Chapter 11

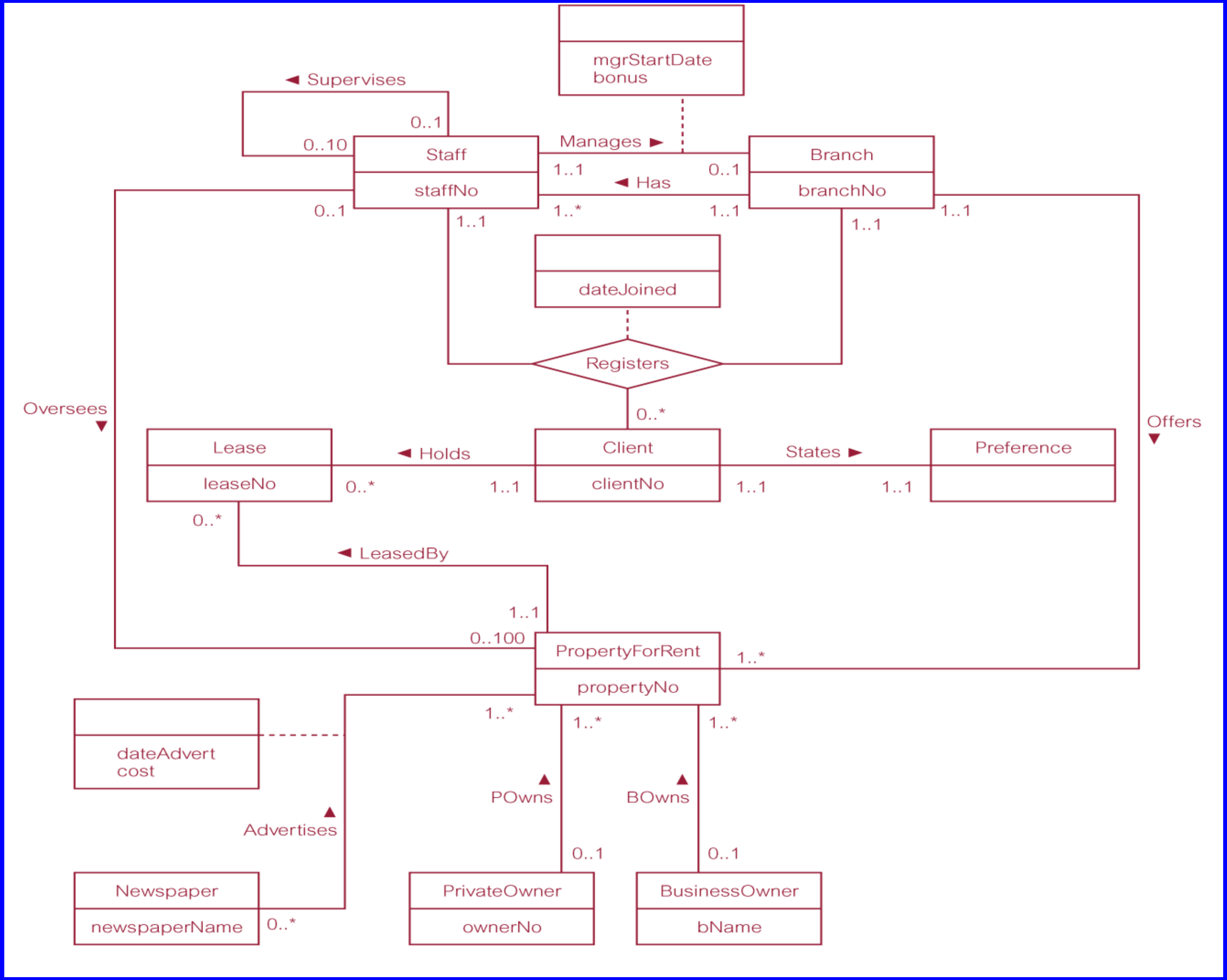
Entity-Relationship modeling

Transparencies

Chapter 11 - Objectives

- 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

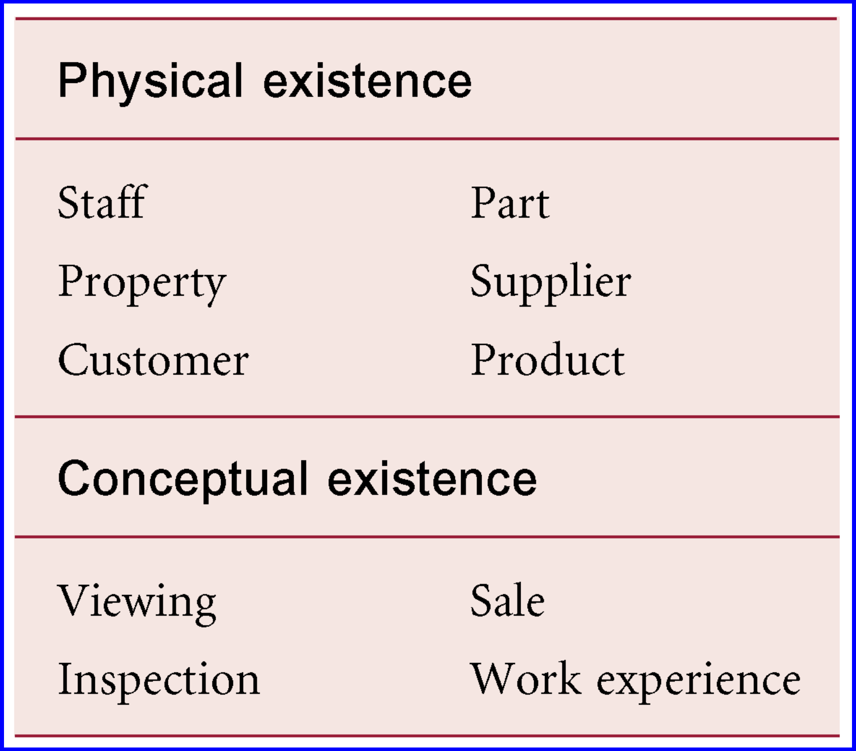
- Entity types
- Relationship types
- Attributes

Entity Type

- **Entity type**
  - **Group of objects with same properties, identified by enterprise as having an independent existence.**

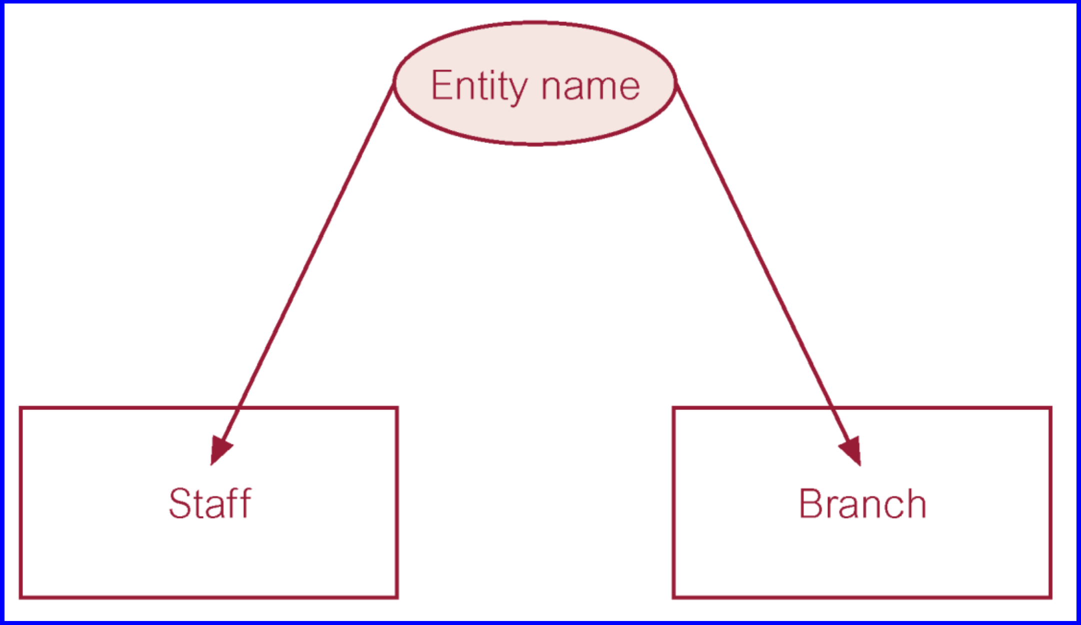
- **Entity occurrence**
  - **Uniquely identifiable object of an entity type.**

Examples of Entity Types



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

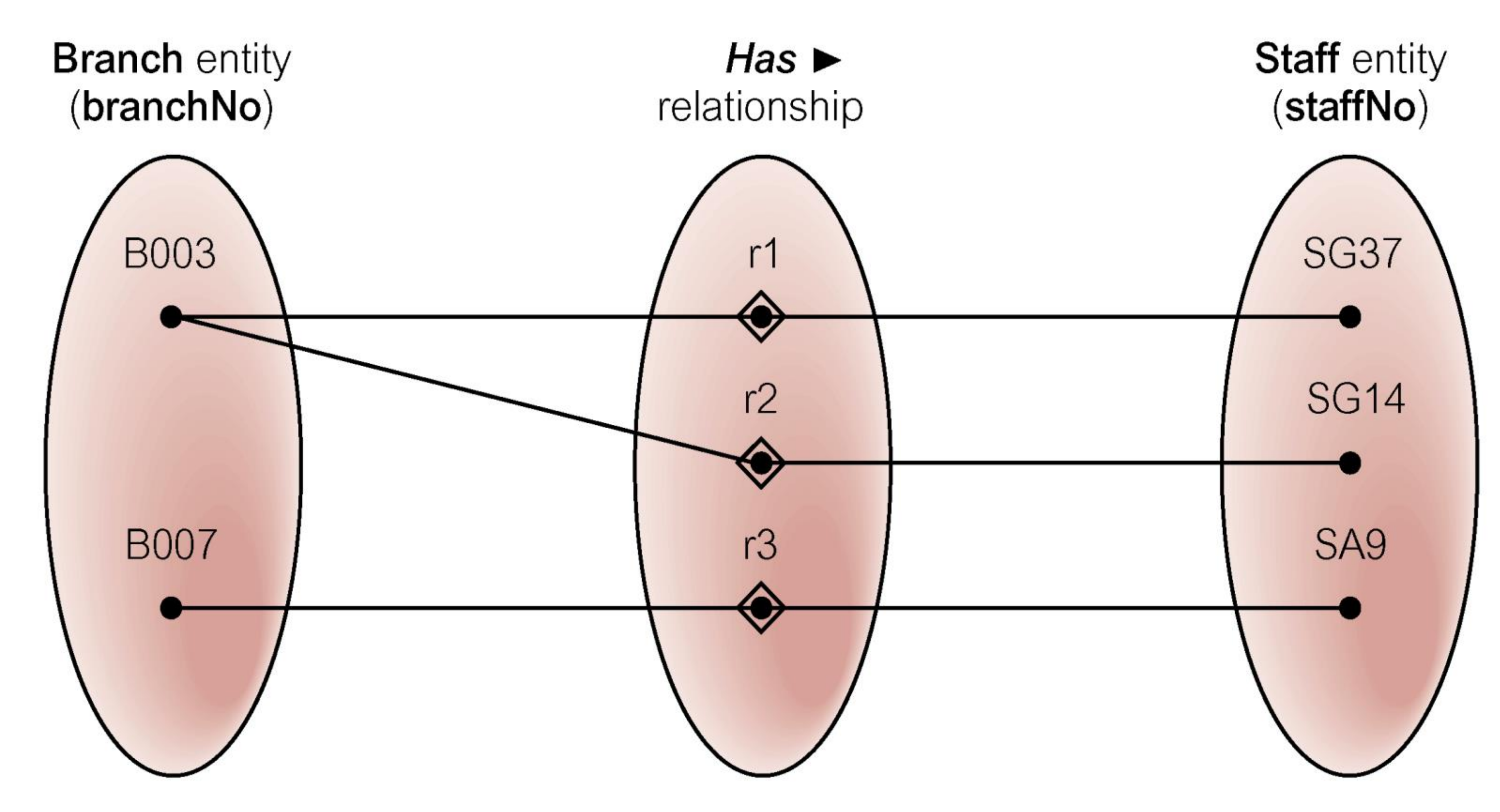
ER diagram of Staff and Branch entity types



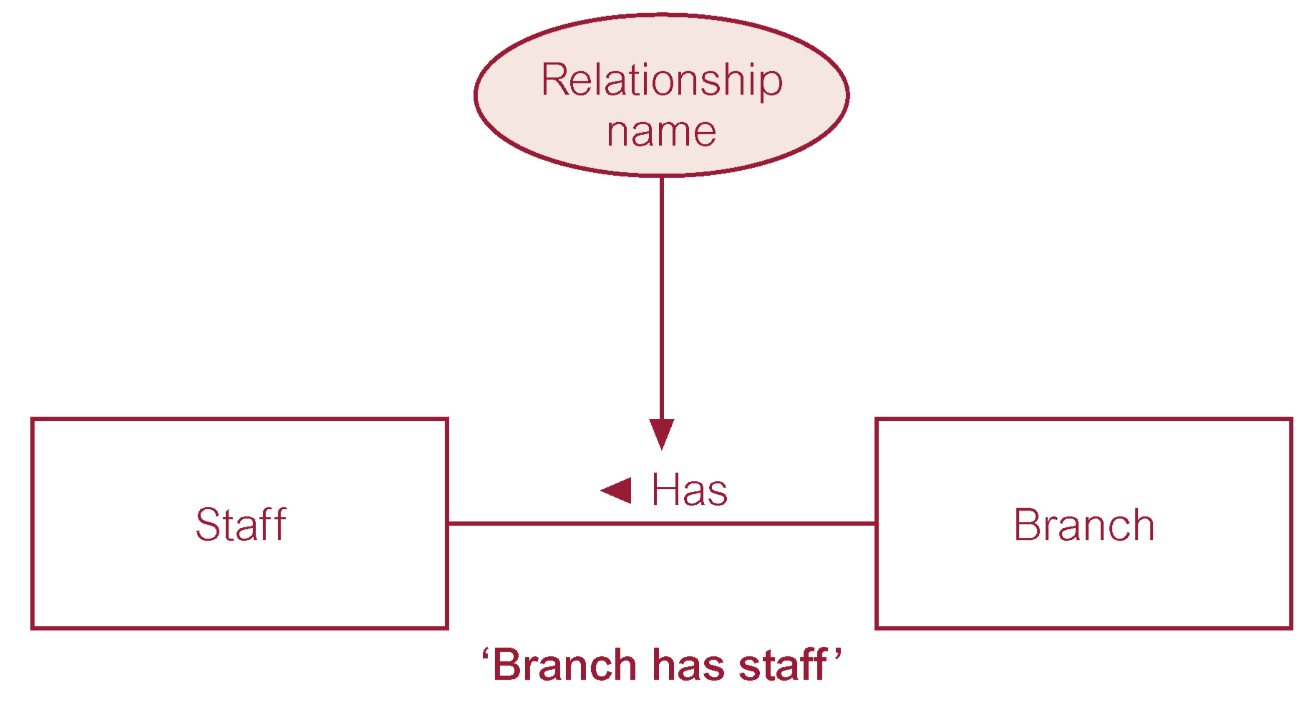
Relationship Types

- 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



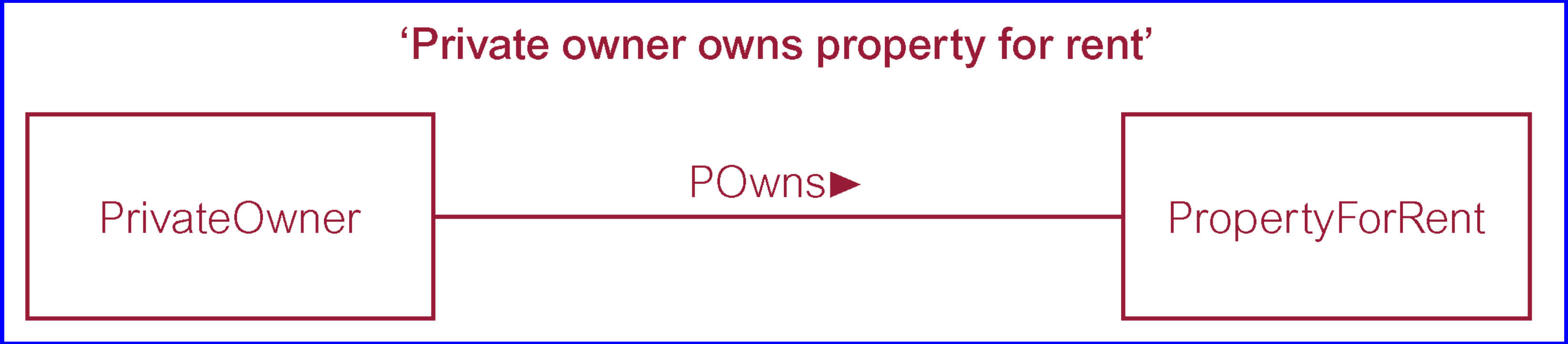
ER diagram of Branch *Has* Staff relationship



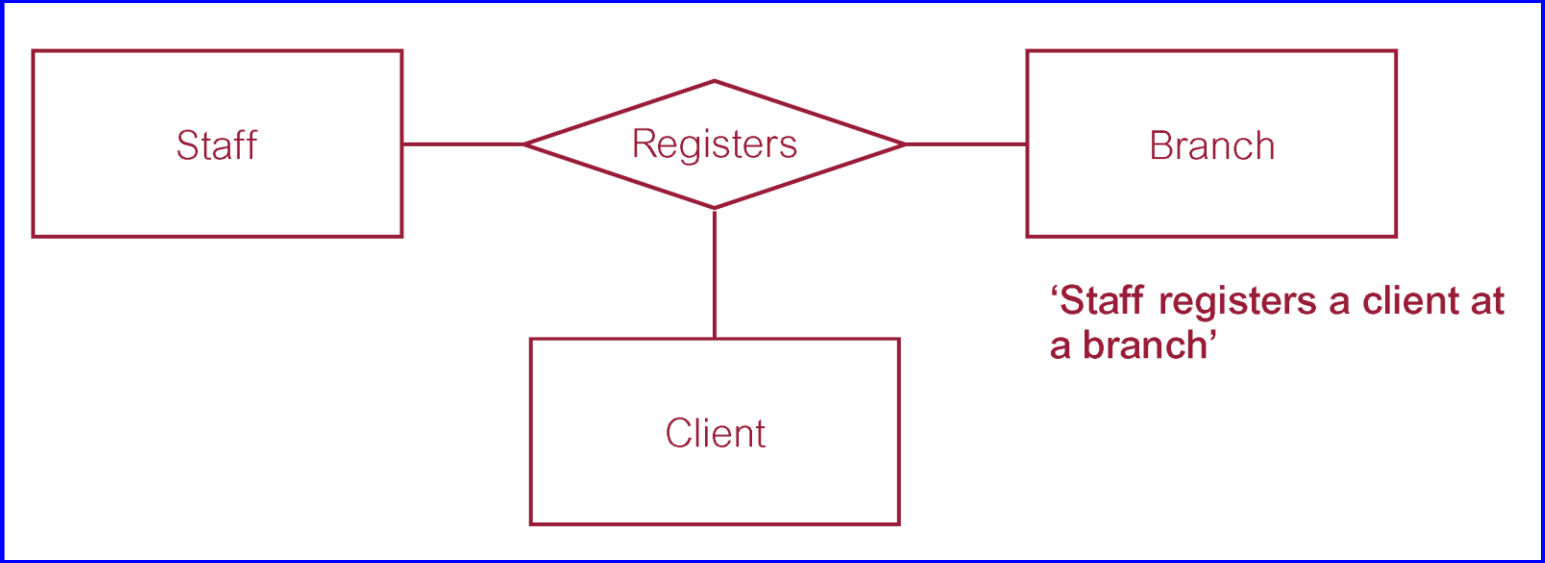
Relationship Types

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

Binary relationship called *POwns*

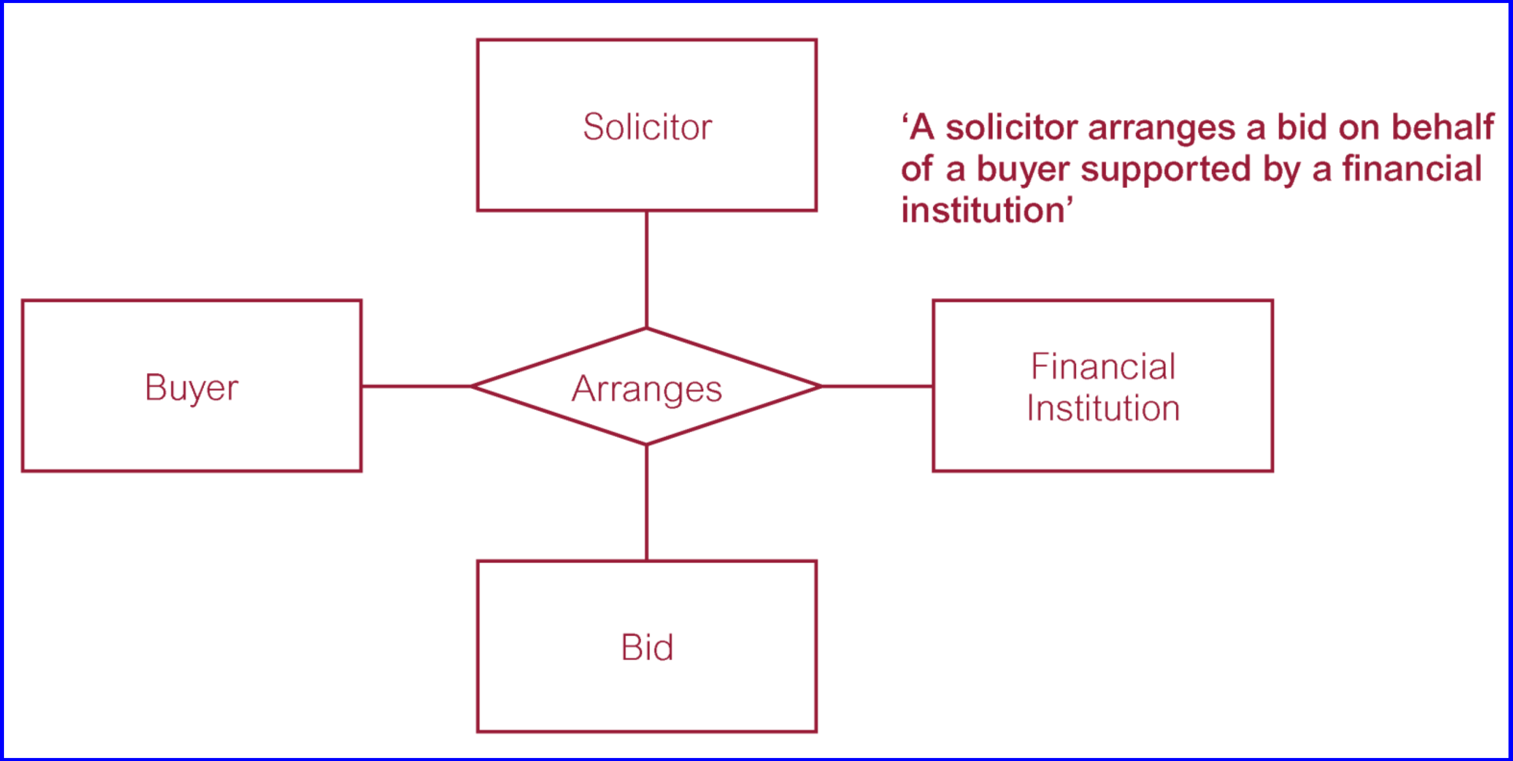


Ternary relationship called *Registers*



'Staff registers a client at a branch'

Quaternary relationship called *Arranges*



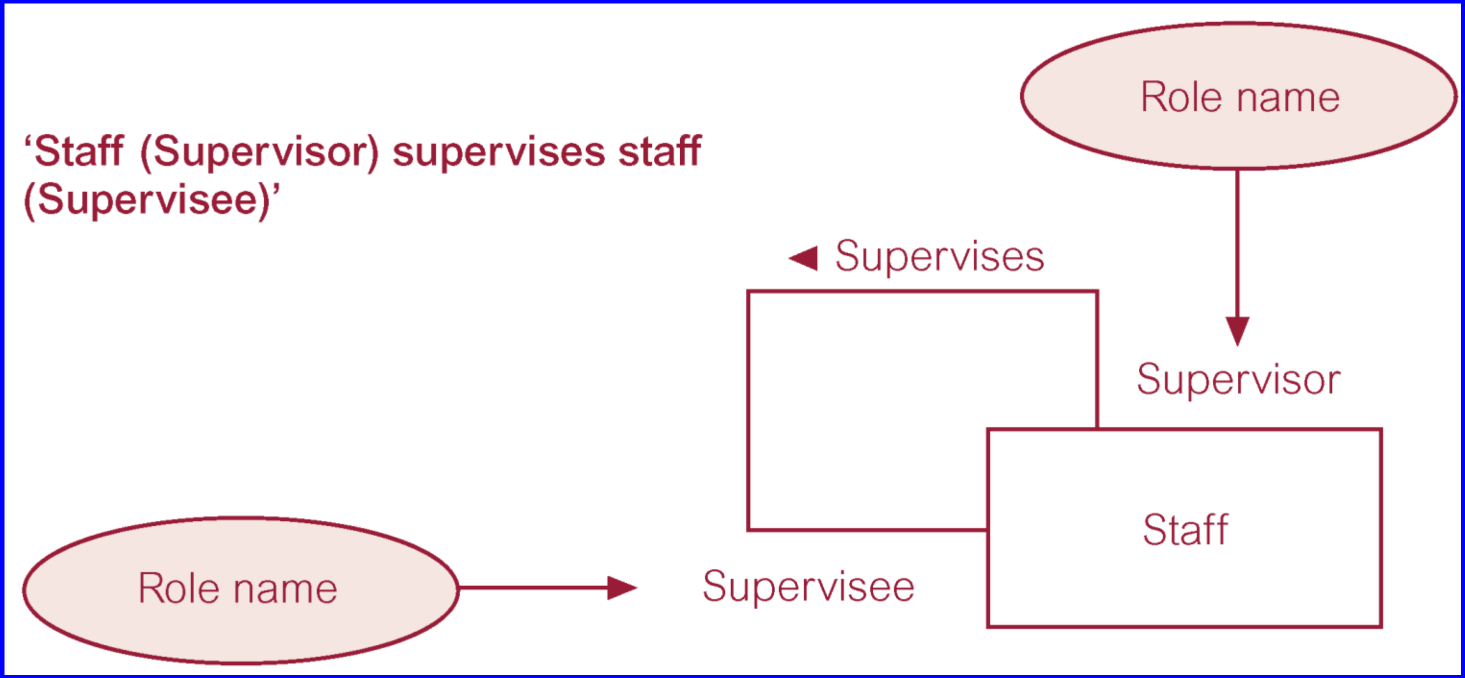
'A solicitor arranges a bid on behalf of a buyer supported by a financial institution'

Relationship Types

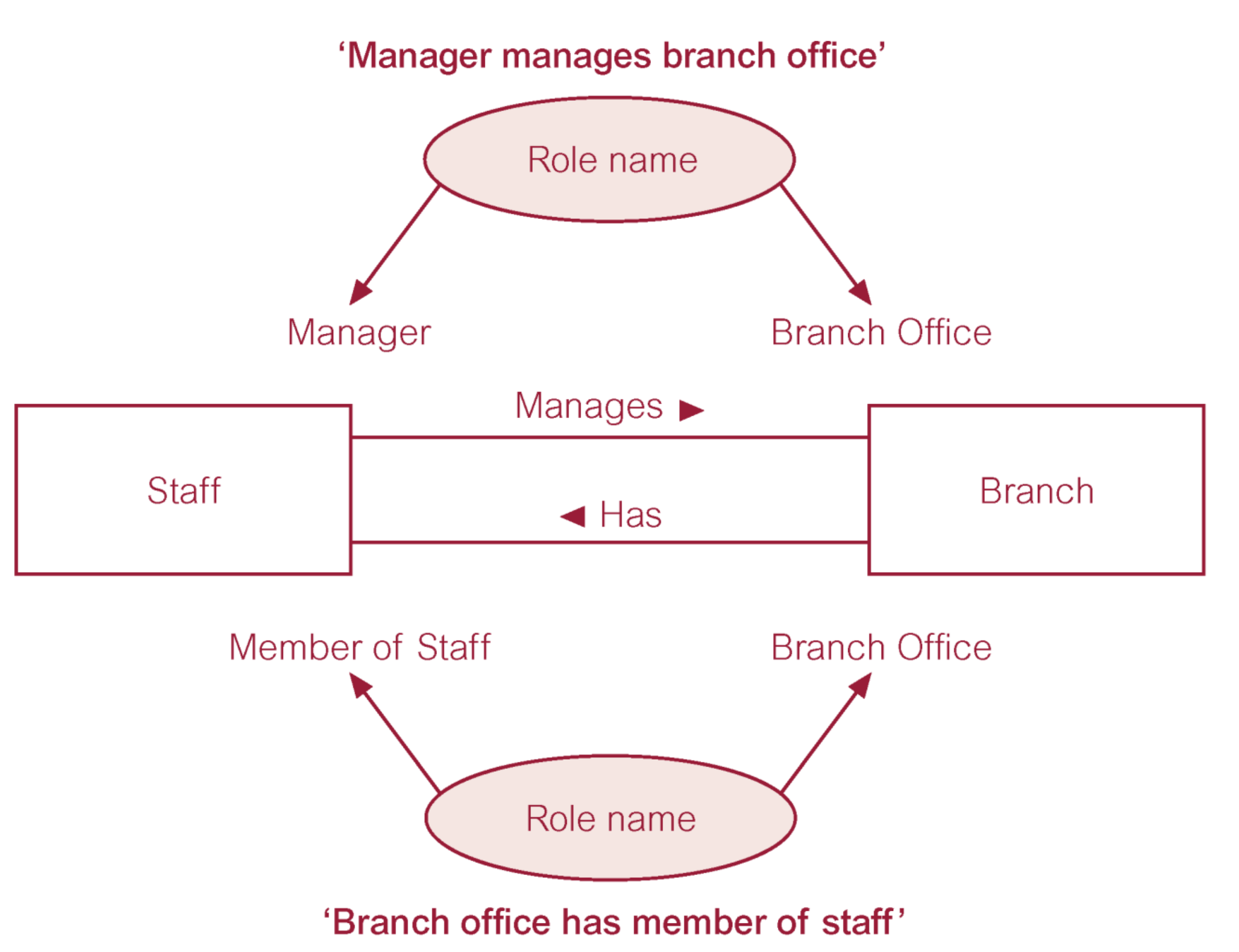
- **Recursive Relationship**
  - **Relationship type where *same* entity type participates more than once in *different roles*.**

- **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



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.

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.

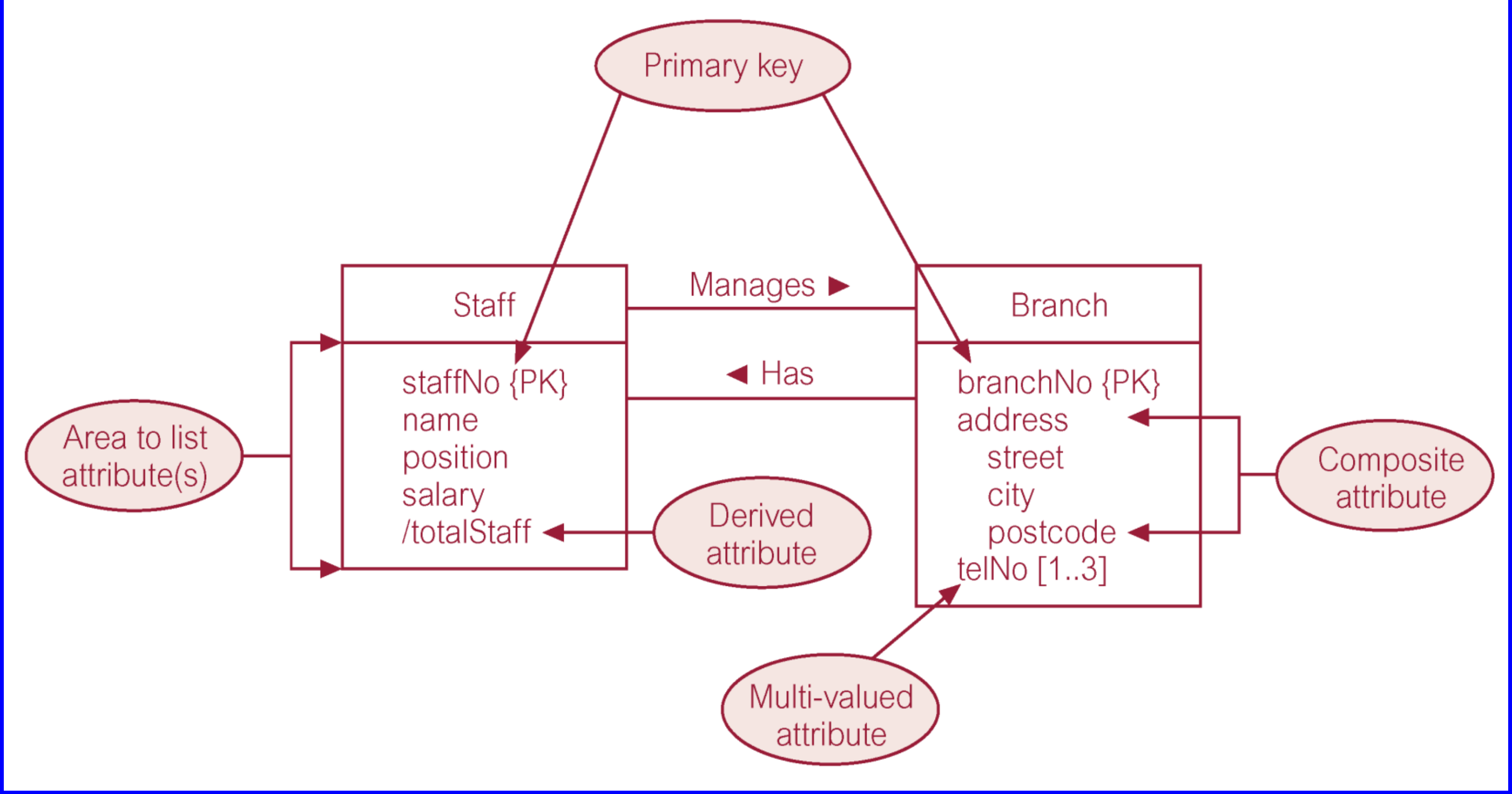
Attributes

- **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.

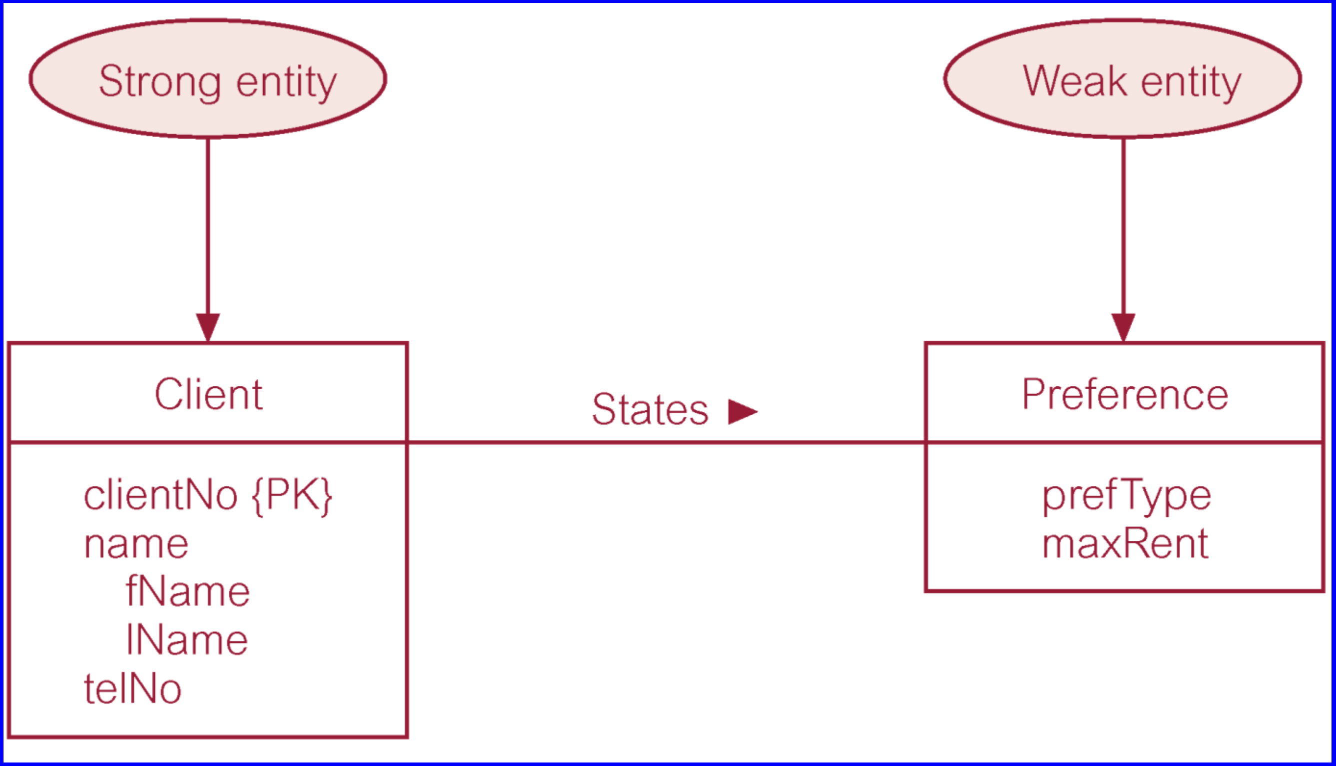
ER diagram of Staff and Branch entities and their attributes



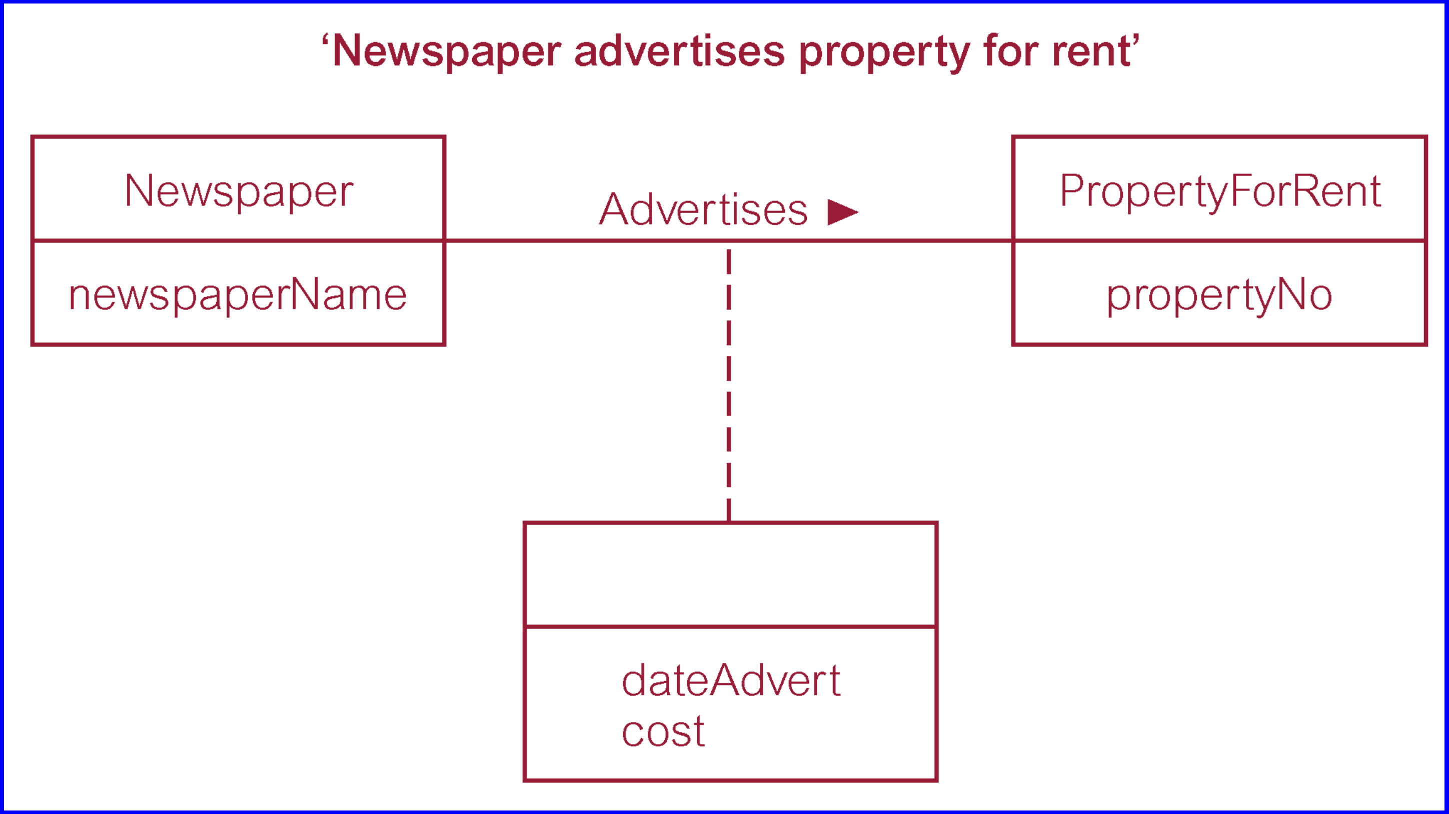
Entity Type

- **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.

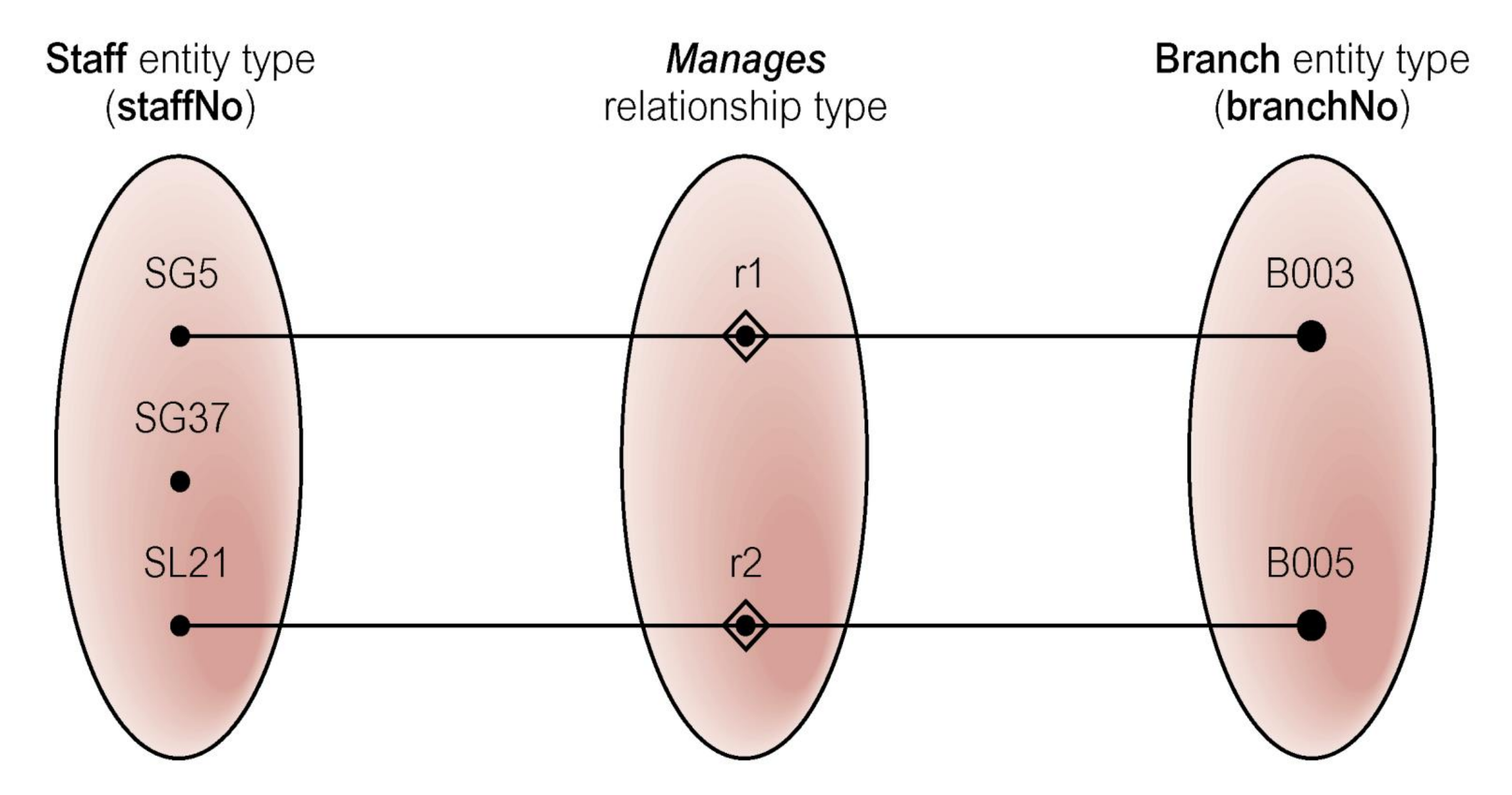
- Represents policies (called ***business rules***) established by user or company.

Structural Constraints

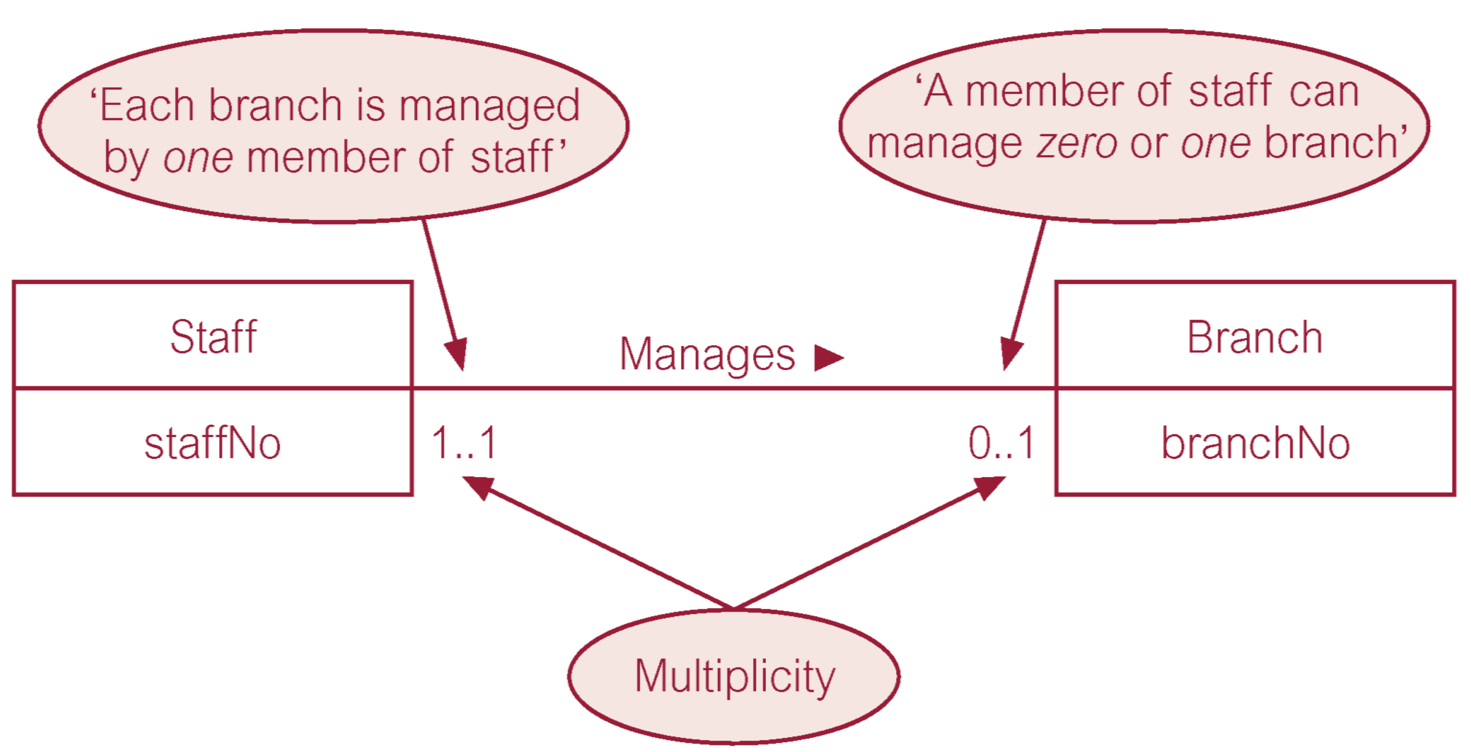
- The most common degree for relationships is binary.

- Binary relationships are generally referred to as being:
  - one-to-one (1:1)
  - one-to-many (1:*)
  - many-to-many (*:*)

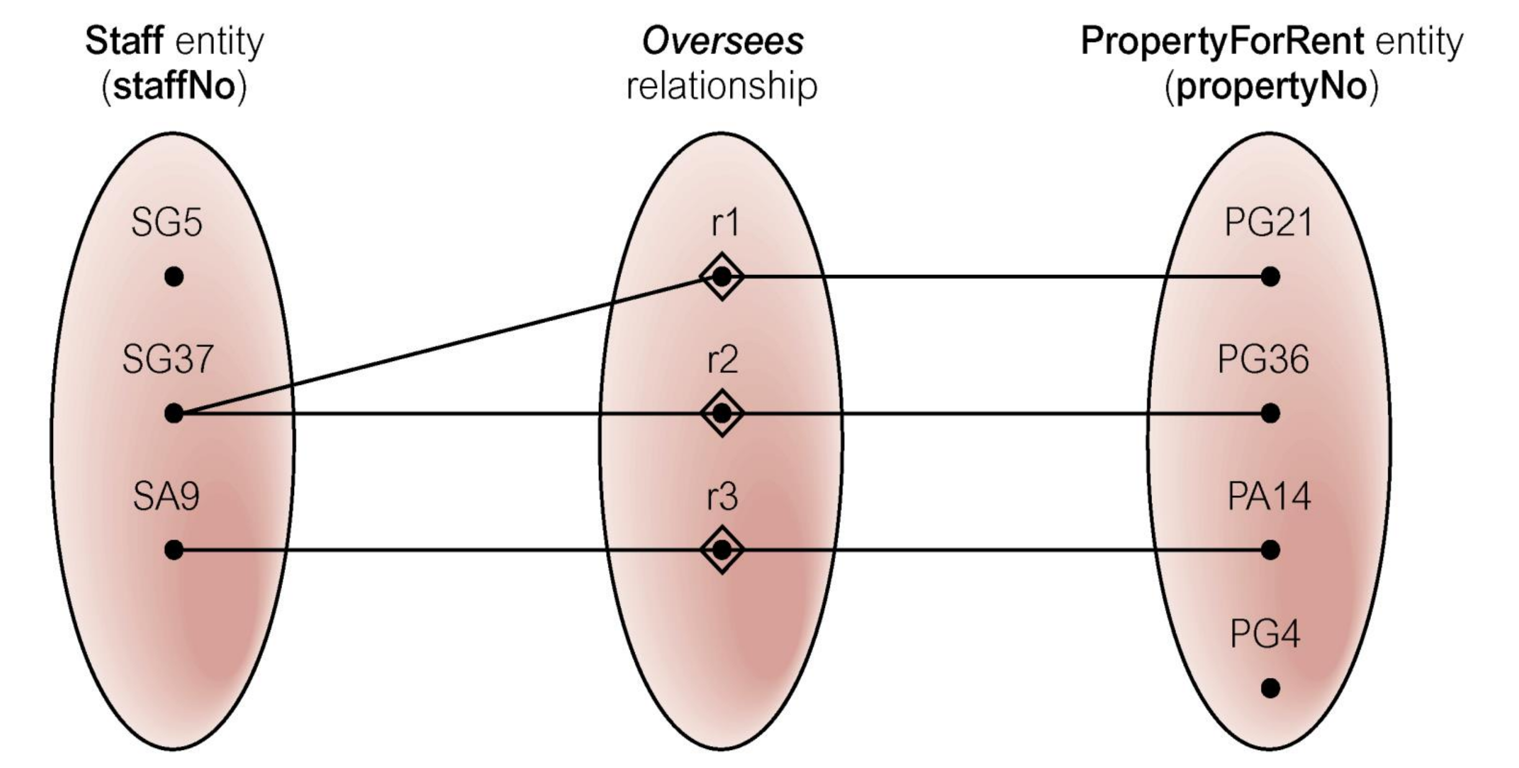
Semantic net of Staff *Manages* Branch relationship type



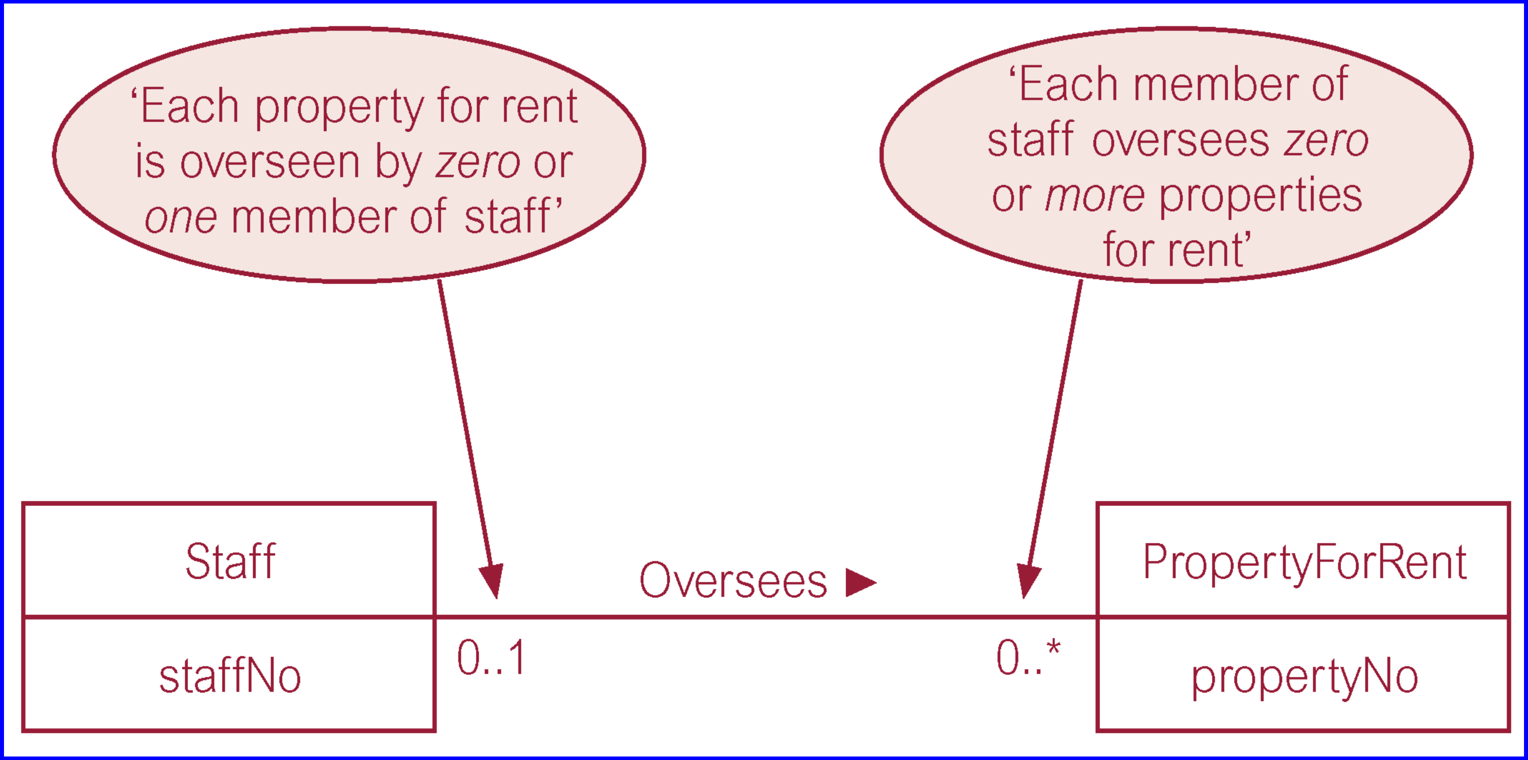
Multiplicity of Staff *Manages* Branch (1:1) relationship


'Each branch is managed by *one* member of staff'
'A member of staff can manage *zero* or *one* branch'
Staff
staffNo
Manages ▶
1..1
0..1
Branch
branchNo
Multiplicity

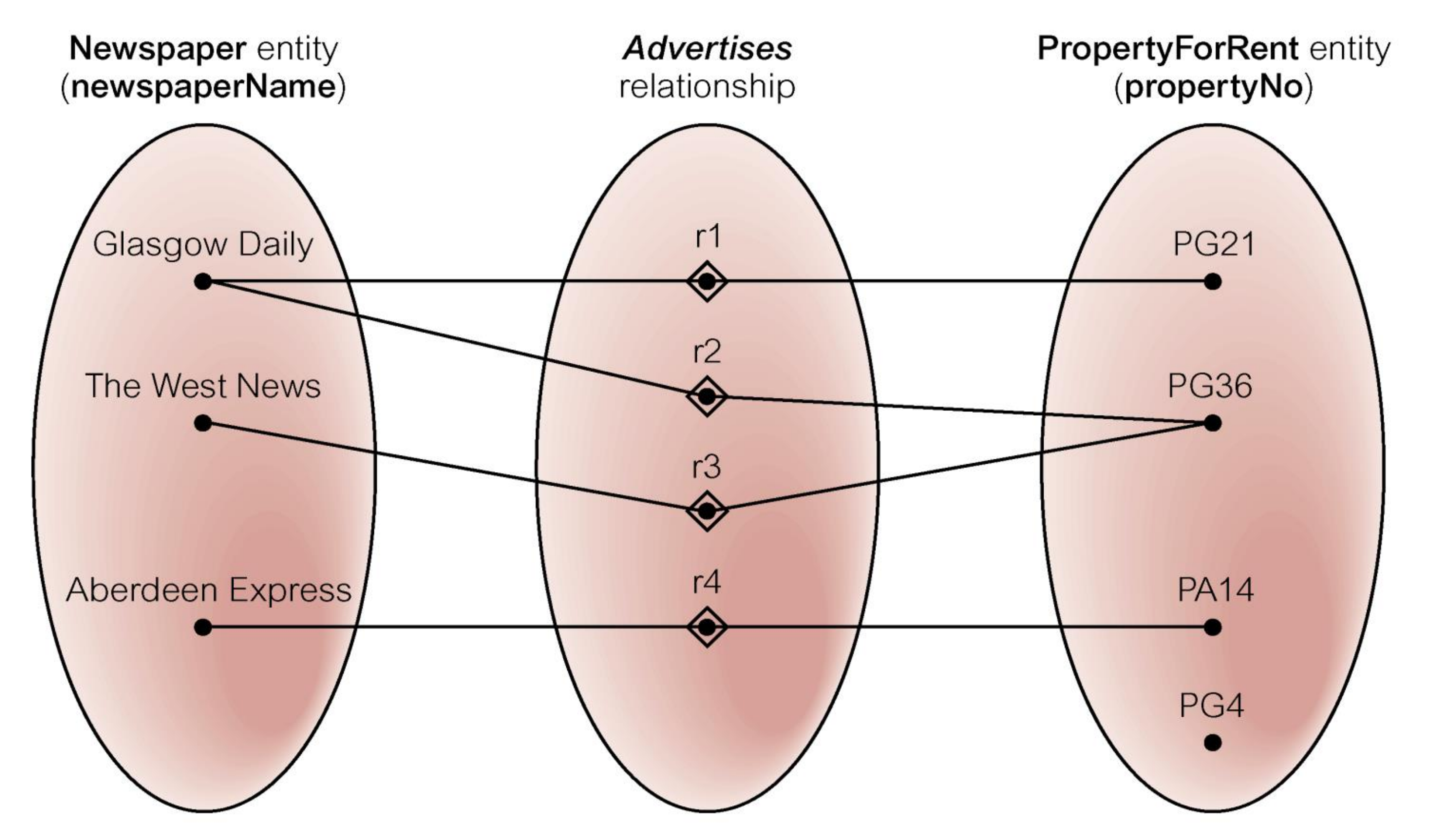
Semantic net of Staff *Oversees* PropertyForRent relationship type



Multiplicity of Staff *Oversees* PropertyForRent (1:*) relationship type

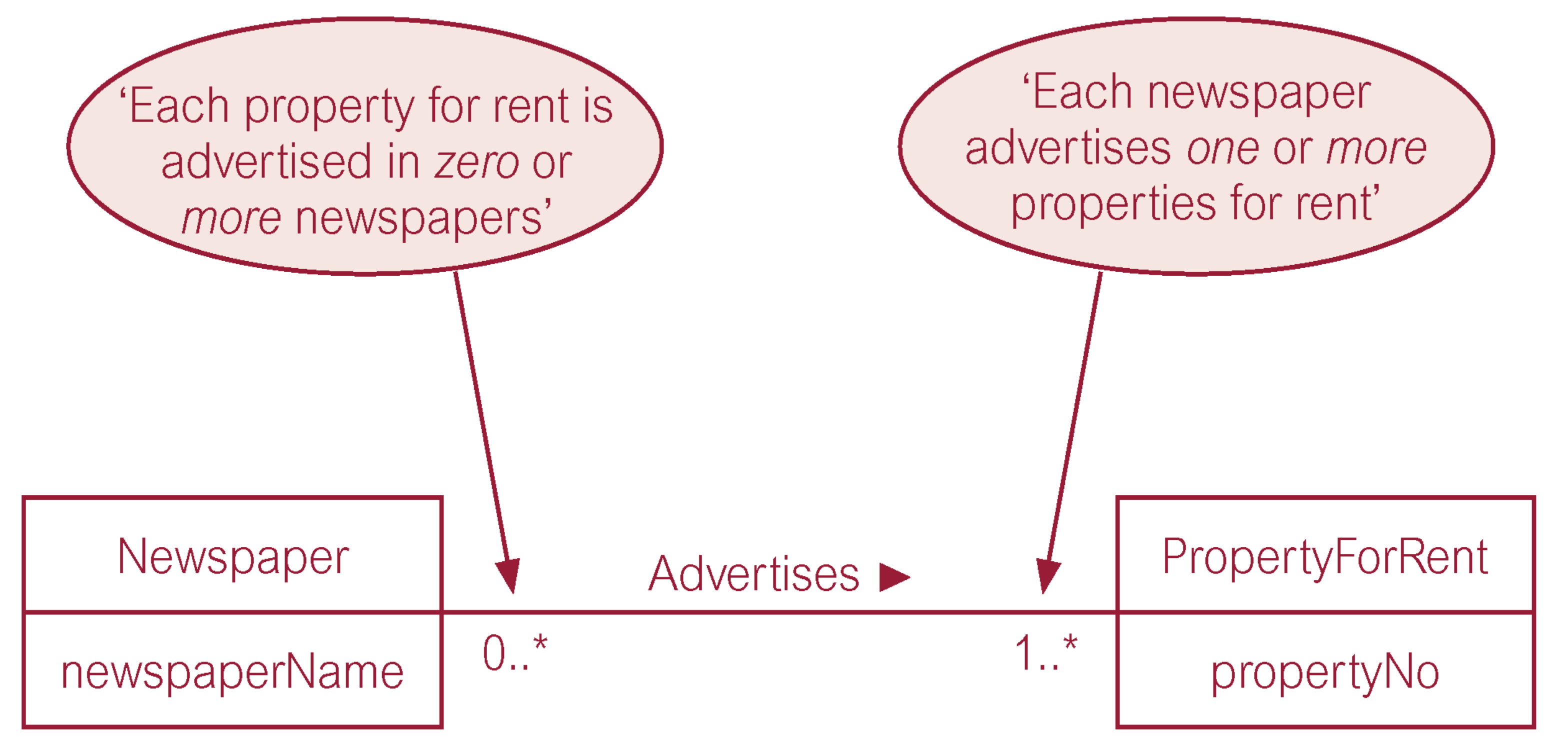

‘Each property for rent is overseen by *zero* or *one* member of staff’
‘Each member of staff oversees *zero* or *more* properties for rent’
Staff
staffNo
Oversees ►
0..1
0..*
PropertyForRent
propertyNo

Semantic net of Newspaper *Advertises* PropertyForRent relationship type



Newspaper entity (**newspaperName**)
Advertises relationship
PropertyForRent entity (**propertyNo**)
Glasgow Daily
The West News
Aberdeen Express
r1
r2
r3
r4
PG21
PG36
PA14
PG4

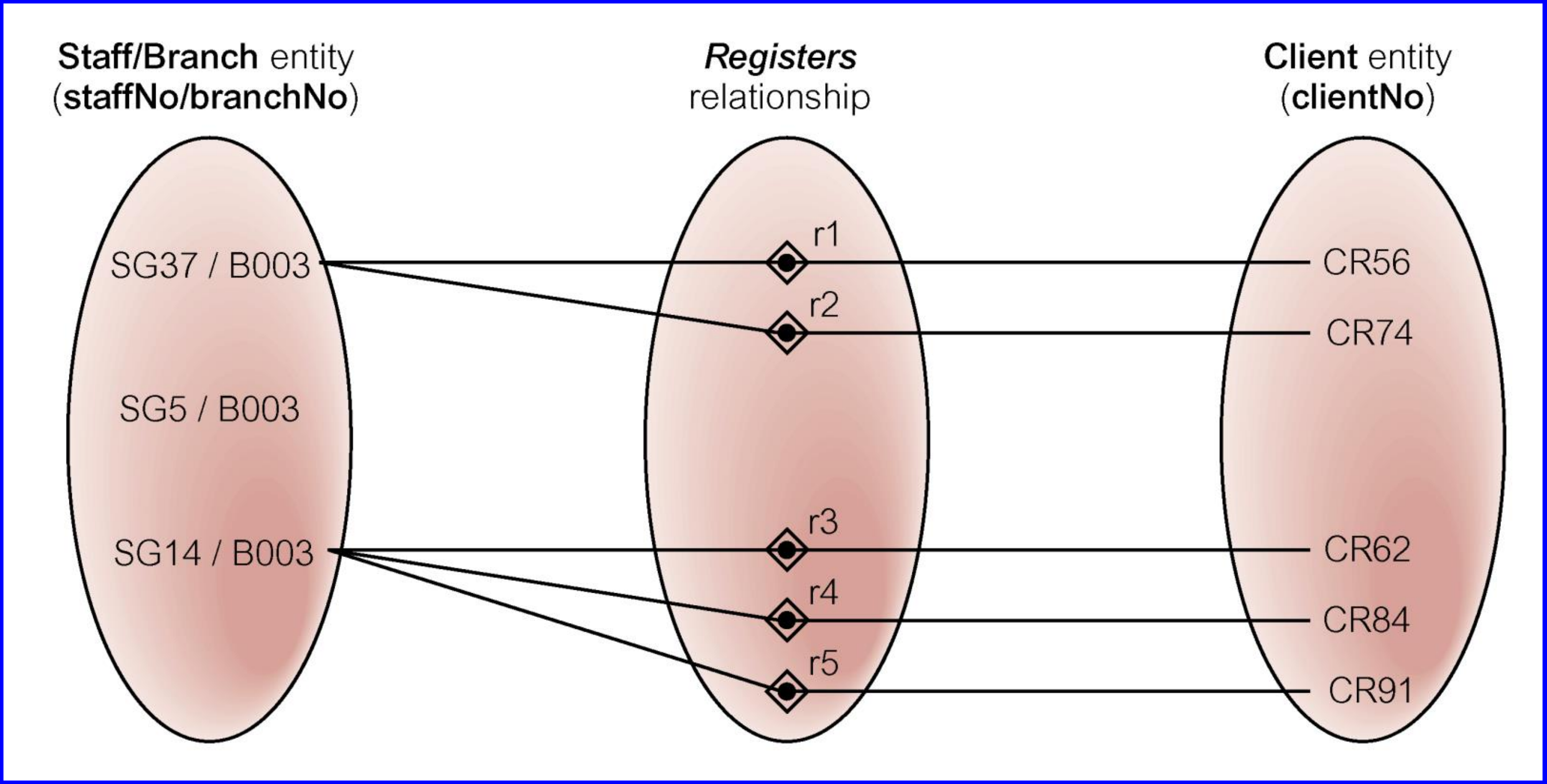
Multiplicity of Newspaper *Advertises* PropertyForRent (*:*) relationship


‘Each property for rent is advertised in *zero* or *more* newspapers’
‘Each newspaper advertises *one* or *more* properties for rent’
Newspaper
newspaperName
Advertises ►
0..*
1..*
PropertyForRent
propertyNo

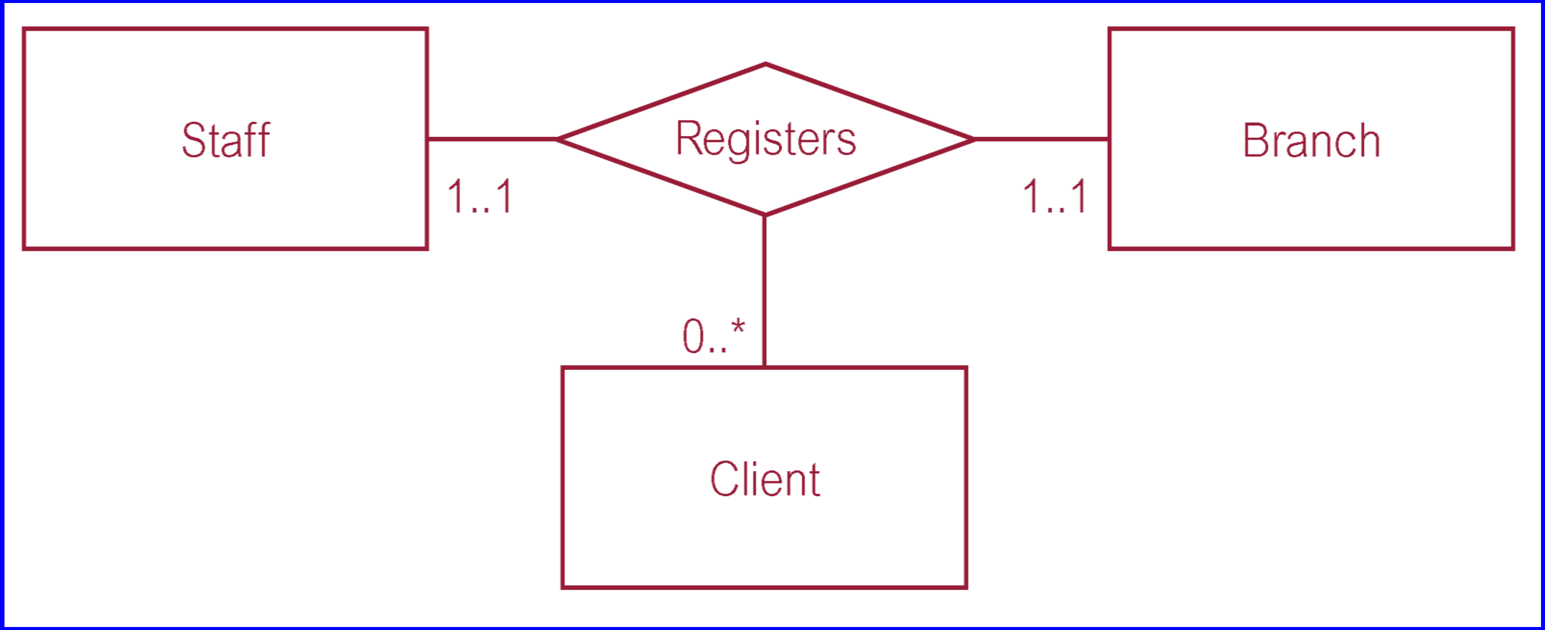
Structural Constraints

- **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.**

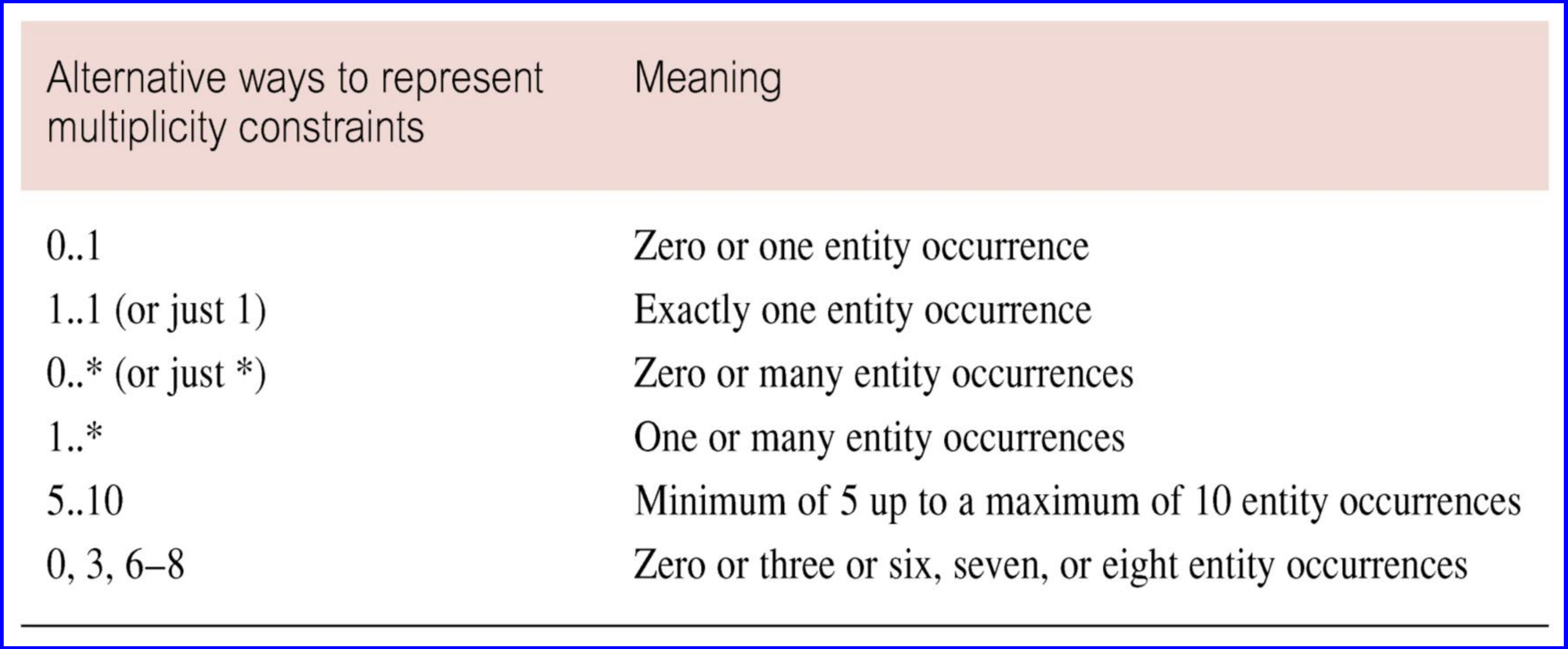
Semantic net of ternary *Registers* relationship with values for Staff and Branch entities fixed



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

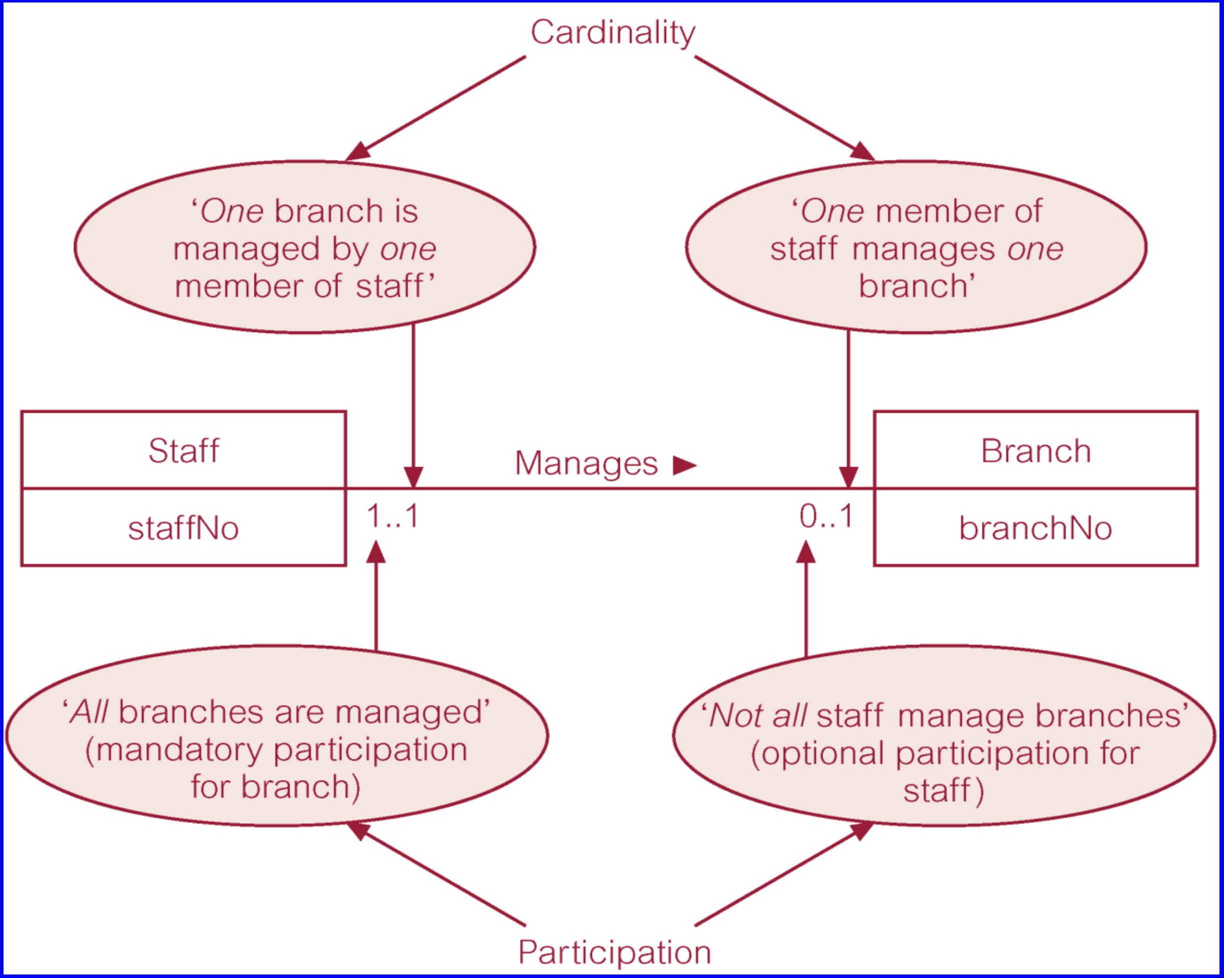
Structural Constraints

- **Multiplicity is made up of two types of restrictions on relationships: *cardinality* and *participation*.**

Structural Constraints

- 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


Cardinality
'*One* branch is managed by *one* member of staff'
'*One* member of staff manages *one* branch'
Staff
staffNo
Manages ►
Branch
branchNo
1..1
0..1
'*All* branches are managed' (mandatory participation for branch)
'*Not all* staff manage branches' (optional participation for staff)
Participation

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.

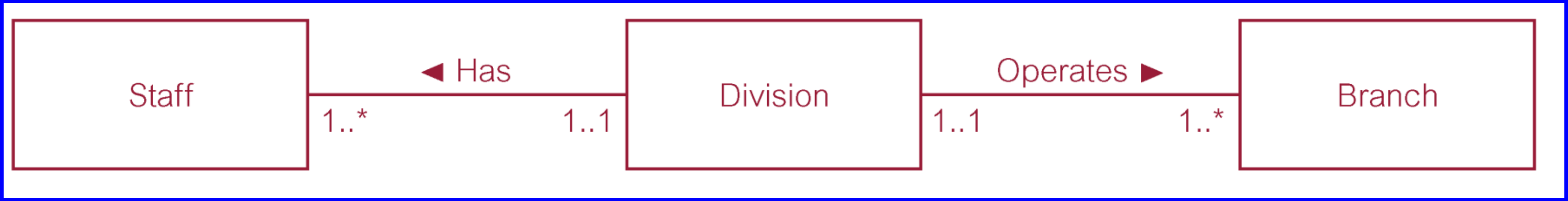
- Two main types of connection traps are called *fan traps* and *chasm traps*.

Problems with ER Models

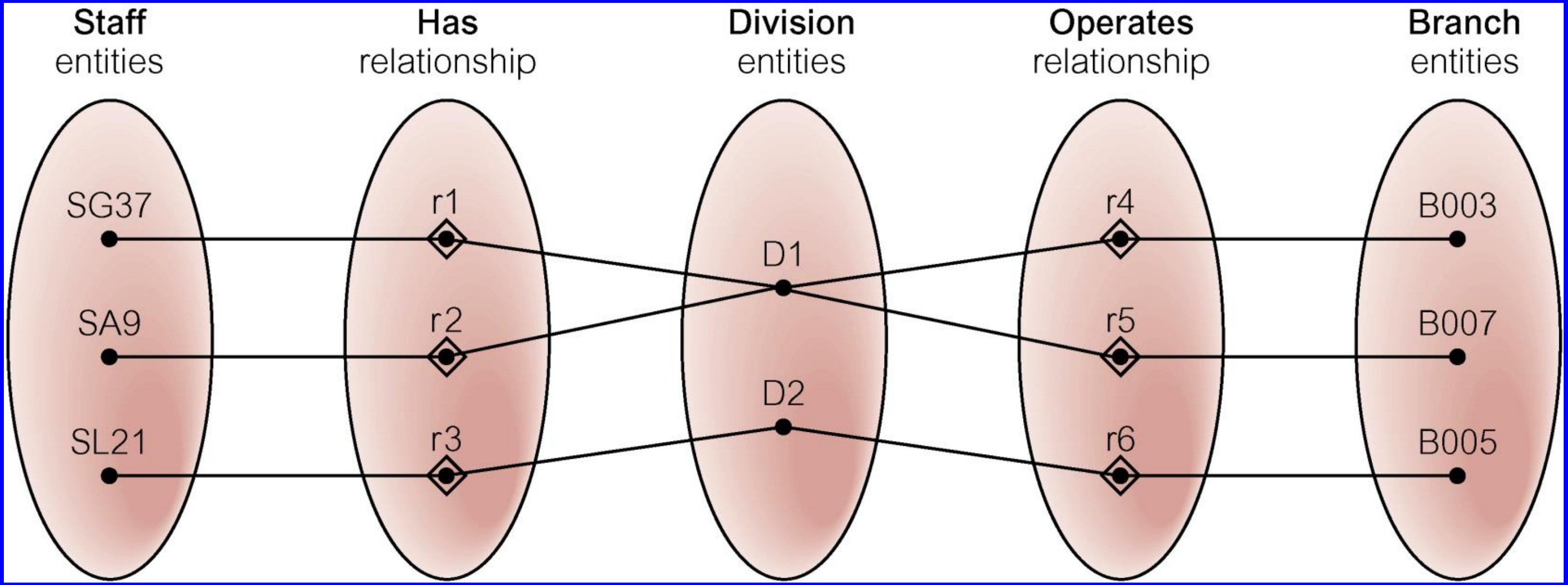
- Fan Trap
  - Where a model represents a relationship between entity types, but pathway between certain entity occurrences is ambiguous.

- 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

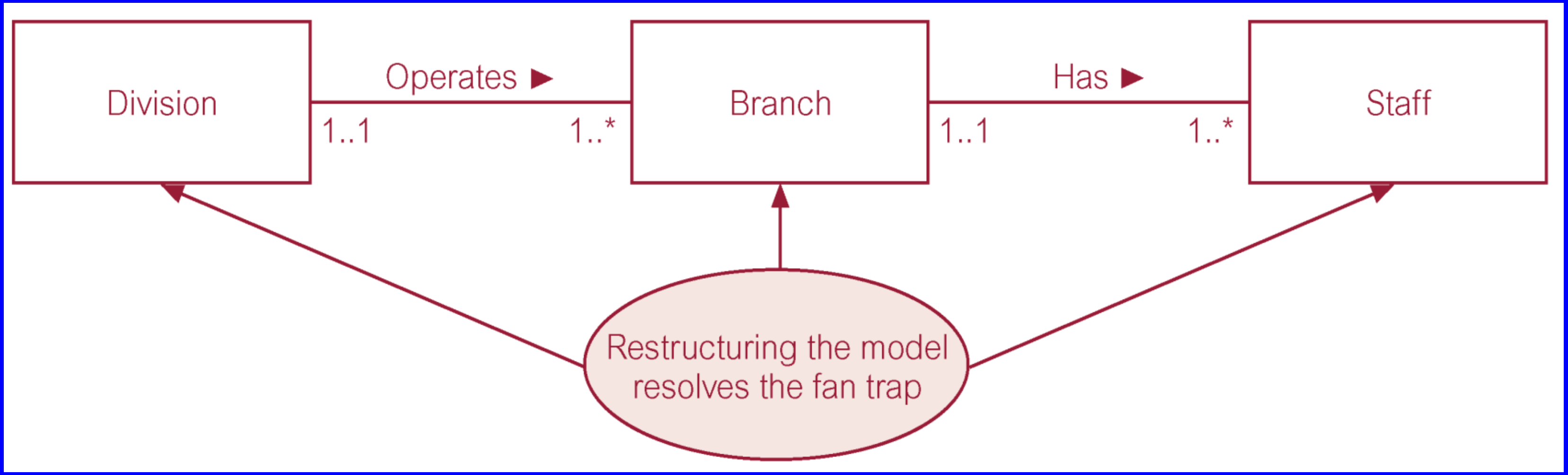


Semantic Net of ER Model with Fan Trap

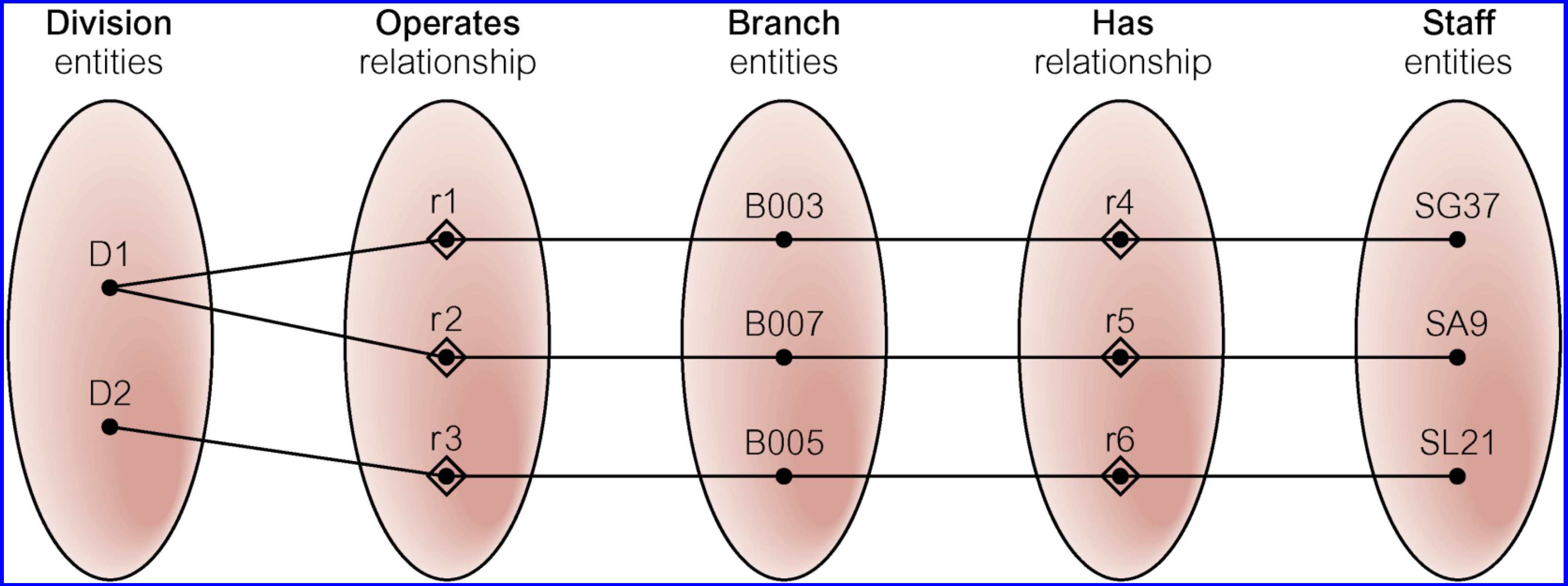


- **At which branch office does staff number SG37 work?**

Restructuring ER model to remove Fan Trap



Semantic Net of Restructured ER Model with Fan Trap Removed



- SG37 works at branch B003.

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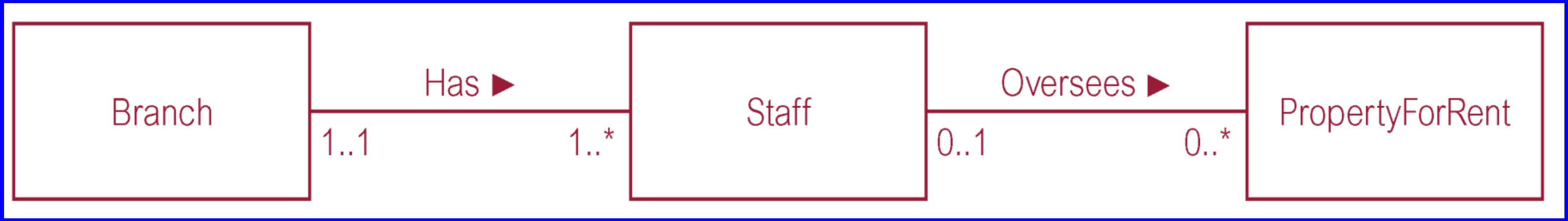
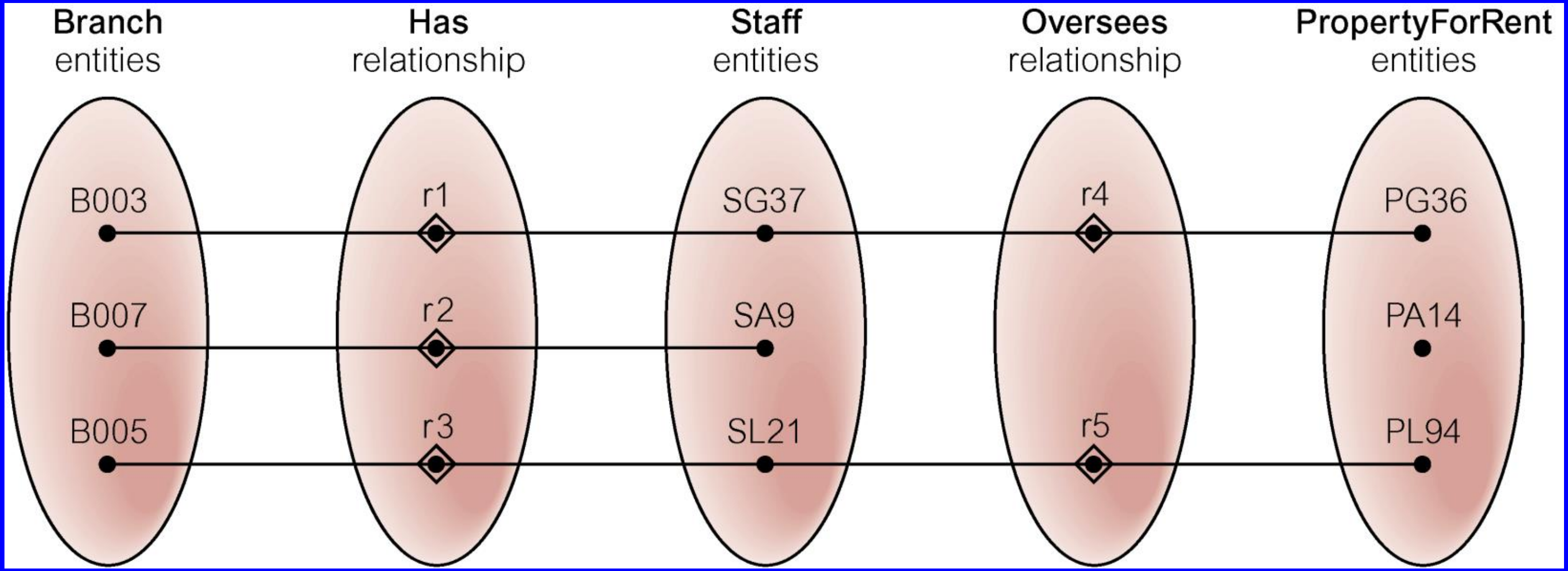
An Example of a Chasm Trap



Semantic Net of ER Model with Chasm Trap



- At which branch office is property PA14 available?

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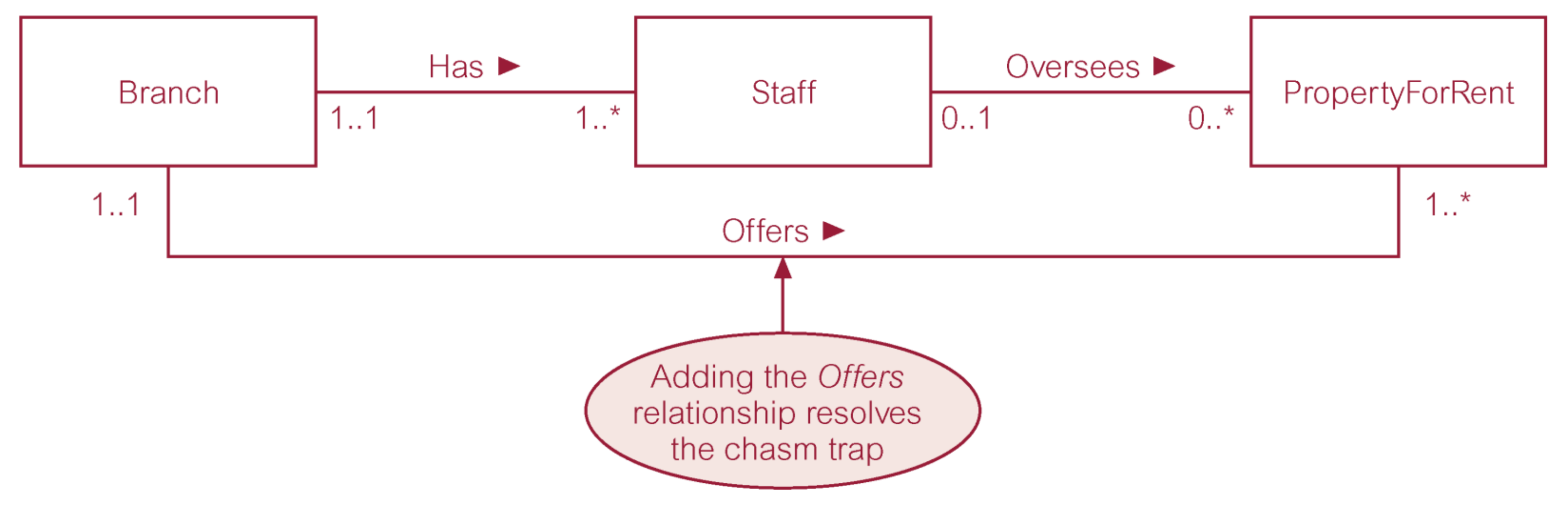
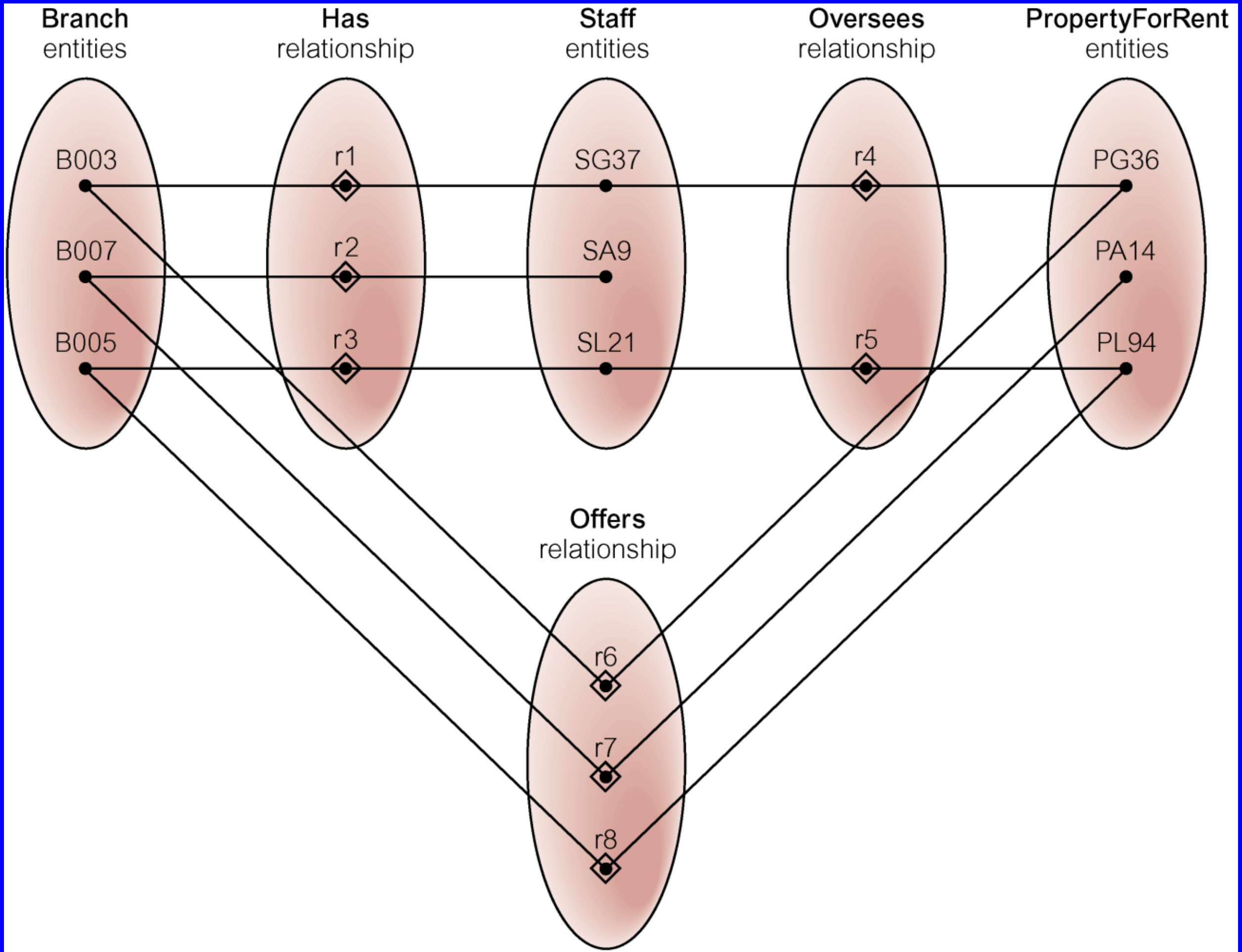
ER Model restructured to remove Chasm Trap



Semantic Net of Restructured ER Model with Chasm Trap Removed



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