15CSE302 Database Management Systems

Lecture 12 Enhanced ER-diagram

B.Tech /III Year CSE/V Semester L T P C 2 0 2 3

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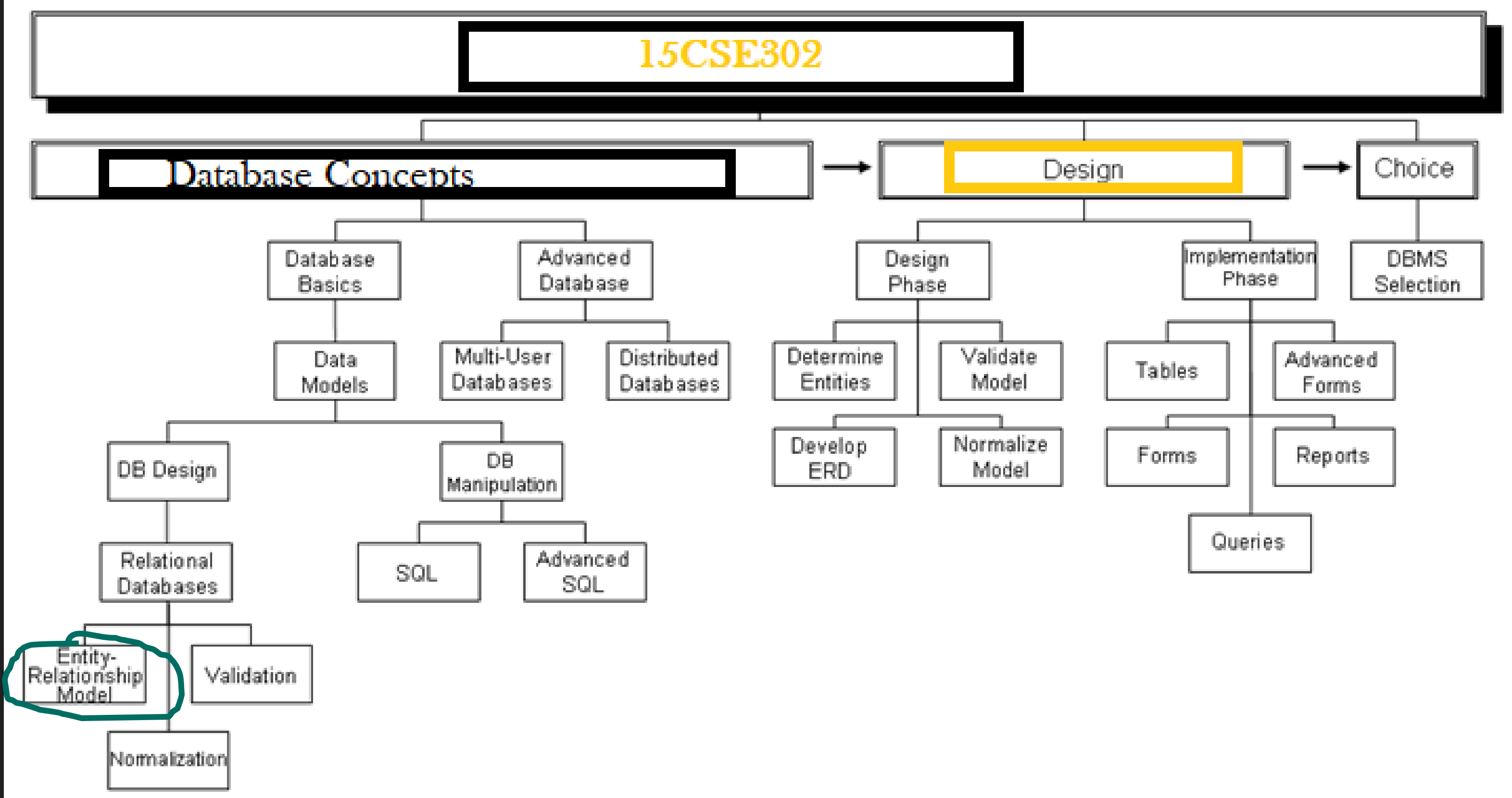
Slides Courtesy :CMSC424, Spring 2005

Syllabus


15CSE302
Database Concepts
Design
Choice
Database Basics
Advanced Database
Design Phase
Implementation Phase
DBMS Selection
Data Models
Multi-User Databases
Distributed Databases
Determine Entities
Validate Model
Tables
Advanced Forms
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Advanced SQL
Entity-Relationship Model
Validation
Normalization

Brief Recap of Previous Lecture

- Converting ER diagram

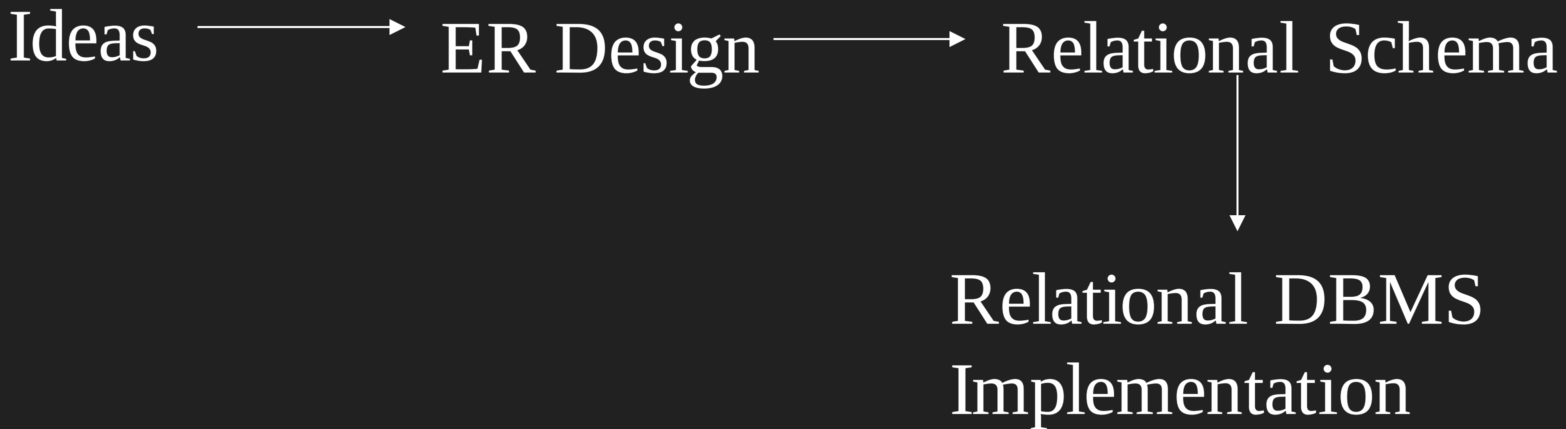
Logical database design

Enhanced ER Diagram

Enhanced ER-diagram

Slides Courtesy:Prof. Sin-Min Lee
Department of Computer Science

Database Modeling and Implementation Process



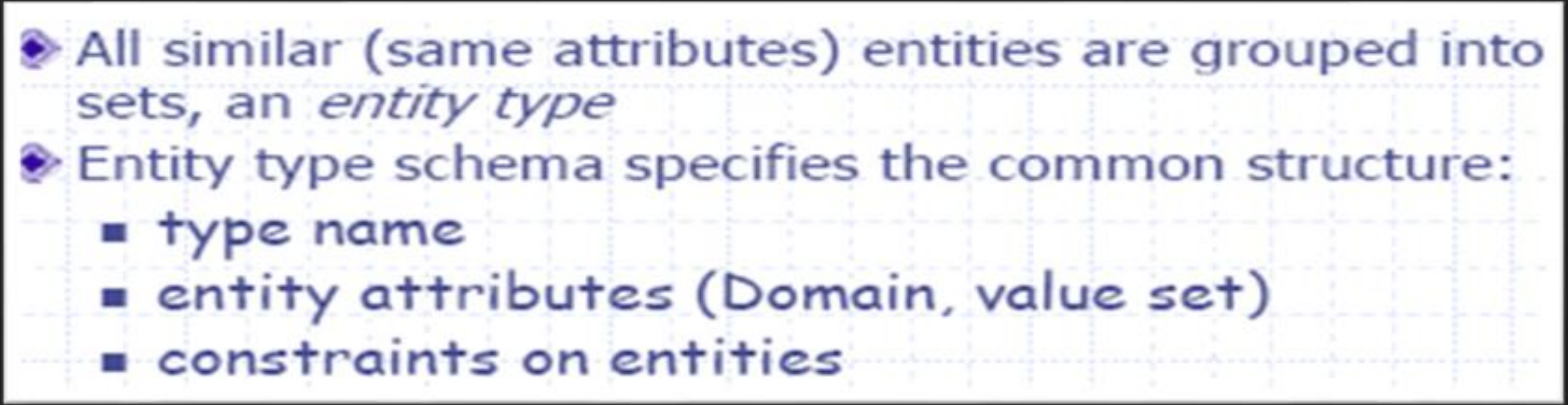
Ideas

ER Design

Relational Schema

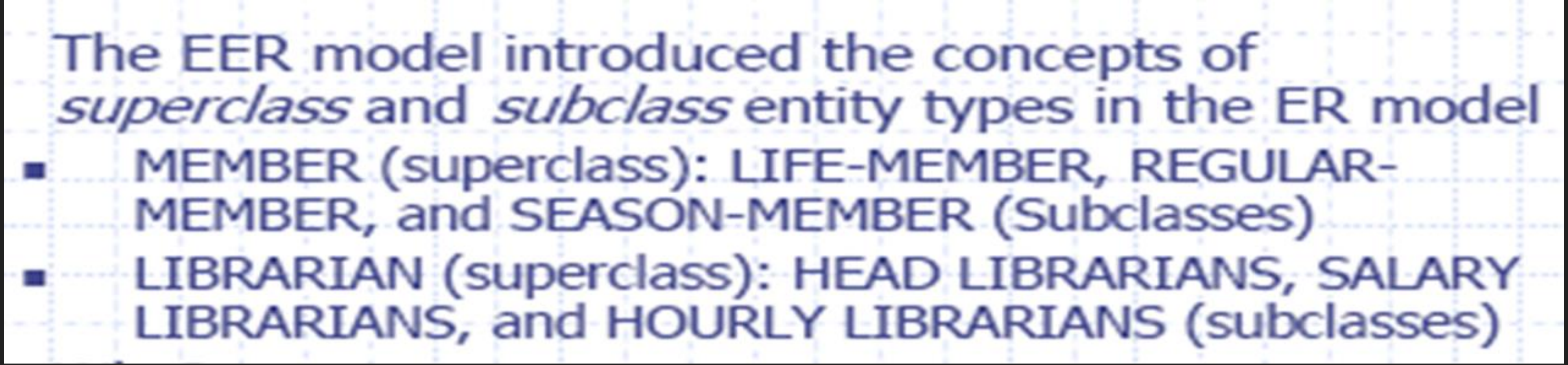
Relational DBMS Implementation

Entity Type



- All similar (same attributes) entities are grouped into sets, an *entity type*
- Entity type schema specifies the common structure:
  - type name
  - entity attributes (Domain, value set)
  - constraints on entities

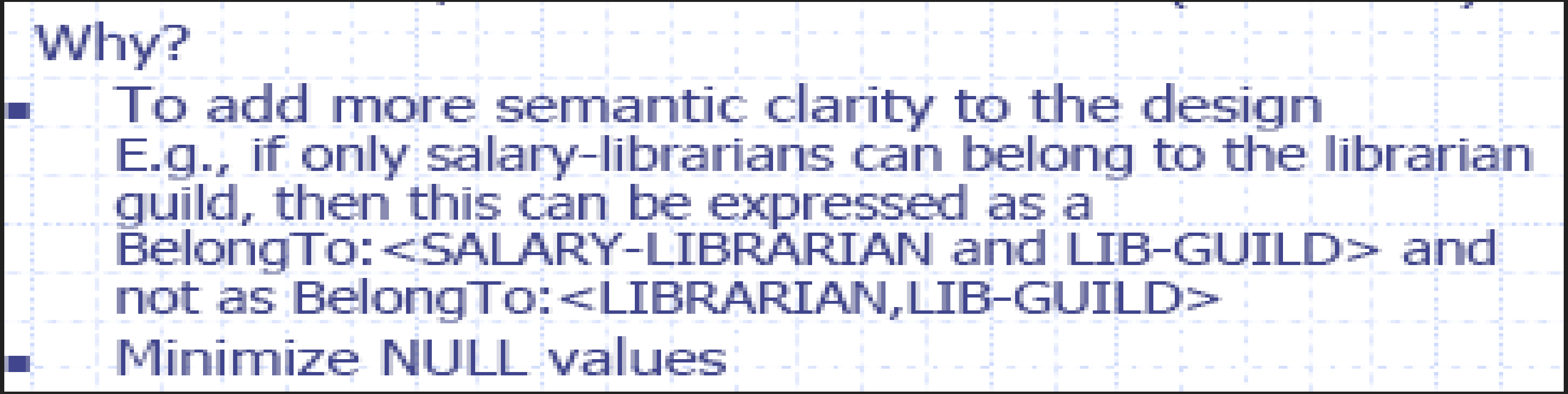
Enhanced Entity-Relationship Model



The EER model introduced the concepts of *superclass* and *subclass* entity types in the ER model

- MEMBER (superclass): LIFE-MEMBER, REGULAR-MEMBER, and SEASON-MEMBER (Subclasses)
- LIBRARIAN (superclass): HEAD LIBRARIANS, SALARY LIBRARIANS, and HOURLY LIBRARIANS (subclasses)

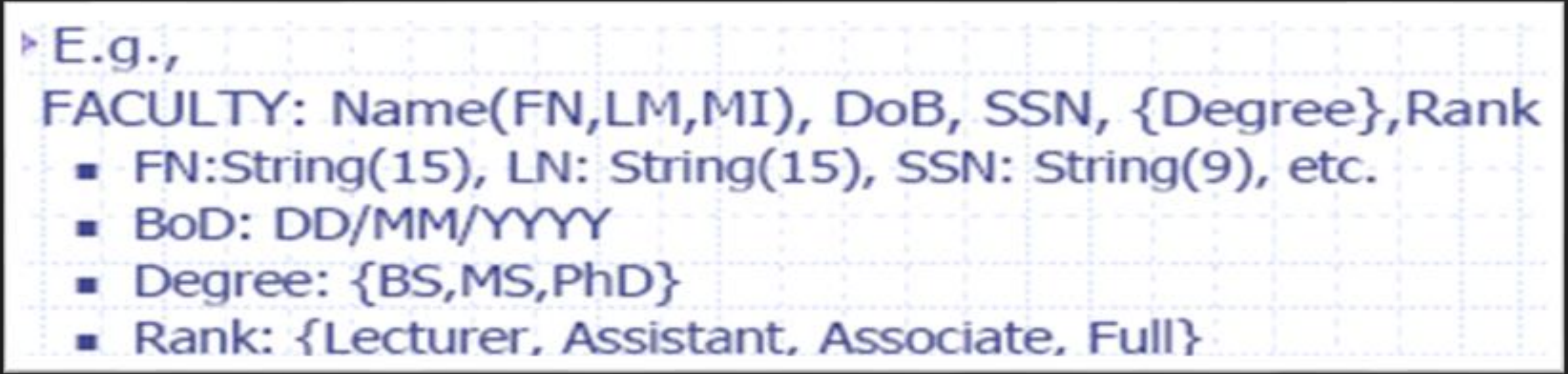
Enhanced Entity-Relationship Model



Why?

- To add more semantic clarity to the design
  E.g., if only salary-librarians can belong to the librarian guild, then this can be expressed as a BelongTo:<SALARY-LIBRARIAN and LIB-GUILD> and not as BelongTo:<LIBRARIAN,LIB-GUILD>
- Minimize NULL values

Entity Type



E.g.,

FACULTY: Name(FN,LM,MI), DoB, SSN, {Degree},Rank

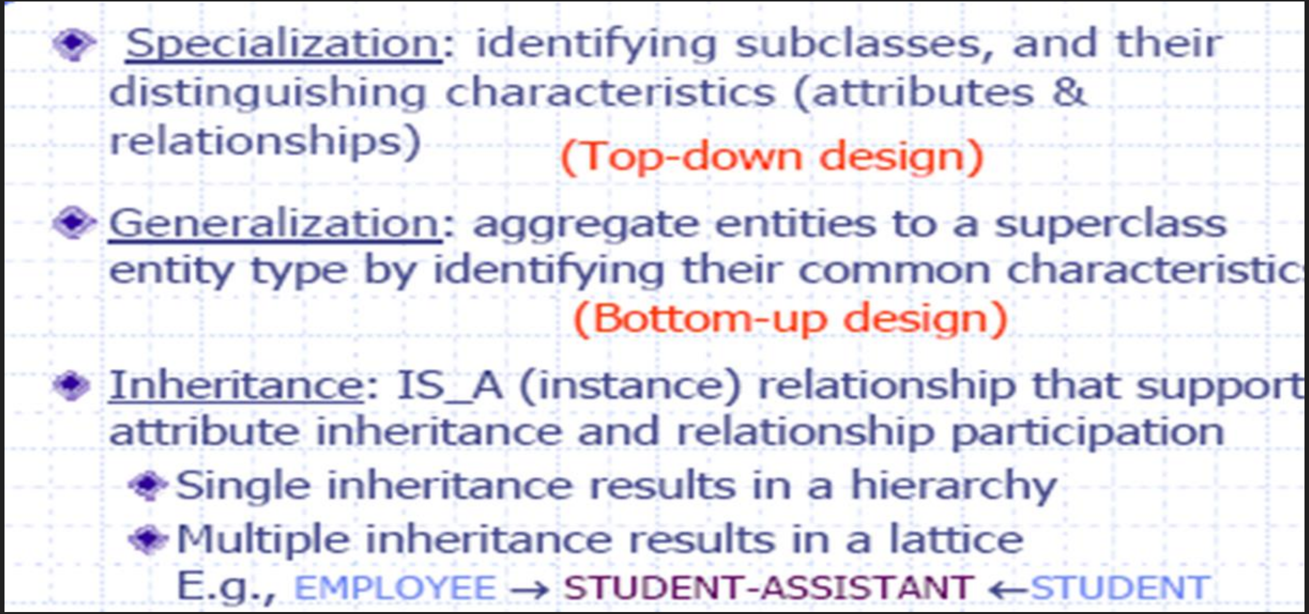
- FN:String(15), LN: String(15), SSN: String(9), etc.
- BoD: DD/MM/YYYY
- Degree: {BS,MS,PhD}
- Rank: {Lecturer, Assistant, Associate, Full}

Enhanced Entity-Relationship Model

- Specialization
- Generalization
- Inheritance

Enhanced Entity-Relationship Model

Specialization Generalization Inheritance

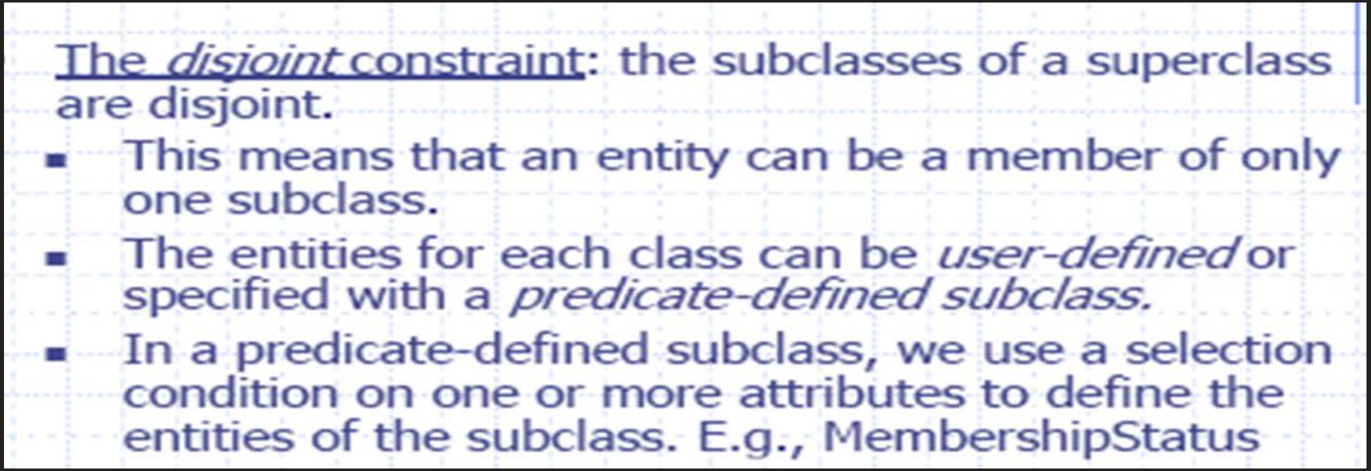


- Specialization: identifying subclasses, and their distinguishing characteristics (attributes & relationships) (Top-down design)
- Generalization: aggregate entities to a superclass entity type by identifying their common characteristic (Bottom-up design)
- Inheritance: IS_A (instance) relationship that support attribute inheritance and relationship participation
  - Single inheritance results in a hierarchy
  - Multiple inheritance results in a lattice

    E.g., EMPLOYEE → STUDENT-ASSISTANT ←STUDENT

Enhanced Entity-Relationship Model

Inclusion of Constraints on Specialization and Generalization

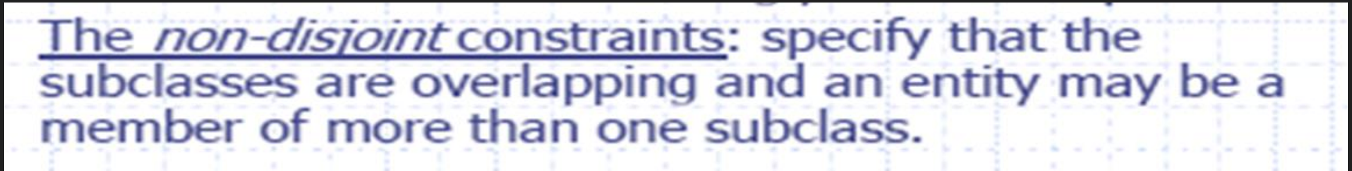


The *disjoint* constraint: the subclasses of a superclass are disjoint.

- This means that an entity can be a member of only one subclass.
- The entities for each class can be *user-defined* or specified with a *predicate-defined subclass.*
- In a predicate-defined subclass, we use a selection condition on one or more attributes to define the entities of the subclass. E.g., MembershipStatus

Enhanced Entity-Relationship Model

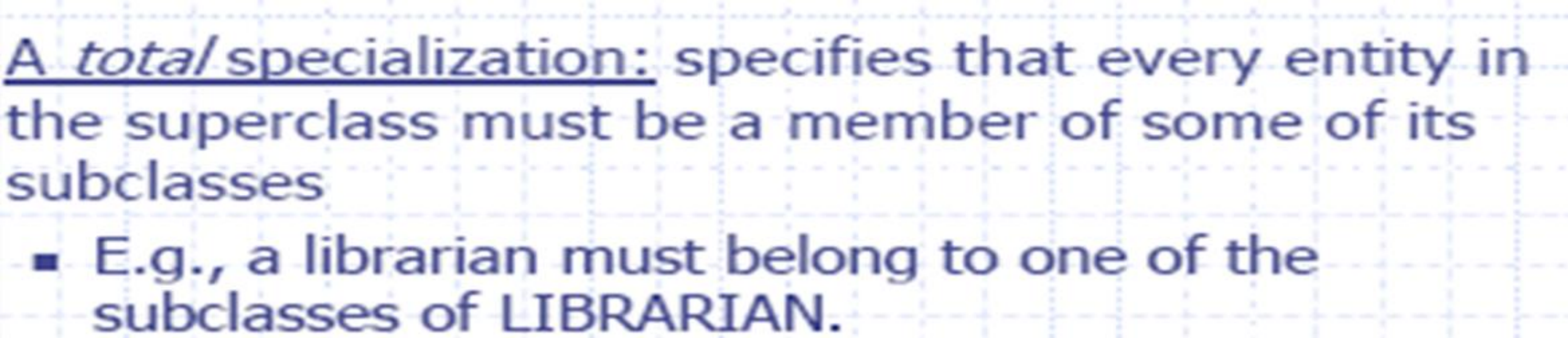
Inclusion of Constraints on Specialization and Generalization



The *non-disjoint* constraints: specify that the subclasses are overlapping and an entity may be a member of more than one subclass.

Enhanced Entity-Relationship Model

Completeness Constraint on Specialization and Generalization

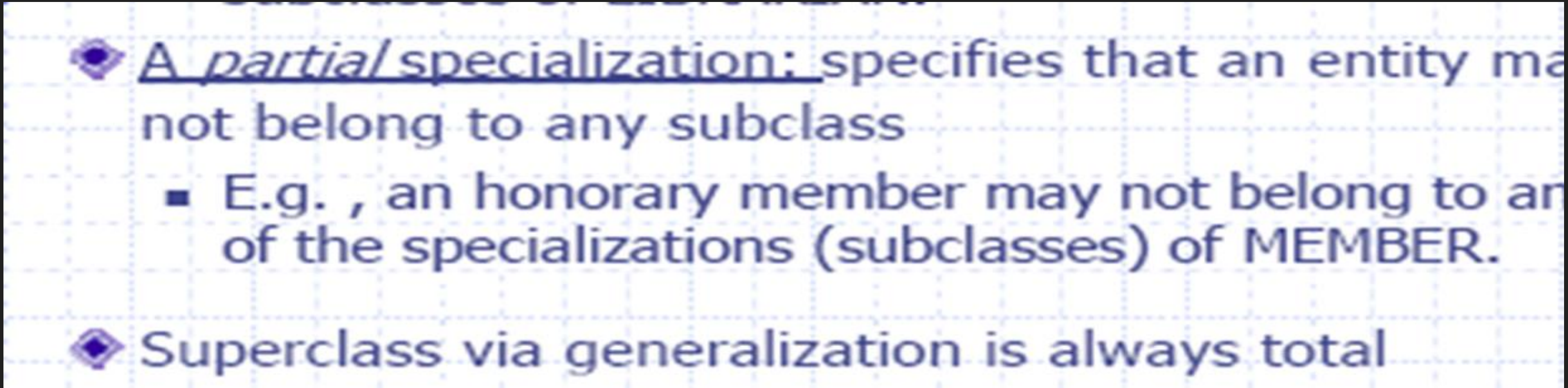


A *total* specialization: specifies that every entity in the superclass must be a member of some of its subclasses

- E.g., a librarian must belong to one of the subclasses of LIBRARIAN.

Enhanced Entity-Relationship Model

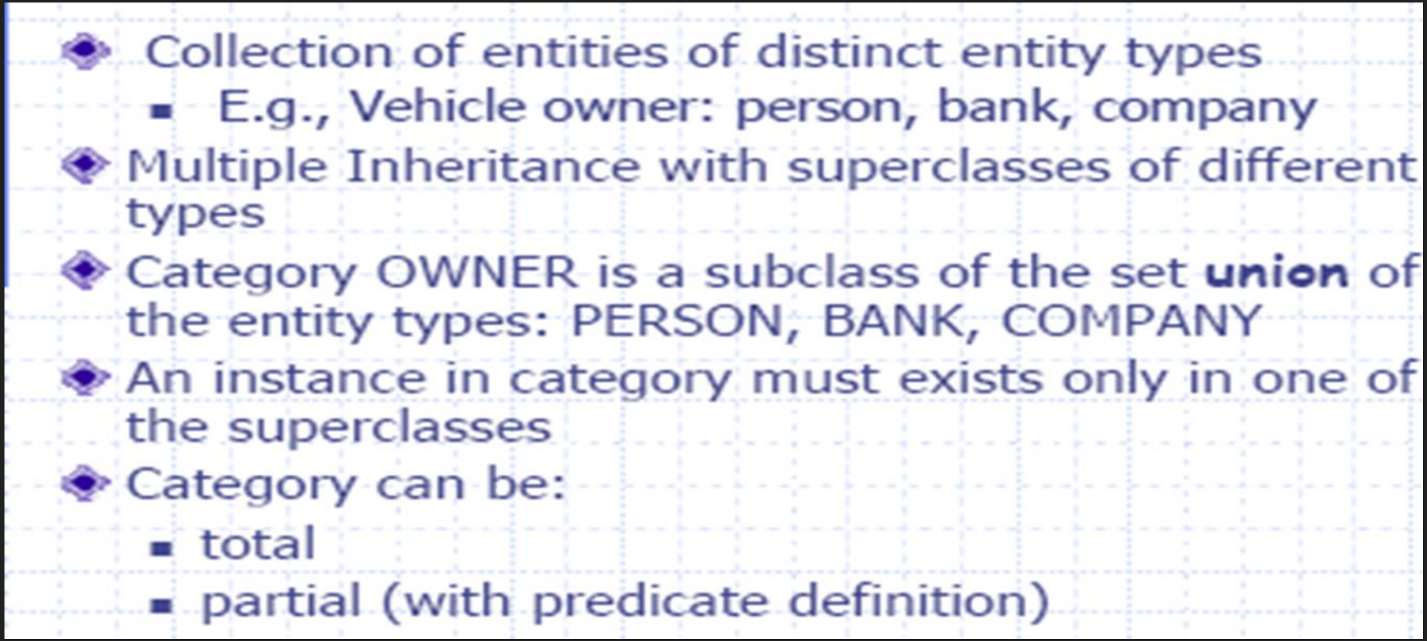
Completeness Constraint on Specialization and Generalization



- A *partial* specialization: specifies that an entity ma not belong to any subclass
  - E.g. , an honorary member may not belong to an of the specializations (subclasses) of MEMBER.
- Superclass via generalization is always total

Enhanced Entity-Relationship Model

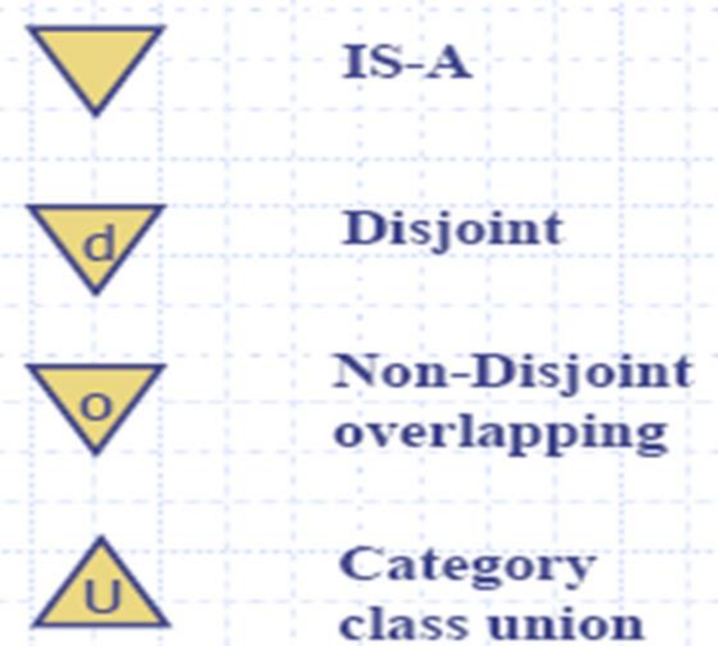
Union Types or Categories



- Collection of entities of distinct entity types
  - E.g., Vehicle owner: person, bank, company
- Multiple Inheritance with superclasses of different types
- Category OWNER is a subclass of the set **union** of the entity types: PERSON, BANK, COMPANY
- An instance in category must exists only in one of the superclasses
- Category can be:
  - total
  - partial (with predicate definition)

Enhanced Entity-Relationship Model

Notations for EER

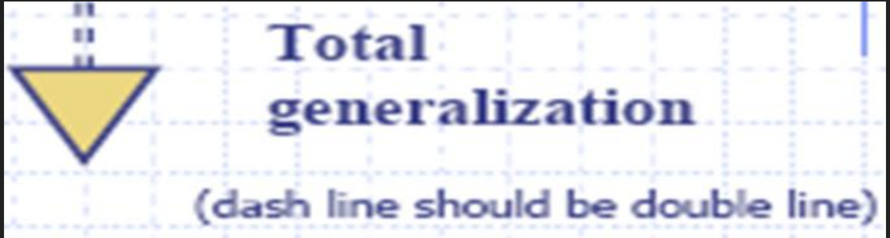


IS-A

Disjoint

Non-Disjoint overlapping

Category class union

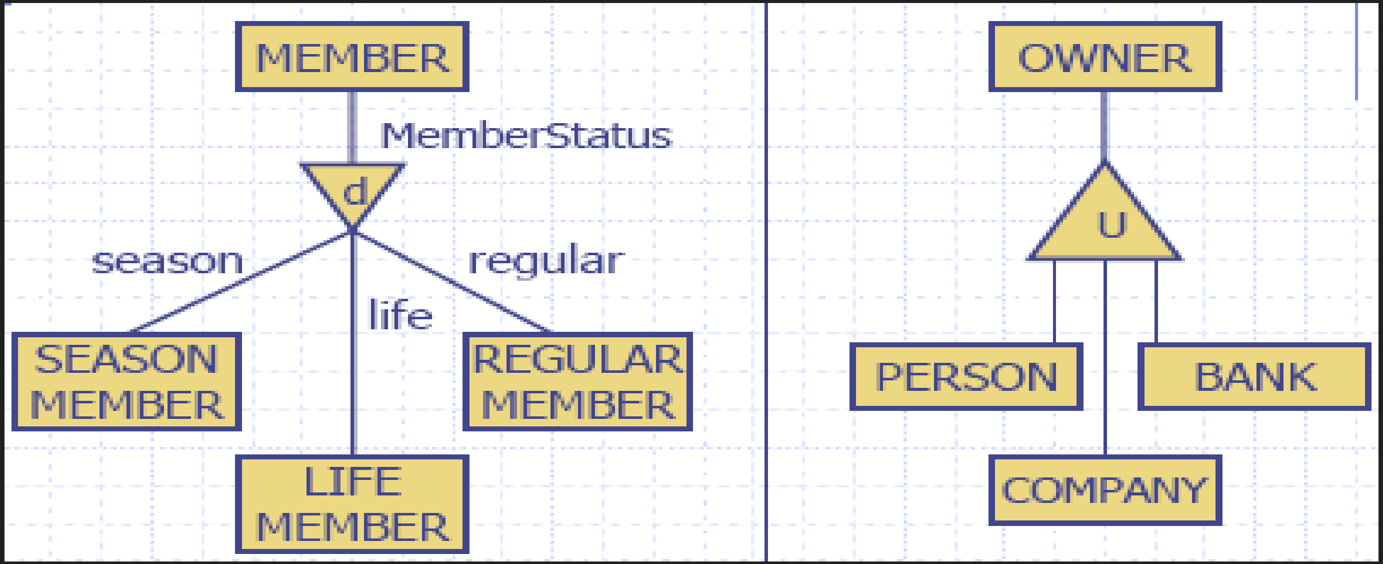


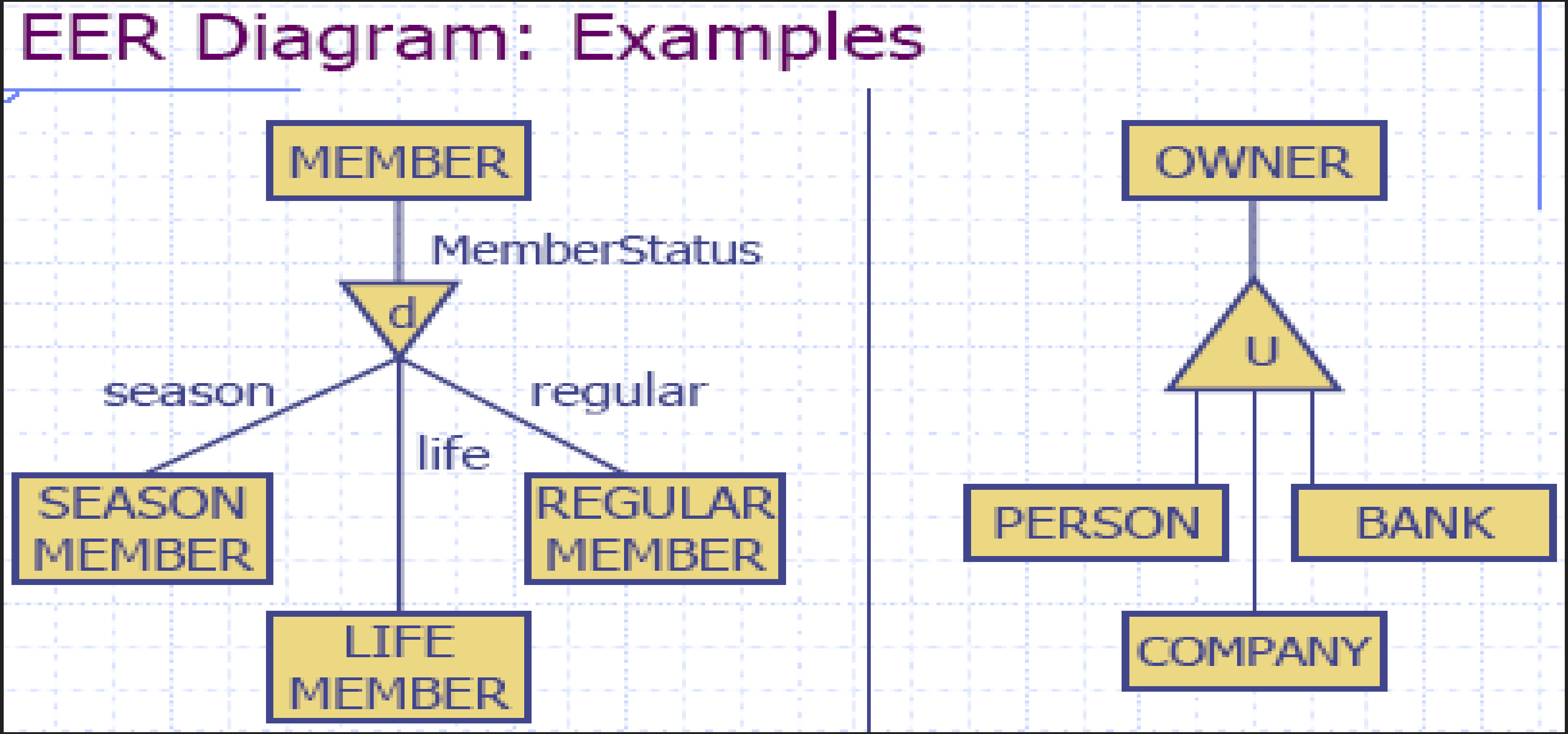
Total generalization

(dash line should be double line)

Enhanced Entity-Relationship Model

Example of EER





EER Diagram: Examples

Enhanced ER-diagram

Example:

- A library database contains a listing of authors that have written books on various subjects (one author per book).
- It also contains information about libraries that carry books on various subjects.

Entity Sets

Example:

- A library database contains a listing of authors that have written books on various subjects (one author per book).
- It also contains information about libraries that carry books on various subjects.

Entity sets: authors, subjects, books, libraries

RELATIONSHIPS

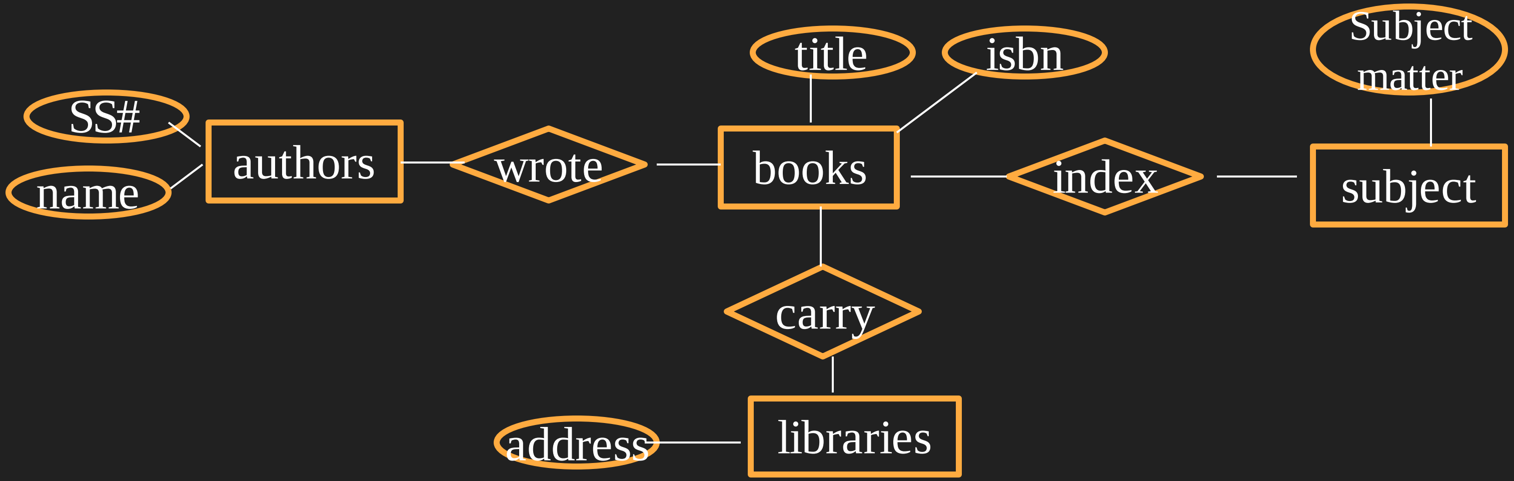
Example:

- A library database contains a listing of authors that have written books on various subjects (one author per book).
- It also contains information about libraries that carry books on various subjects.

Entity sets: authors, subjects, books, libraries

Relationship sets: wrote, carry, indexed

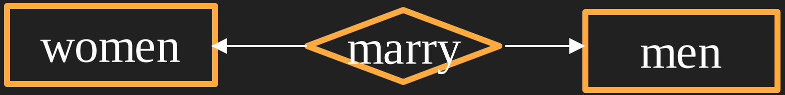
ENTITY SETS and RELATIONSHIPS

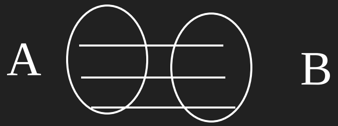


BINARY RELATIONSHIP

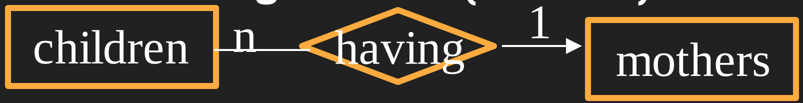
A binary relationship between entity set *A* and *B* might be:

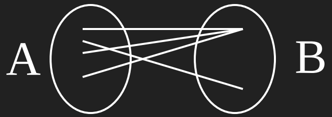
- 1:1 Women marrying Men (function)



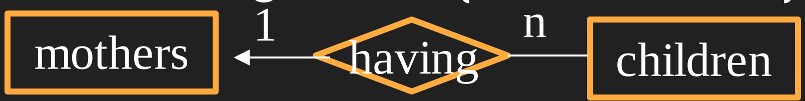


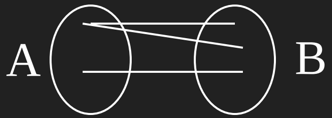
- N:1 Children having mothers (function)



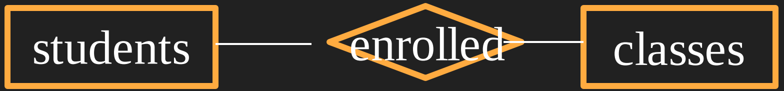


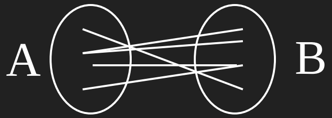
- 1:N Mothers having children (inverse function)





- M:N Students enrolled in a class





KEY

- Entities and relationships are distinguishable using various keys
- A **key** is a combination of one or more attributes, e.g., social-security number, combination of name and social-security number.
- A **superkey** is a key identifies an entity,

e.g.,

social-security number
phone number,
combination of name and social-security number

- defined either for an entity set or relationship set that uniquely identifies

KEY

Entities and relationships are distinguishable using various keys

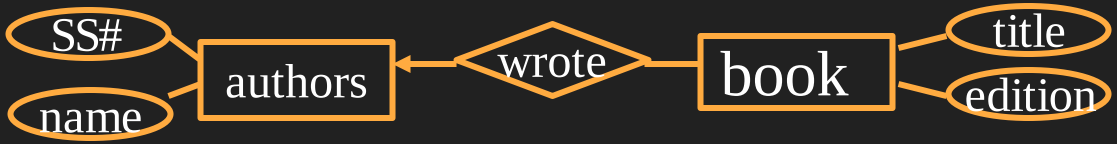
- A **candidate key** is a minimal superkey that uniquely identifies either an entity or a relationship,
- e.g., social-security number, phone number.

- A **primary key** is a candidate key that is chosen by the database designer to identify the entities of an entity set.

KEY

Entities and relationships are distinguishable using various keys

- A foreign key is a set of one or more attributes of a strong entity set that are employed to construct the discriminator of a weak entity set.
- The primary key of a weak entity set is formed by the primary key of the strong entity set on which it is existence-dependent.



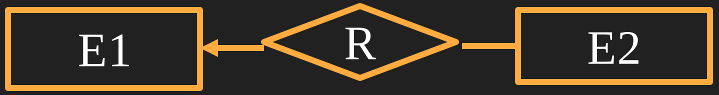
KEY

Entities and relationships are distinguishable using various keys

- Relationship sets also have primary keys.
- Assume *R* is a relationship set involving entity sets $E_1, E_2, ..., E_n$.
- Let primary-key(E_i) denote the primary key for entity set E_i.
- Assume primary-key(E_i) is unique for $1 \leq i \leq n$.
- If **R** has no attributes then its superkey is:

  primary-key(E_1) ∪ primary-key(E_2) ∪ ... ∪ primary-key(E_n)

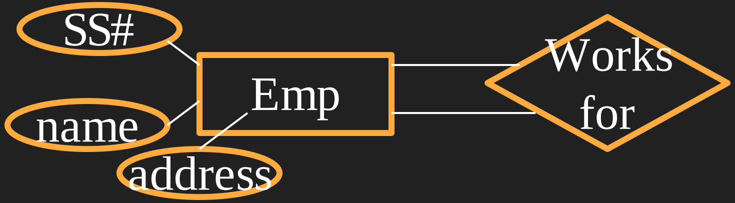
- This is a primary key if the mapping constraint is many-to-many.
- If the mapping constraint is many to one from E1 to E2 then the primary key of R is primary key of E1.



EXAMPLE

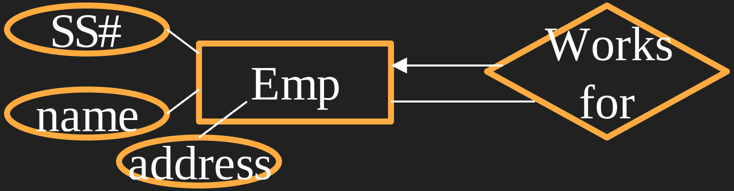
- Employees of a large company, e.g., IBM, where an employee reports to a manager.
- The manager is also an employee who reports to another manager.
- This chain of command continues to the very top where the CEO is the only employee who is not reporting to a manager. Draw the ER diagram for this example.

EXAMPLE



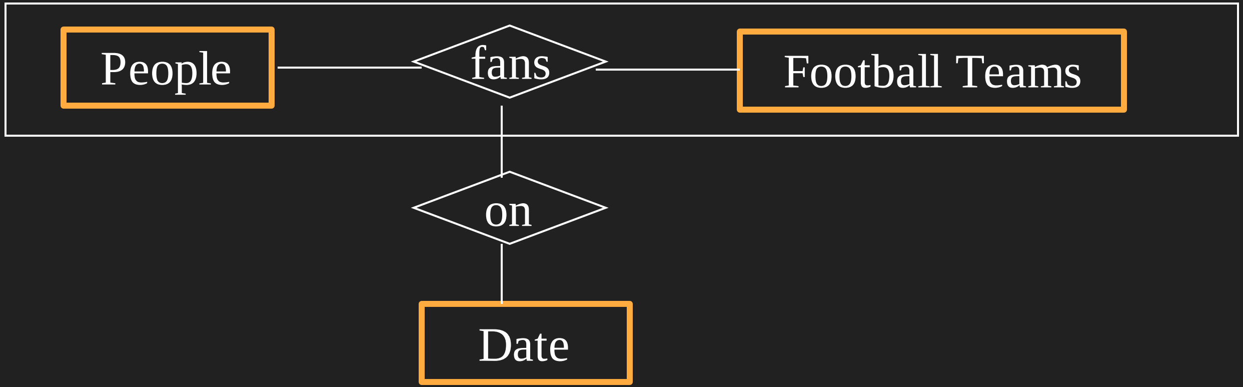
Primary keys:
Emp: SS#
Works-for: (empSS#, mgrSS#)

Primary keys:
Emp: SS#
Works-for: (empSS#)



Relationship

- A relationship may involve *n* entities, N-ary relationship
- It is always possible to replace a non-binary relationship set by a number of distinct binary relationship sets



GENERALIZATION AND SPECIALIZATION

- Generalization is the result of computing the union of two or more entity sets to produce a higher-level entity set.
- It represents the containment relationship that exists between the higher-level entity set and one or more lower-level entity sets.
- ***Specialization*** constructs the lower level entity sets that

GENERALIZATION

- Generalisation is the process of minimising the differences between entities by identifying common features.

- This is the identification of a generalised superclass from the original subclasses.

- This is the process of identifying the common attributes and relationships.

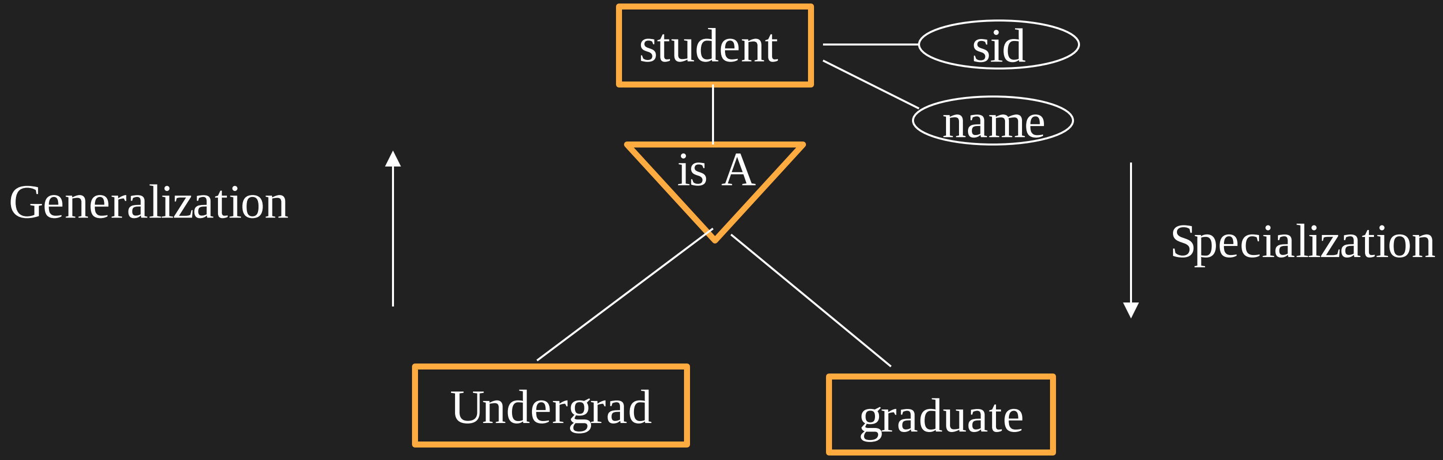
GENERALIZATION AND SPECIALIZATION

- Undergrad and graduate are termed subclasses of the superclass student.
- This is a superclass/subclass or simply class/subclass relationship.
- A member of a subclass MUST be a member of the superclass.
- An alternative notation is the Union symbol
- The circle with d specifies that the specializations are disjoint.
- A member of Undergrad entity set may NOT be a member of the graduate entity set.

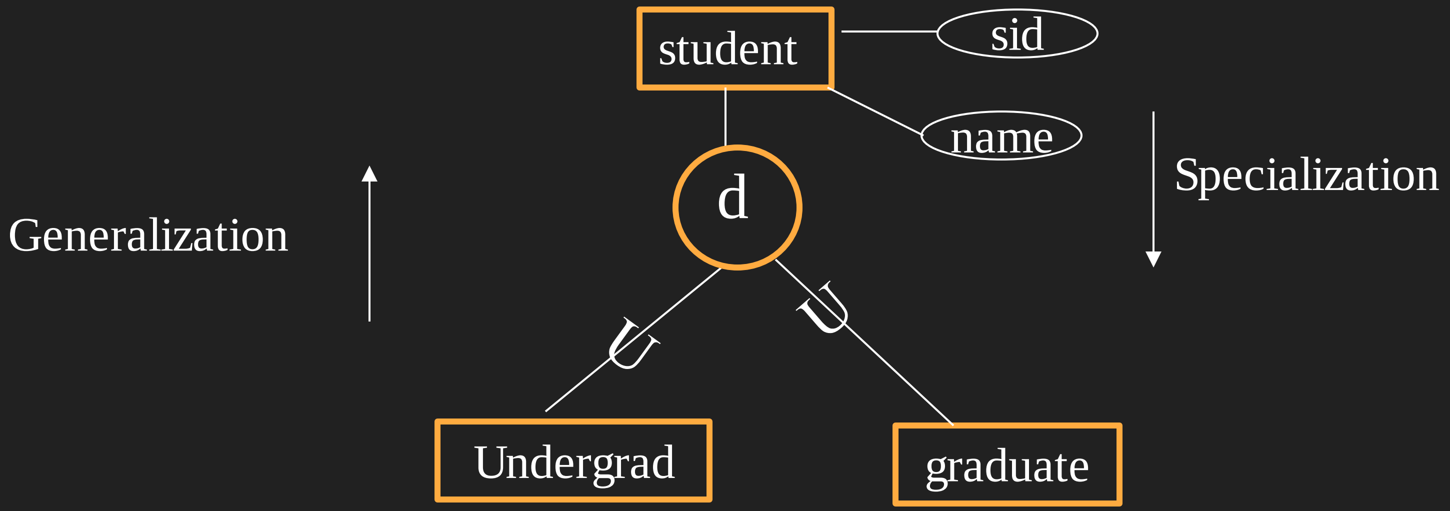
GENERALIZATION AND SPECIALIZATION

- **Specialization constructs the lower level entity sets that are a subset of a higher level entity set.**

GENERALIZATION AND SPECIALIZATION



GENERALIZATION AND SPECIALIZATION



GENERALIZATION AND SPECIALIZATION

- A design may require all members of an entity-set to be specialized. For example, an employee MUST be a member of either a Salaried or Part-time.

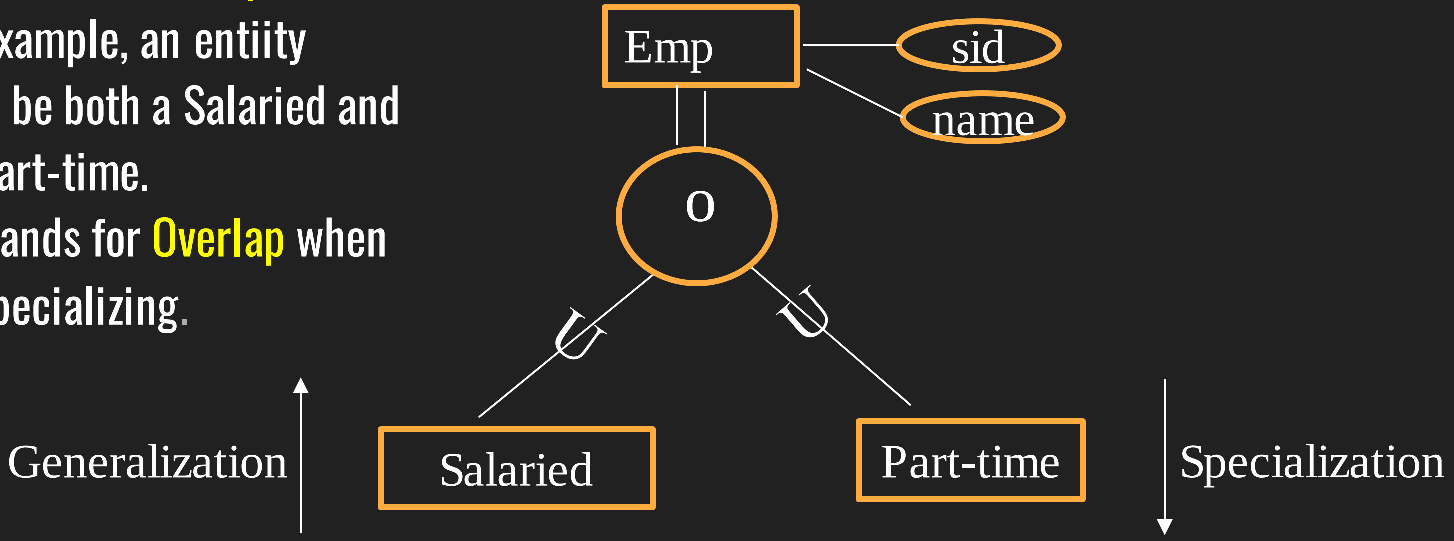
- Use double lines to dictate this constraint

GENERALIZATION AND SPECIALIZATION

One may allow the specialized entity sets to overlap.

For example, an entiity might be both a Salaried and Part-time.

“o” stands for Overlap when specializing.



Summary

- EER

Next Lecture

EER diagram examples

References

https://www.db-book.com/db6/index.html

Thank You

Happy to answer any questions ! ! !