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High Level Database Models

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Database Design & Deployment

- Requirements Analysis
  - Conceptual Database Design
  - Logical Database Design
  - Physical Database Design (DDL/DML)
  - Business Processes
    - SQL Operations & program code
  - Testing
  - Production

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Overview Database Design

• Conceptual Design
  – Use entity-relationship (aka ER) model represented pictorially as ER diagrams
  – Map ER model to relational schema

• Questions to ask yourself
  – What are the entities and relationships in the application?
  – What information about these entities and relationships should we store in the database?
  – What are the integrity constraints or business rules that hold?
ER Model Basics: Entities

- **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. (Until we consider ISA hierarchies, anyway!)
  - Each entity set has a key.
  - Each attribute has a domain.
ER Model Basics: Relationships

- **Relationship**: Association among two or more entities.

- **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 $e_1 \in E_1, \ldots, e_n \in E_n$.
  
  - Same entity set could participate in different relationship sets, or in different “roles” in same set.

\[\text{Employees} \rightarrow \text{Works_In} \rightarrow \text{Departments}\]
Cardinality Ratios of Relationships

- Consider binary relationships, i.e., between two entity sets
- Alternate notation: 1:1, 1:M, M:1, M:N
Key Constraints

- Consider Works_In: An employee can work in many depts; a dept can have many employees: m-to-m
- Consider Manages: each dept has at most one manager
- Dept has a **key constraint** on Manages: each instance of dept appears in at most one instance of manages
- Denoted by an arrow: given a dept entity we can uniquely identify the manages relationship in which it appears
Participation constraints

- Does every dept have a manager?
- If so, this is a participation constraint: the participation of dept in Manages is said to be total (vs. partial). Denoted by thick/double line
- Meaning that every Dept entity must appear in an instance of the Manages relationship
Set Theoretic Formulation

- **Partial Partitipation**: Not all members of the Employees entity set take part in the manages relations
- **Total Partitipation**: All members of the Dept entity set take part in the manages relationship
- Dept has a **key constraint** on Manages: each member of the dept entity set takes part in at most one member of the manages relationship set
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.
- Denoted by a box with double or thick lines
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?
- How much semantics to capture in the form of constraints?
Entity vs. Attribute

- Depends upon how we want to use the address information, and the semantics of the data:
  - If we have several addresses per employee, *address* must be an entity (since attributes cannot be set-valued).
  - If the structure (city, street, etc.) is important, e.g., we want to retrieve employees in a given city, *address* must be modeled as an entity (since attribute values are atomic).