Information Systems Analysis and Design

Application vs Database

Lecture Outline

- Information System Life Cycle
- Phases of Database Design
- ER Modeling
- UML Diagrams

Organizational Context for using Database Systems

- Consolidation and integration of data across organization
- Maintenance of complex data
- Simplicity of developing new applications
- Data independence
  - Protecting application programs from changes in the underlying logical organization and in the physical access paths and storage structures
- External Schemas
  - Allow the same data to be used for multiple applications with each application having its own view of the data

Information System

- Information System includes all resources involved in the collection, management, use and dissemination of the information resources of the organization
- We consider two systems life cycles:
  - Macro Life Cycle
    - Information System Life Cycle
  - Micro Life Cycle
    - Database System Life Cycle

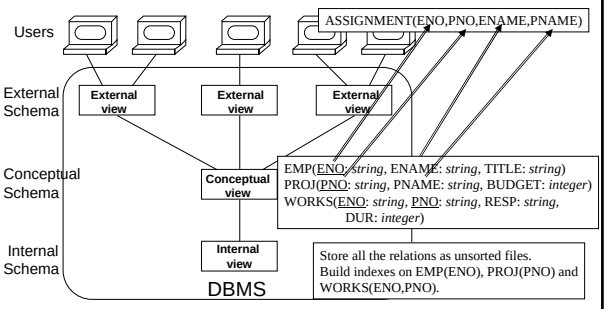
Phases of Information System Life Cycle

- Feasibility Analysis
  - Analyzing potential application areas
  - Identifying the economics of information gathering and dissemination
  - Performing cost benefit studies
  - Setting up priorities among applications
- Requirement Collection and Analysis
  - Detailed Requirements Collection
  - Interaction with Users
- Design
  - Design of Database System
  - Design of programs that use and process the database

Phases of Information System Life Cycle (contd.)

- Implementation
  - Information system is implemented
  - Database is loaded & its transactions are implemented and tested
- Validation and Acceptance Testing
  - Testing against user's requirements
  - Testing against performance criteria
- Deployment, Operation and Maintenance
  - Data conversion
  - Training
  - System maintenance
  - Performance monitoring
  - Database tuning

Database Architecture



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Database System Life Cycle

- System definition
  - Defining scope of database system, its users and applications
- Database Design
  - Logical and physical design of the database system on the chosen DBMS
- Database implementation
  - Specifying conceptual, external and internal database definitions
  - Creating empty database files
  - Implementing software applications

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Database System Life Cycle (contd.)

- Loading or data conversion
  - Populating the database
- Application conversion
  - Converting applications to the new system
- Testing and validation
- Operation
  - Running the new system
- Monitoring and maintenance
  - System maintenance
  - Performance monitoring

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Overview of Database Design Process

- Two main activities:
  - Database design
  - Applications design
- Database design focuses on the conceptual schema for a database application
- Applications design focuses on the programs and interfaces that access the database
  - Generally considered part of software engineering

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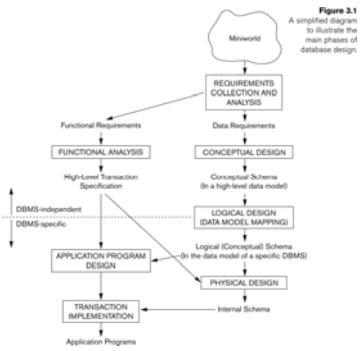
Overview of Database Design Process



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Database Design Process

- Problem
  - Design the logical and physical structure of one or more databases to accommodate the information needs of the users in an organization for a defined set of applications.
- Goals
  - Satisfy the content requirements
  - Provide easy structuring of information
  - Support processing requirements and performance objectives

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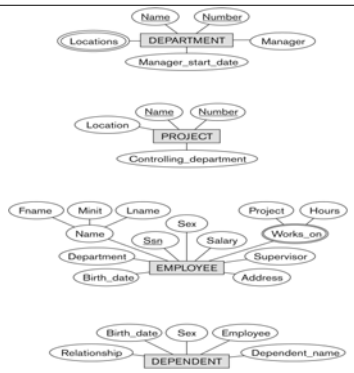
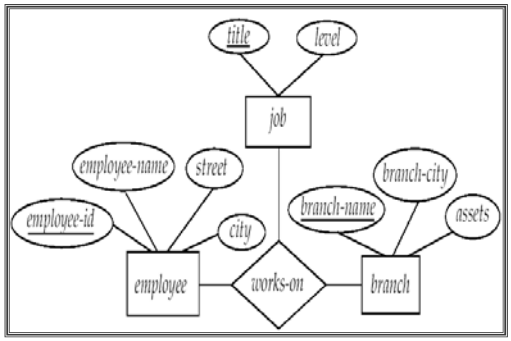
Data Modeling Using the Entity-Relationship (ER) Model

- Overview of Database Design Process
- Example Database Application (COMPANY)
- ER Model Concepts
  - Entities and Attributes
  - Entity Types, Value Sets, and Key Attributes
  - Relationships and Relationship Types
  - Weak Entity Types
  - Roles and Attributes in Relationship Types
- ER Diagrams - Notation
  - Alternative Notations – UML class diagrams, others

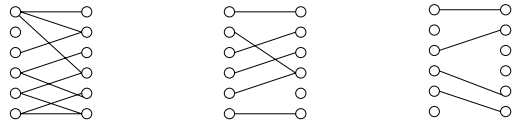
ER Model - Entities



ER Model - Relationships



ER Model - Multiplicity…

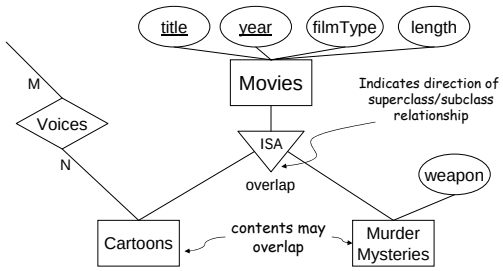


many-many

many-one

one-one

Specialization / Generalization



Phases of Database Design and Implementation Process

- Requirements Collections and Analysis
- Conceptual Database Design
- Choice of a DBMS
- Data Model Mapping (Logical Database Design)
- Physical Database Design
- Database System Implementation and Tuning

Phases of Database Design and Implementation Process (contd.)

- Requirements Collections and Analysis
  - Identifying Users
  - Interacting with users to gather requirements
  - Time consuming BUT very important
    - Very expensive to fix requirements error
- Conceptual Database Design
  - Produce a conceptual schema for the database that is independent of a specific DBMS
  - Involves two parallel activities
    - Conceptual Schema Design
    - Transaction and Application Design

Conceptual Schema Design

- Goal
  - Complete understanding of the database structure, semantics, interrelationships and constraints
- Serves as a stable description of the database contents
- Good understanding crucial for the users and designers
- Diagrammatic description serves as an excellent communication tool

Desired Characteristics of Conceptual Data Model

- Expressiveness
  - Able to distinguish different types of data, relationships and constraints
- Simplicity and Understandability
  - Easy to understand
- Minimality
  - Small number of distinct basic concepts
- Diagrammatic Representation
  - Diagrammatic notation for representing conceptual schema
- Formality
  - Formal unambiguous specification of data

Choice of DBMS

- Many factors to consider
  - Technical Factors
    - Type of DBMS: Relational, object-relational, object etc.
    - Storage Structures
    - Architectural options
  - Economic Factors
    - Acquisition, maintenance, training and operating costs
    - Database creation and conversion cost
  - Organizational Factors
    - Organizational philosophy
      - Relational or Object Oriented
      - Vendor Preference
    - Familiarity of staff with the system
    - Availability of vendor services

Logical Database Design

- Transform the Schema from high-level data model into the data model of the selected DBMS.
- Design of external schemas for specific applications
- Two stages
  1. System-independent mapping
     - DBMS independent mapping
  2. Tailoring the schemas to a specific DBMS
     - Adjusting the schemas obtained in step 1 to conform to the specific implementation features of the data model used in the selected DBMS
- Result
  - DDL statements in the language of the chosen DBMS

Physical Database Design

- Design the specifications for the stored database in terms of physical storage structures, record placements and indexes.
- Design Criteria
  - Response Time
    - Elapsed Time between submitting a database transaction for execution and receiving a response
  - Space Utilization
    - Storage space used by database files and their access path structures
  - Transaction throughput
    - Average number of transactions/minute
    - Must be measured under peak conditions
- Result
  - Initial determination of storage structures and access paths for database files

Database System Implementation and Tuning

- During this phase database and application programs are implemented, tested and deployed
- Database Tuning
  - System and Performance Monitoring
  - Data indexing
  - Reorganization
- Tuning is a continuous process

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UML Diagrams

- Class Diagrams
  - Capture the static structure of the system
  - Represent classes, Interfaces, dependencies, generalizations and other relationships
- Object Diagrams
  - Show a set of objects and their relationships
- Component Diagrams
  - Show the organizations and dependencies among software components
- Deployment Diagrams
  - Represent the distribution of components across the hardware topology

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UML Diagrams (contd.)

- Use Case Diagrams
  - Model the functional interactions between users and system
  - Describe scenarios of use
  - Serve as a communication tool between users and developers

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UML Diagrams (contd.)

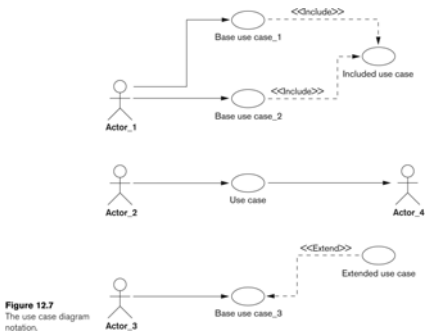

Figure 12.7
The use case diagram notation.

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UML Diagrams (contd.)

- Sequence Diagrams
  - Represent interactions between various objects over time
  - Relate uses cases and class diagrams

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UML Diagrams (contd.)

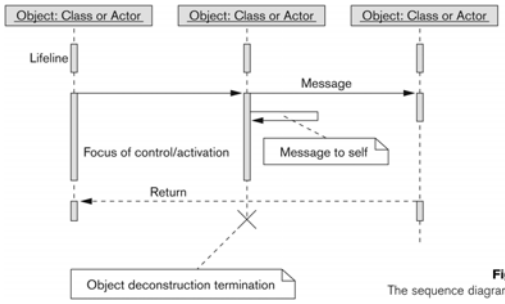

Figure 12.9
The sequence diagram notation.

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UML Diagrams (contd.)

- Collaboration Diagrams
  - Represent interactions between objects as a series of sequenced messages
- Statechart Diagram
  - Describe how an object's state changes in response to external events
  - Consist of states, transitions, actions, activities and events

UML Diagrams (contd.)

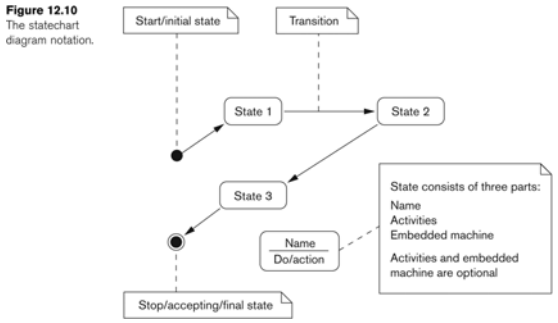

Figure 12.10
The statechart diagram notation.

UML Diagrams (contd.)

- Activity Diagrams
  - Model the flow of control from activity to activity
  - Flowcharts with states