Overview of ER Model

- Proposed for informal database design (conceptual schema)
  - by Peter Chen in 1976

- World/enterprise described in terms of
  - Entities (things)
  - Attributes (properties of things)
  - Relationships (relations between things)

- Visualization: ER diagram.

- Algorithmic ways to convert ER diagrams to relational databases exist.

Basic ER Modeling

- Entity: a distinguishable object
- Entity set: set of entities of same type
  - Examples:
    - students currently at the Institute
    - flights offered by Air Canada
    - burglaries in Ontario during 1994
    - Foods available on campus

- Graphical representation of entity sets:

Basic ER Modeling (cont’d)

- Attributes describe properties of entities
  - Example:
    - For Food: Name, Cuisine, …

- Domain: set of permitted values for an attribute

- Graphical representation of attributes:
Basic E-R Modeling (cont’d)

- **Relationship**: representation of the fact that certain entities (usually two or more) are related to each other.
- **Relationship set**: set of relationships of a given type.
  - Examples:
    - students registered in courses
    - students bought foods
    - passengers booked on flights
    - parents and their children

In order for a relationship to exist, the participating entities must exist.

An ER Diagram

<table>
<thead>
<tr>
<th>Food Service</th>
<th>Food</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ricomini</td>
<td>Beverages</td>
</tr>
<tr>
<td>Ricomini</td>
<td>Sandwich</td>
</tr>
<tr>
<td>Ricomini</td>
<td>Soup</td>
</tr>
<tr>
<td>Brubakers</td>
<td>Pita</td>
</tr>
<tr>
<td>Brubakers</td>
<td>Pizza</td>
</tr>
<tr>
<td>Brubakers</td>
<td>Pasta</td>
</tr>
<tr>
<td>Brubakers</td>
<td>Soup</td>
</tr>
</tbody>
</table>

Example

- Suppose that students prefer to eat certain foods at certain food services.
Multiple Relationships and Roles

- **Role**: the function of an entity set in a relationship set
- **Role name**: an explicit indication of a role
- **Example**:

  Role labels are needed whenever an entity set has multiple functions in a relationship set.

Constraints in E-R Models

- Key Constraints
- Participation Constraints
- Primary keys
- Existence dependencies
  - Weak entities

General
Cardinality
Constraints

N:N Relationships

- **many-to-many (N:N)**: an entity can be related to many entities in the other set, and vice versa.
- **Example**:

  N:N is the least restricted constraint
1:1 Relationships

- **one-to-one (1:1):** each entity in A can be related to at most one entity in B, and vise versa.

- **Example:**

  - Old notation

  ![Diagram](image)

  1:1 is the most restricted constraint

1:N Relationships

- **one-to-many (1:N):** each entity in A can be related to at most one entity in B, but an entity in B may be related to many entities in A.

- **Example:**

  ![Diagram](image)

  similarly: many-to-one (N:1)

General Cardinality Constraints

- Determine lower and upper bounds on the number of relationships of a given relationship set in which a component entity may participate.

  **Participating Constraints**

  ![Diagram](image)

Primary Keys

- Each entity must be distinguishable from any other entity in an entity set by its attributes.

  - **Definition:** a primary key is a minimal set of attributes whose values uniquely determine a particular entity.

  - **Examples:**

    ![Diagram](image)
Existence Dependencies

Sometimes the existence of an entity depends on the existence of another entity.

- If \( x \) is existence dependent on \( y \), then
  - \( y \) is a dominant entity
  - \( x \) is a subordinate entity

**Example:** “Branches are existence dependent on Food Services.”

Identifying Subordinate Entities

Attributes of entity sets with subordinate entities only form key relative to a given dominant entity.

- **Weak entity set:** an entity set with subordinate entities
- **Strong entity set:** an entity set with no subordinate entities

Identifying Relationship Set

A weak entity set must have a 1:N relationship to a distinct entity set.

**Definition:** Discriminator of a weak entity set is a set of attributes that distinguishes subordinate entities of the set, for a particular dominant entity.

**Primary key for a weak entity set:** discriminator + primary key of entity set for dominating entities

Another E-R Diagram Example

A contest 4 diagram is shown with entities and relationships.
Extensions to E-R Modeling

- Structured attributes
- Aggregation
- Specialization
- Generalization

Structured Attributes

- Composite attributes: composed of fixed number of other attributes
- Multi-valued attributes: attributes that are set-valued

Examples:
- Branch
  - Building
  - Floor
- Student
  - Name
  - Major
  - Hobbies

Aggregation

- Relationships can be viewed as higher-level entities
- Example: “Students prefer to eat certain foods at certain food services.”

Specialization

- A specialized kind of entity set may be derived from a given entity set.
- Example: “Salads are food that have Dressing”
Generalization

Several entity sets can be abstracted by a more general entity set.

- Example: “Food abstracts the notion of a Salad, Soup, Sandwich, etc.”

Attributes or Entity Sets?

- Example: Should one model students’ phones by a Phone# attribute, or by a Phone entity set related to the Student entity set?

- Rules of thumb:
  - Is it a separate object?
  - Do we maintain information about it?
  - Can several of its kind belong to a single entity?
  - Does it make sense to delete such an object?
  - Can it be missing from some of the entity set’s entities?
  - Can it be shared by different entities?

- An affirmative answer to any of the above implies introducing a new entity set.

Designing An E-R Schema

Usually many ways to design an E-R schema

- Points to consider
  - use attribute or entity set?
  - use entity set or relationship set?
  - degrees of relationships?
  - extended features?

Non-Binary Relationships?

- Do you prefer Slide 8 or 23?
  - We can always represent a relationship on \( n \) entity sets with \( n-1 \) binary relationships (may need aggregation)
**Entity Sets or Relationships?**

- Instead of representing “manages” as a relationship, we could represent it as a manager entity set.

**A Simple Methodology**

1. Recognize entity sets
2. Recognize relationship sets and participating entity sets
3. Recognize attributes of entity and relationship sets
4. Define binary relationship types and existence dependencies
5. Define general cardinality constraints, keys and discriminators
6. Draw diagram

For each step, maintain a log of assumptions motivating the choices, and of restrictions imposed by the choices.

**Important Notes**

1. Avoid redundancy.
2. Limit the use of weak entity sets.
3. Don’t use an entity set when you can choose an attribute.
4. Don’t use a relationship set when you can choose an entity set.

**Examples of Bad Design**

Contest 5

Recommended Exercises: Ramakrishnan's 2.2 – 2.4 and 2.8