CSE 204 - INTRO TO DATABASE SYSTEMS
E-R MODELING

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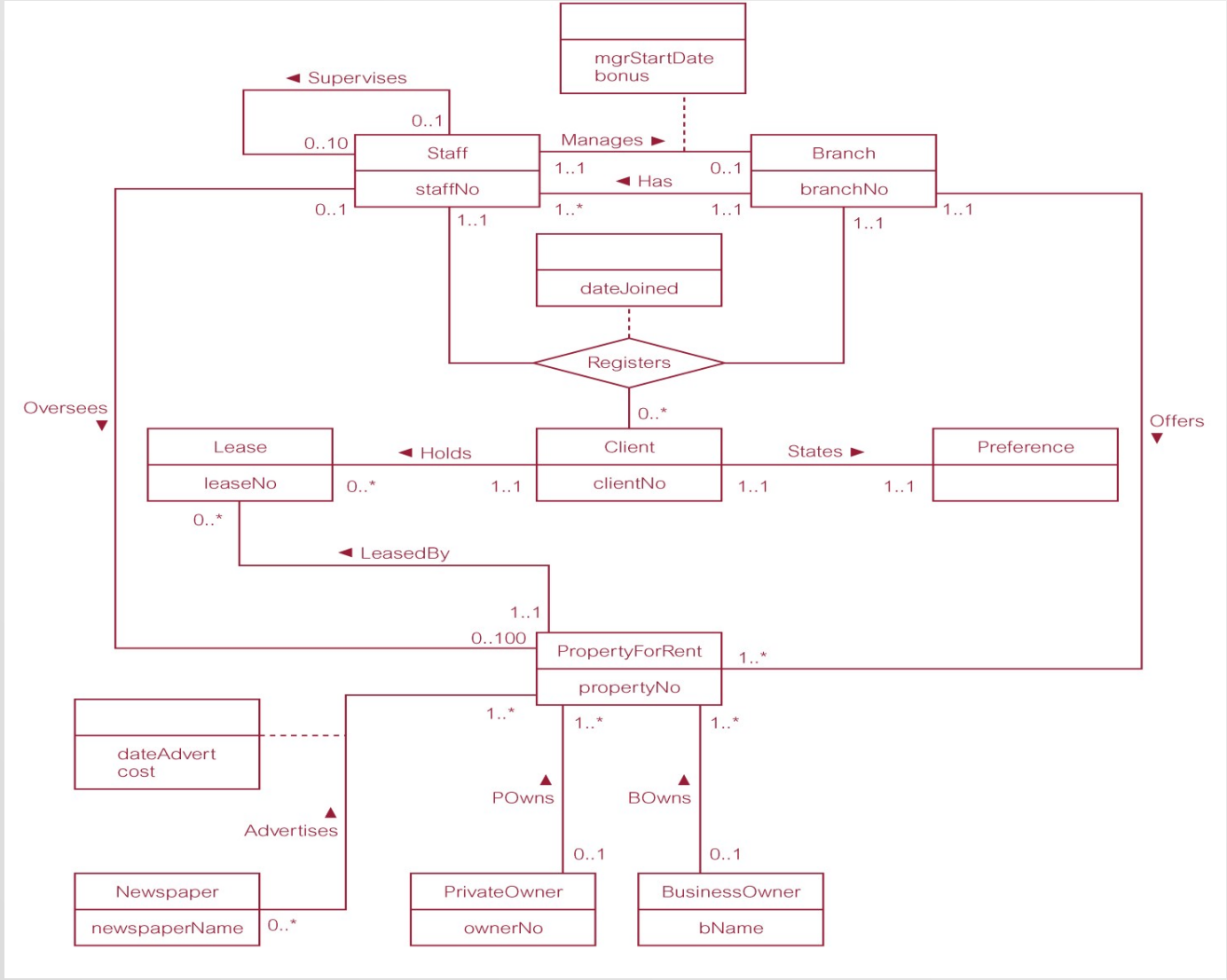
OUTLINE

- How to use Entity–Relationship (ER) modeling in database design.
- Basic concepts associated with ER model.
- Diagrammatic technique for displaying ER model using Unified Modeling Language (UML).
- How to identify and resolve problems with ER models called connection traps.
- How to build an ER model from a requirements specification.

ER DIAGRAM OF BRANCH USER VIEWS OF *DREAMHOME*



CONCEPTS OF THE ER MODEL

- Entity types
- Relationship types
- Attributes

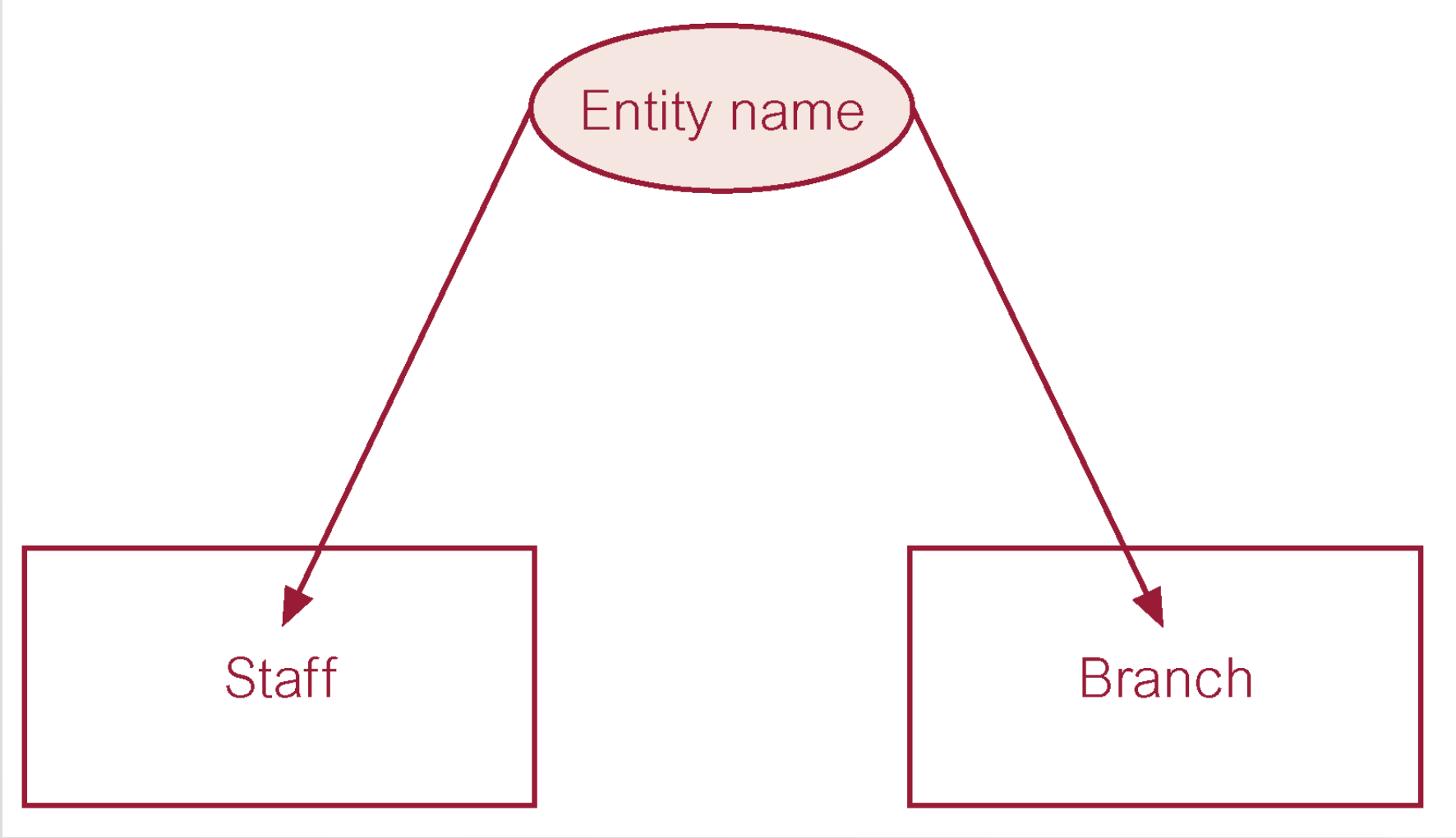
ENTITY TYPE

- Entity type
  - Group of objects with same properties, identified by enterprise as having an independent existence.
- Entity occurrence
  - Uniquely identifiable object of an entity type.

EXAMPLES OF ENTITY TYPES

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

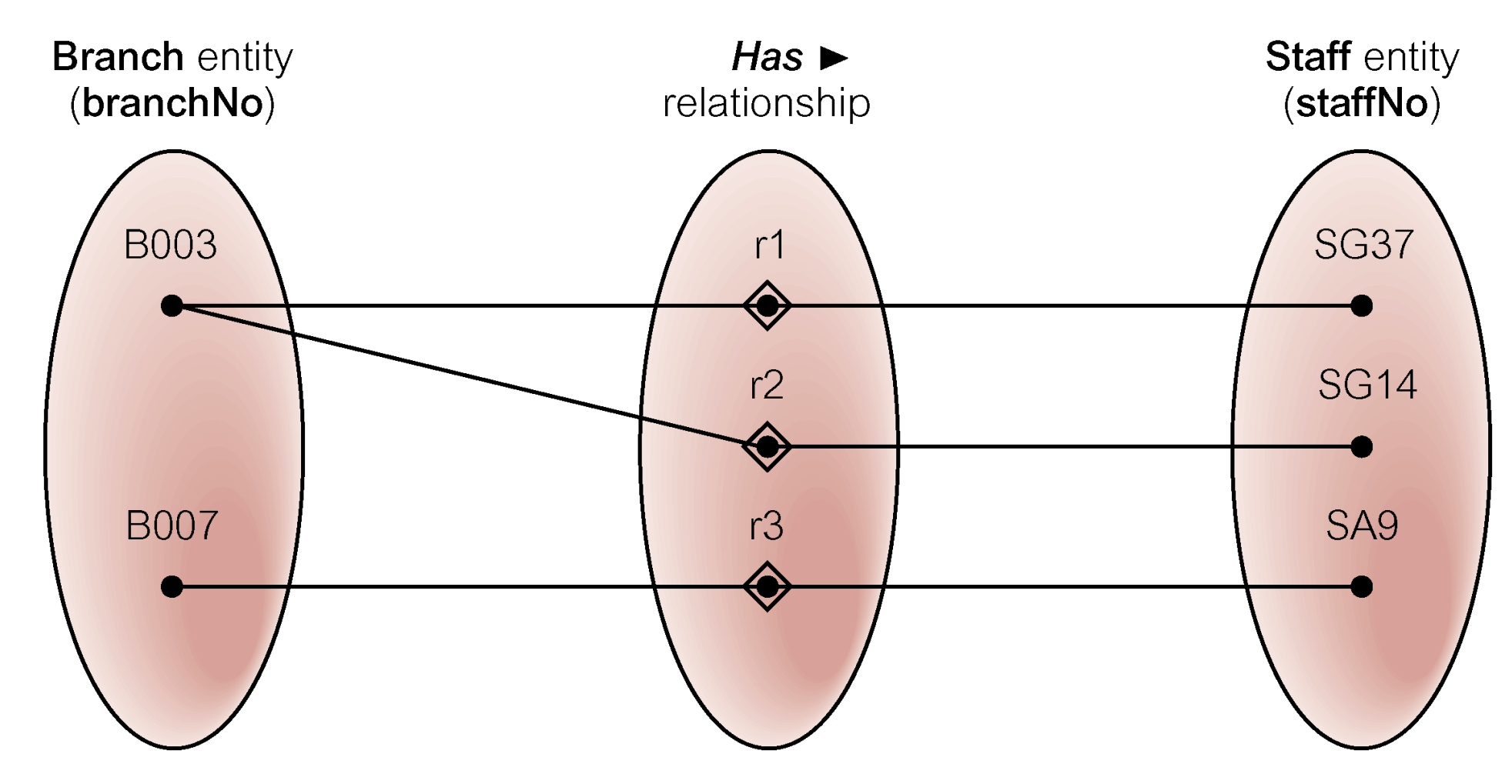
ER DIAGRAM OF STAFF AND BRANCH ENTITY TYPES



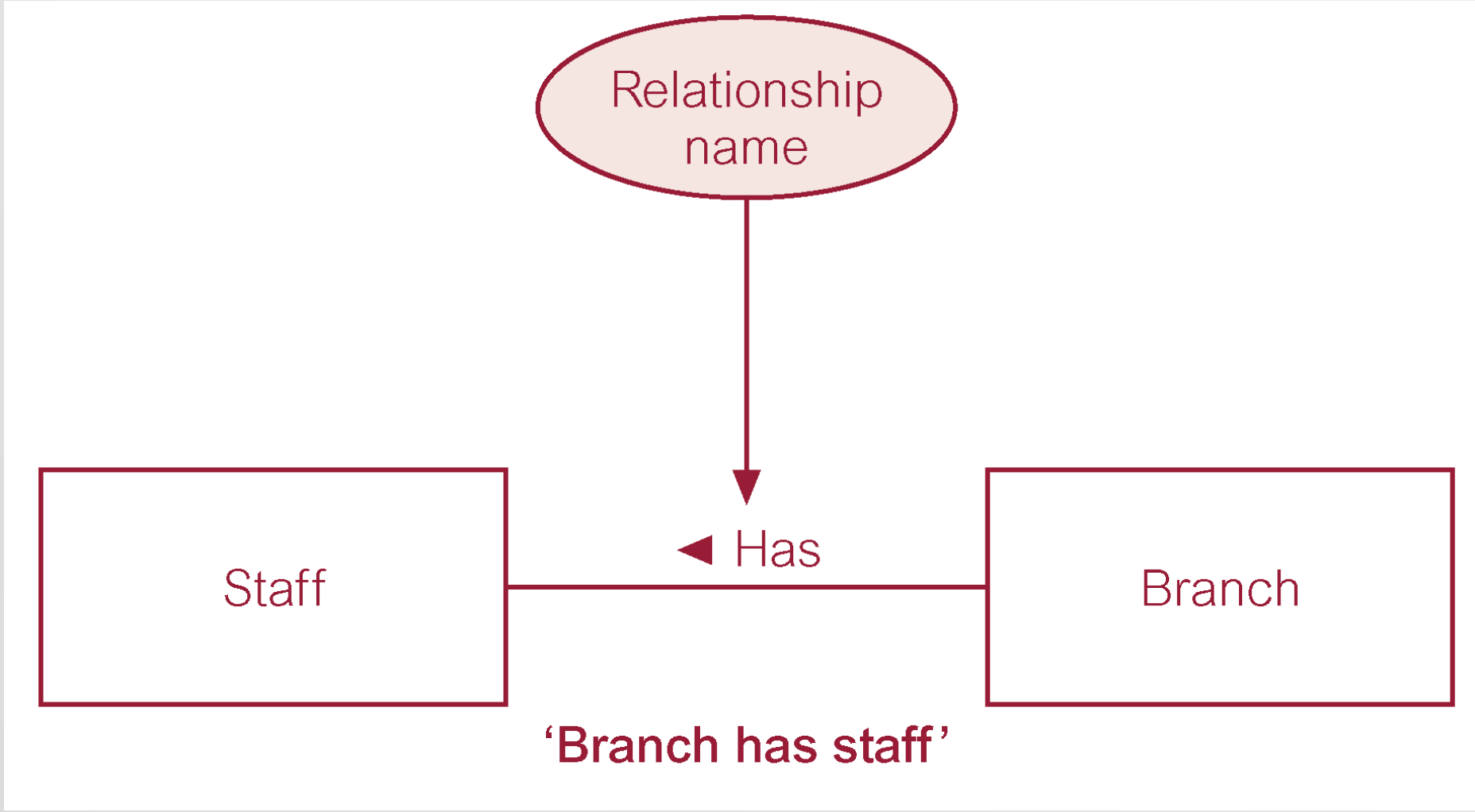
RELATIONSHIP TYPES

- Relationship type
  - Set of meaningful associations among entity types.
- Relationship occurrence
  - Uniquely identifiable association, which includes one occurrence from each participating entity type.

SEMANTIC NET OF *HAS* RELATIONSHIP TYPE



ER DIAGRAM OF BRANCH *HAS* STAFF RELATIONSHIP

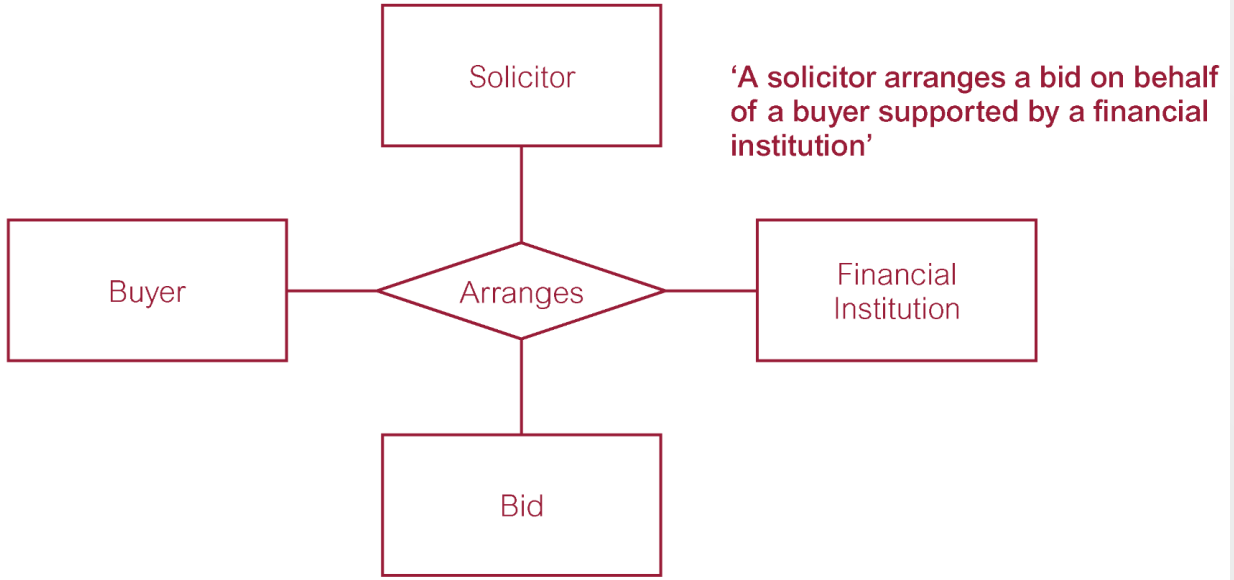


RELATIONSHIP TYPES

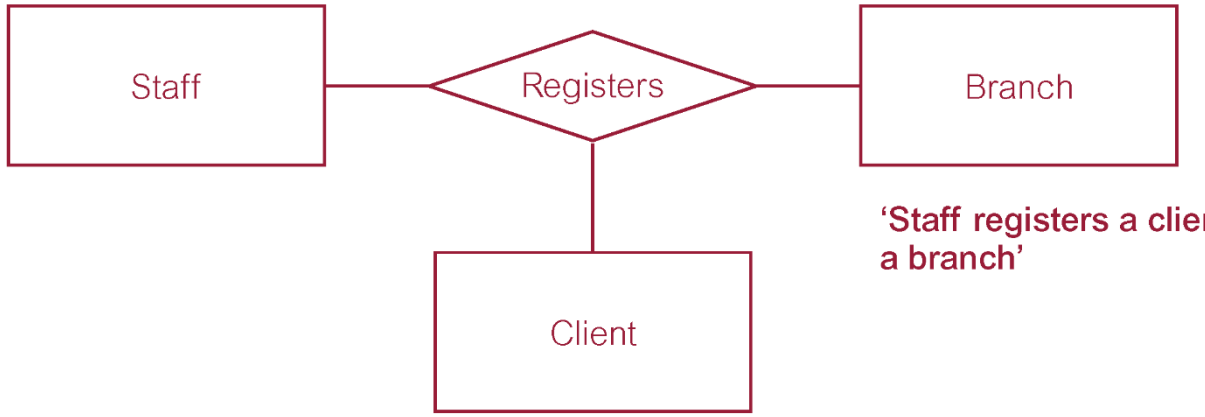
- Degree of a Relationship
  - Number of participating entities in relationship.
- Relationship of degree :
  - two is binary
  - three is ternary
  - four is quaternary.

RELATIONSHIPS

'Private owner owns property for rent'



'A solicitor arranges a bid on behalf of a buyer supported by a financial institution'



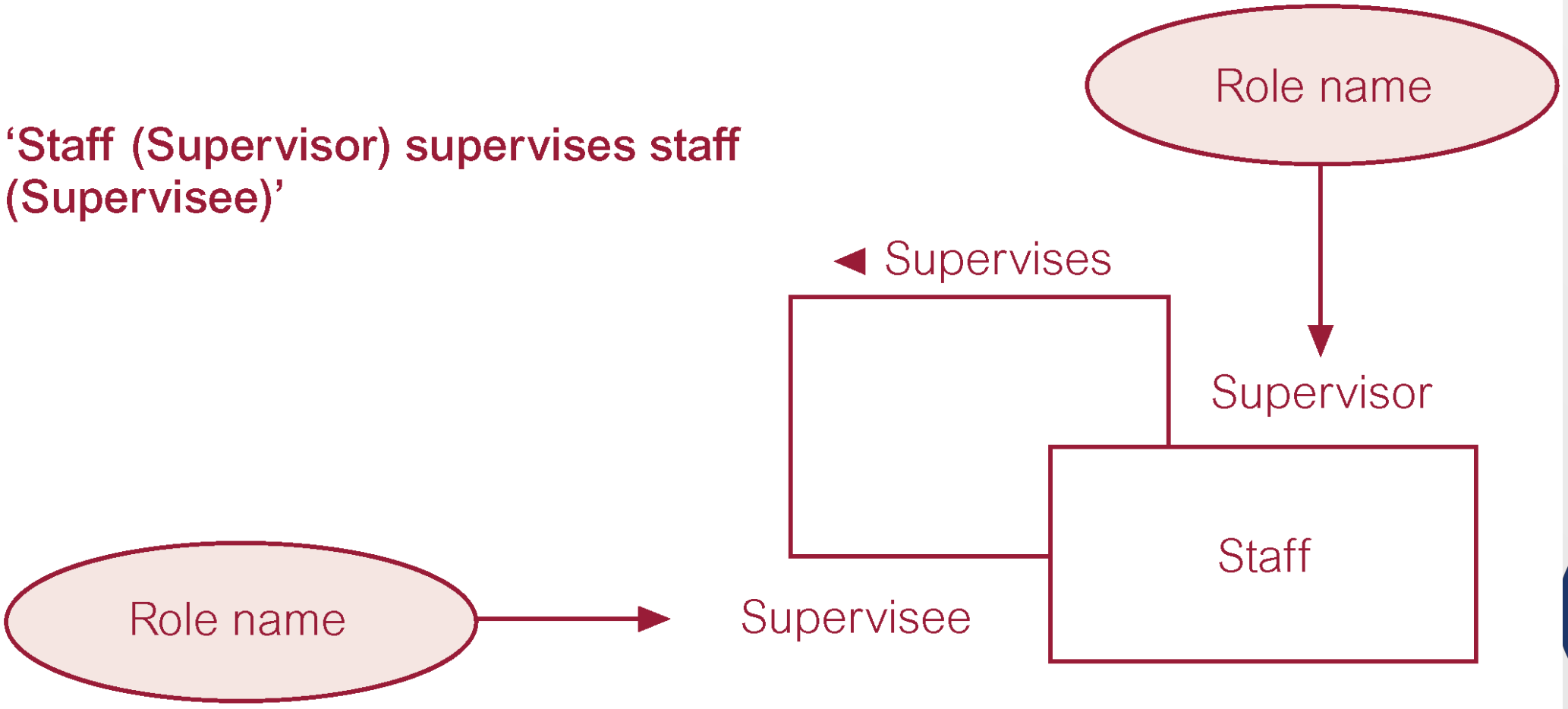
'Staff registers a client at a branch'

RELATIONSHIP TYPES

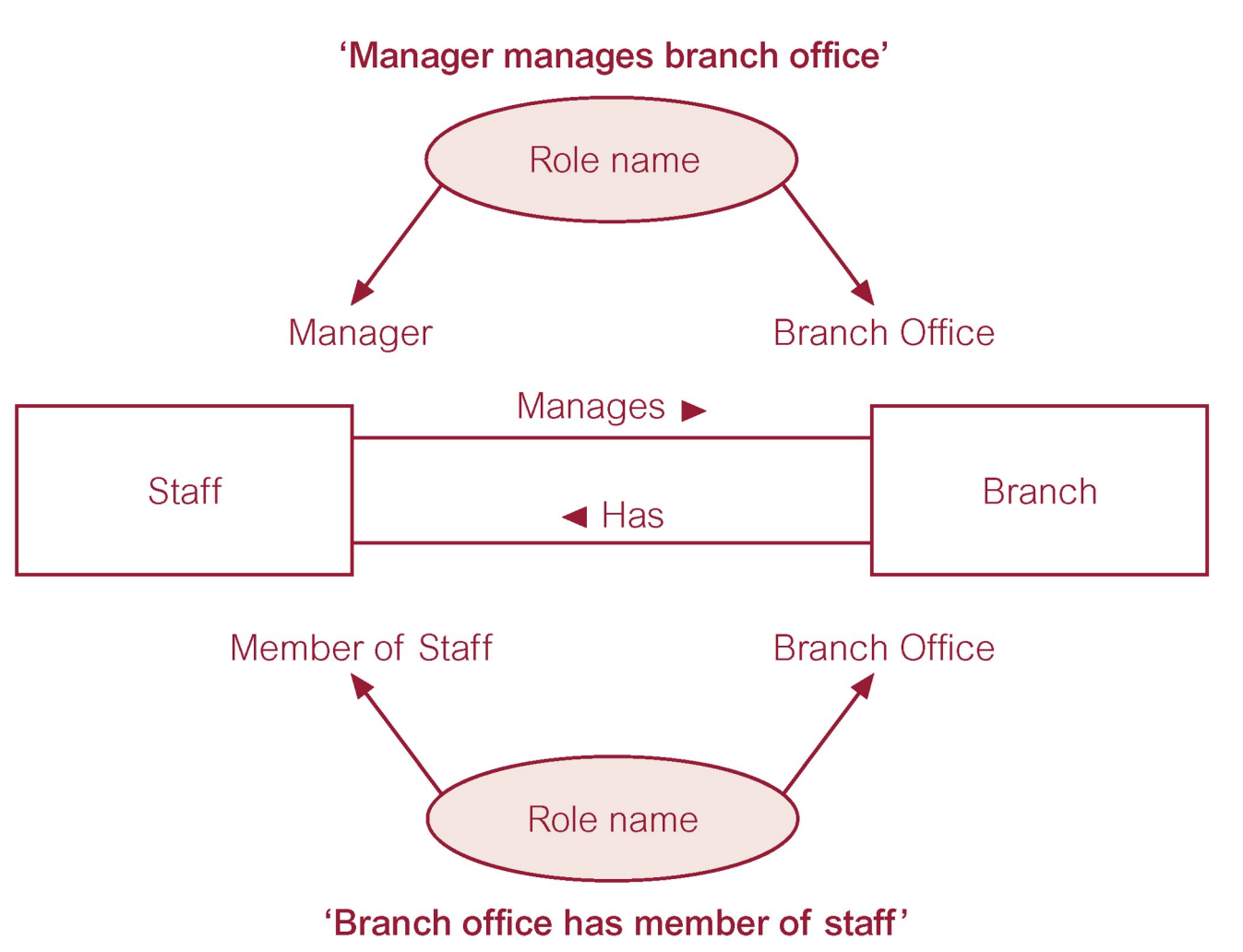
- Recursive Relationship
  - Relationship type where same entity type participates more than once in different roles.
- Relationships may be given role names to indicate purpose that each participating entity type plays in a relationship.

RECURSIVE RELATIONSHIP CALLED *SUPERVISES* WITH ROLE NAMES

'Staff (Supervisor) supervises staff (Supervisee)'



ENTITIES ASSOCIATED THROUGH TWO DISTINCT RELATIONSHIPS WITH ROLE NAMES



ATTRIBUTES

- Attribute
  - Property of an entity or a relationship type.
- Attribute Domain
  - Set of allowable values for one or more attributes.
- Simple Attribute
  - Attribute composed of a single component with an independent existence.
- Composite Attribute
  - Attribute composed of multiple components, each with an independent existence.

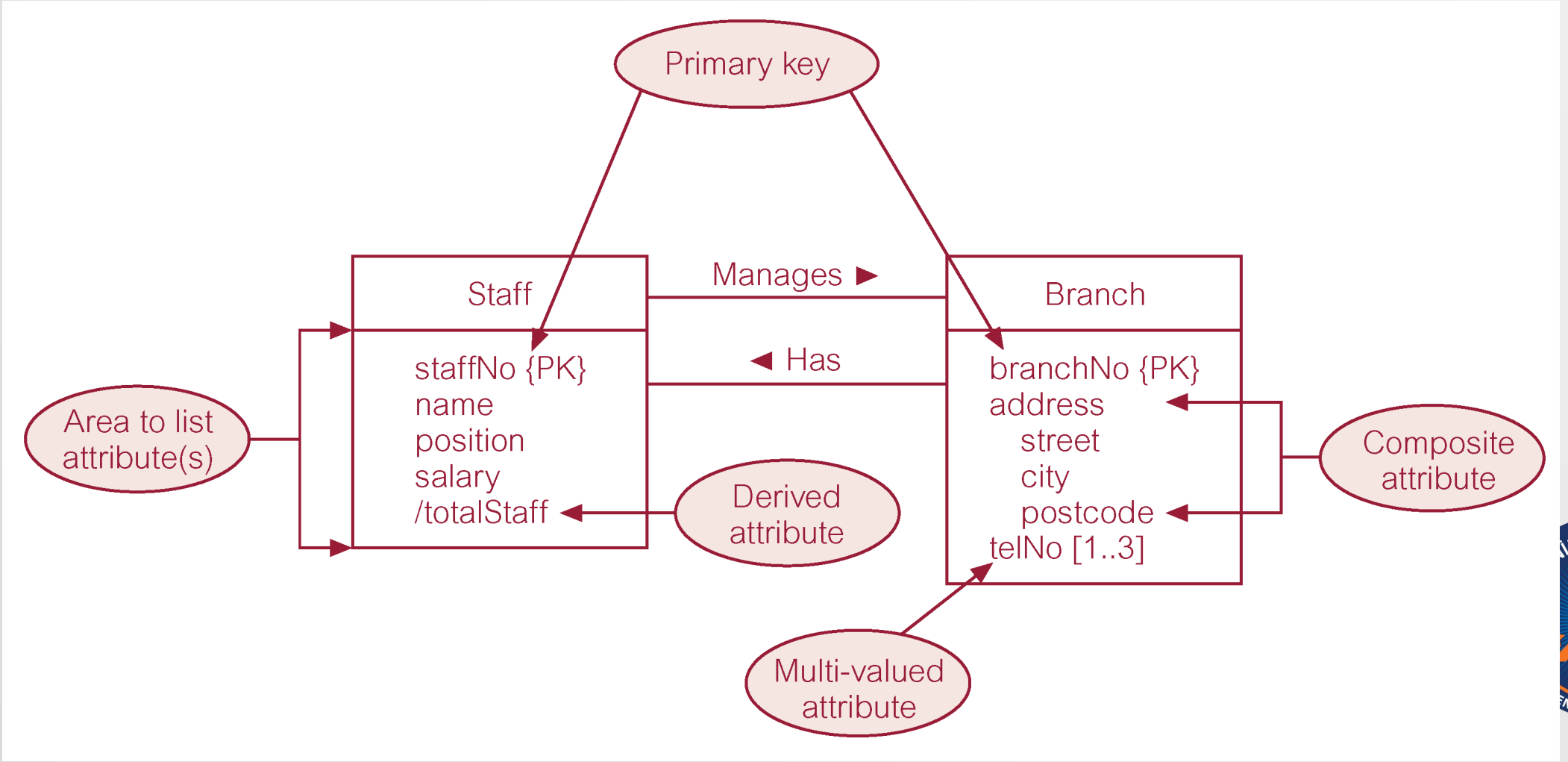
ATTRIBUTES

- Single-valued Attribute
  - Attribute that holds a single value for each occurrence of an entity type.
- Multi-valued Attribute
  - Attribute that holds multiple values for each occurrence of an entity type.
- Derived Attribute
  - Attribute that represents a value that is derivable from value of a related attribute, or set of attributes, not necessarily in the same entity type.

KEYS

- Candidate Key
  - Minimal set of attributes that uniquely identifies each occurrence of an entity type.
- Primary Key
  - Candidate key selected to uniquely identify each occurrence of an entity type.
- Composite Key
  - A candidate key that consists of two or more attributes.

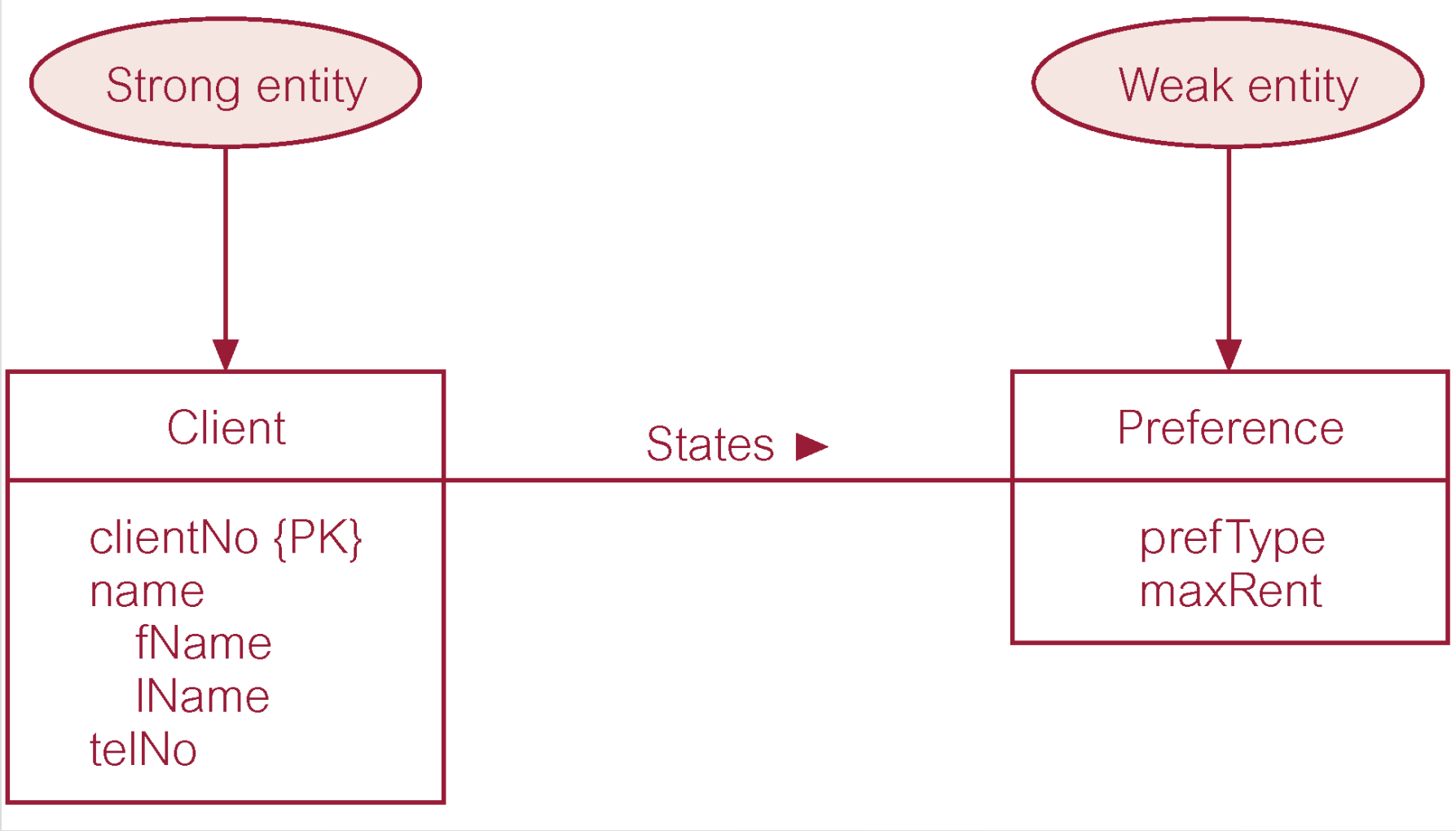
ER DIAGRAM OF STAFF AND BRANCH ENTITIES AND THEIR ATTRIBUTES



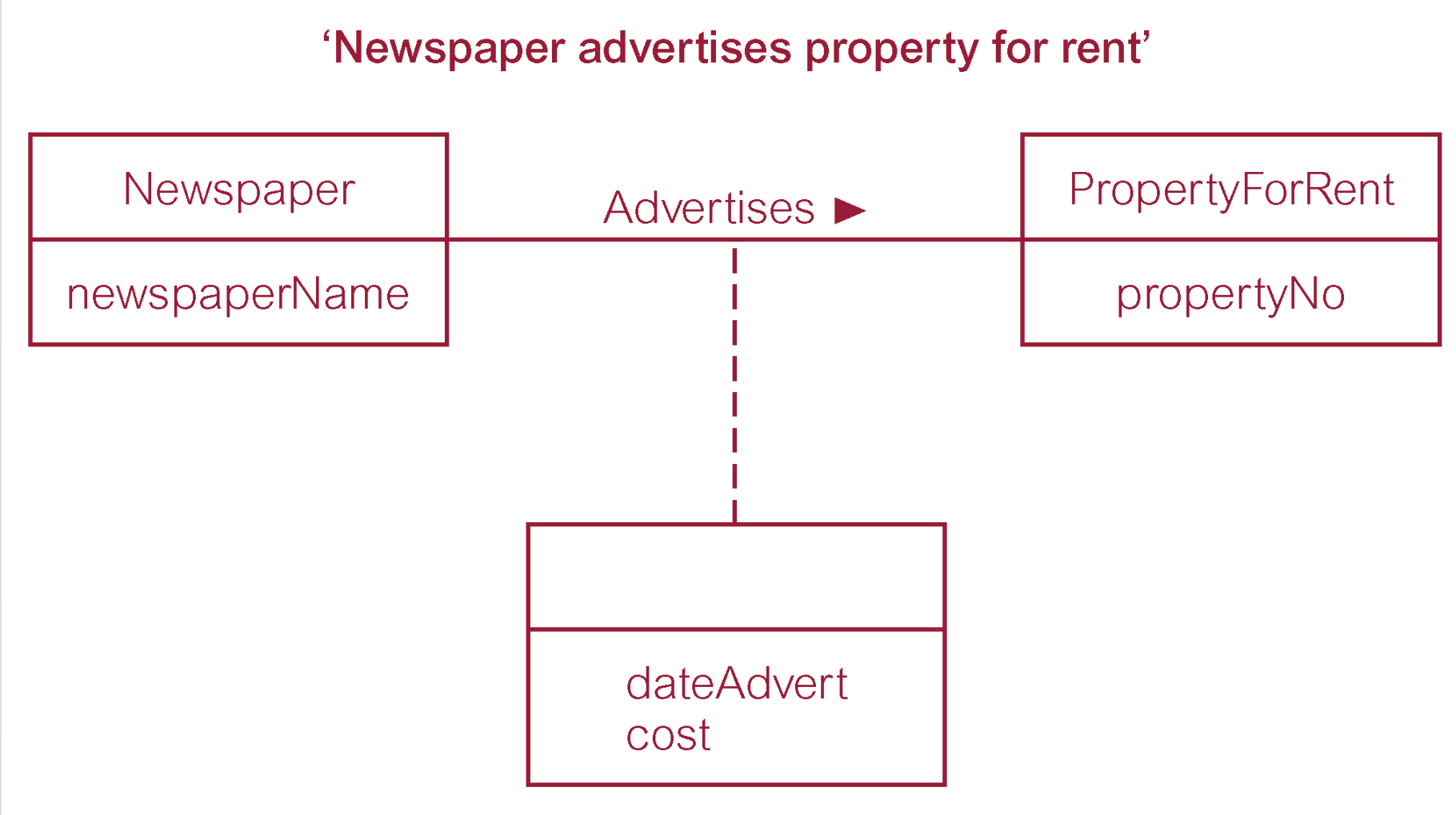
ENTITY TYPE

- Strong Entity Type
  - Entity type that is not existence-dependent on some other entity type.
- Weak Entity Type
  - Entity type that is existence-dependent on some other entity type.

STRONG ENTITY TYPE CALLED CLIENT AND WEAK ENTITY TYPE CALLED PREFERENCE



RELATIONSHIP CALLED *ADVERTISES* WITH ATTRIBUTES



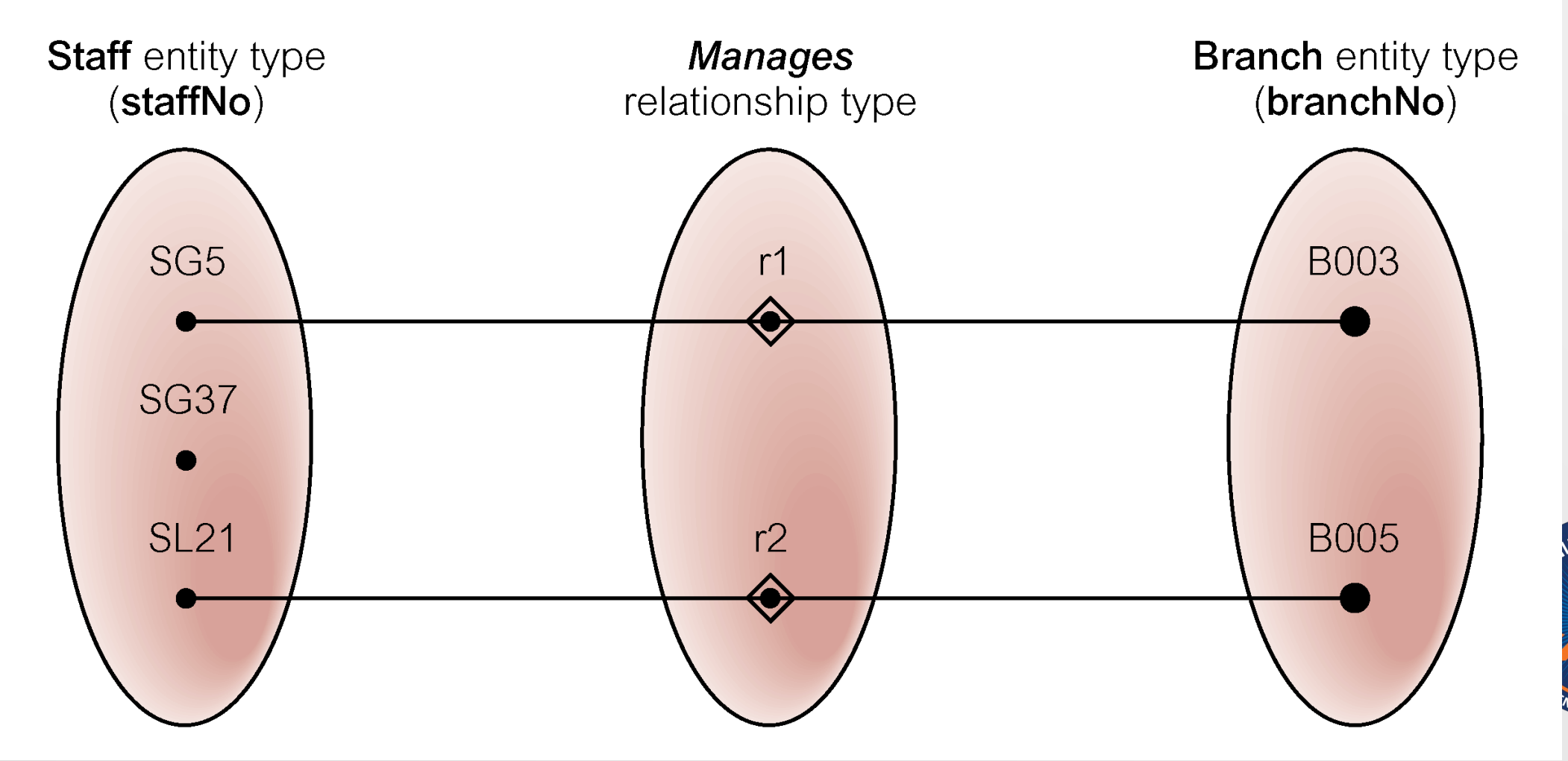
STRUCTURAL CONSTRAINTS

- Main type of constraint on relationships is called ***multiplicity***.
- Multiplicity - number (or range) of possible occurrences of an entity type that may relate to a single occurrence of an associated entity type through a particular relationship.
- Represents policies (called ***business rules***) established by user or company.

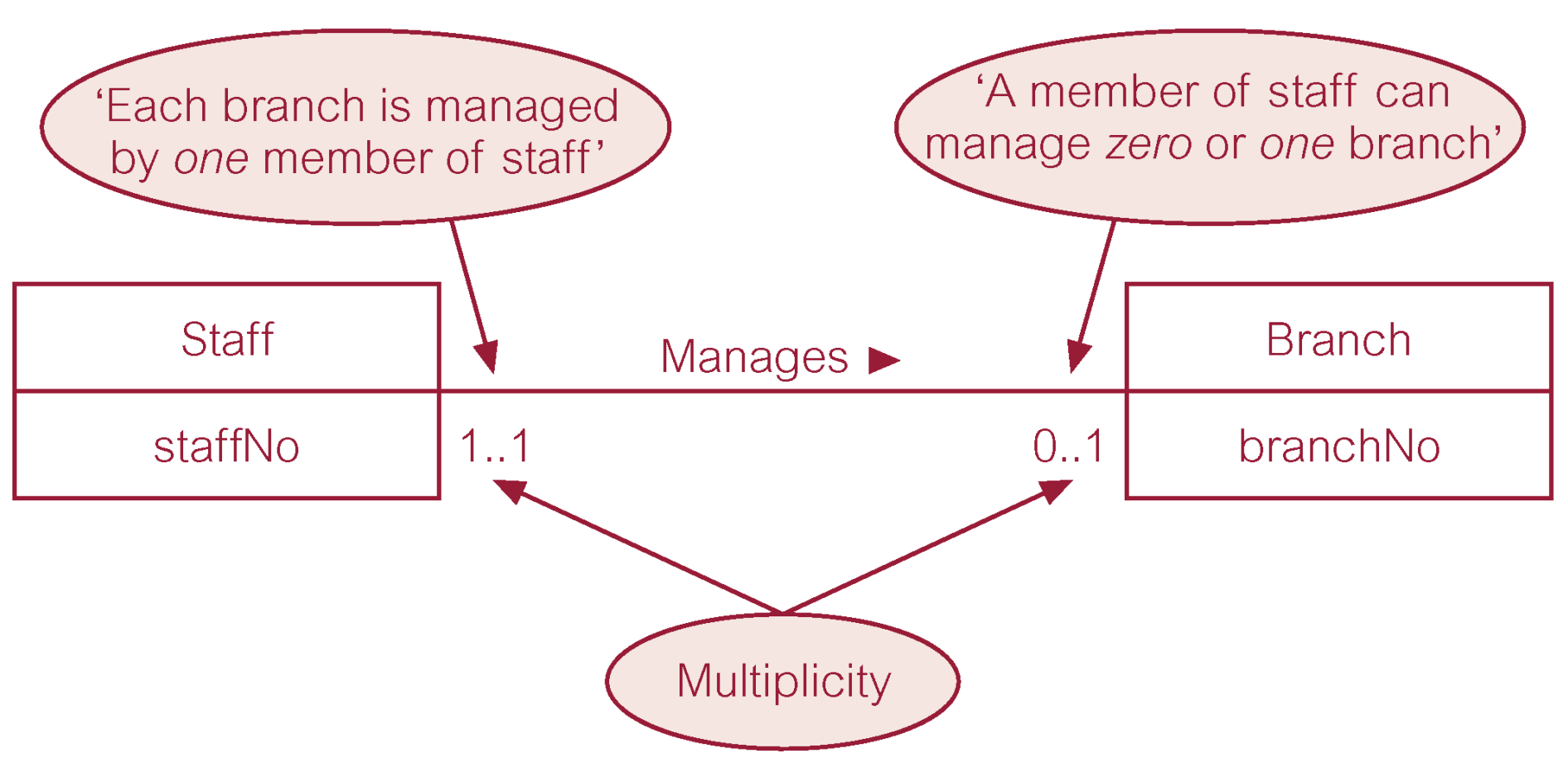
STRUCTURAL CONSTRAINTS

- The most common degree for relationships is binary.
- Binary relationships are generally referred to as being:
  - one-to-one (1:1)
  - one-to-many (1:*)
  - many-to-many (*:*)

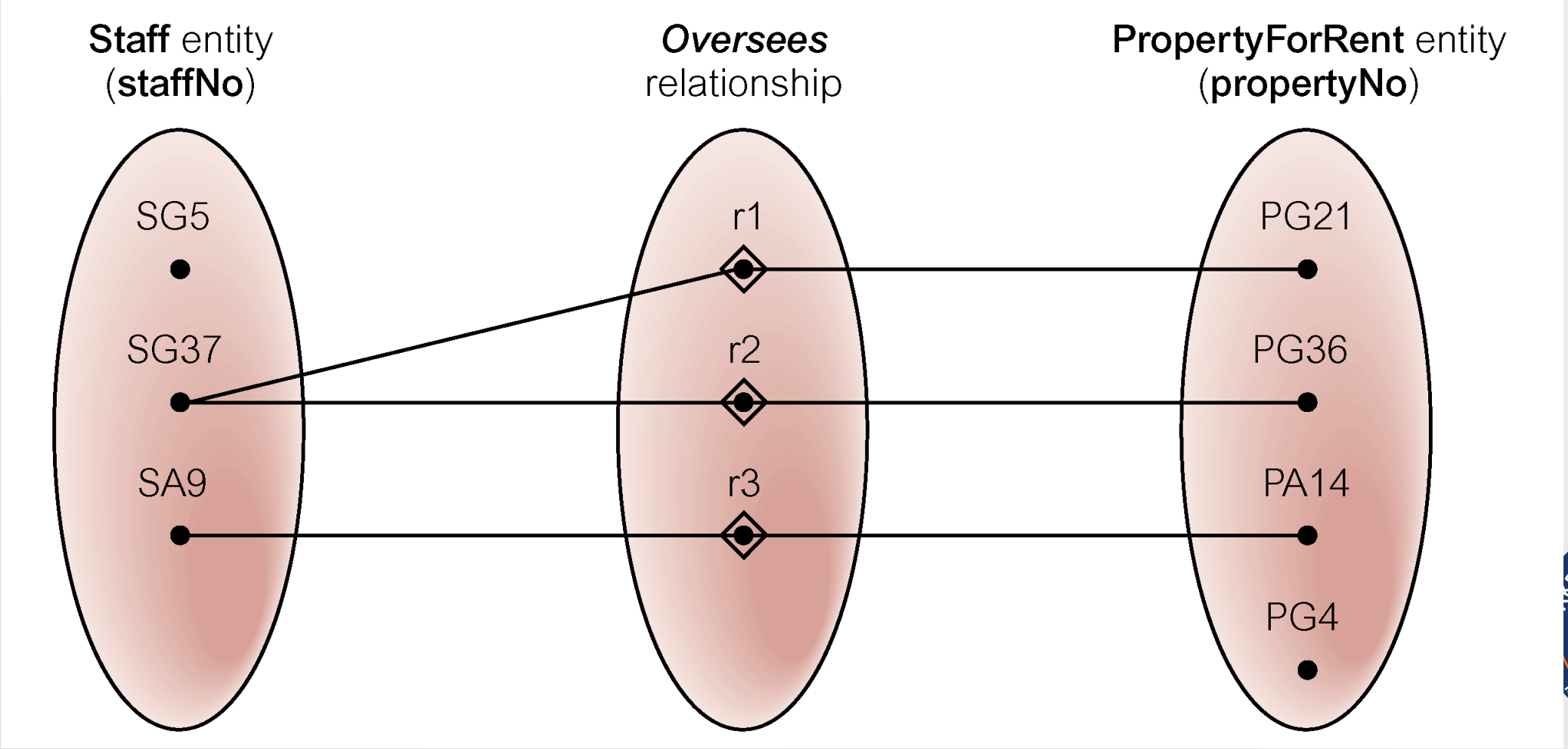
SEMANTIC NET OF STAFF *MANAGES* BRANCH RELATIONSHIP TYPE



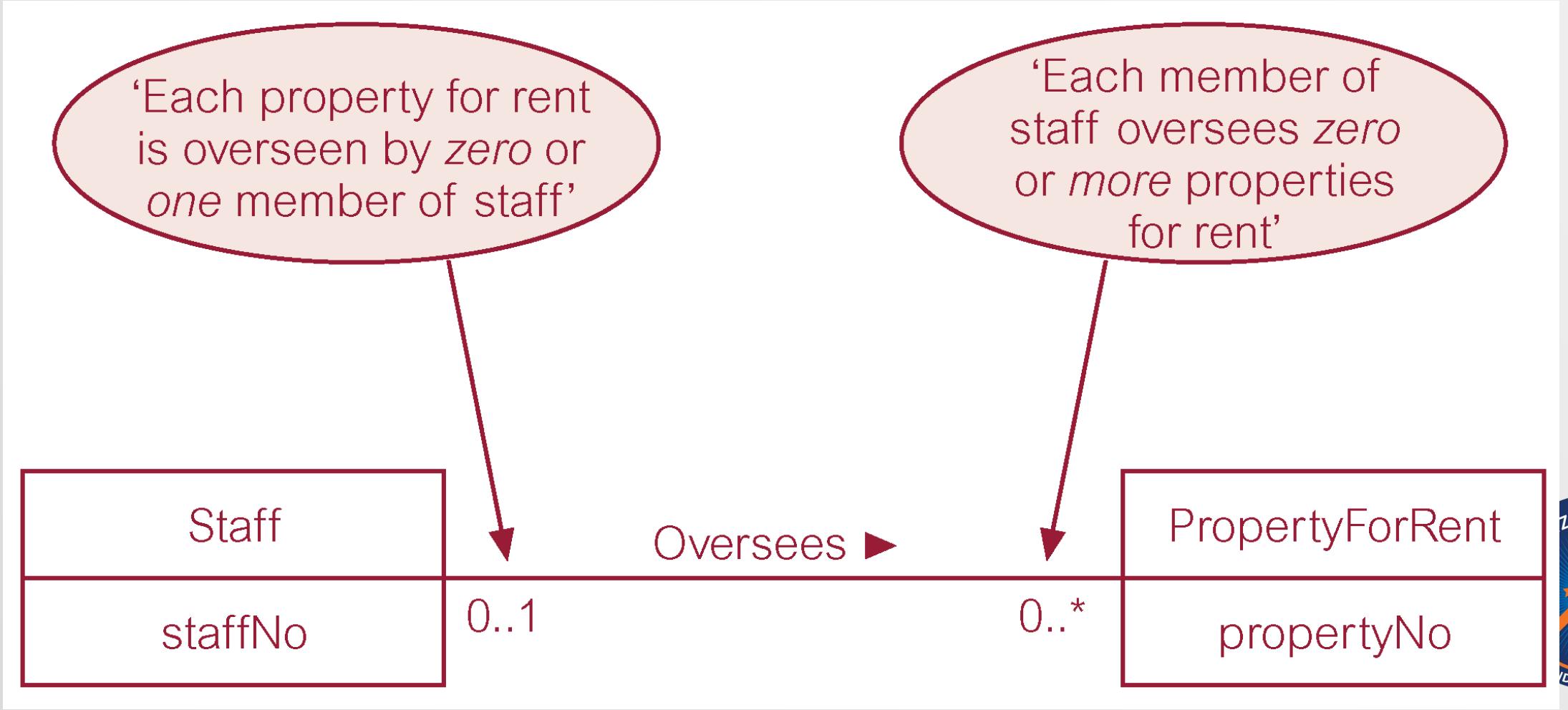
MULTIPLICITY OF STAFF MANAGES BRANCH (1:1) RELATIONSHIP



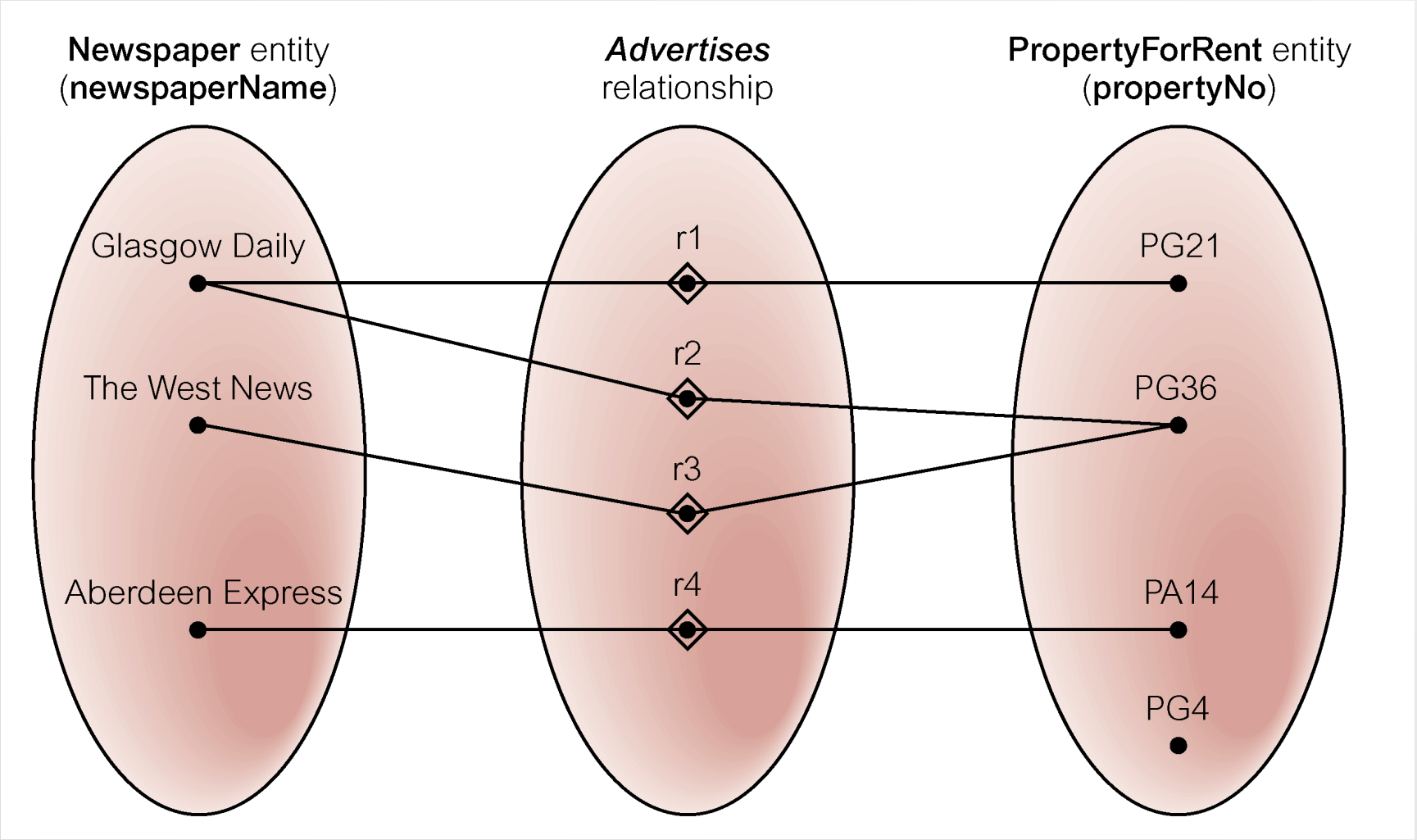
SEMANTIC NET OF STAFF *OVERSEES* PROPERTYFORRENT RELATIONSHIP TYPE



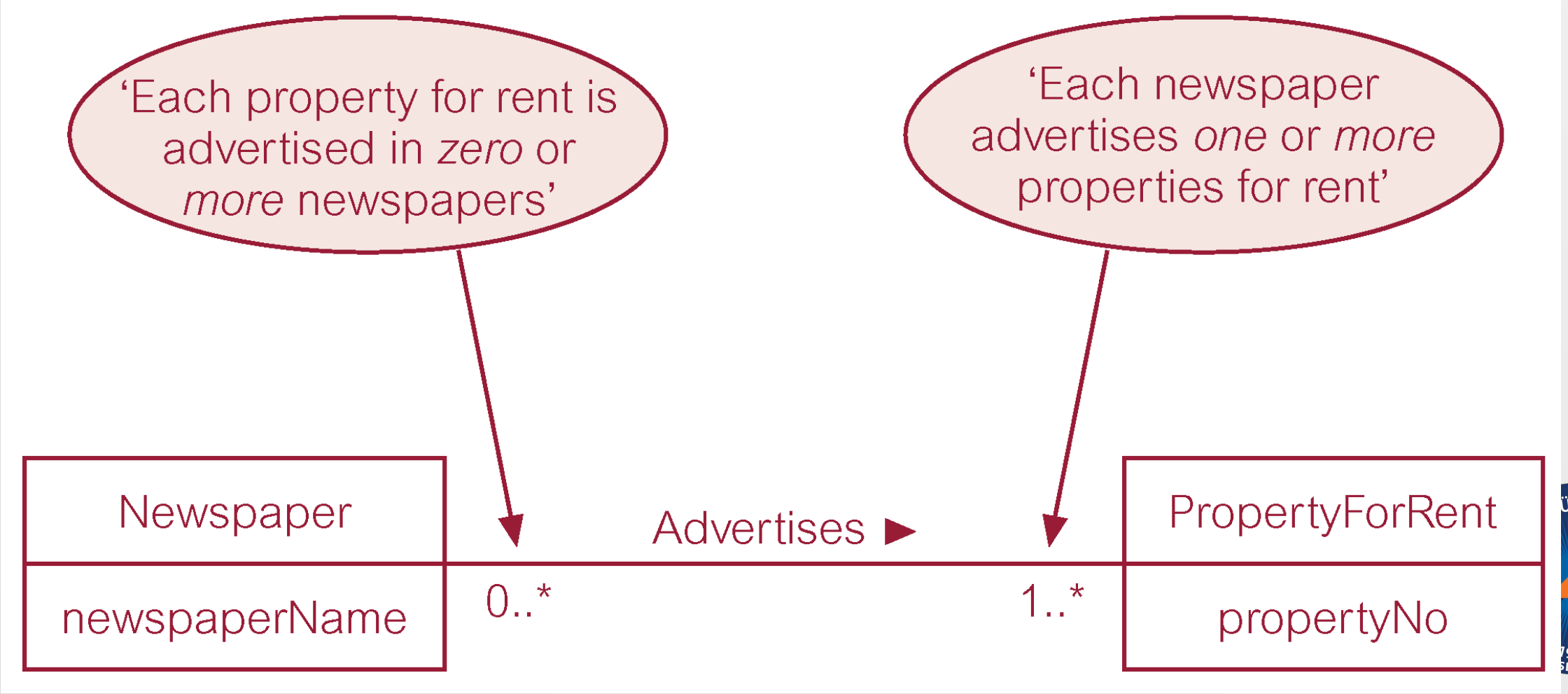
MULTIPLICITY OF STAFF *OVERSEES* PROPERTYFORRENT (1:*) RELATIONSHIP TYPE



SEMANTIC NET OF NEWSPAPER *ADVERTISES* PROPERTYFORRENT RELATIONSHIP TYPE



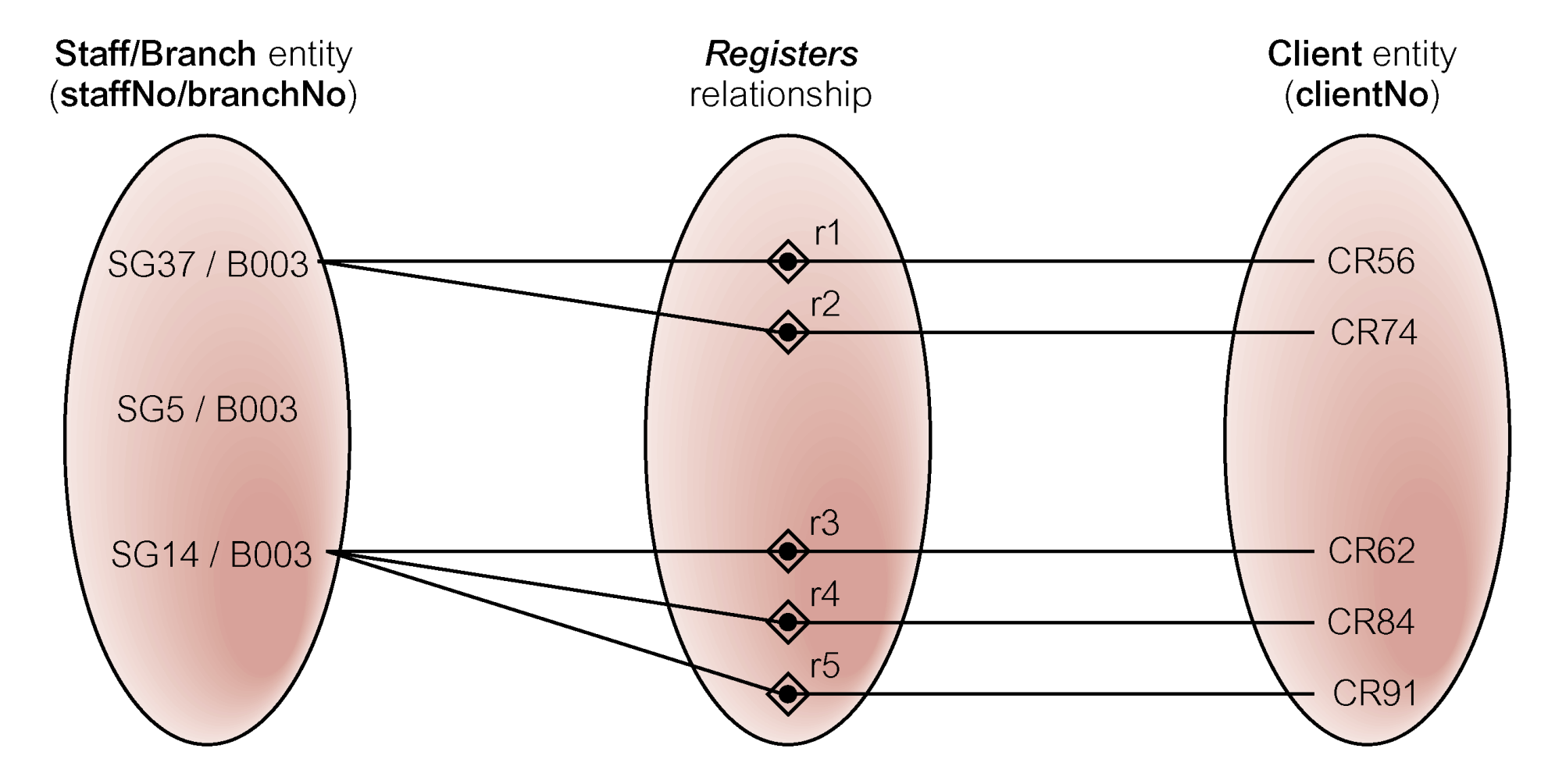
MULTIPLICITY OF NEWSPAPER *ADVERTISES* PROPERTYFORRENT (*:*) RELATIONSHIP



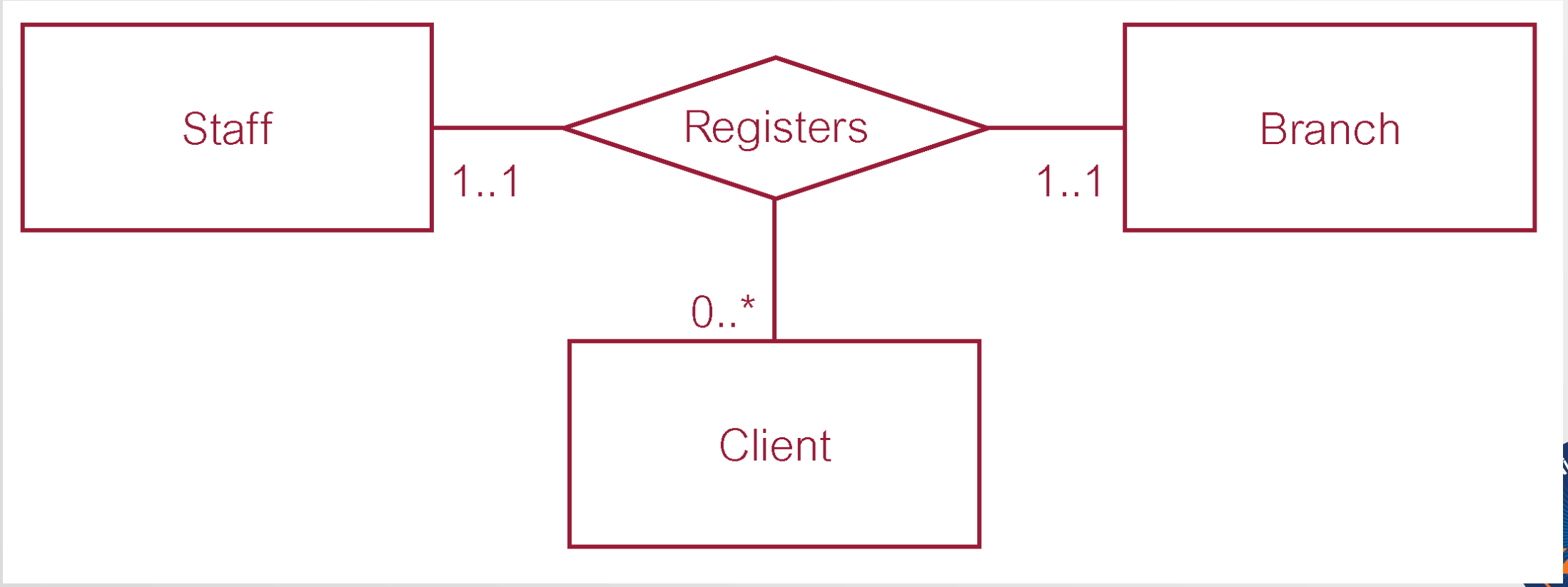
STRUCTURAL CONSTRAINTS

- Multiplicity for Complex Relationships
  - Number (or range) of possible occurrences of an entity type in an n-ary relationship when other (n-1) values are fixed.

SEMANTIC NET OF TERNARY *REGISTERS* RELATIONSHIP WITH VALUES FOR STAFF AND BRANCH ENTITIES FIXED



MULTIPLICITY OF TERNARY *REGISTERS* RELATIONSHIP



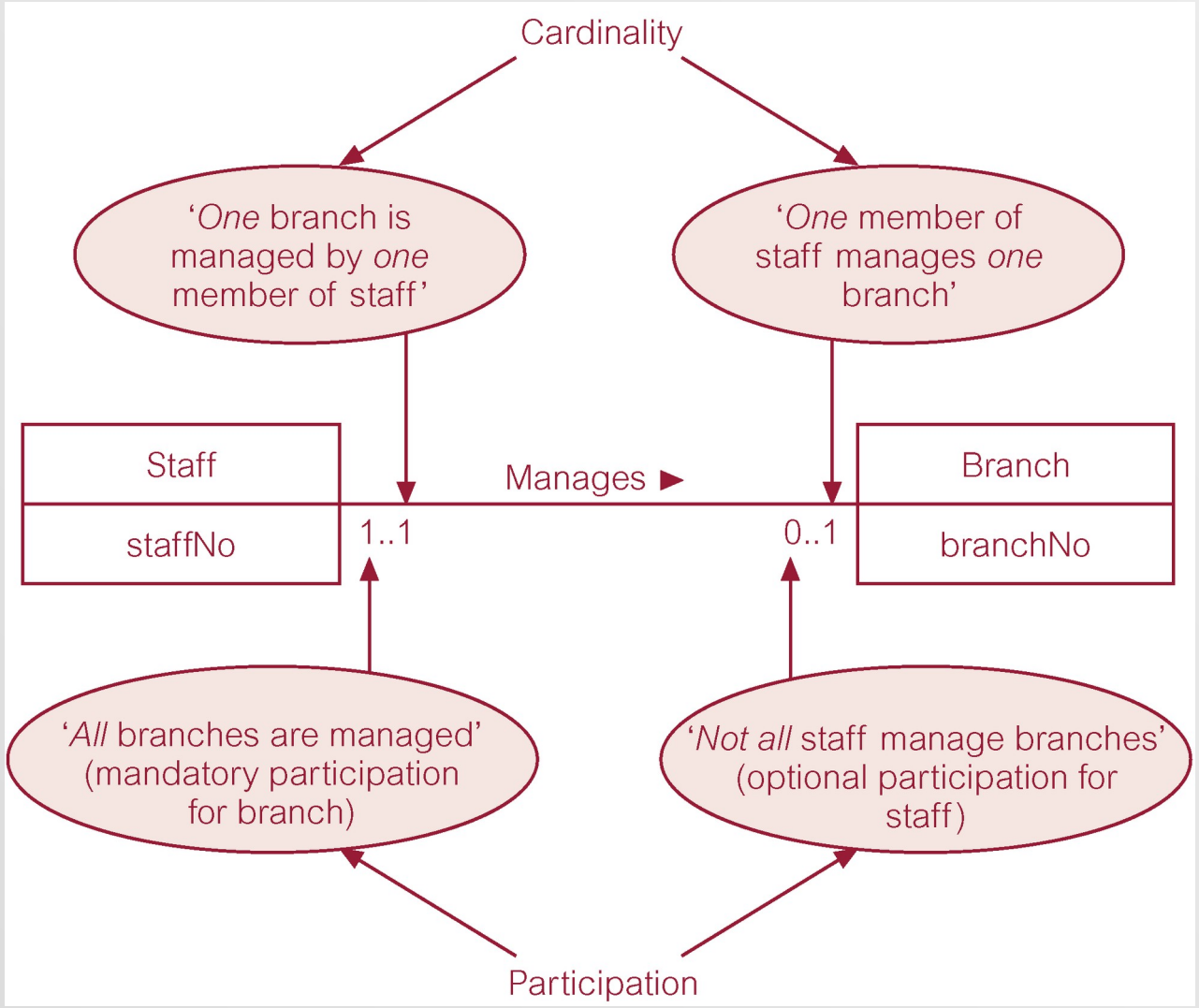
SUMMARY OF MULTIPLICITY CONSTRAINTS

Alternative ways to represent multiplicity constraints	Meaning
0..1	Zero or one entity occurrence
1..1 (or just 1)	Exactly one entity occurrence
0..* (or just *)	Zero or many entity occurrences
1..*	One or many entity occurrences
5..10	Minimum of 5 up to a maximum of 10 entity occurrences
0, 3, 6–8	Zero or three or six, seven, or eight entity occurrences

STRUCTURAL CONSTRAINTS

- Multiplicity is made up of two types of restrictions on relationships: cardinality and participation.
- Cardinality
  - Describes maximum number of possible relationship occurrences for an entity participating in a given relationship type.
- Participation
  - Determines whether all or only some entity occurrences participate in a relationship.

MULTIPLICITY AS CARDINALITY AND PARTICIPATION CONSTRAINTS

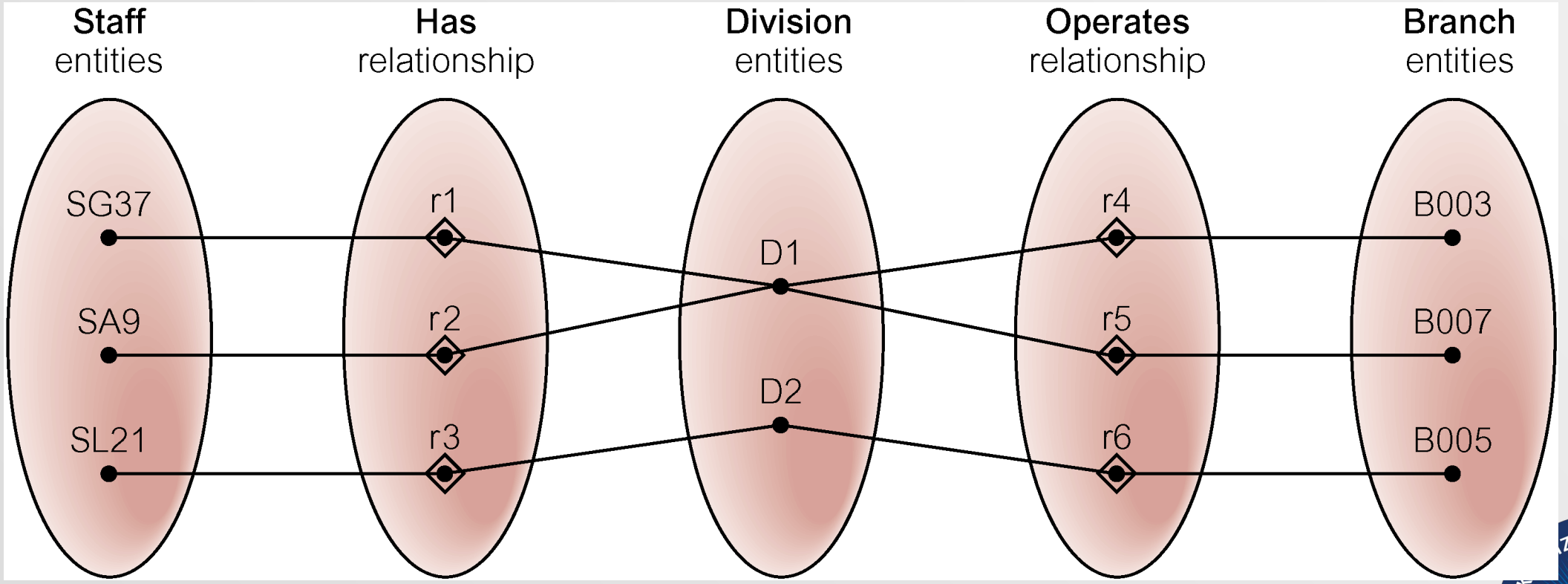


PROBLEMS WITH ER MODELS

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

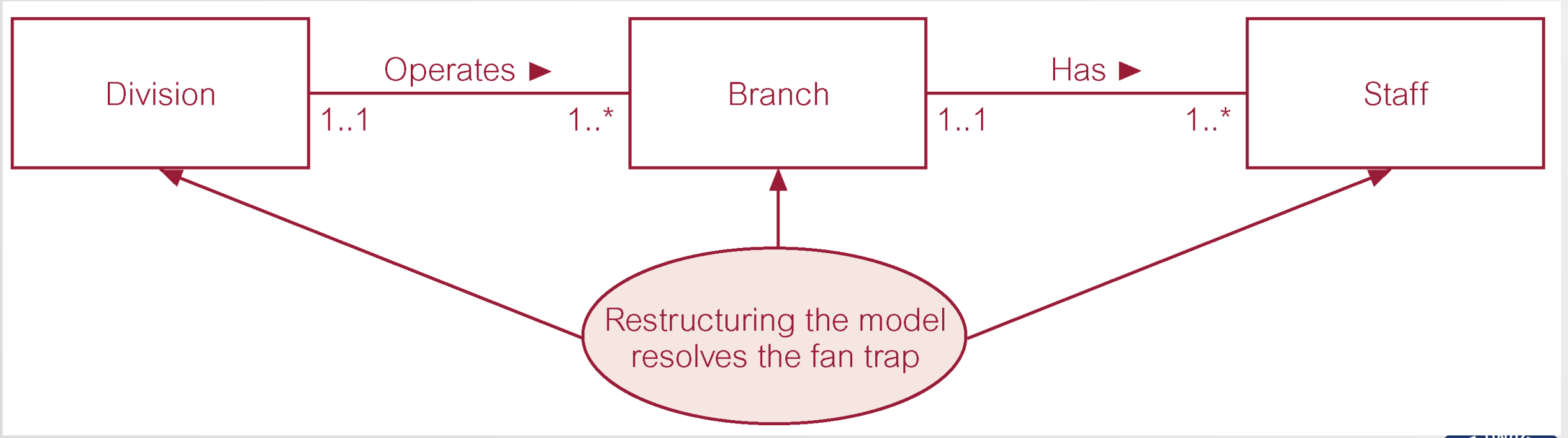
AN EXAMPLE OF A FAN TRAP

SEMANTIC NET OF ER MODEL WITH FAN TRAP

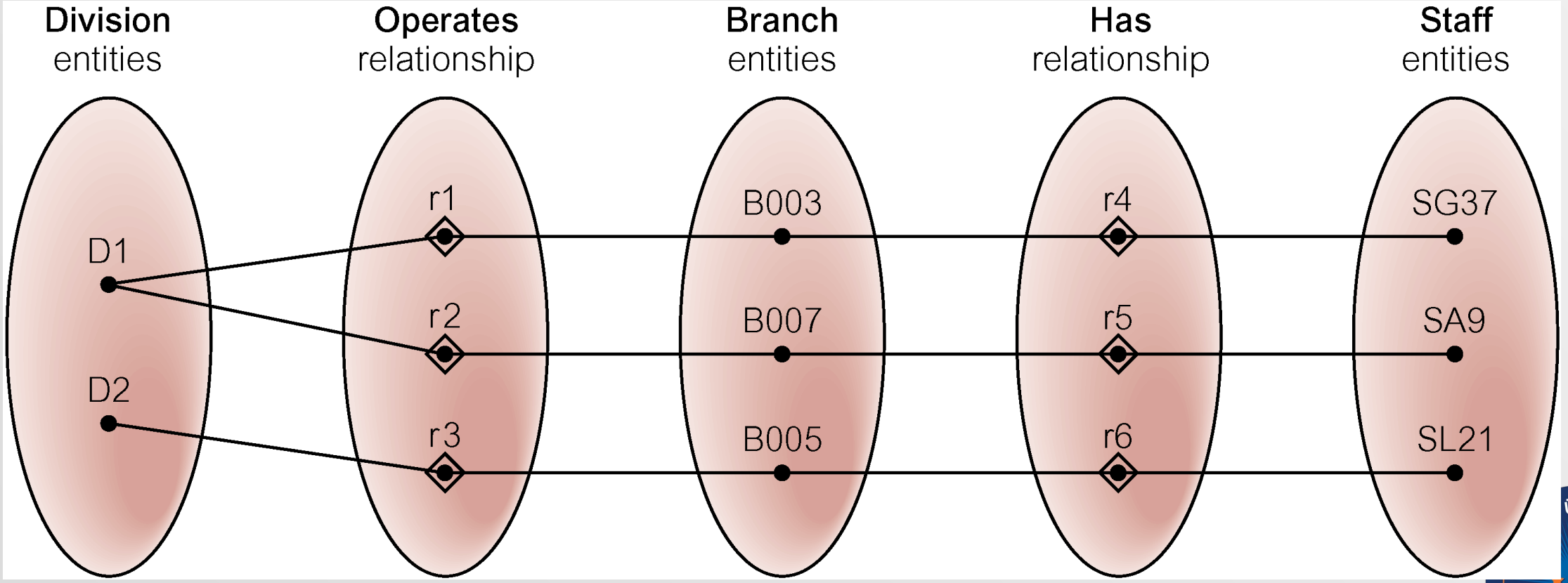


- At which branch office does staff number SG37 work?

RESTRUCTURING ER MODEL TO REMOVE FAN TRAP



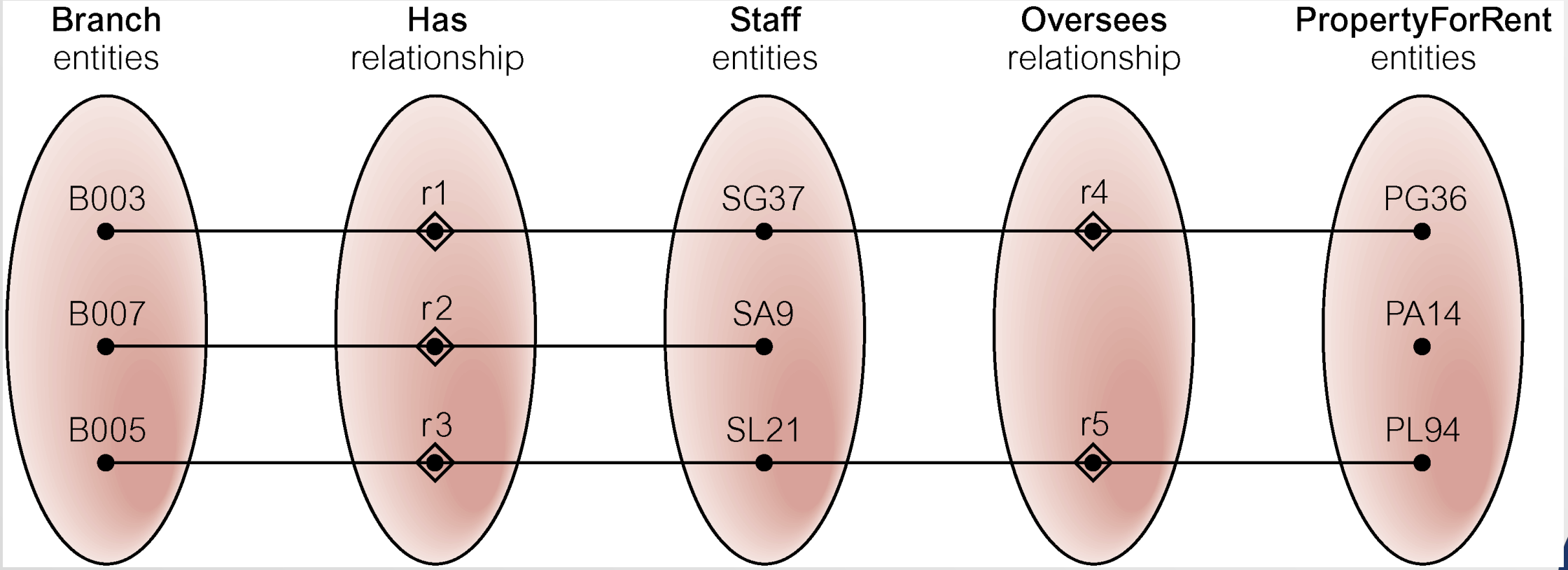
SEMANTIC NET OF RESTRUCTURED ER MODEL WITH FAN TRAP REMOVED



- SG37 works at branch B003.

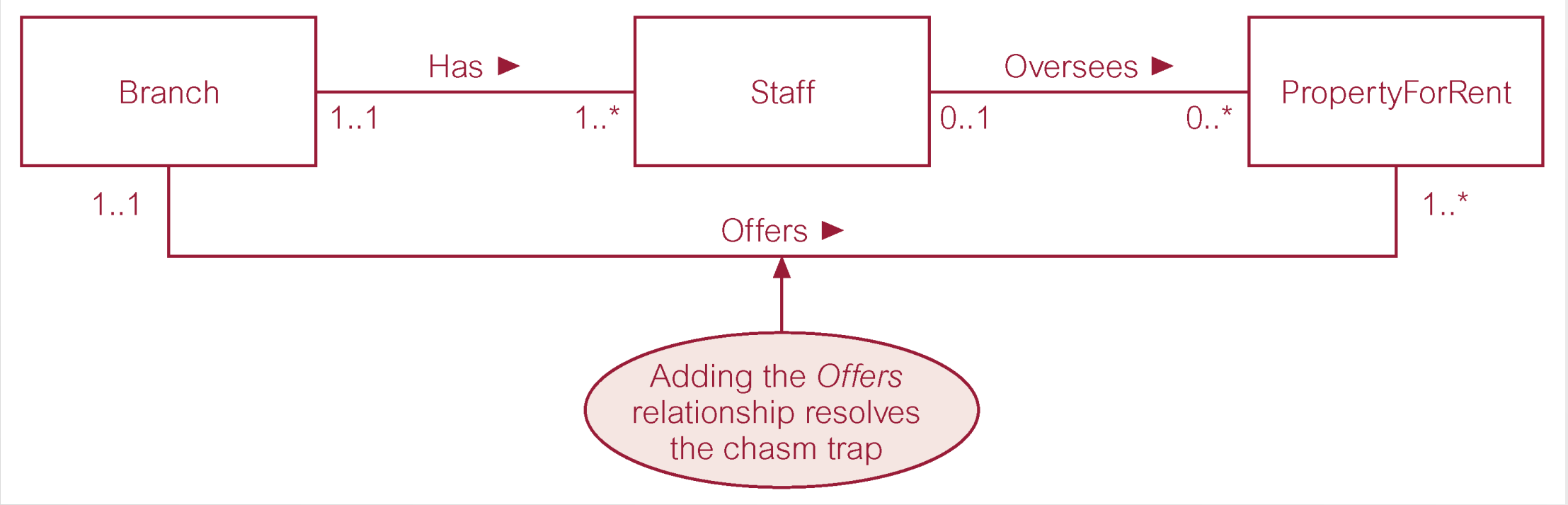
AN EXAMPLE OF A CHASM TRAP

SEMANTIC NET OF ER MODEL WITH CHASM TRAP

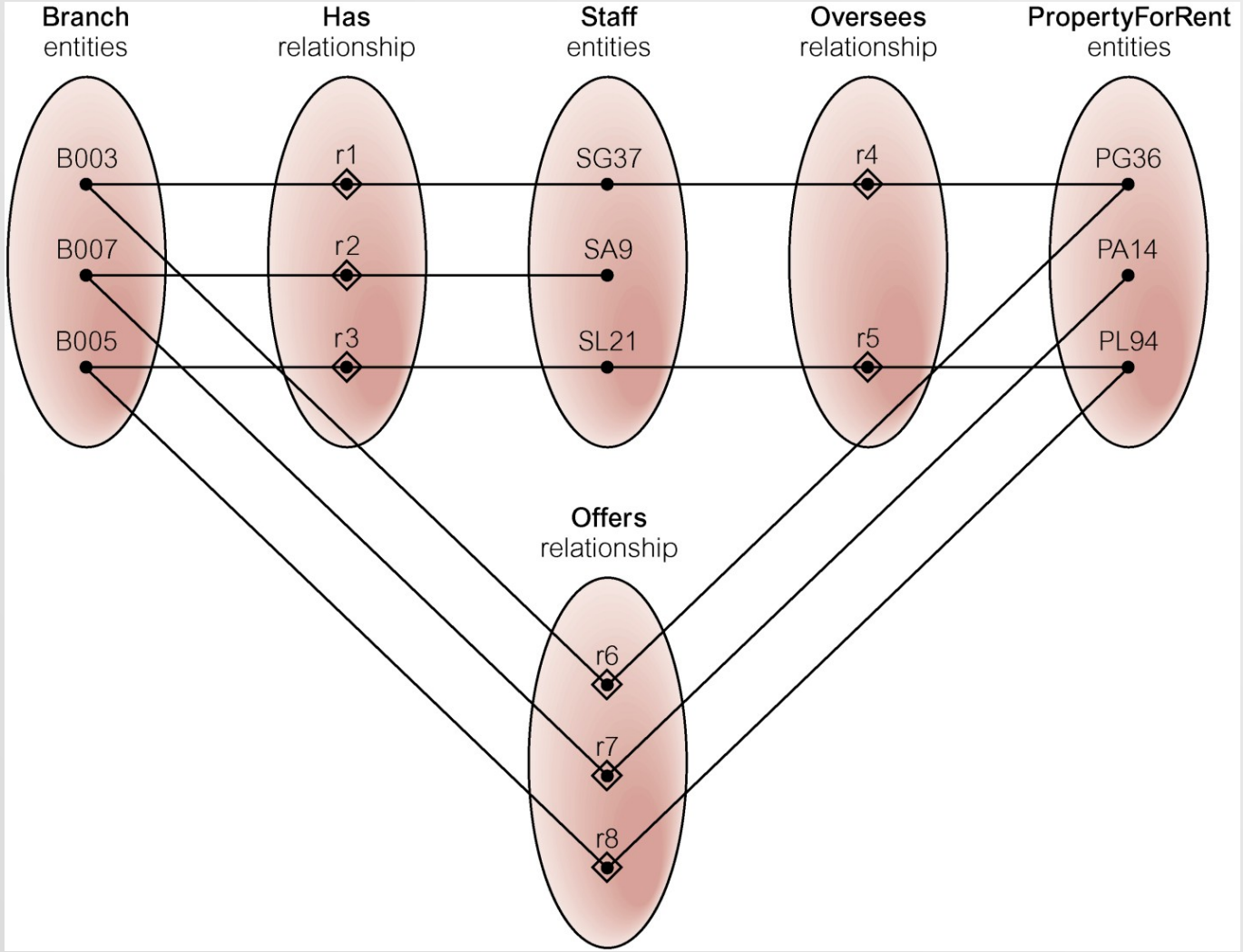


- At which branch office is property PA14 available?

ER MODEL RESTRUCTURED TO REMOVE CHASM TRAP



SEMANTIC NET OF RESTRUCTURED ER MODEL WITH CHASM TRAP REMOVED



CHAPTER 13 - OUTLINE

- Limitations of basic concepts of the ER model and requirements to represent more complex applications using additional data modeling concepts.
- Most useful additional data modeling concept of Enhanced ER (EER) model is called specialization/generalization.
- A diagrammatic technique for displaying specialization/generalization in an EER diagram using UML.

ENHANCED ENTITY-RELATIONSHIP MODEL

- Since 1980s there has been an increase in emergence of new database applications with more demanding requirements.
- Basic concepts of ER modeling are not sufficient to represent requirements of newer, more complex applications.
- Response is development of additional ‘semantic’ modeling concepts.
- Semantic concepts are incorporated into the original ER model and called the Enhanced Entity-Relationship (EER) model.
- Examples of additional concept of EER model is called specialization / generalization.

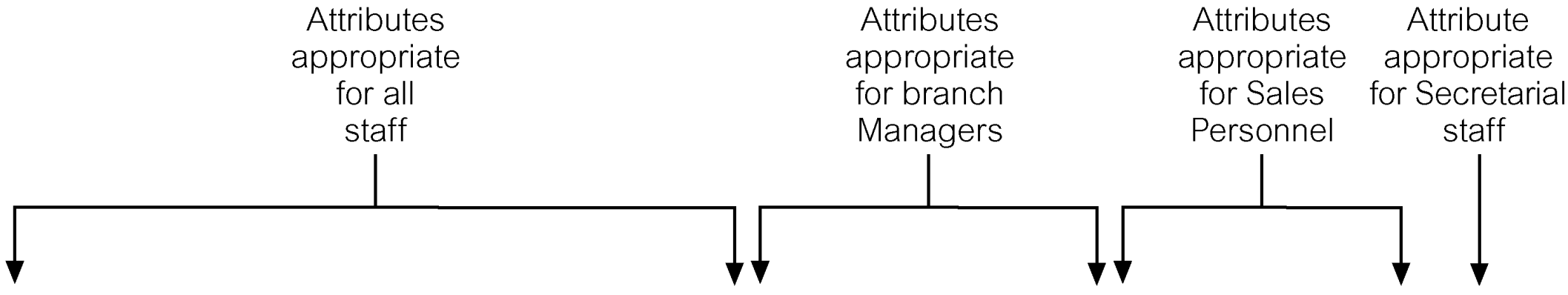
SPECIALIZATION / GENERALIZATION

- Superclass
  - An entity type that includes one or more distinct subgroupings of its occurrences.
- Subclass
  - A distinct subgrouping of occurrences of an entity type.
- Superclass/subclass relationship is one-to-one (1:1).
- Superclass may contain overlapping or distinct subclasses.
- Not all members of a superclass need be a member of a subclass.

SPECIALIZATION / GENERALIZATION

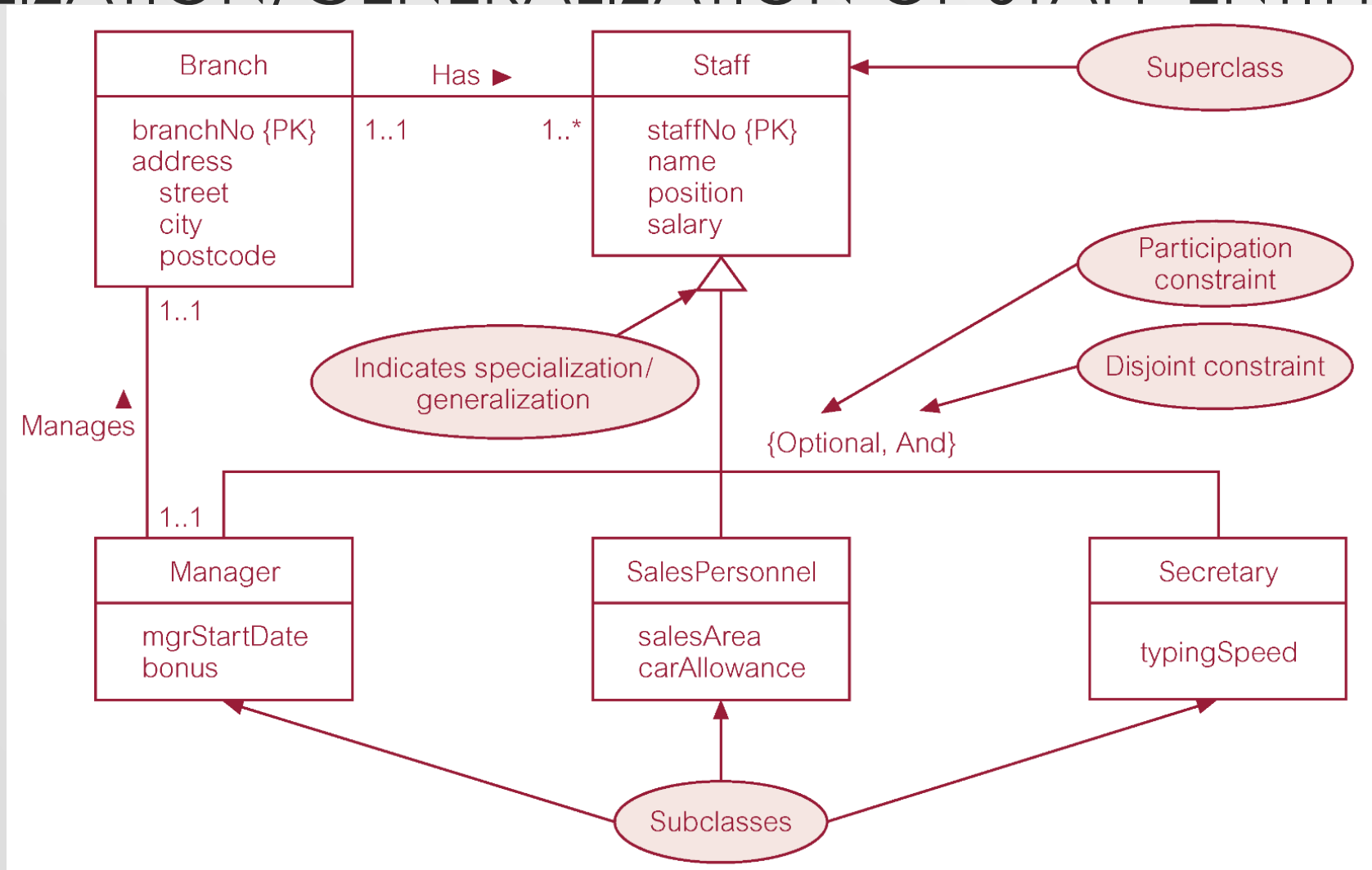
- Attribute Inheritance
  - An entity in a subclass represents same ‘real world’ object as in superclass, and may possess subclass-specific attributes, as well as those associated with the superclass.
- Specialization
  - Process of maximizing differences between members of an entity by identifying their distinguishing characteristics.
- Generalization
  - Process of minimizing differences between entities by identifying their common characteristics.

ALLSTAFF RELATION HOLDING DETAILS OF ALL STAFF

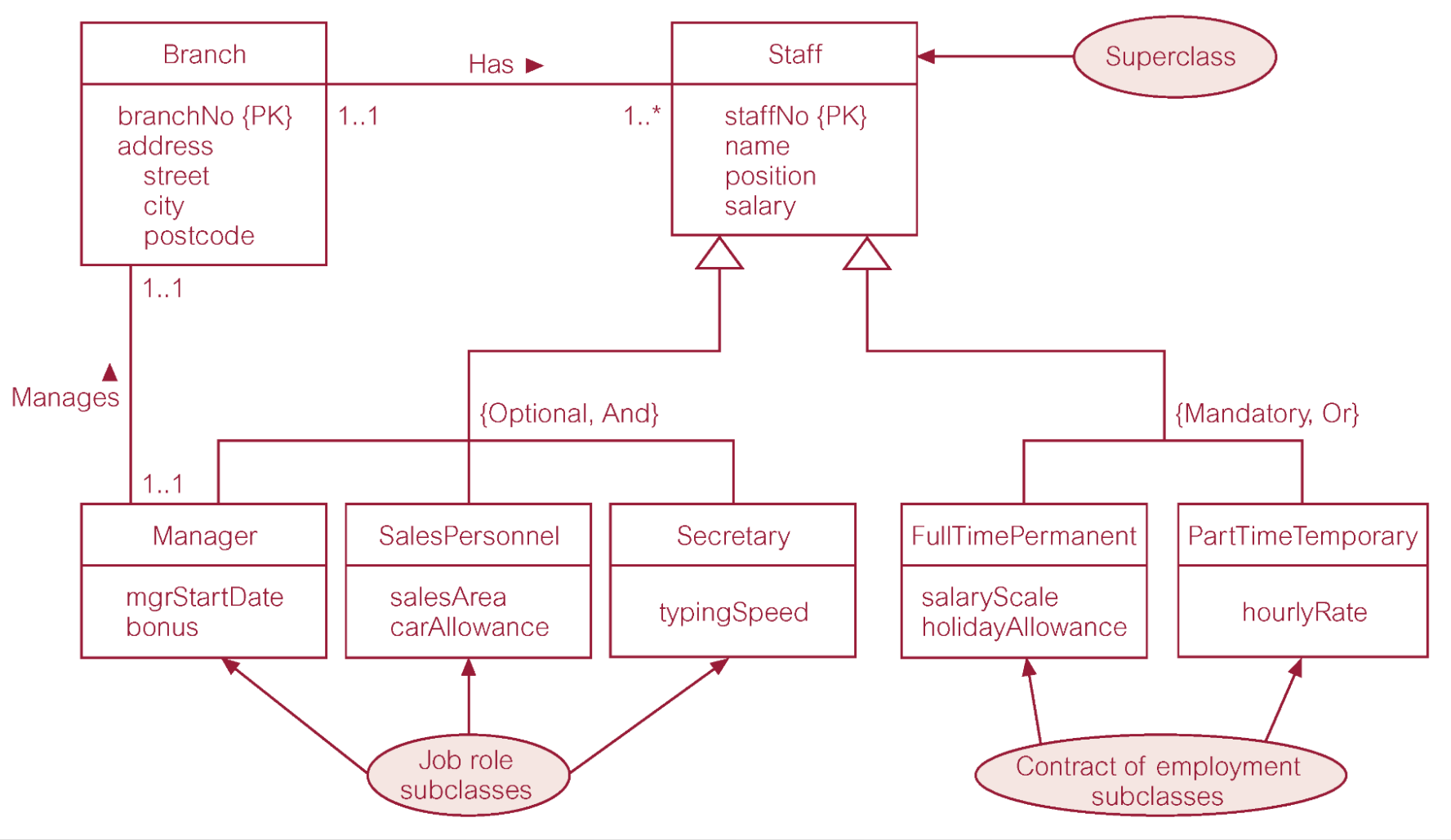


staffNo	name	position	salary	mgrStartDate	bonus	sales Area	car Allowance	typing Speed
SL21	John White	Manager	30000	01/02/95	2000			
SG37	Ann Beech	Assistant	12000					
SG66	Mary Martinez	Sales Manager	27000			SA1A	5000	
SA9	Mary Howe	Assistant	9000					
SL89	Stuart Stern	Secretary	8500					100
SL31	Robert Chin	Snr Sales Asst	17000			SA2B	3700	
SG5	Susan Brand	Manager	24000	01/06/91	2350			

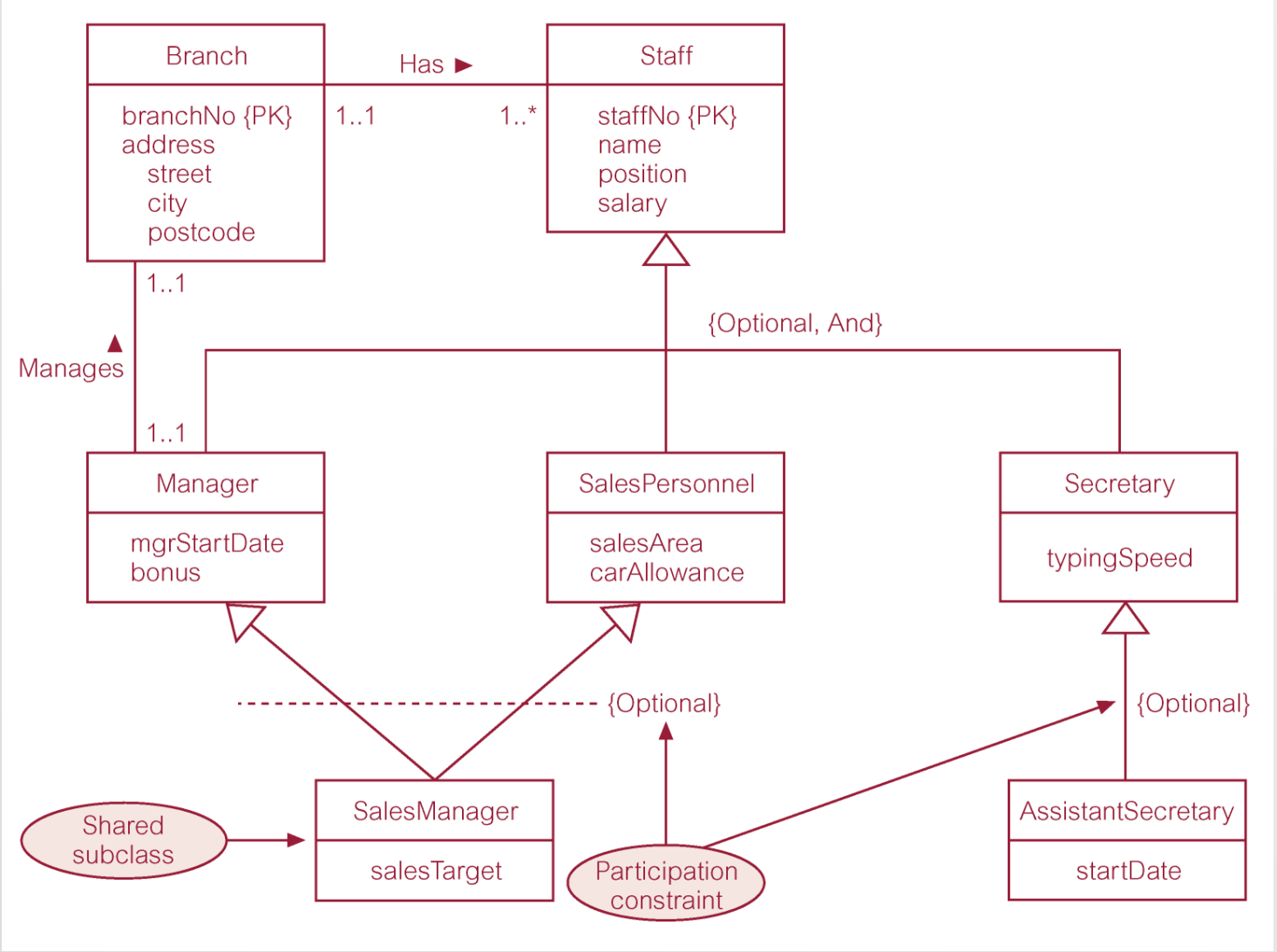
SPECIALIZATION/GENERALIZATION OF STAFF ENTITY INTO SU



SPECIALIZATION/GENERALIZATION OF STAFF ENTITY INTO JOB ROLES AND CONTRACTS OF EMPLOYMENT



EER DIAGRAM WITH SHARED SUBCLASS AND SUBCLASS WITH ITS OWN SUBCLASS



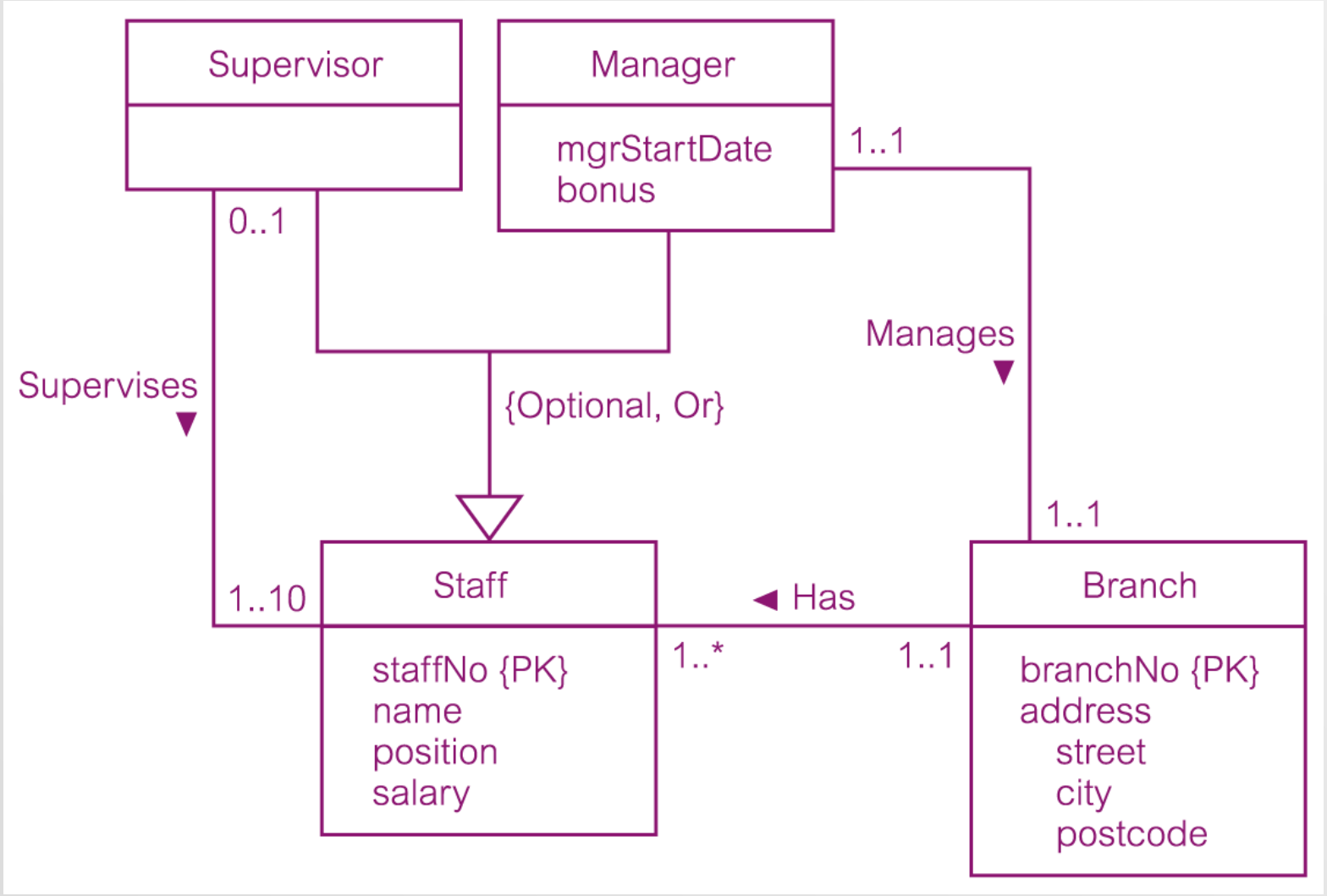
CONSTRAINTS ON SPECIALIZATION / GENERALIZATION

- Two constraints that may apply to a specialization/generalization:
  - participation constraints
  - disjoint constraints.
- Participation constraint
  - Determines whether every member in superclass must participate as a member of a subclass.
  - May be mandatory or optional.

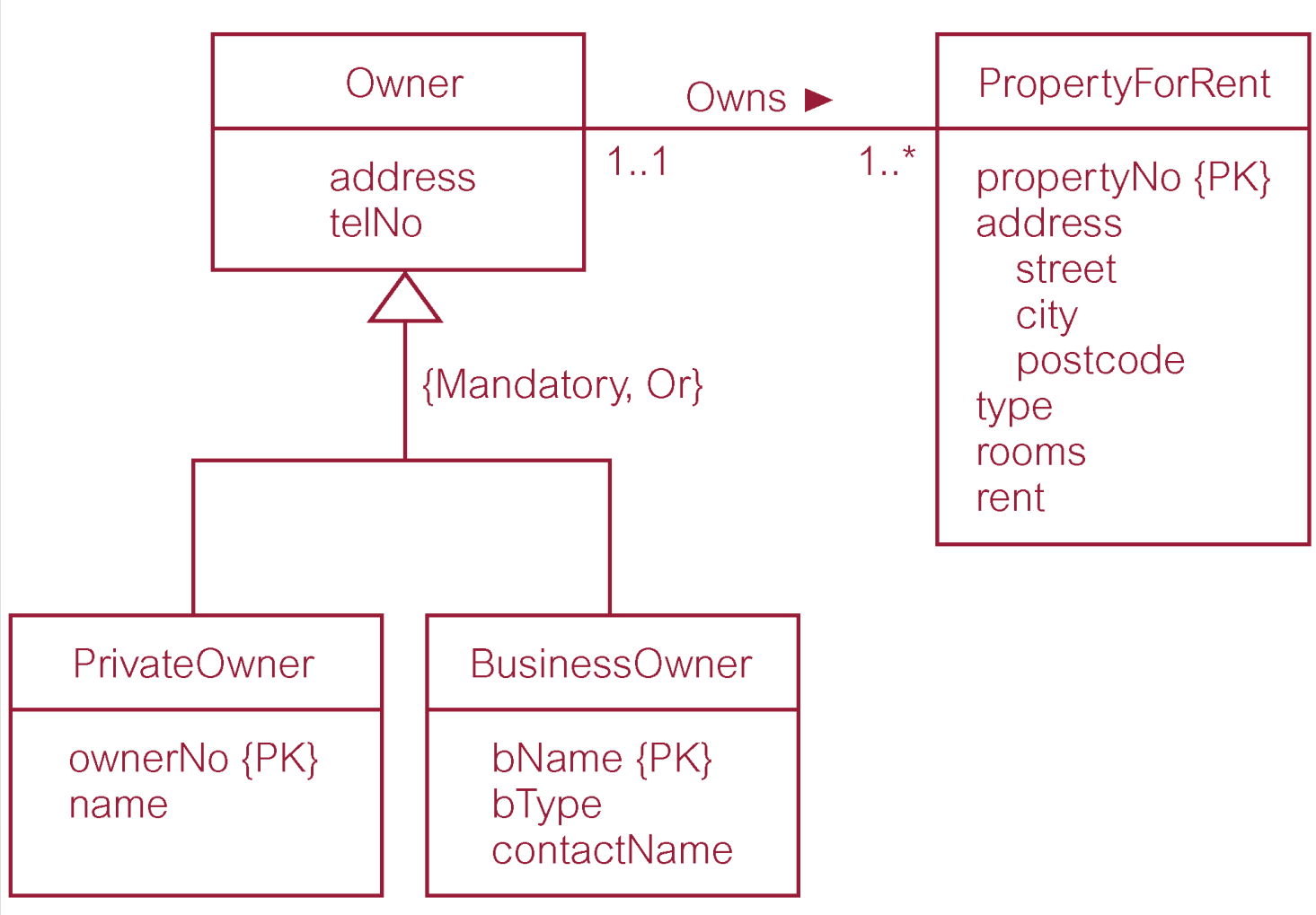
CONSTRAINTS ON SPECIALIZATION / GENERALIZATION

- Disjoint constraint
  - Describes relationship between members of the subclasses and indicates whether member of a superclass can be a member of one, or more than one, subclass.
  - May be disjoint or nondisjoint.
- There are four categories of constraints of specialization and generalization:
  - mandatory and disjoint
  - optional and disjoint
  - mandatory and nondisjoint
  - optional and nondisjoint.

DREAMHOME WORKED EXAMPLE - STAFF SUPERCLASS WITH SUPERVISOR AND MANAGER SUBCLASSES



DREAMHOME WORKED EXAMPLE - OWNER SUPERCLASS WITH PRIVATEOWNER AND BUSINESSOWNER SUBCLASSES



DREAMHOME WORKED EXAMPLE - OWNER SUPERCLASS WITH PRIVATEOWNER AND BUSINESSOWNER SUBCLASSES