Extended Entity Relationship Model

Enhanced-ER (EER) Model Concepts

- Includes all modeling concepts of basic ER
- Additional concepts: subclasses/superclasses, specialization/generalization, categories, attribute inheritance
- The resulting model is called the enhanced-ER or Extended ER (E^2R or EER) model
- It is used to model applications more completely and accurately if needed
- It includes some object-oriented concepts, such as inheritance

Subclasses and Superclasses (1)

- An entity type may have additional meaningful subgroupings of its entities
- Example: EMPLOYEE may be further grouped into SECRETARY, ENGINEER, MANAGER, TECHNICIAN, SALARIED_EMPLOYEE, HOURLY_EMPLOYEE,…
  - Each of these groupings is a subset of EMPLOYEE entities
  - Each is called a subclass of EMPLOYEE
  - EMPLOYEE is the superclass for each of these subclasses
- These are called superclass/subclass relationships.
- Example: EMPLOYEE/SECRETARY, EMPLOYEE/TECHNICIAN

Subclasses and Superclasses (2)

- These are also called IS-A relationships (SECRETARY IS-A EMPLOYEE, TECHNICIAN IS-A EMPLOYEE, …).
- Note: An entity that is member of a subclass represents the same real-world entity as some member of the superclass
  - The Subclass member is the same entity in a distinct specific role
  - An entity cannot exist in the database merely by being a member of a subclass; it must also be a member of the superclass
  - A member of the superclass can be optionally included as a member of any number of its subclasses
- Example: A salaried employee who is also an engineer belongs to the two subclasses ENGINEER and SALARIED_EMPLOYEE
  - It is not necessary that every entity in a superclass be a member of some subclass

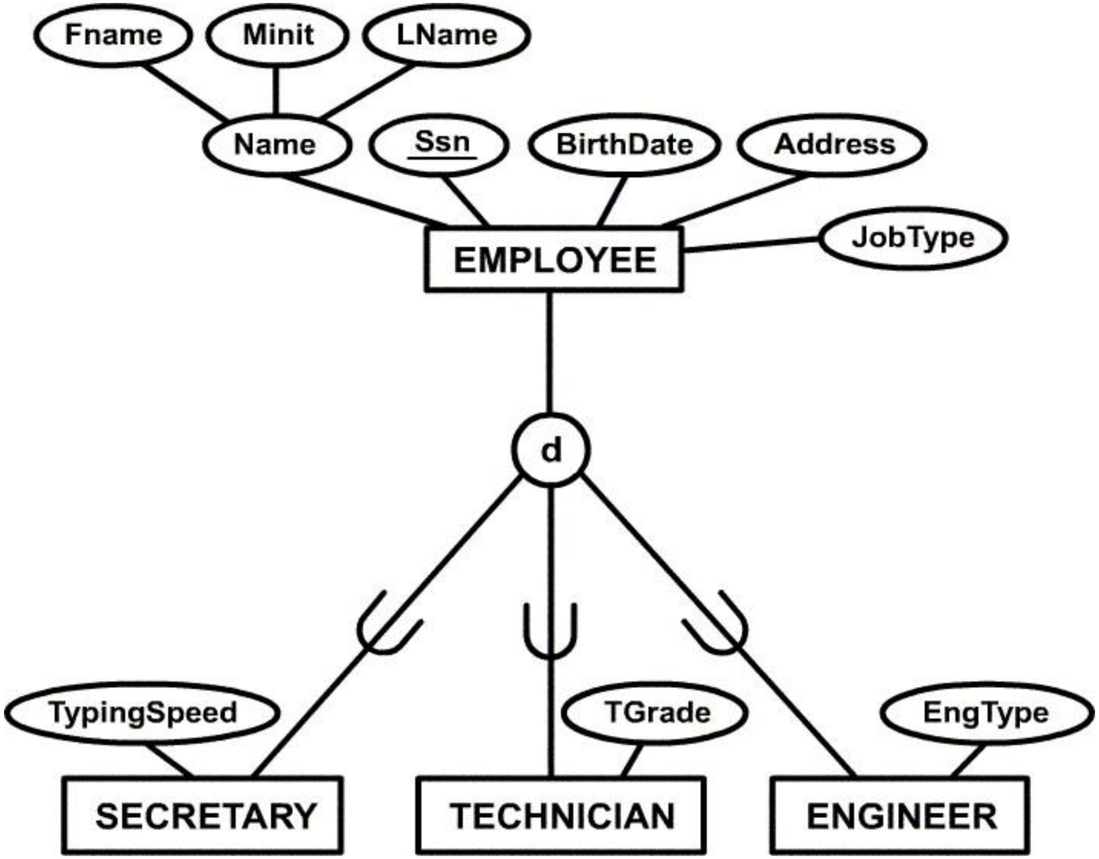
Attribute Inheritance in Superclass / Subclass Relationships

- An entity that is member of a subclass *inherits* all attributes of the entity as a member of the superclass
- It also inherits all relationships

Specialization

- Is the process of defining a set of subclasses of a superclass
- The set of subclasses is based upon some distinguishing characteristics of the entities in the superclass
- Example: {SECRETARY, ENGINEER, TECHNICIAN} is a specialization of EMPLOYEE based upon *job type*.
  - May have several specializations of the same superclass
- Example: Another specialization of EMPLOYEE based in *method of pay* is {SALARIED_EMPLOYEE, HOURLY_EMPLOYEE}.
  - Superclass/subclass relationships and specialization can be diagrammatically represented in EER diagrams
  - Attributes of a subclass are called specific attributes. For example, TypingSpeed of SECRETARY
  - The subclass can participate in specific relationship types. For example, BELONGS_TO of HOURLY_EMPLOYEE

Example of a Specialization



Generalization

- The reverse of the specialization process
- Several classes with common features are generalized into a superclass; original classes become its subclasses
- Example: CAR, TRUCK generalized into VEHICLE; both CAR, TRUCK become subclasses of the superclass VEHICLE.
  - We can view {CAR, TRUCK} as a specialization of VEHICLE
  - Alternatively, we can view VEHICLE as a generalization of CAR and TRUCK

Generalization and Specialization

- Diagrammatic notation sometimes used to distinguish between generalization and specialization
  - Arrow pointing to the generalized superclass represents a generalization
  - Arrows pointing to the specialized subclasses represent a specialization
  - We do not use this notation because it is often subjective as to which process is more appropriate for a particular situation
  - We advocate not drawing any arrows in these situations
- Data Modeling with Specialization and Generalization
  - A superclass or subclass represents a set of entities
  - Shown in rectangles in EER diagrams (as are entity types)
  - Sometimes, all entity sets are simply called classes, whether they are entity types, superclasses, or subclasses

Constraints on Specialization and Generalization (1)

- If we can determine exactly those entities that will become members of each subclass by a condition, the subclasses are called *predicate-defined* (or condition-defined) subclasses
  - Condition is a constraint that determines subclass members
  - Display a predicate-defined subclass by writing the predicate condition next to the line attaching the subclass to its superclass
- If all subclasses in a specialization have membership condition on same attribute of the superclass, specialization is called an *attribute defined*-specialization
  - Attribute is called the defining attribute of the specialization
  - Example: JobType is the defining attribute of the specialization {SECRETARY, TECHNICIAN, ENGINEER} of EMPLOYEE
- If no condition determines membership, the subclass is called *user-defined*
  - Membership in a subclass is determined by the database users by applying an operation to add an entity to the subclass
  - Membership in the subclass is specified individually for each entity in the superclass by the user

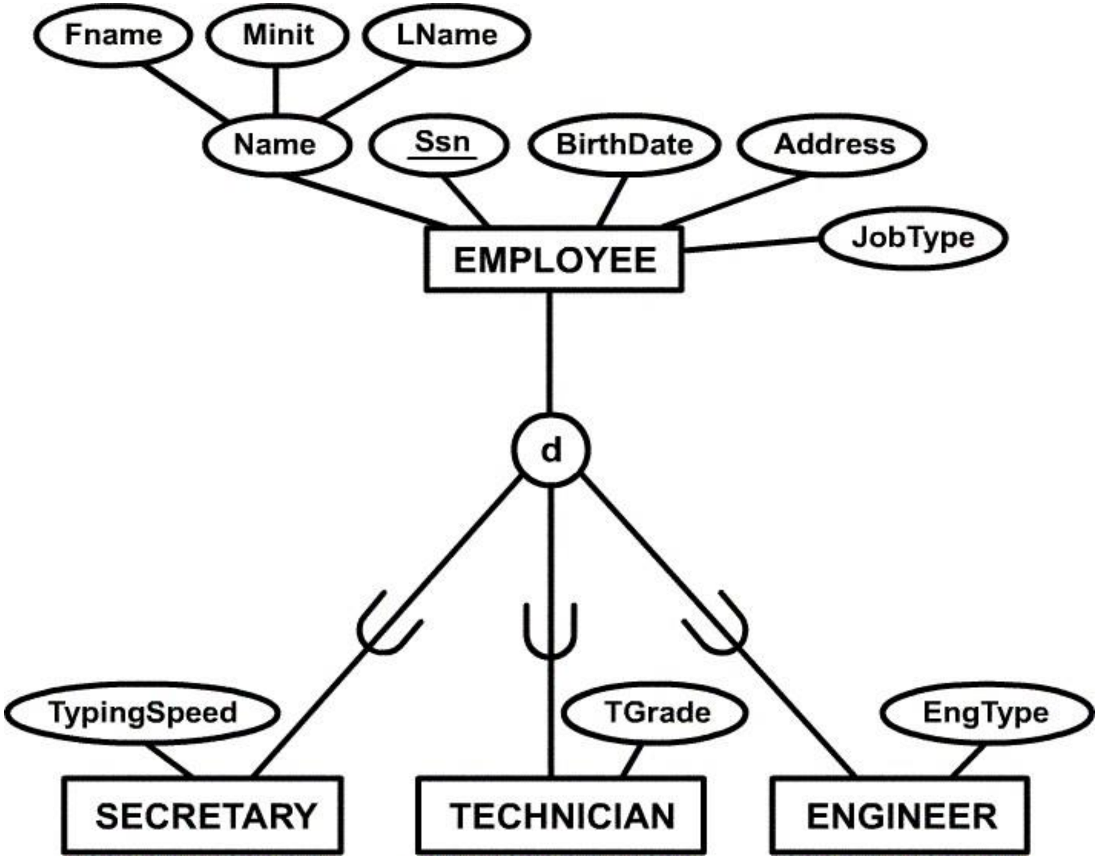
Constraints on Specialization and Generalization (2)

- Two other conditions apply to a specialization/generalization:
- **Disjointness Constraint**:
  - Specifies that the subclasses of the specialization must be disjointed (an entity can be a member of at most one of the subclasses of the specialization)
  - Specified by d in EER diagram
  - If not disjointed, overlap; that is the same entity may be a member of more than one subclass of the specialization
  - Specified by o in EER diagram
- **Completeness Constraint**:
  - Total specifies that every entity in the superclass must be a member of some subclass in the specialization/ generalization
  - Shown in EER diagrams by a double line
  - Partial allows an entity not to belong to any of the subclasses
  - Shown in EER diagrams by a single line

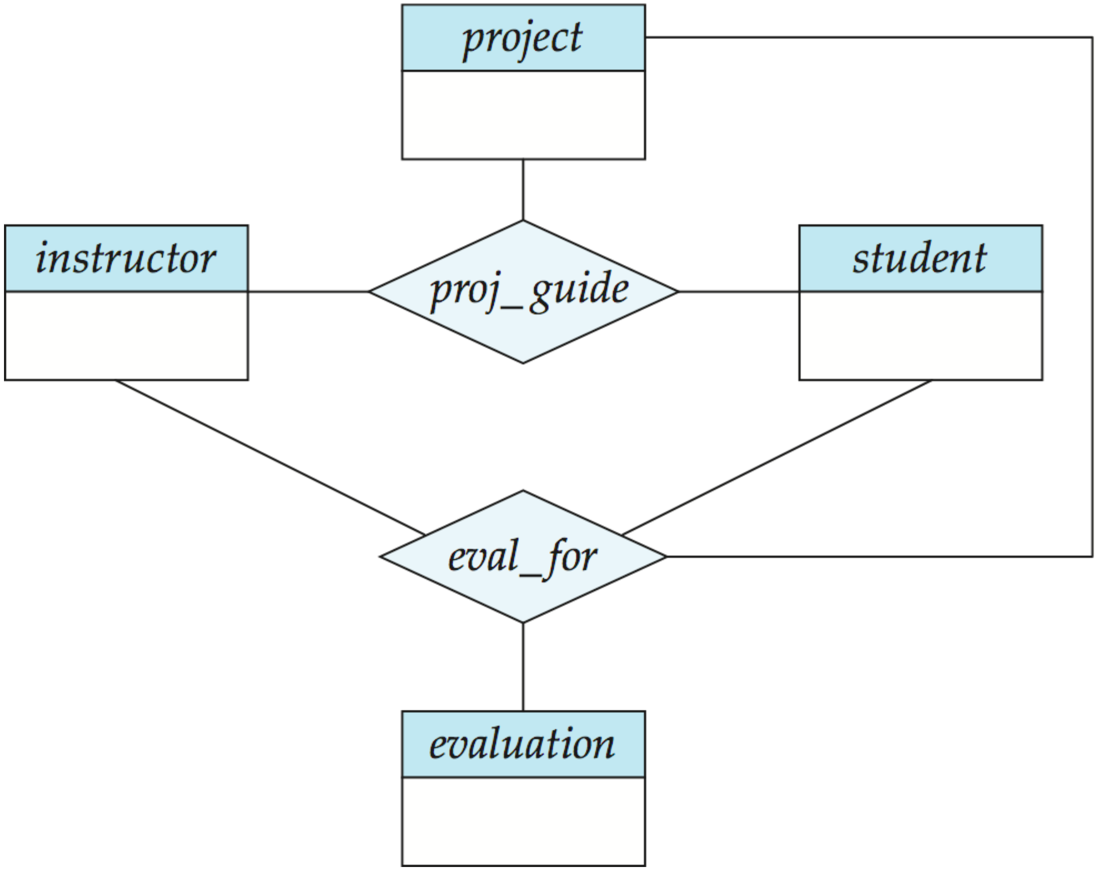
Constraints on Specialization and Generalization (3)

- Hence, we have four types of specialization/generalization:
  - Disjoint, total
  - Disjoint, partial
  - Overlapping, total
  - Overlapping, partial
- Note: Generalization usually is total because the superclass is derived from the subclasses.

Example of disjoint partial Specialization



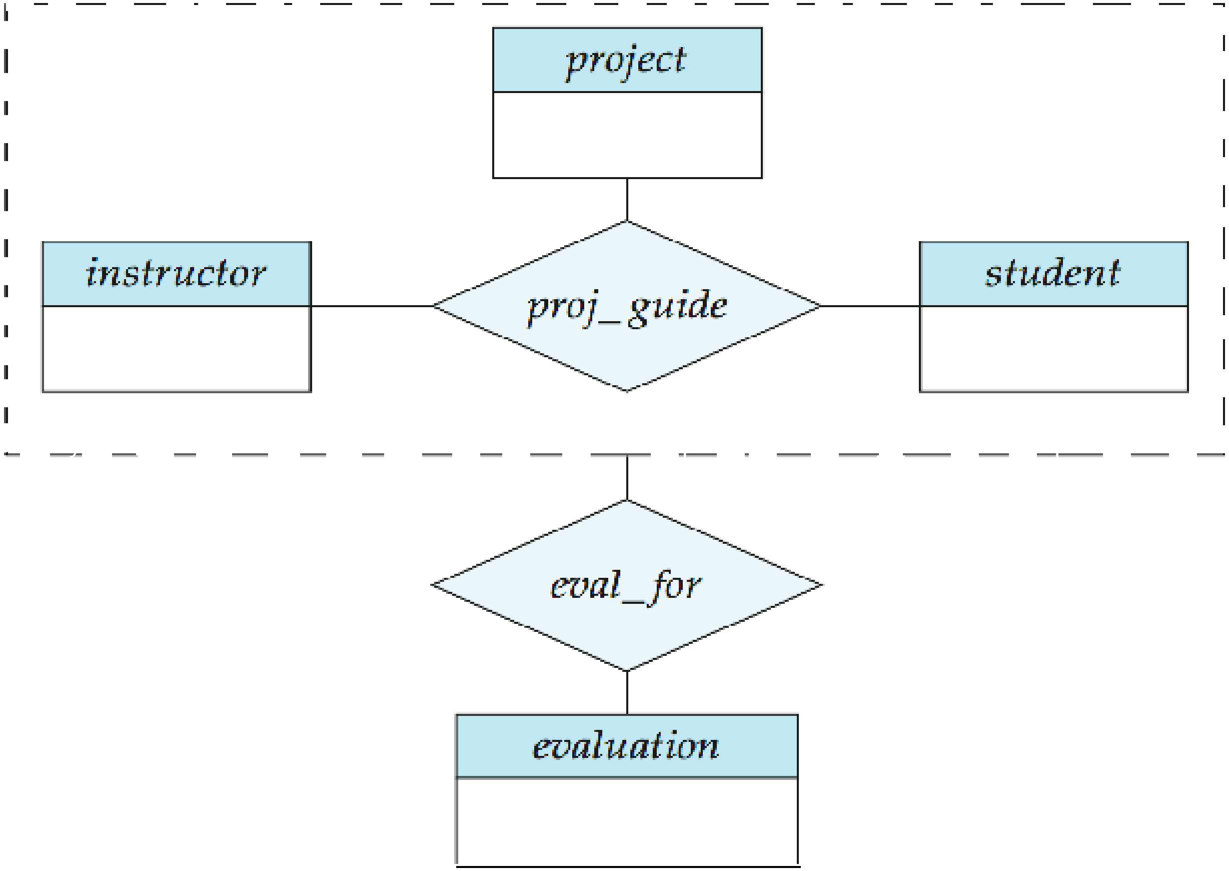
Motivation for Aggregation



Aggregation (Cont.)

- Aggregation is an important concept in database design where composite objects can be modelled during the design of database applications.
- Without introducing redundancy, the following diagram represents:
  - A student is guided by a particular instructor on a particular project
  - A student, instructor, project combination may have an associated evaluation

Aggregation - a feature of the entity relationship model that allows a relationship set to participate in another relationship set. This is indicated on an ER diagram by drawing a dashed box around the aggregation


project
instructor
proj_guide
student
eval_for
evaluation