Database Foundations

Relationships

3-6
Roadmap

Conceptual and Physical Data Models

Business Rules

Entities

Attributes

Unique Identifiers

Relationships

Validating Relationships

Tracking Data Changes over Time

Validating Data Using Normalization

You are here
Objectives

This lesson covers the following objectives:

• Identify relationships
• Identify the optionality of relationships
• Identify the cardinality of relationships
• Identify nontransferable relationships
• Name relationships
Relationships

A relationship is a bidirectional, significant association between two entities or between an entity and itself.
Components of a Relationship

Each direction of a relationship has:

- A name
- Cardinality

![Diagram of a relationship between DEPARTMENT and EMPLOYEE, showing cardinality with One Mandatory, Optional, and Many (crow's foot) notations.]
What Is Optionality in a Relationship?

Relationships are either mandatory or optional. Consider the two entities, **EMPLOYEE** and **JOB**. Based on what you know about instances of the entities, you can determine optionality by answering two questions:

- Must every employee have a job? In other words, is this a mandatory or an optional relationship for an employee?
- Must every job be done by an employee? In other words, is this a mandatory or optional relationship for a job?
What Is Cardinality in a Relationship?

• Cardinality measures the quantity of something.
• In a relationship, it determines the degree to which one entity is related to another by answering “How many?”

For example:

• How many jobs can one employee hold? One job only? Or more than one job?
• How many employees can hold one specific job? One employee only? Or more than one employee?
Optionality and Cardinality: Examples

• Each EMPLOYEE must hold one and only one JOB.
• Each JOB may be held by one or more EMPLOYEES.
• Each PRODUCT must be classified by one and only one PRODUCT TYPE.
• Each PRODUCT TYPE may classify one or more PRODUCTS.
Relationship Types

All relationships represent the information requirements and the rules of the business.

- Many-to-one (M:1) or one-to-many (1:M)
- Many-to-many (M:M)
- One-to-one (1:1)

Example of a 1:M relationship

CUSTOMER

place

ORDER

placed by
Many-to-One and One-to-Many Relationships

• Many-to-one and one-to-many relationships (M:1 and 1:M) have cardinality of one or more in one direction and one and only one in the other direction.

• Business rules:
  – Each CUSTOMER must be visited by one and only one SALES REPRESENTATIVE.
  – Each SALES REPRESENTATIVE may be assigned to one or more CUSTOMERS.
Many-to-Many Relationships

- Many-to-many relationships (M:M) have cardinality of one or more in both directions.

**Business rules:**
- Each EMPLOYEE may be assigned to one or more JOBS.
- Each JOB may be carried out by one or more EMPLOYEES.
One-to-One Relationships

• One-to-one relationships (1:1) have cardinality of one and only one in both directions.

• Business rules:
  – Each **COMPUTER** must contain one and only one **MOTHERBOARD**.
  – Each **MOTHERBOARD** must be contained in one and only one **COMPUTER**.
Recursive Relationships

• A relationship with an entity and itself

- Business rules:
  - Each EMPLOYEE may manage one or more EMPLOYEES.
  - Each EMPLOYEE must be managed by one and only one EMPLOYEE.
Non-Transferable Relationships

• A non-transferable relationship cannot be moved between instances of the entities it connects.

• A non-transferable relationship is represented by a diamond on the relationship.

• Non-transferable relationships can only be mandatory. For example, the birth country of a person is non-transferable.

![Diagram showing a non-transferable relationship between a person and a country]
Case Scenario

A membership must be held by exactly one person. The membership relationship cannot be moved to another person.

Transferable or Non-transferable?
Relationship Matrix: Collecting Information

A relationship matrix can be used to collect initial information about the relationships among a set of entities.

<table>
<thead>
<tr>
<th></th>
<th>CUSTOMER</th>
<th>ITEM</th>
<th>ORDER</th>
<th>WAREHOUSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>CUSTOMER</td>
<td></td>
<td></td>
<td>place</td>
<td></td>
</tr>
<tr>
<td>ITEM</td>
<td></td>
<td></td>
<td>contained on</td>
<td>stored in</td>
</tr>
<tr>
<td>ORDER</td>
<td>placed by</td>
<td></td>
<td>issued for</td>
<td></td>
</tr>
<tr>
<td>WAREHOUSE</td>
<td></td>
<td>store</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Relationship Matrix: Mapping the Contents
Map the contents of the relationship matrix to an ERD.

- ORDER is issued for ITEM.
- CUSTOMER places the ORDER.
- ITEM is contained on WAREHOUSE.
- WAREHOUSE stores the ITEM.

Diagram: 
- ORDER to ITEM: issued for
- ORDER to CUSTOMER: placed by
- ITEM to WAREHOUSE: stored in
- CUSTOMER to WAREHOUSE: place
Determining a Relationship's Existence

Examine each pair of entities to determine whether a relationship exists.

<table>
<thead>
<tr>
<th></th>
<th>ACTIVITY</th>
<th>DEPARTMENT</th>
<th>EMPLOYEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTIVITY</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>DEPARTMENT</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EMPLOYEE</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Naming the Relationship

Name each direction of a relationship.

<table>
<thead>
<tr>
<th></th>
<th>ACTIVITY</th>
<th>DEPARTMENT</th>
<th>EMPLOYEE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACTIVITY</td>
<td></td>
<td></td>
<td>assigned to</td>
</tr>
<tr>
<td>DEPARTMENT</td>
<td></td>
<td></td>
<td>composed of</td>
</tr>
<tr>
<td>EMPLOYEE</td>
<td>participate in</td>
<td>assigned to</td>
<td></td>
</tr>
</tbody>
</table>
Determining the Relationship’s Minimum Cardinality

What is the minimum cardinality in each direction?

DEPARTMENT

Zero (optional)

composed of

One (mandatory)

EMPLOYEE

assigned to
Determining the Relationship’s Maximum Cardinality

What is the maximum cardinality in each direction?

One (one and only one)

Many (one or more)
Validating the Relationship

Reexamine the ERD and validate the relationship.

- **Each** EMPLOYEE **must be assigned to one and only one DEPARTMENT**.
- **Each** DEPARTMENT **may be composed of one or more EMPLOYEES**.
Create ERDish sentences to represent ERDs

- Use ERDish language to state relationships between entities in an ERD.
- Simply break down each ERDish sentence into its components.

Breaking down ERDish

BOOK written by the author of AUTHOR
Components of ERDish

• EACH
• Entity A
• OPTIONALITY (must be/may be)
• RELATIONSHIP NAME
• CARDINALITY (one and only one/ one or more)
• Entity B
ERDish Example

Because a relationship has two sides, first read one side from left to right.

1. EACH
2. BOOK (entity A)
3. MUST BE (optionality, solid line)
4. WRITTEN BY (relationship name)
5. ONE (AND ONLY ONE) (cardinality, single toe)
6. AUTHOR (entity B)

Next, read the relationship from right to left.

1. EACH
2. AUTHOR (entity B)
3. MAY BE (optionality, dotted line)
4. THE AUTHOR OF (relationship name)
5. ONE OR MORE (cardinality, crow's foot)
6. BOOK (entity A)
Case Scenario

1. EACH
2. BOOK (entity A)
3. MUST BE (optionality, solid line)
4. WRITTEN BY (relationship name)
5. ONE AND ONLY ONE (cardinality, single toe)
6. AUTHOR (entity B)

1. EACH
2. AUTHOR (entity B)
3. MAY BE (optionality, dotted line)
4. THE AUTHOR OF (relationship name)
5. ONE OR MORE (cardinality, crow's foot)
6. BOOK (entity A)
Summary

In this lesson, you should have learned how to:
• Identify relationships
• Identify the optionality of relationships
• Identify the cardinality of relationships
• Identify nontransferable relationships
• Name relationships