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# Extended ER Features: Generalization, Specialization, Inheritance

- As the complexity of data increased in the data late 1980's, it became more and more difficult to use traditional ER Model for database modelling.
- Some improvement or enhancements were made to the existing ER Model to make it able to handle the complex application better.
- Hence as part of Extended ER Model, along with other improvements, three new concepts were added to the existing ER Model.
  - ✓ Generalization
  - ✓ Specialization
  - ✓ Inheritance



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# Extended ER Features: Generalization

- Generalization is the process of extracting common properties from a set of entities and create a generalized entity from it.
- Generalization is a bottom-up approach in which two or more entities can be combined to form a higher-level entity if they have some attributes in common.
- It is used to emphasize the similarities among lower-level entity set and to hide the differences in the schema.



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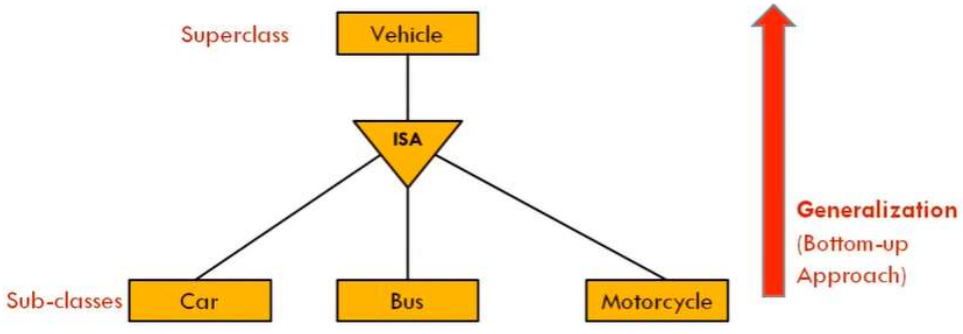
# Extended ER Features: Generalization

- Consider we have 3 entities Car, Bus, Motorcycle. Now these three entities can be generalized into one higher-level entity (or super class) named as Vehicle.



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# Extended ER Features: Specialization

- Specialization is the opposite of Generalization.
- In Specialization, any entity is broken down into sub-entities based on their characteristics.
- It is a top-down approach where higher level entity is specialized into two or more lower-level entities.
- It is used to identify subset of an entity set that shares same distinguish characteristic.
- It can be repeatedly applied to refine the design of schema.
- It is represented by triangle component labeled ISA.



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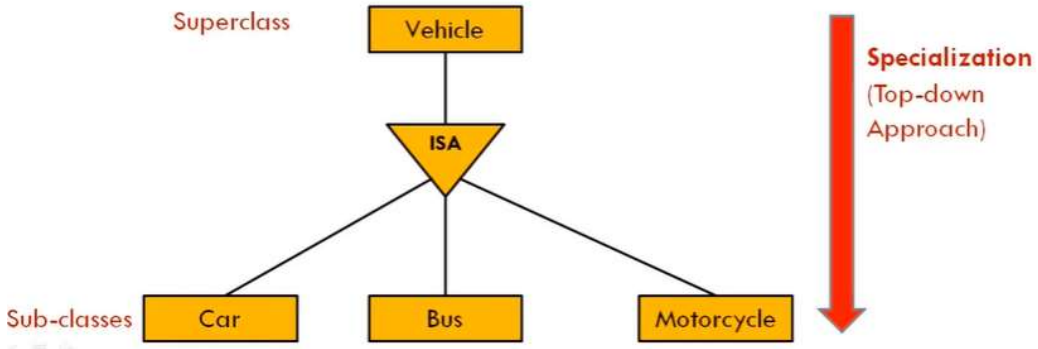
# Extended ER Features: Specialization

- Vehicle entity can be Car, Truck, Motorcycle.
- Normally the super class defined first, then the subclass and its related attributes are defined next and relationship set are then added.



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# Extended ER Features: Inheritance

- Inheritance is an important feature of Specialization and Generalization.
- Attribute inheritance allows lower-level entities to inherit the attributes of higher-level entities.
  - For example, Consider relations Car and Bus inheriting the attributes of vehicle. Thus, Car is described by attributes of super-class Vehicle as well as its own attributes.
- This also extends to participation inheritance in which relationships involving higher-level entity sets are also inherited by lower-level entity sets.
  - A lower-level entity set can participate in its own relationship sets, too



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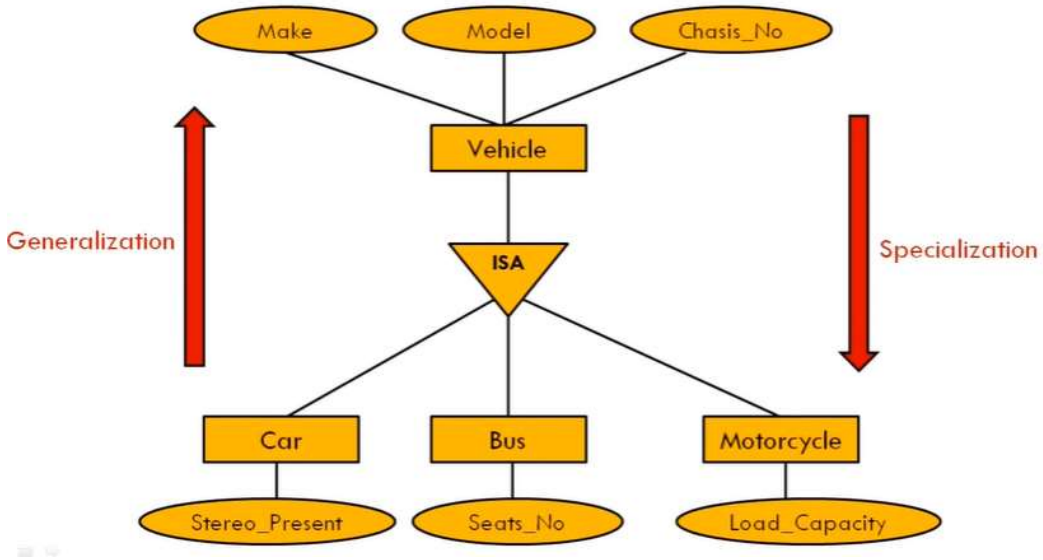
# Extended ER Features: Inheritance



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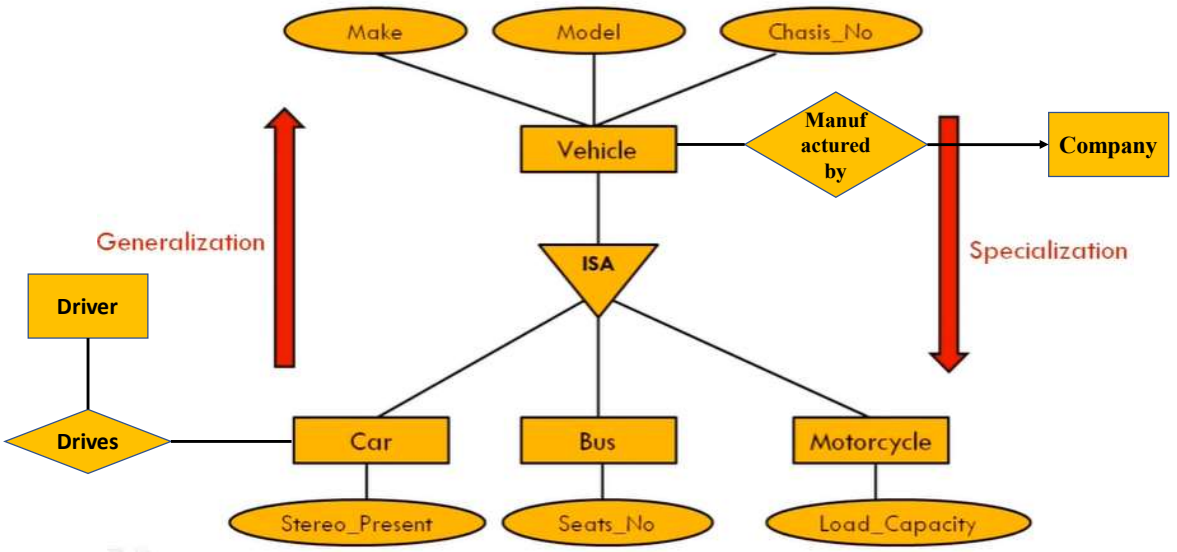
# Extended ER Features: Inheritance



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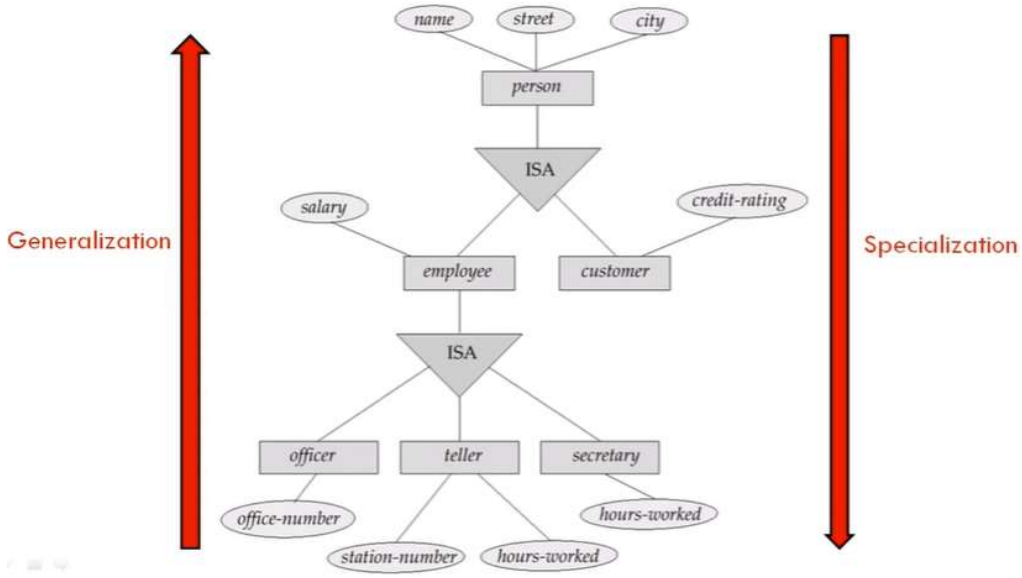
# Extended ER Features: Inheritance



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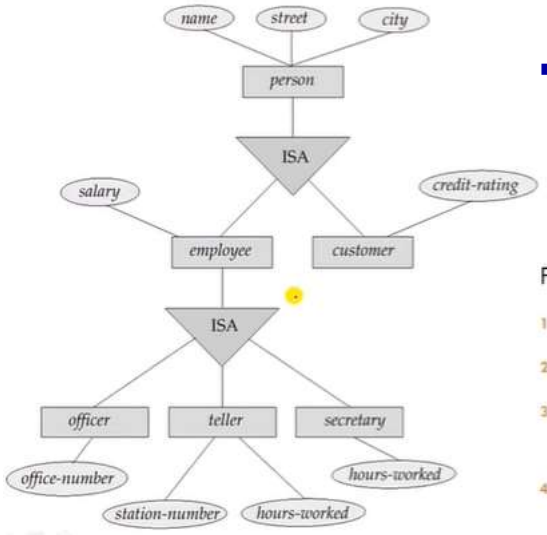
# How Schema or Tables can be formed?




- Tables will be created only for leaf nodes or subclasses.

Four tables can be formed:

1. **customer** (name, street, city, credit_rating)
2. **officer** (name, street, city, salary, office_number)
3. **teller** (name, street, city, salary, station_number, hours_worked)
4. **secretary** (name, street, city, salary, hours_worked)

Introduction: 1-11

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# Aggregation

- Aggregation is used when we need to express a relationship among relationships.
- Aggregation is an abstraction through which relationships are treated as higher levels entities.
- Aggregation is process when a relationship between two entities is considered as a single entity and again this single entity has a relationship with another entity.

Introduction: 1-12

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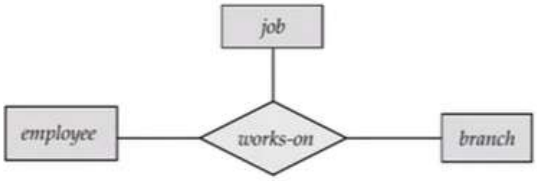
# Aggregation

- Basic ER Model can not represent relationships involving other relational model.
- Consider a ternary relationship works_on between employee, job and branch.
  - An employee works on a particular job at a particular branch.




- ✓ Suppose we want to assign a manager for jobs performed by an employee at a branch (i.e., we want to assign a manager to each employee, job and branch)
  - Need a separate Manager entity set.
  - Relationship between each manager, employee, job and branch entity sets.



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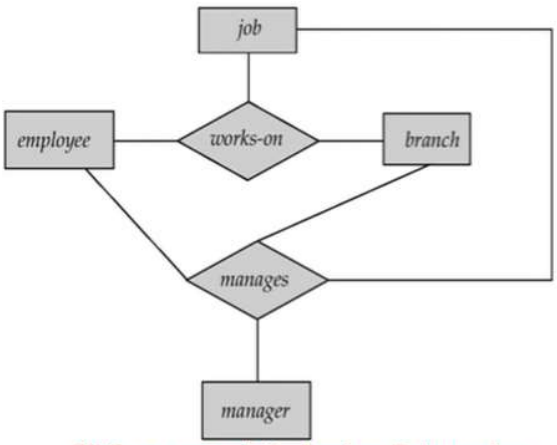
# Example: Redundant Relationship




ER Diagram with Redundant Relationship

- Relationship sets works-on and manages represent overlapping (redundant) information.
  - Every manages relationship corresponds to a works_on relationship.
  - However, some works_on relationship may not correspond to any manages relationship.
  - So, we can not discard the works_on relationship.



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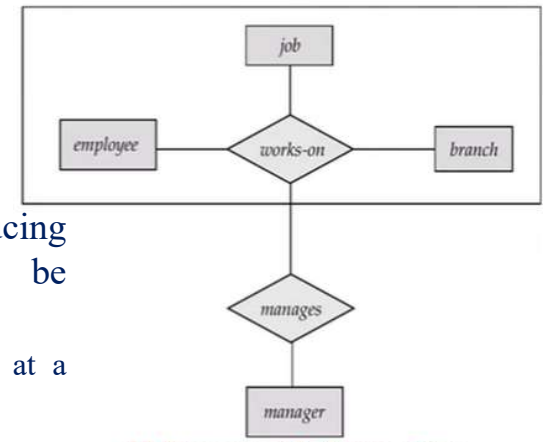
# Aggregation

- Eliminates this redundancy via Aggregation
  - ✓ Treat relationship as an abstract entity.
  - ✓ Allow relationships between relationships.
  - ✓ Abstraction of relationship into new entity.



ER Diagram with Aggregation

- With aggregation (without introducing redundancy) the ER diagram can be represented as
  - ✓ An employee works on a particular job at a particular branch.
  - ✓ An employee, job branch combination may have an associated manager.



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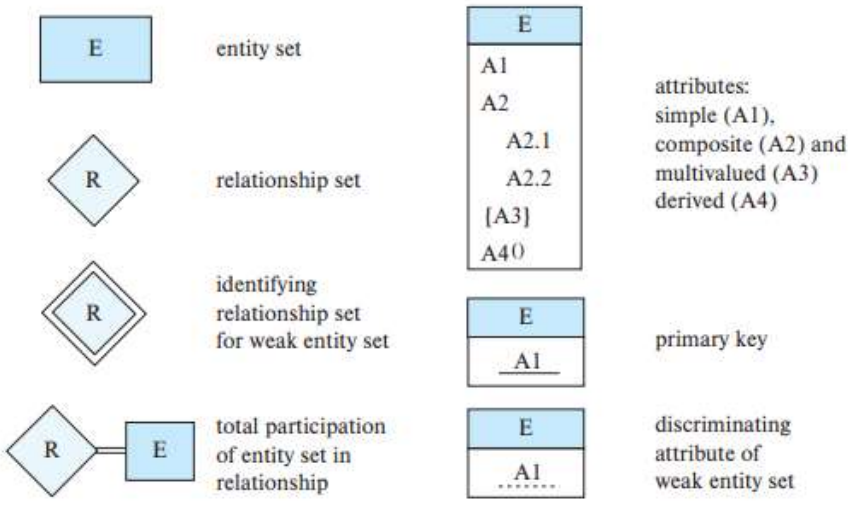
# Symbols used in the E-R notation.



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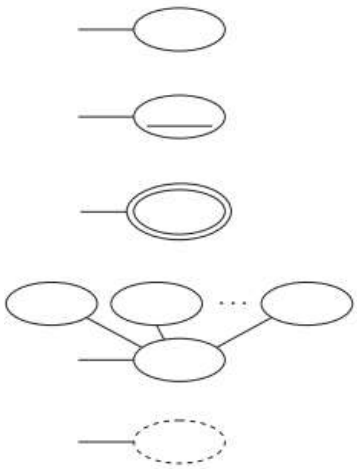
# Symbols used in the E-R notation.



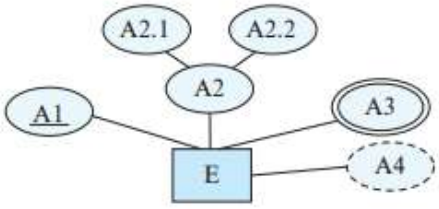
Attribute

Key Attribute

Multivalued Attribute

Composite Attribute

Derived Attribute




entity set E with
simple attribute A1,
composite attribute A2,
multivalued attribute A3,
derived attribute A4,
and primary key A1



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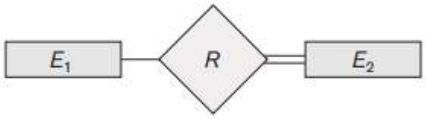
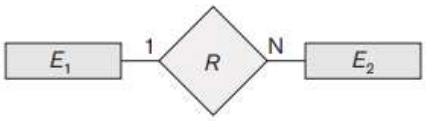
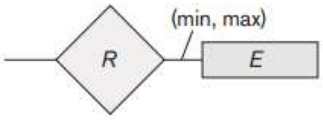
# Symbols used in the E-R notation.




Total Participation of $E_2$ in $R$




Cardinality Ratio 1: N for $E_1 : E_2$ in $R$




Structural Constraint (min, max)
on Participation of $E$ in $R$



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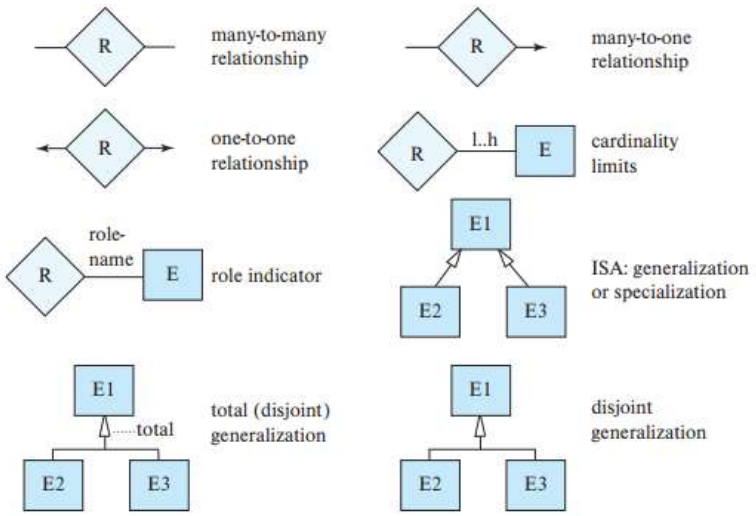
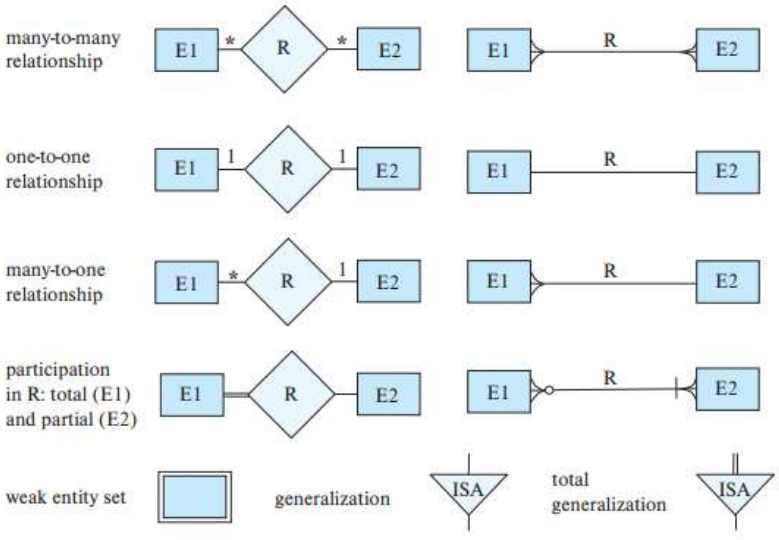
# Symbols used in the E-R notation.








# Symbols used in the E-R notation.



# How to draw ER Diagram?

- Steps to draw an ER Diagram:
  - ✓ Identify the Entities.
  - ✓ Identify the Attributes.
  - ✓ Identify the Primary Key.
  - ✓ Identify the Relationships.
  - ✓ Identify the Cardinality.
  - ✓ Identify the Participation Constraints.
  - ✓ Identify the Specialization, Generalization and Aggregation



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# How to draw ER Diagram? Example 1

- A publishing company produces books on various subjects. The books are written by authors who specialize in one particular subject. The company employs editors who, not necessarily being specialists in a particular area, each take sole responsibility for editing one or more book publications. Every book require some items for publication. These items supplied by suppliers. One supplier can supply many items. Shop owner buys books from the publisher. Shop owner can buy many books, but one book can be bought by one shop owner only. Books are uniquely identified by book id.
  - ✓ Identify the entities, attributes and relationship.
  - ✓ Construct a clean and concise ER diagram and clearly indicate the cardinality mappings, participation constraints as well as any role indicators in your ER diagram.



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# Identifying Entities

- A publishing company produces books on various subjects. The books are written by authors who specialize in one particular subject. The company employs editors who, not necessarily being specialists in a particular area, each take sole responsibility for editing one or more book publications. Every book require some items for publication. These items supplied by suppliers. One supplier can supply many items. Shop owner buys books from the publisher. Shop owner can buy many books but one book can be bought by one shop owner only. Books are uniquely identified by book id.



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# Identifying Entities

- Identify the Entities:
  - ✓ Publishing Company / Publisher
  - ✓ Book
  - ✓ Subject
  - ✓ Author
  - ✓ Editor
  - ✓ Item
  - ✓ Supplier
  - ✓ Shop Owner



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# Identifying Attributes for Entities

- Identify the Entities:
  - ✓ Publishing Company / Publisher: Name, Address, Phone, Established_date, etc.
  - ✓ Book: Book_Id, Book_Name, Book_Price, Print_Date, etc;
  - ✓ Subject: Subject_Code, Subject_Name;
  - ✓ Author: Author_Id, Author_Name, Author_Details, etc.
  - ✓ Editor: Editor_Id, Editor_Name, No_of_BooksEdited, etc.
  - ✓ Item: Item_No, Item_Name, Manufactured_Date, Expiry_Dtae, etc.
  - ✓ Supplier: Supplier_id, Supplier_Name, No_of_items, Date, Phone, etc.
  - ✓ Shop Owner: Name, Address, Phone, etc.



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# Identifying Relationships

- A publishing company produces books on various subjects. The books are written by authors who specialize in one particular subject. The company employs editors who, not necessarily being specialists in a particular area, each take sole responsibility for editing one or more book publications. Every book require some items for publication. These items supplied by suppliers. One supplier can supply many items. Shop owner buys books from the publisher. Shop owner can buy many books but one book can be bought by one shop owner only. Books are uniquely identified by book id.



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# How to draw ER Diagram?

- Identify the Relationship:
  - ✓ Publisher – Book : Produces
  - ✓ Book – Subject : On / About
  - ✓ Book – Author :Written by
  - ✓ Subject – Author: Specialize in
  - ✓ Publisher – Editor: Employs
  - ✓ Editor – Book: Edit
  - ✓ Item – Book: Require
  - ✓ Supplier – Item: Supplied by
  - ✓ Shop Owner – Book: Buy



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# Identifying Cardinality

- A publishing company produces books on various subjects. The books are written by authors who specialize in one particular subject. The company employs editors who, not necessarily being specialists in a particular area, each take sole responsibility for editing one or more book publications. Every book require some items for publication. These items supplied by suppliers. One supplier can supply many items. Shop owner buys books from the publisher. Shop owner can buy many books but one book can be bought by one shop owner only. Books are uniquely identified by book id.



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# How to draw ER Diagram?

- Identify the Relationship:
  - ✓ Publisher – Book : Produces
  - ✓ Book – Subject : On / About
  - ✓ Book – Author :Written by
  - ✓ Subject – Author: Specialize in
  - ✓ Publisher – Editor: Employs
  - ✓ Editor – Book: Edit
  - ✓ Item – Book: Require
  - ✓ Supplier – Item: Supplied by
  - ✓ Shop Owner – Book: Buy
- Identify the Cardinality:
  - ✓ Publisher – Book : One to Many
  - ✓ Book – Subject : Many to One
  - ✓ Book – Author : Many to Many
  - ✓ Subject – Author: One to Many
  - ✓ Publisher – Editor: One to Many
  - ✓ Book – Editor: Many to One
  - ✓ Book – Item: Many to Many
  - ✓ Supplier – Item: Many to Many
  - ✓ Book – Shop Owner: Many to One



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# Identifying Primary Key

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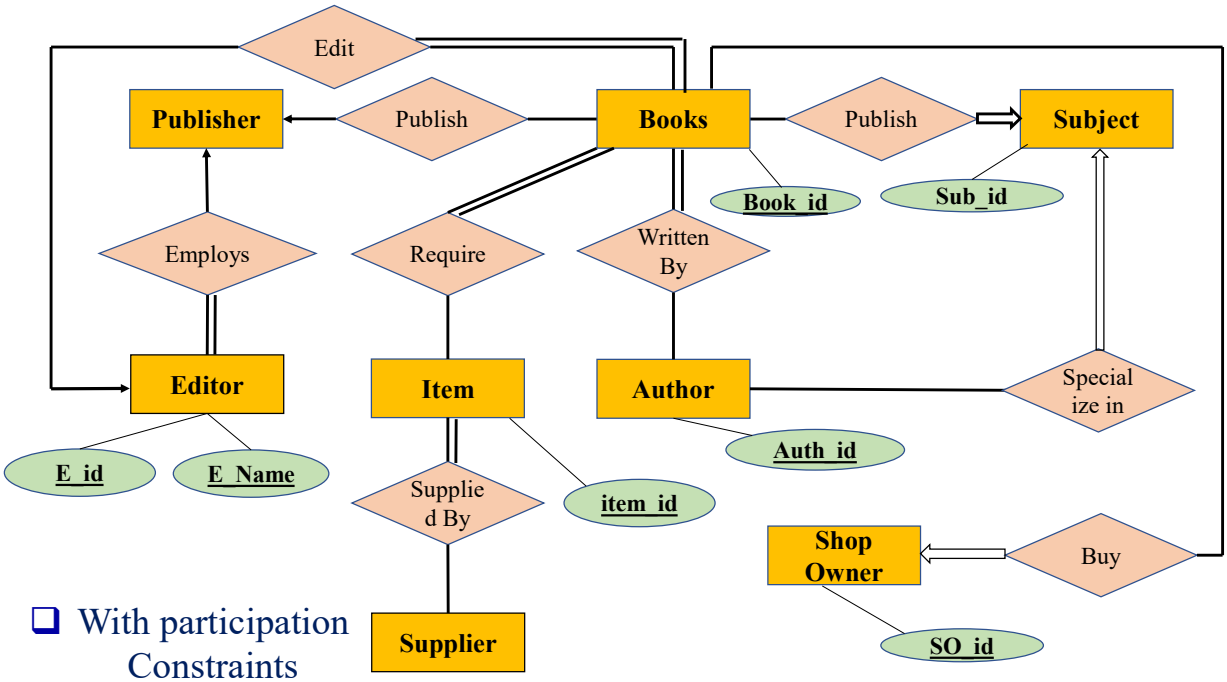


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# Exercise

Suppose you are given the following requirements for a simple database for the Vietnam Premier League (VPL):

a) the VPL has eight teams

b) each team has a name, a city, a coach, a captain, and a set of players

c) each player belongs to only one team

d) each player has a name, a position (such as goalkeeper, defender, or striker, and a set of records

e) a team captain is also a player

f) a game is played between two teams (referred to as host_team and guest_team) and has a date (such as May 11th, 2022) and a score (such as 0 - 3).

- ✓ Identify the entities, attributes and relationship
- ✓ Construct a clean and concise ER diagram for the VPL database and clearly indicate the cardinality mappings as well as any role indicators in your ER diagram.

Introduction: 1-32

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