Database Design Process

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

- Divisions (Colleges)
- Departments
- Faculty
- Students

The College Report

<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>
</tr>
<tr>
<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>
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</table>

College of Business
Mary B. Jefferson, Dean
Phone: 232-1187
Campus Address: Business Building, Room 100
The Department Report

Information Systems Department
College of Business
Chairperson: Brammer, Nathaniel D
Phone: 236-0011
Campus Address: Social Science Building, Room 213

<table>
<thead>
<tr>
<th>Professor</th>
<th>Office</th>
<th>Phone</th>
</tr>
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<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>
</tr>
</tbody>
</table>

The Department Major Report

Student Major List
Information Systems Department
Chairperson: Brammer, Nathaniel D Phone: 236-0011

<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>
</tbody>
</table>
The Student Acceptance Letter

Mr. Fred Parks
123 Elm Street
Los Angeles, CA 90002

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/Hp

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

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

<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>
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

A solid line indicates an identifying relationship
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

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
- 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