



Information System Management

Chapter Five – Part 2: Database Design

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Department of Industrial Engineering

Database Application Systems

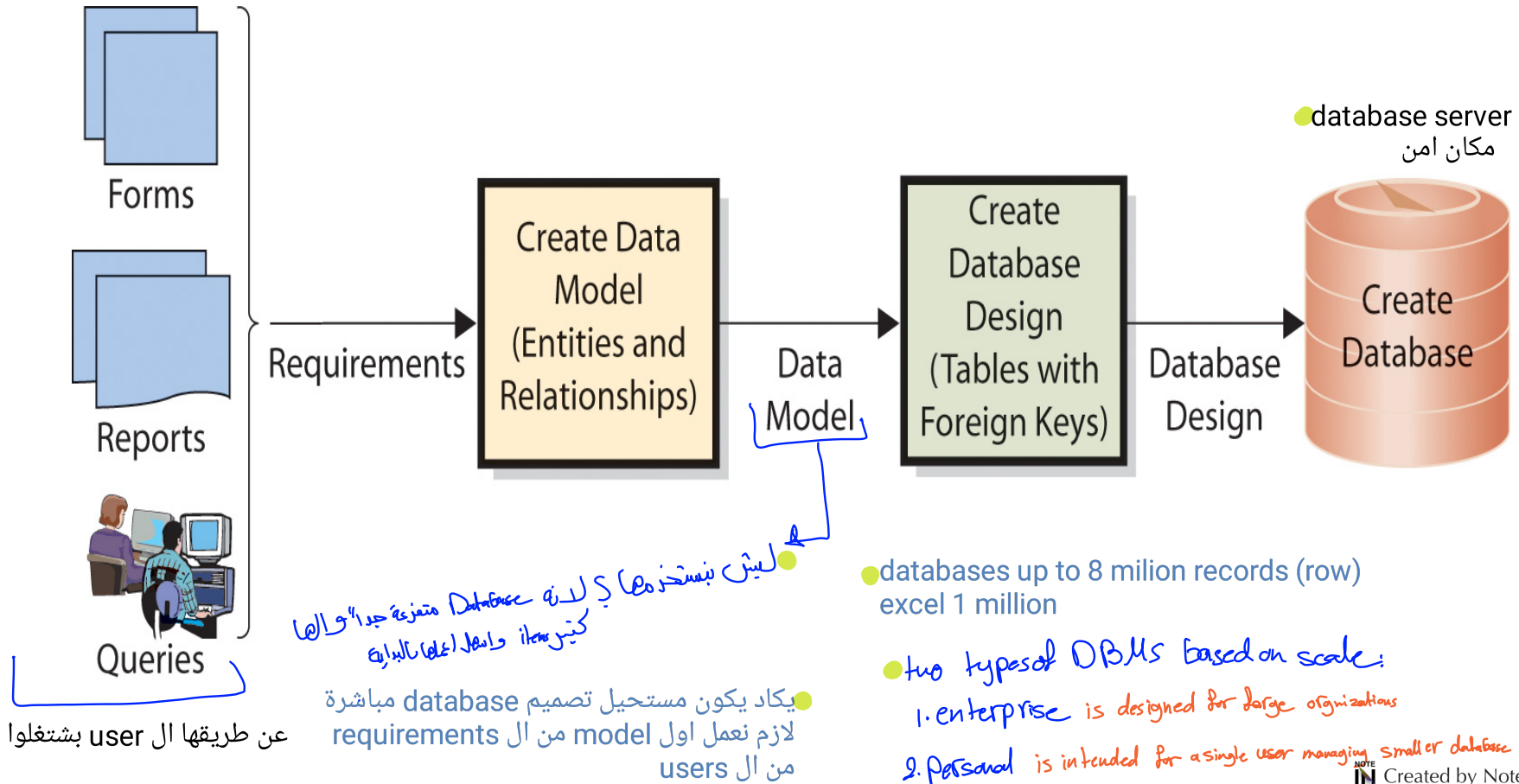
end users هو بتعامل معها ال 

بعمل لهم Access عن طريق ال database management system

- Database application consists of:
 - Forms
 - Reports
 - Queries
 - Application programs

How Are Systems Developed?

● شغل المهندس بناء ال model



Database Application System Development Process

- Developers interview users
- Develop requirements for new system
 - Analyze existing reports, forms, and user activities
- Requirements summarized in data model
 - Logical representation of structure of data
 - Contains description of data and relationships
- Users validate and approve model
- Design implemented in a database
 - Database filled with user data

Database

dynamic دائما يتم تغييرها وتحديثها عملية متواصلة

- Must include all data necessary for users to perform jobs
- Contains only that amount of data, and no more
- Developers rely on users to:
 - Tell them what to include
 - Check data model
 - Verify correctness and completeness

Database Design

- Process of converting data model
 - Transforms entities into tables
 - Expresses relationships
 - Defines foreign keys
 - Shows data constraints

لے لیزم تو نا خدزی

THE PROBLEM

Email Table

EmailNum	Date	Message	Student Number
1	2/1/2007	For homework 1, do you want us to provide notes on our references?	1325
2	3/15/2007	My group consists of Swee Lau and Stuart Nelson.	1325
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Student Table

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1644	LAU, SWEE	75	90	90
2881	NELSON, STUART	100	90	98
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3559	TAM, JEFFREY		100	88
4867	VERBERRA, ADAM	70	90	92
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Office_Visit Table

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How can we describe the structure of this database to others?

The metadata!

SEM

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THE PROBLEM

Using Text?

« چگونه استفاده از متن؟ »

EMAIL (EmailNum, Date, Message, *Student Number*)

STUDENT (Student Number, Student Name, HW1, HW2, MidTerm)

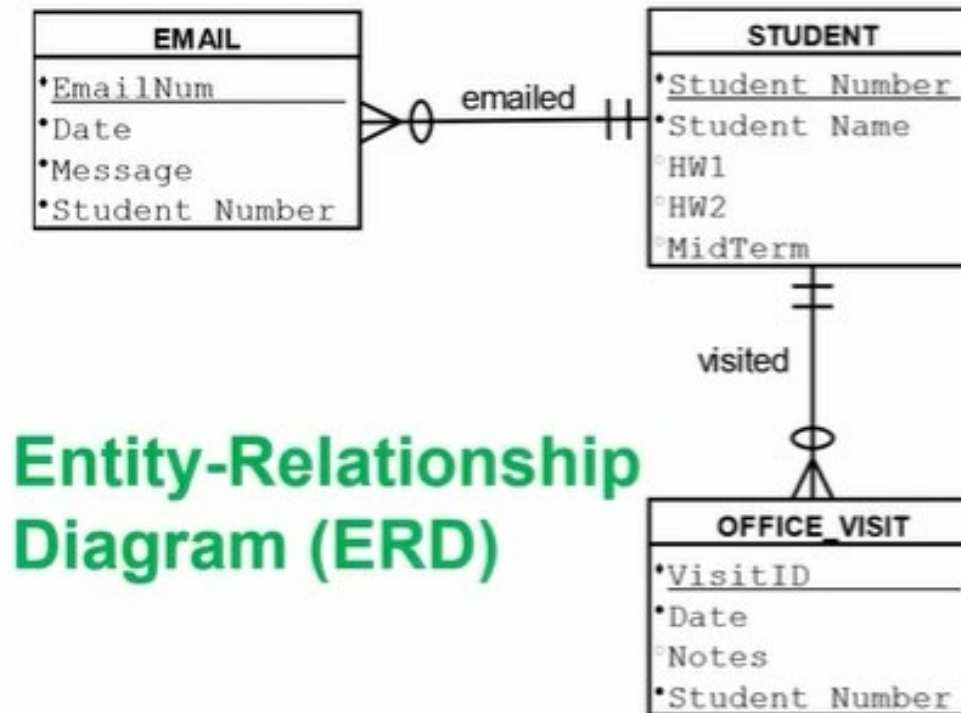
OFFICE_VISIT (VisitID, Date, Notes, *Student Number*)

Has limitations:

- » Lacks relationships.
- » Lacks properties of attributes.
- » Hard to visualize.

THE PROBLEM

Using a Diagram?



Entity-Relationship
Diagram (ERD)

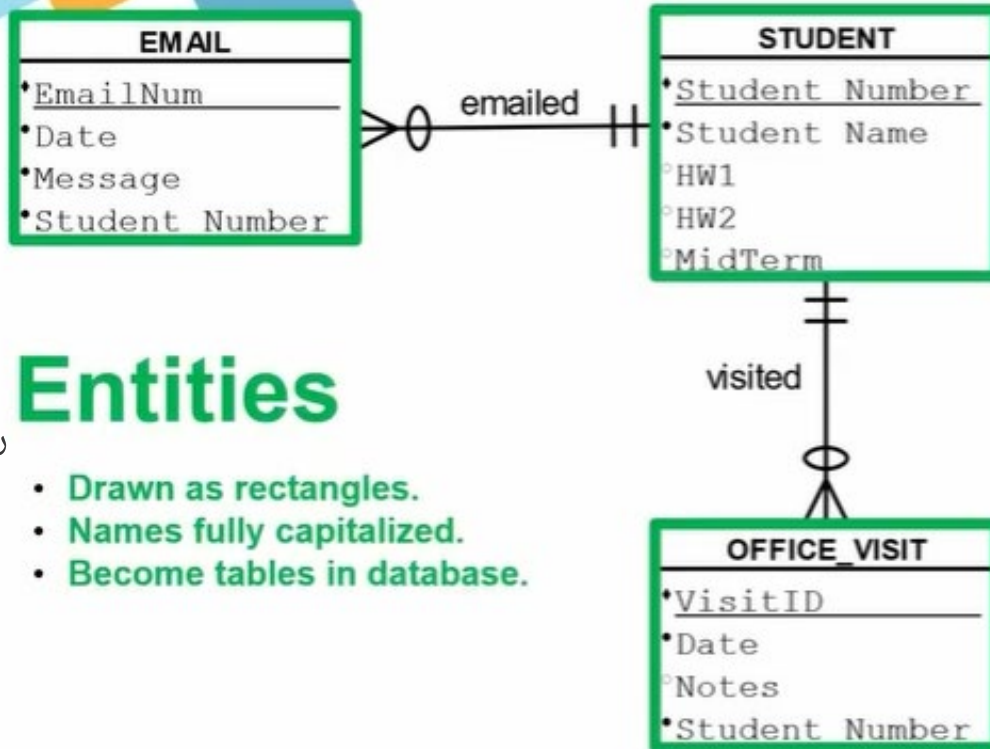


E-R DIAGRAM (ERD)

What is an E-R Diagram (ERD)?

- ◆ Type of flowchart that illustrates a database's **data model**.
- ◆ Shows how **entities** are **related** to each other and the **attributes** they contain.
- ◆ Used in database design as an **initial step** to represent the database in a system independent way.

ERD SYMBOLS & NOTATIONS

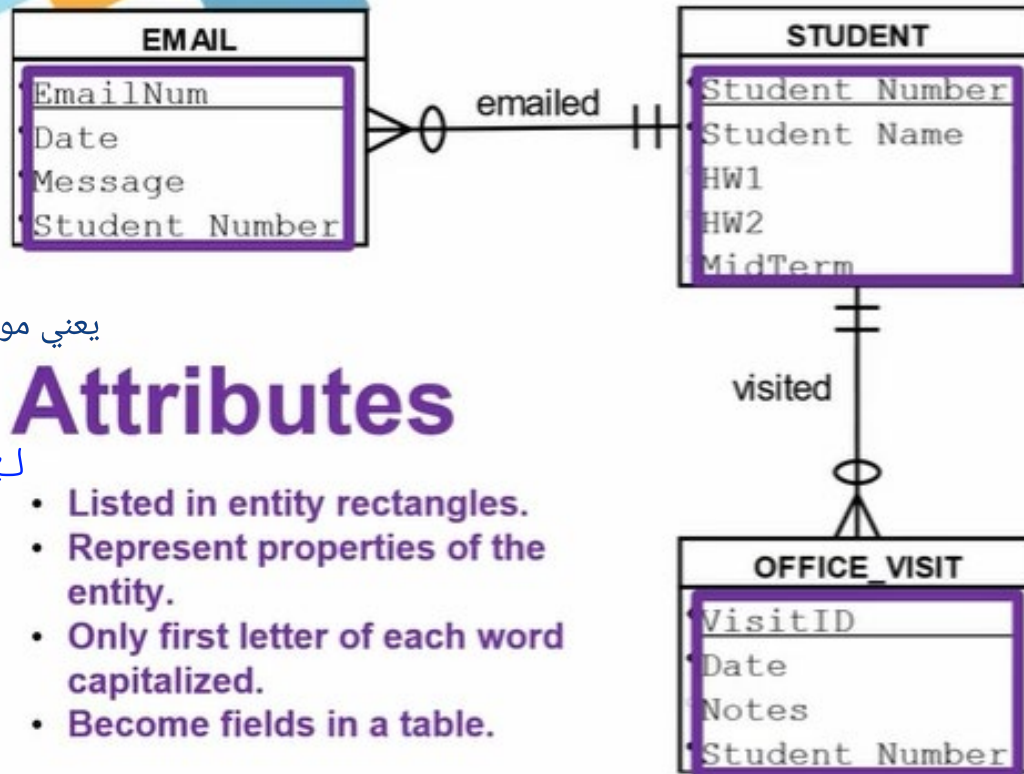


Entities

- Drawn as rectangles.
- Names fully capitalized.
- Become tables in database.

رح يتحول ل table

ERD SYMBOLS & NOTATIONS



يعني مواصفات الطالب

Attributes

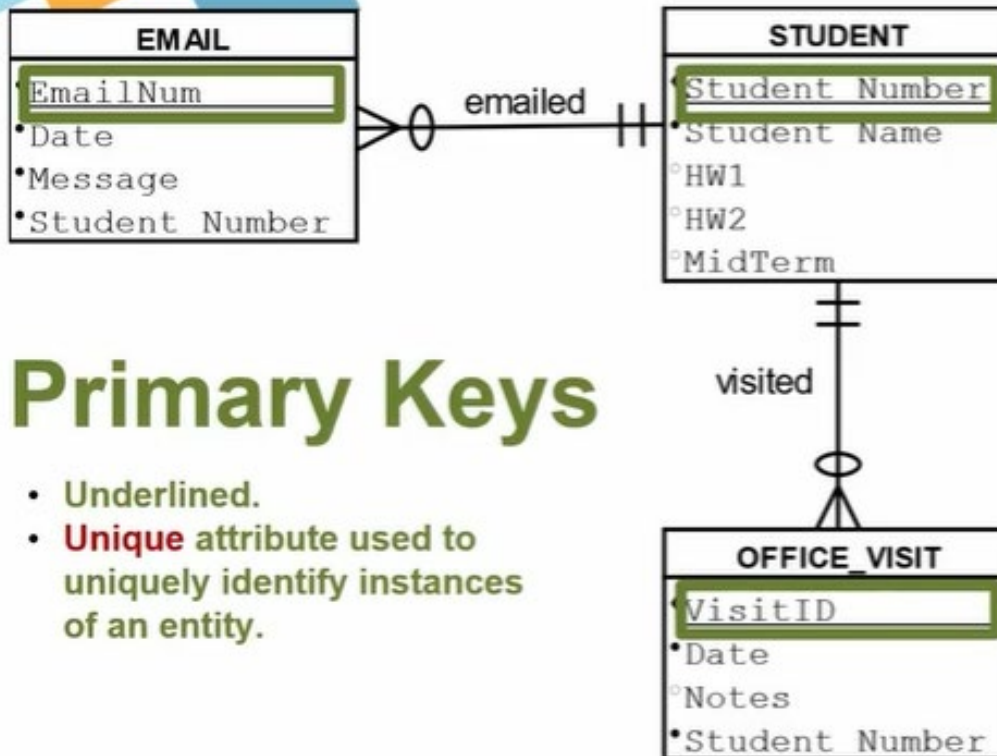
للمواصفات
Entity

- Listed in entity rectangles.
- Represent properties of the entity.
- Only first letter of each word capitalized.
- Become fields in a table.

المواصفات داخل ال data structure

كل مستطيل بضم data structure بضم اول
اشي إلى هو الاسم الايميل وهو اسم ال entity
نفسه وهو كأنه نوع من ال metadata ورح
يضم attribute والي هي مواصفات entity إلى
عندي اياها

ERD SYMBOLS & NOTATIONS



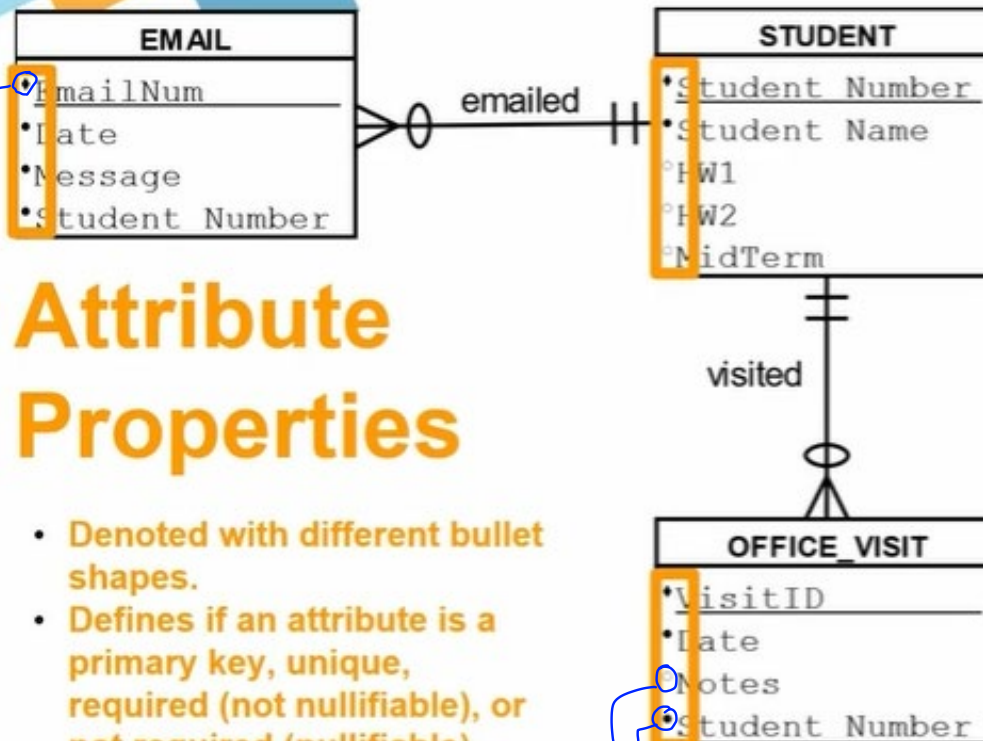
لما ادخل عليه أسماء
طلاب هاد اسمه
instances لانو هذول
بتغيرو(اشي حاليا موجود
وقابل يتغير بالمستقبل)

المعرف الاساسي

Primary Keys

- Underlined.
- **Unique** attribute used to uniquely identify instances of an entity.

ERD SYMBOLS & NOTATIONS



Attribute Properties

- Denoted with different bullet shapes.
- Defines if an attribute is a primary key, unique, required (not nullifiable), or not required (nullifiable).

not required → Required

ERD SYMBOLS & NOTATIONS

Attribute Properties



Primary Key Attribute

Also denotes a primary key.



Nullifiable Attribute

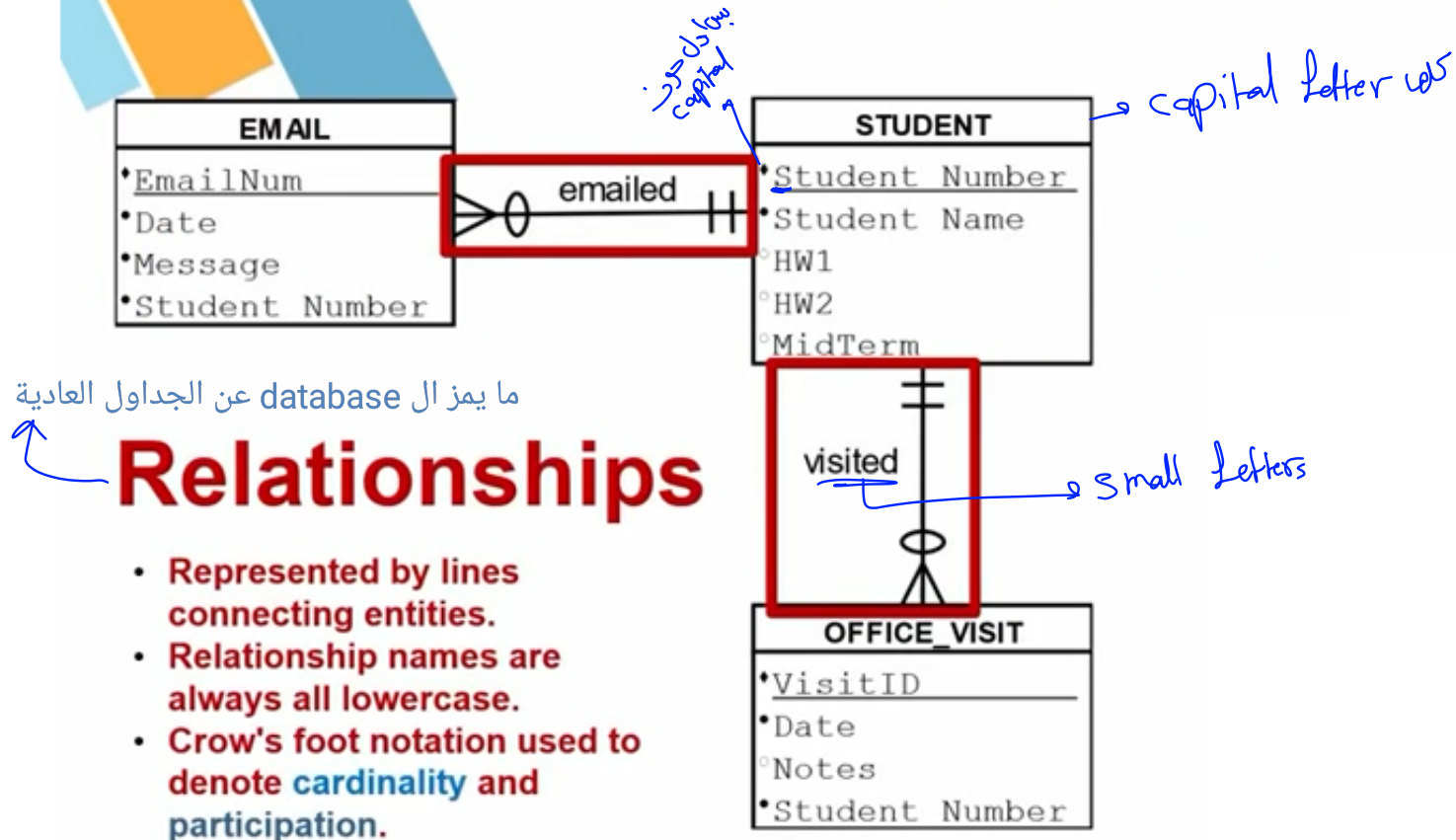
An instances of an entity may have no value for this attribute (e.g. students are **NOT** required to have a date of birth).



Required Attribute

Each instances of an entity must have a value of this attribute (e.g. all students must have a name).

ERD SYMBOLS & NOTATIONS





CARDINALITY

- » Indicates the **number** of instances of the entities that are **involved in the relationship**.

NOTE: **Not** the total number of instances in the entity.

This regards how many instances in one Entity are **related** to how many instances in the other Entity in the relationship

CARDINALITY

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1:N

one to many

الطالب يرسل اكثر من ايميل وهكذا

كل ايميل ينبعث من بس طالب واحد

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1:N



CARDINALITY

- » **1:1 relationships**
 - ◇ Single entity instance to single entity instance
- » **1:N (N:1) relationships**
 - ◇ One to many
 - ◇ Single entity instance to many entity instances
- » **N:M relationships**
 - ◇ Many to many
 - ◇ Many entity instances to many entity instances



PARTICIPATION

(a.k.a. Modality -or- Multiplicity)

- » The participation of an entity in a relationship indicates whether **all** or only **some** of the instances of the entity are involved in the relationship



PARTICIPATION

(a.k.a. Modality -or- Multiplicity)

عدد المشتركين في العلاقة نفسها على الأقل أو الأكثر

- » “**Mandatory**” participation:
 - ◊ **All** of the instances are involved in the relationship

- » “**Optional**” participation:
 - ◊ If **NOT all** of the instances are involved in the relationship

In Other Words: every time an instance is added to an entity, **must** an associated instance be added to the related entity ?

يحدد ال limit في العلاقة

PARTICIPATION

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All e-mails must have a student (mandatory).

على الأقل اسم واحد في الايميل

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Not all students will have sent an e-mail (optional).

يمكن الطالب ما يبعث

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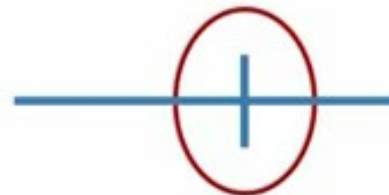
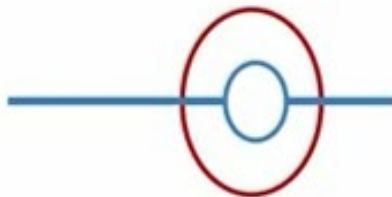


CROW'S FOOT NOTATION

Cardinality (Multiplicity - [one] -or- [many]):



Participation Level ([optional] -or- [mandatory]):



must

CROW'S FOOT NOTATION

One and ONLY One



(Only One Instance BUT Mandatory)

على الأكثر واحد

Zero or One



(Only One Instance BUT Optional)

على الأكثر ١

One or Many



(One or More Instance BUT Mandatory)

على الاقل واحد

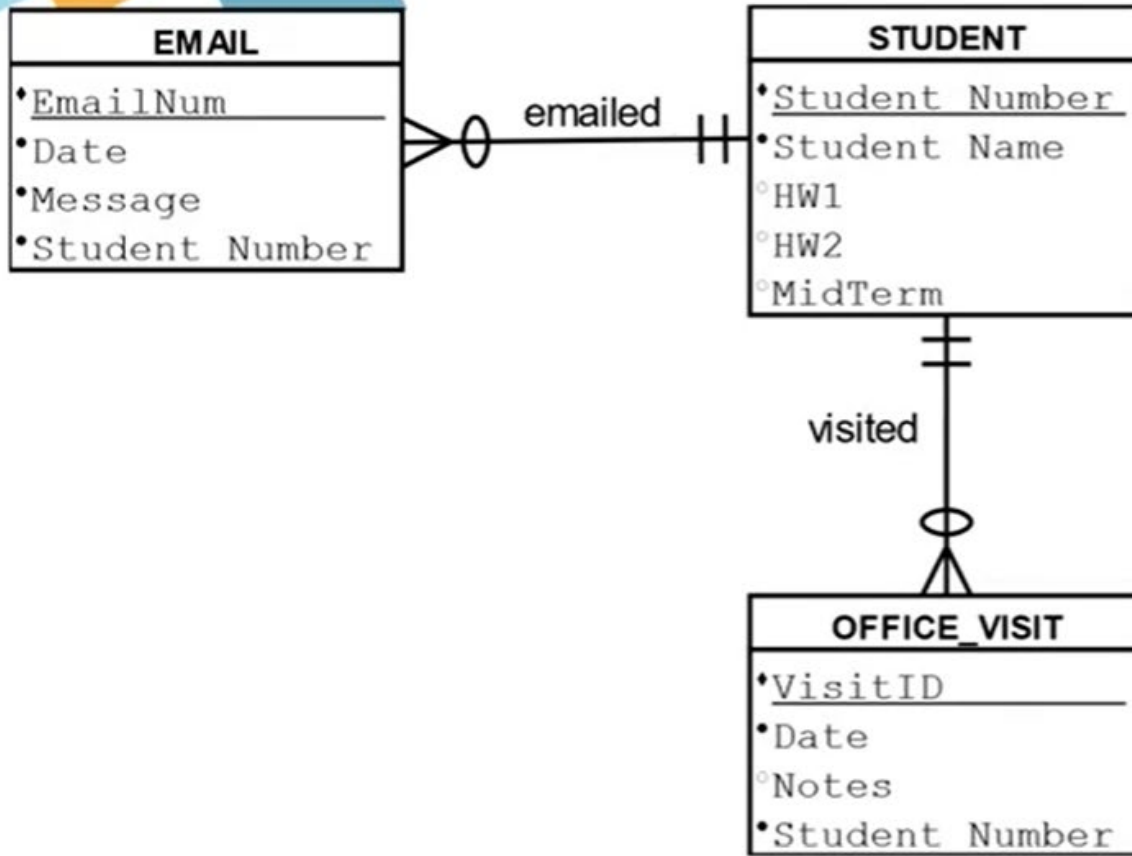
Zero or Many



(One or More Instance BUT Optional)

على الاقل صفر

CROW'S FOOT NOTATION



Normalization

- Process
 - Converts table into two or more tables
 - Changes from poorly structured to well-structured
- Data integrity problems
 - Different names for the same entity
 - Produces incorrect and inconsistent information
 - Resolve by eliminating duplicated data
- Normalized tables
 - Eliminate data duplication
 - Slower to process
 - Every table has single topic

Relational Database Design

- Designer creates table for every entity
- Entity identifier becomes primary key of table
- Attributes of entity become columns
- Tables normalized to single theme هاد معنى ال normalization
- Represent relationships between tables
- Add foreign key to one or more tables

رح تضلها نوع من ال identifier إلى بلزمني استخدمه في غير ال table الأساسي تاها

What Is the Users' Role?

نبدأ وننتهي فيه

- Final judges as to what data should be contained
- Determine how records are related to each other
- Need to review data model
- Must insure that model reflects an accurate view of business

Who Will Volunteer?

- Consultant creates data model
 - Based on interviews with users
- Data model reviewed and approved
- Database tables constructed
 - Primary and foreign keys selected
 - Based on interviews
- Microsoft Access database created
 - Relationships indicated
 - Forms and reports constructed

نوع من انواع ال البيرسونال داتا بيسد منجمنت سيستم



DESIGNING AN E-R MODEL/DIAGRAM

The 7 Steps

Step 1: Collect & review ALL the data.

Step 2: Identity **entities** & **attributes** draw them on your ER diagram

Step 3: Identify the **key attribute(s)** and underline them on your diagram

Step 4: Decide on the **relationships** and draw lines between the entities, including any **attributes** of the relationships.

Step 5: Decide on the **cardinality** of each relationship and add it to the diagram

Step 6: Decide on the **participation** of each entity in each relationship and *add* if required.

Step 7: Add the **foreign keys** of each relationship for each entity pairs and *add* relationship attributes if present.



EXAMPLE SCENARIO

The Doctor's Office

Requirements/Use Cases

1. Nurses **work for** the Doctor in the office.
2. Each Nurse **works for** (assigned to) a **single** Doctor.
3. Every Doctor has **one or more** Nurses **working for** (assigned) them.
4. Each Nurse has a **first name**, **last name** and a unique **Nurse's ID**.
5. Each Doctor has a **first name**, **last name** and a unique **Doctor's ID**.
6. Only a Doctor can **order** a type of **Test**, but **not all** Doctors **order Tests**.
7. Each type of **Test** has a unique **Test ID number** and the **name of Test**.
8. If known, keep track of the **hours per week** worked by the Nurse.
9. We need to keep track of the **date** that any **Test order** was placed.

STEP 1 & 2

Step 1: Collect & review ALL the data.

Step 2: Identity **entities** & **attributes** draw them on your ER diagram

NURSE

DOCTOR

TEST

1. **Nurses** work for the **Doctor** in the office.
2. Each **Nurse** works for (assigned to) a single **Doctor**.
6. Only a **Doctor** can order a type of **Test**, but not all **Doctors** order **Tests**.



STEP 1 & 2

Step 1: Collect & review ALL the data.

Step 2: Identity **entities** & **attributes** draw them on your ER diagram

NURSE

nurse ID
lastName
firstName

DOCTOR

doctor ID
lastName
firstName

TEST

test ID
type

4. Each **Nurse** has a **first name**, **last name** and a unique **Nurse's ID**.
5. Each **Doctor** has a **first name**, **last name** and a unique **Doctor's ID**.
7. Each type of **Test** has a unique **Test ID number** and the **name of Test**.



STEP 1 & 2

Step 1: Collect & review ALL the data.

Step 2: Identity **entities** & **attributes** draw them on your ER diagram

NURSE
•NurseID
•FirstName
•LastName

DOCTOR
•DoctorID
•LastName
•FirstName

TEST
•TestID
•TypeName

STEP 3

Step 3: Identify the **key attribute(s)** and underline them on your diagram

NURSE
•NurseID
•FirstName
•LastName

DOCTOR
•DoctorID
•LastName
•FirstName

TEST
•TestID
•TypeName

4. Each Nurse has a first name, last name and a unique Nurse's ID.
5. Each Doctor has a first name, last name and a unique Doctor's ID.
7. Each type of Test has a unique Test ID number and the name of Test.

STEP 3

Step 3: Identify the **key attribute(s)** and underline them on your diagram

NURSE
• <u>NurseID</u>
• FirstName
• LastName

كلهم مطلوبين

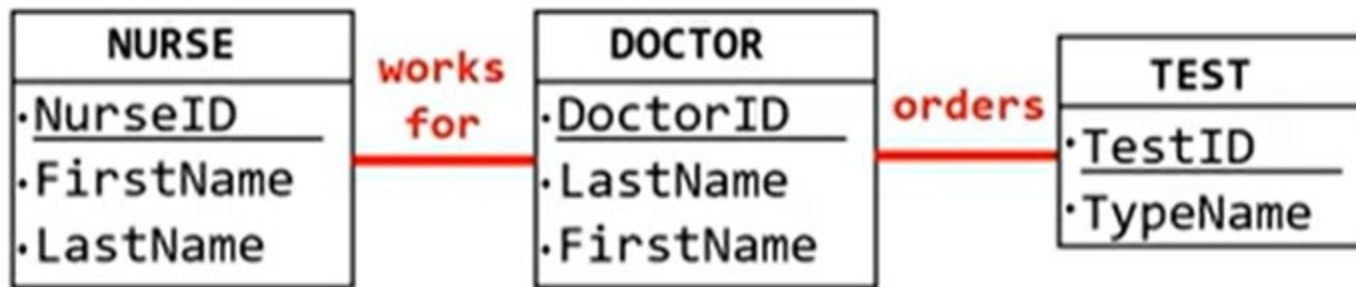
DOCTOR
• <u>DoctorID</u>
• LastName
• FirstName

TEST
• <u>TestID</u>
• TypeName

STEP 4

Step 4: Decide on the **relationships** and draw lines between the entities, including any **attributes** of the relationships.

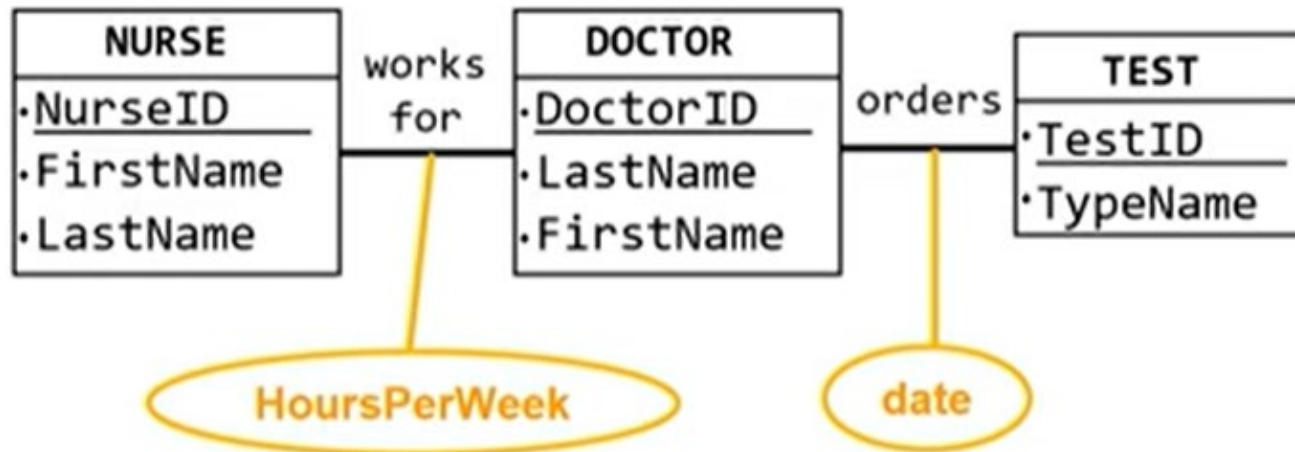
طبيعة العلاقات إلى عندي اياها



1. Nurses **work for** the **Doctor** in the office.
6. Only a **Doctor** can **order** a type of **Test**, but not all **Doctors order Tests**.

STEP 4

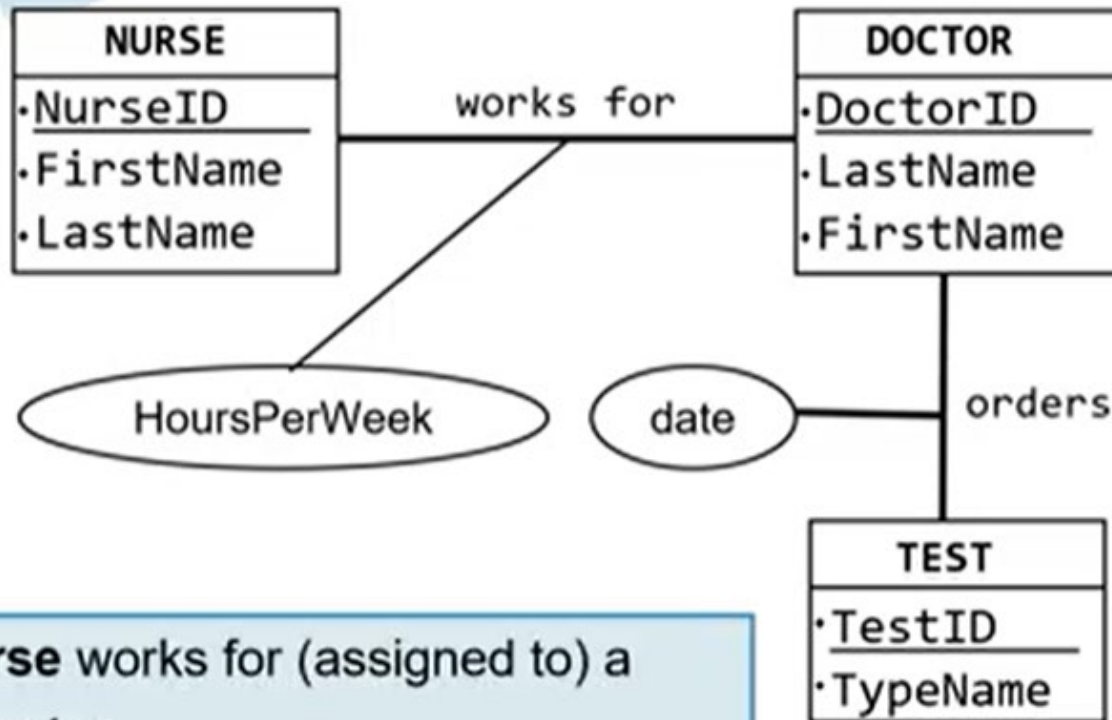
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9. We need to keep track of the **date** that any **Test order** was placed.

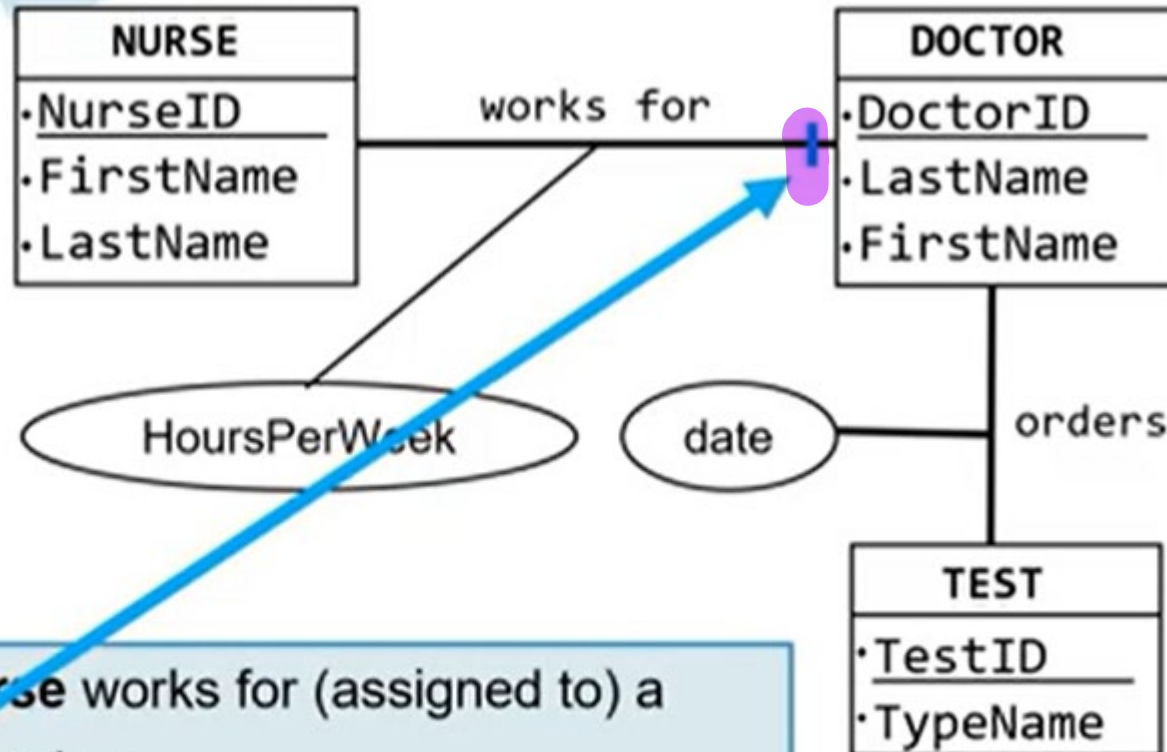
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Step 5: Decide on the **cardinality** of each relationship and add it to the diagram.

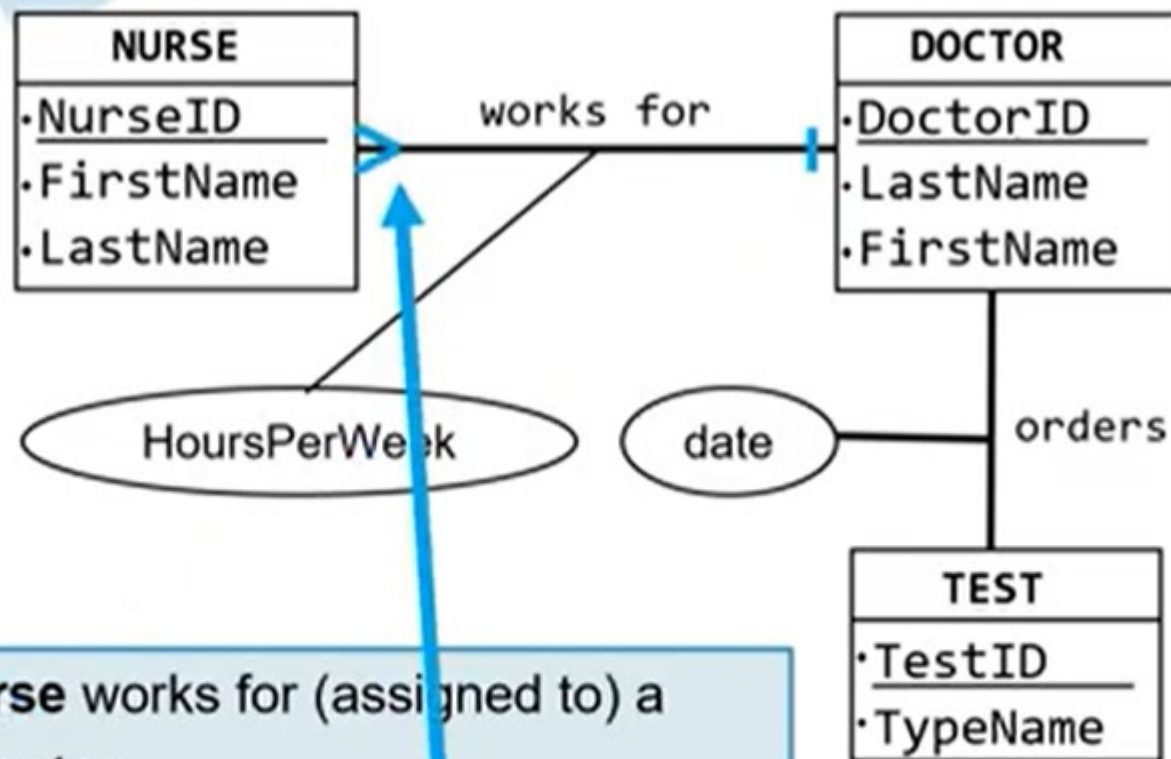


2. Each **Nurse** works for (assigned to) a **single Doctor**.
3. Every **Doctor** has one or **more Nurses** working for (assigned) them.

دائما نخطها على الطرف الاخر

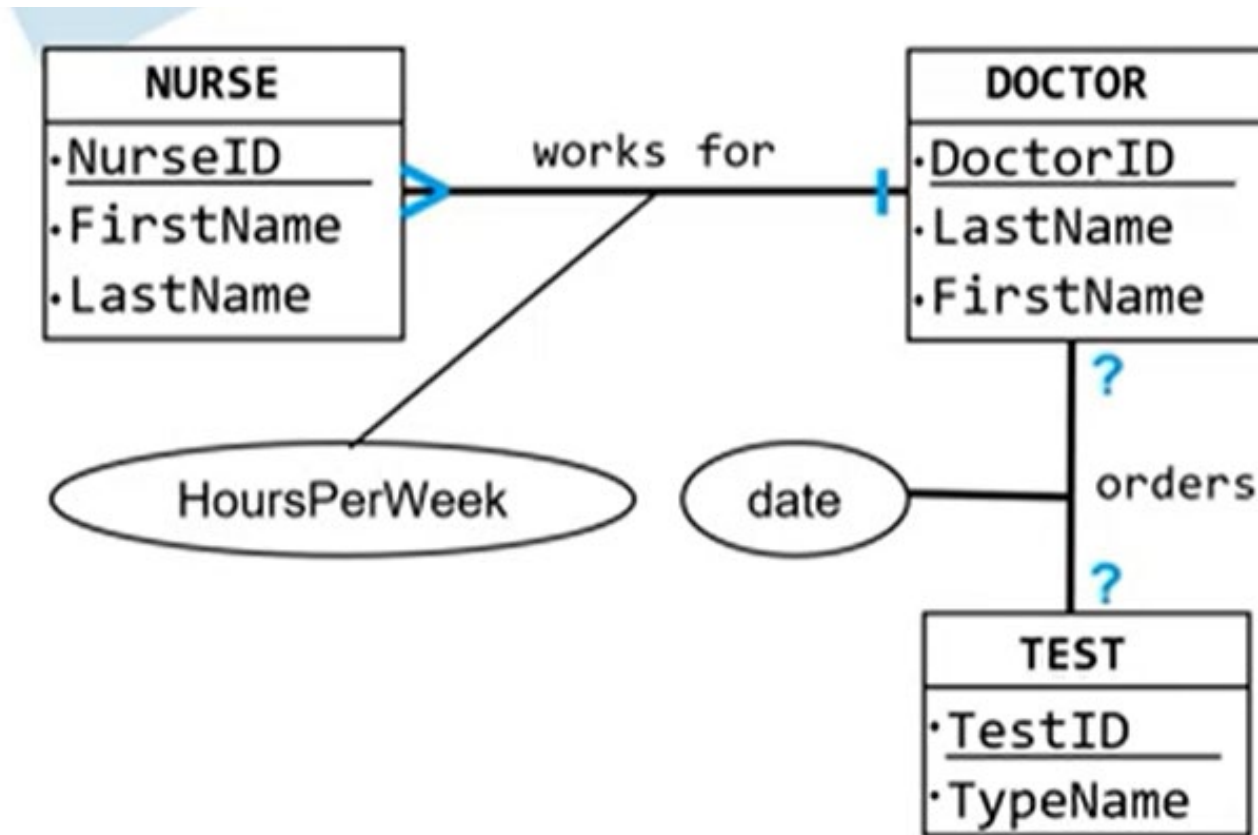


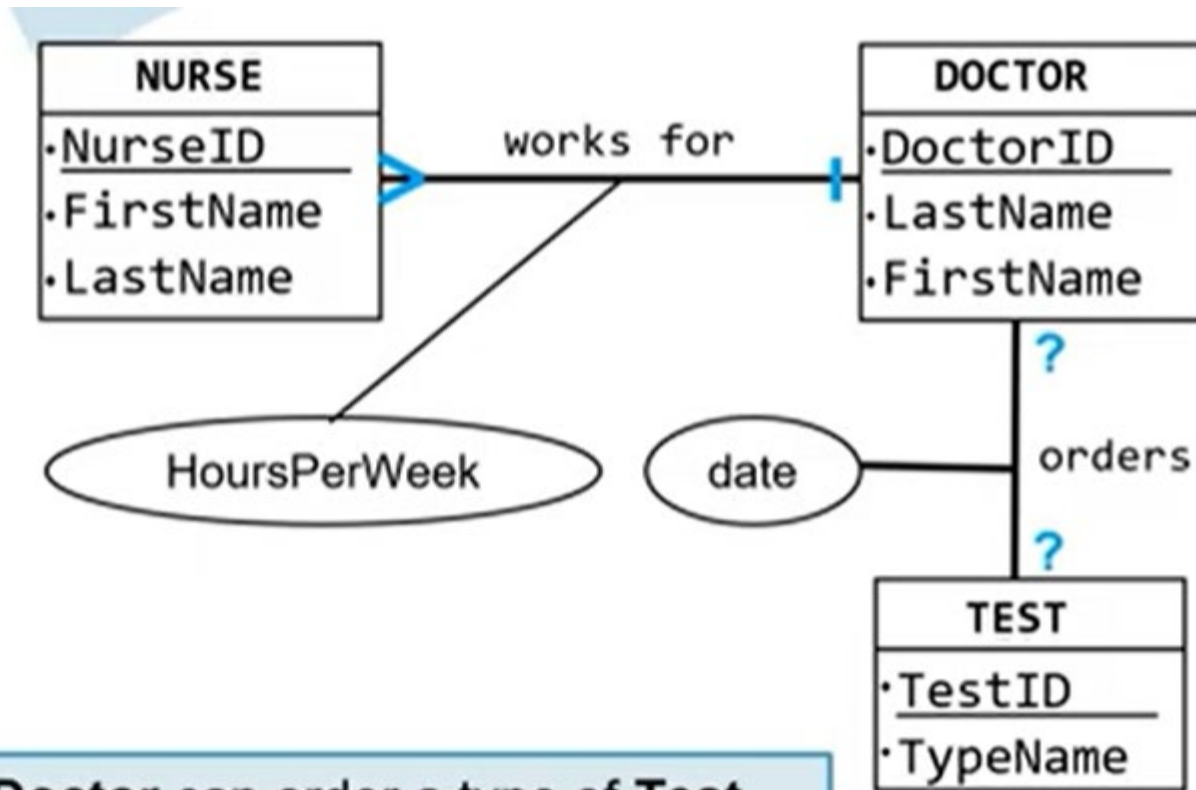
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دائما على الطرف المقابل لها

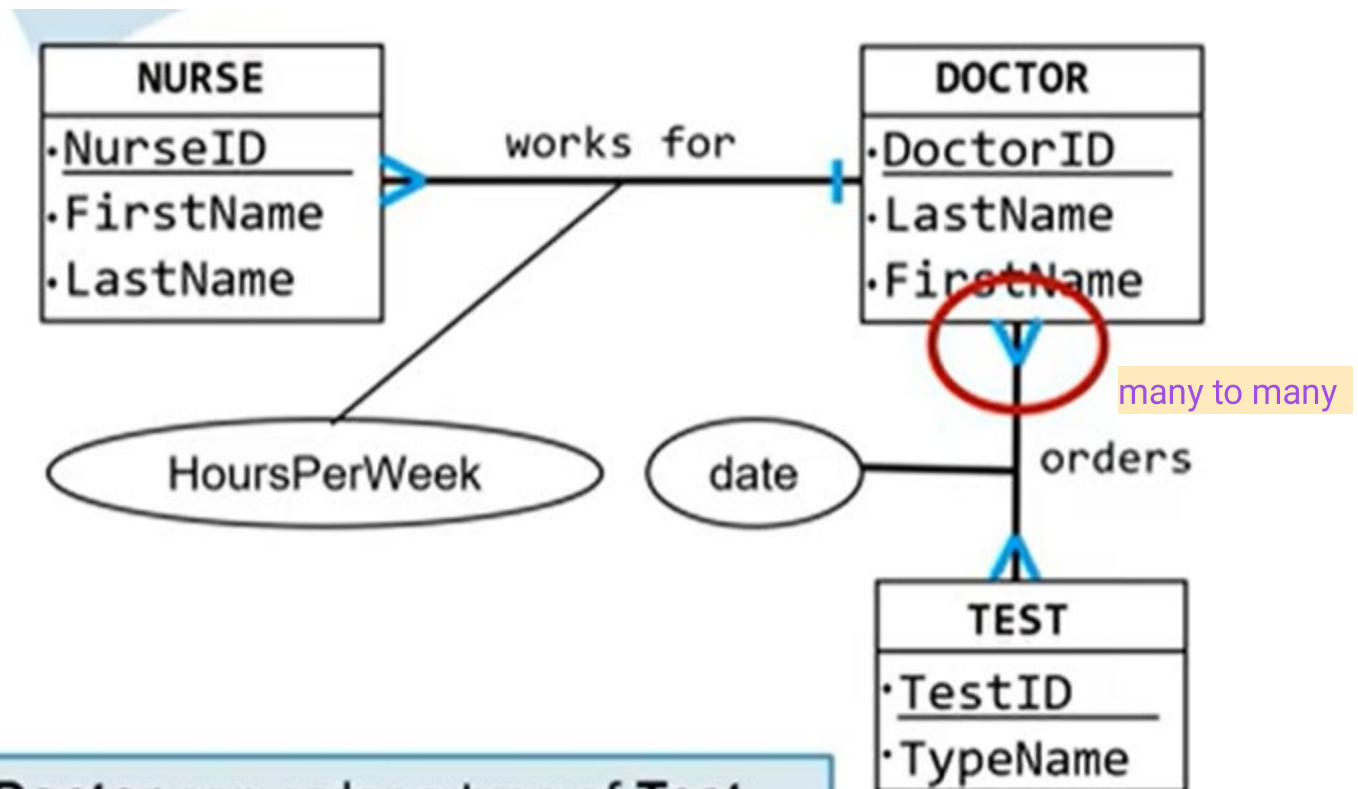




6. Only a **Doctor** can order a type of **Test**, but not all Doctors order **Tests**.

(notice the ambiguity – now common sense comes in to play ...)

ممکن ینطلب اکثر من تست والی یطلبهم اکثر من دکتور

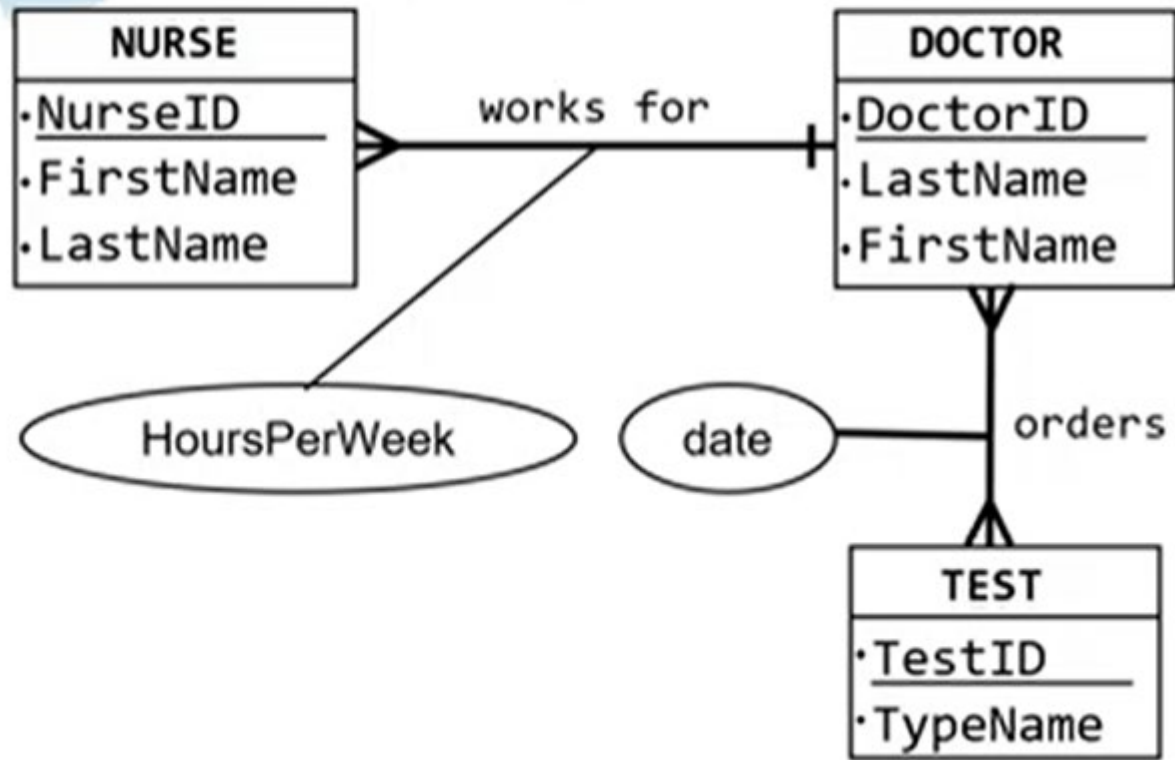


6. Only a **Doctor** can order a type of **Test**, but not all Doctors order **Tests**.

Test can be ordered by different Doctors (e.g. both Dr. A and Dr. B can order a MRI).

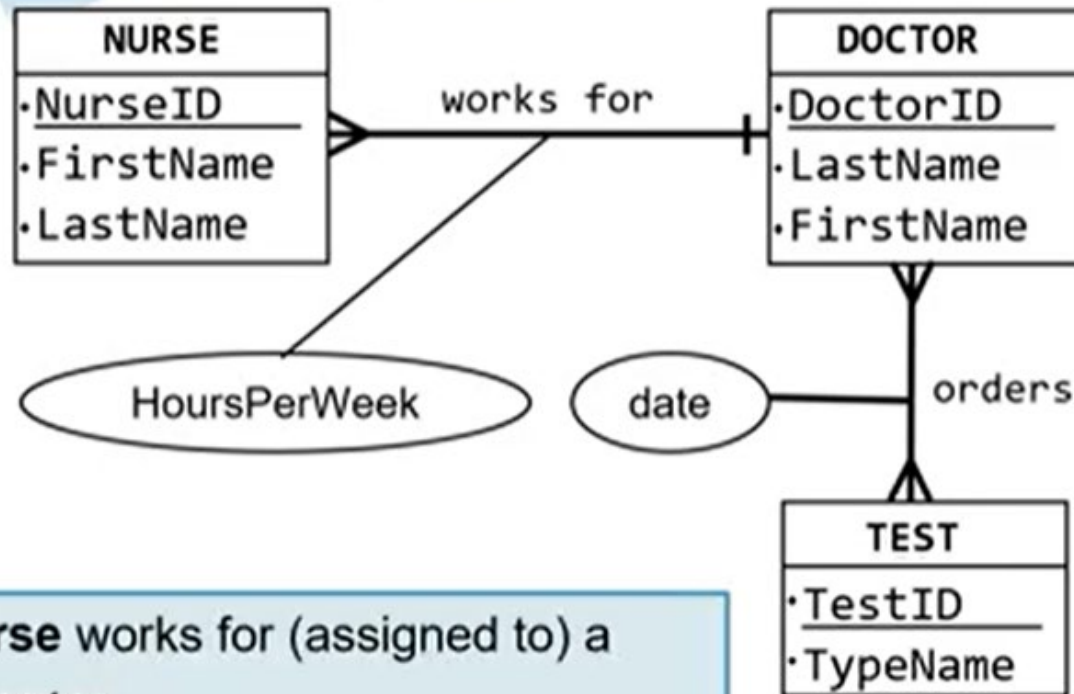
STEP 6

Step 6: Decide on the **participation** of each entity in each relationship and *add* if required.

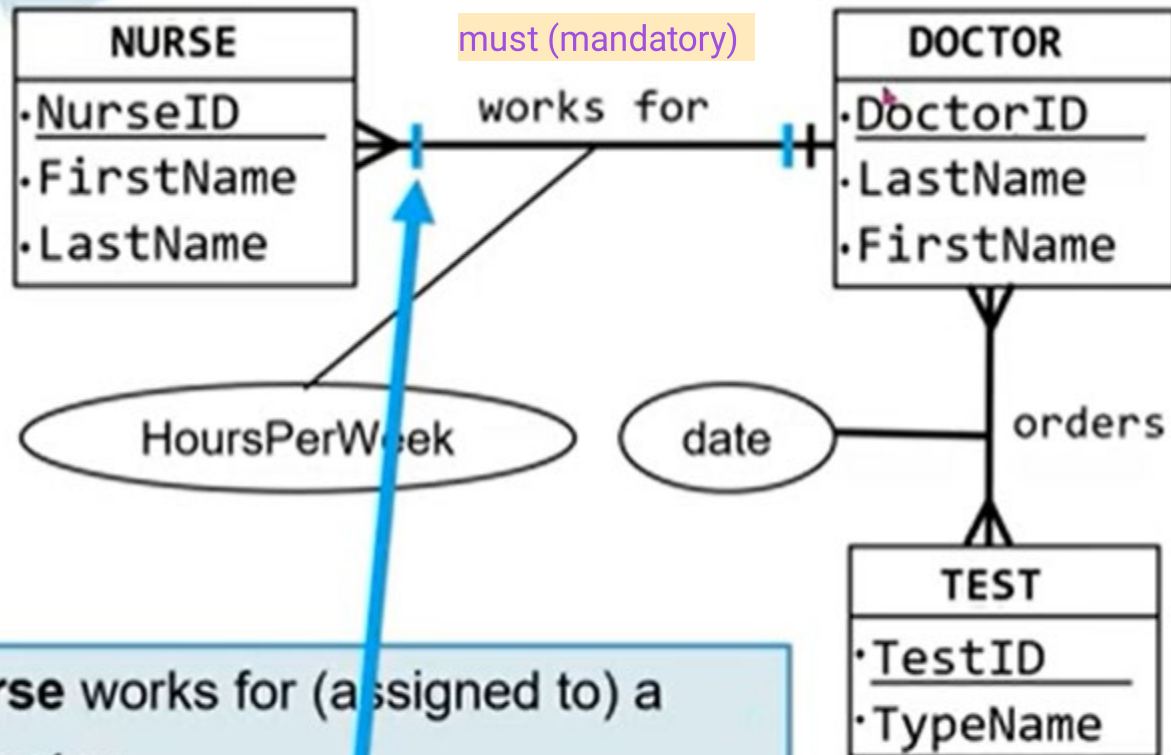


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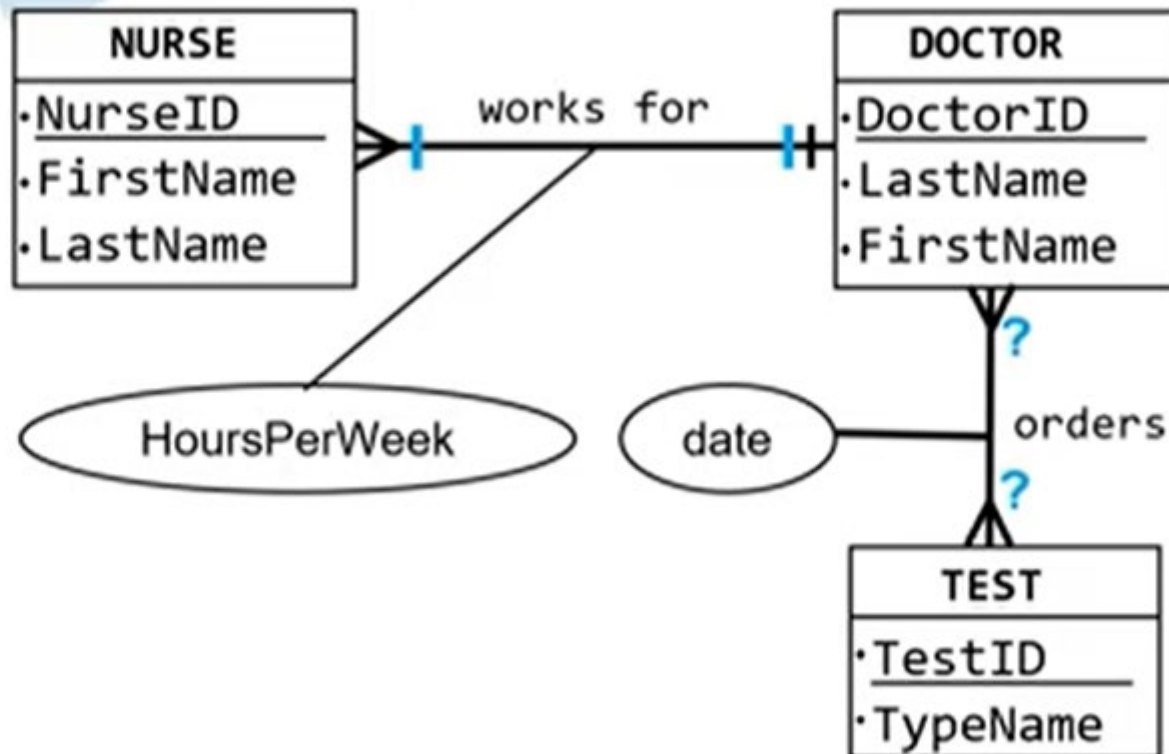


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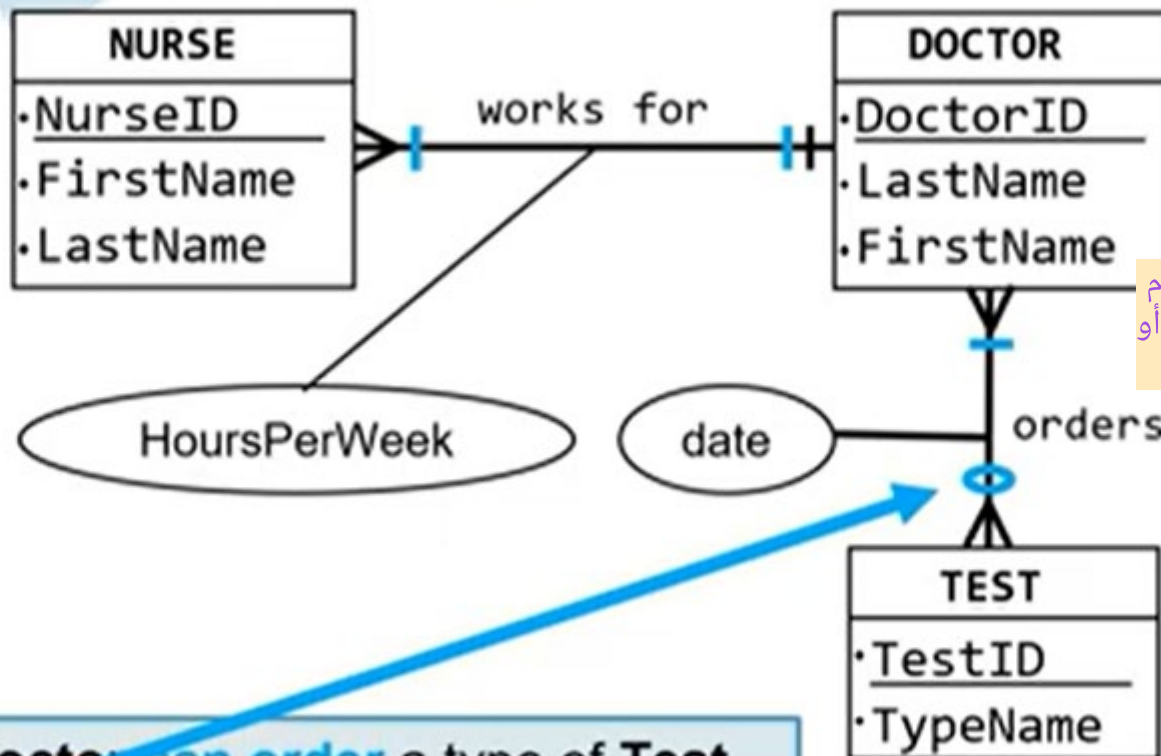


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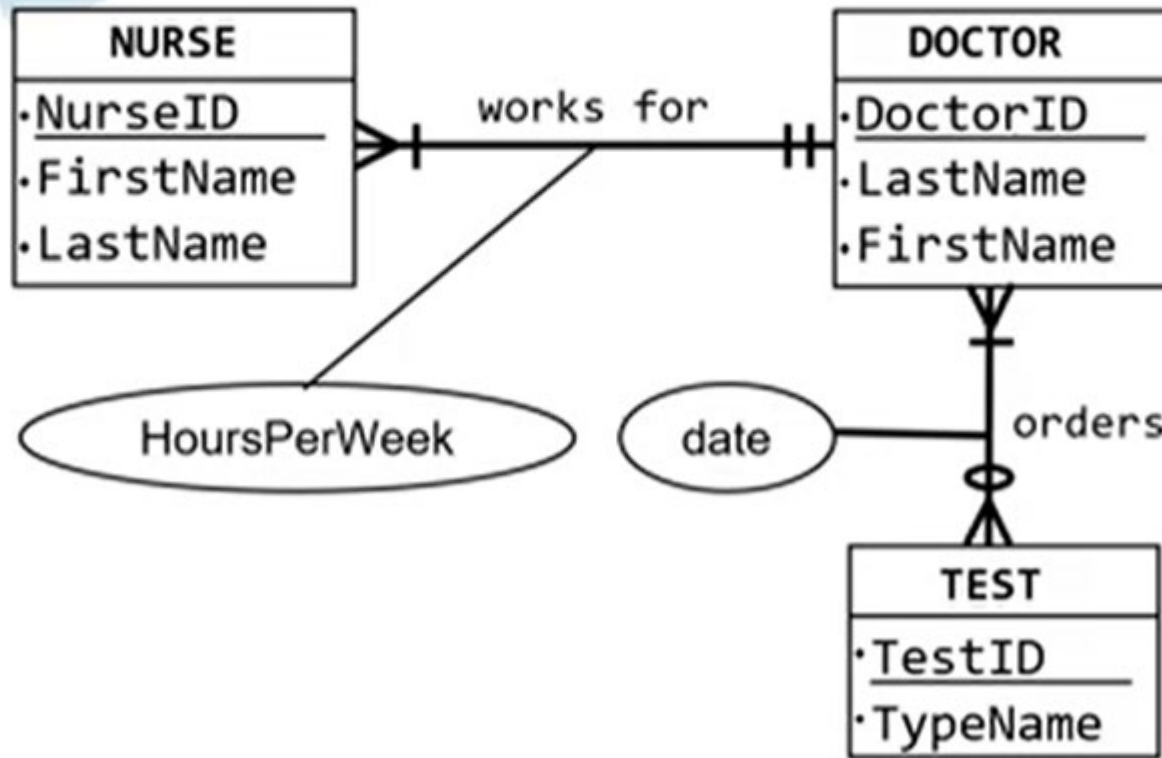
بس كل تيست لازم
ينطلب من دكتور أو
اكثر

ممکن optional
ينطلب تيست و ممکن
لا

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STEP 7

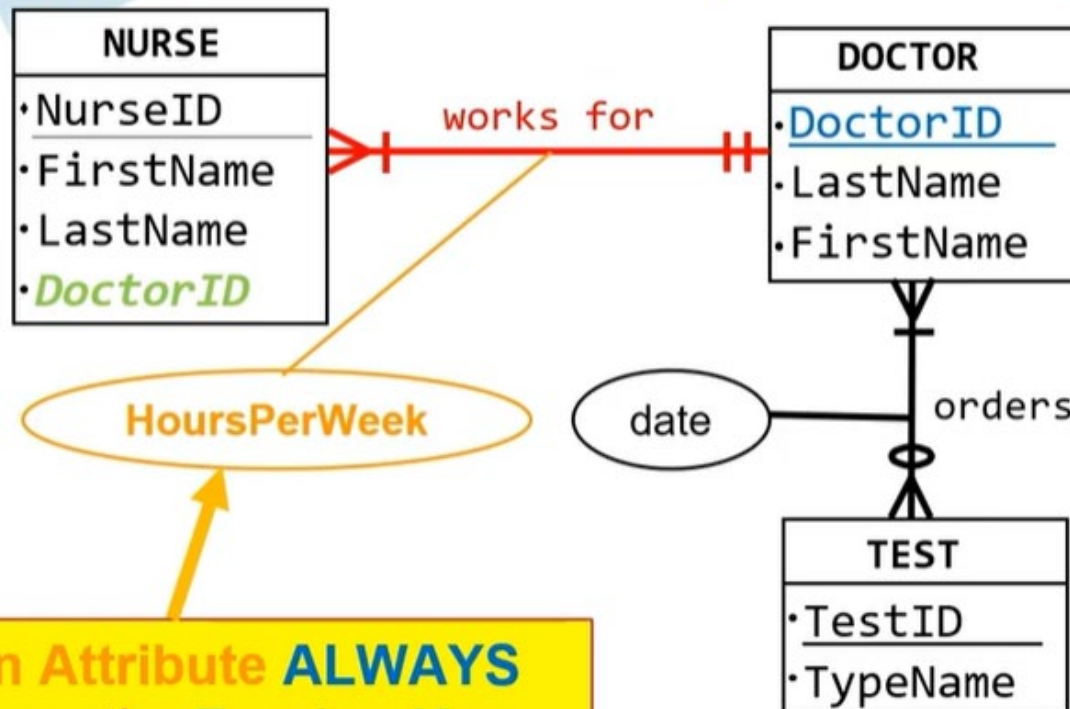
Step 7: Add the **foreign keys** of each **relationship** for each entity pairs and **add relationship attributes** if present.



STEP 7

لازم تكون primary key في entity مختلفة

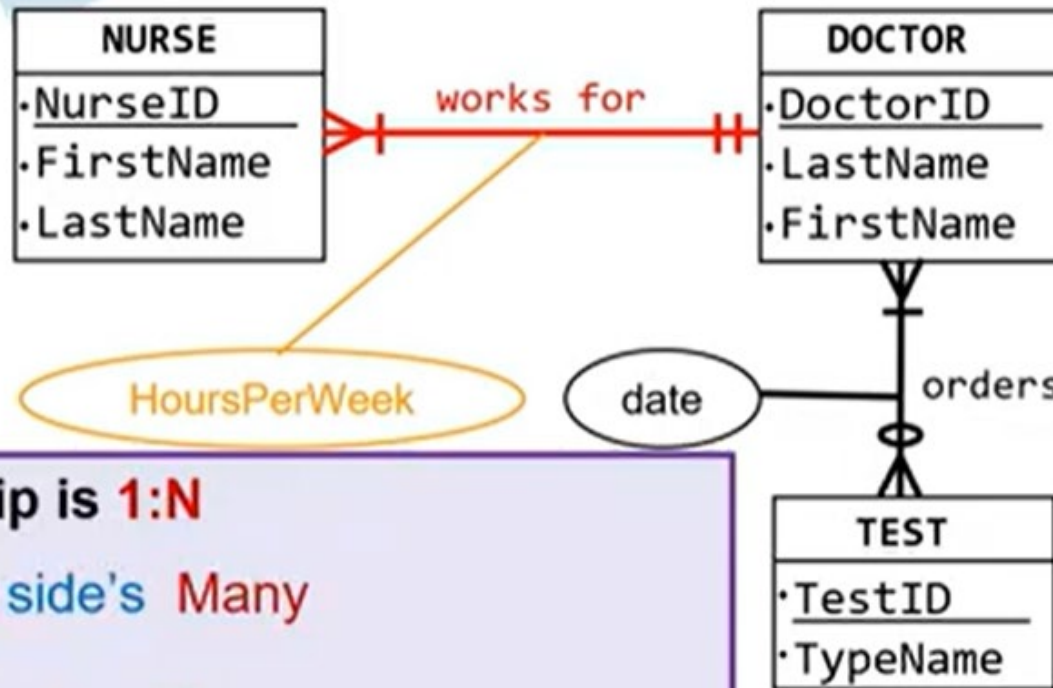
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- Relation Attribute **ALWAYS** follows the **Foreign Key**

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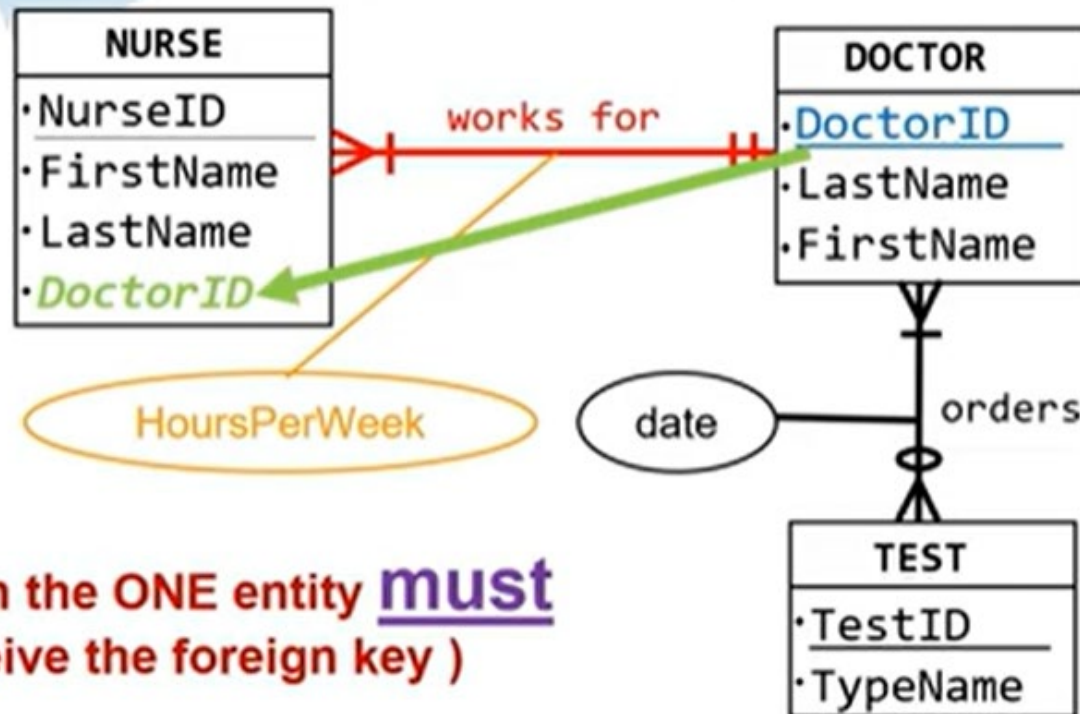
Relationship is 1:N

if only one side's **Many**
- and -

the other side is **One**
(then the **ONE** entity must
receive the foreign key)

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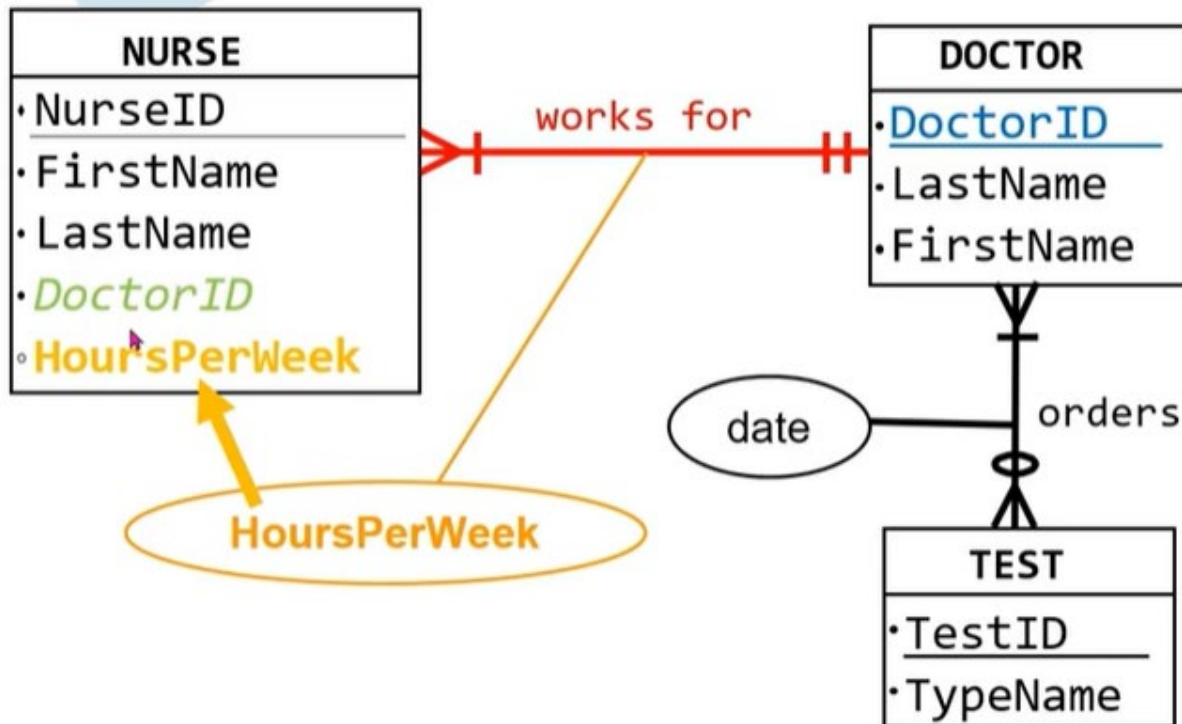


(1:N - then the ONE entity **must** receive the foreign key)

- This is a 1:N connection : so **Primary** from MANY entity becomes **Foreign** in the ONE entity

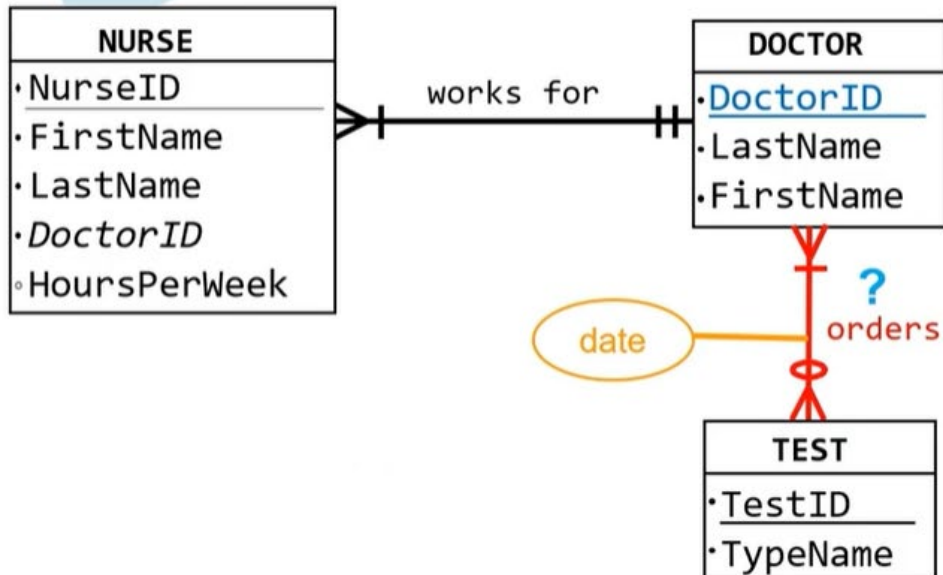
STEP 7

Step 7: Add the **foreign keys** of each **relationship** for each entity pairs and **add relationship attributes** if present.



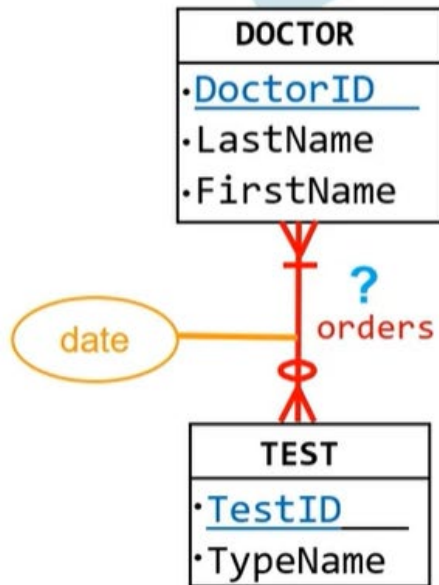
STEP 7B: SPECIAL CASE

Step 7b: Special case: Resolve N:M relationships (create relationship entities).



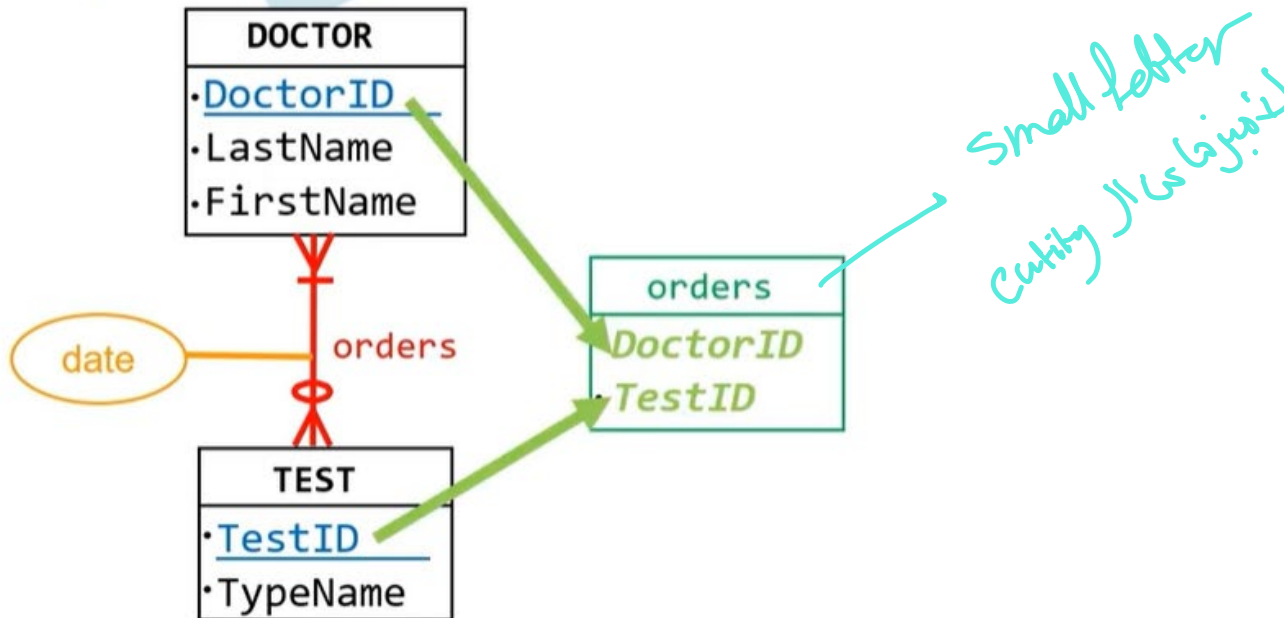
STEP 7B: SPECIAL CASE

Step 7b: Special case: Resolve N:M relationships (create relationship entities).



STEP 7B: SPECIAL CASE

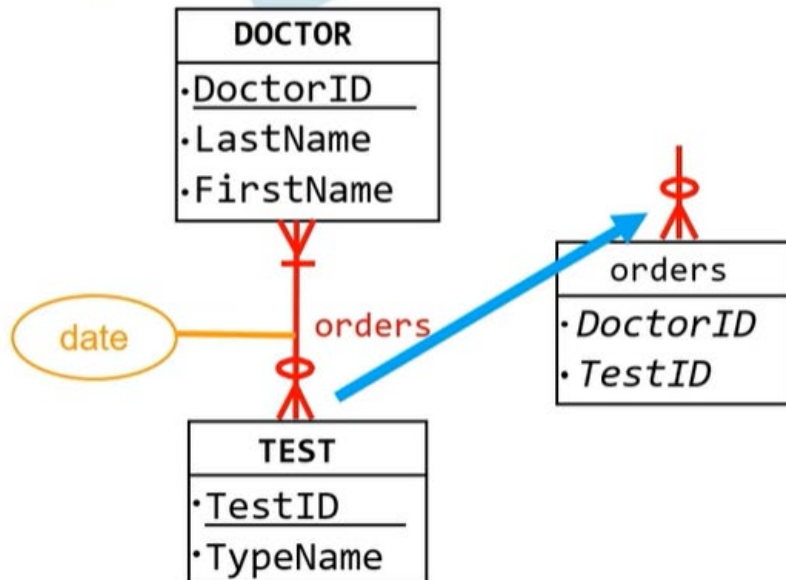
Step 7b: Special case: Resolve N:M relationships (create relationship entities).



Create new **relationship entity** with **primary keys** from both entities as **foreign keys** in the new **relationship entity**.

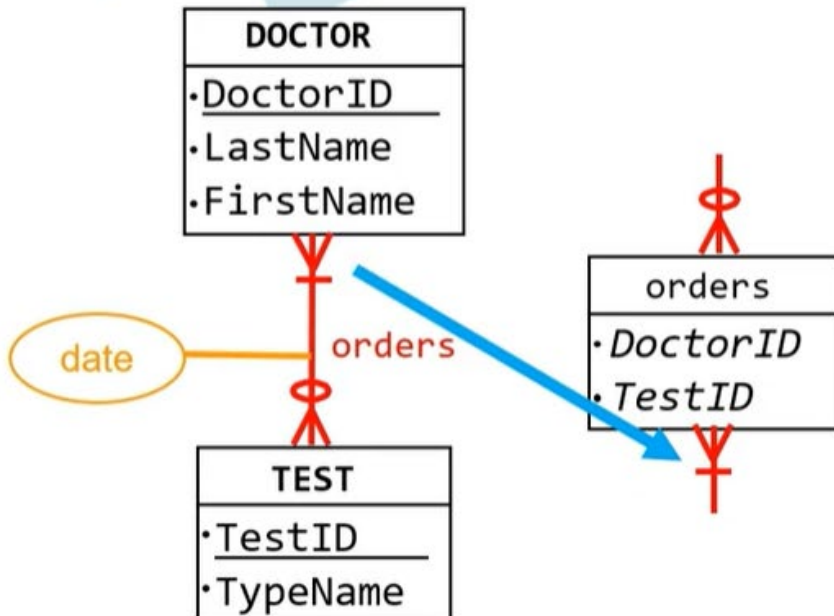
STEP 7B: SPECIAL CASE

Step 7b: Special case: Resolve N:M relationships (create relationship entities).



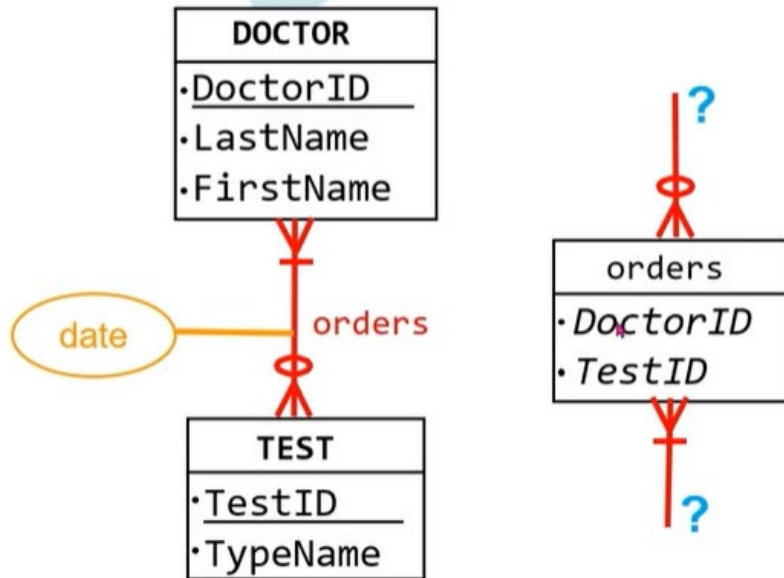
STEP 7B: SPECIAL CASE

Step 7b: Special case: Resolve N:M relationships (create relationship entities).



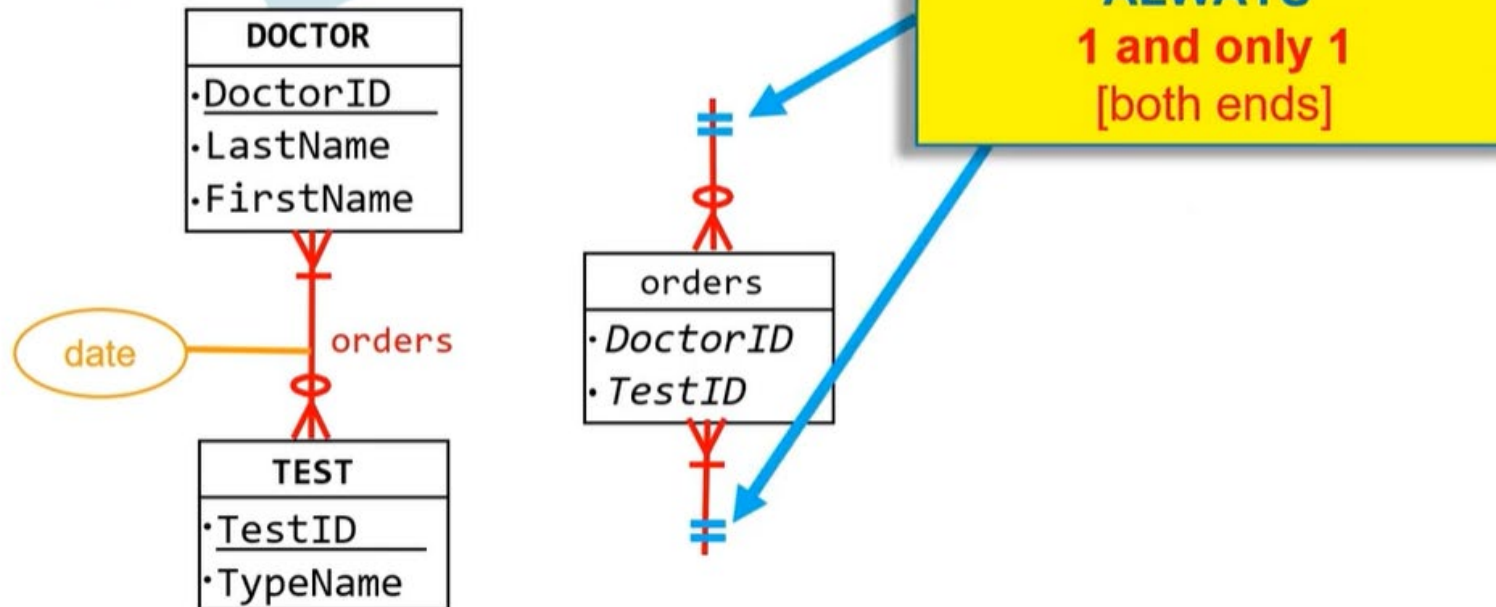
STEP 7B: SPECIAL CASE

Step 7b: Special case: Resolve N:M relationships (create relationship entities).



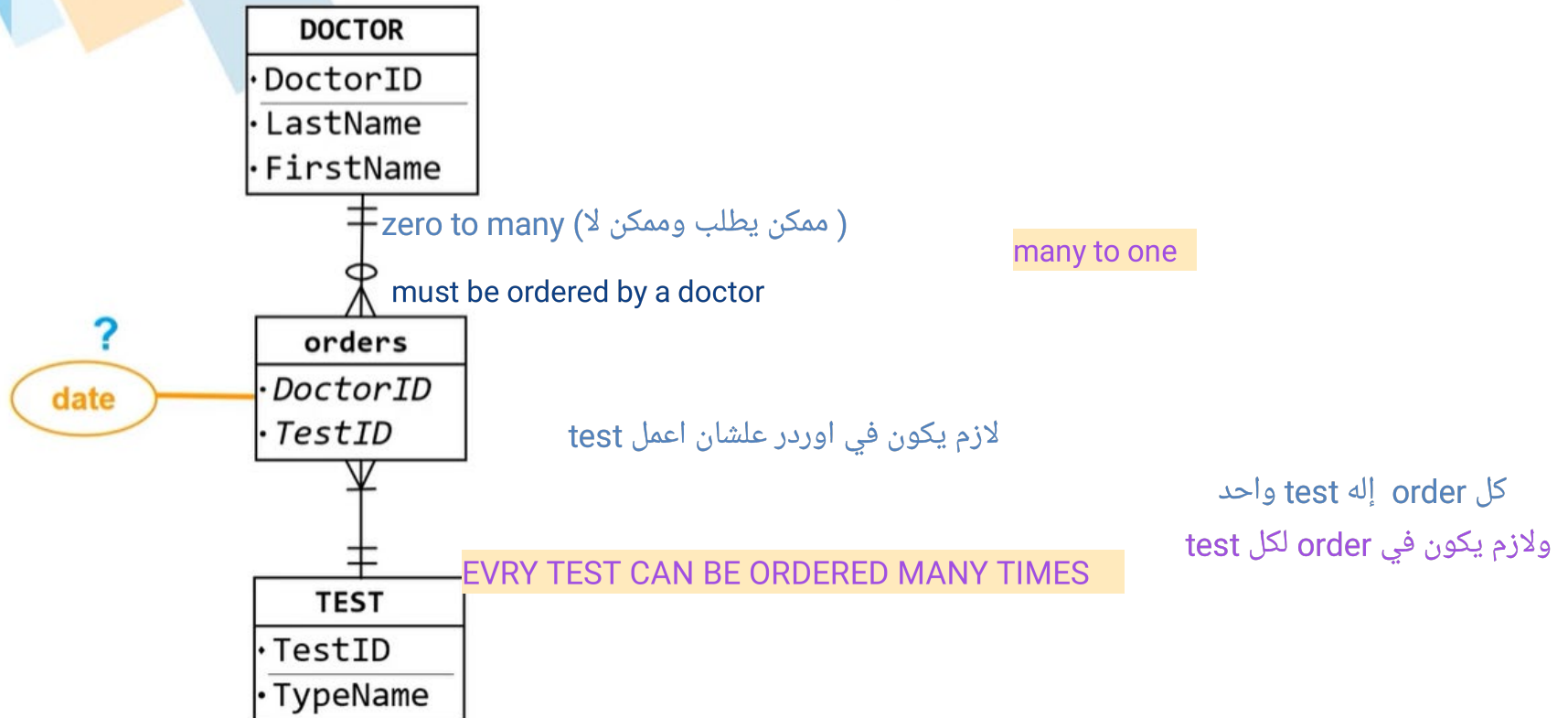
STEP 7B: SPECIAL CASE

Step 7b: Special case: Resolve N:M relationships (create relationship entities).



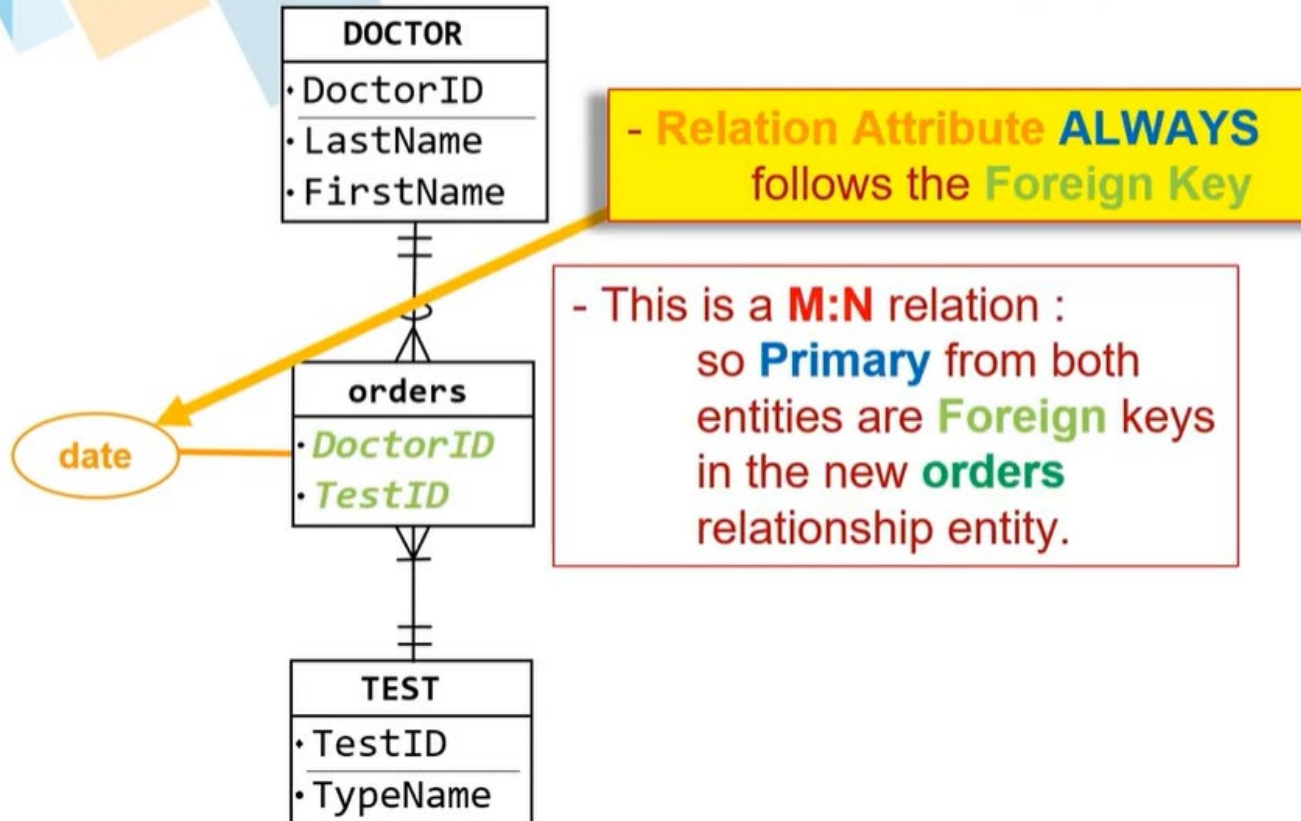
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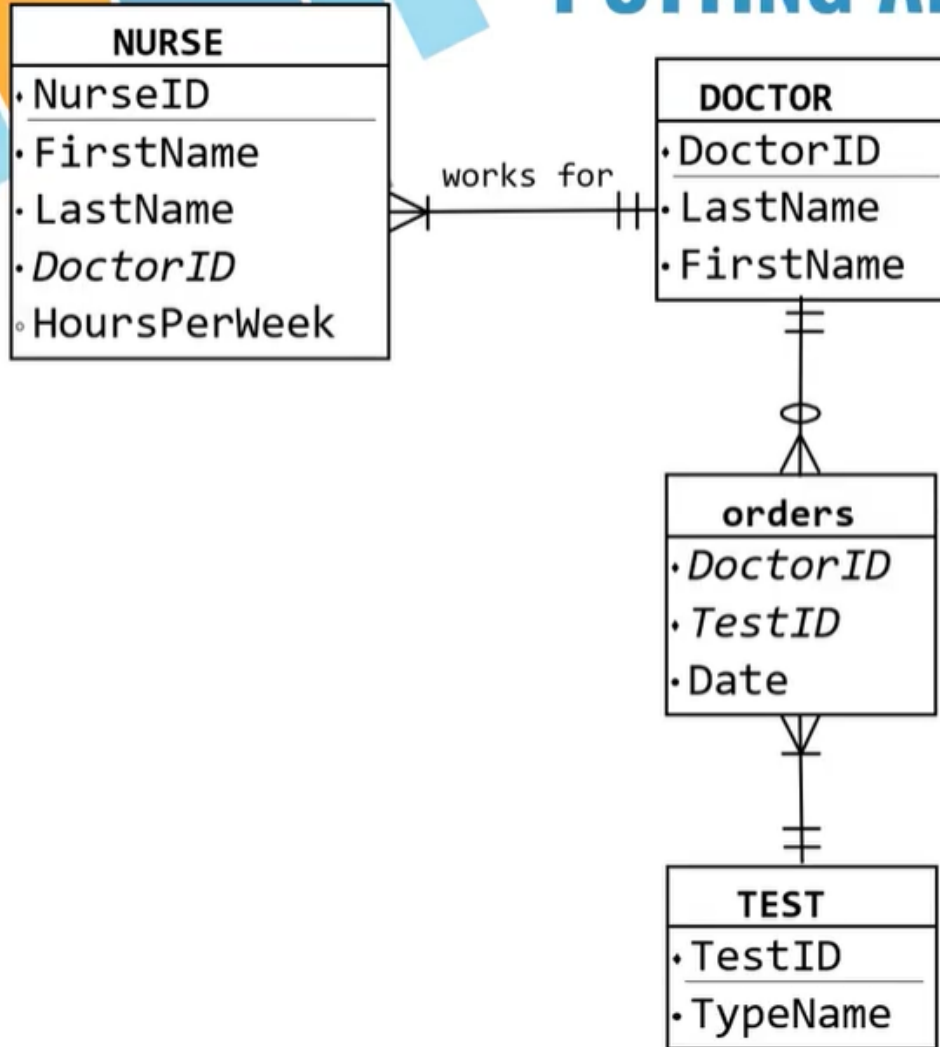


STEP 7B: SPECIAL CASE

Step 7b: Special case: Resolve N:M relationships (create relationship entities).



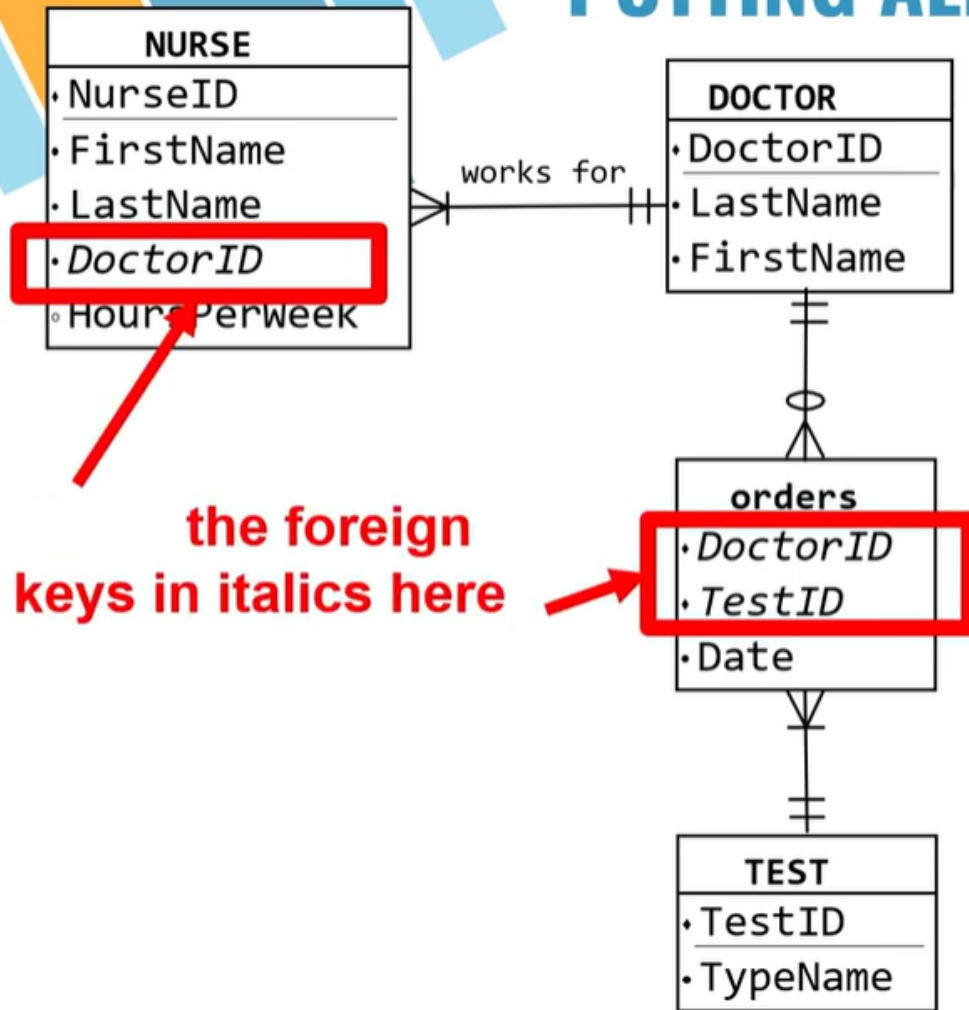
PUTTING ALL TOGETHER

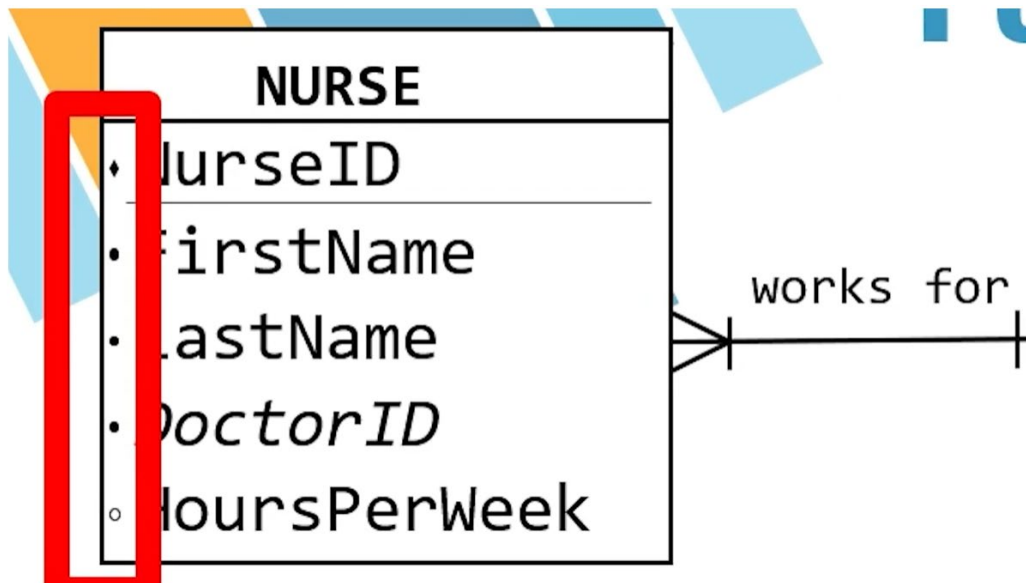


No primary key in orders entity

- Allowed in relationship entities.
- Can have multiple orders for same Doctor and Test.

PUTTING ALL TOGETHER





Primary Key Attribute

Also denotes a primary key.

Required Attribute

Each instances of an entity must have a value of this attribute (e.g. all students must have a name).

Nullifiable Attribute

An instances of an entity may have no value for this attribute (e.g. students are **NOT** required to have a date of birth).

USAGE

PRIMARY KEYS: (always!)

Nullable (**NO**) - can NOT be blank (empty)

Unique (**YES**) - the data can NOT be the repeated

A Primary Key must be filled in and must be unique.