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…

course
  title: DB Mgt Sys
  number: 4240

teaches
  (P. Laverty, 4249)

teaches
  (P. Wu, 4240)

course
  title: E-Business
  number: 4249

teacher
  name: P. Laverty
  phone: x 9420

teacher
  name: P. Wu
  phone: x 9427
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.

```
  teacher  teaches  course
    |           |
    |__name__   |  taught by |
    |           |
    |__phone__  |           |
        |           |
```

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.

```
  student  takes  course
        |     |     |
        |__   |     |
        |     |__   |
        |     |
```

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Relationship and Attributes

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

- 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 and Roles

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

Relationship and Roles

• The same two entity sets can be related to each other in two different relationship sets.
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 \textit{(binary)} relationship, the cardinality ratio specifies the ratio between number of related entities in the relationship.
- For example: \textit{at most} one manager for every department, and a manager manages \textit{no more} than one department. \textit{one-to-one}.
- Every department must have a manager.

Cardinality Ratios

- There may be other forms of ratios...
- We label only these forms – \textit{1:1}, \textit{1:M}, \textit{M:1}, \textit{M:M}.
- Many employees may serve the same department, but each employee may \textit{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: \((\text{min}, \text{max})\) notation

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

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

Two notations are related...

- The \(\text{min}\) value of 0 implies partial participation.
- The \(\text{min}\) value of 1 or larger implies total participation.
- What can we say about the \(\text{max}\) values and cardinality ratios?
Two notations are related...

- The \textit{max} values on both sides indicate the \textit{cardinality ratio}.
- The min value on either side has nothing to do with cardinality ratio.
- \((\_, 1)\) vs \((\_, 1)\) on both sides indicates \textit{one-to-one} relationship.
- \((\_, *)\) vs \((\_, *)\) on both sides indicates \textit{many-to-many} relationship
  … The max value of 2 or larger works the same way as *.
- \((\_, *)\) vs \((\_, 1)\) in that direction indicates \textit{one-to-many} relationship.
- \((\_, 1)\) vs \((\_, *)\) in that direction indicates \textit{many-to-one} relationship.

Relationship to Tables

- A \textit{relationship set} may or may \textit{not} be translated into a table.
• If each course is taught by at most one instructor.

• An addition column to the course table suffices.

- If a course may be taught by more than one instructors, we may need to create another table.
Relationship to Tables

- Use another table for the relationship set…

<table>
<thead>
<tr>
<th>instructor</th>
<th>teaches</th>
<th>course</th>
</tr>
</thead>
<tbody>
<tr>
<td>name</td>
<td>name</td>
<td>number</td>
</tr>
<tr>
<td>phone</td>
<td>phone</td>
<td>title</td>
</tr>
<tr>
<td>Laverty</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9429</td>
<td></td>
<td>Database Management</td>
</tr>
<tr>
<td>Wu</td>
<td></td>
<td>Document Processing</td>
</tr>
<tr>
<td>9426</td>
<td></td>
<td>Electronic Business</td>
</tr>
</tbody>
</table>

- 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.

E1
k1 a1
...
...

E2 (extended for R)
k2 a2 k1 a3
...
...
...

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)
k1 a1 k2 a3
...
...
...

E2 (extended for R)
k2 a2 k1 a4
...
...
...
... 30...