Databases with *MYSQL*

3. Entity-Relationship Diagram

Dante – Digital Area for Networking Teachers and Educators

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Learning Outcomes

After this lesson, the learner will be able to conduct a Requirements Analysis of a system to design a Relational Database using the Development Methodologies of the Entitity-Relationship Model. The learner should be able to conduct the following activities:

- Identifying Entities
- Identifying Attributes
- Identifying Keys (Primary, Foreign)
- Identifying Subsets of Entities
- Occurrence Diagram
- Cardinality Analysis
  - 1:1 Relationship
  - 1:N Relationship
  - M:N Relationship
- Identifying Participation

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Database Design

Bottom-Up

1. **Normalization**;
2. Relational Model
   (Small projects, 6-10 tables)

Top-Down

1. **Entity-Relationship**;
2. Cardinality and participation analysiss;
3. Relational Model
   (Large Projects)

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Entity-Relationship Diagram (ERD)

- Most used methodology for top-down development (development from the general to the particular), because it starts by identifying the main objects of the system, and only then identifies the interactions between them and their properties.
- It is used to interpret, specify, and document the needs for processing the database.
- The ERD was introduced by Peter Chen in 1976 and has undergone many changes since then.

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Entity-Relationship Diagram (ERD)

- An E-R model is a logical model based on objects: entities and relationships between entities.

- For a good understanding of this model, it is necessary to define the terms **entity**, as well as **attribute**, **identifier** and **relationship**.

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Entity-Relationship (E-R) Model Relationships within Relational Database

- Relationship classifications
  - 1:1
  - 1:M
  - M:N

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Entity-Relationship Diagram (ERD) Symbols

- Rectangles represent entities
- Diamonds represent the relationship(s) between the entities
- "1" side of relationship
  - Number 1
  - "Many" relationships
  - Letter "M" and "N"

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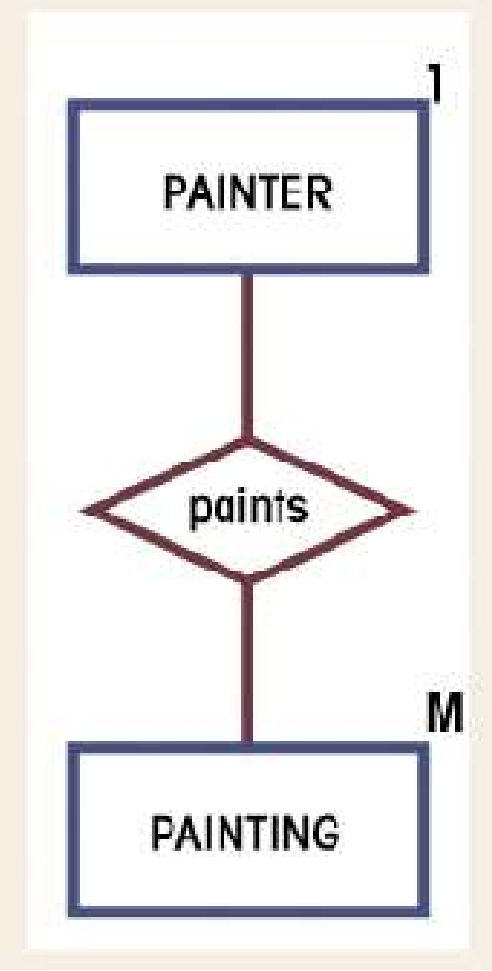
Example 1:M Relationship



One Painter Paints many Paintings

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Example 1:M Relationship

Table name: PAINTER
Primary key: PAINTER_NUM
Foreign key: none

Database name: CH2_MUSEUM

PAINTER_NUM	PAINTER_LNAME	PAINTER_FNAME	PAINTER_INITIAL
123	Ross	Georgette	P
126	Itero	Julio	G

link

Table name: PAINTING
Primary key: PAINTER_NUM
Foreign key: PAINTER_NUM

PAINTING_NUM	PAINTING_TITLE	PAINTER_NUM
1338	Dawn Thunder	123
1339	Vanilla Roses To Nowhere	123
1340	Tired Flounders	126
1341	Hasty Exit	123
1342	Plastic Paradise	126

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Example M:N Relationship

One student has many classes and one class has many students

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Example M:N Relationship

Database name: CH2_TEXT

Table name: STUDENT_FIG2_24

STU_NUM	STU_LNAME	CLASS_CODE
321452	Bowser	10014
321452	Bowser	10018
321452	Bowser	10021
324257	Smithson	10014
324257	Smithson	10018
324257	Smithson	10021

Table name: CLASS_FIG2_24

CLASS_CODE	STU_NUM	CRS_CODE	CLASS_SECTION	CLASS_TIME	CLASS_ROOM	PROF_NUM
10014	321452	ACCT-211	3	TTh 2:30-3:45 p.m.	BUS252	342
10014	324257	ACCT-211	3	TTh 2:30-3:45 p.m.	BUS252	342
10018	321452	CIS-220	2	MWF 9:00-9:50 a.m.	KLR211	114
10018	324257	CIS-220	2	MWF 9:00-9:50 a.m.	KLR211	114
10021	321452	QM-261	1	MWF 8:00-8:50 a.m.	KLR200	114
10021	324257	QM-261	1	MWF 8:00-8:50 a.m.	KLR200	114

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Entity Relationship Diagram

- Shows entities – similar to a table structure
- An entity is an object that exists and is distinguishable from other objects. It is anything such as a person, place, thing or event about which data are to be collected and stored
- An entity is represented by a set of attributes
- An attribute has a domain (i.e. a set of permitted values)
- Entities are associated by relationships

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Identifying Keys

- A key is used to identify and locate the information contained in a particular record
- A key consists of one or more attributes that determine other attributes
- Two types of keys we will address: *Primary Key* and *Foreign Key*

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Requirements Analysis
Analysis of the situation to be addressed

Types of Actions:

- User interviews;
- Observations on the forms and reports used in the current system;
- Analysis of existing files and databases.

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Requirements Analysis
Analysis of the situation to be addressed

- Two different approaches: from particular to general / from general to particular (bottom-up/top-down)
- From the general to the particular an overview of the system in a narrative way in order to find all the entities involved in the system.
- From the particular to the general, it uses sample screens and reports to find attributes that are later grouped into entities.

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Identifying Entities

From the general to the particular (**Top-Down)**

- Through a description of the system's functionality overview, a list of the necessary entities for the system is compiled;
- An entity can be a person, place, event or something for which it is necessary to store data;
- At this stage, the characteristics of the entities found must be ignored (eg, if data on the supplier is required, ignore the supplier's name, taxpayer number, address, etc.)

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Identifying Entities

Example: From the general to the particular (**Top-Down)**

Through the following text let´s identify the necessary entities.

A librarian needs to know information about borrowing books from the library. It is necessary to know which books are lent to readers, through the reader's name or reader number. It is also necessary to know which books exist by category (such as fantasy, children's, reference etc). It should also be possible to search for books by their title.

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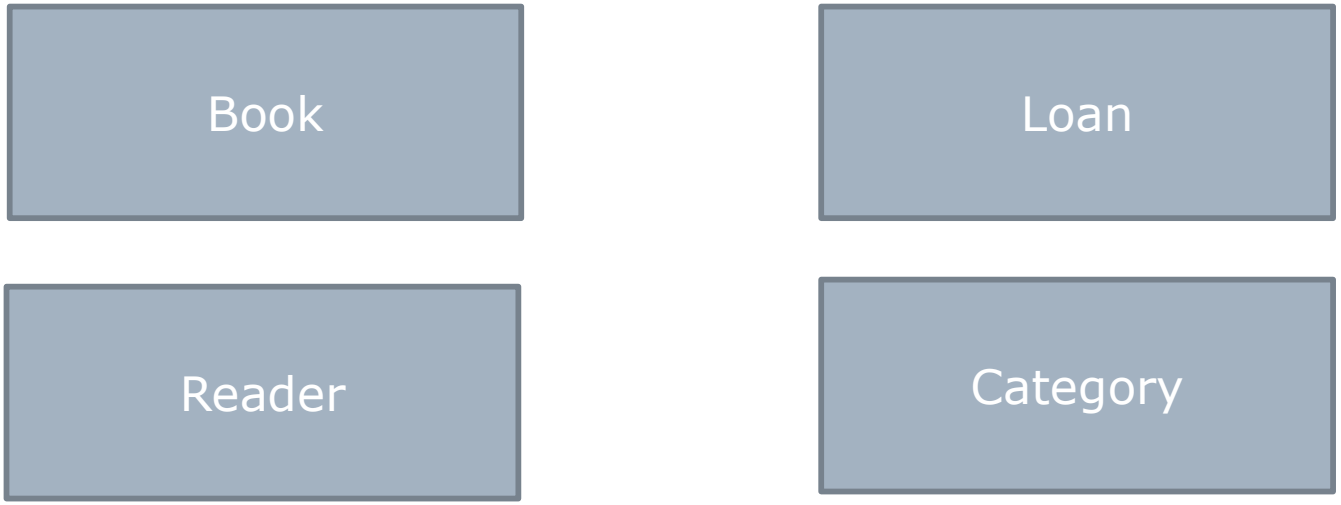
Identifying Entities

We can identify following entities:



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Attributes

- Attributes are characteristics of Entities.
- They *describe* an entity
- Attributes have a Domain

example: CLIENT_NAME

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Discovering Attributes

1. A composer writes/creates many compositions.
2. The composer includes the name, country, year of birth, year of death and era (e.g. classical, baroque, romantic, or modern).
3. The composition includes a title, type of composition (symphony, concerto, instrumental, chamber, opera, or choral)

Attributes – because these *describe* the entity

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Discovering Attributes

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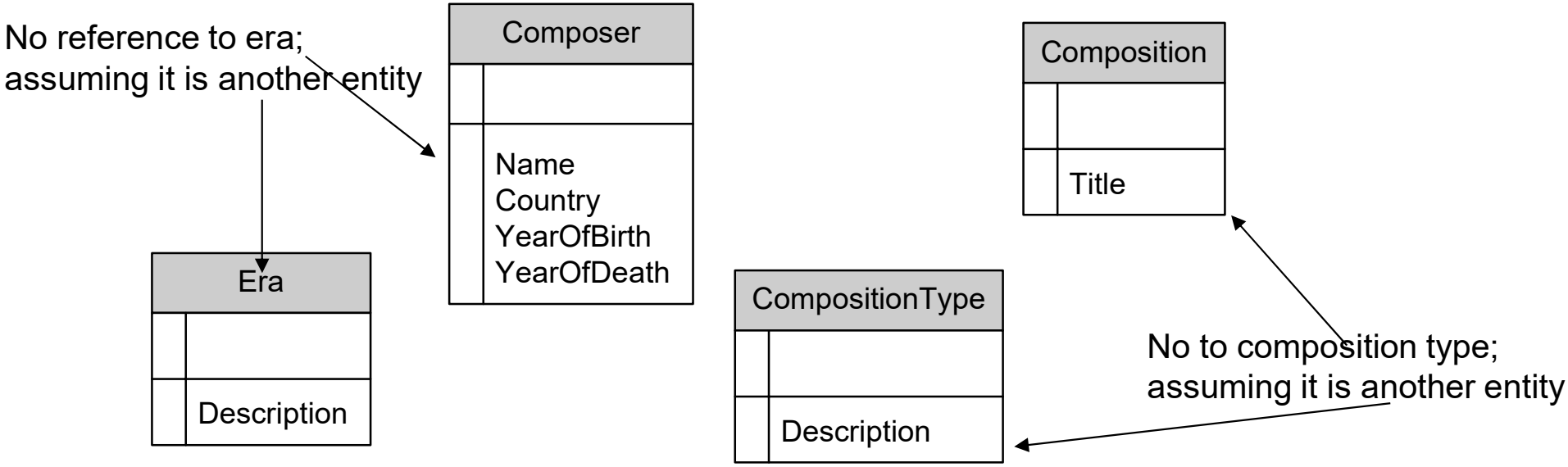

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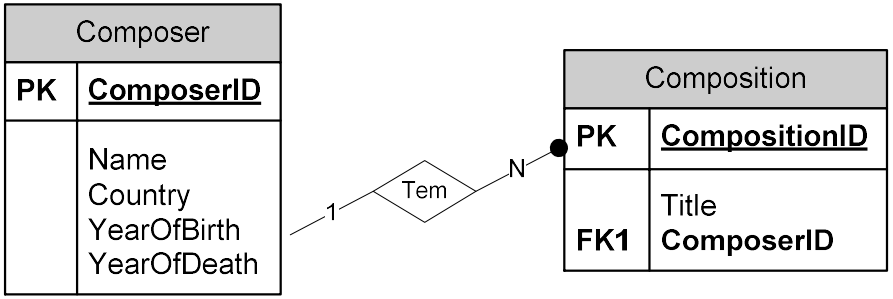
Identifying Keys

- Primary Key
  - *Uniquely* identifies any given entity

ComposerID could uniquely identifyies Composer and therefore is a candidate to be a primary key it is also a foreign key in Composition

CompositionID could uniquely identify Composition and therefore is a candidate to be a primary key



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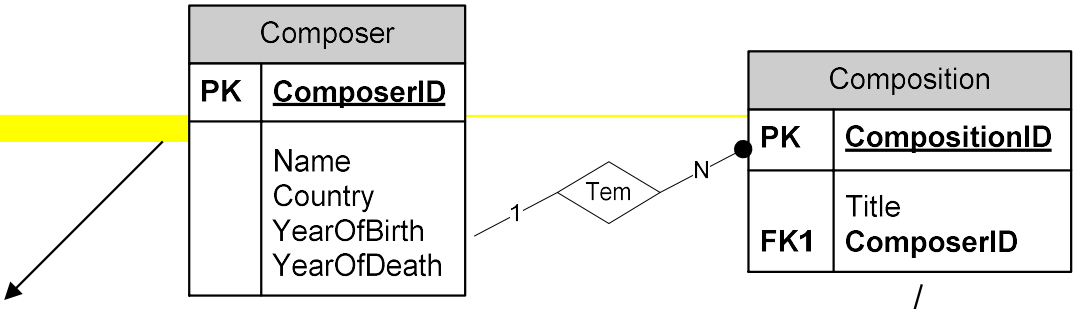
Relational Model



ComposerID	Name	Country	YearOfBirth	YearOfDeath
B33	Johann Sebastian Bach	Germany	1685	1750
B76	Ludwig van Beethoven	Germany	1770	1827
B90	Irving Berlin	America	1888	1989
B113	Johannes Brahms	Germany	1833	1897
G18	George Gershwin	America	1898	1937
G80	Orlando Gibbons	England	1583	1625

Primary keys are obvious – they uniquely identify a row.

Foreign keys are obvious – they reference a field (column) in another table.

CompositionID	Title	ComposerID
111	Rhapsody in Blue	G18
222	Second Rhapsody	G18
333	Academic Festival Overture	B113
444	Tragic Overture	B113
555	Ein deutsches Requiem	B113

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Practice

Multiple Real Estate Listing Service (MRELS) is a company that has offices throughout Europe. These offices have a number of Real Estate agents working for them. MRELS deals in both residential and commercial real estate. Agents work with customers to get a listing or to find a listing for a customer. A listing will include the address and the type of property (residential or commercial), square footage, annual taxes and closing date. If it is a residential property, it will include number of bedrooms, number of bathrooms, special features (central air, heated by gas or oil, radiators or forced air, for instance). For a commercial property, it will include number of offices as well as number of docking bays (where trucks back up to be loaded/unloaded).

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Identifying Entities and Attributes Example

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Identifying Entities and Attributes Example

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Subsets of Entities

There are cases where in the same system the same entity can be treated in different ways, that is, there are different subsets of the same entity.

These subsets may have different attributes and different relationships with other entities.

Example:
A property can be a commercial property or a residential property.

The data processing of these two types of properties is different, it can be determined that the property entity has two different subsets (roles), Commercial and Residential. The way to represent roles is through lines with arrows from the source entity to the different subsets.

The source entity, which in this case is the property, will keep all the attributes common to Residential and Commercial and its identifier (primary key) is the property code. Each of the subsets must also keep the property code as its primary key, despite having other specific attributes.

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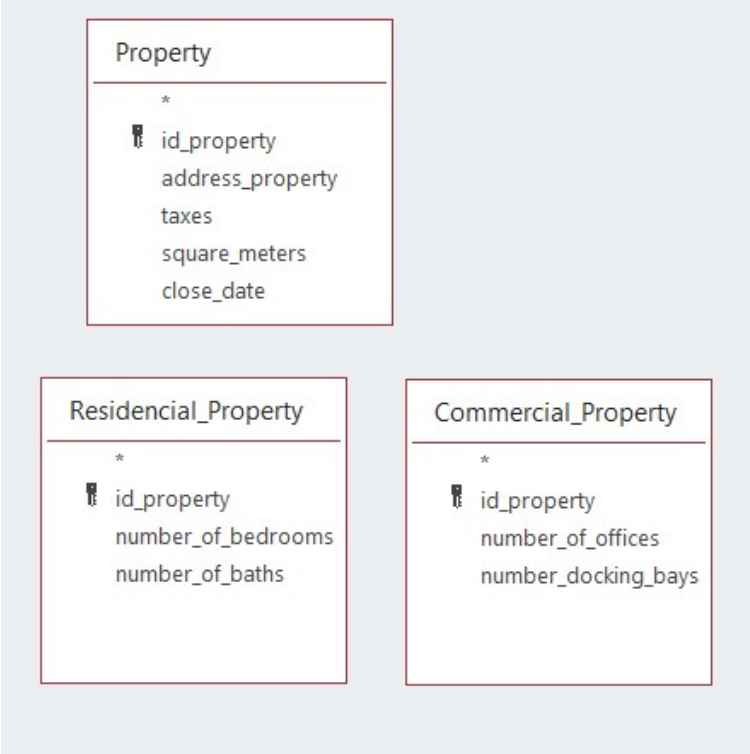
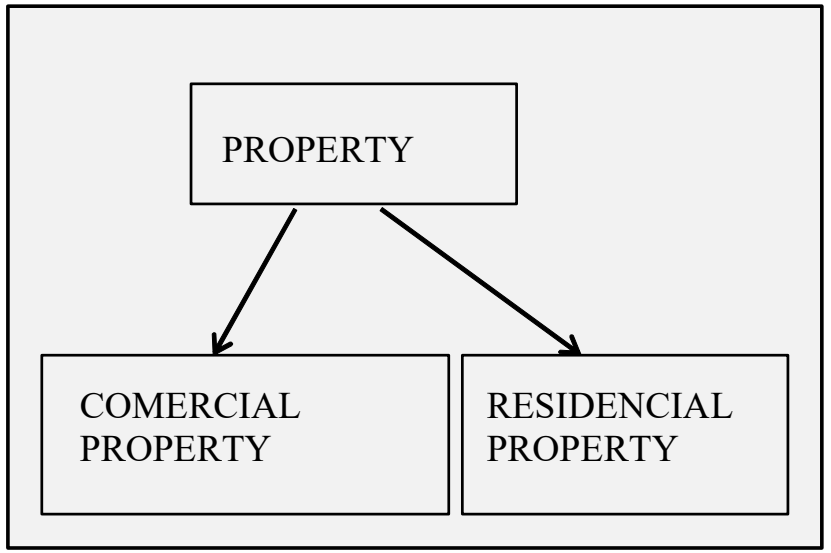
Subsets of Entities - Example

The entities that represent the subsets are treated as normal entities, to which the already known rules apply.

Sub-entities have the same primary key as the source entity.





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Cardinality of Relationships

- **1:1 Relationship**
  An instance of an entity can only be related to an instance of another entity and vice versa.

- **1:N Relationship**
  An instance of an entity (a) can be related to several instances of another entity (b).

- **M:N Relationship**
  Each instance of an entity (a) can be related to several instances of another entity (b) and vice versa.

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Occurrence Diagram Cardinality Analysis

Through the occurrence diagrams, the cardinality of the relationships can be determined, which defines the number of relationships between two entities (1:1, 1:N, M:N).

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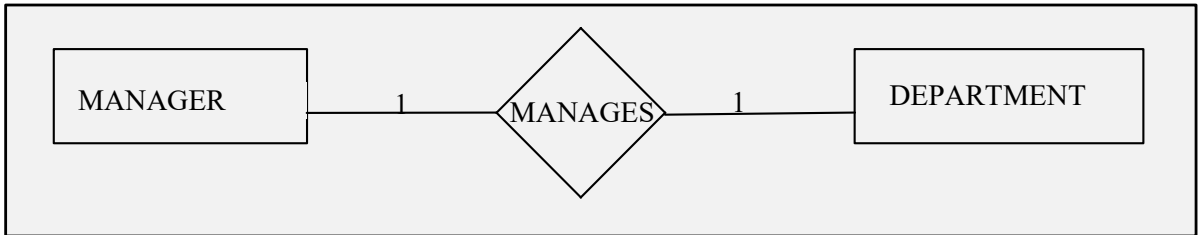
Identifying Cardinality

If an employee is a manager, then he can manage only one department and a department can only be managed by one manager



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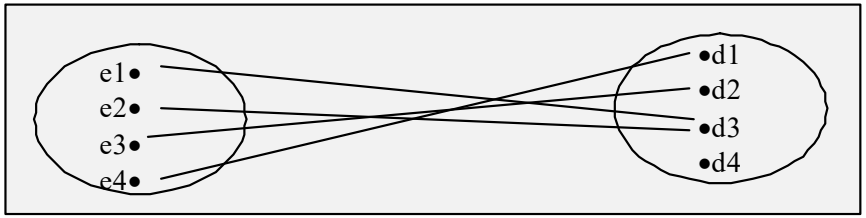
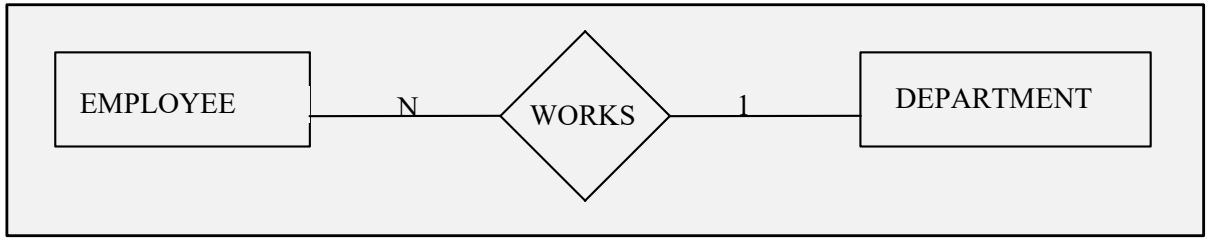
Identifying Cardinality

There are many employees in each department. However, each employee can only work in one department.





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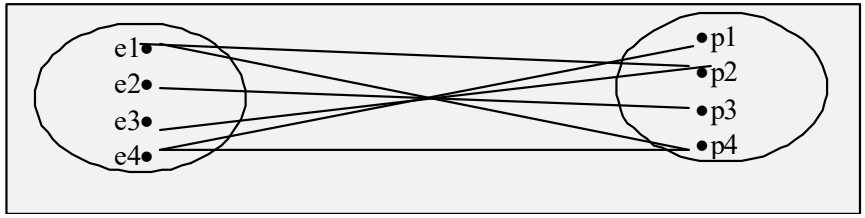
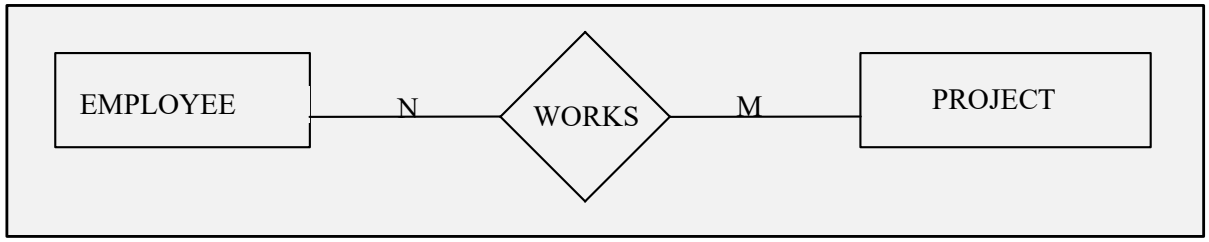
Identifying Cardinality

One employee can work on several projects and each project can have several employees working on each project.





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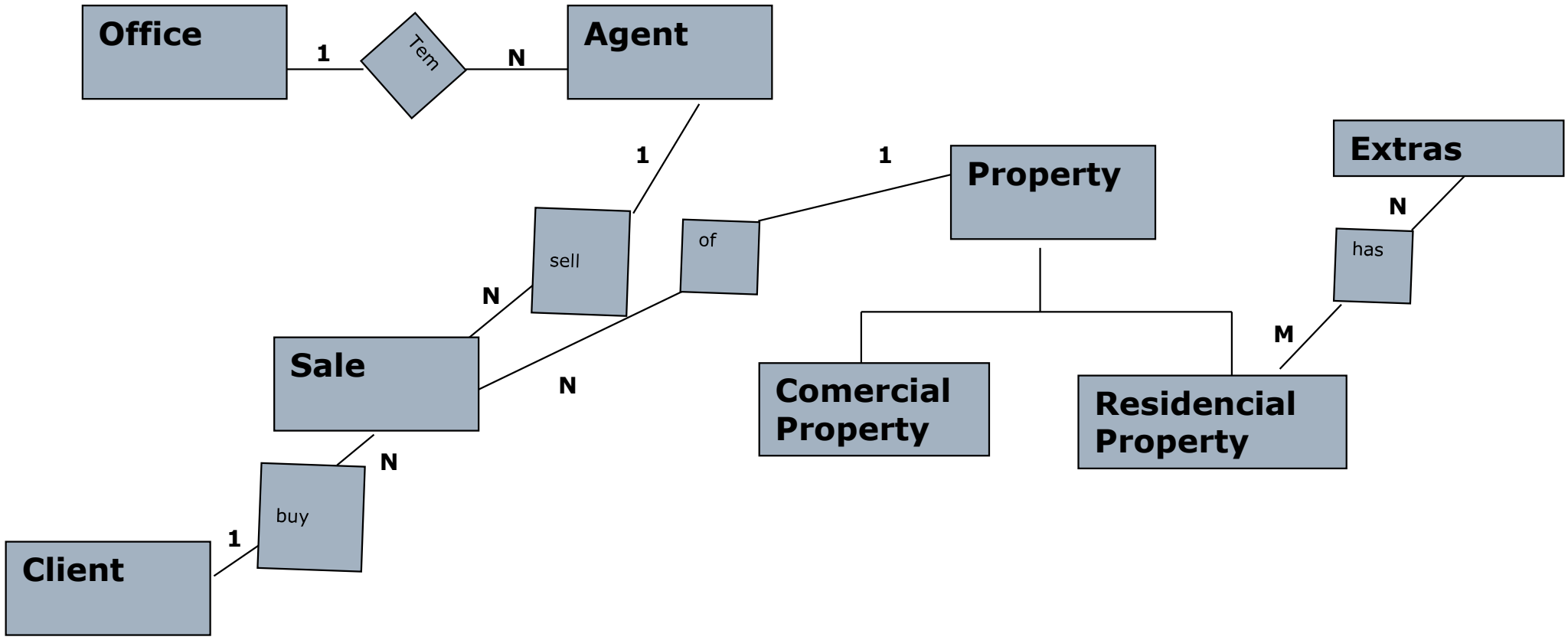
Determine Relationships - Example



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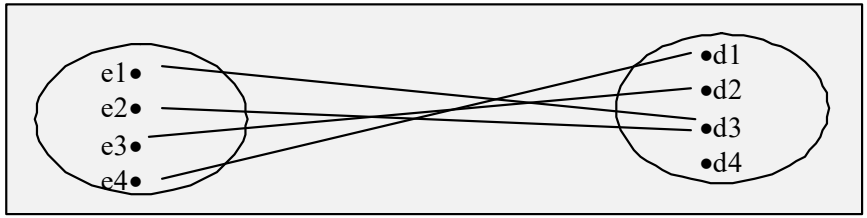
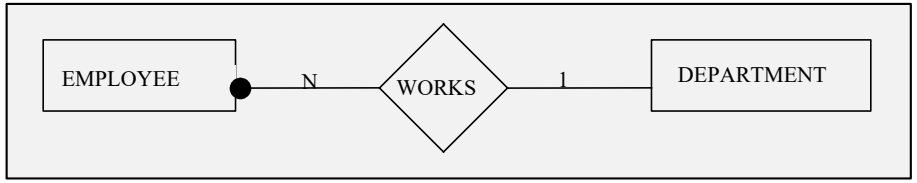
Determine Participation

- Participation restrictions specify whether the existence of an entity depends on its being related to another entity. Participation can be mandatory or optional.
- Mandatory : All occurrences of participate in at least one relationship.
- Optional: Only certain occurrences participate in the relationship.





Each employee is assigned to a department, but the department may not have employees. Represented by a closed circle.

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Determine Participation - Example