Database Design

Overview

- What is database?
- Why do we bother?
- Relational database
- Entity-Relationship Modeling
- Mapping class diagrams to tables

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What Is Database?

- A tool that stores data, and lets you create, read, update, and delete the data
- Information container
- Various types of database
  - Flat files
  - spreadsheets
  - XML
  - relational databases
    - mySQL, Oracle, DB2, Access

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Why Do We Use Database?

- Every non-trivial application uses databases to keep program states, to store, manipulate, and retrieve data
- Database plays a critical role in applications
  - Corrupted data => execution failure
  - Poor data organization => poor performance
- A poorly designed database application allows developers to put in arbitrary data
  - Enter a string "none" as a phone number

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Relational Database

- A digital database with a collection of tables
  - Each table contains rows and columns, with a unique key for each row
  - Each entity type described in a database has its own table
    - E.g., "Employee", "Item", "Order"
  - Each row represents an instance of the entity
    - E.g., "John Jenny", "Soap"
  - Each column represents an attribute
    - E.g., "phone number", "price"

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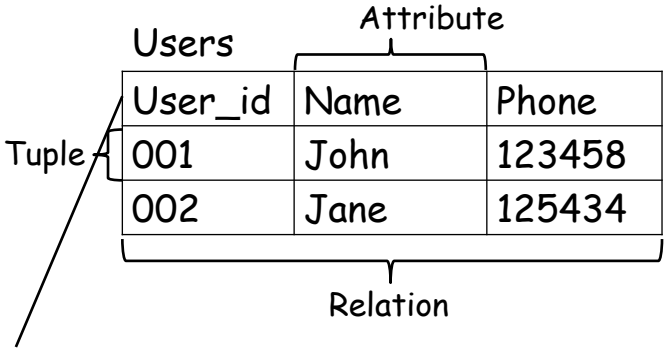
Relational Databases (cont.)



Primary Key/Unique Key: to uniquely specify a tuple in a table

Foreign Key: an attribute in a relational table that matches the primary key column of another table. It can be used to cross-reference tables.

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Entity-Relationship Models

- Entity-relationship (ER) diagrams are similar to semantic object modelings (class diagrams)
- It uses different notations
- Focuses more on relations and less on class structure

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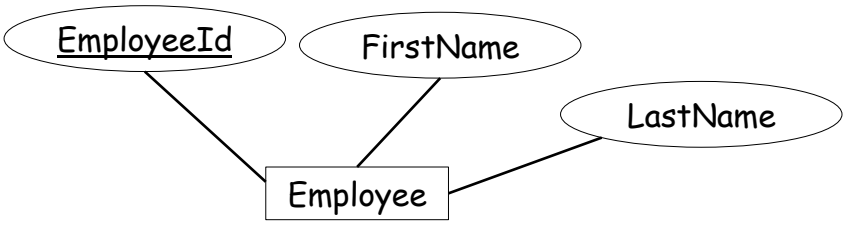
Entities and Attributes

- An entity is similar to a semantic object
- It includes attributes that describe the object



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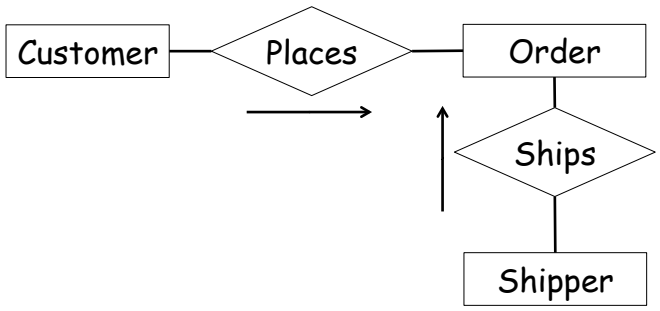
Relationships

- An ER diagram indicates a relationship between entities with a diamond
- Sometimes arrows are added to indicate direction of relationship



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Cardinality

- Numbers used to describe relationship quantitatively

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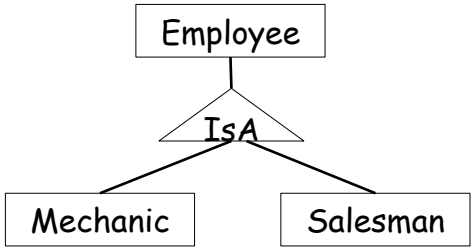
Inheritance

- A triangle named "IsA" represents the inheritance relationship



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Mapping Class Diagrams to Tables

Mapping Classes to Tables

Course
courseId name description
…

Student
studentId firstName lastName
…

Courses
CourseId
Name
Description

Students
StudentId
FirstName
LastName

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Key Points about Tables

- Sometimes you need to explicitly add a primary key to distinguish data in tables
- Database usually provides functionality to automatically increment primary key

Sale
date: Date isComplete:bool
…

Sales
SaleId
Date
IsComplete

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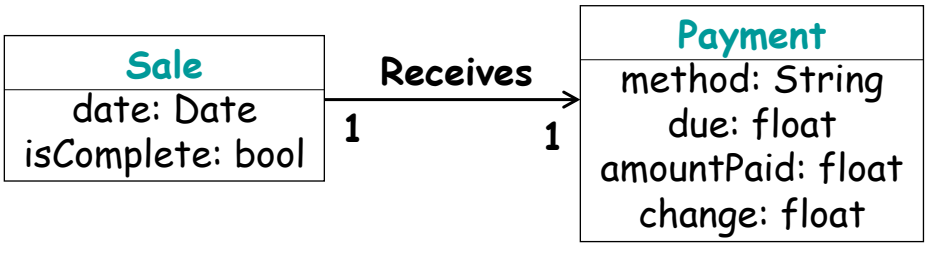
Mapping Associations

Mapping One-to-One Associations



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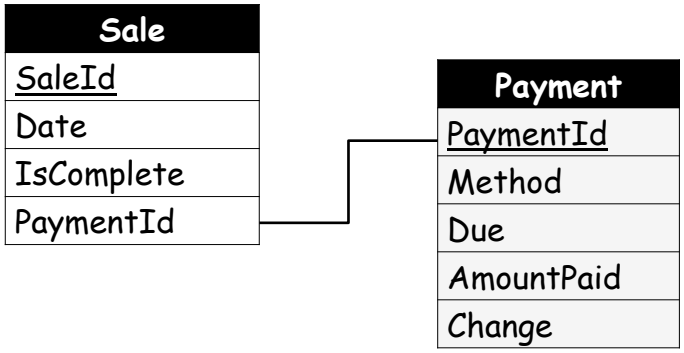
What Are the Tables?



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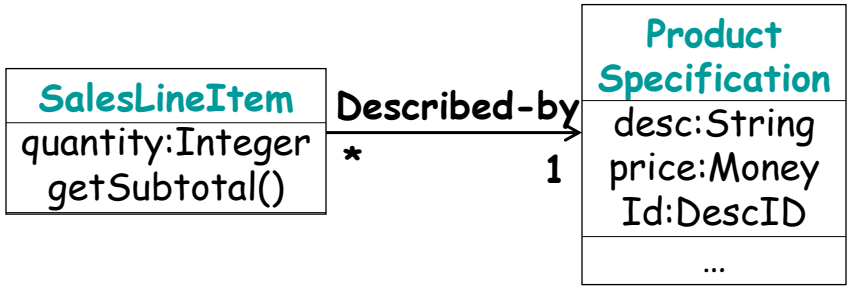
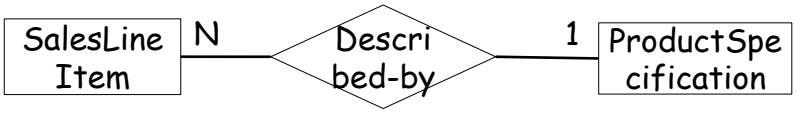
Mapping One-to-Many Associations





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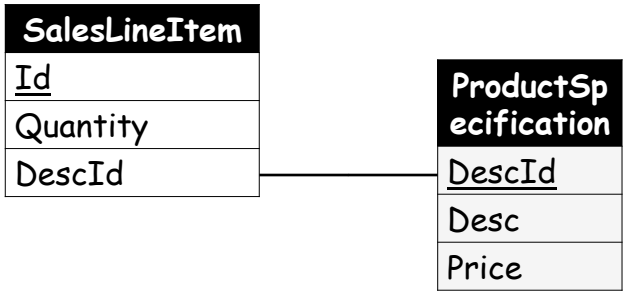
What Are the Tables?



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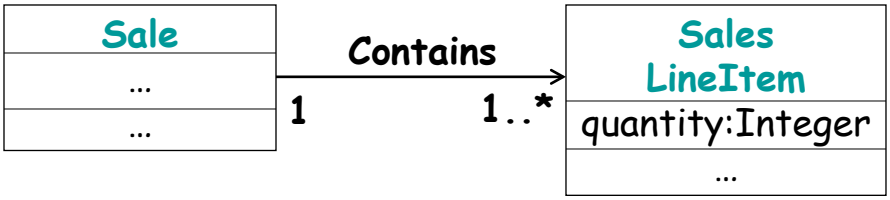
Mapping Many-to-One Associations



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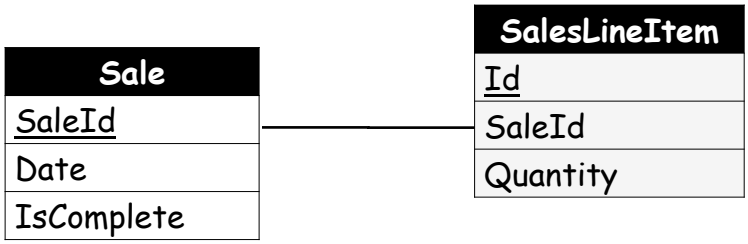
What Are the Tables?



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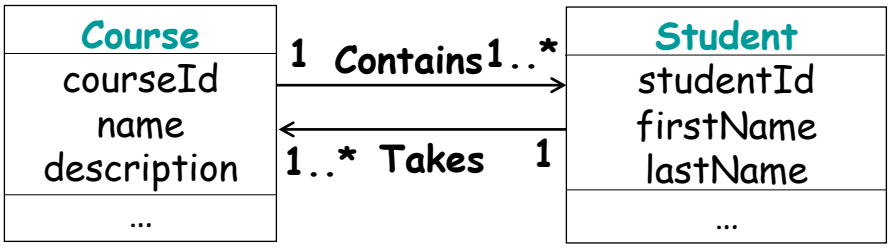
Mapping Many-to-Many Associations to Table



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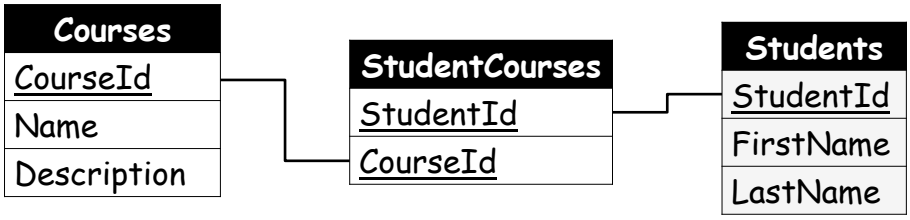
What Are the Tables?



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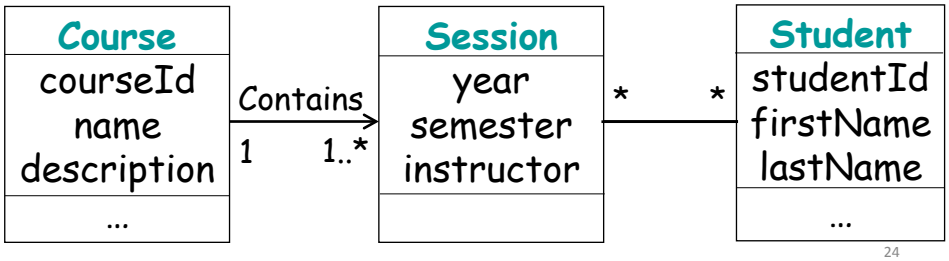
Multiple Many-to-Many

- What if we want to know students' enrollment over time for each year and semester
  - E.g., to distinguish students enrolled different time)?



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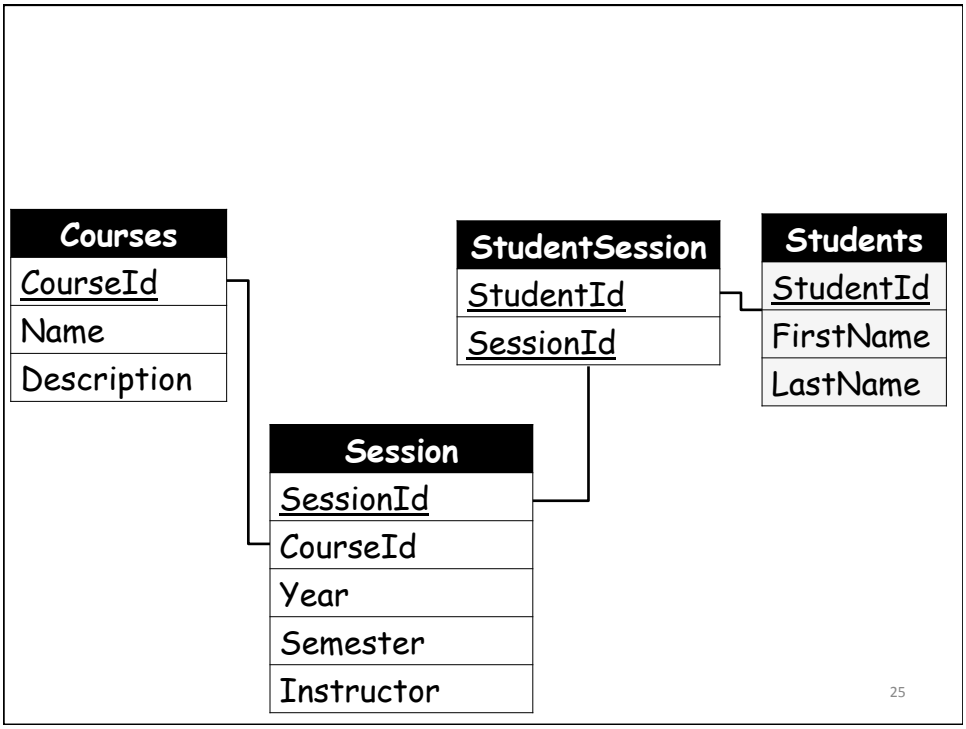

Multiple-Object Associations

- Definition
  - Many different kinds of objects are collectively associated with each other
- Case study
  - Making a movie requires a whole horde of people including a director, a bunch of actors, and a huge number of crew members

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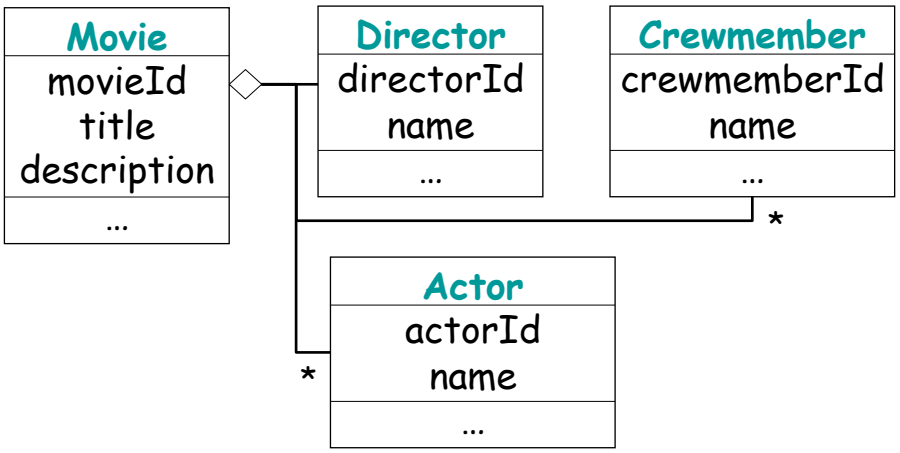
Class Diagram for Movie-making



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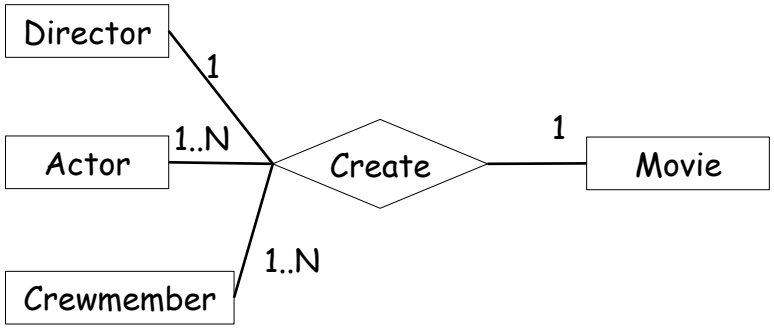
ER Diagram for Movie Making



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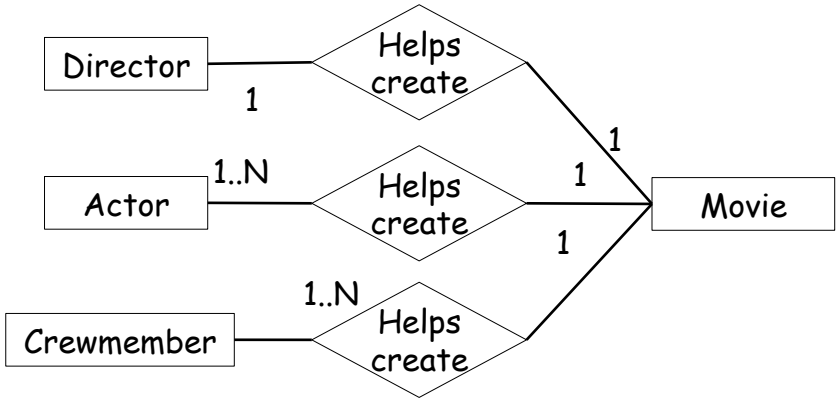
Consider the Relationship as a Combination of Simpler Relationships



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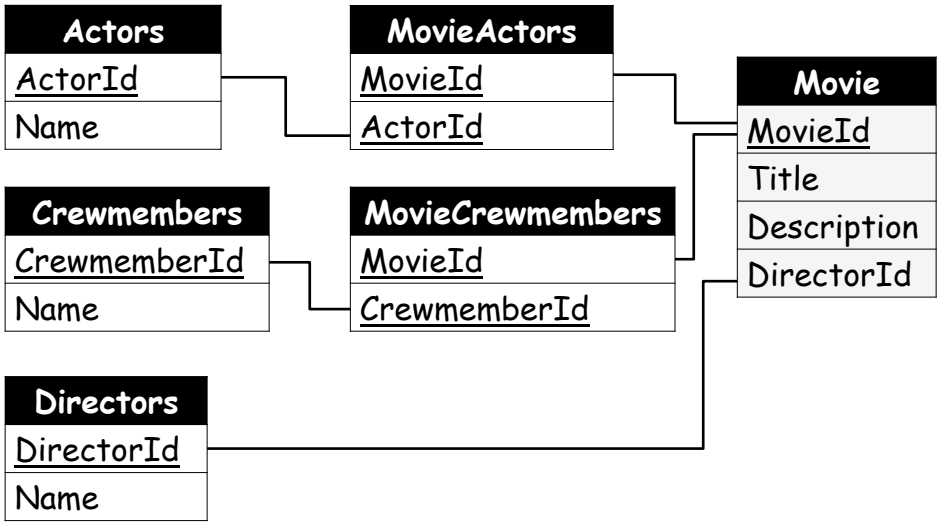

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Repeated Attribute Associations

- Some entities have multiple attributes that represent either the same kind of data or very similar kind of data
  - Some people may have multiple phone numbers for different purposes
  - Some people may have only one number to serve all purposes

Person
personId firstName lastName workPhone cellPhone homePhone dayPhone nightPhone
…

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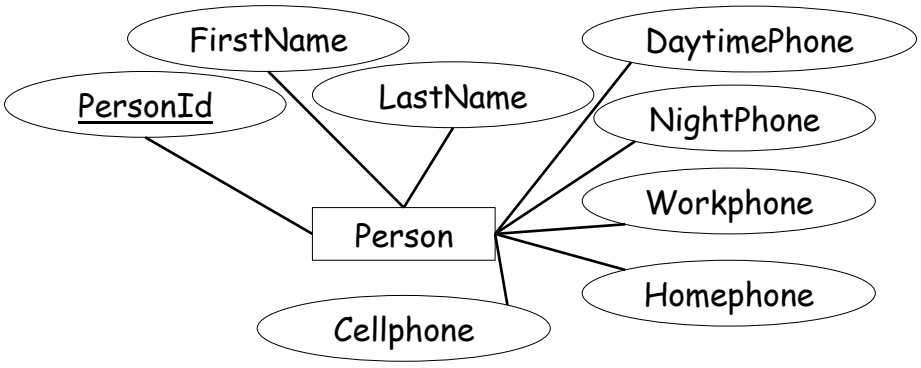
How to design the tables to avoid repetition or sparse data?



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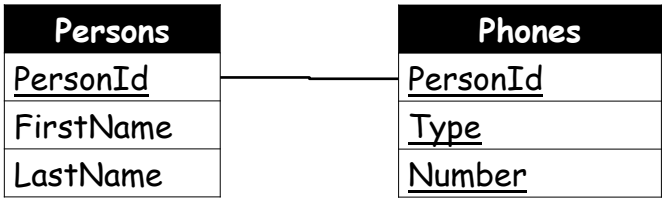

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Reflexive Associations

- An object refers to an object of the same class
  - One-to-One reflexive association
  - One-to-Many reflexive association
  - Many-to-Many reflexive association

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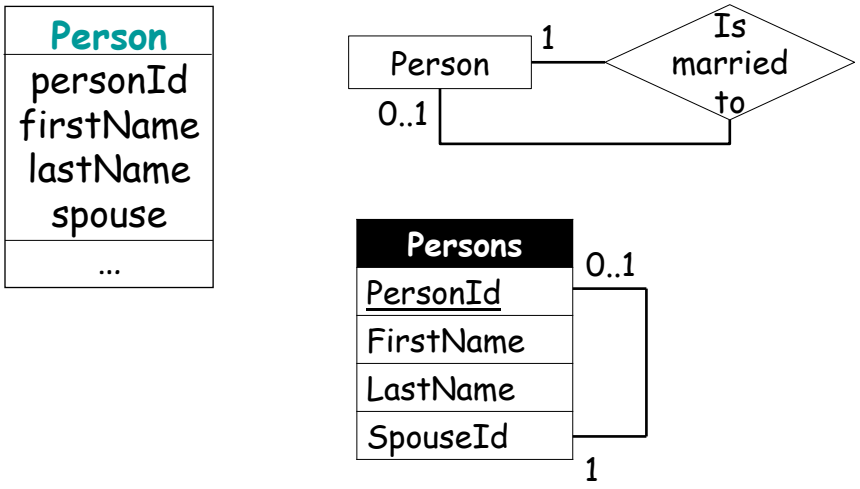
One-to-One Reflexive Association



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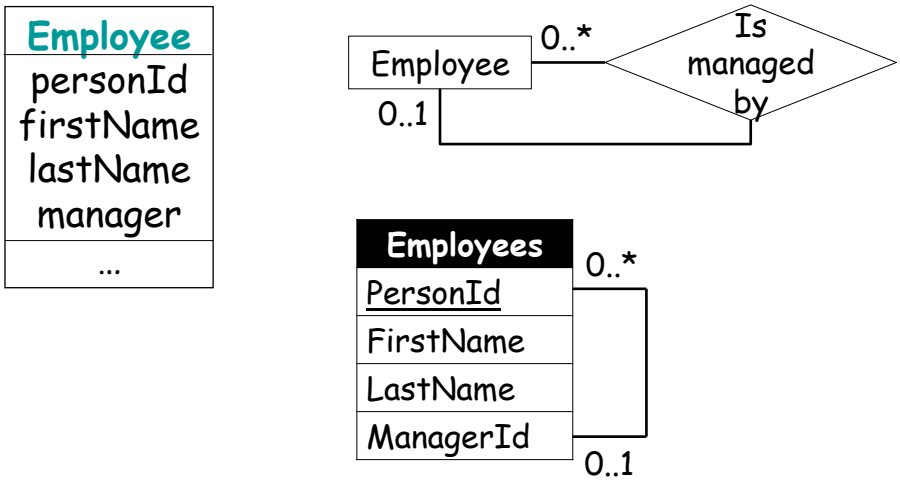
One-to-Many Reflexive Association



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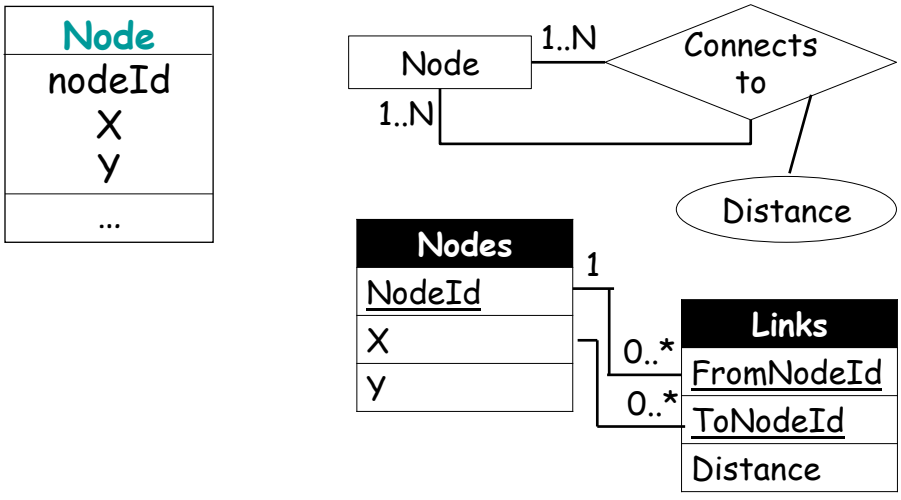
Many-to-Many Reflexive Association



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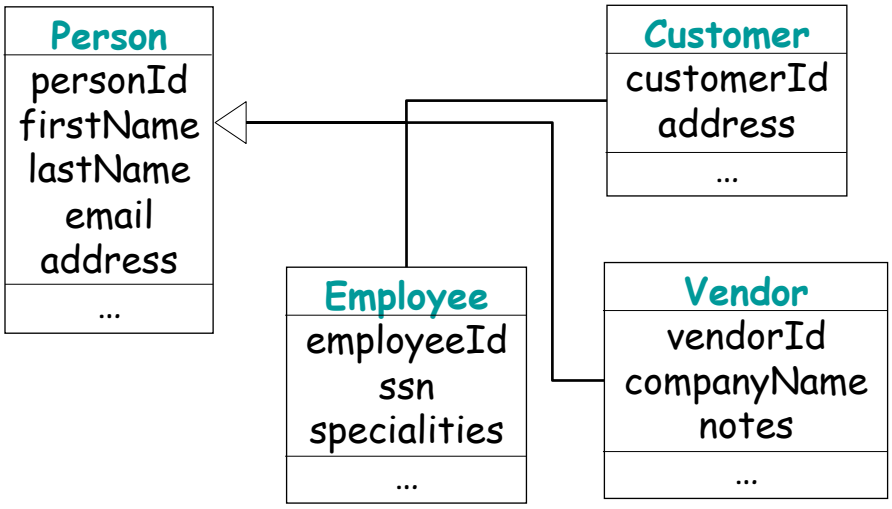
Inheritance



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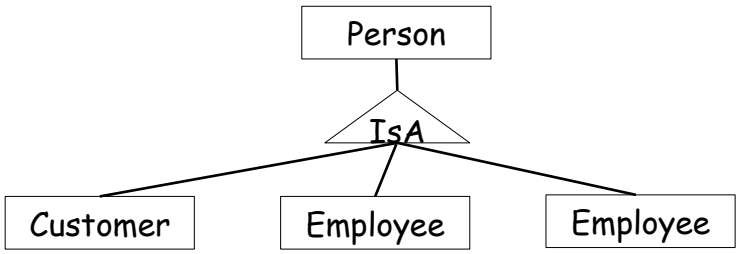
ER-Diagram



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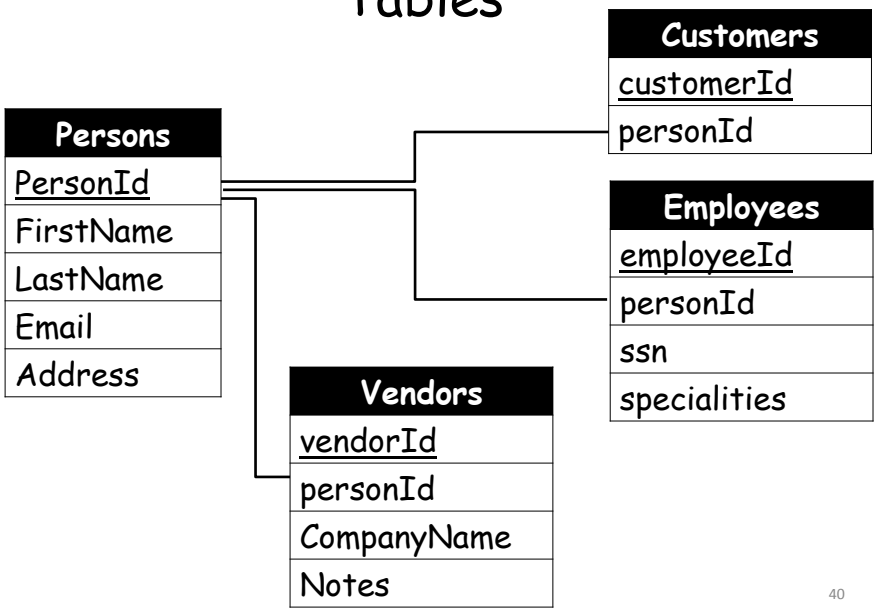
Tables



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