Entity-Relationship Model

From Chapter 5, Kroenke book
Database Design Process

- Requirements analysis
- Conceptual design → data model
- Logical design
- Schema refinement: Normalization
- Physical tuning
Problem: University Database

- Divisions (Colleges)
- Departments
- Faculty
- Students
### The College Report

**College of Business**  
*Mary B. Jefferson, Dean*

<table>
<thead>
<tr>
<th>Department</th>
<th>Chairperson</th>
<th>Phone</th>
<th>Total Majors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accounting</td>
<td>Jackson, Seymour P.</td>
<td>232-1841</td>
<td>318</td>
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<tr>
<td>Finance</td>
<td>HeuTeng, Susan</td>
<td>232-1414</td>
<td>211</td>
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<tr>
<td>Info Systems</td>
<td>Brammer, Nathaniel D.</td>
<td>236-0011</td>
<td>247</td>
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<td>Management</td>
<td>Tuttle, Christine A.</td>
<td>236-9988</td>
<td>184</td>
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<tr>
<td>Production</td>
<td>Barnes, Jack T.</td>
<td>236-1184</td>
<td>212</td>
</tr>
</tbody>
</table>

Phone: 232-1187  
Campus Address:  
*Business Building, Room 100*
The Department Report

<table>
<thead>
<tr>
<th>Professor</th>
<th>Office</th>
<th>Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jones, Paul D.</td>
<td>Social Science, 219</td>
<td>232-7713</td>
</tr>
<tr>
<td>Parks, Mary B</td>
<td>Social Science, 308</td>
<td>232-5791</td>
</tr>
<tr>
<td>Wu, Elizabeth</td>
<td>Social Science, 207</td>
<td>232-9112</td>
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The Department Major Report

<table>
<thead>
<tr>
<th>Major's Name</th>
<th>Student Number</th>
<th>Phone</th>
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<tbody>
<tr>
<td>Jackson, Robin R.</td>
<td>12345</td>
<td>237-8713</td>
</tr>
<tr>
<td>Lincoln, Fred J.</td>
<td>48127</td>
<td>237-8713</td>
</tr>
<tr>
<td>Madison, Janice A.</td>
<td>37512</td>
<td>237-8713</td>
</tr>
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</table>
Mr. Fred Parks  
123 Elm Street  
Los Angeles, CA 98002  

Dear Mr. Parks:

You have been admitted as a major in the Accounting Department at Highline University, starting in the Fall Semester, 2005. The office of the Accounting Department is located in the Business Building, Room 210.

Your adviser is professor Elizabeth Johnson, whose telephone number is 232-8740 and whose office is located in the Business Building, Room 227. Please schedule an appointment with your adviser as soon as you arrive on campus.

Congratulations and welcome to Highline University!

Sincerely,

Jan P. Smathers  
President  
JPS/rkp
Conceptual Design Overview

- Entity-Relationship (ER) Model
- What are the **entities** and **relationships** for given problem?
- What information about these entities and relationships should we store?
- What are the **integrity constraints** or business rules that hold?
Entities

- Something that can be identified and the users want to track
  - Entity class
  - Entity instance
- There are usually many instances of an entity in an entity class.
Attributes

- **Attributes**: describe the characteristics of an entity
- Entity instances:
  - Same attributes
  - Different values
Identifiers

- **Identifiers** = attributes that identify entity instances
- **Composite identifiers**: Identifiers that consist of two or more attributes
Relationships

- **Relationships**: associations between entities
- No attributes
- Relationship **degree**
Cardinality

- **Cardinality** means “count” - a number
- **Maximum cardinality**
- **Minimum cardinality**
Maximum Cardinality

- **Maximum cardinality**: maximum number of entity instances that can participate in a relationship
- One-to-One [1:1]
- One-to-Many [1:N]
- Many-to-Many [N:M]
Minimum Cardinality

- **Minimum cardinality**: minimum number of entity instances that must participate in a relationship.
  - zero [0] → optional
  - one [1] → mandatory
HAS-A Relationships

- Previous relationships: **HAS-A relationships**:
  - Each entity instance *has a* relationship with another entity instance:
    - An EMPLOYEE *has one* BADGE
    - A BADGE *has an* assigned EMPLOYEE.
Data Modeling Notation: ERwin

<table>
<thead>
<tr>
<th>ERwin Symbol Use</th>
<th>Meaning</th>
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<tbody>
<tr>
<td>Oval with hash mark</td>
<td>0 or 1 entities are allowed</td>
</tr>
<tr>
<td>Hash mark alone</td>
<td>Exactly 1 entity is allowed</td>
</tr>
<tr>
<td>Hash mark with crow’s foot</td>
<td>1 or more entities are allowed</td>
</tr>
<tr>
<td>Oval, hash mark, and crow’s foot</td>
<td>0, 1, or more entities are allowed</td>
</tr>
</tbody>
</table>
Class Exercise

- Give examples of the following relationships:
  - Maximum cardinality:
    - One-to-One
    - One-to-Many
    - Many-to-Many
  - Minimum cardinality
    - Optional-Optional
    - Mandatory-Optional
    - Mandatory-Mandatory
ID-Dependent Entities

- **ID-dependent entity**: entity (child) whose identifier includes the identifier of another entity (parent)
- Example:
  - BUILDING : APARTMENT
- Minimum cardinality from the ID-dependent entity to the parent is always one
ID-Dependent Entities

A solid line indicates an identifying relationship
Weak Entities

- A weak entity is an entity whose existence depends upon another entity.
- All ID-Dependent entities are considered weak.
- But there are also non-ID-dependent weak entities.
  - The identifier of the parent does not appear in the identifier of the weak child entity.
Weak Entities (Continued)

A dashed line indicates a **nonidentifying relationship**.

Weak entities must be indicated by an accompanying text box in Erwin — There is no specific notation for a nonidentifying but weak entity relationship.

Note: AUTO is a weak, but not ID-dependent, entity.

<table>
<thead>
<tr>
<th>VIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color</td>
</tr>
<tr>
<td>DateManufactured</td>
</tr>
<tr>
<td>Cost</td>
</tr>
<tr>
<td>SalesPrice</td>
</tr>
<tr>
<td>DateSold</td>
</tr>
</tbody>
</table>
ID-Dependent and Weak Entities

- **ID-Dependent entity**: Identifier depends (includes) another identifier
  - Identifying relationship
  - Ex: BUILDING:APARTMENT

- **Weak entity**: existence depends on another entity
  - Ex: MODEL:CAR

- ID-Dependent $\rightarrow$ Weak

- Weak does NOT imply ID-Dependent
Subtype Entities

- **Subtype entity**: special case of a supertype entity:
  - STUDENT: UNDERGRADUATE or GRADUATE

- Supertype:
  - all common attributes
  - [discriminator attribute]

- Subtypes:
  - specific attributes
Subtypes: Exclusive or Inclusive

- If subtypes are **exclusive**, one supertype relates to at most one subtype.
- If subtypes are **inclusive**, one supertype can relate to one or more subtypes.
Subtypes: Exclusive or Inclusive

(a) Exclusive:
Employee Can Be MANAGER or DB_ADMIN, but not Both

(b) Inclusive:
Employee Can Be MANAGER, DB_ADMIN, or Both
Subtypes: IS-A relationships

- **IS-A relationships**: a subtype IS A supertype.
- Supertype and subtypes identifiers are **identical**
- Use subtypes if
  - Have attributes that make sense only for subtypes
  - Want to specify a relationship only for subtype or supertype
ER Summary

- Entities, attributes, identifiers
- HAS-A Relationships
  - Degree: binary, ternary
  - Maximum cardinality
  - Minimum cardinality
- Weak entities
  - ID-dependent entities; identifying relationships
- IS-A Relationships
  - Inclusive, Exclusive
Class Exercise

- Draw ER diagram for a database used to manage IT360 class (at least 3 entities)
  - Specify entities, attributes, identifiers
  - Specify relationships
  - Specify cardinalities for relationships
Class Exercise

- Drugwarehouse.com has offered you a free lifetime supply of prescription drugs (no questions asked) if you design its database schema. Given the rising cost of health care, you agree. Here is the information that you gathered:
- Patients are identified by their SSN, and we also store their names and age
- Doctors are identified by their SSN, and we also store their names and specialty
- Each patient has one primary care physician
- Each doctor has at least one patient