Entity-Relationship Modeling: RELATIONSHIPS

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Topics

• Relationships
• Structural Constraint
• (min,max) Notation
• Translation into Relational Tables
Relationship

- Entities may be related to one another, each entity takes a role in the **relationship**.
  
  Example: a course, a teacher, and a student may be related – the student is taking the course taught by the teacher.

- The number of *roles* (therefore entities, in general) involved is called the **degree** of the relationship.

- In our ER modeling, we only need to focus on:
  - relationships of a fixed degree;
  - relationships of degree 2, binary relationships.

- Justification: sufficient, and readily implementable.

Relationship Instances…

<table>
<thead>
<tr>
<th>course</th>
<th>course</th>
</tr>
</thead>
<tbody>
<tr>
<td>title: DB Mgt Sys number: 4240</td>
<td>title: E-Business number: 4249</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>teacher</th>
<th>teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td>name: P. Laverty phone: x 9420</td>
<td>name: P. Wu phone: x 9427</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>teaches</th>
<th>teaches</th>
</tr>
</thead>
<tbody>
<tr>
<td>(P. Laverty, 4249)</td>
<td>(P. Wu, 4240)</td>
</tr>
</tbody>
</table>
Relationship Set in ER Model

- A **relationship set** is represented as a *diamond* in the ER diagram, connecting entity sets.
- We *may* label the roles along the connecting lines.

![ER Diagram Example](image_url)

Relationship and Relationship Set

- A **relationship** is a generic description of the nature of a relationship between the entity types.
- A **relationship instance** brings together the *specific* entities which are related by the relationship.
- A **relationship set** is the collection of all the relationship instances of the relationship type.

![ER Diagram Example](image_url)
Relationship and Attributes

- A Relationship may have attributes, too.
- Identifies a property or characteristic of each instance of the relationship type…

Relationship: patron - loan - book

- The *due date* is an attribute in each *instance* of a patron taking out a book on loan.

Relationship and Attributes

Each competitor will compete and get rated by a panel of judges, each giving a score…

Relationship: Judge - rates - Competitor

Judge rates Competitor

score
Relationship and Roles

• The same entity set can be related to the same relationship set; note the different roles.

![Diagram showing pre-requisite relationship]

Relationship and Roles

• The same two entity sets can be related to each other in two different relationship sets.

![Diagram showing relationships between faculty, student, teaches, advises]
Structural Constraints

• The information structure depicted in our ER model may have certain constraints, pertaining to the nature of the relationships in the model:
  – Participation Constraint: about how the entity sets are participating in the relationship.
  – Cardinality Constraint: about the ratio of the number of entities in each entity sets being related.
• Collectively, these are known as the structural constraints of the Entity-Relationship model.

Participation Constraint

When an entity set participates in a relationship, it may participate partially, or totally.
• Partial Participation: some entities of the set do not participate in any relationship instance.
• Total Participation: every entity of the set participate in at least one relationship instance.
Partial Participation

- Example of partial participation: some employees may not work on any project. The entity set Employee participates partially in the relationship “works on”.
- But we may not allow a project with no employees.

Total Participation

- Every project must have at least one employee.
- The entity set Project participates totally in the “works on” relationship: a double connection line.
Cardinality Ratio: 1-to-1

- When an entity set participates in a (binary) relationship, the cardinality ratio specifies the ratio between number of related entities in the relationship.
- For example: at most one manager for every department, and a manager manages no more than one department. One-to-one.

Cardinality Ratios

- There may be other forms of ratios...
- We label only these forms – 1:1, 1:M, M:1, M:M.
- Many employees may serve the same department, but each employee may not serve more than one department.
Cardinality Ratio: M-to-M

- An example of M:M ratio – an employee may work on more than one project; any project may have more than one employee working on it. **M-to-M.**

Cardinality Ratio and Participation

- Two *different dimensions* of the constraints on a relationship: *any* combination is possible.
Cardinality and Participation

- Every department must have at least one employee.
- Every employee must serve exactly one department.
- There may be many employees serving one department.

Structural Constraints: \((\text{min, max})\) notation

- We may label participation in a relationship \((\text{min, max})\) to specify the range for each entity in the participation: 
  \(\text{min}/\text{max}\) is an integer value or \(*\) - an arbitrary number.
Structural Constraints: (min,max) notation

- An employee may serve no department; min=0.
- An employee may serve at most one department; max=1.
- A department must have at least one employee; min=1.
- A department may have up to any number of employees; max=*

Two notations are related...

- The min value of 0 implies partial participation.
- The min value of 1 or larger implies total participation.
- What can we say about the max values and cardinality ratios?
Relationship to Tables

- A relationship set may or may not be translated into a table.

- If each course is taught by at most one instructor.

- An additional column to the course table suffices.
If a course may be taught by more than one instructors, we may need to create another table.

Use another table for the relationship set...

Note how the keys from the entity sets work for the relationship set in the table.
Relationship: M-to-M

- Create a new table for the relationship.
- Combine keys from both Entity Sets to be its Key.
- Add a column for each of its own attributes.

Relationship: 1-to-M or M-to-1

- No new table necessary (unless preferred).
- Extend table on the M-side (in this case E2), with total participation.
- Add a column for each of the key attributes of E1.
- Add a column for each attribute of relationship R.
Relationship: 1-to-1

- Extend either table or both tables; if total participation.
- Add a column (to an extended table) for each key attributes of the other entity set (to both tables, if both extended).
- For each attribute of relationship R, add a column to either one of the extended tables.

### E1 (extended for R)

<table>
<thead>
<tr>
<th>k1</th>
<th>a1</th>
<th>k2</th>
<th>a3</th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

### E2 (extended for R)

<table>
<thead>
<tr>
<th>k2</th>
<th>a2</th>
<th>k1</th>
<th>a4</th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>29...</td>
</tr>
</tbody>
</table>