Conceptual Design
The Entity-Relationship (ER) Model

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Entities and Entity Sets

Keys

Entity Set Representation
Relationships and Relationship Sets

- **Relationship**: Association among two (or more) entities
  - “Gabriel works in CS department”
  - Can have descriptive attributes: e.g., “since 9/1/2011”
  - But relationship must be fully determined by entities!
  - Binary, ternary or multi-way (n-way) relationships

- **Relationship Set**: Collection of similar relationships
  - Contains n-tuples (e₁, ..., eₙ), where eᵢ belongs to entity set Eᵢ
  - Instance: “snapshot” of relationship set at some point in time

Visualizing Relationships and Rel. Sets

![Diagram](image)

- Edge = Relationship
- Set of Edges = Relationship Set

A Special Case of Relationship

- An entity set can participate in a relationship set with itself
  - Entities in same set play different roles in the relationship
  - Role indicators express the role

Representation Convention:

- Relationship sets: diamonds
- Edges connect relationship sets to entity sets, and relationship sets to relationship set attributes

Example 1

- **Works_In relationship**: an employee can work in many departments; a dept can have many employees. *many-to-many*

Key Constraints

- How many other entities can an entity have a relationship with?
  - Also referred to as relationship multiplicity

![Diagram](image)

- 1-to-1
- 1-to-Many
- Many-to-1
- Many-to-Many
**Example 2**

- **Manages** relationship: each dept has *at most one* manager
  - one-to-many
  - from Employees to Departments, or
  - many-to-one
  - from Departments to Employees

**Participation Constraints**

- **Total vs Partial Participation**
  - **Total**: every department must have a manager
  - "Departments" entity set has total participation in relationship
  - Represented as thickened line (there is a key constraint as well)
  - **Partial**: not every employee is a manager
  - "Employees" entity set has partial participation

**Design Choices in the ER Model**

- Should a concept be modeled as an entity or an attribute?
- Should a concept be modeled as an entity or a relationship?
  - Considers hierarchies and inheritance
  - Outside the scope of this class

**Entity vs. Attribute**

- Should *address* be an attribute of Employees or an entity (connected to Employees by a relationship)?

Sometimes *address* may have to be an entity:

- If we have several addresses per employee (since attributes cannot be set-valued)
- If the structure (city, street, etc.) is important, e.g., retrieve employees in a given city (attribute values are atomic!)
Example
Design a database for a bank, including information about customers and their accounts. Information about customers includes their name, address, phone and SSN. Accounts have numbers, types (e.g., savings/checking) and balances.
1. Draw the E/R diagram for this database.
2. Modify the E/R diagram such that each customer must have at least one account.
3. Modify the E/R diagram further such that an account can have at most one customer.