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200
1822 - 2022

Entity Relationship modelling

Man Geni Addysg Uwch yng Nghymru
Where Higher Education Began in Wales

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So far

- Understand the concept – DBMS
- Identify different types of databases
- Components of DBMS
- DBMS system Architecture
- Relational Keys

Today's lesson

- **Entity, Entity Set**
- **Kinds of Entities**
- **Types of Attributes**
- **Types of Relationships**
- **Mapping of ERD to tables**

Database Design Process

What happens after DB design is done? How apps use it, how to restrict access to relations and implement access rules

Analyse relations and identify any potential problems and refine it. **Normalisation** comes here

Develop high level description of **Data & its Constraints, ER modelling** comes here

Requirement Analysis → **Conceptual Design** → Logical DB Design → Schema Refinement → Physical DB Design → Application Security & Design

Understand the application, identify **what data** & **what operations** should be stored

Choose a **DBMS** to implement the design and **convert the ER model to DB Schema**

DB Design refined to ensure that it meets performance criteria. **Indexing, clustering etc** comes here

E-R Data Model

- **Three** principal element types:

Entity	Attributes	Relationships
• Entity-abstract object of some sort • Entity Sets-a collection of similar entities	• Properties of the entities in that set • Assumptions: attributes are of primitive types, such as strings, integers, or real numbers	• Connections among two or more entity sets

Entity, Entity Set and Entity Type

An ***entity*** is an object in the real world with an independent existence that can be differentiated from other objects. An entity might be

- An object with physical existence (e.g., a lecturer, a student, a car)
- An object with conceptual existence (e.g., a course, a job, a position)

Entity

Objects in real life that are distinguishable from other objects.

Usually nouns in a scenario description but not every noun becomes an entity – think carefully when you finalize on the entities

Question: If you are building a data model for a **small retail store**, then the potential entities may be ?

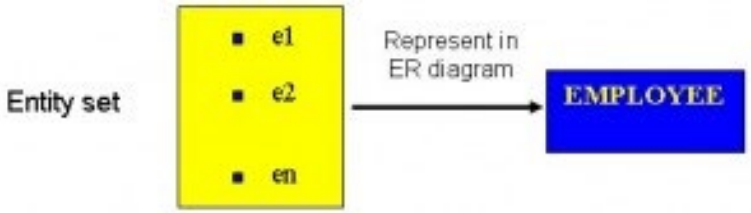
Entity

- If you are building a data model for a small retail store, then the potential entities may be
    - Products
    - Suppliers
    - Customers
    - Employees
    - Inventory
    - Orders
    - Promotions/Discounts

Entity, Entity Set

An ***entity set*** is a collection of entities of an entity type at a particular point of time. In an entity relationship diagram (ERD), an entity type is represented by a name in a box. For example, the entity is EMPLOYEE.

EmployeeID	FirstName	LastName	DateOfBirth	Gender	Position	Department
1	John	Doe	1985-06-15	Male	Software Dev	IT
2	Jane	Smith	1990-09-20	Female	Data Analyst	IT
3	Mike	Brown	1988-12-05	Male	HR Manager	Human Resources
4	Emily	Davis	1992-02-10	Female	Accountant	Finance
5	David	Wilson	1983-11-25	Male	Project Manager	Operations



Entity – Notation

- **Entity Instance:** Values associated with the entities. (rows in the table at a given point in time)

Notation: ***rectangle*** labelled with the name of the entity.

Notation for an Entity

Identify the Entity & entity sets from the data below;

Movie

MovieID	Title	ReleaseDate	Duration	Rating	GenreID	DirectorID
1	Inception	2010-07-16	148	8.8	1	1
2	The Dark Knight	2008-07-18	152	9.0	2	1
3	Interstellar	2014-11-07	169	8.6	1	1
4	Titanic	1997-12-19	195	7.8	3	2

Actor

ActorID	FirstName	LastName	DateOfBirth	Nationality
1	Leonardo	DiCaprio	1974-11-11	American
2	Joseph	Gordon-Levitt	1981-02-17	American
3	Ellen	Page	1987-02-21	Canadian
4	Christian	Bale	1974-01-30	British
5	Kate	Winslet	1975-10-05	British

Kinds of Entities

You should also be familiar with different kinds of entities including independent entities, dependent entities and characteristic entities. These are described below.

Types of Entities

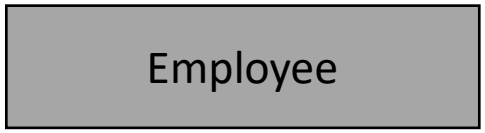
Regular Entities

- Called as Strong Entities.
- Independent Entities
- E.g. Employee

Weak Entities

- Its existence depends on some other entity
- E.g. EmployeeDependants
  - If an Employee Instance is deleted, then the dependants too are deleted. They do not exist without the employee.

Notation for a Regular Entity



Notation for a Weak Entity

Regular and Weak Entities

Example Data:

Student Table:

StudentID	FirstName	LastName	DateOfBirth	Email
1	John	Doe	2000-01-15	john.doe@example.com
2	Jane	Smith	1999-03-22	jane.smith@example.com

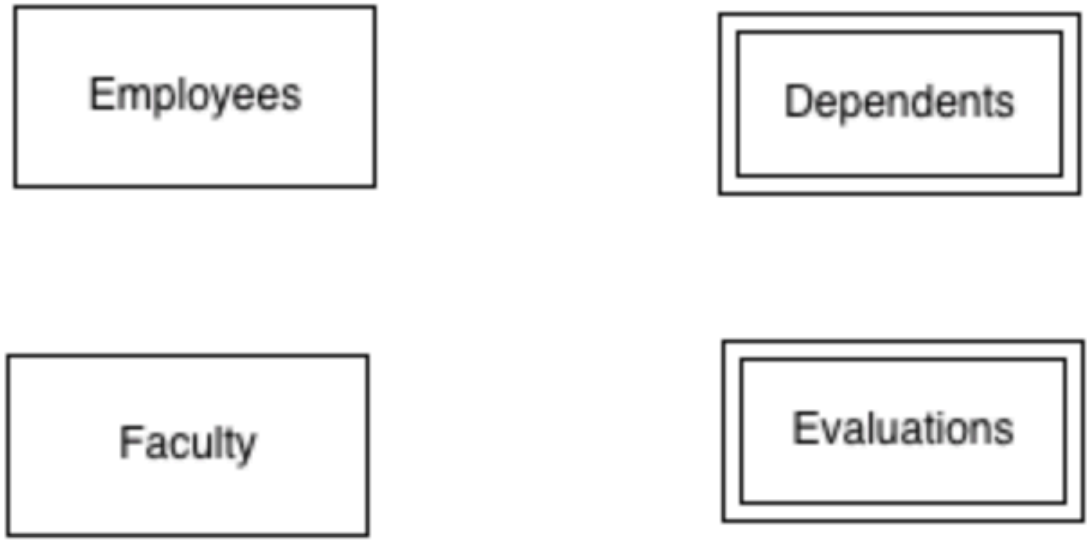
Course Table:

CourseID	CourseName	Credits	Department
101	Database Systems	4	Computer Science
102	Calculus I	3	Mathematics

Enrollment Table:

StudentID	CourseID	EnrollmentDate	Grade
1	101	2023-09-01	A
2	101	2023-09-01	B
1	102	2023-09-01	A-

Entities - Examples



Knowledge Check - Entities

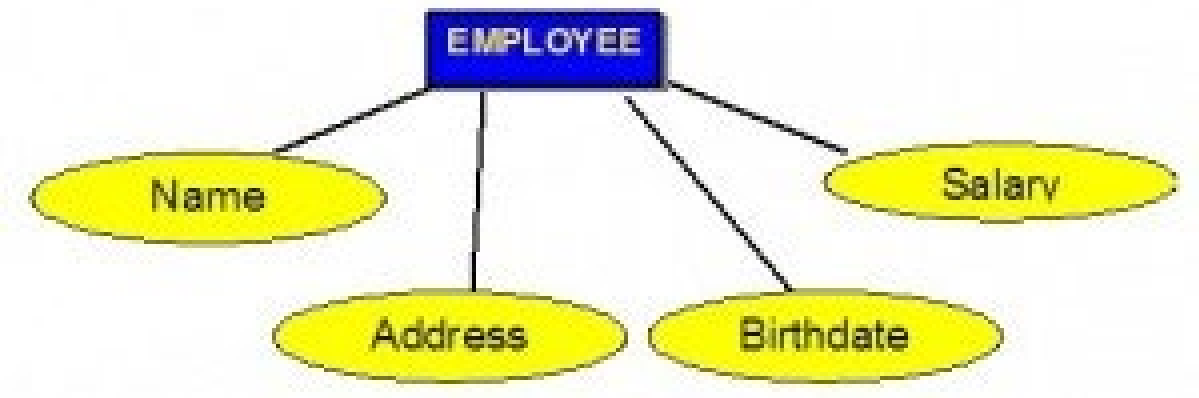
https://forms.office.com/e/KGnQsAxqmt

Attributes

In the entity, shown below, what are the attributes that define ‘Employee’ entity?

Attributes

In the entity relationship diagram, shown below, each attribute is represented by an oval with a name inside.



Attribute Types

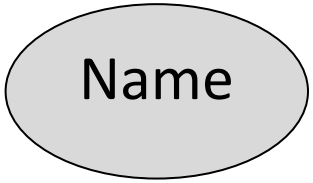
- Each entity has attributes – **properties that describe it.**
- A particular entity will have values for its attributes.
- E.g. an employee entity may have name, age, home address, home phone etc as their attributes.

Attribute Types			
Simple vs Composite	Single vs Multivalued	Stored vs Derived	Null vs Complex

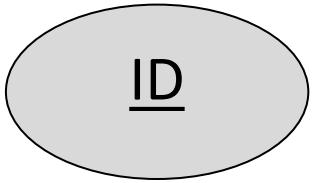
Attributes Notation

- **Attribute Domain:** The set of allowable values for one or more attributes.
- Each attribute is associated with a set of values.
- **Notation:** Attributes are represented by ovals.

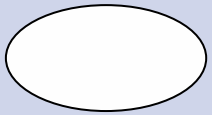
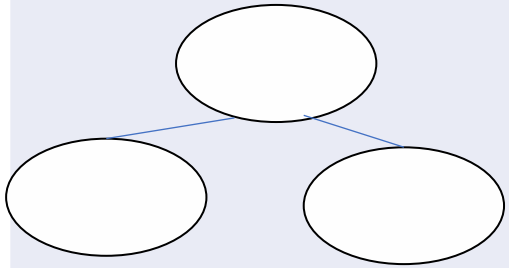
Notation for an Attribute



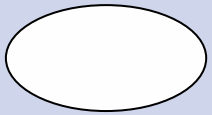
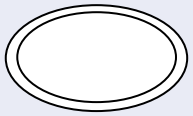
Notation for a **Key** Attribute



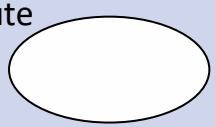
Attribute Types - 1

Type	Description	Example
Simple Attribute 	An attribute that **cannot be broken down** into smaller meaningful parts. Also called as **atomic** attributes.	Employee entity: Age, EmployeeID, colour, Position, salary etc.
Composite Attribute 	An attribute composed of multiple components, each with an independent existence.	Employee entity: Address → can be made up of *street, town, country, postcode*

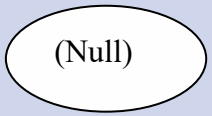
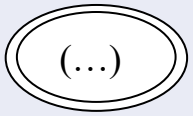
Attribute Types - 2

Type	Description	Example
Single Valued Attribute 	An attribute that holds a single value for each occurrence of an entity type.	Employee entity: Salary → can be only one value. Cannot draw more than one salary. Email, Date of birth, NI number
Multi Valued Attribute 	An attribute that holds multiple values for each occurrence of an entity type.	Employee entity: PhoneNo → A person can have one or more mobile phone number, landline etc.

Attribute Types - 3

Type	Description	Example
Stored Attribute 	An attribute that holds a value provided as is.	Employee entity: Name → can be set by the user as used as is.
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 type.	Employee entity: Age → can be derived from dateOfBirth and currentDate.

Attribute Types - 4

Type	Description	Example
NULL Attribute  	An attribute that means either the value is unknown or inapplicable. It does not mean zero.	Employee entity: Commission → can be NULL
Complex Attribute  	An attribute that is formed by nesting composite attributes and multi-valued attributes in arbitrary way. We can say this as the both are in the attribute.	Employee entity: A person can have many phone numbers, many e-mail addresses, home addresses etc. So, if there is an attribute in the name of 'Contact detail', it can be a complex attribute.

Nulls

Example of how null can be used

Use the Salary table (Salary_tbl) to follow an example of how null can be used.

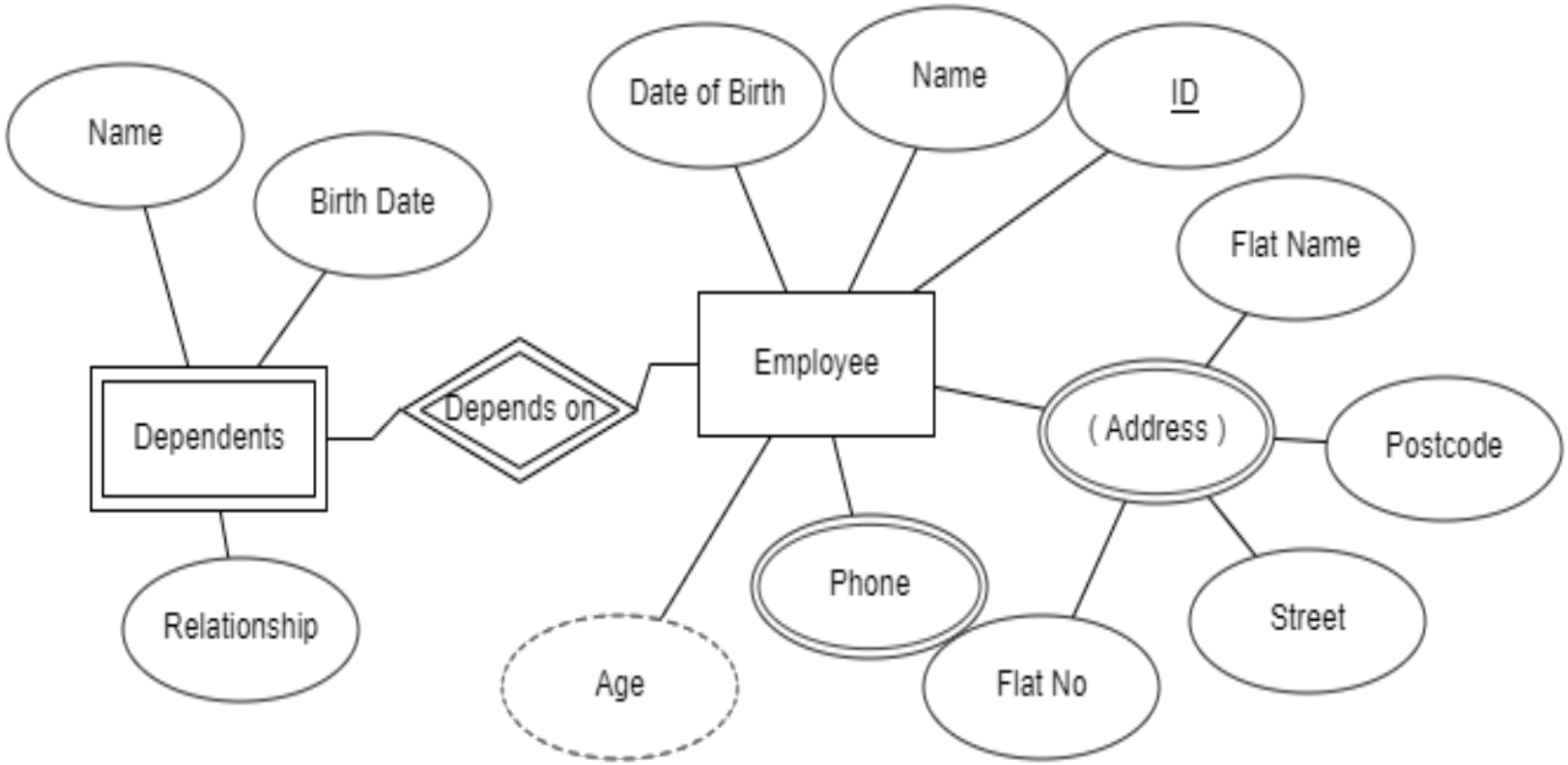
Salary_tbl

emp#	jobName	salary	commission
E10	Sales	12500	32090
E11	Null	25000	8000
E12	Sales	44000	0
E13	Sales	44000	Null

Knowledge Check: Attributes

https://forms.office.com/e/EkZ8AhrXAx

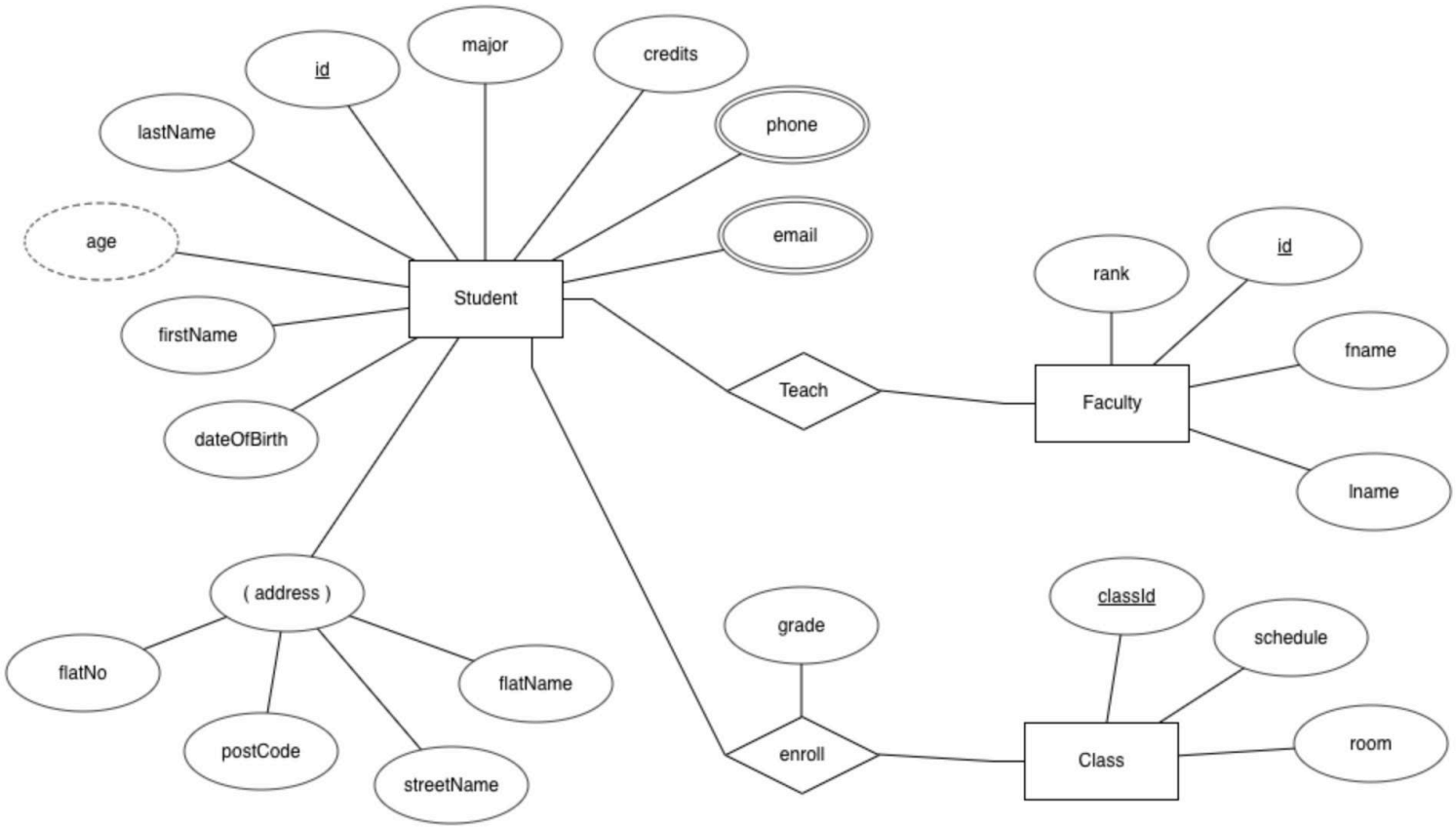
Entity, Attributes & Relationship



Entity, Attributes & Relationship

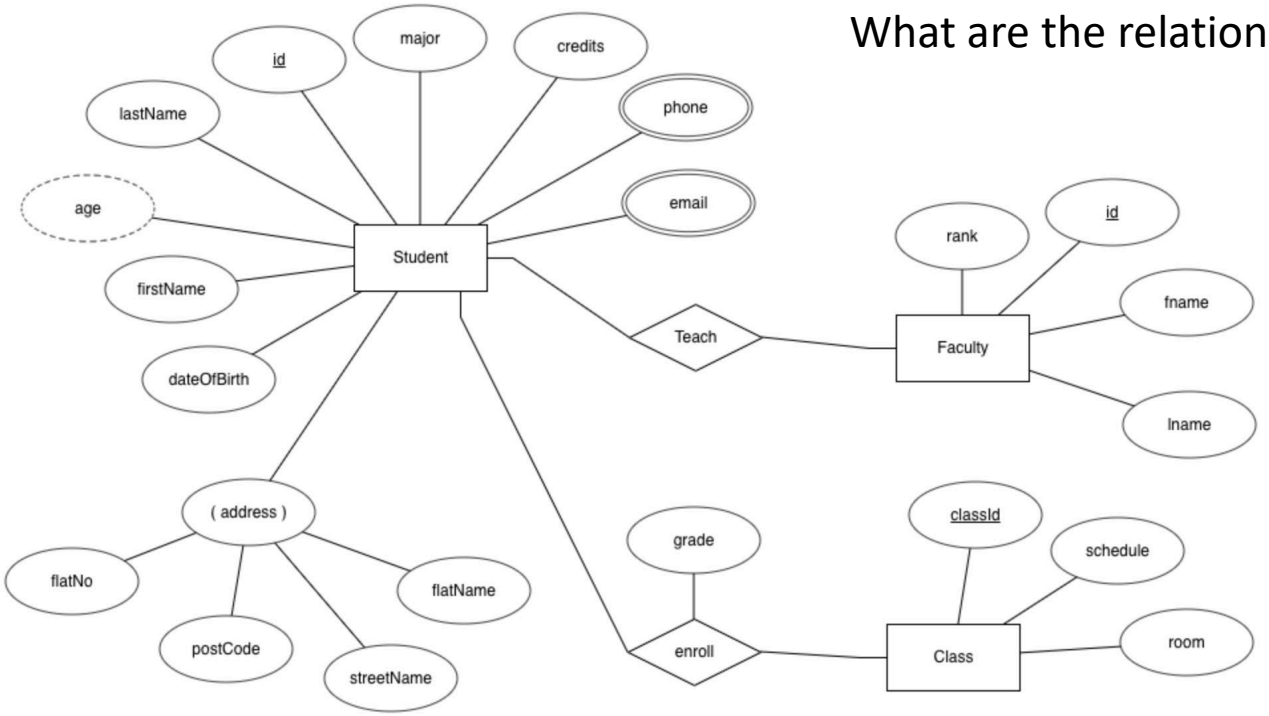
- Identify the entities, attributes and possible relation for simple University Database and represent it in ERD

Entity & Attributes



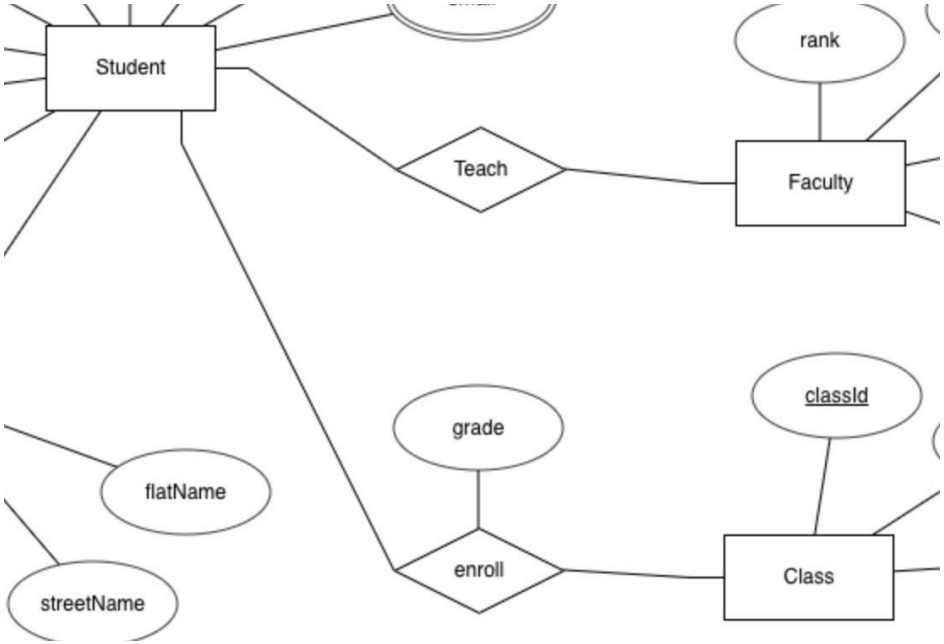
Entity & Attributes

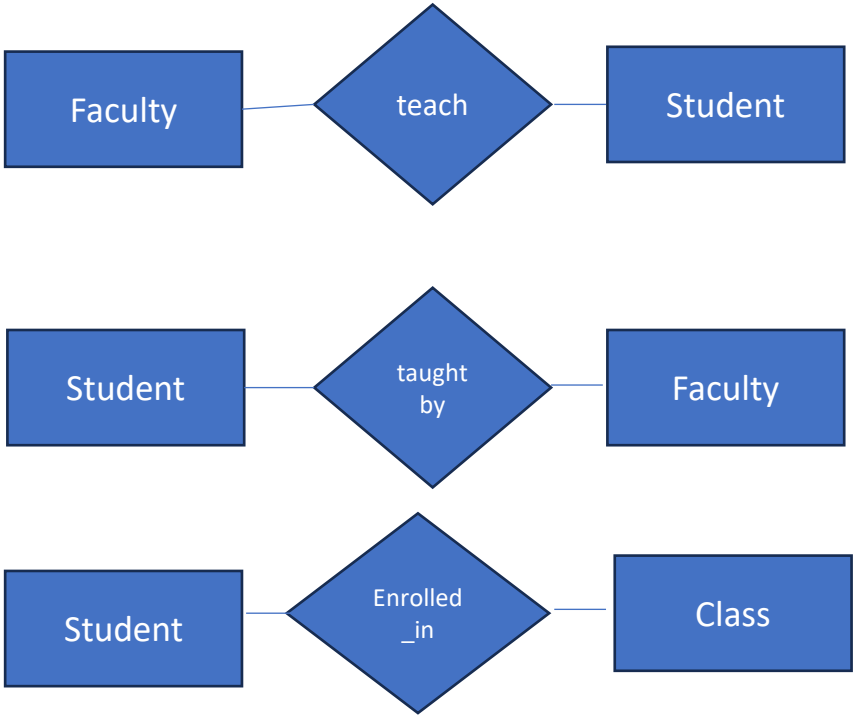
What are the relationships that link the tables?



Relationships

What are the relationships that link the tables?

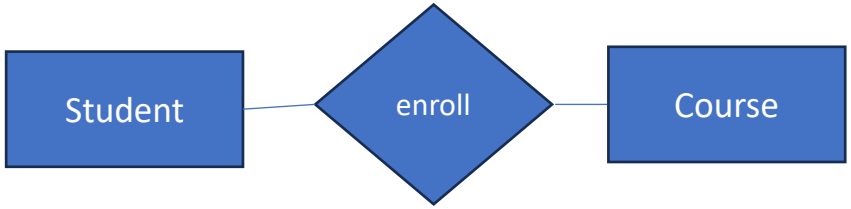




Relationships

Which one is possibly true?

a) One student enrols to One course
b) One student enrols to many courses
c) Many students enrol in many courses



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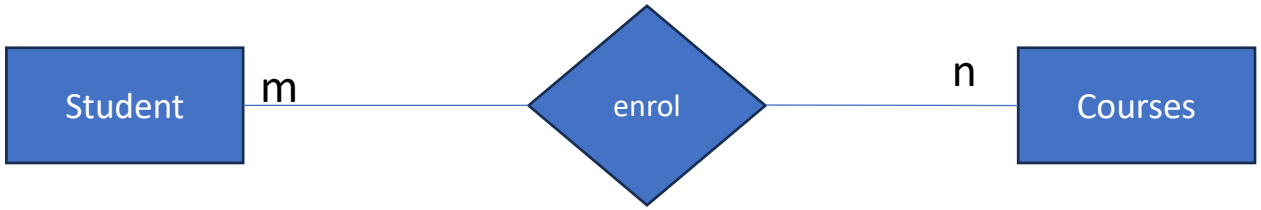

many to many relationship

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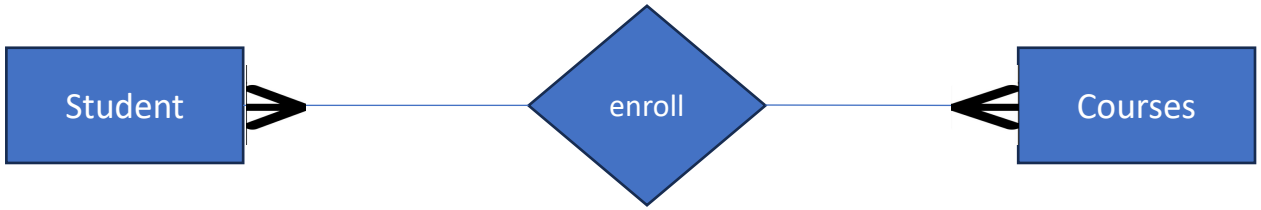
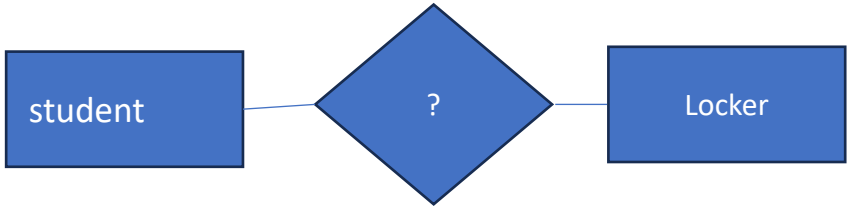


many to many relationship

Relationships- student & Locker

What is the relationship?



Relationships- student & Locker

Which one is possibly true?

a) each student is assigned to exactly one Locker
b) Many Lockers are assigned to one student

Relationships- student & Locker

Which one is possibly true?

a) **<u>each student is assigned to exactly one Locker</u>**

b) Many Lockers are assigned to one student

Relationships- Student & Locker

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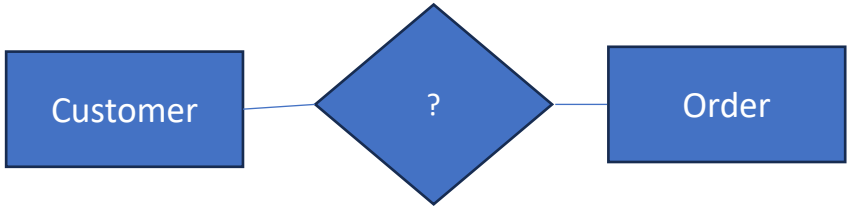
b) Many Lockers are assigned to one student

Relationships- Customer & Order

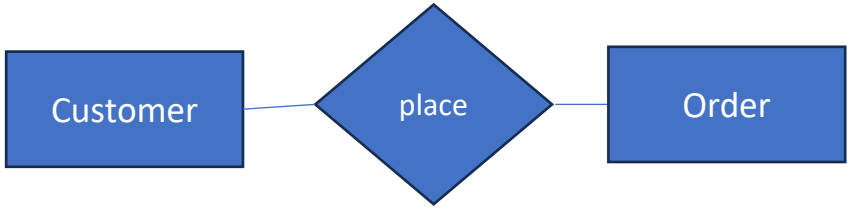
Identify the possible relationship between customer and order



Relationships- Customer & Order

Which one is possibly true?

- A customer can place multiple orders
- A customer can place only one order



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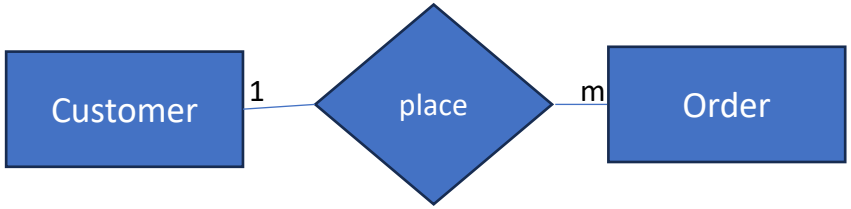

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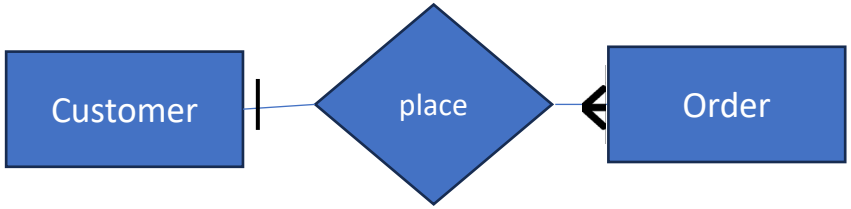

Relationships- Notations in ERD

one-to-one

one-to-many

many-to-many

Knowledge Check - Relationships

A school has students, and each student is assigned one locker. Each locker is assigned to only one student.

What type of relationship is this?

A) One-to-One
B) One-to-Many
C) Many-to-One
D) Many-to-Many

Knowledge Check - Relationships

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Knowledge Check - Relationships

A company has employees and departments. Each employee is assigned to exactly one department, but each department can have many employees. What type of relationship is this?

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C) Many-to-One
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Knowledge Check - Relationships

A university has courses and students. Each student can enrol in multiple courses, and each course can have multiple students enrolled. What type of relationship is this?

A) One-to-One

B) One-to-Many

C) Many-to-One

D) Many-to-Many

Knowledge Check - Relationships

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D) <u>Many-to-Many</u>

Knowledge Check - Relationships

A library has books, and each book has a unique ISBN. Each ISBN is assigned to only one book. What type of relationship is this?

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Knowledge Check - Relationships

A hospital has patients and doctors. Each patient can be treated by multiple doctors, and each doctor can treat multiple patients. What type of relationship is this?

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B) One-to-Many

C) Many-to-One

D) **Many-to-Many**

Knowledge Check - Relationships

A school has classes and teachers. Each class is assigned one teacher, but each teacher can teach multiple classes. What type of relationship is this?

A)One-to-One

B) One-to-Many

C) Many-to-One

D) Many-to-Many

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A)One-to-One

B) **One-to-Many**

C) Many-to-One

D) Many-to-Many

Knowledge Check - Relationships

A music streaming service has playlists and songs. Each playlist can contain multiple songs, and each song can appear in multiple playlists. What type of relationship is this?

A)One-to-One

B) One-to-Many

C) Many-to-One

D) Many-to-Many

Knowledge Check - Relationships

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A)One-to-One

B) One-to-Many

C) Many-to-One

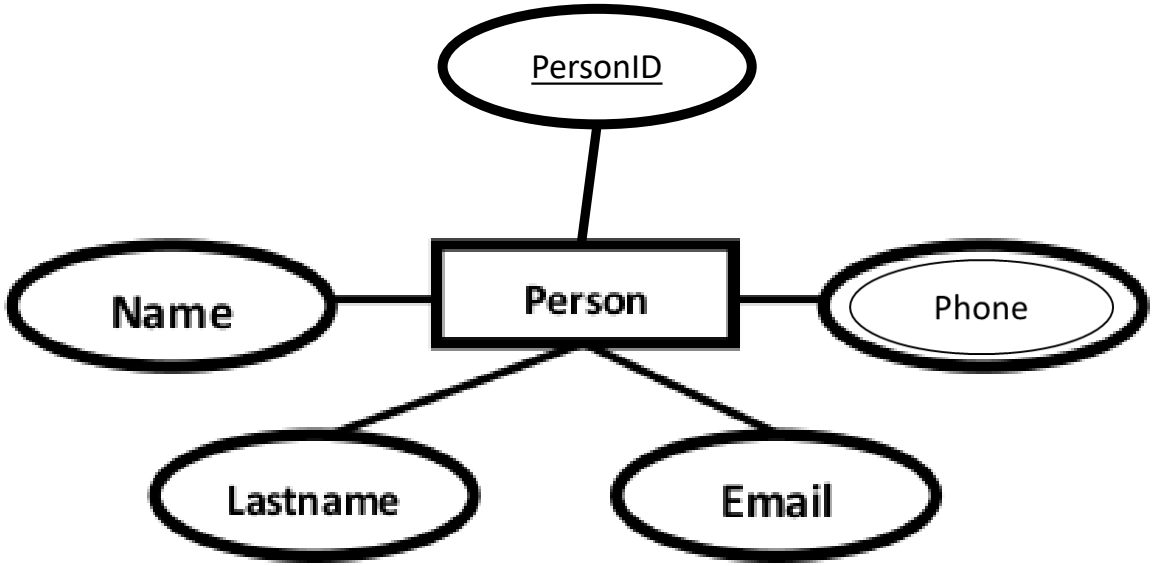
D**) Many-to-Many**

ERD to Relational Table – Mapping Algorithm

Mapping Algorithm - Entities and Simple Attributes

Person(personid , name, lastname, email)

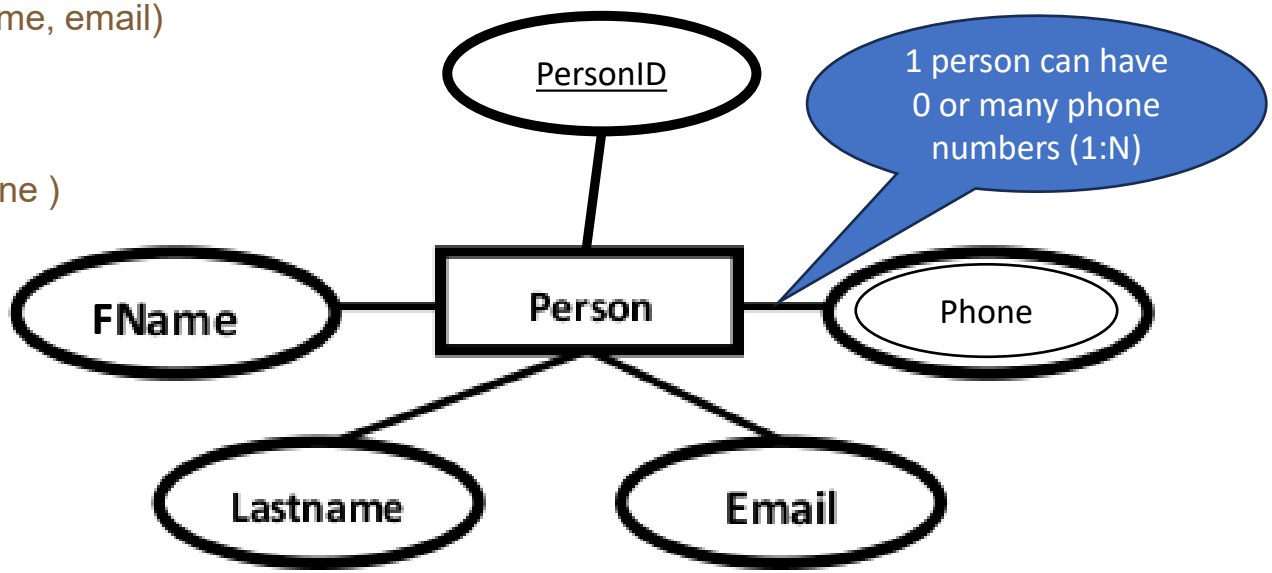
What happens to Phone-multivalued attribute?



Mapping Algorithm – Multivalued attribute

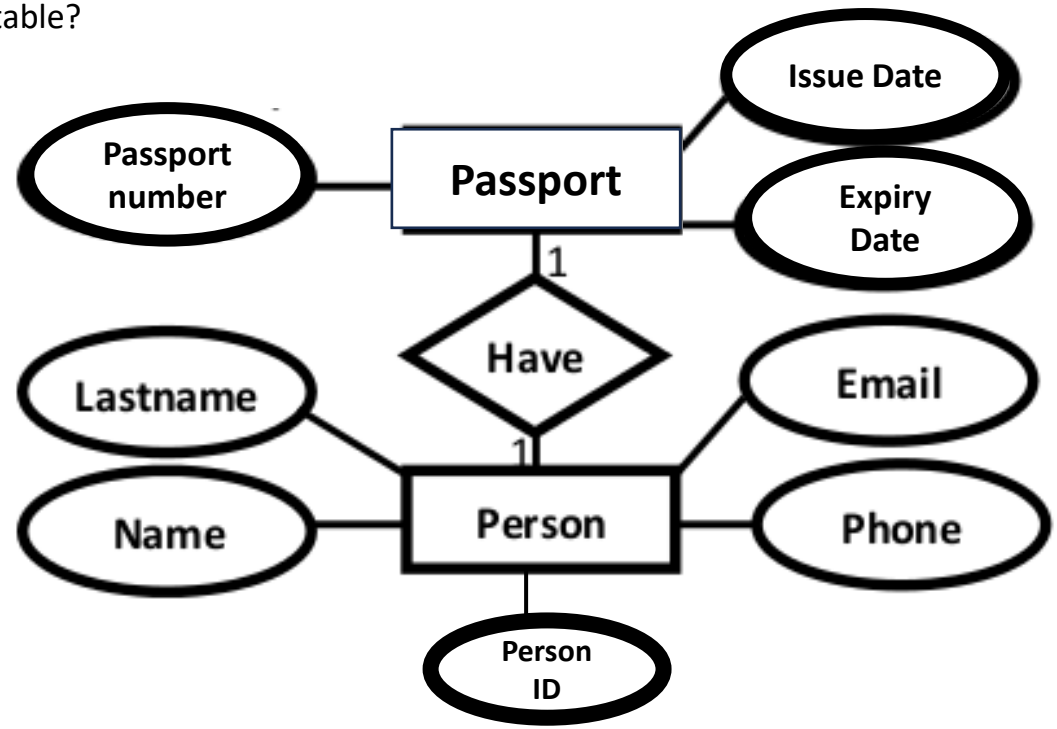
Person(personid , FName, lastname, email)

Phone (phoneid , ***personid***, phone)



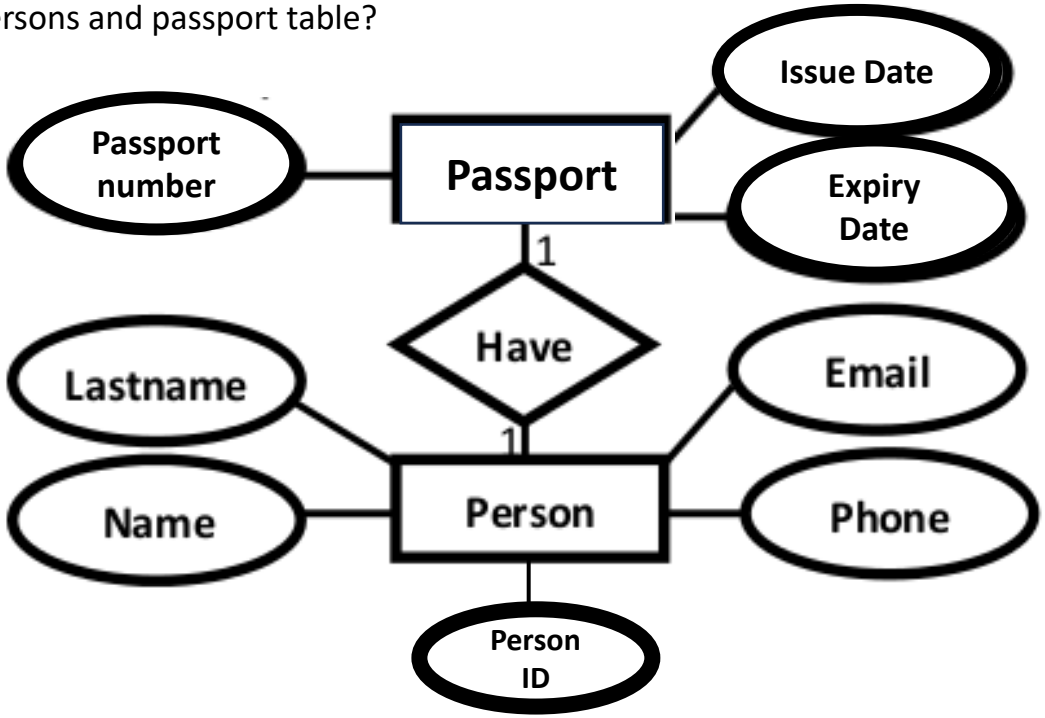
Mapping Algorithm – 1:1 Relationships

which will be the foreign key creating a reference between Persons and passport table?



Mapping Algorithm – 1:1 Relationships

which will be the foreign key creating a reference between Persons and passport table?



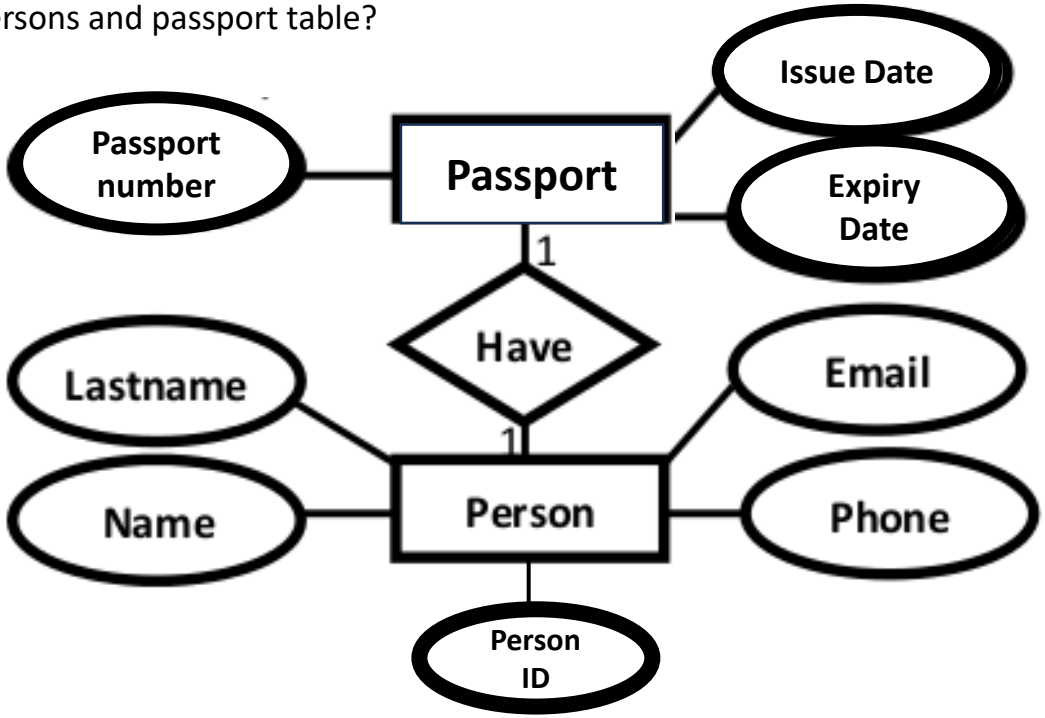
Person (personid{PK},name,lastname,email,passportnumber*{FK}*)

passport (passportnumber{PK}, issuedate,expirydate)

Can you think of an alternative approach?

Mapping Algorithm – 1:1 Relationships

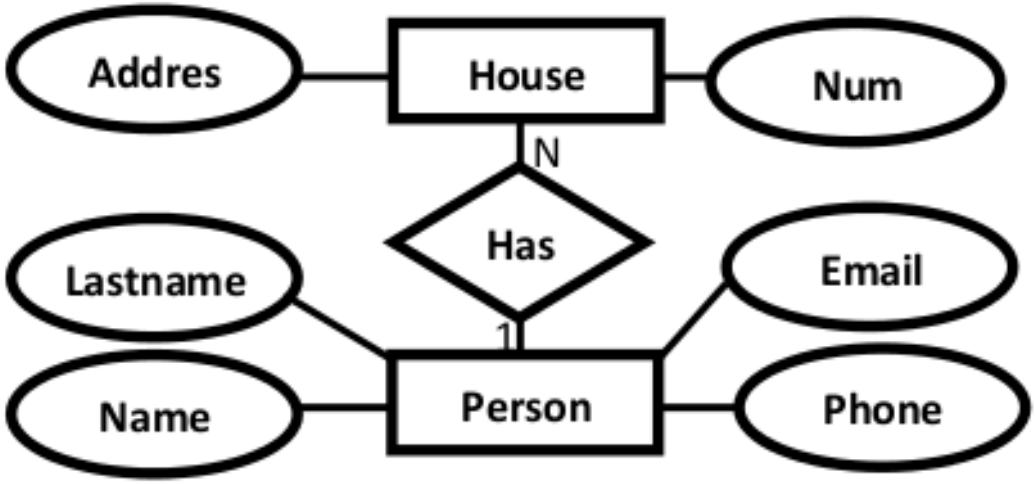
which will be the foreign key creating a reference between Persons and passport table?



Person
(personid{PK},name,lastname,email,)

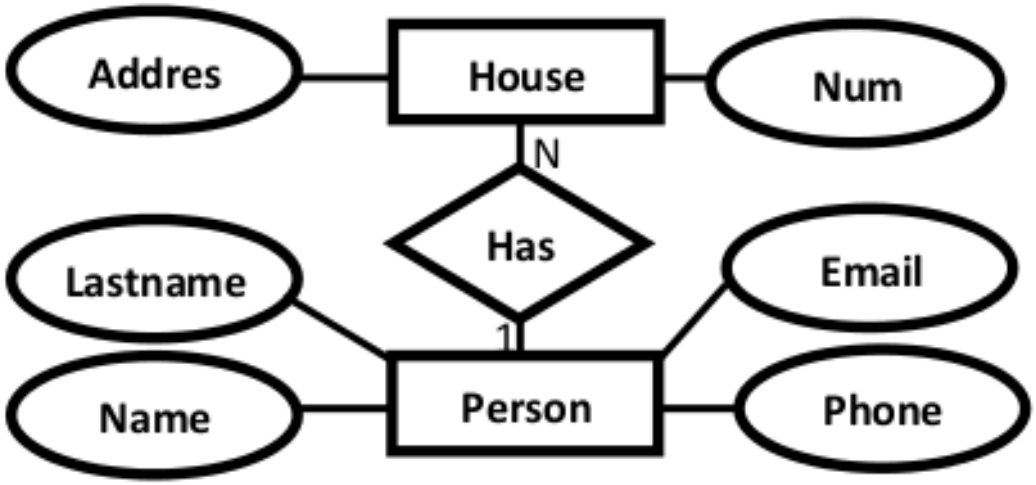
passport
(passportnumber{PK}, issuedate,expirydate, *personid{FK},)*

Mapping Algorithm – 1:N Relationships



How is this converted to?
Give a try…

Mapping Algorithm – 1:N Relationships



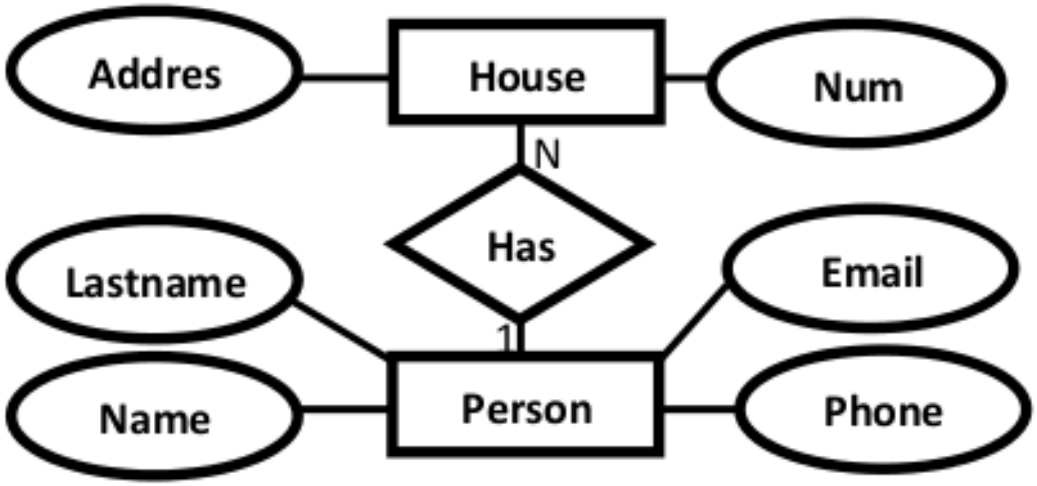
House

houseid	personid
H1	1
H2	2
H3	1

person

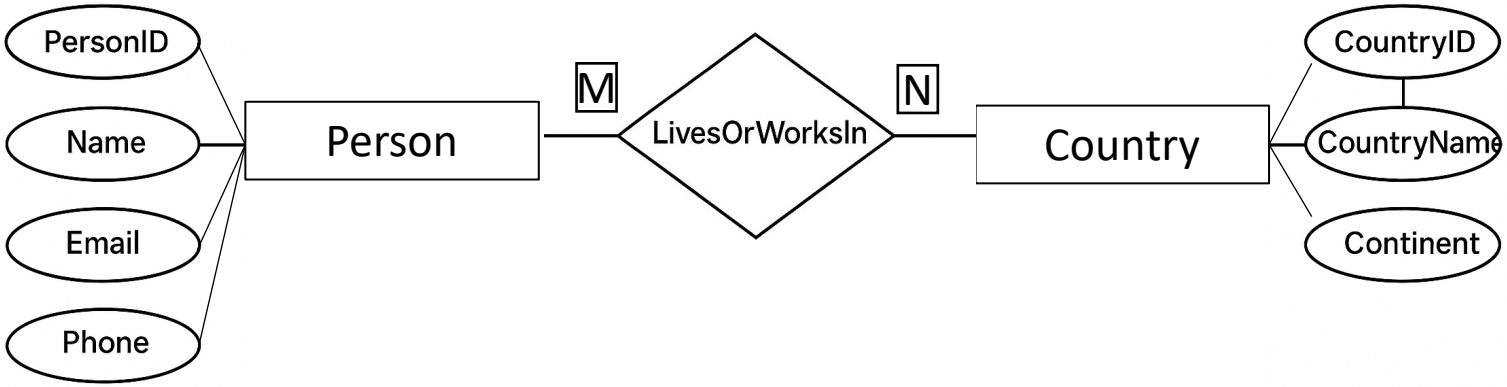
personid	houseid
1	H1,H3
2	H2
3	<null>

Mapping Algorithm – 1:N Relationships



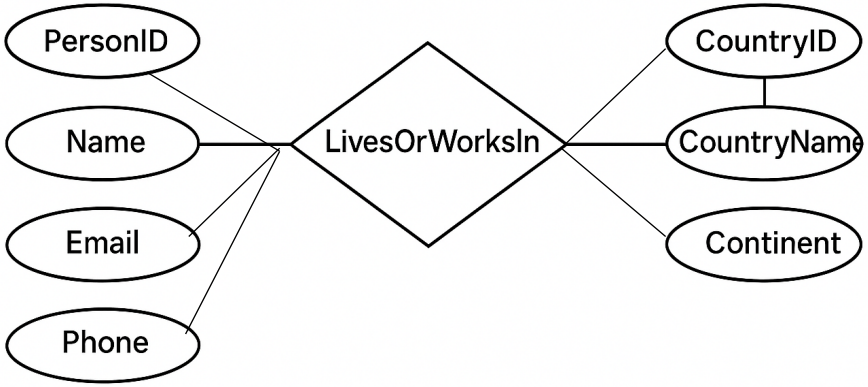
Person(personid[PK] , name, lastname, email)
House (housed[PK] , num , address, *personid[FK]*)

Mapping Algorithm – N:N Relationships



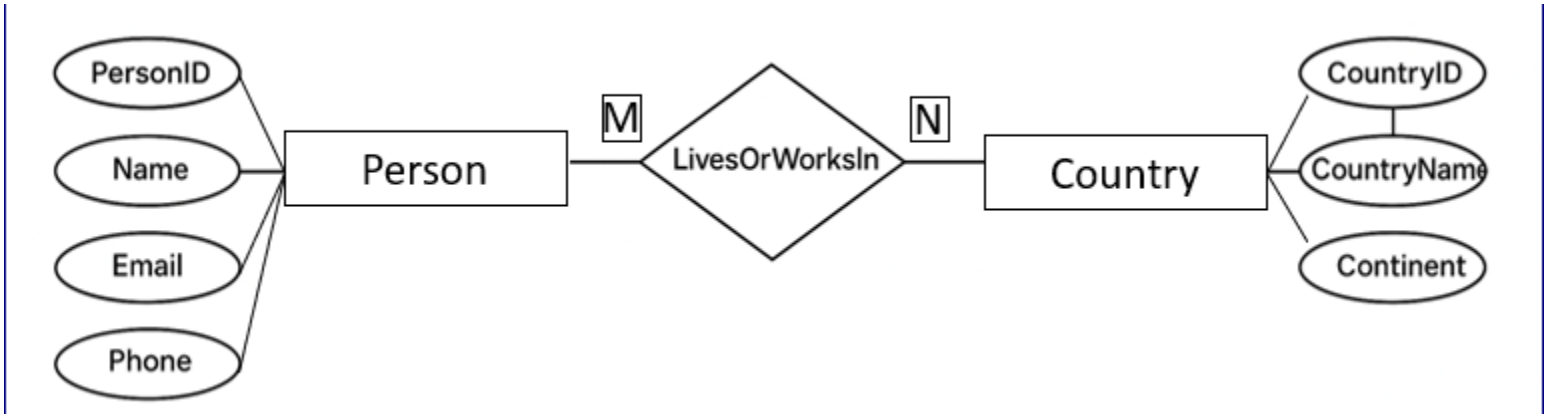
How is this converted?

Give a try…



Mapping Algorithm – N:N Relationships

The Person can live or work in many countries. Also, a country can have many people.



Person

personid	countryid
p1	c1
p2	c1
p3	c1,c2

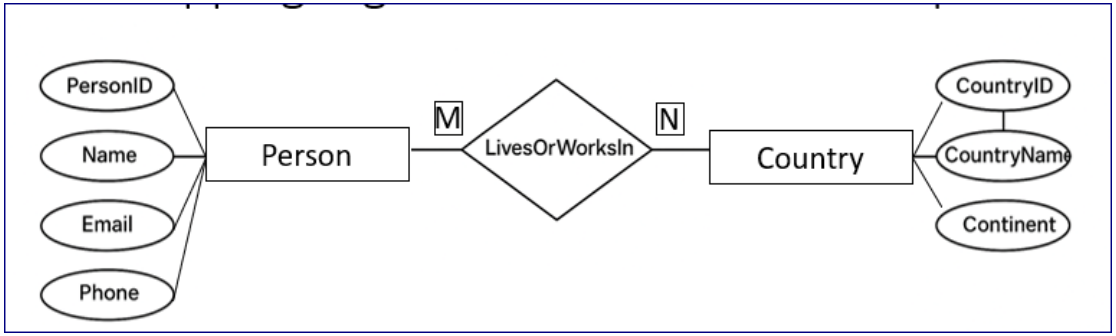
Country

countryid	personid
c1	p1,p2,p3
c2	p3
c3	-

Mapping Algorithm – N:N Relationships

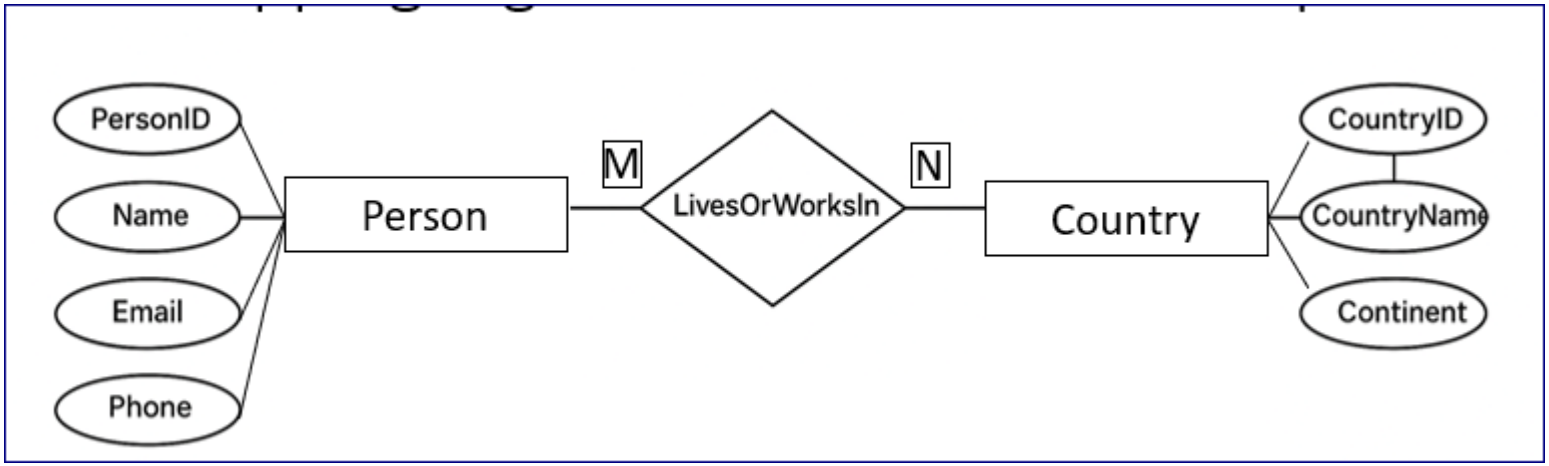
countryid	personid
c1	p1,p2,p3
c2	p3
c3	-

personid	countryid
p1	c1
p2	c1
p3	c1,c2



LivesOrWorksin_id	personid	countryid
has1	P1	C1
has2	P2	C1
has3	p3	C1
has4	p3	c2

Mapping Algorithm – N:N Relationships



Persons(<u>personid</u> , name, lastname, email)
Country (<u>countryid</u> , name, code)
LivesOrWorksin(LivesOrWorksin_id, *personid , countryid*)

Further Reading :

Chapter 11 Database Analysis and the DreamHome Case Study

Chapter 12: Entity–Relationship Modelling

Chapter 13 Enhanced Entity–Relationship Modelling

Database Systems: A Practical Approach to Design, Implementation, and Management Sixth edition by • Thomas Connolly • Carolyn Begg