V. Advanced Data Modeling

Extended Entity Relationship Model (EERM)

- Result of adding more semantic constructs to the original entity relationship (ER) model
- **EER diagram (EERD)**: Uses the EER model

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Entity Supertypes and Subtypes

- **Entity supertype**: Generic entity type related to one or more entity subtypes
  - Contains common characteristics
- **Entity subtype**: Contains unique characteristics of each entity subtype
- Criteria to determine the usage
  - There must be different, identifiable kinds of the entity in the user's environment
  - The different kinds of instances should each have one or more attributes that are unique to that kind of instance

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Specialization and Generalization

Specialization	Generalization
• Top-down process • Identifies lower-level, more specific entity subtypes from a higher-level entity supertype • Based on grouping unique characteristics and relationships of the subtypes	• Bottom-up process • Identifies a higher-level, more generic entity supertype from lower-level entity subtypes • Based on grouping common characteristics and relationships of the subtypes

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Specialization Hierarchy

- Depicts arrangement of higher-level entity supertypes and lower-level entity subtypes
- Relationships are described in terms of "is-a" relationships
- Subtype exists within the context of a supertype
- Every subtype has one supertype to which it is directly related
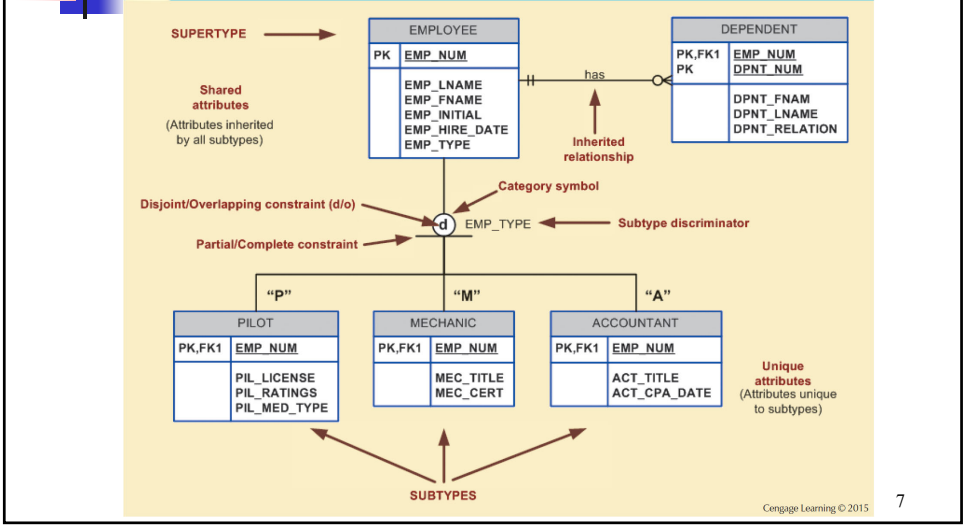- Supertype can have many subtypes
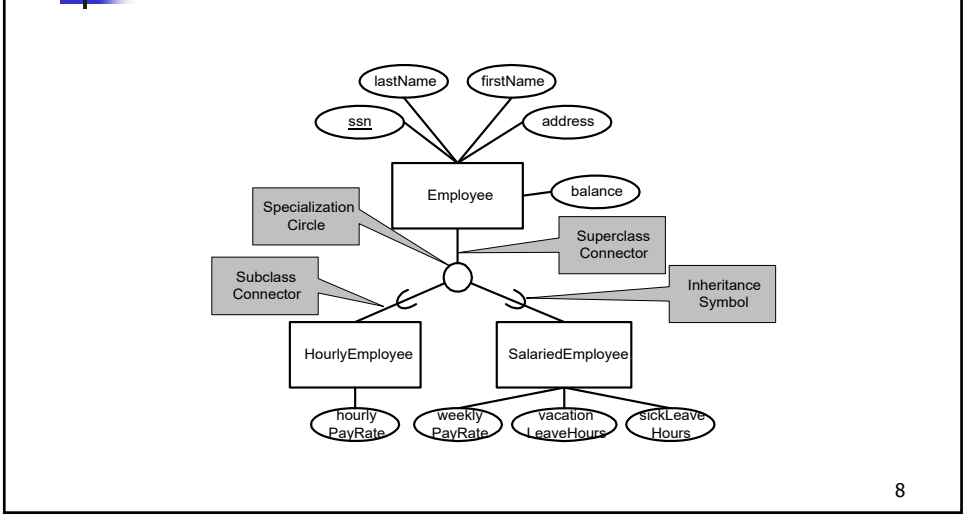
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Specialization Hierarchy

- Provides the means to:
  - Support attribute inheritance
  - Define a special supertype attribute known as the subtype discriminator
  - Define disjoint/overlapping constraints and complete/partial constraints

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Specialization Hierarchy

Another example

Inheritance

- Enables an entity subtype to inherit attributes and relationships of the supertype
- All entity subtypes inherit their primary key attribute from their supertype
- At the implementation level, supertype and its subtype(s) maintain a 1:1 relationship
- Lower-level subtypes inherit all attributes and relationships from its upper-level supertypes

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Subtype Discriminator

- Attribute in the supertype entity that determines to which entity subtype the supertype occurrence is related
- Default comparison condition is the equality comparison

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Disjoint and Overlapping Constraints

- **Disjoint subtypes**: Contain a unique subset of the supertype entity set
  - Known as **nonoverlapping subtypes**
  - Implementation is based on the value of the subtype discriminator attribute in the supertype
- **Overlapping subtypes**: Contain nonunique subsets of the supertype entity set
  - Implementation requires the use of one discriminator attribute for each subtype

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Specialization Hierarchy with Overlapping Subtypes
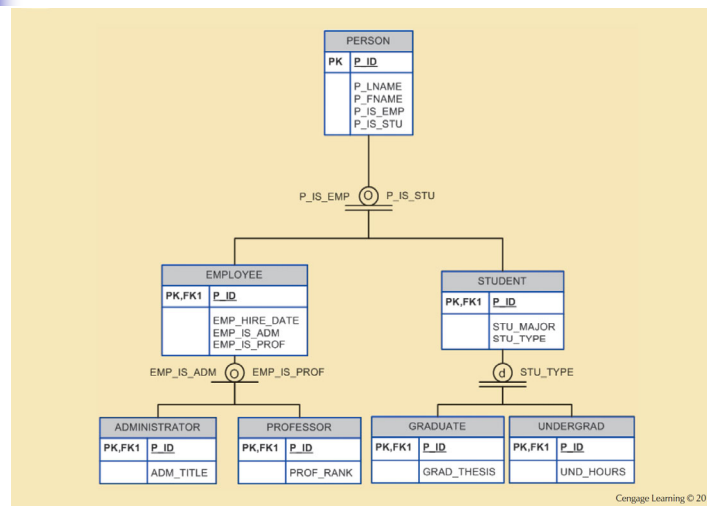
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Completeness Constraint

- Specifies whether each supertype occurrence must also be a member of at least one subtype
- Types
  - **Partial completeness**: Not every supertype occurrence is a member of a subtype
  - **Total completeness**: Every supertype occurrence must be a member of at least one subtype

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Specialization Hierarchy Constraint Scenarios

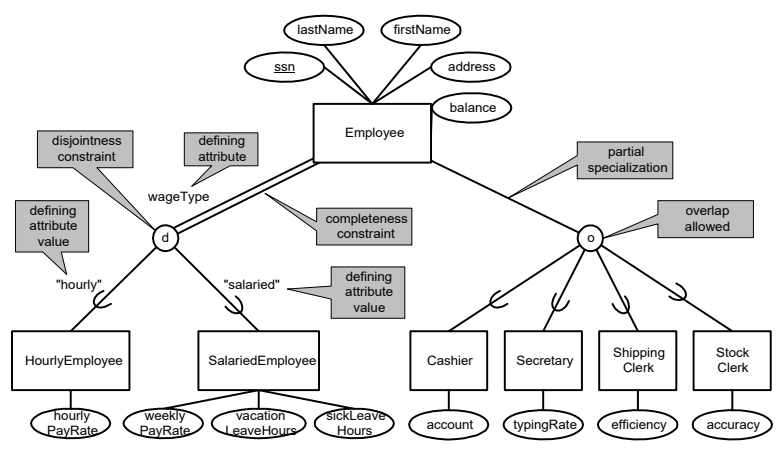| TYPE	DISJOINT CONSTRAINT	OVERLAPPING CONSTRAINT
Partial	Supertype has optional subtypes. Subtype discriminator can be null. Subtype sets are unique.	Supertype has optional subtypes. Subtype discriminators can be null. Subtype sets are not unique.
Total	Every supertype occurrence is a member of only one subtype. Subtype discriminator cannot be null. Subtype sets are unique.	Every supertype occurrence is a member of at least one subtype. Subtype discriminators cannot be null. Subtype sets are not unique.

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Multiple subclass hierarchies
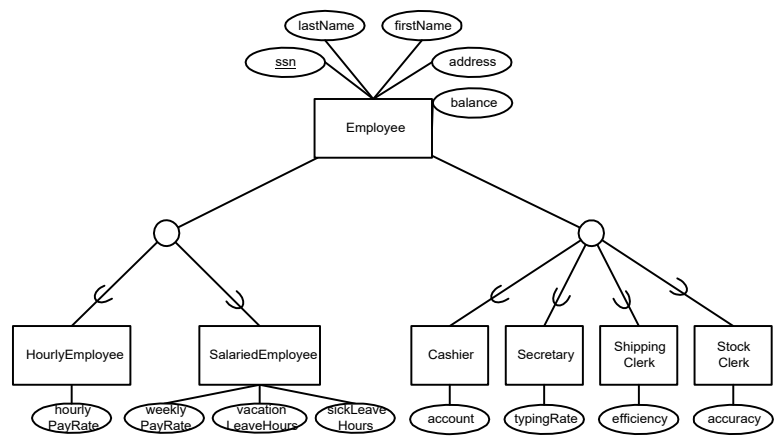
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With constraints

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Multiple inheritance

Employee

Staff   Faculty   Student
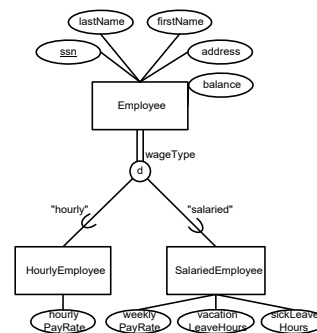
Multiple
Inheritance

Teaching
Assistant
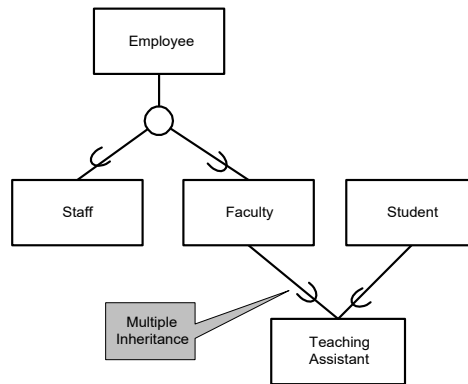
Specialization Hierarchies in the Relational Model

- Three possibilities
  - 1. Create a table for the superclass with its attributes and a table for each subclass with its attributes
  - 2. Create a table for the superclass with all of the subclass attributes
  - 3. Create a table for each subclass that includes both subclass and superclass attributes

lastName firstName
ssn address
balance
Employee
wageType
d
"hourly"   "salaried"
HourlyEmployee   SalariedEmployee
hourlyPayRate weeklyPayRate vacationLeaveHours sickLeaveHours

Specialization Hierarchies in the Relational Model

- Employee:(<u>ssn</u>, lastName, firstName, address, balance, wageType)
- HourlyEmployee:(<u>ssn</u>, hourlyRate)
- SalariedEmployee:(<u>ssn</u>, weeklyPayRate, vacationLeaveHours, sickLeaveHours)

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