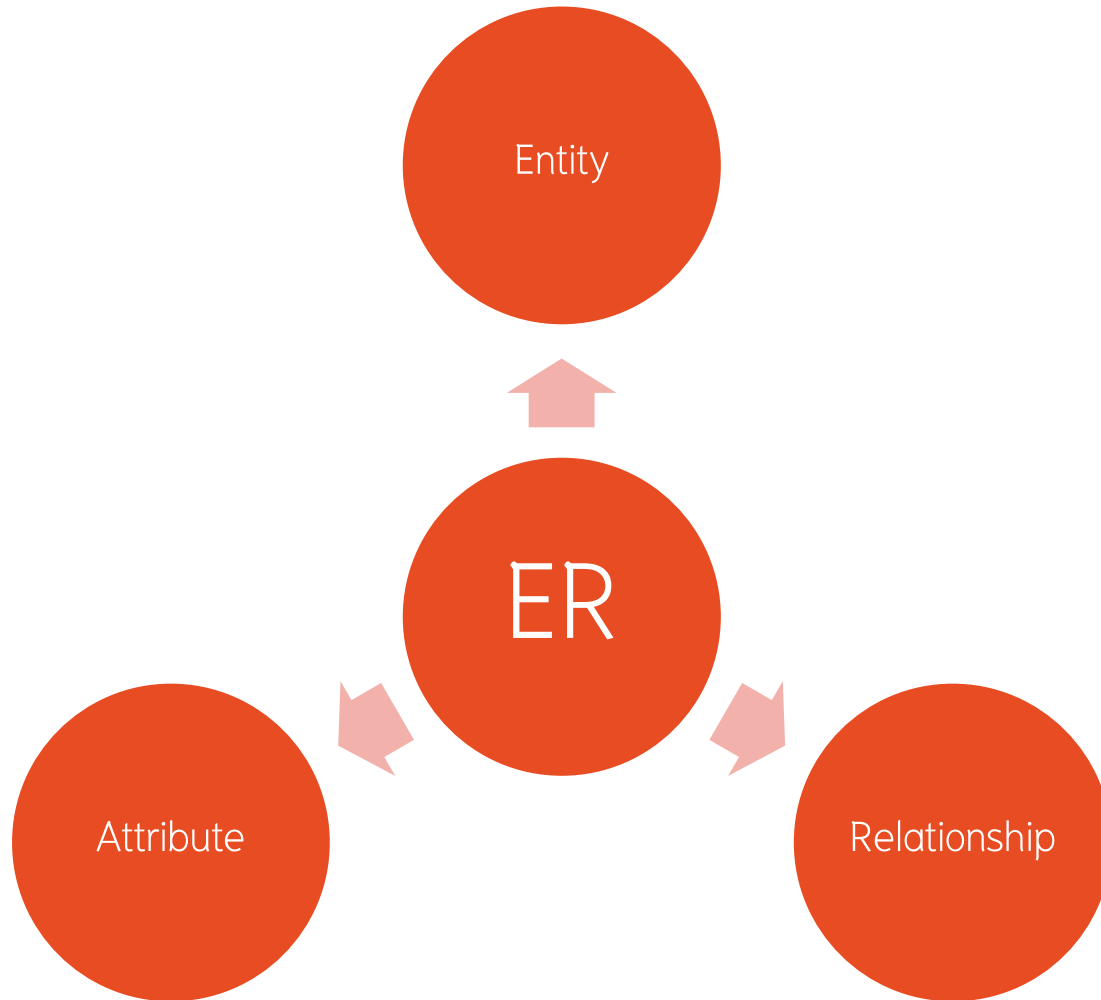


Database Systems and Database System Design

Entity-Relational Model

Entity-Relationship Diagram



Entity

Entity

- Entity types

“A group of objects with the same properties which are identified by the enterprise having an independent existence”

- Represent the group of object in the real world with the same properties.
- Object can be either physical or conceptual.

Staff

Customer

Part

Supplier

Book

Product

Physical existence

Viewing

Inspection

Sale

Work experience

Conceptual existence

Entity

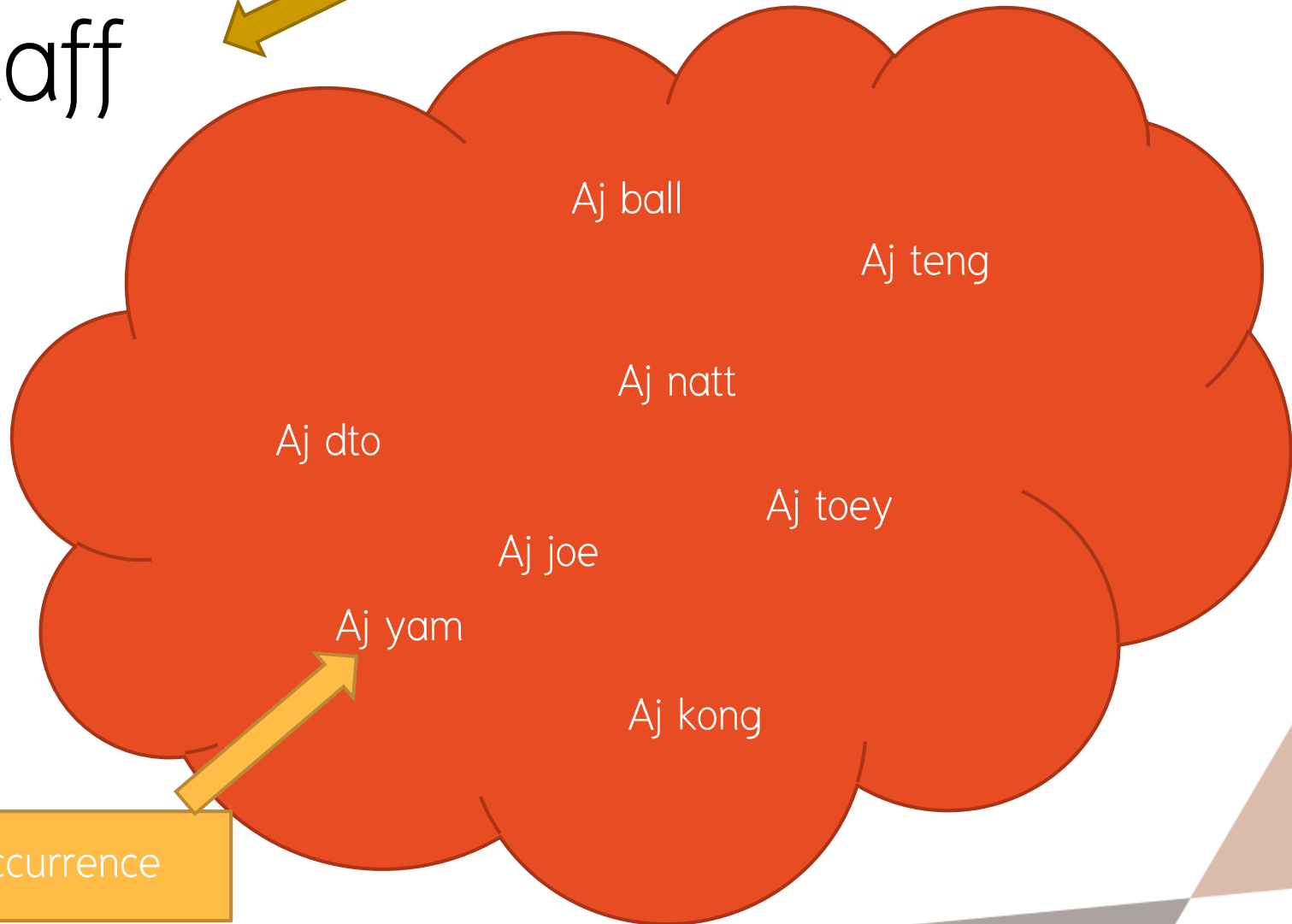
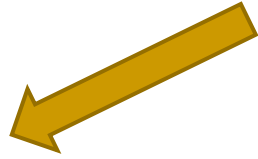
- Entity occurrence

“A uniquely identifiable object of an entity type.”

- Refer to a group of object that share some characteristics or properties.
- A unique identifiable object of an entity type.
- The name of the entity in a certain system is unique.

Staff

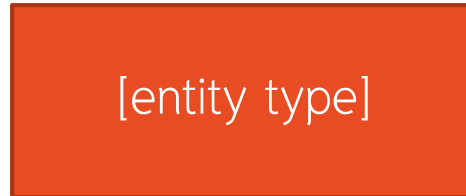
Entity
type



Entity occurrence

Entity

- ER diagram Symbol for entity
 - A rectangle with the name of the entity in the middle of the symbol



Entity naming convention

- The name must be a **SINGLE** word.
 - Eg. Staff, Student, Teacher ...
- The name must be a **MEANINGFUL** word.
- The name must be a **SINGULAR** noun.
- The name must be **CONSISTENT**.
 - Every application must refer to the same name.

staff

product

bill

customer

order

course

book

enrollment

student

Attribute

Attribute

- Attribute

“A characteristic or a property of an entity or a relationship type.”

- The attribute is something that describes the entity.
- Each occurrence in the entity must contain all of attributes.

FLOWER

color

breed

The FLOWER entity is described by color and breed.

Attribute

- Attribute domain

“The set of allowable values for one or more attributes”

- Each value of each attribute must follow the possible value in the domain.

- Null value

“Null is the special attribute value that indicates an unknown or missing value.”



0 vs NULL

Attribute

Attribute	Ex Value 1	Ex Value 2	Domain
Student ID	520551023	590112569	String (9)
First name	Prompong	Sirawat	String (20)
Age	12	30	Int (positive)
Course ID	953103	953212	String (6)
Course name	Abstract Datatype	Database Management	String (20)
Color	Red	Blue	String (20)
Telephone	0819928810	0816721251	String (10)

Why not int?

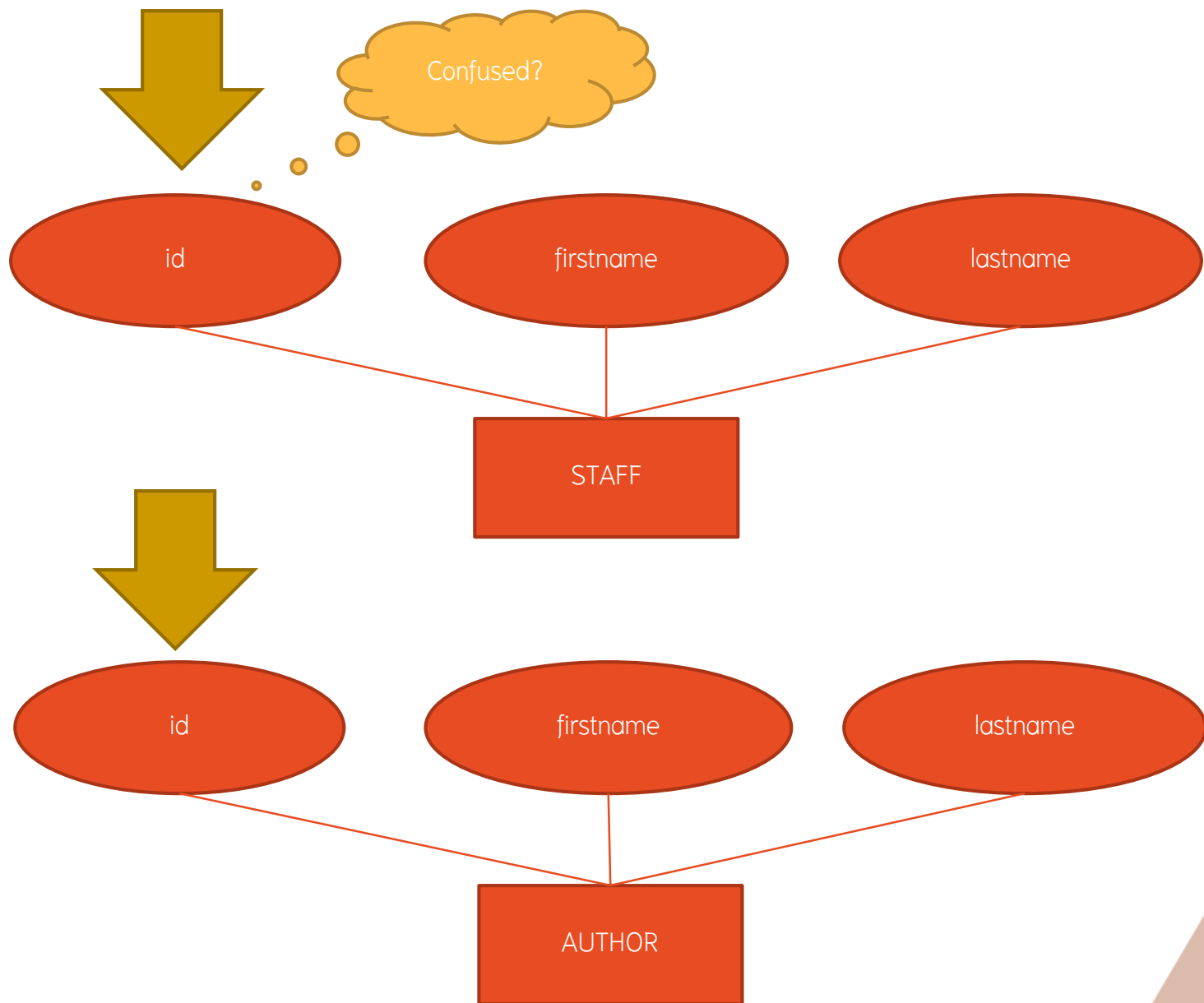


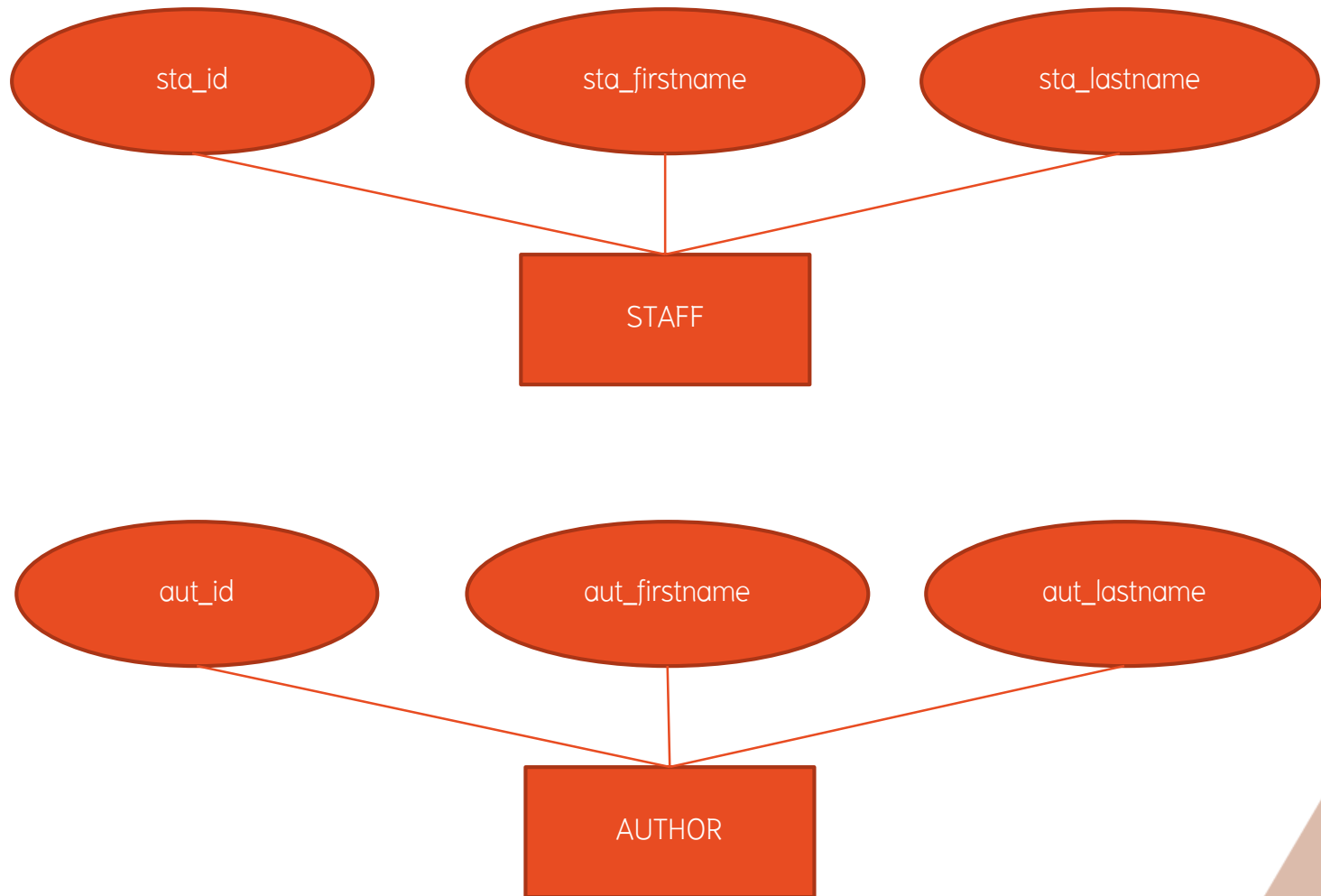
Attribute

Student ID	Course ID	Grade
520551036	953103	A
592001436	953103	NULL
592974739	953103	F

Attribute naming convention

- The name must be a **MEANINGFUL** word.
- The name should be **NOUN**.
- The name of the attribute in the same entity has to be **UNIQUE**.
- The name should include the entity name to avoid confusion.
 - std_firstname, std_lastname
- The name must not include the special character





Type of attribute

- Simple attribute

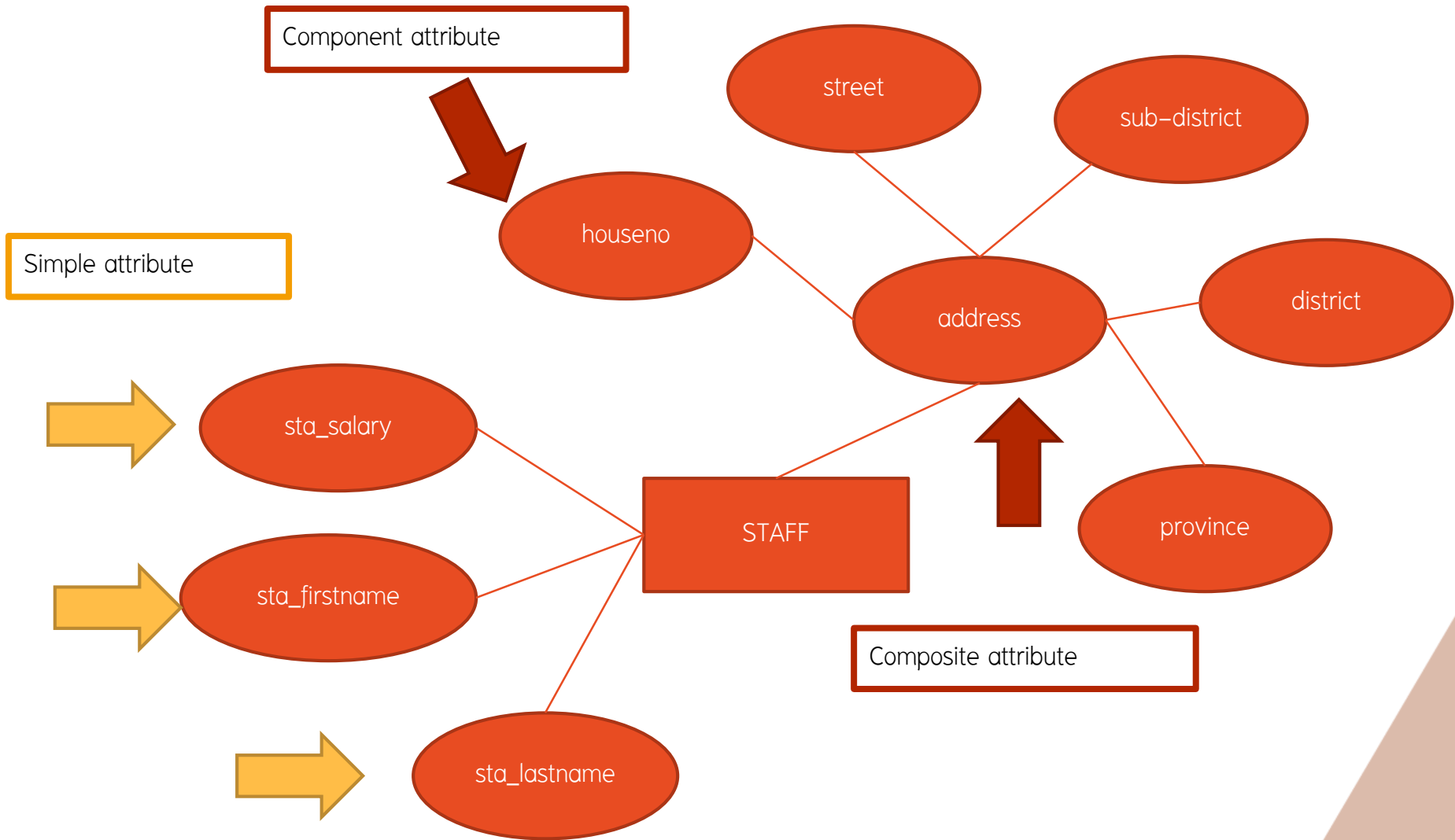
“An attribute composed of a single component with an independent existence.”

- Cannot be divided anymore
- Represent by **ellipses with the attribute's name in the center.**
- E.g.: salary, first name, last name

- Composite attribute

“An attribute composed of a multiple component with an independent existence.”

- Can be divided into sub-attribute.
- Represent by the **same symbol as simple attributes but has attributes attached to it.**
- E.g. : address consists of house no, street, sub-district, district, province



Attribute

- Single-valued attribute

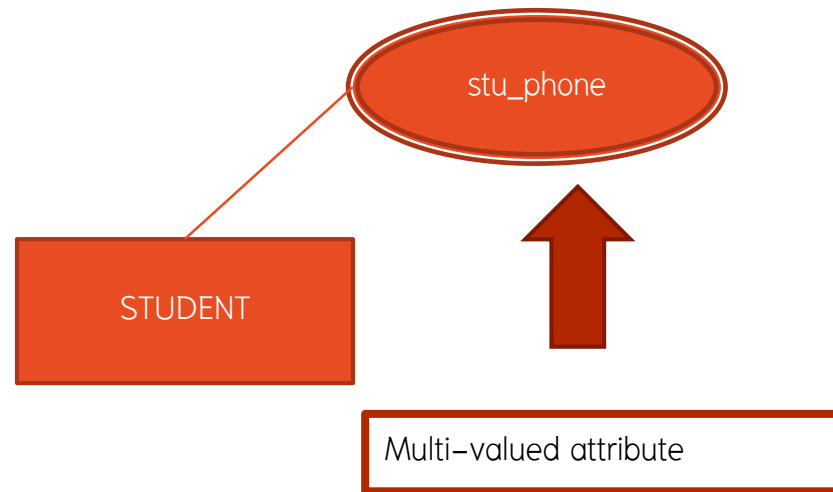
“An attribute that holds a single value for each occurrence of an entity type.”

- There is only one value of this attribute in an entity occurrence.
- Represent by the same symbol as simple attribute
- E.g. The attribute firstname of the student

- Multi-valued attribute

“An attribute that holds multiple values for each occurrence of an entity type.”

- There are many value of this attribute in an entity occurrence.
- Represent by **double ellipses with the attribute's name in the center.**
- E.g. phone number attribute of a student



Attribute

- Stored attribute

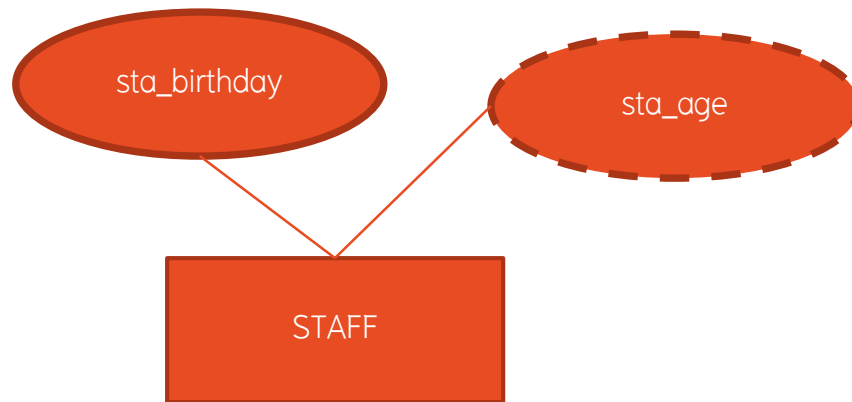
“An attribute that represents a value that is independent from other attribute.”

- The value is simply added and stored in the system.
- Represent by the same symbol as simple attribute

- Derived attribute

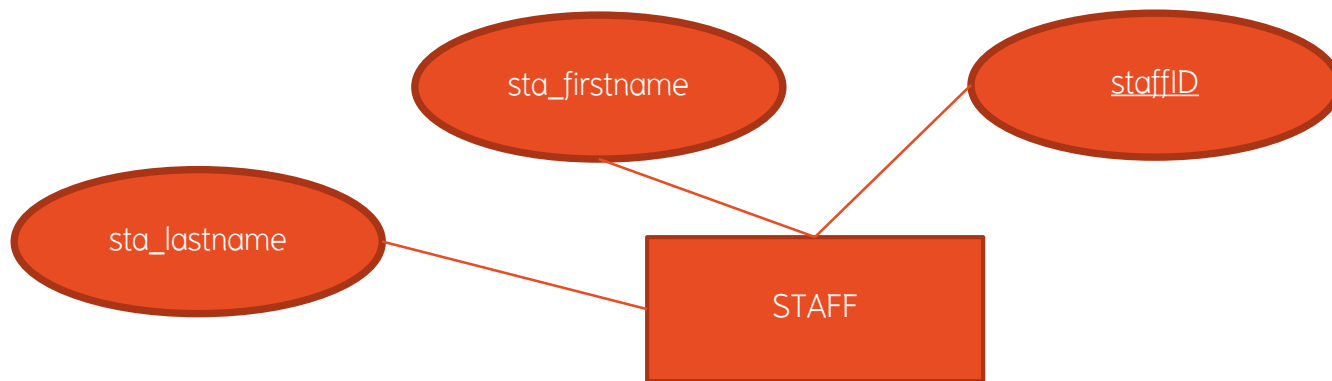
“An attribute that represents a value that is derivable from the value of a related Attribute or set of attributes, not necessary in the same entity type.”

- This attribute is calculated from other attribute in the database.
- Represent by dashed ellipses
- Age is calculated from the date of birth.



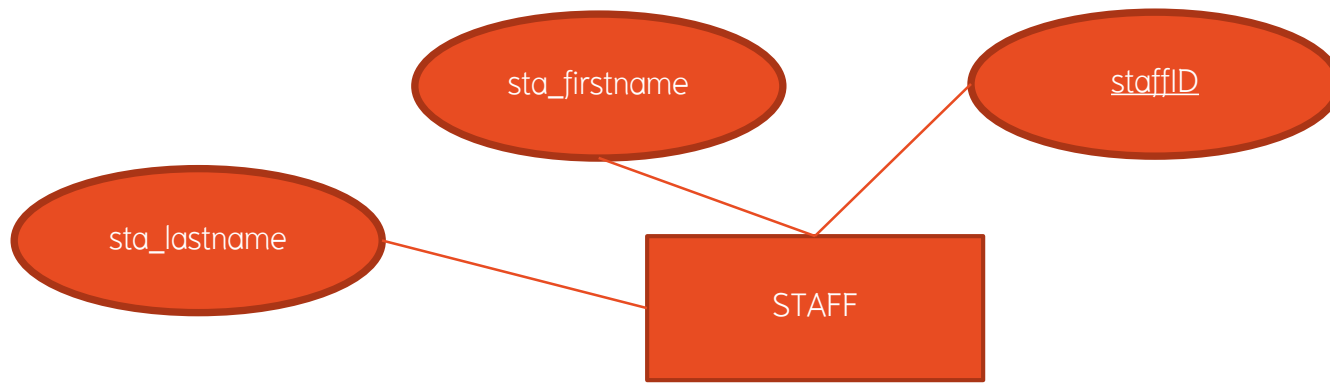
Key

- Key is a type of attribute.
- Distinct and Unique for each entity occurrence.
- The key in the ER diagram is an attribute whose name is underlined inside the oval.



Mapping Entity to Relation

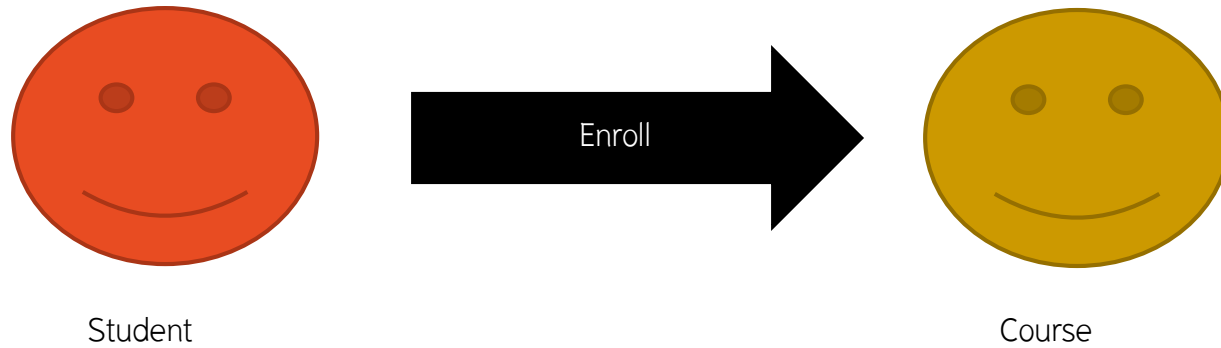
- One attribute in entity to one attribute in relation



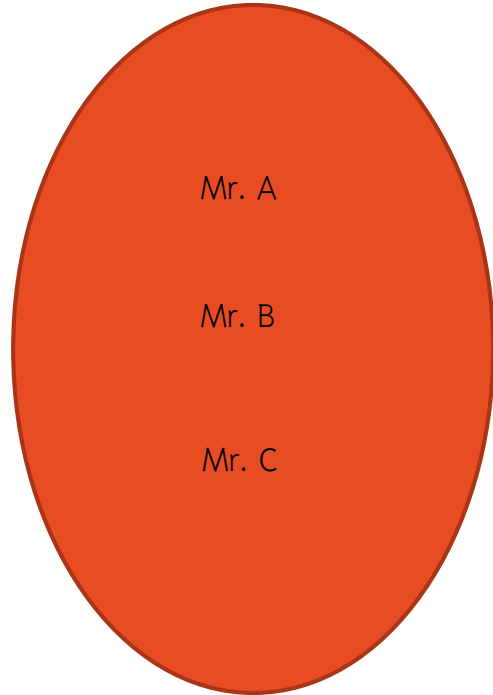
staffID	sta_firstname	sta_lastname

Relationship

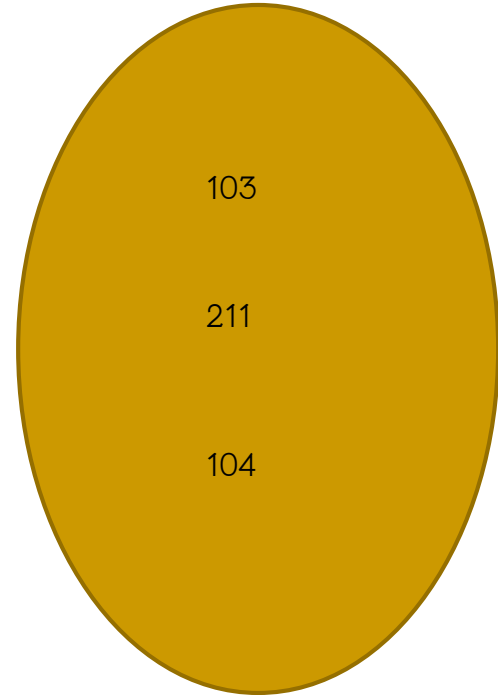
Relationship



Relationship



Student



Course

Relationship

- Mr A enroll 103 and 211.

(Mr A, 103) (Mr A, 211)

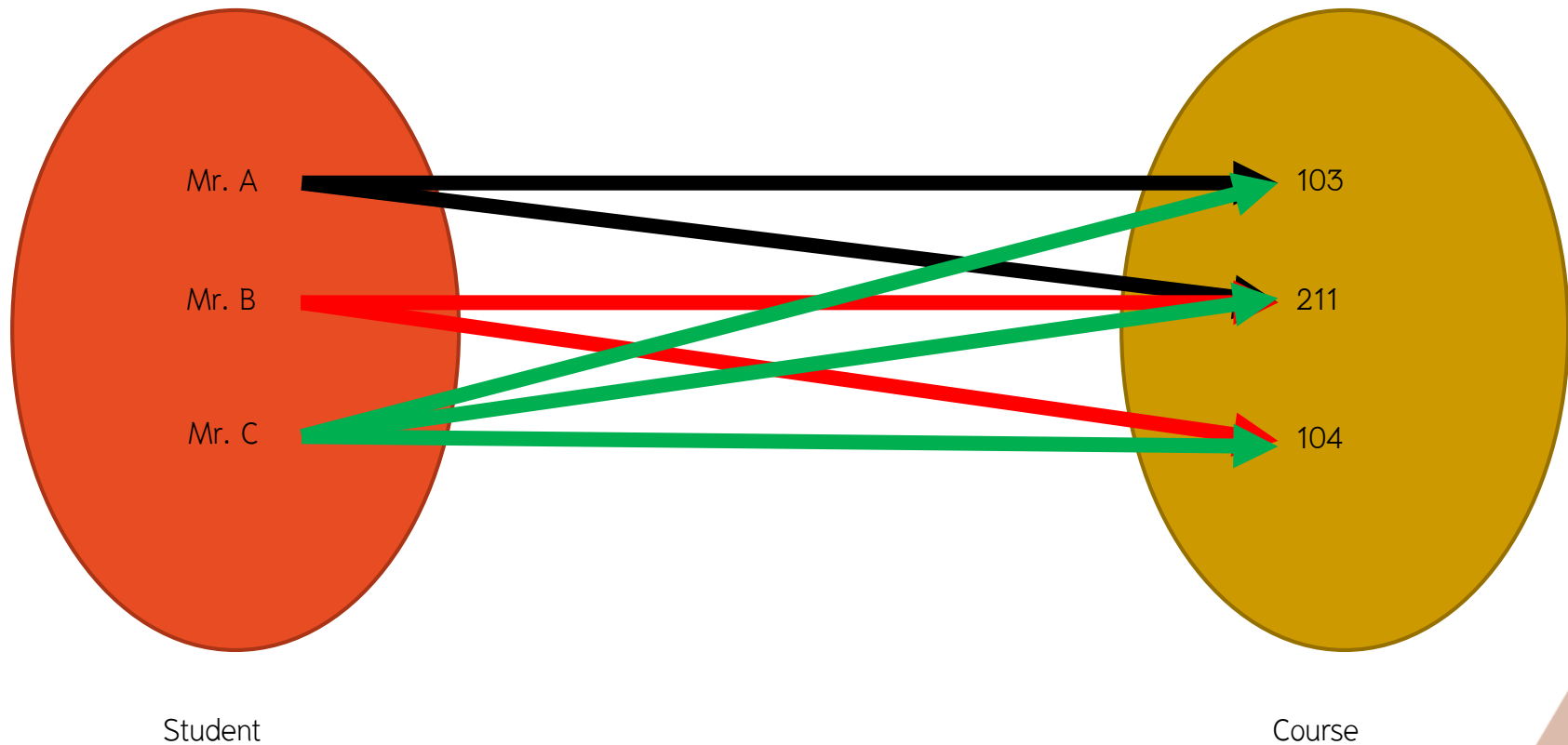
- Mr B enroll 104 and 211.

(Mr B, 104) (Mr B, 211)

- Mr C enroll 103, 104 and 211.

(Mr C, 103) (Mr C, 104) (Mr C, 211)

Relationship

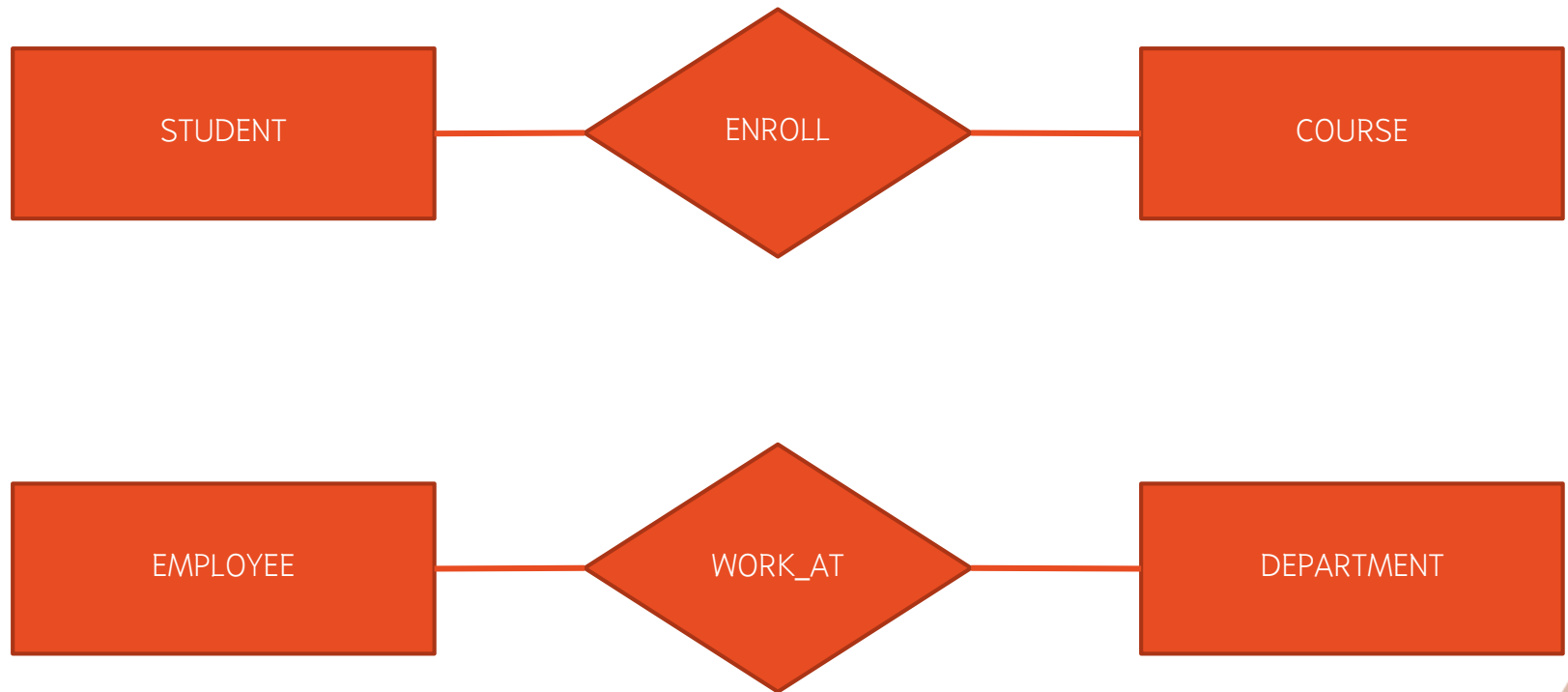


Relationship

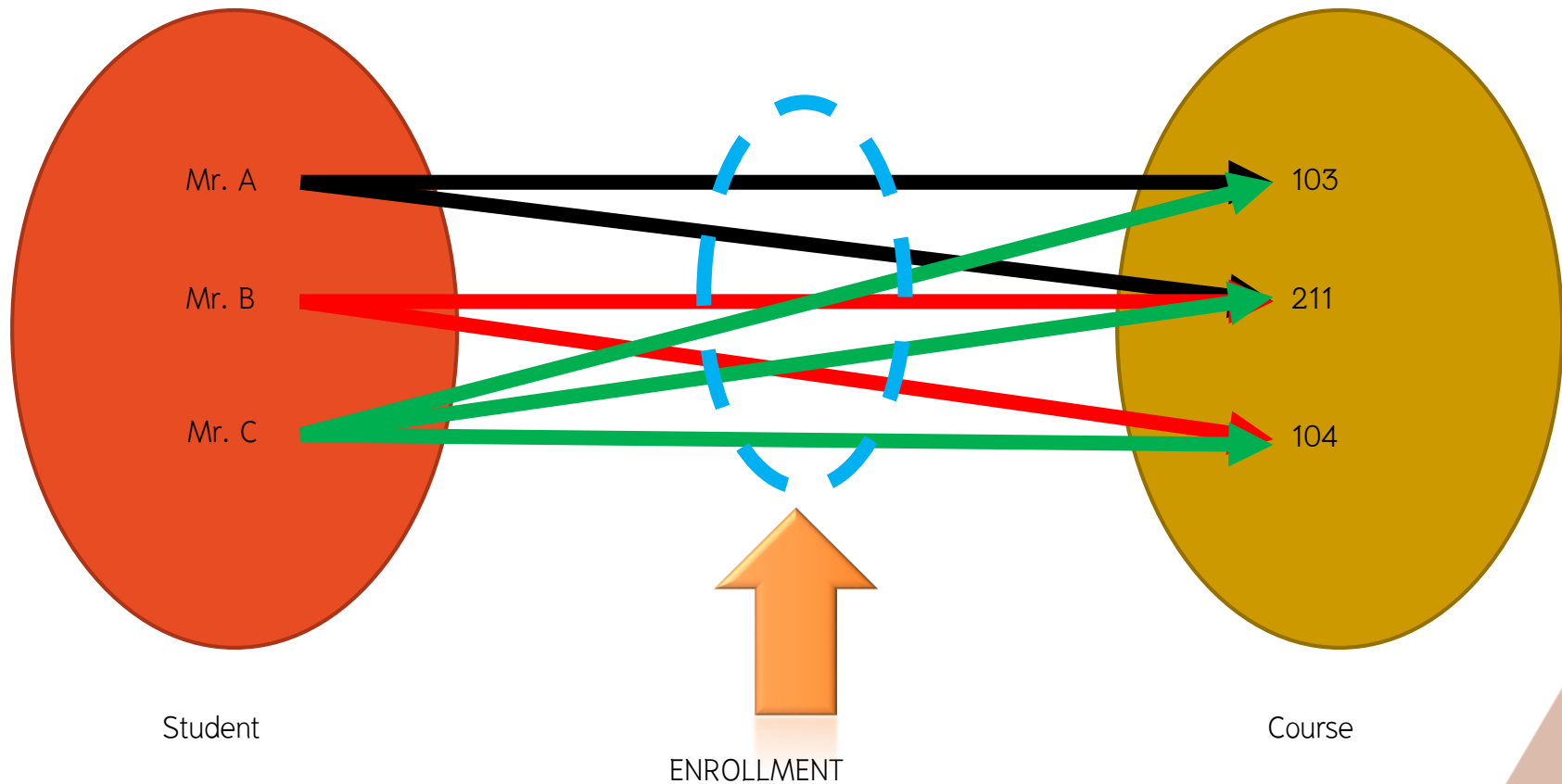
- Relationship types

“A set of meaningful association among entity types.”

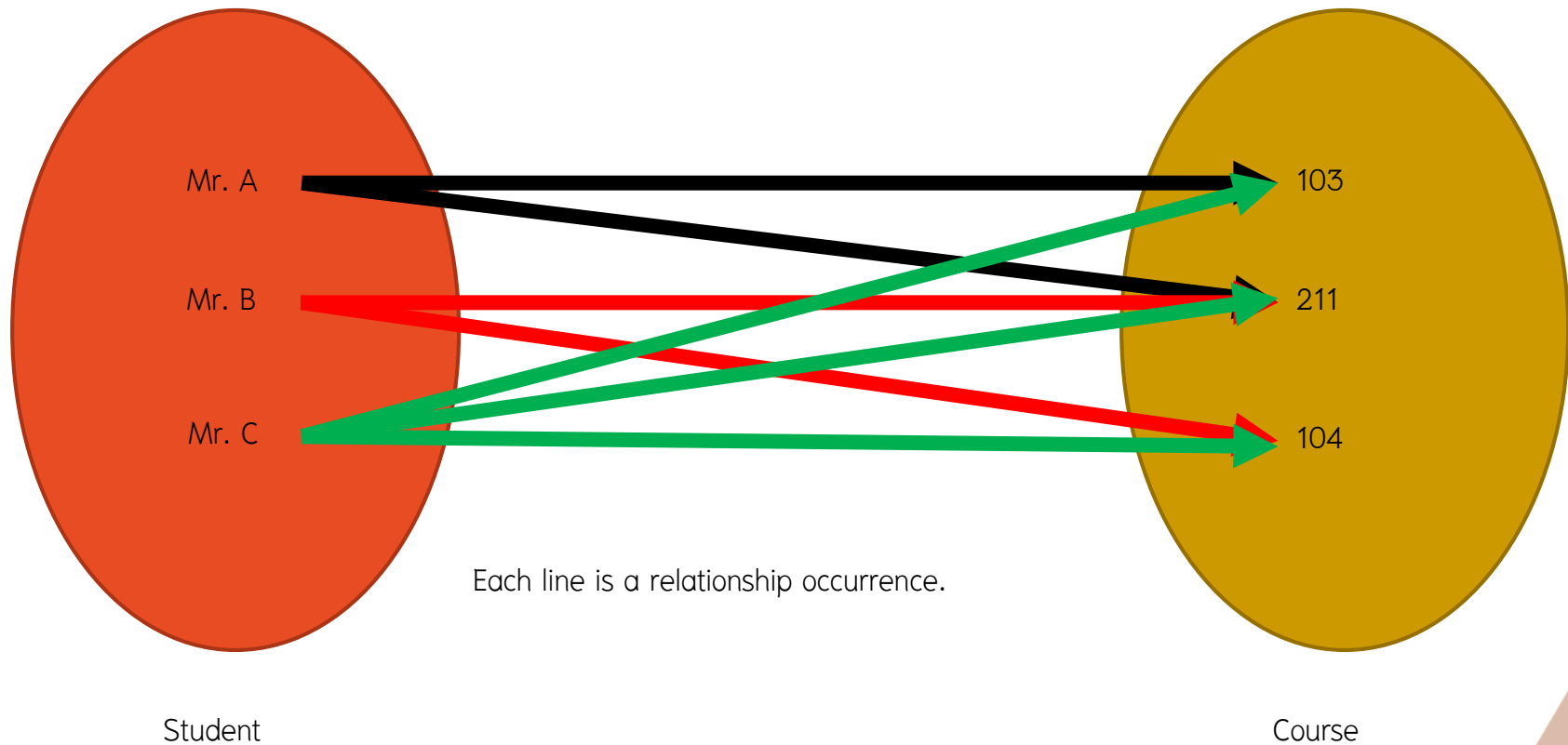
- Basically, it is a relation between 2 or more entity.
- The mapping set is called *relationship set*.
- The relationship set is denoted by diamond-shaped box with the name of the relationship inside.



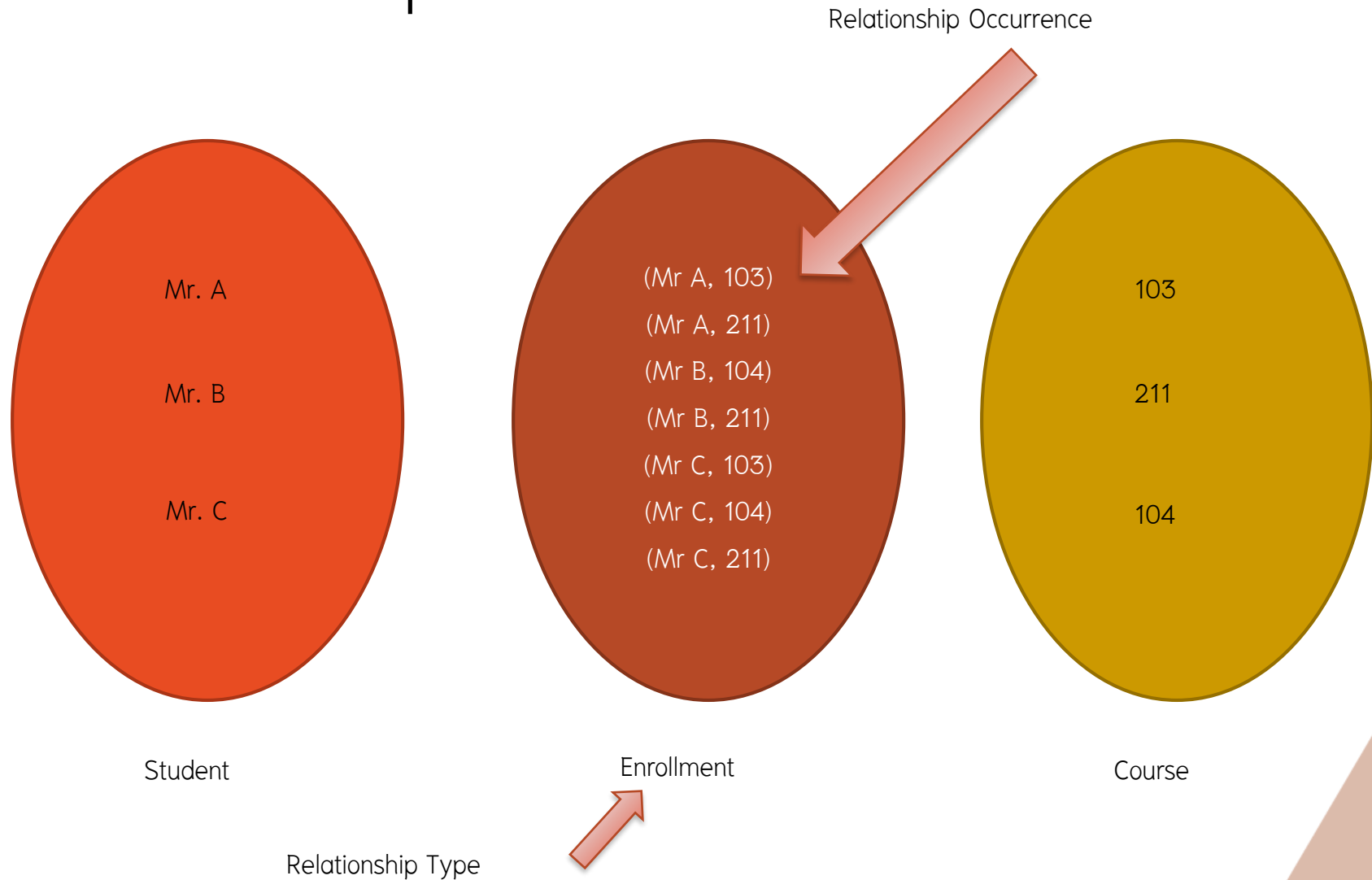
Relationship Type



Relationship Occurrence



Relationship



(Mr A, 103)

(Mr A, 211)

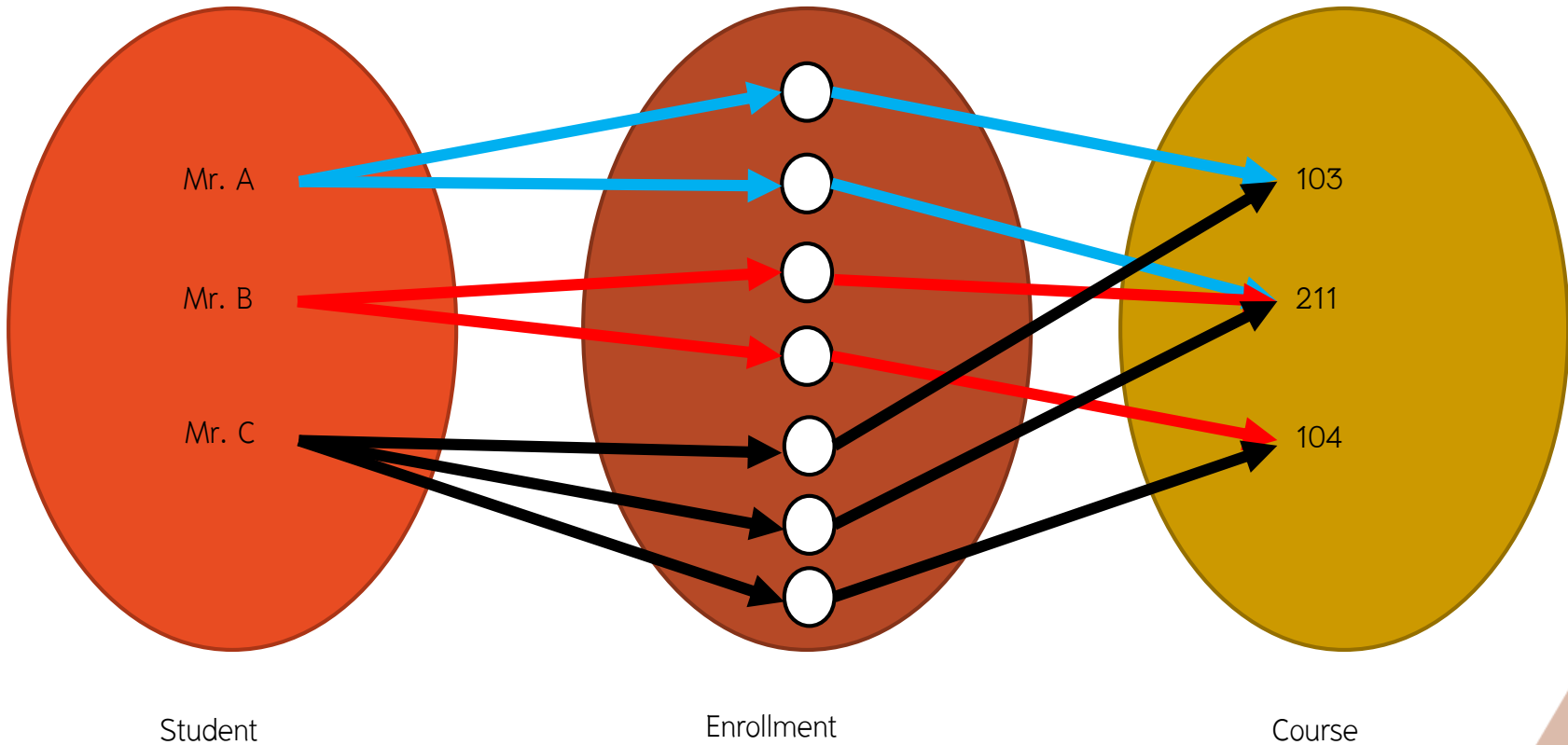
(Mr B, 104)

(Mr B, 211)

(Mr C, 103)

(Mr C, 104)

(Mr C, 211)



Structural constraints

- Multiplicity

“The 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”

- Represent the policy establish by user or enterprise.

- There are 3 types

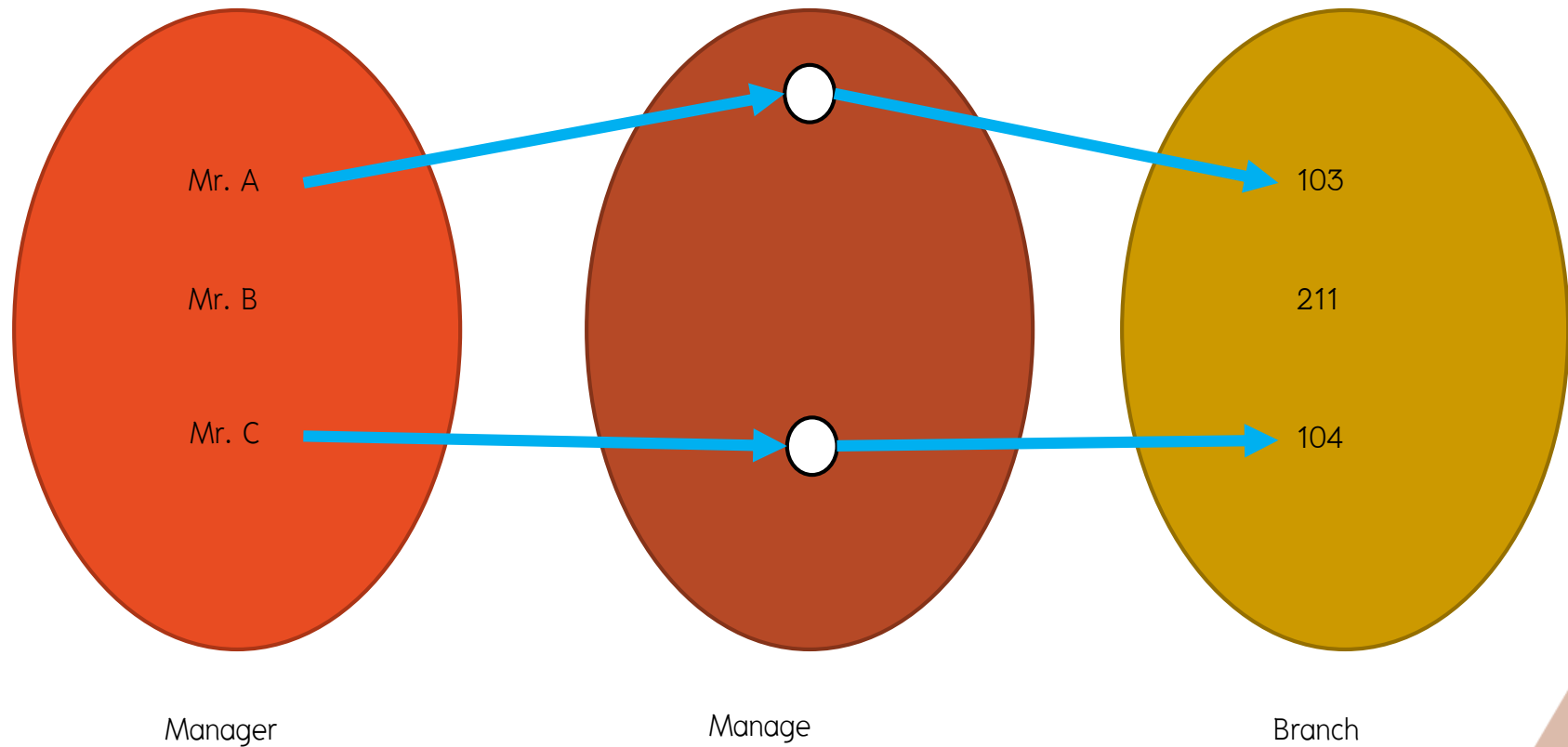
- One-to-one
- One-to-many
- Many-to-many

One-to-one

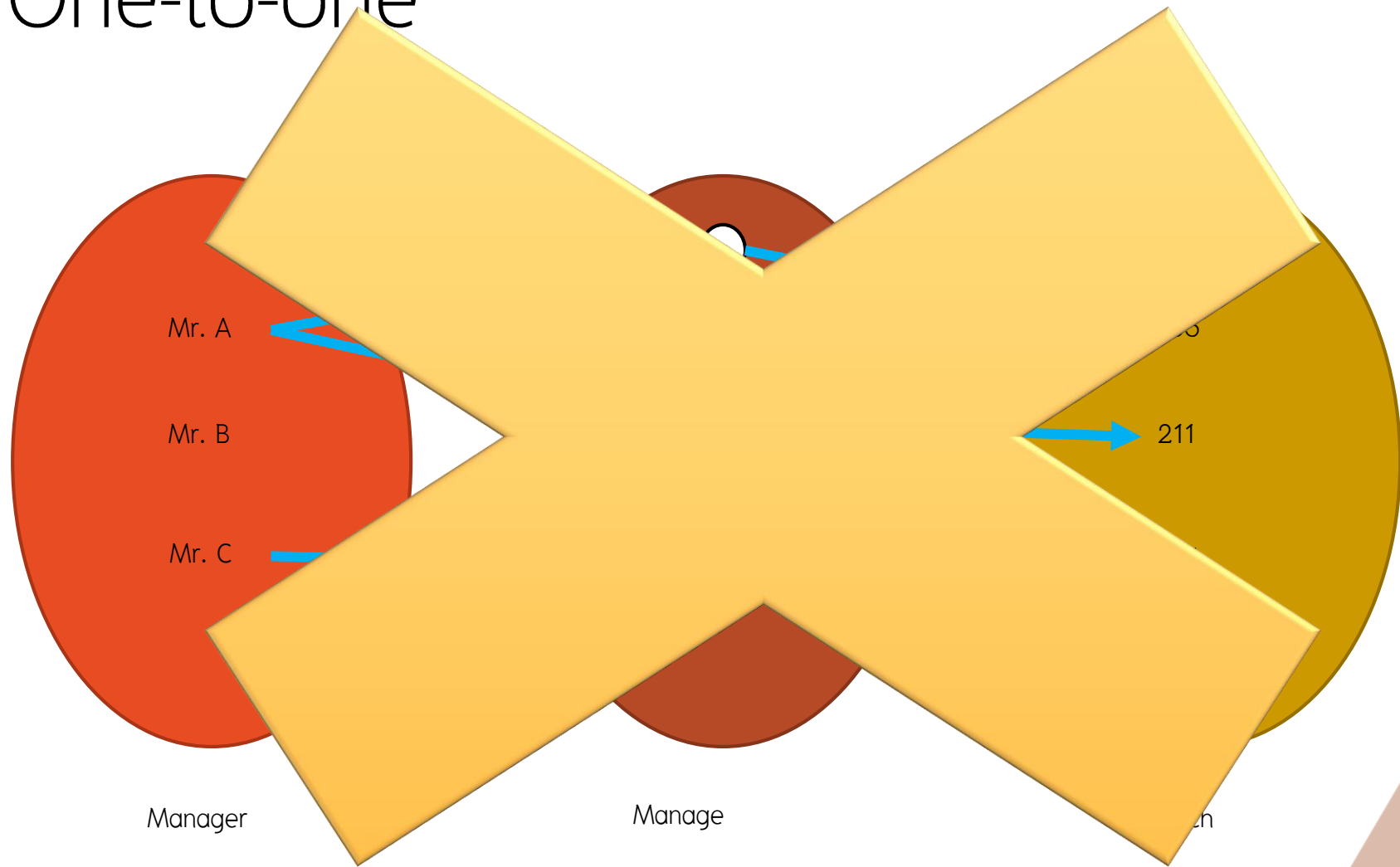
- Each row in one database table is linked to 1 **and only** 1 other row in another table.
 - There must be a row and the row is linked with other entity.
- The notation is denoted by the number “0..1” beside the entity side in the relation.
- “0” represents the scenarios where there is no linking row.



One-to-one



One-to-one

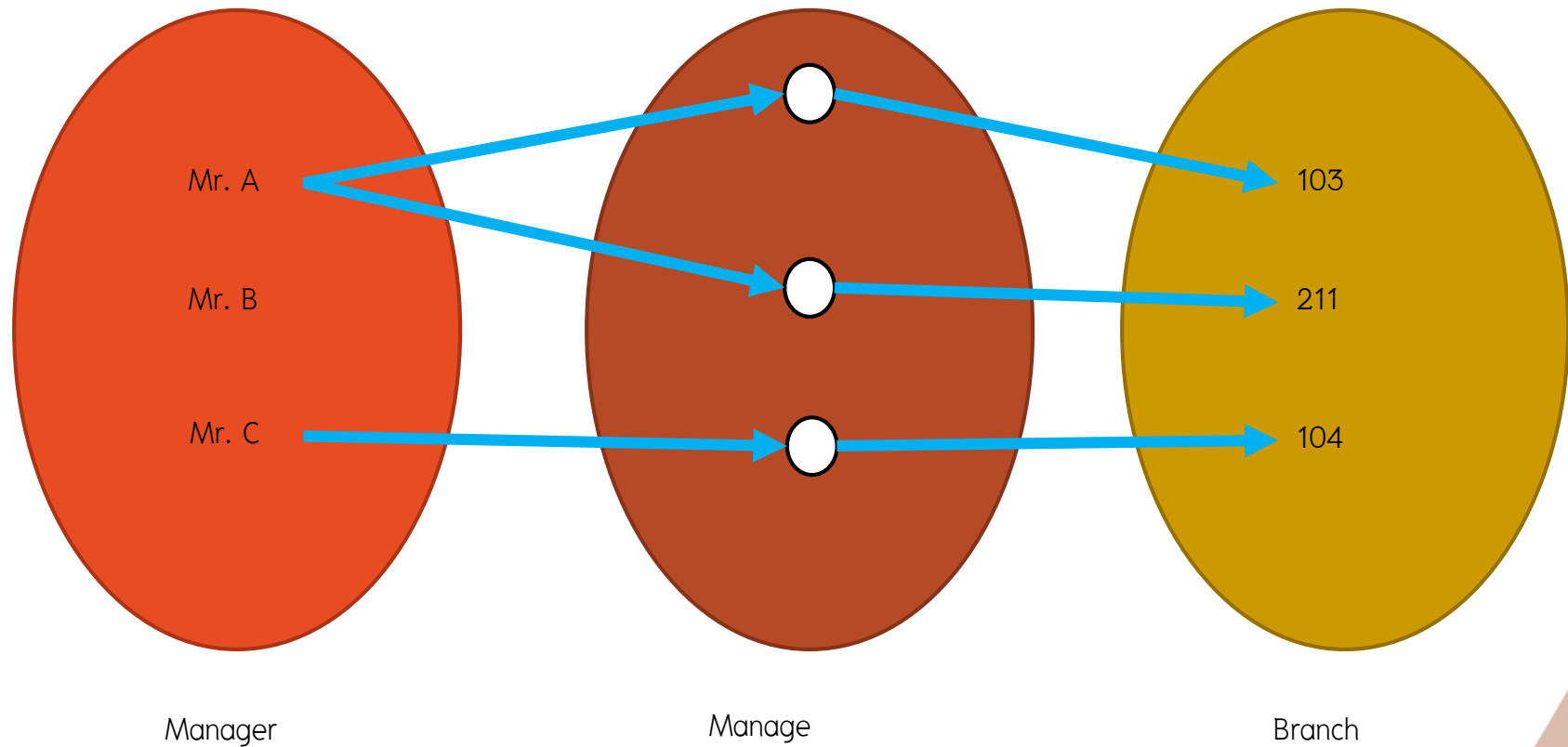


One-to-Many

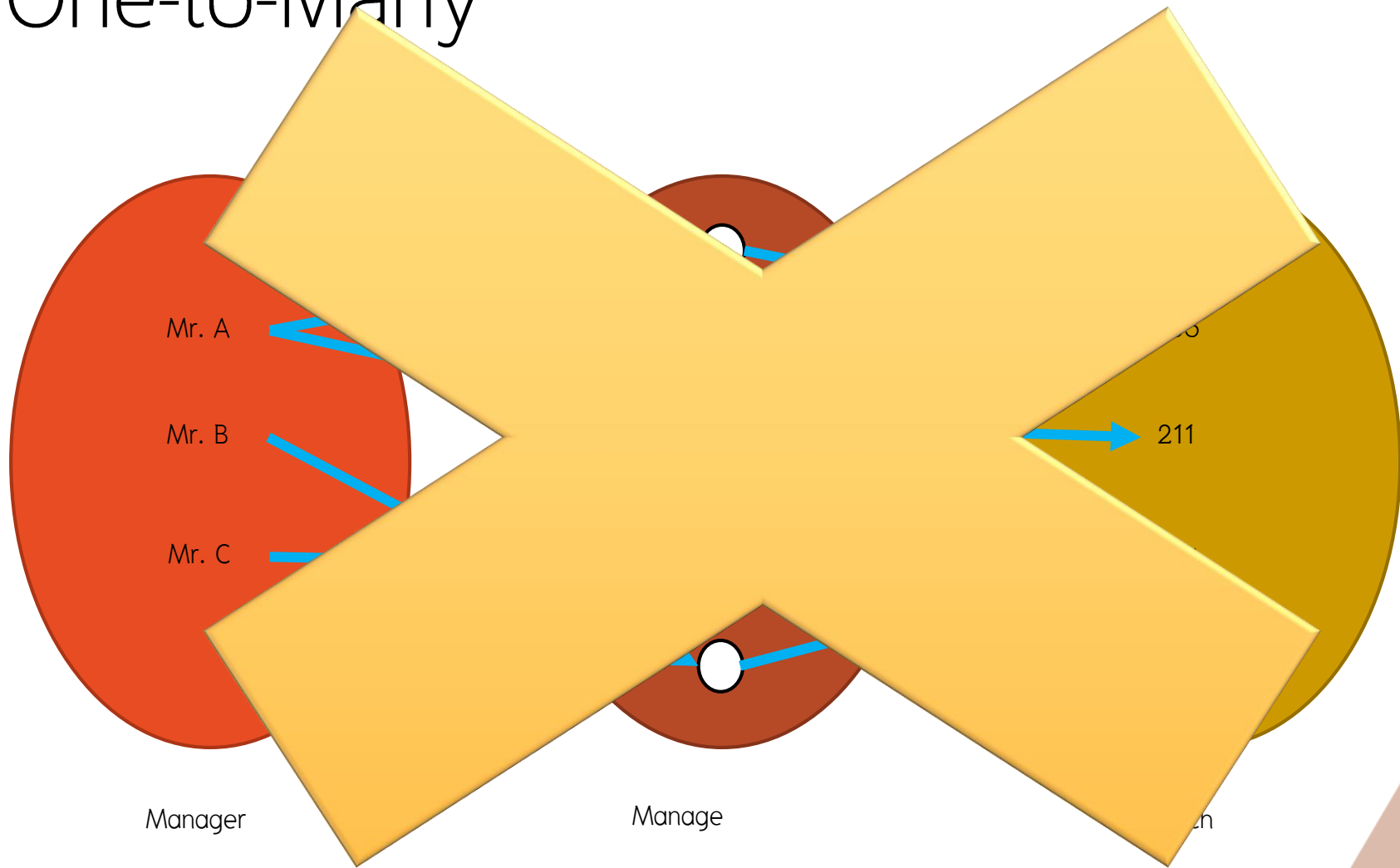
- Each row in one database table is linked to **more than** 1 other row in another table.
- The notation is a denoted by the number "0..1" beside the entity side in the relation which is on the 1 side.
- The notation is a denoted by the number "0..*" beside the entity side in the relation which is on the many side.
- "0" represents the scenarios where there is no linking row.



One-to-Many



One-to-Many

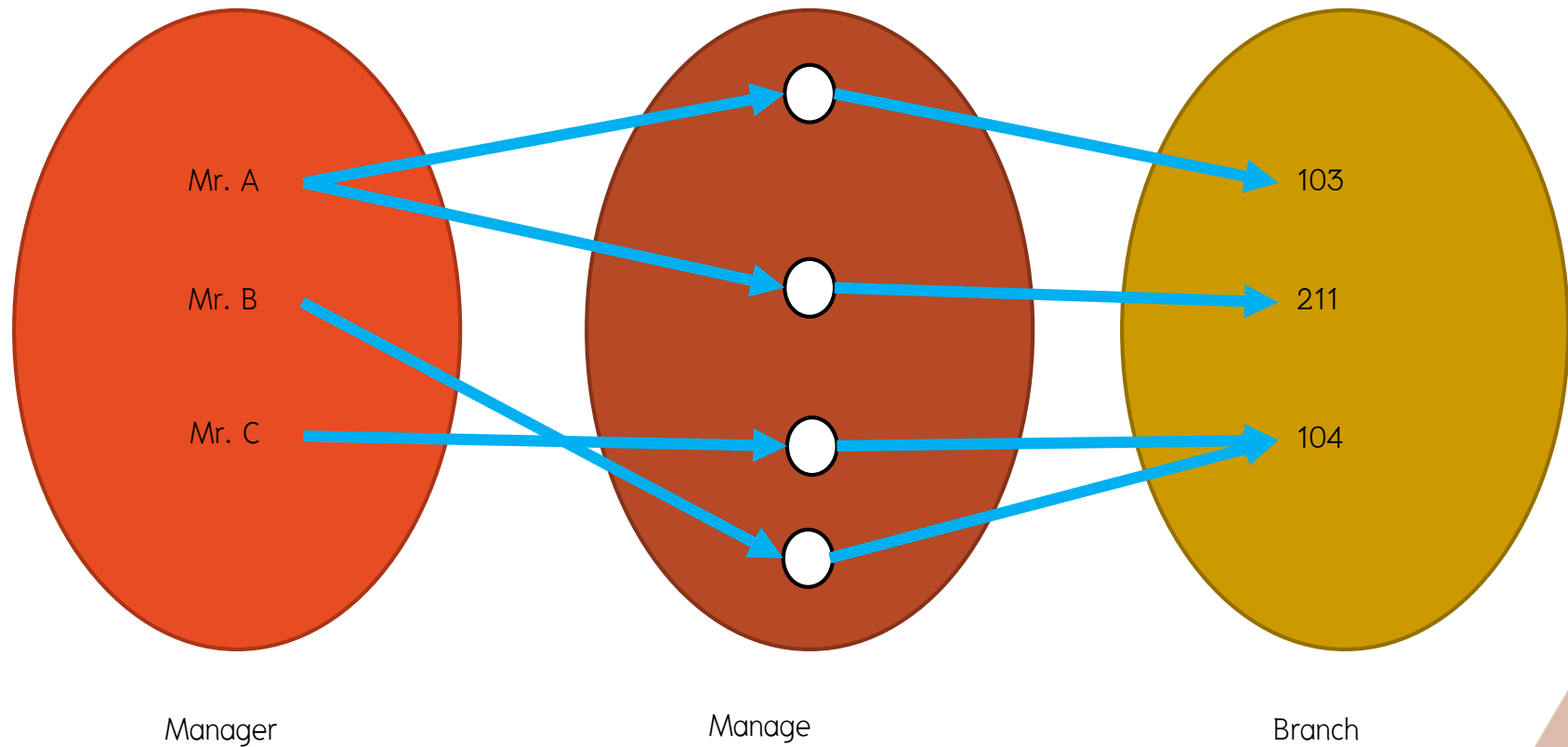


Many-to-Many

- Two table, A and B.
- Each row in table A is linked to more than one other row in another table B.
- Each row in table B is linked to more than one other row in another table A.
- The notation is a denoted by the number "0..*" beside the entity side in the relation.

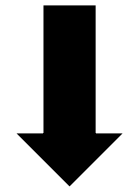
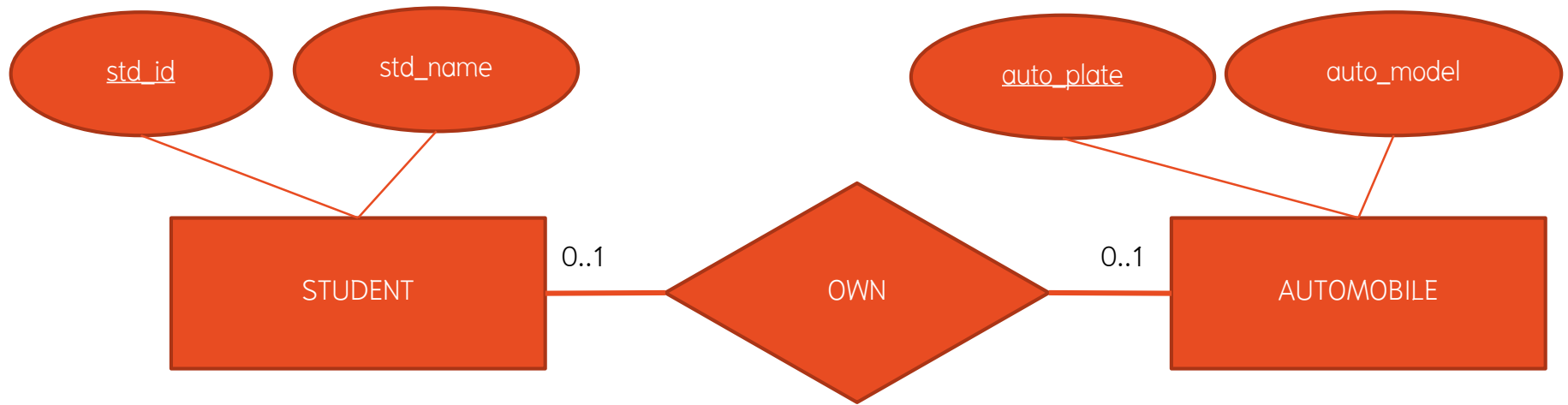


Many-to-Many



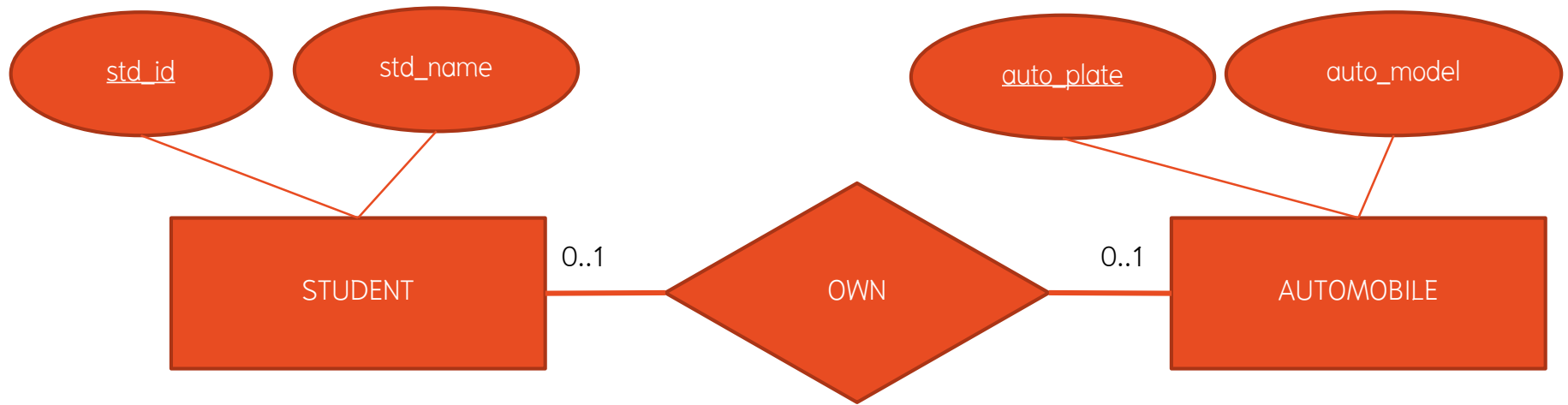
Mapping ER with Relationships to Relation

- One-to-one relation
 - The primary key of an entity will be assigned as a foreign of other entity.
 - You might need to analyze the semantics.



std_id	std_name

auto_plate	auto_model	std_id

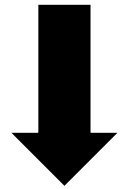
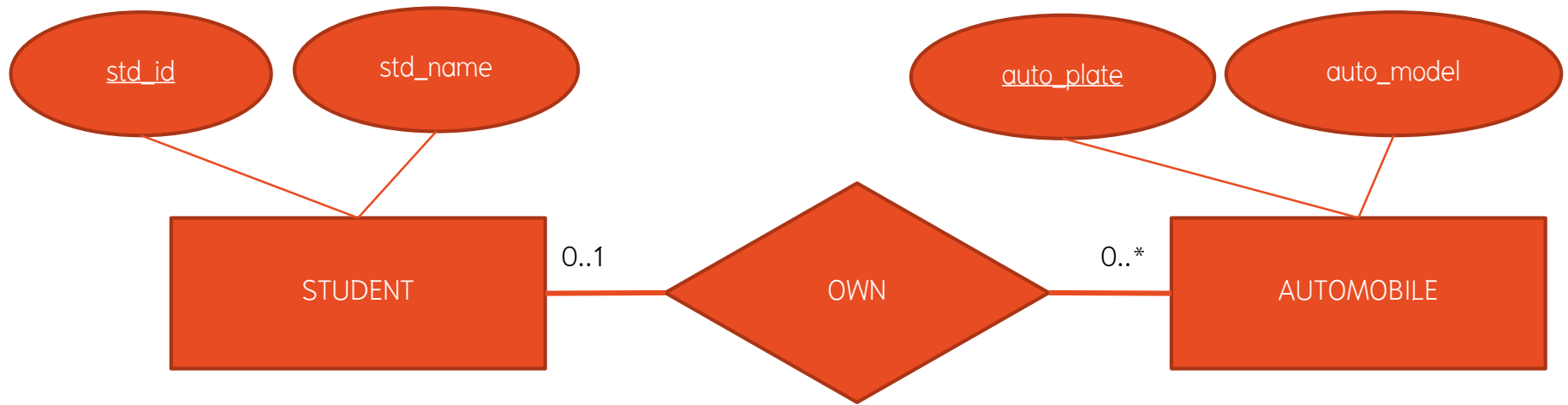


std_id	std_name	auto_plate

auto_plate	auto_model

Mapping Relation to Relation

- One-to-Many
- The primary key of an entity of the one side will be assigned as a foreign key of the entity on the many side.



std_id	std_name

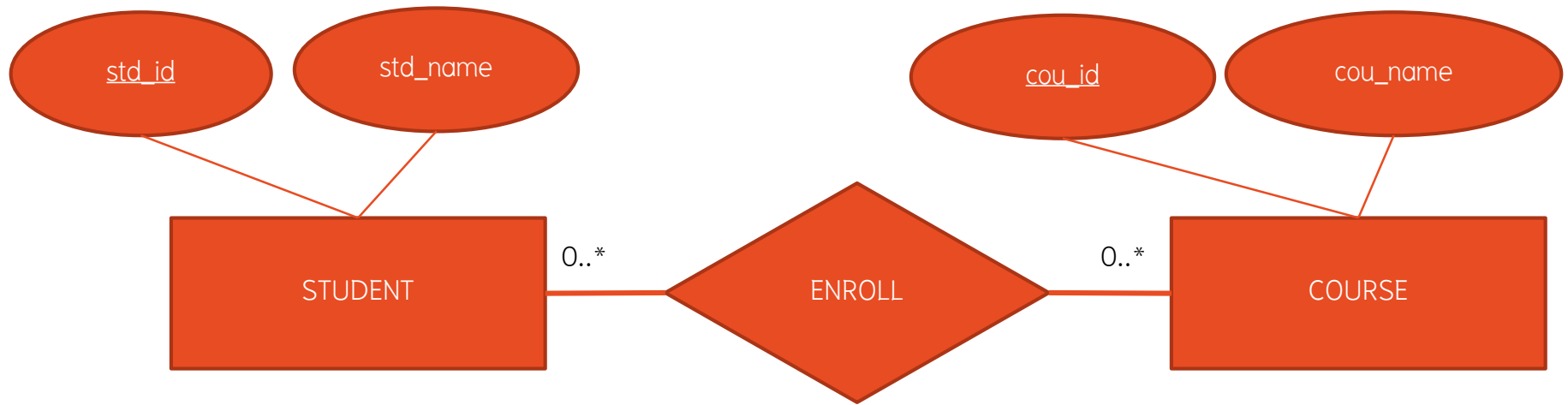
auto_plate	auto_model	std_id

Mapping Relation to Relation

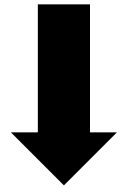
- Many-to-Many
- Let's do some experiment.
 - Apply the technique from one-to-many

"A student can enroll in multiple courses."

"A course can be enrolled by multiple student."



std_id	std_name	cou_id



cou_id	cou_name	std_id

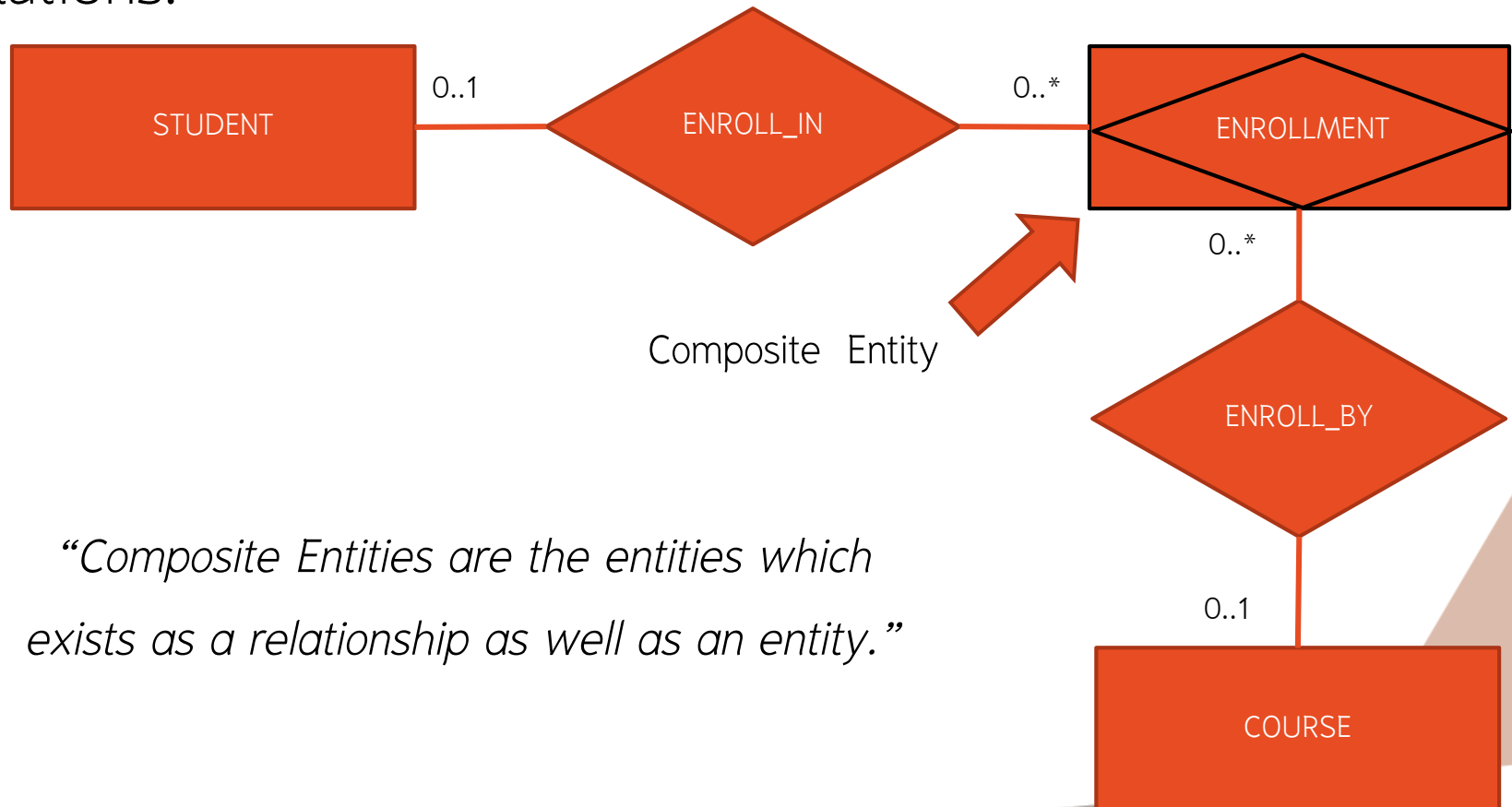
<u>std_id</u>	std_name	auto_plate
001	A	103
002	B	212
001	A	212

<u>cou_id</u>	cou_name	std_id
103	H	001
212	T	002
212	T	001

THE INFORMATION IN THE ROW IS UNNECESSARY REPEATED.

Solution

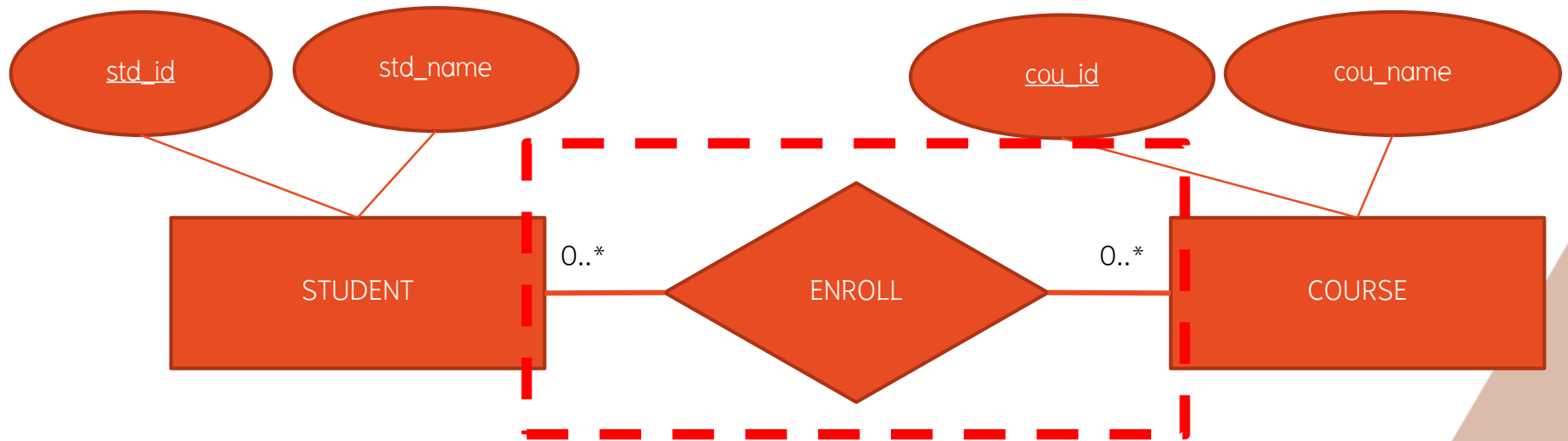
- Convert 1 many-to-many relation to 2 one-to-many relations.



“Composite Entities are the entities which exists as a relationship as well as an entity.”

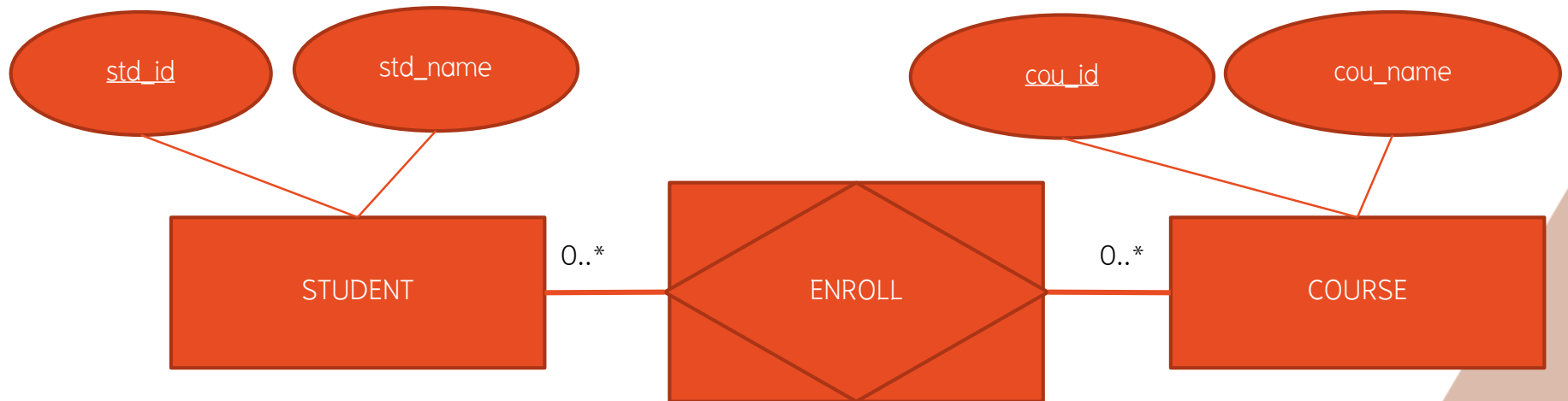
Solution

- Conversion process
 - Identify the many-to-many relationship in the diagram.



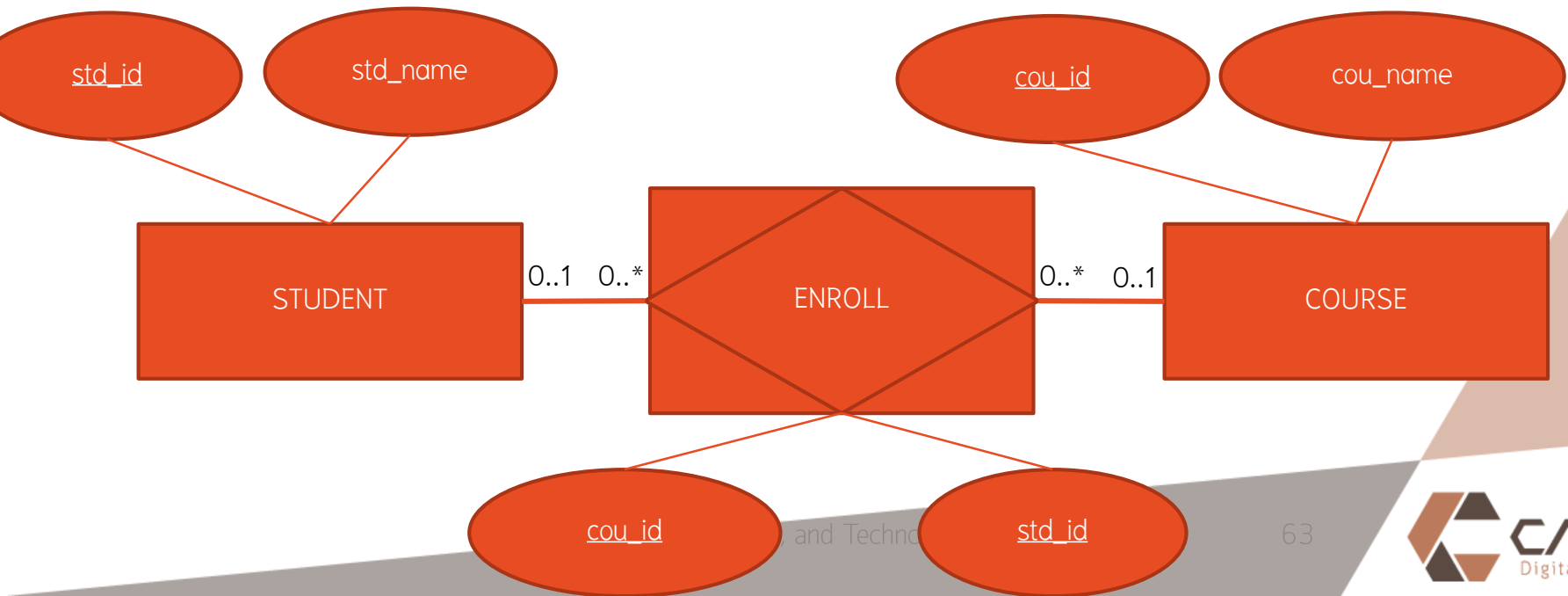
Solution

- Conversion process
 - Identify the many-to-many relationship in the diagram.
 - Convert the relationship symbol to composite entity symbol.



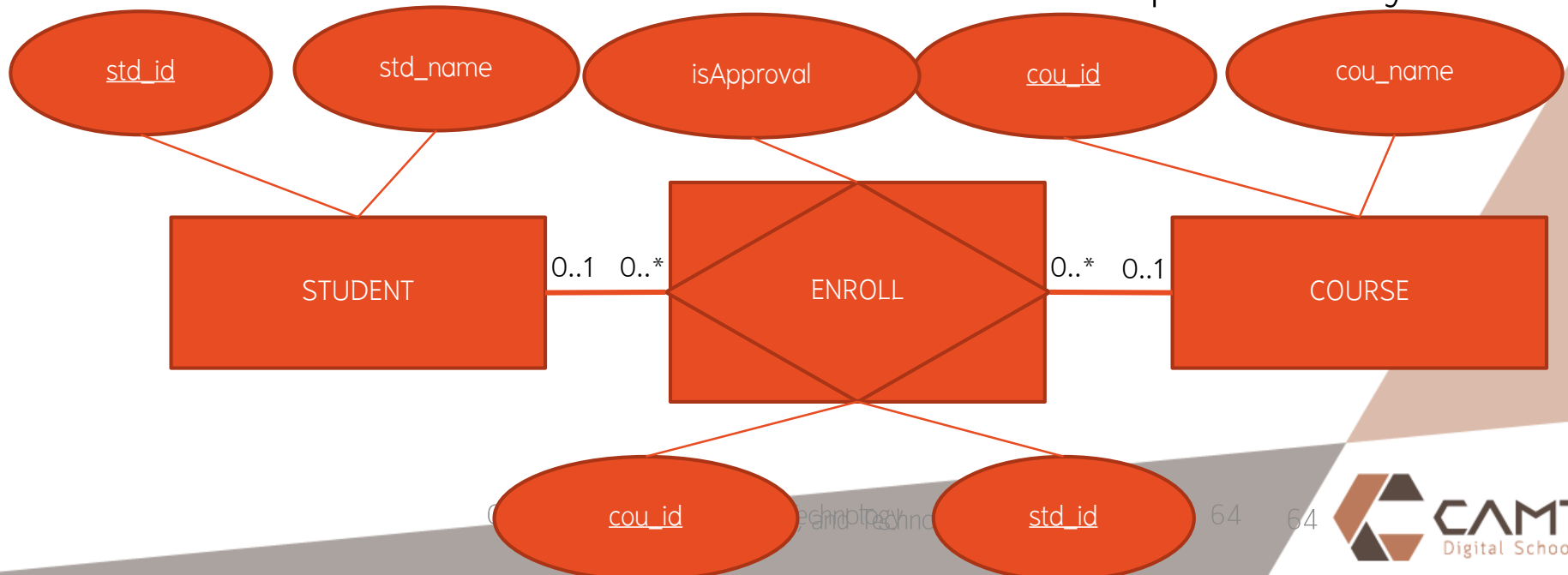
Solution

- Conversion process
 - Identify the many-to-many relationship in the diagram.
 - Convert the relationship symbol to composite entity symbol.
 - The composite key of the composite entity is derived from the other entity.



Solution

- Conversion process
 - Identify the many-to-many relationship in the diagram.
 - Convert the relationship symbol to composite entity symbol.
 - The composite key of the composite entity is derived from the other entity.
 - The additional information is allowed in the composite entity.



<u>std_id</u>	std_name
001	A
002	B

<u>cou_id</u>	cou_name
103	H
212	T

<u>std_id</u>	<u>cou_id</u>	isApproval
001	103	T
001	212	F
002	212	T

Strong and Weak Entity

Strong entity and Weak entity

- Existence-dependent
- The existence of the row in an table is dependent on the existence of row(s) in other entity.
- There are 2 types:
 - Strong entity
 - Weak entity
- One trick to identify each type is foreign key.

Strong entity and Weak entity

- Strong entity

*“An entity type that is **not** existence–dependent on some other entity type.”*

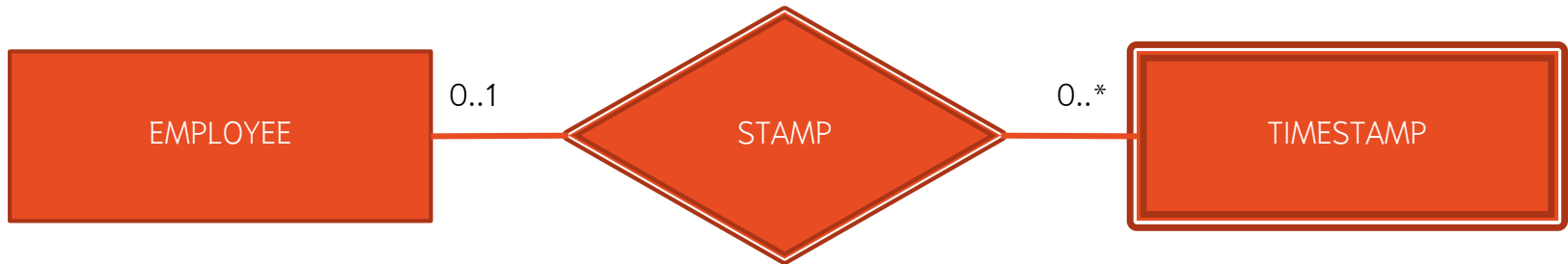
- The existence of data in an entity does not relate to the data in other entity.
- A table without a foreign key is or a table that contains a foreign key which can contain NULLS is a strong entity.

Strong entity and Weak entity

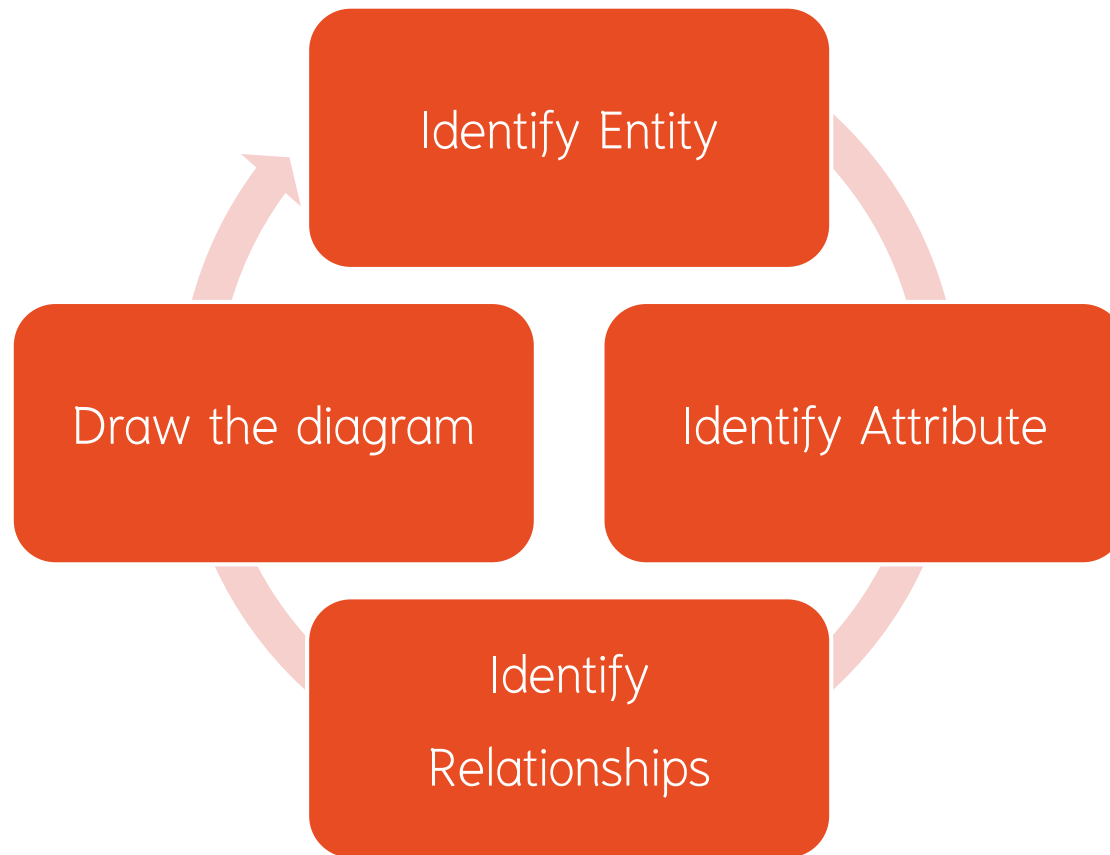
- Weak entity

“An entity type that is existence–dependent on some other entity type.”

- The existence of data in an entity relate to the data in other entity.
 - They cannot exist without entity with which it has a relationship.
- Primary key is derived from the primary key of the parent entity.
- The notation for weak entity is a double line rectangle.
 - The relation is also a double line diamond.



How to create ER diagram



Identification of Entity

- Replace the pronoun with the corresponding noun.
 - Its, their, they,
- Look for a noun in the context.
- An entity should has more than 1 instance.
 - Ignore the representation for the whole system.
 - Ignore the noun describing noun (Potential Attribute)
- Create the noun pool
 - Set of noun
 - Candidate to be an entity in the system.

Case study

- A company has several departments. Each department has a supervisor and at least one employee. Employees must be assigned to at least one, but possibly more departments. At least one employee is assigned to a project, but an employee may be on vacation and not assigned to any projects. The important data fields are the names of the departments, projects, supervisors and employees, as well as the supervisor and employee number and a unique project number.

Case study

- A **company** has several **departments**. Each **department** has a **supervisor** and at least one **employee**. **Employees** must be assigned to at least one, but possibly more **departments**. At least one **employee** is assigned to a **project**, but an **employee** may be on **vacation** and not assigned to any **projects**. The important data fields are the **names of the departments, projects, supervisors and employees**, as well as the **supervisor and employee number and a unique project number**.

Case Study: Noun Pool

- Company
- Departments
- Supervisor
- Employee
- Project
- Vacation
- Name of department
- Name of project
- Name of supervisor
- Name of employee
- Supervisor number
- Employee number
- Project number

Case Study

- Eliminate the whole system keyword.

Company

Departments

Supervisor

Employee

Project

Vacation

Name of department

Name of project

Name of supervisor

Name of employee

Supervisor number

Employee number

Project number

Case Study

- Eliminate the noun describing noun

Departments

Supervisor

Employee

Project

Vacation

Name of department

Name of project

Name of supervisor

Name of employee

Supervisor number

Employee number

Project number

Case Study

- The result noun pool

Departments

Supervisor

Employee

Project

Identification of Attribute

- Use the eliminated list from the previous step and linked to the entity

Vacation

Name of department

Name of project

Name of supervisor

Name of employee

Supervisor number

Employee number

Project number

Identification of Attribute

Entity	Attribute
Departments	<ul style="list-style-type: none">• Name of department
Supervisor	<ul style="list-style-type: none">• Name of supervisor• Supervisor number
Employee	<ul style="list-style-type: none">• Name of employee• Employee number• Vacation
Project	<ul style="list-style-type: none">• Name of project• Project number

Identification of Attribute

- Identify the key attributes

Entity	Attribute	Key attribute
Departments	<ul style="list-style-type: none">• Name of department	<ul style="list-style-type: none">• Name of department
Supervisor	<ul style="list-style-type: none">• Name of supervisor• Supervisor number	<ul style="list-style-type: none">• Supervisor number
Employee	<ul style="list-style-type: none">• Name of employee• Employee number• Vacation	<ul style="list-style-type: none">• Employee number
Project	<ul style="list-style-type: none">• Name of project• Project number	<ul style="list-style-type: none">• Project number

Identification of Relationships

- Create a mapping between the entity in the system
- Fill in the relationships between entity
 - List the verbs that match between the entity.
 - Extract the information (sentence) and rewrite them in entity driven sentence.
- Fill in the cardinality
 - Identify the cardinality from both side.

Identification of Relationships

- Create the mapping between the entity

<div>destination</div> <div>Source</div>	Departments	Supervisor	Employee	Project
Departments				
Supervisor				
Employee				
Project				

Case study: List entity

- A company has several **departments**. Each **department** has a **supervisor** and at least one **employee**. **Employees** must be assigned to at least one, but possibly more **departments**. At least one **employee** is assigned to a **project**, but an **employee** may be on vacation and not assigned to any **projects**. The important data fields are the names of the departments, projects, supervisors and employees, as well as the supervisor and employee number and a unique project number.

Case study: Identify the verb connecting the entities.

- A company has several **departments**. Each **department** has a supervisor and at least one **employee**. **Employees** must be assigned to at least one, but possibly more **departments**. At least one **employee** is assigned to a **project**, but an **employee** may be on vacation and not assigned to any **projects**. The important data fields are the names of the departments, projects, supervisors and employees, as well as the supervisor and employee number and a unique project number.

source\destination	Departments	Supervisor	Employee	Project
Departments				
Supervisor	Runs			
Employee	Belongs to			Assigned to
Project				

Case study: Rewrite the sentence

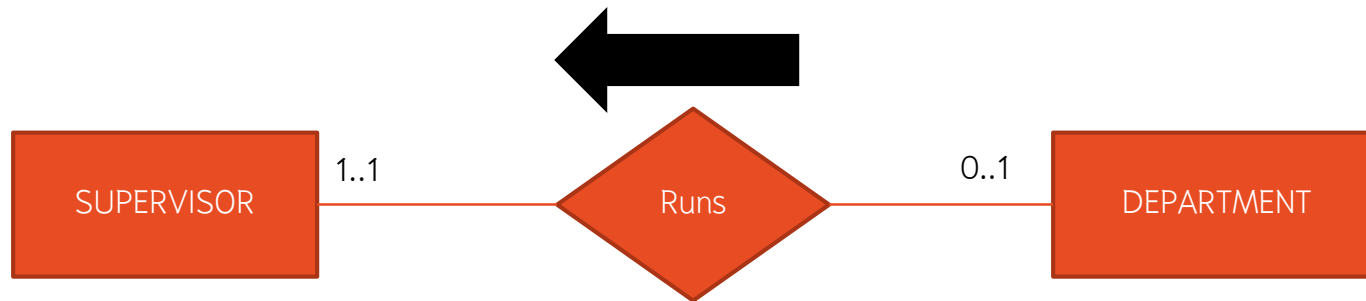
- Departments
 - Each department runs by 1 supervisor.
 - Each department has at least 1 employee.
- Supervisor
 - Each supervisor can runs more than 1 department.
- Employee
 - Each employee belongs to at least 1 department.
 - Each employee is assigned to zero (on vacation) project or multiple projects.
- Project
 - Each project is assigned with at least 1 employees

Case study: Rewrite the sentence

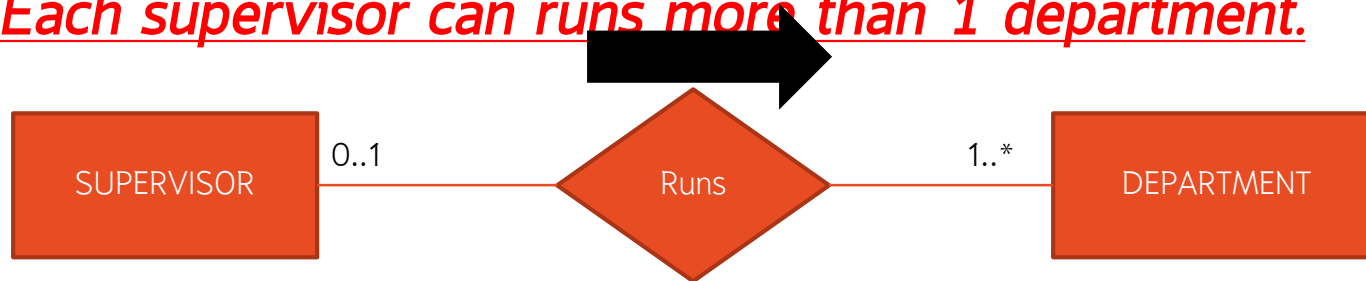
- Departments
 - *Each department runs by 1 supervisor.*
 - Each department has at least 1 employee.
- Supervisor
 - *Each supervisor can runs more than 1 department.*
- Employee
 - Each employee belongs to at least 1 department.
 - Each employee is assigned to zero (on vacation) project or multiple projects.
- Project
 - Each project is assigned with at least 1 employees

Case study

- Each department runs by 1 supervisor.



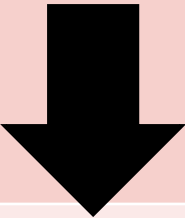
- Each supervisor can runs more than 1 department.



Case study

- Each department runs by 1 supervisor.
- Each supervisor can runs more than 1 department.



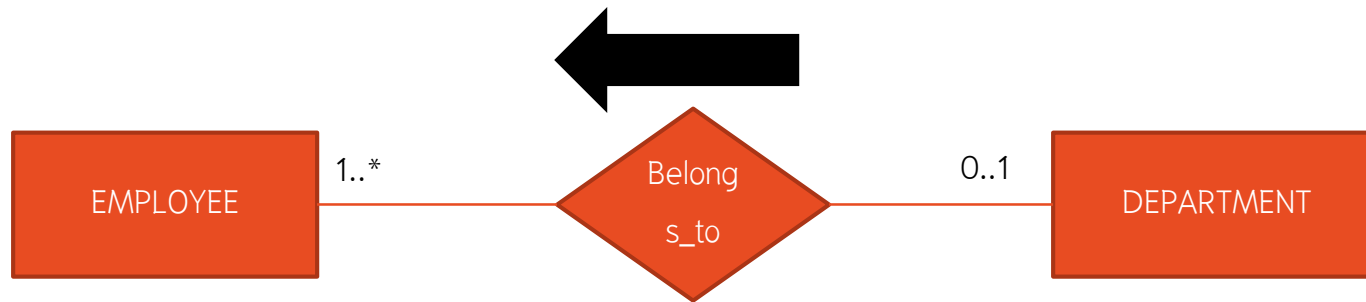
source/destination	Departments	Supervisor	Employee	Project
Departments				
Supervisor	Runs (one-to-many)			
Employee				
Project				

Case study: Rewrite the sentence

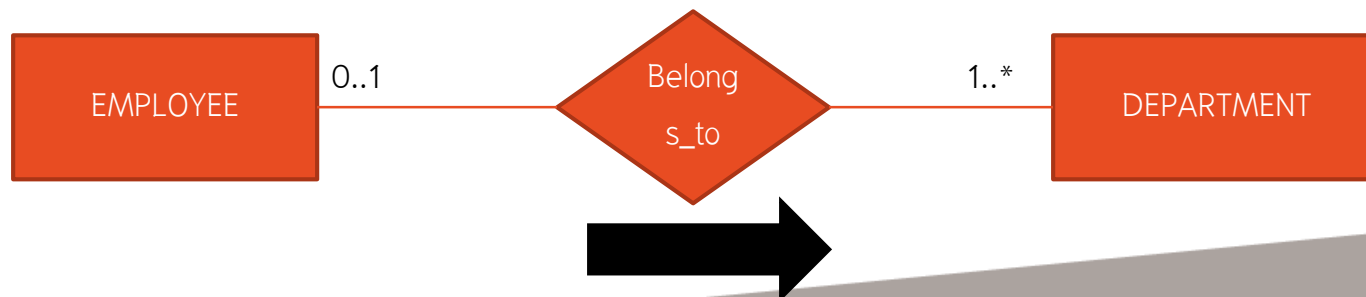
- Departments
 - Each department runs by 1 supervisor.
 - **Each department has at least 1 employee.**
- Supervisor
 - Each supervisor can runs more than 1 department.
- Employee
 - **Each employee belongs to at least 1 department.**
 - Each employee is assigned to zero (on vacation) project or multiple projects.
- Project
 - Each project is assigned with at least 1 employees

Case study

- Each department has at least 1 employee.



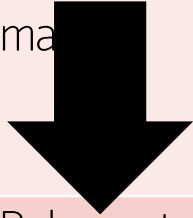
- Each employee belongs to at least 1 department.



Case study

- Each department has at least 1 employee.
- Each employee belongs to at least 1 department.



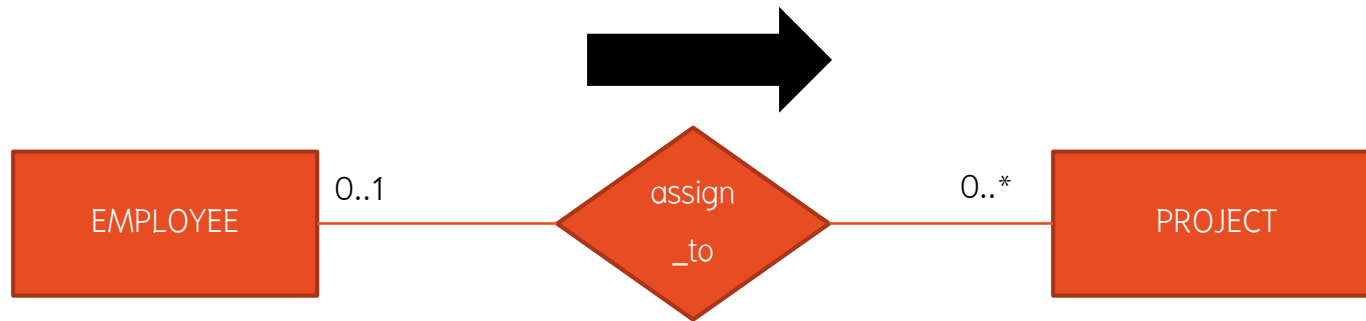
source/destination	Departments	Supervisor	Employee	Project
Departments				
Supervisor	Runs (one-to-many) 			
Employee	Belongs to (many-to-many)			
Project				

Case study: Rewrite the sentence

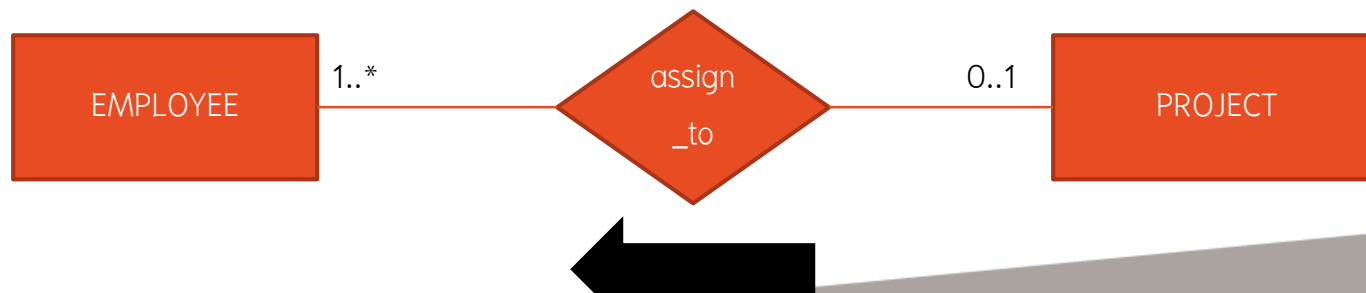
- Departments
 - Each department runs by 1 supervisor.
 - Each department has at least 1 employee.
- Supervisor
 - Each supervisor can runs more than 1 department.
- Employee
 - Each employee belongs to at least 1 department.
 - *Each employee is assigned to zero project or multiple projects.*
- Project
 - *Each project is assigned with at least 1 employees*

Case study

- Each employee is assigned to zero project or multiple projects.



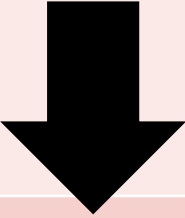
- Each project is assigned with at least 1 employees



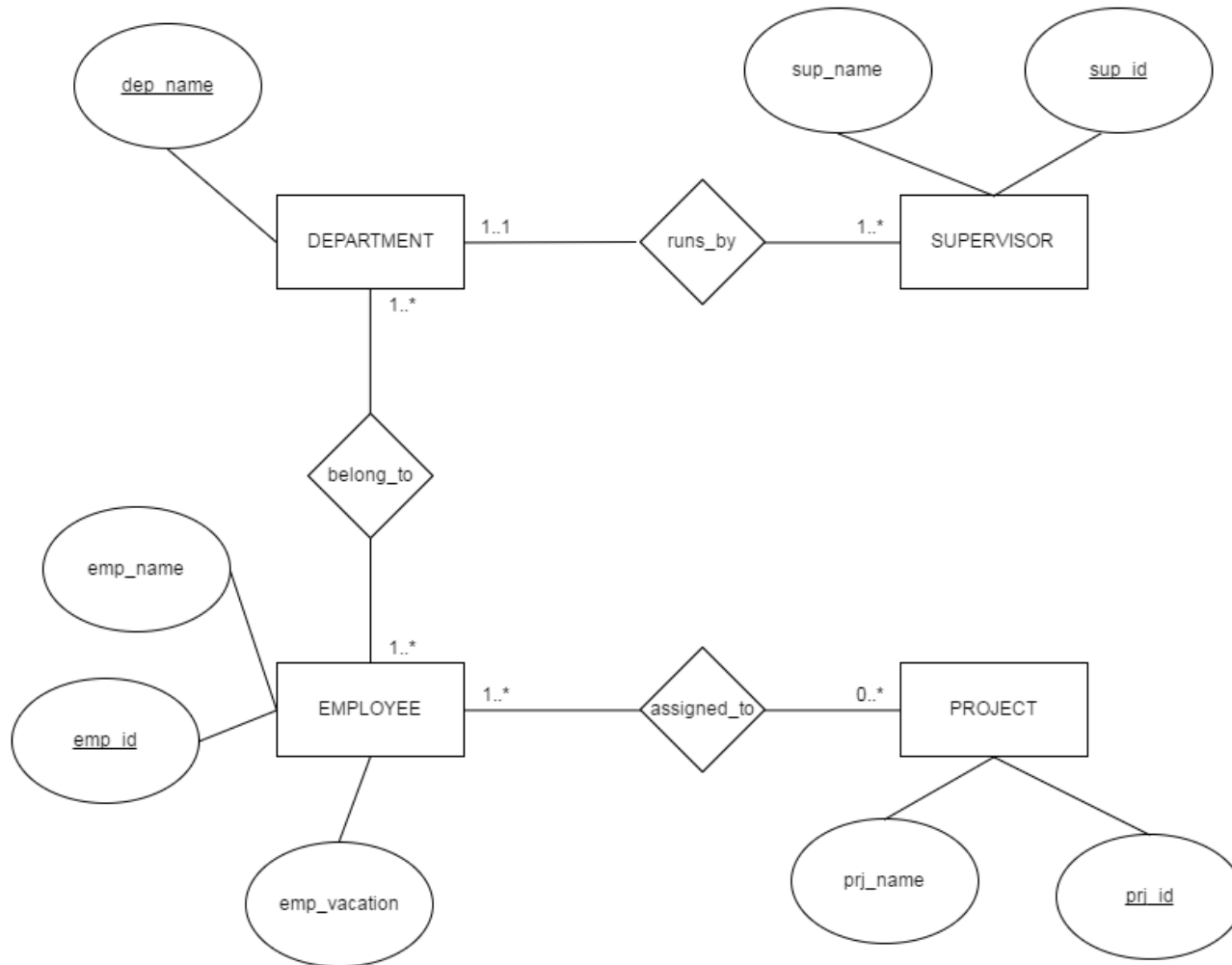
Case study

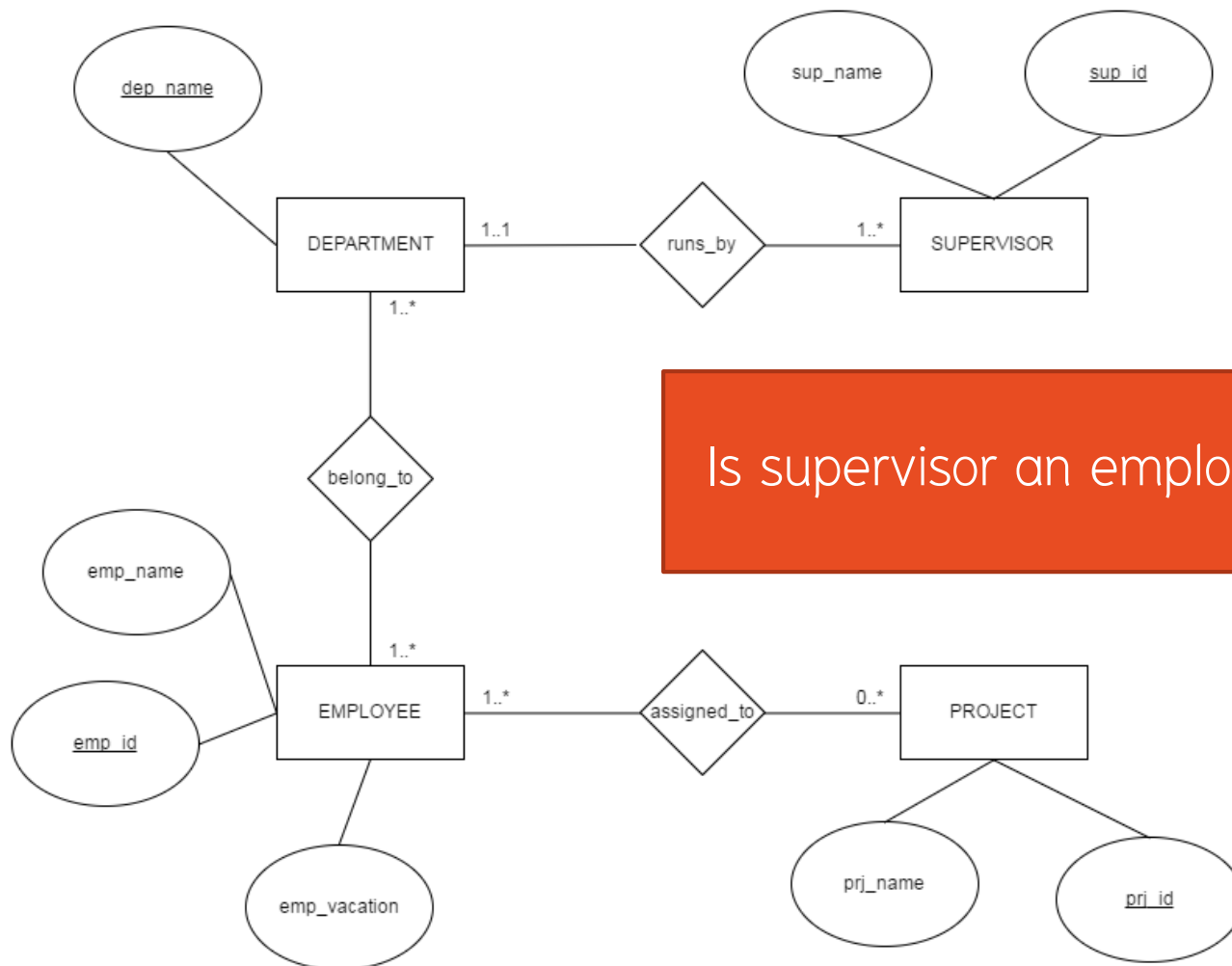
- Each project has at least 1 employee.
- Each employee belongs to at least 1 project.



source/destination	Departments	Supervisor	Employee	Project
Departments				
Supervisor	Runs (one-to-many)			
Employee	Belongs to (many-to-many)			
Project				

Draw the diagram





Is supervisor an employee ??

Data Dictionary

Data Dictionary

- The ER diagram provide
 - Structure of information
 - Description of information
 - Organization of information
- It does not provide the implementation details.
- Data dictionary provides the implementation detail of the database.

Data Dictionary

- The data dictionary contain the following information
 - Attribute name
 - Data type
 - Constraints
 - Attribute size
 - Remark

Attribute name	Data type	Size	Constraint	Remark
emp_id	varchar	9	<ul style="list-style-type: none"> • Unique • Primary key 	
emp_name	varchar	30	<ul style="list-style-type: none"> • Not null 	
emp_vacation	int			