



Enhanced-ER Data Model



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Motivation

- ER data model is useful to describe “traditional” applications
- Newer types of applications were difficult to model, for example:
 - Design and manufacturing (CAD/CAM)
 - Geographic Information Systems (GIS)
- These applications had more complex requirements
- Semantic data modeling concepts needed to be incorporated
 - Result⇒ Enhanced (or Extended) ER data model



EER Model Concepts

- Includes all modeling concepts of basic ER
- Additional concepts: subclasses/superclasses, specialization/generalization, categories, attribute inheritance
- It is used to model applications more completely and accurately if needed
- It includes some object-oriented concepts, such as inheritance



Key Ideas of EER

- Generalization
 - Compute the union of two or more entity sets (or subclasses)
 - ⇒ Produce a higher-level entity set (or superclass)
 - ⇒ Containment relationship between the superclass and subclass(es)
- Specialization
 - Construct the subclasses that are a subset of superclasses
 - Reverse of generalization
- Example

We focus on specialization afterward



Why Specialization

- The process allows us to
 - Define a set of subclasses of an entity type
 - Establish additional specific attributes with each subclass
 - Establish additional specific relationship sets between each subclass and other entity sets

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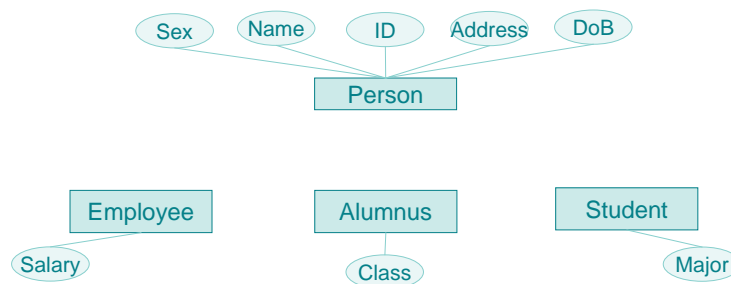
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Subclass

- Subclass entities inherit attributes from the superclass
- An entity can be a member of a number of subclasses



- An entity cannot just being a member of a subclass but not superclass
 - It is not essential that every entity in a superclass be a member of some subclass

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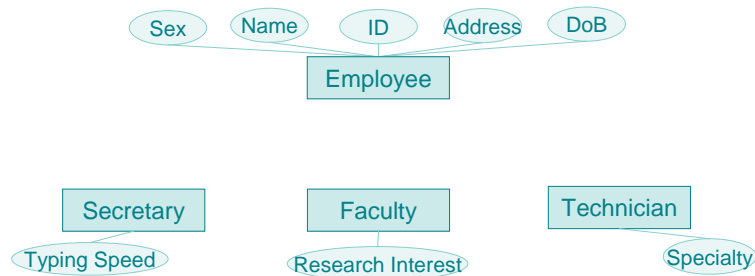
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Different Types of Specialization

- Predicate-defined (or condition-defined)
 - Determine subclass membership by examining the value of a specific attribute (termed “defining attribute”)



- User-defined
 - The user specifies subclass membership individually

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Different Types of Specialization

- Disjoint: an entity can be a member of at most one subclass
- Overlap: when the subclasses are not disjoint

- Total: each entity must be a member of some subclass
- Partial: An entity might belong to no subclass

- Disjointness and completeness constraints are independent
 - Hence, four combinations are possible

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Hierarchies vs. Lattices

- Hierarchy has a constraint that every subclass has only one superclass (called single inheritance)
- In a lattice, a subclass can be subclass of more than one superclass (called multiple inheritance)
 - A subclass with more than one superclass is called a **shared subclass**
- In a lattice or hierarchy, a subclass inherits attributes not only of its direct superclass, but also of all its predecessor superclasses

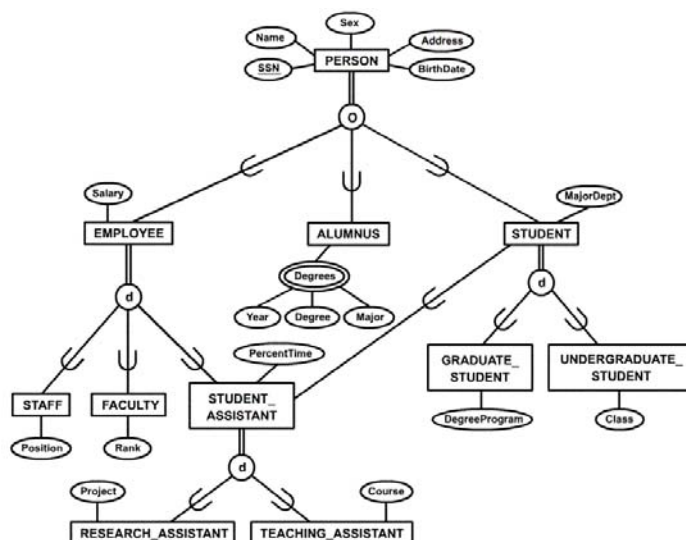
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Lattice Example



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Categories (UNION TYPES)

- In some cases, need to model a single superclass/subclass relationship with more than one superclass
 - Superclasses represent different entity types
 - Such a subclass is called a category or UNION TYPE
- Example: Database for vehicle registration, vehicle owner can be a person, a bank (holding a lien on a vehicle) or a company.
 - Category (subclass) OWNER is a subset of the union of the three superclasses COMPANY, BANK, and PERSON

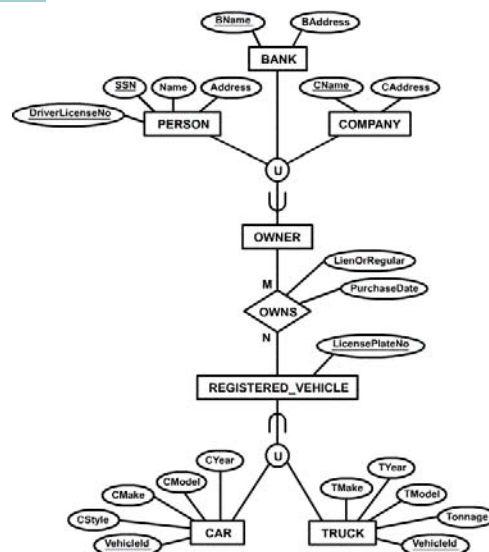
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Example of Categories



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Category Member vs. Shared Subclass

- A category member must exist in at least one of its superclasses
- Note: The difference from shared subclass, which is subset of the intersection of its superclasses (shared subclass member must exist in all of its superclasses).



Example: Railway System

- Each line has a unique line code
 - Lines may run via mountain or sea
 - Each line is associated with origin, destination, intermediate stops, and all scheduled departure time, and scheduled arrival time
 - Not every line runs every day
 - Every time the line runs must be recorded.
- There are four types of trains: each has fixed cars
 - TzeChiang, ChuKuang,
 - TzeChiang: the fastest one
 - ChuKuang: the second fastest
 - FuHsing: the slowest one
 - EMU: where customers can sit anywhere
- Tickets
 - The types of tickets are classified into normal, half-fare, and platform tickets



Example: Railway System (Contd.)

- Information of normal and half-fare tickets includes
 - The origin
 - The destination
 - Price
 - The line he takes
 - The date he takes
 - Car number and seat number should also be recorded except for EMU
 - If all seats were sold out, passengers will get tickets without seats
 - If a customer bought a round trip ticket, he could get 10% discount
- Customers can book tickets by the Internet or by telephone
 - One customer can book up to four tickets at one time
- Booking information includes
 - Personal ID of the customer
 - The date he booked the tickets
 - The information of the tickets
 - Booked tickets are only reserved for 5 days
 - If a customer didn't pay for the booked tickets in time, the booking is invalid and the seats are released for other customers



Example: Reservation System

- Reservation System for airline companies
 - Each company has many aircrafts
 - Each has a registration number, make, model, and the maximum capacity of passengers
 - Each company has many flights
 - Flights can be classified into domestic or international routes
 - Each flight departs from and arrives at registered airports
 - An airport also has an airport code, description name, city and country
 - Flight may stop at some intermediate stops
 - Customers could take a transfer flight from intermediate stops
 - Each flight has three seat classes
 - First Class, Business Class, and Economy class
 - For every flight, the system should store a list of available seats
 - The seat arrangements are associated with aircrafts
 - Each seat can only be reserved to one customer
 - Ticket prices are associated with classes and time
 - Customers can make reservation without reserving seats
 - Each flight allow 20% overbooking



Example: Reservation System (Contd.)

- The reservation system should keep
 - A unique identifier for each customer
 - This identifier is assigned automatically once customers make a new reservation in the system
 - Customer information
 - Flight information
 - The time that reservation was made
 - A credit-card number associated with the reservation
 - A flag which indicates whether this particular reservation is paid or not
 - When a reservation is paid it is transformed automatically to a ticket
 - The reservation can be canceled before flight departure, however the ticket is still valid (to exchange some products)
- Each reservation might be associated with many flights

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Example: Registration-System

- For University System of Taiwan (UST)
- Each school has many departments
- Each department will offer many courses
 - Some courses are specially designed for students majoring in some subjects
 - Some courses will be offered regularly
 - For some courses, there will be many classes in one semester taught by different instructors
 - Some courses will have prerequisite subjects
 - Some classes will control the number of seats
 - The system should avoid time conflicts when students schedule their courses

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Example: Registration-System (Cond.)

- Some courses are specially designed for graduate students
- Graduate students can become TAs of certain classes
 - However, he/she has to take this course before
- A full-time student should enroll in at least
 - 8-units/semester for graduate students
 - 6-units/semester for graduate students who have TA/RAs
 - 12-units/semester for undergraduate students
- The instructors of classes can be
 - Faculty
 - PhD students (who can only teach undergraduate-level classes)
- Students receiving RAs should work with some faculty



Example: Movie On Demand System

- The movie-on-demand (MoD) provider operates several video servers in different geographical locations that let customers view movies at home via a special set-top box that interfaces with their TV and that further connects to the video server network.
- The database must represent the following information:
 - Video Movie Information
 - A movie has a title, release date, rating, running time, director, and one or more actors
 - Movies are split between domestic and foreign movies
 - A foreign movie uses a language other than English and may provide English subtitles
 - Domestic movies are further categorized into comedy, drama, action, and horror movies
 - A comedy movie has the degree of “funniness” which ranges between 1 and 5
 - A drama movie has a short description such as “love story”, “documentary”, “humanity”, etc.



Example: Movie On Demand System (Con.)

- Each movie could be reviewed by one or more critics, each of whom evaluates it as between zero and five stars
 - A critic has a name and a phone number
 - He or she might review one or more movies
- A movie may have won one or more academy awards (i.e., "Oscars")
 - If that is the case, then the movie has a list of all the categories in which it won
 - E.g., "best picture", "best actor", "best actress", etc.
- Each movie is stored on a number of different video servers
 - Each video server has a unique ID and an address (location)
 - If a customer requests a movie then that movie is delivered (streamed) from one of the video servers to the customer's home
 - Each movie can be supplied by only one distributor
- One distributor might provide several movies
 - For each distributor, the MoD provider keeps track of information about its name, address, and phone number
 - A distributor's address can be accessed as street address, city, state, and zip code individually
 - However, the entire address of a distributor can also be retrieved as a unit



Example: Movie On Demand System (Con.)

- Employee Information
 - An employee has a name, a social security number, date of birth, salary, and a phone number
 - He or she may have a supervisor
 - Employees are either permanent or temporary, but not both
 - Each permanent employee has an employee number
 - All supervisors are permanent employees
 - An employee works at the location of one of the video servers
- Customer Information
 - A customer has a social security number, a name, a phone number, and an address
 - Each customer must have one or more credit cards
 - Each credit card includes a type of credit card (Visa/MasterCard/...), a card number, and an expiration date.
- Viewing Transaction Information
 - Each customer can view movies from a video server
 - For each viewing transaction, the viewing date and time is recorded.



Example: Movie On Demand System (Con.)

- **Bill Statement Information**
 - Each customer receives one bill statement after each viewing transaction
 - Each statement has a billing date, a billing number, one or more movie titles, and a total charge.
 - A billing number is unique for a particular customer
 - It is not unique across different customers
- **Release Charge Information**
 - For each movie, a release type is defined
 - Arbitrarily recent movies are marked as “new release,” whereas others are marked as “ordinary release.”
 - The store keeps track of different charge information for different release types
 - For newly released movies, the fee is \$100 for the first viewing and \$30 for each additional viewing
 - For the other ones, the fee is \$50 for the first viewing and \$15 for each additional viewing