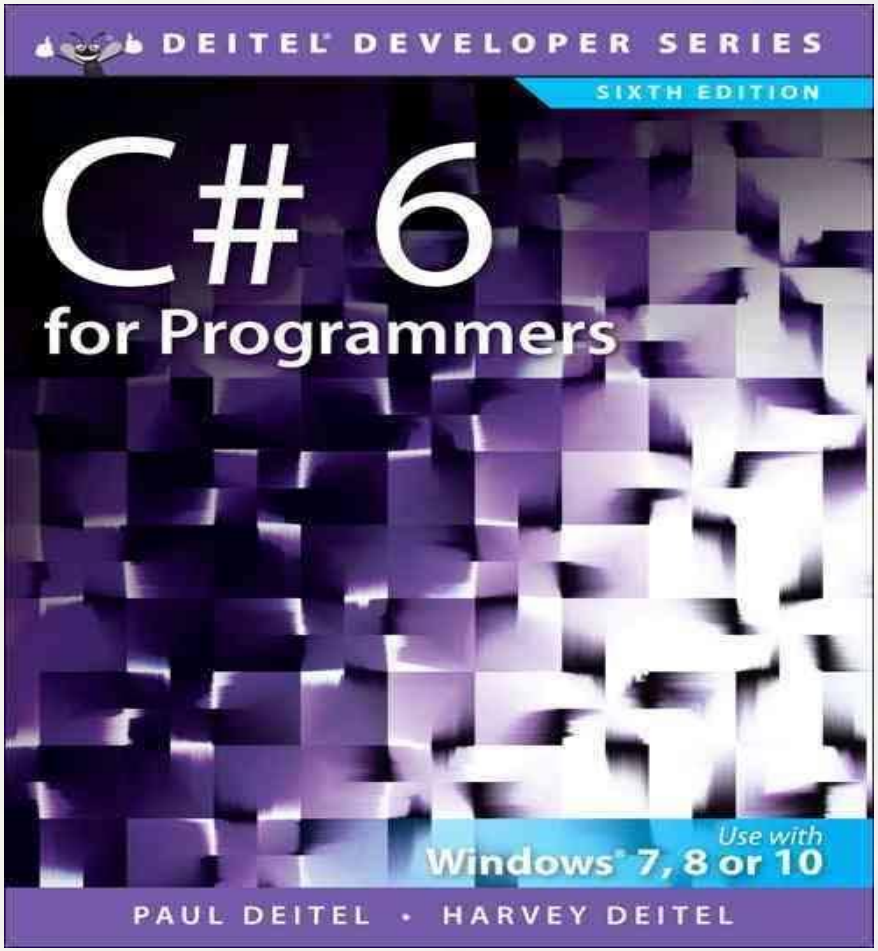
ASP. Net MVC Text Books for Projects



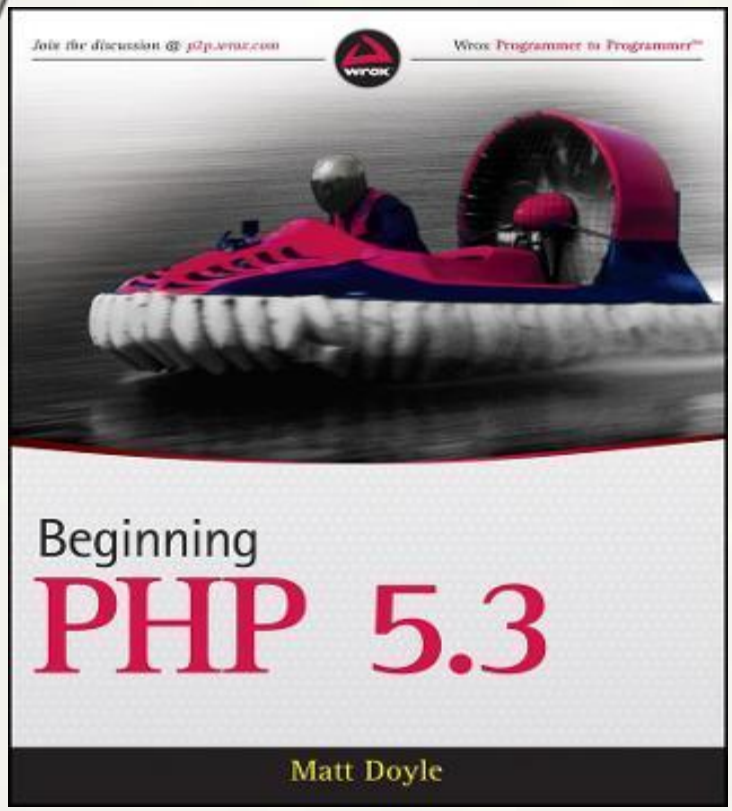


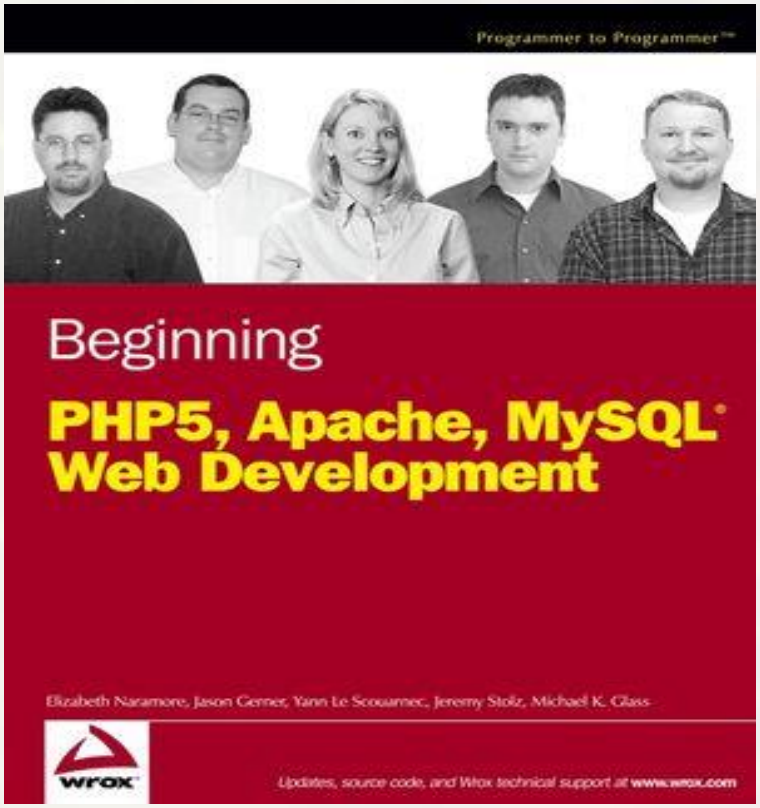
C# Text Books for Projects





PHP Text Books for Projects





Database Tools

- MS SQL Server 2019
  - https://www.microsoft.com/en-us/sql-server/sql-server-downloads
- Sql Server Management Studio (SSMS) for MS SQL Server
  - https://docs.microsoft.com/en-us/sql/ssms/download-sql-server-management-studio-ssms?view=sql-server-ver15
- MySQL Community Server
  - https://dev.mysql.com/downloads/mysql/
- PhpMyAdmin for MYSQL
  - https://www.phpmyadmin.net/downloads/
- SQLYog Editor for MySQL
  - https://sqlyog.en.download.it/
- Oracle
  - https://www.oracle.com/database/technologies/oracle-database-software-downloads.html
- Toad Editor for Oracle
  - https://www.toadworld.com/products/downloads?type=Trial&download=toad-for-oracle

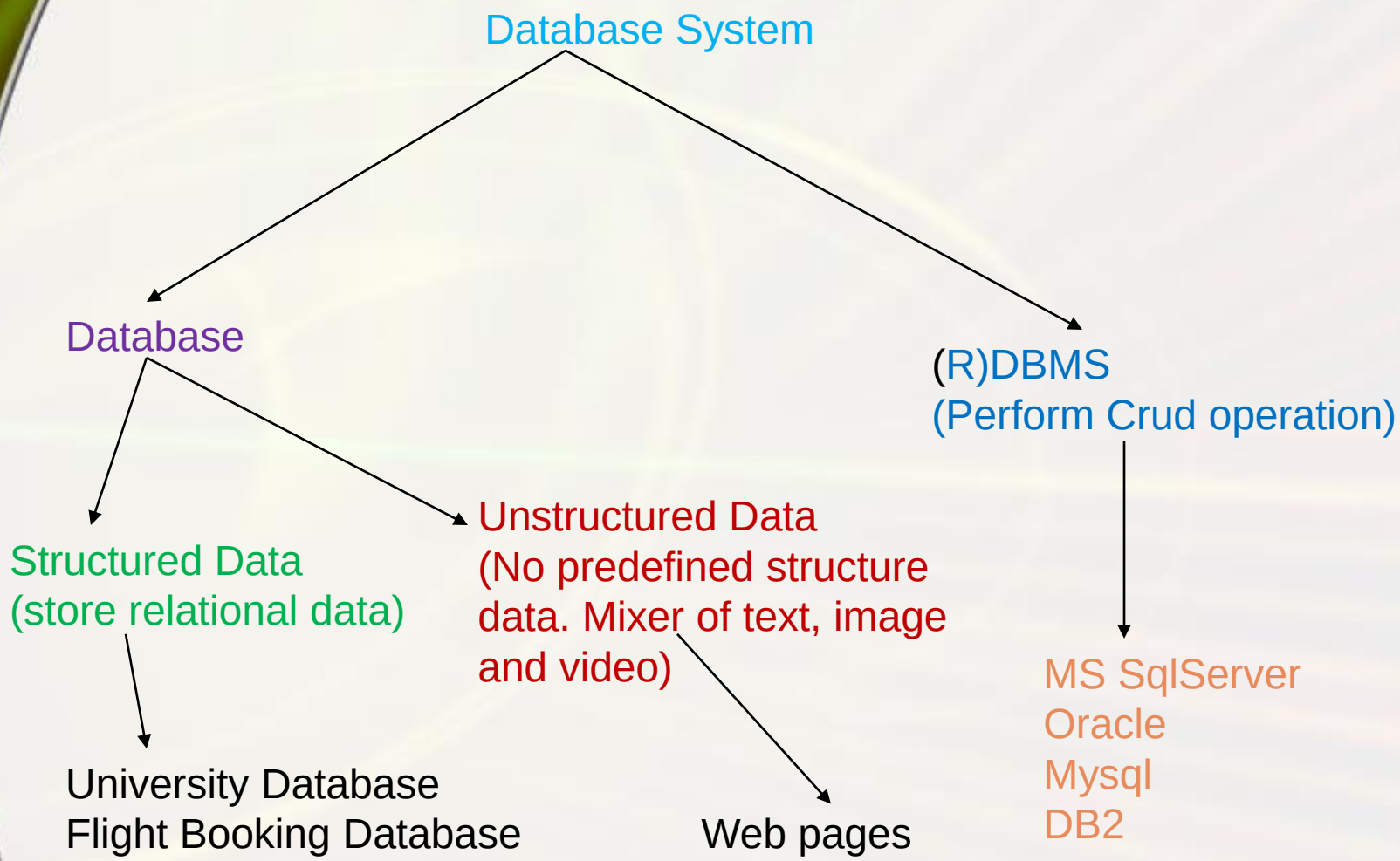
Semester Project

- Project Selection
  - Select database based project
    - EX: Web based project or Mobile web etc.
    - Project must include CRUD operations
  - Use any language to build your project.
    - Most popular ones are Asp.net/MVC, PHP, Python etc.
  - Finalize your project topic within two weeks.
  - Submit your project topic to me via email on or before (2078-10-17)
  - Prepare Prototype of your project (I will tell you later how to make prototype).

Introduction

- **Basic Definitions**
- **Database**: A collection of related data with an implicit meaning is a database
  - For example, a library card catalog is a database that may be created and maintained manually or it may be computerized.
- **Data**: Known facts that can be recorded and have an implicit meaning.
  - For example, consider the names, telephone numbers, and addresses of the people you know
- **Mini-world or universe of discourse (UoD**): Represent some part of the real world about which data is stored in a database.
  - For example, student grades and transcripts at a university.
- **Database Management System (DBMS):** A software package/ system to facilitate the creation and maintenance of a computerized database.
  - For example: MySQL, PostgreSQL, Microsoft Access, SQL Server, Oracle
- **Database System**: The DBMS software together with the data itself. Sometimes, the applications are also included.
  - in other words, we will call the database and DBMS software together a database system

Introduction



Typical DBMS Functionality

- **Define a database** : in terms of data types, structures and constraints
- Construct or Load the Database on a secondary storage medium
- **Manipulating the database** : querying, generating reports, insertions, deletions and modifications to its content
- **Concurrent Processing and Sharing by a set of users and programs** – yet, keeping all data valid and consistent
  - Sharing a database allows multiple users and programs to access the database simultaneously.
- **Other features**:
  - Protection: includes system protection against hardware or software malfunction (or crashes)
  - Security measures: to prevent unauthorized or malicious access
  - “Active” processing to take internal actions on data
  - Presentation and Visualization of data

Example of a Database (with a Conceptual Data Model)

- Mini-world for the example: Part of a UNIVERSITY environment.
- Some mini-world entities:
  - STUDENTs
  - COURSEs
  - SECTIONs (of COURSEs)
  - (academic) DEPARTMENTs
  - INSTRUCTORs
- Note: The above could be expressed in the ENTITY-RELATIONSHIP data model.
- Some mini-world relationships:
  - SECTIONs are of specific COURSEs
  - STUDENTs take SECTIONs
  - COURSEs have prerequisite COURSEs
  - INSTRUCTORs teach SECTIONs
  - COURSEs are offered by DEPARTMENTs
  - STUDENTs major in DEPARTMENTs
- Note: The above could be expressed in the ENTITY-RELATIONSHIP data model.

Main Characteristics of the Database Approach

- **Self-describing nature of a database system**: A DBMS catalog stores the description of the database. The description is called meta-data. This allows the DBMS software to work with different databases.
- Below is Example of Database Catalog.

Relations	
Relation_Name	No_of_Columns
Student	4
Course	3

Columns		
Col_Name	Data_Type	Belongs_to_Relation
Name	Char(30)	Student
CourseName	Char(30)	Course

- **Insulation between programs and data**: Called program-data independence. Allows changing data storage structures and operations without having to change the DBMS access programs.
  - In traditional file processing: structure of data files is embedded in the application programs
  - In database approach: structure of data files is stored in the DBMS catalog which is separate from access programs (program data independence)
- **Data Abstraction:** A data model is used to hide storage details and present the users with a conceptual view of the database.

Main Characteristics of the Database Approach

- **Support of multiple views of the data:** Each user may see a different view of the database, which describes only the data of interest to that user.
  - A view is subset of database which contains virtual data derived from database (
  - not explicitly stored).
- **Sharing of data and multiuser transaction processing** : allowing a set of concurrent users to retrieve and to update the database. Concurrency control within the DBMS guarantees that each **transaction** is correctly executed or completely aborted. OLTP (Online Transaction Processing) is a major part of database applications.
  - Example reservation of particular seat by flight booking agent

Database Users

- Users may be divided into those who actually use and control the content (called “Actors on the Scene”) and those who enable the database to be developed and the DBMS software to be designed and implemented (called “Workers Behind the Scene”).
- Actors on the scene
  - **Database administrators**: responsible for authorizing access to the database, for coordinating and monitoring its use, acquiring software, and hardware resources, controlling its use and monitoring efficiency of operations.
  - **Database Designers**: responsible to define the content, the structure, the constraints, and functions or transactions against the database. They must communicate with the end-users and understand their needs.
  - **End-users**: they use the data for queries, reports and some of them actually update the database content.

Categories of End-users

- **Casual** : access database occasionally when needed
- **Naïve or Parametric** : they make up a large section of the end-user population. They use previously well-defined functions in the form of “canned transactions” against the database. Examples are bank-tellers or reservation clerks who do this activity for an entire shift of operations. Social media users post and read items on social media Web sites.
- **Sophisticated** : these include business analysts, scientists, engineers, others thoroughly familiar with the system capabilities. Many use tools in the form of software packages that work closely with the stored database.
- **Stand-alone** : mostly maintain personal databases using ready-to-use packaged applications. An example is a tax program user that creates his or her own internal database.

Advantages of Using the Database Approach

- Controlling redundancy in data storage and in development and maintenance efforts.
- Sharing of data among multiple users.
- Restricting unauthorized access to data.
- Providing persistent storage for program Objects (in Object-oriented DBMS's – see Chs. 20-22)
- Providing Storage Structures for efficient Query Processing
- Providing backup and recovery services.
- Providing multiple interfaces to different classes of users.
  - These include apps for mobile users, query languages for casual users, programming language interfaces for application programmers, forms and command codes for parametric users, and menu-driven interfaces and natural language interfaces for standalone users. GUI or Web GUI
- Representing complex relationships among data.
- Enforcing integrity constraints on the database.
  - The simplest type of integrity constraint involves specifying a data type for each data item, primary key, foreign key etc.
- Drawing Inferences and Actions using rules
  - Triggers

Additional Implications of Using the Database Approach

- **Potential for enforcing standards**: this is very crucial for the success of database applications in large organizations Standards refer to data item names, display formats, screens, report structures, meta-data (description of data) etc.
- **Reduced application development time**: incremental time to add each new application is reduced.
- **Flexibility to change data structures**: database structure may evolve as new requirements are defined.
- **Availability of up-to-date information** – very important for on-line transaction systems such as airline, hotel, car reservations.
- **Economies of scale**: by consolidating data and applications across departments wasteful overlap of resources and personnel can be avoided.

Historical Development of Database Technology

- **Early Database Applications**: The Hierarchical and Network Models were introduced in mid 1960's and dominated during the seventies. A bulk of the worldwide database processing still occurs using these models.
- **Relational Model based Systems**: The model that was originally introduced in 1970 was heavily researched and experimented with in IBM and the universities. Relational DBMS Products emerged in the 1980's.
- **Object-oriented applications:** OODBMSs were introduced in late 1980's and early 1990's to cater to the need of complex data processing in CAD and other applications. Their use has not taken off much.
- **Data on the Web and E-commerce Applications:** Web contains data in HTML (Hypertext markup language) with links among pages. This has given rise to a new set of applications and E-commerce is using new standards like XML (eXtended Markup Language).

Extending Database Capabilities

- **New functionality is being added to DBMSs in the following areas**:
  - Scientific Applications : data from experiment
  - Image Storage and Management : X-ray, MRI images etc.
  - Audio and Video data management: Storage and retrieval of videos, such as movies, and video clips from news or personal digital cameras
  - Data Mining: applications that analyze large amounts of data to search for the occurrences of specific patterns or relationships, and for identifying unusual patterns in areas such as credit card fraud detection
  - Spatial data management: applications that store and analyze spatial locations of data, such as weather information, maps used in geographical information systems, and automobile navigational systems
  - Time Series and Historical Data Management: applications that store information such as economic data at regular points in time, such as daily sales and monthly gross national product figures
- *The above gives rise to new research and development in incorporating new data types, complex data structures, new operations and storage and indexing schemes in database systems.*

Emergence of Big Data Storage Systems and NOSQL Databases

- The proliferation of applications and platforms such as social media Web sites, large e-commerce companies, Web search indexes, and cloud storage/backup led to a surge in the amount of data stored on large databases and massive servers
- New types of database systems were necessary to manage these huge databases—systems that would provide fast search and retrieval as well as reliable and safe storage of nontraditional types of data, such as social media posts and tweets
- Some of the requirements of these new systems were not compatible with SQL relational DBMSs (SQL is the standard data model and language for relational databases).
- Therefore, NOSQL comes into existence.
- The term *NOSQL* is generally interpreted as Not Only SQL, meaning that in systems than manage large amounts of data, some of the data is stored using SQL systems, whereas other data would be stored using NOSQL, depending on the application requirements.
- Example of NoSQL DB is MonoDB

When not to use a DBMS

- **Main inhibitors (costs) of using a DBMS**:
  - High initial investment and possible need for additional hardware.
  - Overhead for providing generality, security, concurrency control, recovery, and integrity functions.
- **When a DBMS may be unnecessary**:
  - If the database and applications are simple, well defined, and not expected to change.
  - If there are stringent real-time requirements that may not be met because of DBMS overhead.
  - If access to data by multiple users is not required.
- **When no DBMS may suffice**:
  - If the database system is not able to handle the complexity of data because of modeling limitations
  - If the database users need special operations not supported by the DBMS.

Review Questions

- Define the following terms: data, database, DBMS, database system, database catalog, program-data independence, user view, DBA, end user, canned transaction, deductive database system, persistent object, meta-data, and transaction-processing application.
- What four main types of actions involve databases? Briefly discuss each.
- Discuss the main characteristics of the database approach and how it differs from traditional file systems.
- What are the responsibilities of the DBA and the database designers?
- What are the different types of database end users? Discuss the main activities of each.
- Discuss the capabilities that should be provided by a DBMS.
- Discuss the differences between database systems and information retrieval systems.

Any Questions