

## IT420: Database Management and Organization

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### Introduction to Entity-Relationship Model (Chapter 5)

## Last Time

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- Why Database Management Systems?
  - High-level abstractions for data access, manipulation, and administration
  - Data integrity and security
  - Performance and scalability
  - Transactions

## Goals of This Lecture

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- Database design: Entity-Relationship Model

## Database Design Process

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- 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<br>Mary B. Jefferson, Dean |                       |  |              |
|--|-----------------------|--|--------------|
| Phone: 232-1187                                |                       | Campus Address:<br>Business Building, Room 100 |              |
| Department                                     | Chairperson           | Phone  | Total Majors |
| Accounting                                     | Jackson, Seymour P.   | 232-1841                                       | 318          |
| Finance  | HeuTeng, Susan        | 232-1414                                       | 211          |
| Info Systems                                   | Brammer, Nathaniel D. | 236-0011                                       | 247          |
| Management                                     | Tuttle, Christine A.  | 236-9988                                       | 184          |
| Production                                     | Barnes, Jack T.       | 236-1184                                       | 212          |

## The Department Report

| Information Systems Department<br>College of Business |                     |          |
|---|---------------------|----------|
| Chairperson: Brammer, Nathaniel D                     |                     |          |
| Phone: 236-0011                                       |                     |          |
| Campus Address: Social Science Building, Room 213     |                     |          |
| Professor   | Office              | Phone    |
| Jones, Paul D.  | Social Science, 219 | 232-7713 |
| Parks, Mary B   | Social Science, 308 | 232-5791 |
| Wu, Elizabeth   | Social Science, 207 | 232-9112 |

## The Department Major Report

| Student Major List<br>Information Systems Department |                |                 |
|--|----------------|-----------------|
| Chairperson: Brammer, Nathaniel D                    |                | Phone: 236-0011 |
| Major's Name   | Student Number | Phone           |
| Jackson, Robin R.                                    | 12345          | 237-8713        |
| Lincoln, Fred J.                                     | 48127          | 237-8713        |
| Madison, Janice A.                                   | 37512          | 237-8713        |

## The Student Acceptance Letter

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?

## Data Model

- A **data model** is a plan, or blueprint, for a **database**.
- General
- Abstract (no implementation suggested)
- Easy to change

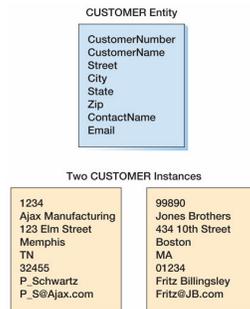
## ER Model

- **Entity-Relationship model**: set of concepts and graphical symbols
- Versions
  - **Original E-R model**
  - **Extended E-R model**
  - **Information Engineering (IE)**
  - **IDEF1X**
  - **Unified Modeling Language (UML)**

Original E-R model — Peter Chen (1976).  
Extended E-R model — Extensions to the Chen model.  
Information Engineering (IE) — James Martin (1990); it uses "crow's foot" notation, is easier to understand and we will use it.  
IDEF1X — A national standard developed by the NIST.  
Unified Modeling Language (UML) — The Object Management Group; it supports object-oriented methodology.

## 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

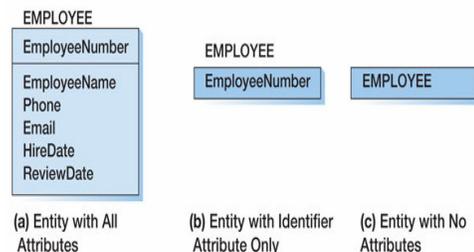
- Attributes:** describe the characteristics of an entity
- Entity instances:
  - Same attributes
  - Different values



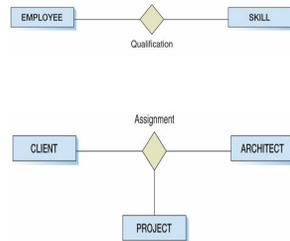
## Identifiers

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

## Entity Attributes Display in Data Models



## Relationships

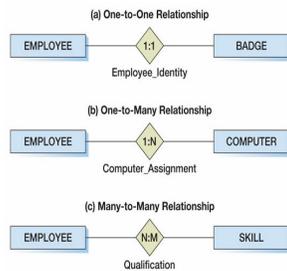


## Cardinality

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

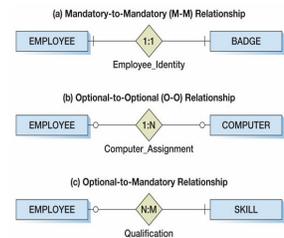
## Maximum Cardinality

- **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

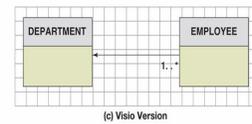
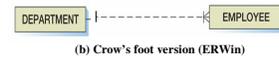
- **Minimum cardinality:** minimum number of entity instances that **must** participate in a relationship.
- **zero [0]** → optional
- **one [1]** → mandatory



## 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



## Data Modeling Notation: ERwin



| ERwin Symbol Use                 | Meaning                            |
|----------------------------------|------------------------------------|
| Oval with hash mark              | 0 or 1 entities are allowed        |
| Hash mark alone                  | Exactly 1 entity is allowed        |
| Hash mark with crow's foot       | 1 or more entities are allowed     |
| Oval, hash mark, and crow's foot | 0, 1, or more entities are allowed |

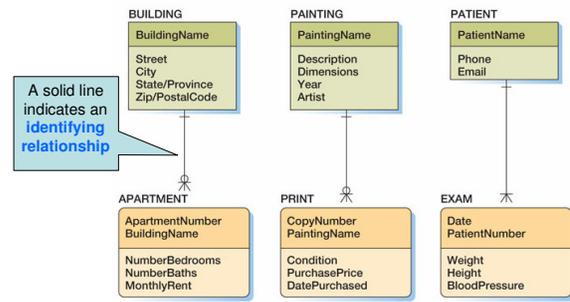
## Class Exercise

- 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

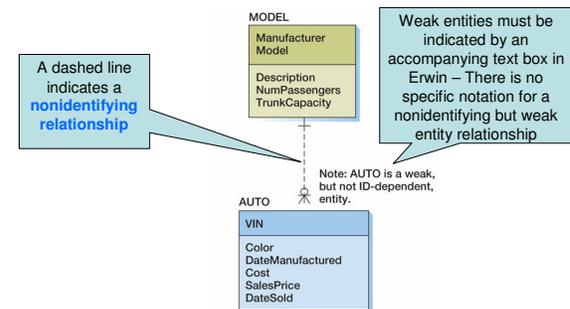
## ID-Dependent Entities



## 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)

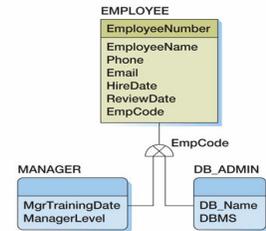


## ID-Dependent and Weak Entities

- **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 → Weak
- Weak does NOT imply ID-Dependent

## Subtype Entities

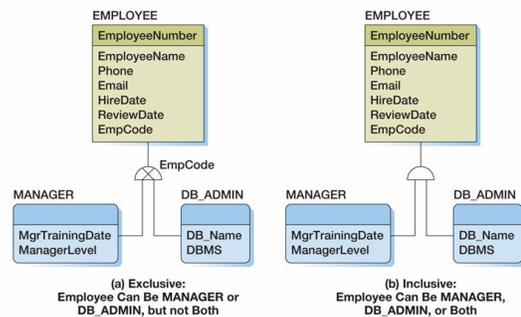
- **Subtype entity**: special case of a **supertype entity**:
  - STUDENT : UNDERGRADUATE or GRADUATE
- **Supertype**:
  - all common attributes
  - [discriminator attribute]
- **Subtypes**:
  - specific attributes



## 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



## Subtypes: IS-A relationships

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- **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

## Class Exercise

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- Drugwarehouse.com has offered you a free life-time 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

## ER Summary

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- 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

## For Next Time

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- Read Chapter 5