The Entity-Relationship Model

Overview of Database Design

- Requirements analysis
- Conceptual design → data model
- Logical design
- Schema refinement: Normalization
- Physical tuning

Conceptual Design

- **Conceptual design**: *(ER Model is used at this stage.)*
  - What are the entities and relationships in the enterprise?
  - What information about these entities and relationships should we store in the database?
  - What are the integrity constraints or business rules that hold?
  - A database `schema` in the ER Model can be represented pictorially *(ER diagrams)*.
  - Can map an ER diagram into a relational schema.

Entities

- Employees
  - ssn
  - name
  - lot
**ER Model Basics**

- **Entity**: Real-world object distinguishable from other objects. An entity is described (in DB) using a set of attributes.
- **Entity Set**: A collection of similar entities. E.g., all employees.
  - All entities in an entity set have the same set of attributes.
  - Each entity set has a **key**.
  - Each attribute has a **domain**.

**Relationships**

- **Relationship**: Association among two or more entities.
  - E.g., Attishoo works in Pharmacy department.
- **Relationship Set**: Collection of similar relationships.
  - An n-ary relationship set $R$ relates n entity sets $E_1 \ldots E_n$.
  - Each relationship in $R$ involves entities $e_1$ in $E_1$, $\ldots$, $e_n$ in $E_n$.

**ER Model Basics (Contd.)**

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**Relationships (Contd.)**

- **Want to capture supervisor-subordinate relationship**

Database Management Systems, R. Ramakrishnan and Johannes Gehrke
Relationships (Contd.)

- Want to capture information that a Supplier supplies Part to Department.

Ternary Relationship

How are these different?

Key Constraints

- An employee can work in many departments; a dept can have many employees.

- Each dept has at most one manager, according to the key constraint on Manages.
Key Constraints: Examples

- Example Scenario 1: An inventory database contains information about parts and manufacturers. Each part is constructed by exactly one manufacturer.
- Example Scenario 2: A customer database contains information about customers and sales persons. Each customer has exactly one primary sales person.
- What do the ER diagrams look like?

Exercise: What does this mean?

- Example Scenario 1 (Contd.): Each part is constructed by exactly one or more manufacturer.
- Example Scenario 2: Each customer has exactly one primary sales person.

Participation Constraints

- An employee can work in many departments; a dept can have many employees.
- Each employee works in at least one department according to the participation constraint on Works_In.
Weak Entities

- A weak entity can be identified uniquely only by considering the primary key of another (owner) entity.
  - Owner entity set and weak entity set must participate in a one-to-many relationship set (one owner, many weak entities).
  - Weak entity set must have total participation in this identifying relationship set.

ISA (‘is a’) Hierarchies

- As in C++, or other PLs, attributes are inherited.
- If we declare A ISA B, every A entity is also considered to be a B entity.
  - Overlap constraints: Can Joe be an Hourly_Emps as well as a Contract_Emps entity? (Allowed/disallowed)
  - Covering constraints: Does every Employees entity also have to be an Hourly_Emps or a Contract_Emps entity? (Yes/no)
- Reasons for using ISA:
  - To add descriptive attributes specific to a subclass.
  - To identify entities that participate in a relationship.

Aggregation

- Used when we have to model a relationship involving (entity sets and) a relationship set.
- Aggregation allows us to treat a relationship set as an entity set for purposes of participation in (other) relationships.

Class Exercise

- Give two real-life examples where each of the following would occur:
  - A key constraint
  - A participation constraint
  - A weak entity set
Class Exercise

Draw ER diagram for a database used to manage SI440 class (at least 3 entities)
- Specify entities, attributes, identifiers
- Specify relationships
- Specify constraints

Class Exercise

Drugwarehouse.com has offered you a free lifetime supply of prescription drugs (no questions asked) if you design its database schema. Given the rising cost of health care, you agree. Here is the information that you gathered:
- Patients are identified by their SSN, and we also store their names and age
- Doctors are identified by their SSN, and we also store their names and specialty
- Each patient has one primary care physician
- Each doctor has at least one patient

Conceptual Design Using the ER Model

- Design choices:
  - Should a concept be modeled as an entity or an attribute?
  - Should a concept be modeled as an entity or a relationship?
  - Identifying relationships: Binary or ternary? Aggregation?
- Constraints in the ER Model:
  - A lot of data semantics can (and should) be captured.
  - But some constraints cannot be captured in ER diagrams.

Summary of Conceptual Design

- Conceptual design follows requirements analysis
- ER model popular for conceptual design
- Basic constructs: entities, relationships, and attributes
- Some additional constructs: weak entities, ISA hierarchies, and aggregation.
- Note: There are many variations on ER model.