Data Modeling using ER Model

- Database design process
  - requirements collection and analysis:
    database requirements and functional requirements
  - conceptual DB design using a high-level model:
    easier to understand and communicate with others
  - logical DB design (data model mapping):
    conceptual schema is transformed from a high-level data model into implementation data model
  - physical database design:
    internal data structures and file organizations for DB are specified
  - application programs and transactions are designed and implemented according to the high-level specification
Entity-Relationship (ER) Model

- Entities and attributes
  - entity: an object in the real-world with an independent existence (either physical or conceptual)
  - entity type defines a set of entities with the same properties: people, buildings, departments
  - attributes: a set of properties that describes the entity attributes (people) = age, color, SSN, address ...
  - a particular entity has a value for each of its attributes
  - distinction between entities and attributes depends entirely on the context
    <ex> color may be an entity with attributes name and freq
  - an entity is represented by the values of its attributes
  - key attribute of entity type: unique value for an entity
ER Model

- Relationships
  - an association among several entities

- binary relationships: only 2 entity sets involved

- mapping cardinality:
  - one-to-one (1:1), one-to-many (1:N), many-to-many (N:M)
  - enrollment: many-to-many
  - manages: one-to-many

- function: one-to-many binary relationship

- N:M relationship is not a function, difficult to represent in some logical models
ER Diagrams

entity: rectangles

relationship: diamonds

attributes: ellipses

Students

enrollment

Courses

Name
SSN
Major

Course#
C.description

Semester

Term
Year

Name
SSN
Major

Course#
C.description

Semester

Term
Year
ER Diagrams

A customer can have several accounts
An account can be owned by several customers.
Representing Relationships

Relationships in ER model should not be confused with relations in relational model

● Relational model
  - as a relation
  - uniformity: both data (entity sets) and relationships are represented by a collection of tables (relations), each having # of columns with unique names

● Network model
  - link between records
  - data records are organized as collections of arbitrary graphs

● Hierarchical model
  - link between records
  - data records are organized as collections of trees
Representing Relationships

Relational

<table>
<thead>
<tr>
<th>Name</th>
<th>Street</th>
<th>City</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowery</td>
<td>Maple</td>
<td>NY</td>
<td>900</td>
</tr>
<tr>
<td>Shiver</td>
<td>North</td>
<td>DC</td>
<td>555</td>
</tr>
<tr>
<td>Shiver</td>
<td>North</td>
<td>DC</td>
<td>667</td>
</tr>
<tr>
<td>Hong</td>
<td>Sunny</td>
<td>Cheville</td>
<td>801</td>
</tr>
<tr>
<td>Hong</td>
<td>Sunny</td>
<td>Cheville</td>
<td>667</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number</th>
<th>Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>900</td>
<td>1055</td>
</tr>
<tr>
<td>555</td>
<td>1000</td>
</tr>
<tr>
<td>667</td>
<td>2000</td>
</tr>
<tr>
<td>801</td>
<td>100</td>
</tr>
</tbody>
</table>
Representing Relationships

Network

Lowery  Maple  NY  900  1055
Shiver  North  DC  555  1000
Hong    Sunny  Cheville  667  2000

Hierarchical

Lowery  Maple  NY  900  1055
Shiver  North  DC  555  1000
Hong    Sunny  Cheville  667  2000

One tree for each customer
Many-to-many relationships are handled by duplicating records
System Structure of DBMS

- Divide and conquer
  - DBMS is a complex software system, need to be partitioned into components to deal with each of the responsibilities
  - DB manager, file manager, compilers, query processor
  - OS provides the most basic services: overhead

- Database manager
  - handles database access at run-time, enforcing integrity
  - scheduling, concurrency control, recovery, cache manage
  - access to disk goes through file manager

- File manager (stored data manager)
  - control access to DBMS information stored on disk:
    - data files and meta-data (data dictionary)

- Compilers and query processor
  - compiers for DDL and DML, and interactive queries
Different user groups use different interfaces

- naive (parametric) users: canned application programs such as automatic teller machine (min. keystrokes)
- casual users: query formulation using DML, menu/form-based interfaces, graphical interfaces
- application programmers: use DML and API embedded in host languages
- DBA (database administrator) staff: use DDL statements and privileged commands to construct and maintain DB schemas, and to control database manager and file managers during run-time e.g., creating accounts, setting system parameters, granting authorization, changing schemas.
Database Administrator (DBA)

The group or person responsible for proper and efficient operation and use of the database

- Functions of DBA
  - schema definition
  - storage and access methods definition (physical schema)
  - access authorization and control
  - integrity constraints specification
  - data validation
  - performance monitoring and restructuring if necessary