Chapter 5

Entity-Relationship modeling

Transparencies

Chapter 5 - Objectives

- **The use of high-level conceptual data models to support database design.**
- **The basic concepts associated with the Entity-Relationship (ER) model, a high-level conceptual data model.**
- **How to identify problems called connection traps, which may occur when creating an ER model.**

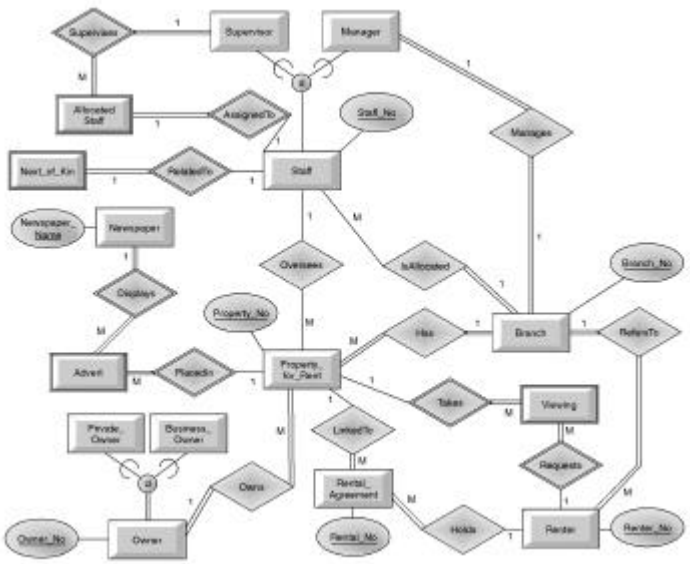
Chapter 5 - Objectives

- **The limitations of the basic ER modeling concepts and the requirements to model more complex applications using enhanced data modeling concepts.**
- **The main concepts associated with the Enhanced Entity-Relationship (EER) model called specialization / generalization and categorization.**

Concepts of the Entity-Relationship Model

- **Entity types**
- **Relationship types**
- **Attributes**

An Example EER Model



Entity Type

- **Entity Type**
  - **An object or concept that is identified by the enterprise as having an independent existence.**
- **Entity**
  - **An object or concept that is uniquely identifiable.**

Examples of Entity Types

Physical existence	
Staff	Part
Property	Supplier
Customer	Product
Conceptual existence	
Viewing	Sale
Inspection	Work experience

Entity Type

- **Weak Entity Type vs. Strong Entity Type**
  - **An entity type that is existence-dependent on some other entity type is weak.**
  - **Otherwise, it is strong, having an independent existence.**

Attributes

- **Attribute**
  - **A property of an entity or a relationship type.**
- **Attribute Domain**
  - **A set of values that may be assigned to a single-valued attribute.**

Attributes

- **Simple Attribute vs Composite Attributes**
  - **simple: An attribute composed of a single component with an independent existence.**
  - **Composite: An attribute composed of multiple components each with an independent existence.**
  - **Example: JobTitle vs Address**

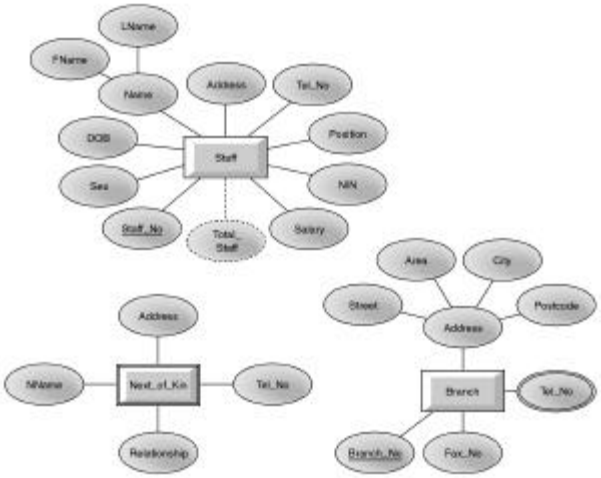
Attributes

- **Single-valued vs Multi-valued Attribute**
  - **An attribute that holds a single-value for a single entity.**
  - **An attribute that holds multiple values for a single entity.**
  - **Example: Age vs Awards**

Attributes

- **Derived Attribute**
  - **An attribute that represents a value that is derivable from the value of a related attribute or set of attributes, not necessarily in the same entity.**

Diagrammatic Representation of Entities and their Attributes



Keys

- **Candidate Key, Primary Key, Composite Key**
  - **uniquely identifies individual occurrences of an entity type.**
  - **An entity type may have one or more possible candidate keys, one of which is selected to be the primary key.**
  - **A candidate key that consists of two or more attributes is considered composite.**

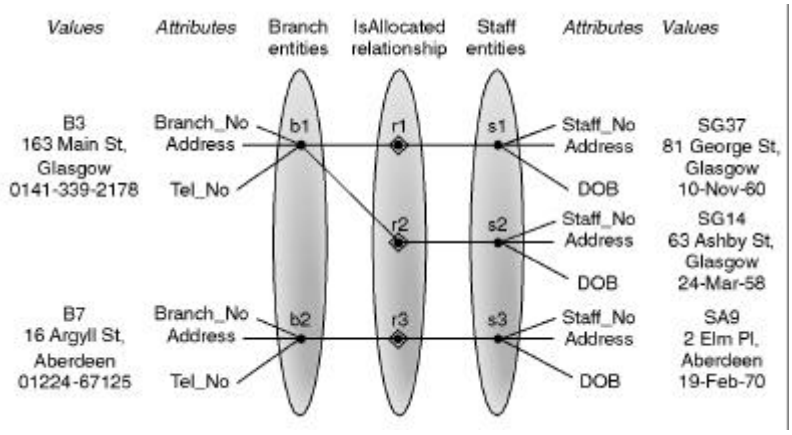
Relationship Types

- **Relationship Type**
  - **A meaningful association among entity types.**
- **Relationship**
  - **An association of entities where the association includes one entity from each participating entity type.**

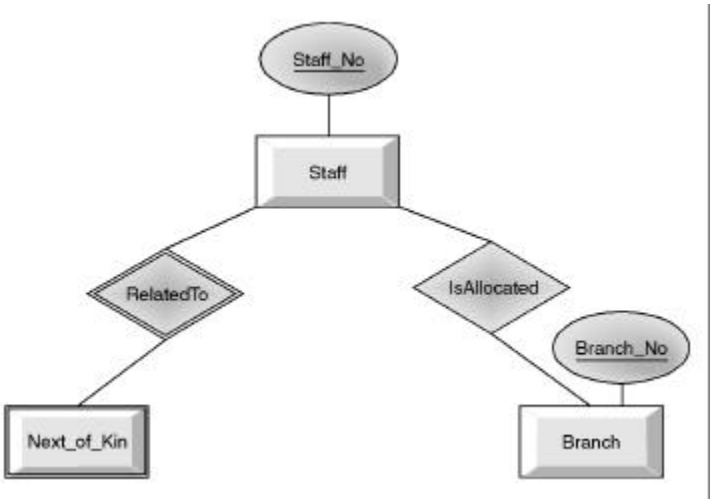
Relationship Types

- **Degree of a Relationship**
  - **The number of participating entities in a relationship.**
- **Recursive Relationship**
  - **A relationship where the same entity participates more than once in a different roles.**

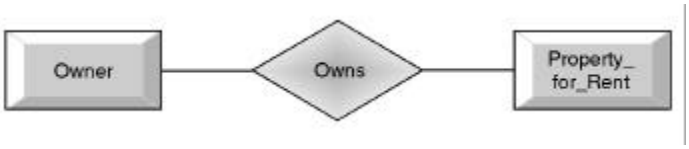
Semantic Net Model of the Branch *IsAllocated* Staff Relationship



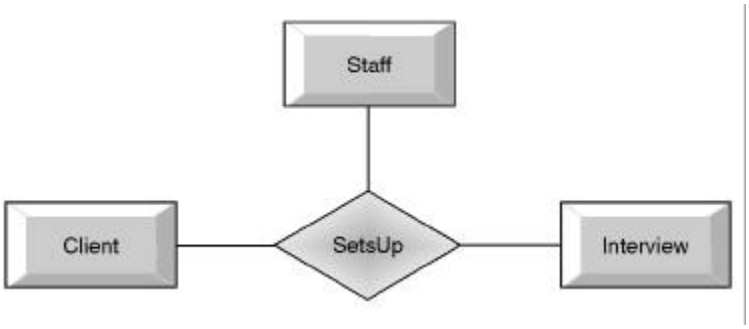
Diagrammatic Representation of Entities, Relationships, and Primary Key Attributes



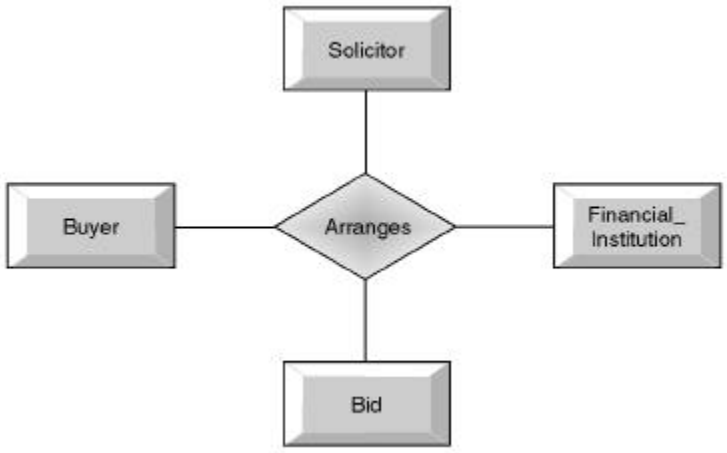
Binary Relationship called *Owns*



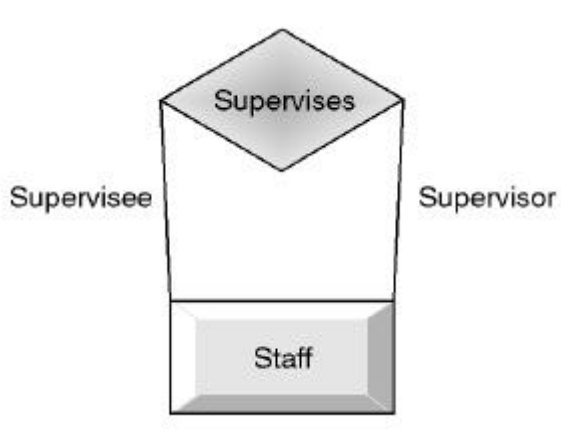
Ternary Relationship called *SetsUp*



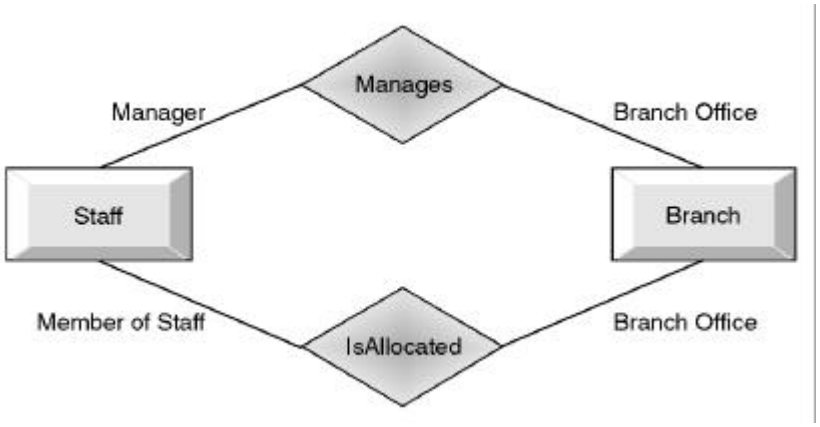
Quaternary Relationship called *Arranges*



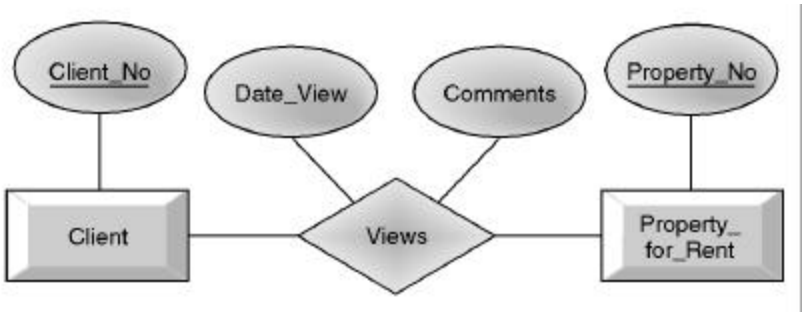
Recursive Relationship called *Supervises*



Entities associated through two distinct Relationships



Relationship called *Views* with attributes



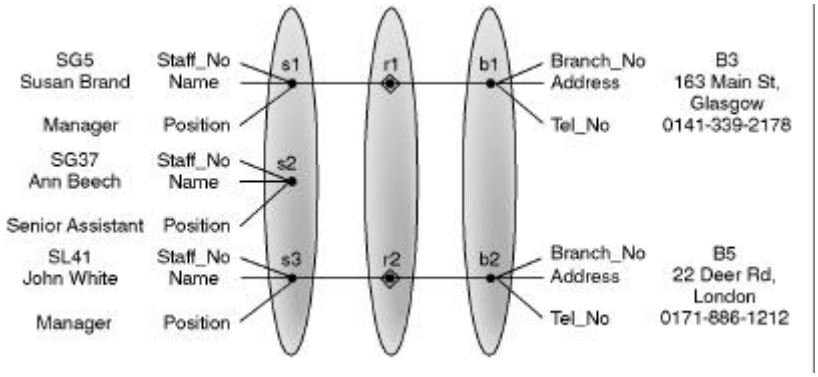
Structural Constraints

- **Two main types of restrictions on relationships are cardinality and participation constraints.**
- **Cardinality Constraints (Ratio)**
  - **Determines the number of possible relationships for each participating entity.**
  - **Most common degree for relationships is binary with cardinality ratios of one-to-one (1:1), one-to-many (1:M) or many-to-many (M:N).**

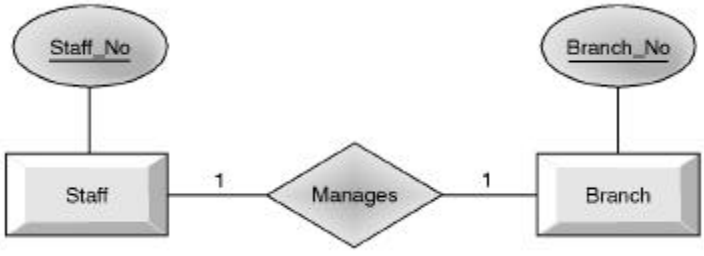
Structural Constraints

- **Participation Constraints**
  - **Determines whether the existence of an entity depends on its being related to another entity through the relationship.**

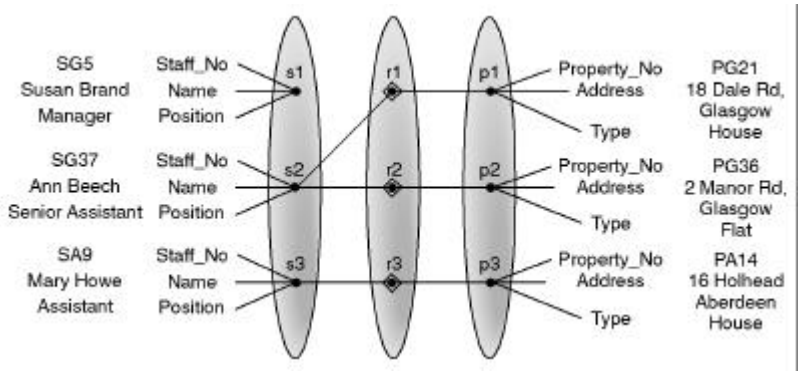
A Semantic Net Model of Staff *Manages* Branch Relationship



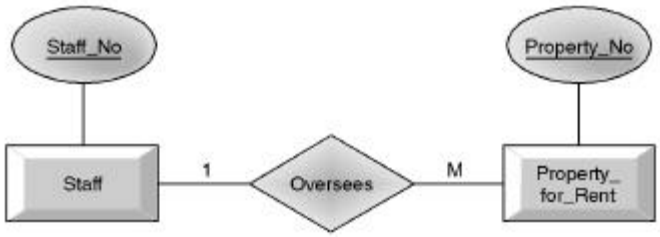
Staff *Manages* Branch (1:1) Relationship



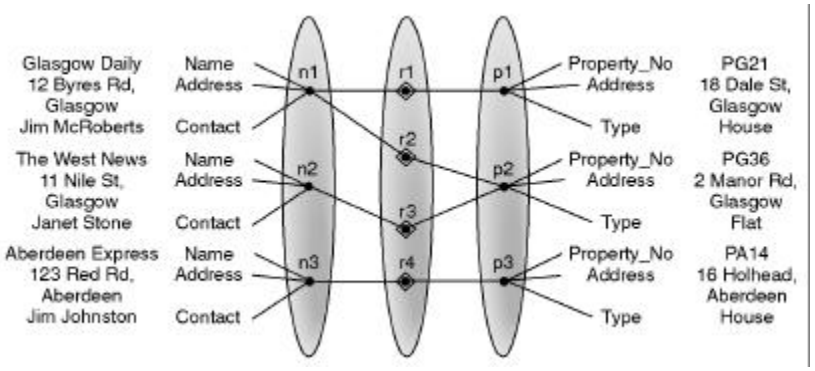
Semantic Net Diagram of Staff *Oversees* Property_for_Rent Relationship



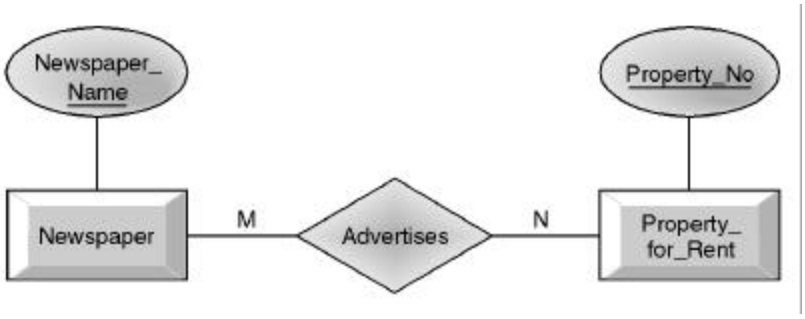
Staff *Oversees* Property_for_Rent (1:M) Relationship



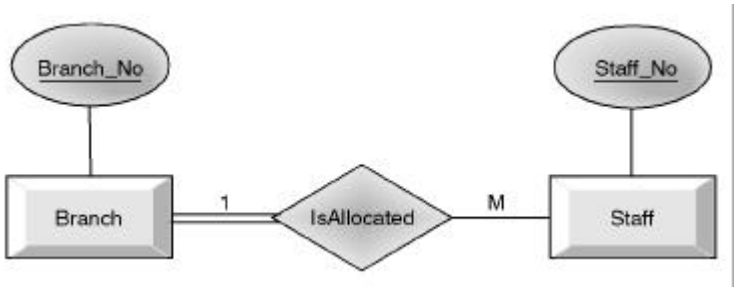
Semantic Net Diagram of Newspaper *Advertises* Property_for_Rent Relationship



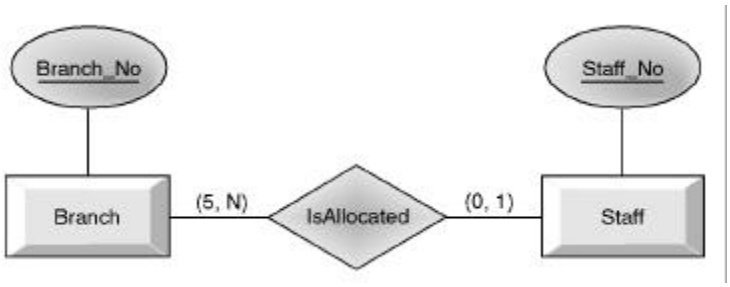
Newspaper *Advertises* Property_for_Rent (M:N) Relationship



Participation Constraints of Branch *IsAllocated* Staff Relationship



Displaying Participation Constraints using (Min, Max) Notation



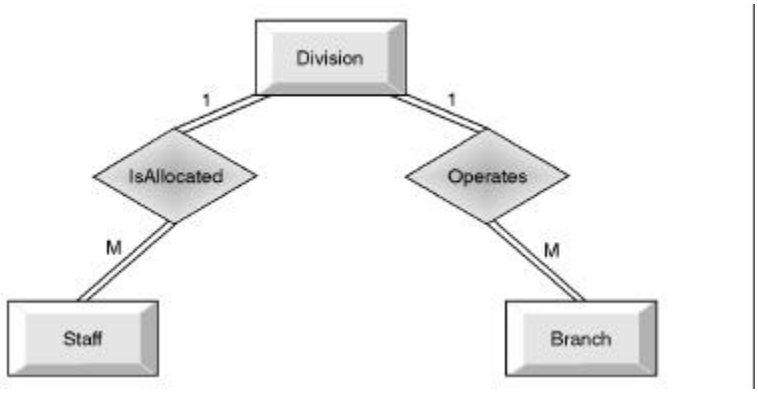
Problems with ER Models

- **Problems may arise when designing a conceptual data model called connection traps.**
- **Often due to a misinterpretation of the meaning of certain relationships.**
- **Two main types of connection traps are called *fan* traps and *chasm* traps.**

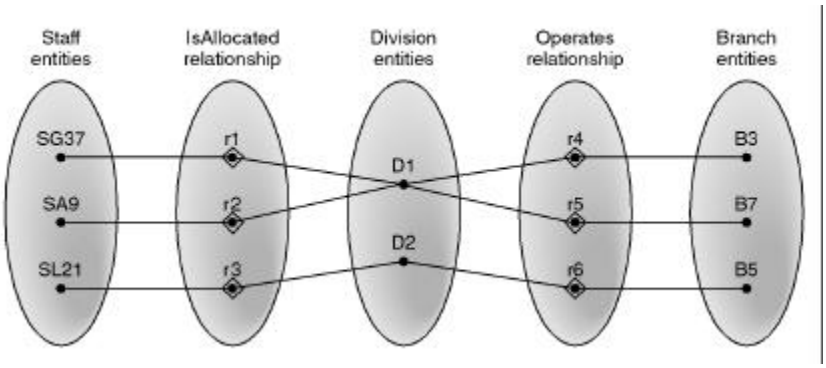
Problems with ER Models

- **Fan Trap**
  - **When a model represents a relationship between entity types, but the pathway between certain entity occurrences is ambiguous.**
- **Chasm Trap**
  - **When a model suggests the existence of a relationship between entity types, but the pathway does not exist between certain entity occurrences.**

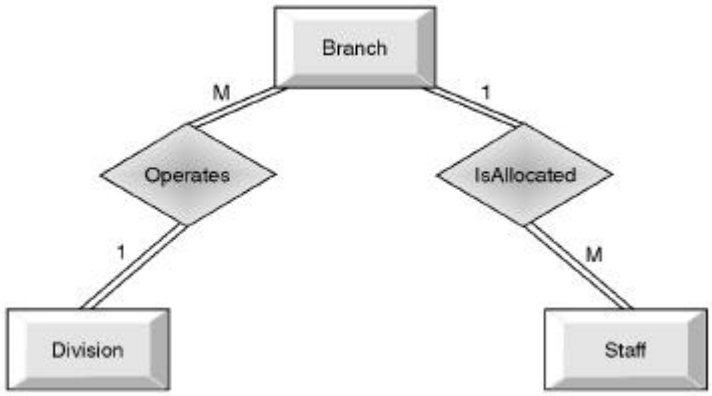
An Example of a Fan Trap



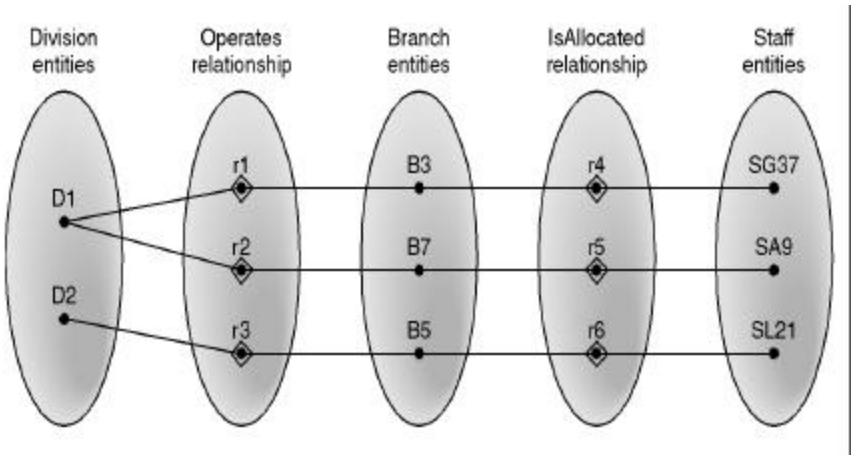
Semantic Net of ER Model with Fan Trap



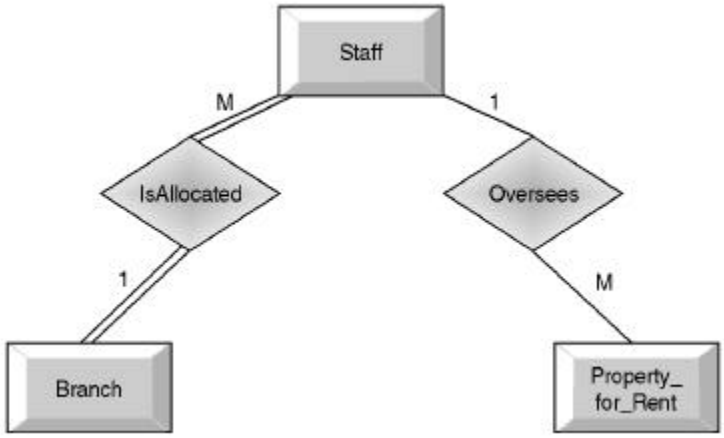
Restructuring ER model to remove Fan Trap



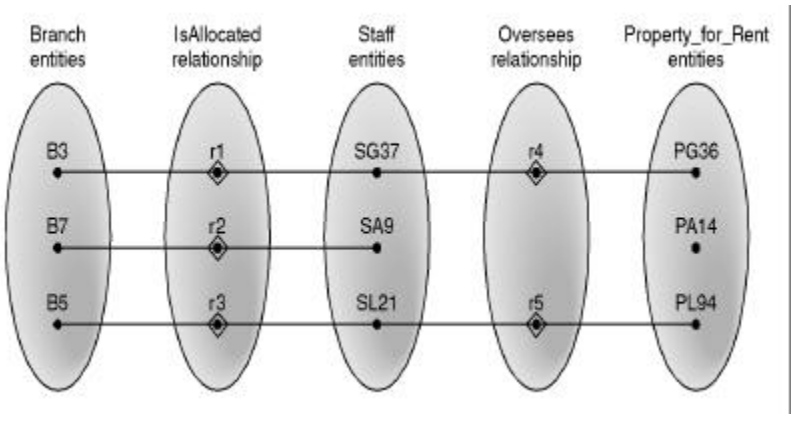
Semantic Net of Restructured ER Model with Fan Trap Removed



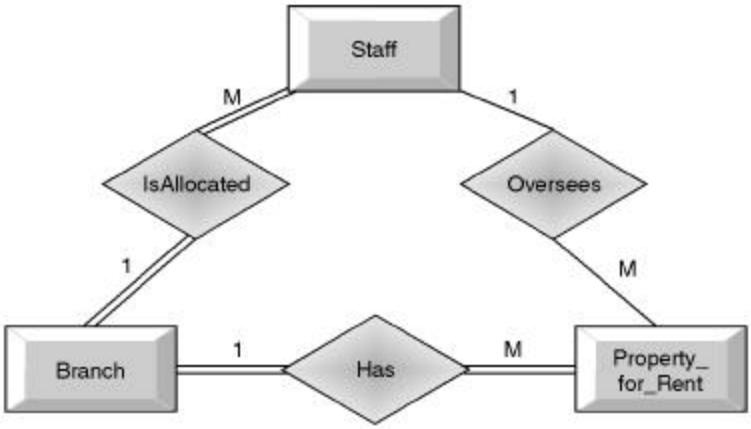
An Example of a Chasm Trap



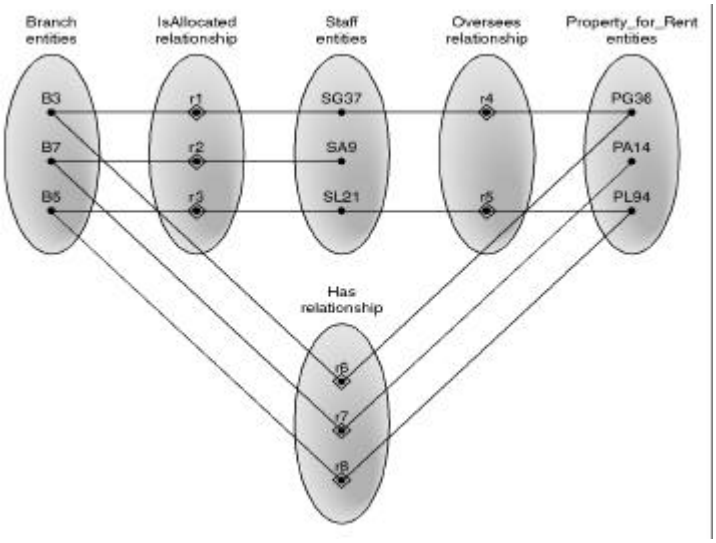
Semantic Net of ER Model with Chasm Trap



ER Model restructured to remove Chasm Trap



Semantic Net of Restructured ER Model with Chasm Trap Removed



The Enhanced Entity-Relationship Model

- **Since the 1980s there has been an increase in the emergence of new database applications with more demanding requirements.**
- **Basic concepts of ER modeling are not sufficient to represent the requirements of the newer, more complex applications.**
- **Response is development of additional 'semantic' modeling concepts.**

The Enhanced Entity-Relationship Model

- **Semantic concepts are incorporated into the original ER model and is called the Enhanced Entity-Relationship (EER) model.**
- **Additional concepts of EER model includes specialization / generalization, and categorization.**

Concept of Specialization / Generalization

- **Associated with the related concepts of entity types described as superclasses or subclasses and the process of attribute inheritance.**
- **Superclass**
  - **An entity type that includes distinct subclasses that require to be represented In a data model.**

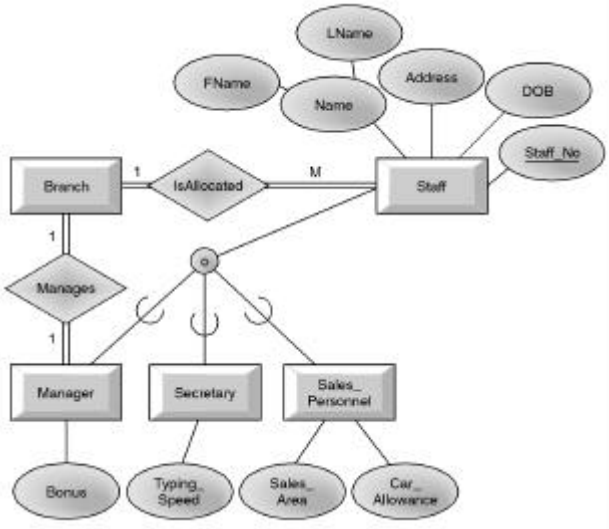
Concept of Specialization / Generalization

- **Subclass**
  - **A subclass is an entity type that has a distinct role and is also a member of the superclass.**
- **Attribute Inheritance**
  - **An entity in a subclass may possess subclass specific attributes, as well as those associated with the superclass.**

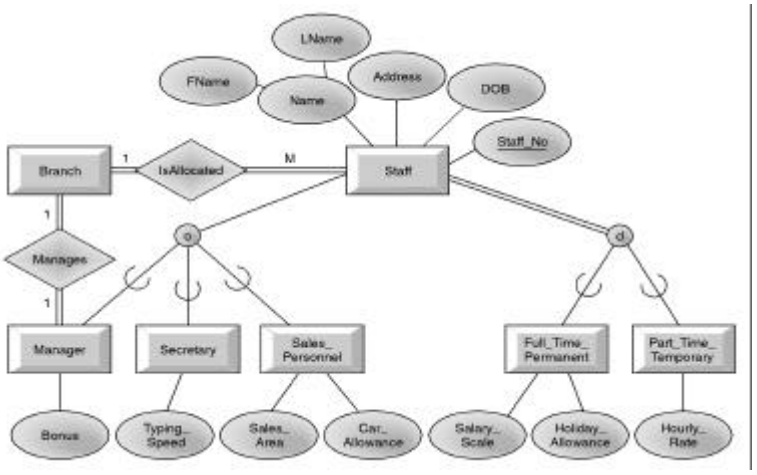
Concept of Specialization / Generalization

- **Generalization**
  - **The process of minimizing the differences between entities by identifying their common features.**
- **Specialization and generalization has disjoint and participation constraints.**

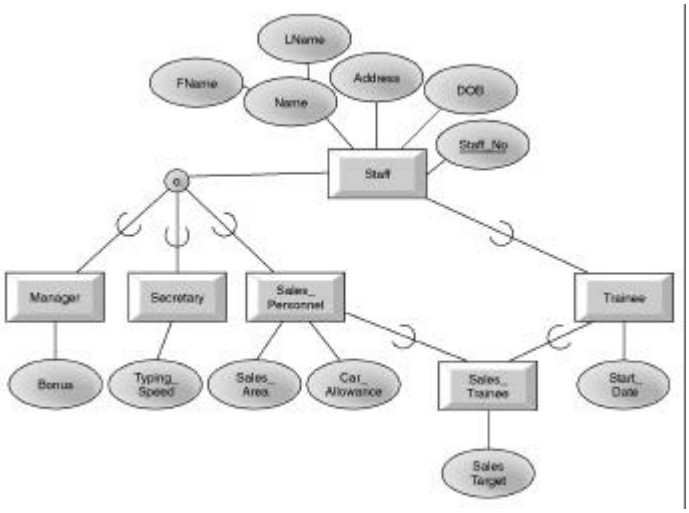
Specialization of Staff Entity into Job Roles Subclasses



Specialization of Staff Entity into Job Roles and Contract of Employment Subclasses



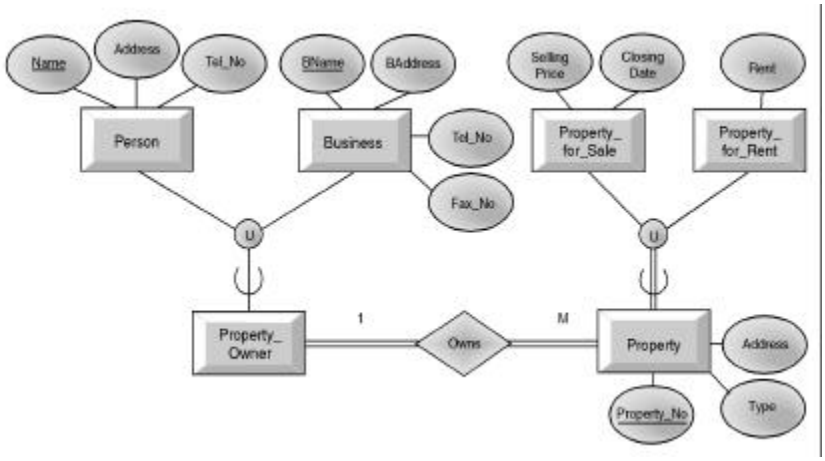
A Shared Subclass called Sales_Trainee



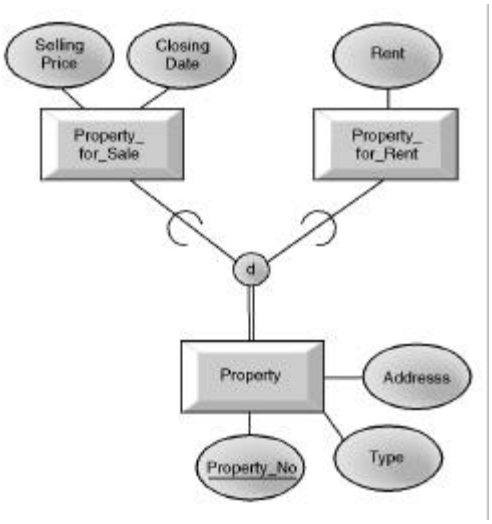
Categorization

- **The modeling of a single subclass (called a category) with a relationship that involves more than one distinct superclass.**
- **A category subclass has selective inheritance.**
- **Divided based on total or partial participation.**
  - **Total - every occurrence of all superclasses must appear in the category.**
  - **Partial - constraint is removed.**

Property_Owner and Property Categories



Property represented as a Specialization / Generalization.



Manager's View of *DreamHome* Case Study Building an EER Model

- **Identify entity types.**
- **Identify relationship types.**
- **Determine cardinality and participation constraints of relationship types.**
- **Identify and associate attributes with entity or relationship types.**

Manager's View of *DreamHome* Case Building an EER Model

- **Determine candidate and primary key attributes.**
- **Specialize / generalize entity types.**
- **Categorize entity types.**
- **Draw the EER Diagram.**

Manager's View Major Relationships

Entity type	*Relationship type*	*Entity type*
Branch	*IsAllocated*	Staff
	Has	Property_for_Rent
Staff	*Oversees*	Property_for_Rent
	RelatedTo	Next_of_Kin
	AssignedTo	Allocated_Staff
Manager	*Manages*	Branch
Supervisor	*Supervises*	Allocated_Staff
Property_for_Rent	*PlacedIn*	Advert
Private_Owner	*Owns*	Property_for_Rent
Business_Owner	*Owns*	Property_for_Rent
Renter	*CallsAt*	Branch
	Requests	Viewing
	Holds	Rental_Agreement
Viewing	*Of*	Property_for_Rent
Rental_Agreement	*For*	Property_for_Rent
Advert	*PlacedIn*	Newspaper
Newspaper	*Displays*	Advert

Manager's View
Entities and their attributes

Entity type	*Attribute*
Branch	Branch_No Address (Street, Area, City, Postcode) Tel_No Fax_No
Staff	Staff_No Name (FName and LName) Address Tel_No Sex DOB (Date of Birth) NIN (National Insurance Number) Position Salary Date_Joined
Manager	Staff_No (Same attributes as Staff entity) Date_Mgr_Start Car_Allowance Bonus_Payment
Next_of_Kin	NName Relationship Address Tel_No
Supervisor	Staff_No (Same attributes as Staff entity)
Property_for_Rent	Property_No Address (Street, Area, City, Postcode) Type Rooms Rent

Manager's View
Entities and their attributes (Continued)

Entity type	*Attribute*
Private_Owner	Owner_No Name (FName and LName) Address Tel_No
Business_Owner	Owner_No BName BType Address Tel_No Contact_Name
Renter	Renter_No Name (FName and LName) Address Tel_No Pref_Type Max_Rent
Viewing	Date_View Comments
Rental_Agreement	Rental_No Rent_Start Rent_Finish
Advert	Date_Advert Newspaper_Name Cost
Newspaper	Newspaper_Name Address Tel_No Fax_No Contact_Name

Manager's View
Entity and primary and alternate keys

Entity	*Primary key*	*Alternate key(s)*
Branch	Branch_No	Tel_No Fax_No
Staff	Staff_No	FName, LName, DOB NIN
Manager	Staff_No	FName, LName, DOB NIN
Next_of_Kin		
Supervisor	Staff_No	FName, LName, DOB NIN
Allocated_Staff		
Property_for_Rent	Property_No	
Private_Owner	Owner_No	
Business_Owner	Owner_No	Tel_No Fax_No
Renter	Renter_No	
Viewing		
Rental_Agreement	Rental_No	
Advert		
Newspaper	Newspaper_Name	Tel_No Fax_No