DATABASE SYSTEMS

CS – 355/ CE – 373

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PARTIAL AND TOTAL PARTICIPATION

- The participation of an entity set *E* in a relationship set *R* is said to be ***total*** if every entity in *E* must participate in at least one relationship in *R*. (double lines used to indicate these).
- If it is possible that some entities in *E* do not participate in relationships in *R*, the participation of entity set *E* in relationship *R* is said to be ***partial***.

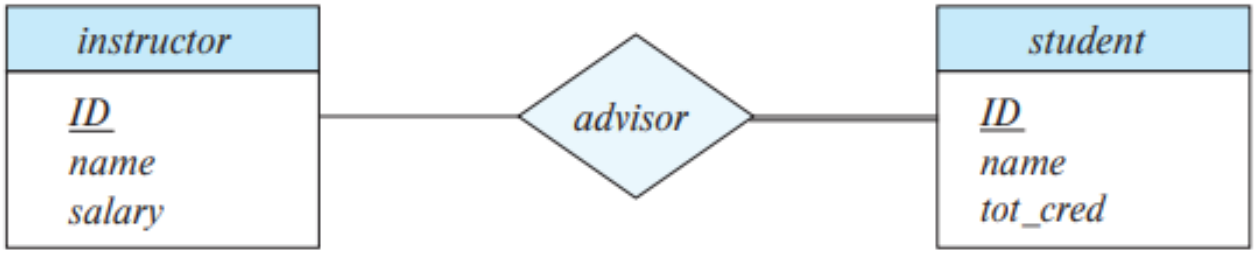
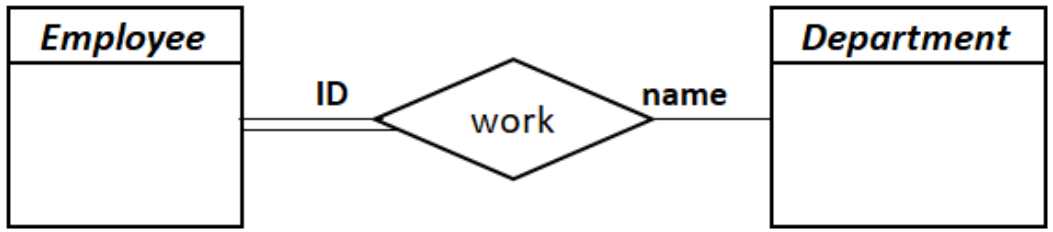


Figure 6.12 E-R diagram showing total participation.

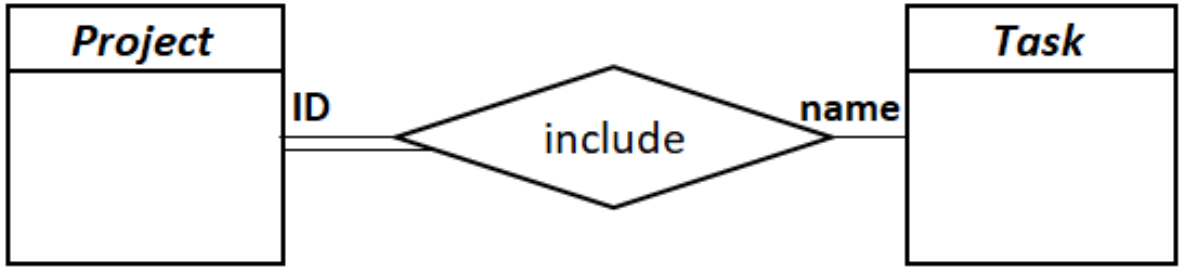
PARTIAL AND TOTAL PARTICIPATION

- Examples:
  - Employee works in a department
    - Each employee works in a department, so employee will have **total participation** in the "works" relationship
    - A department may or may not have any employees, so department has **partial participation** in this relationship



PARTIAL AND TOTAL PARTICIPATION

- Examples:
  - A project includes tasks
    - Every project must include at least one task, so Project has **total participation** in the “includes” relationship
    - A task does not need to be part of every project, so Task has **partial participation** in the “includes” relationship



PARTIAL & TOTAL PARTICIPATION – EXAMPLES

- Activity Sheet:
  - Attempt **Question 9**

PARTIAL & TOTAL PARTICIPATION – EXAMPLES

- Activity Sheet **Question 9** Solution:
  - ER Model Q9 Solution

STRUCTURAL CONSTRAINTS

- E-R diagrams provide ways to indicate numerical constraints on the number of times an entity may participate in a relationship.
- A line may have an associated minimum and maximum cardinality, shown as $l..h$, where l is the minimum and h is the maximum cardinality.

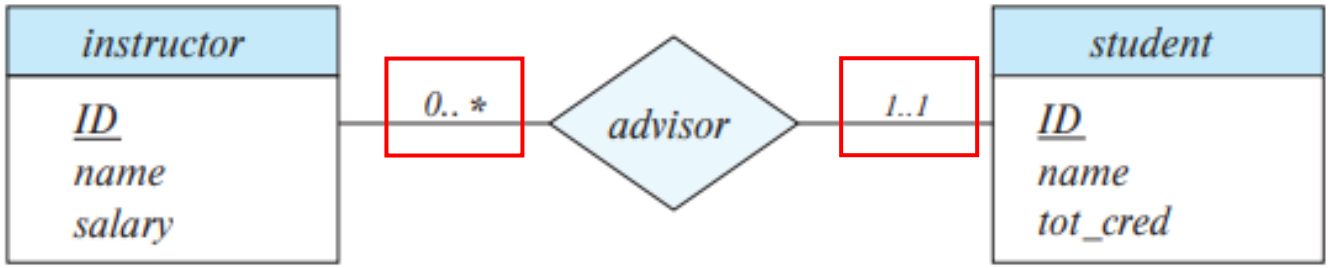


Figure 6.13 Cardinality limits on relationship sets.

STRUCTURAL CONSTRAINTS

- A minimum value of 1 indicates total participation of the entity set in the relationship set; that is, each entity in the entity set occurs in at least one relationship in that relationship set.
- A maximum value of 1 indicates that the entity participates in at most one relationship.
- A maximum value $*$ indicates no limit.

EQUIVALENCE OF NOTATIONS

- Is

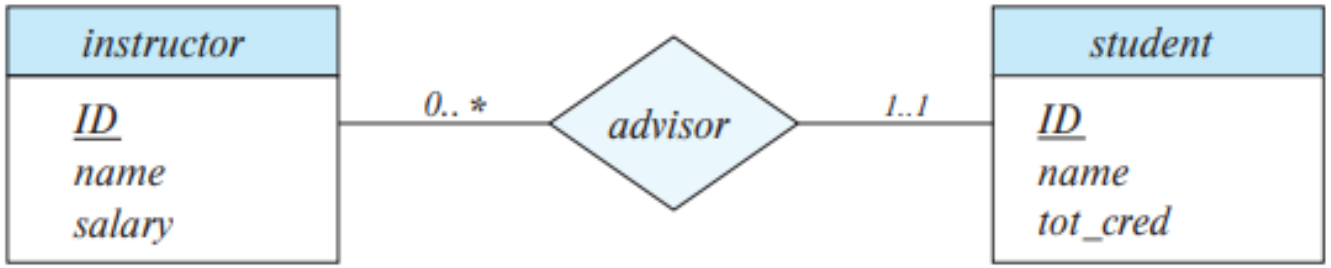


Figure 6.13 Cardinality limits on relationship sets.

- equivalent to

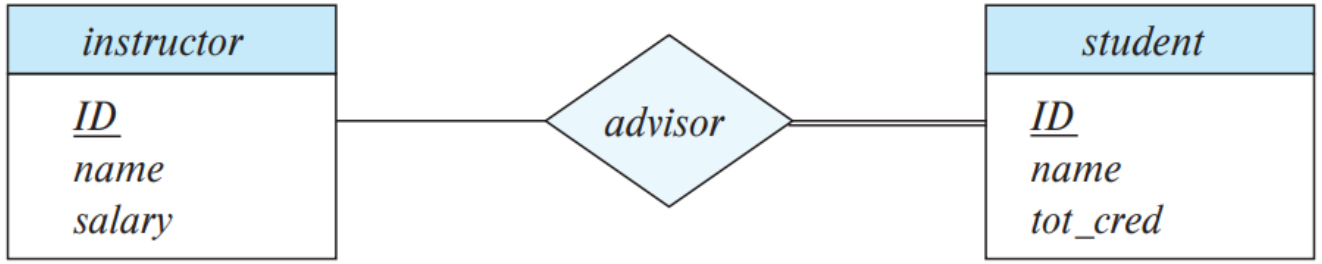
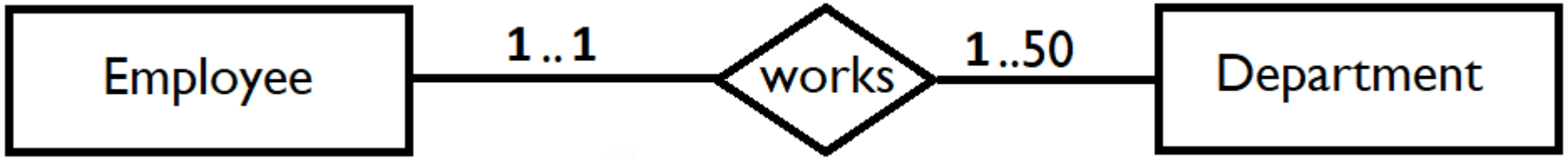


Figure 6.12 E-R diagram showing total participation.

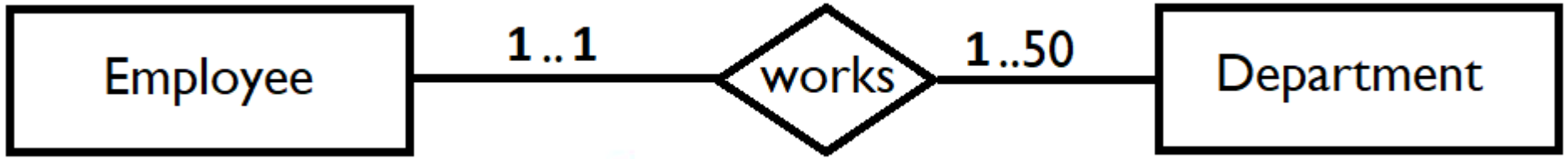
STRUCTURAL CONSTRAINTS – EXAMPLE

- Interpret the following:



STRUCTURAL CONSTRAINTS – EXAMPLE

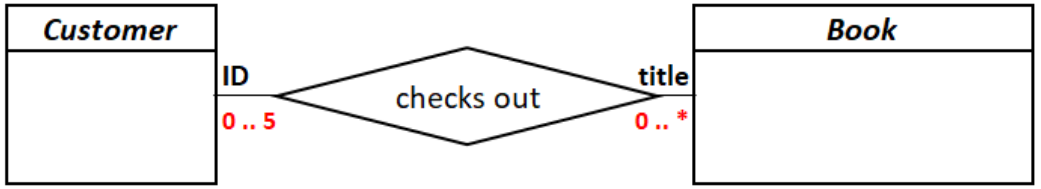
- Interpret the following:



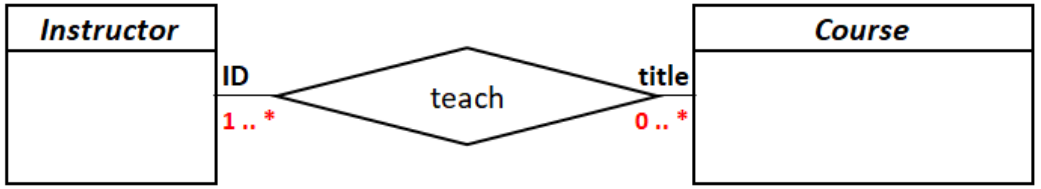
- Each employee works for at most one department, i.e. one-to-one relationship
- One department can have 50 employees working in it

STRUCTURAL CONSTRAINTS

- Examples:
  - A customer can check out 5 books at a time



  - An instructor must teach at least one course every semester



STRUCTURAL CONSTRAINTS – EXAMPLES

- Activity Sheet:
  - Attempt **Question 10**

STRUCTURAL CONSTRAINTS – EXAMPLES

- Activity Sheet **Question 10** Solution:
  - ER Model Q10 Solution

PRIMARY KEY

- A key for an entity set is the unique set of attribute values that can uniquely identify an entity instance.
- Keys can be classified as superkey, candidate key and primary key.
- Primary keys can also be defined for relationship sets.

ATTRIBUTES OF RELATIONSIP SETS

- The ***attributes of a relationship set*** are the attributes that comprise the primary keys of the entity sets involved in the relationship set.
- This becomes more crucial in case of implicit roles defined for the relationship
- For example, in an instructor-student advisor relationship:

- It is crucial to deduce the attributes involved in this relationship set.
- Whether it will be Instructor ID advising Student ID, or Instructor ID advising Student Name, Instructor Name advising Student ID, etc

ATTRIBUTES OF RELATIONSIP SETS

- Usually, it is the primary keys (or some combination of them) of the entities involved in the relationship set
- In the instructor-student example, the attributes of the relationship set, *advisor* will be defined by **{ID, ID}**
- Having same attribute name can be misleading so the attributes must be renamed to something like **{Instructor_ID, Student_ID}**
- Once renamed, it becomes a valid attribute of the relationship set, *advisor*

ATTRIBUTES OF RELATIONSIP SETS

- Example:
  - Suppose two entities: ***Customer*** and ***Account***
  - The relationship set is *access* for functional requirement: Customer accessing his/her account
  - What should be the attribute of this relationship set?
    - Use primary keys of the entities involved
      - CNIC is the primary key of ***Customer***
      - account_number is the primary key of ***Account***
    - The attributes of the relationship set *access* are then **{CNIC, account_number}**
  - This gives enough information to enable us to relate an account to a person

ATTRIBUTES OF RELATIONSIP SETS

- If the relationship has descriptive attributes, those are also included in its attribute set
- For example, we might add the attribute date to the above relationship set, signifying the date of last access to an account by a particular customer
- Note that this attribute cannot be placed in either entity set as it relates to both a customer and an account

ATTRIBUTES OF RELATIONSIP SETS

- Let R be a relationship set involving entity sets E_1, E_2, …, E_n. Let primary-key(E_i) denote the set of attributes that forms the primary key for entity set E_i.
- If the relationship set R has no attributes associated with it, then the set of attributes describes an individual relationship in set R.

$$\textbf{primary-key}(E_1) \cup \textbf{primary-key}(E_2) \cup \cdots \cup \textbf{primary-key}(E_n)$$

- Therefore this set of attributes, forms a ***superkey*** for the relationship set R, *i.e.*

$$\textbf{primary-key}(E_1) \cup \textbf{primary-key}(E_2) \cup \cdots \cup \textbf{primary-key}(E_n)$$

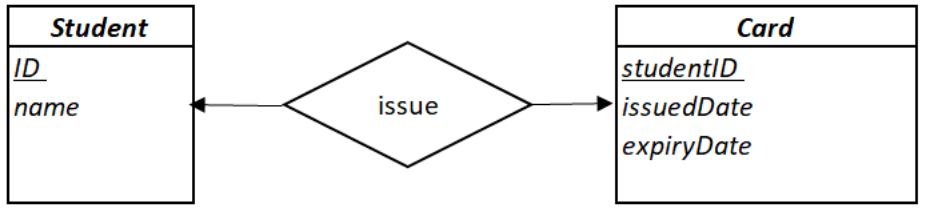
- If the names of primary key attributes of the entity sets involved and the names of attributes of the relationship set are not all unique, some attributes must be renamed

MINIMAL PRIMARY KEY OF RELATIONSIP SETS

- However this superkey set can be huge depending on the number of entities involved, and the number of primary keys in each entities
- Hence, we need to get the minimal primary key
- This choice depends on the ***mapping cardinalities*** between the entities involved, as well as the ***descriptive attributes***

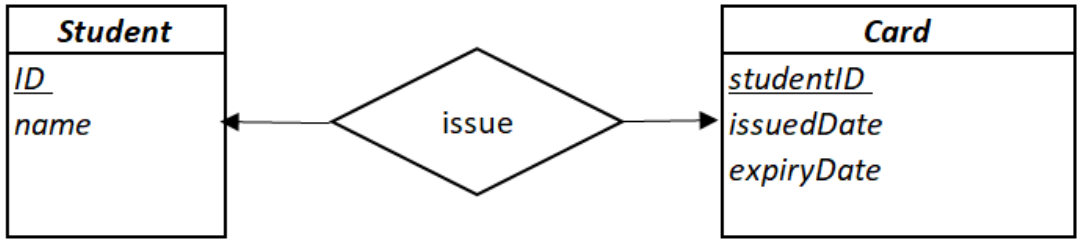
MINIMAL PRIMARY KEY OF RELATIONSIP SETS

- **Case 1**: ***Relationship set has no descriptive attributes***
  - Check the mapping cardinalities:
    - For ***one-to-one relationships***, primary key of either side can be used as the minimal primary key.
      - This is because there can be only one relationship between the entities, so by default primary keys are used
    - For example, Alex is issued an identity card with his student ID on it. This has a one-to-one relationship.



MINIMAL PRIMARY KEY OF RELATIONSIP SETS

- **Case 1**: ***Relationship set has no descriptive attributes***
  - Check the mapping cardinalities:
    - In this example, there are no descriptive attributes, so the ***superkeys*** set will be {**ID**, **studentID**}
    - But is this the minimal primary key of relationship set? For one-to-one relationship, it will be the primary key(s) of one of the entities
    - Therefore, here the minimal primary key would be: **{ID}** or **{studentID}**
    - This is sufficient to describe the relationship set of "issue"

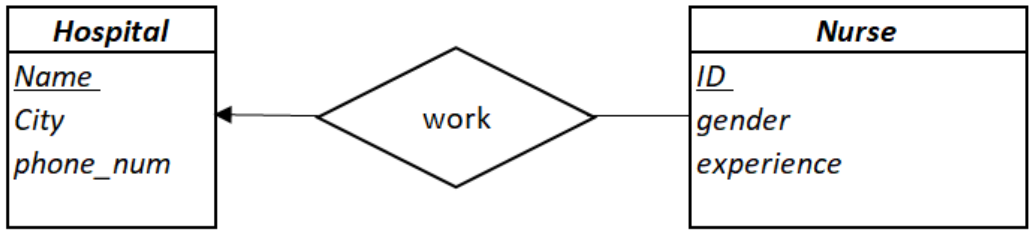


MINIMAL PRIMARY KEY OF RELATIONSIP SETS

- **<u>Case 1</u>**: ***Relationship set has no descriptive attributes***
  - Check the mapping cardinalities:
    - ➢ For ***many-to-one relationship***, the minimal primary key is the primary key of the "many" side
    - ➢ For ***one-to-many relationship***, the minimal primary key is the primary key of the "many" side
    - ❖ Here, the entity with at most one relationship will have a default association to its primary key, which will be insufficient for the "many" side that can have multiple relationships
    - ❖ Hence using the primary keys of many side will define the minimal primary keys for the relationship set

MINIMAL PRIMARY KEY OF RELATIONSIP SETS

- **Case 1**: ***Relationship set has no descriptive attributes***
  - Check the mapping cardinalities:
    - Example: ABC hospital has several male nurses
    - Here Hospital has a many-to-one relationship with Nurse
    - The ***superkeys*** set is: **{Name, ID}**
    - For the minimal set, we choose the attributes of the "many" side
      - That is, **{ID}** because as the hospital name is constant for all nurses, so just knowing the ID of the nurse would be sufficient to describe the "work" relationship

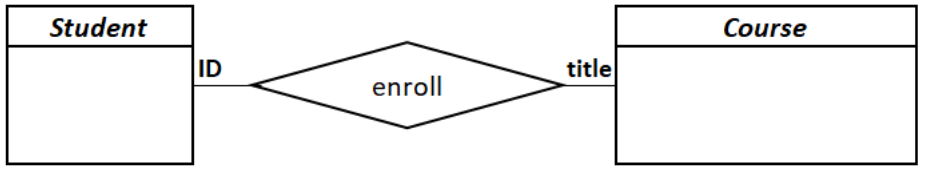


MINIMAL PRIMARY KEY OF RELATIONSIP SETS

- **<u>Case 1</u>**: ***Relationship set has no descriptive attributes***
  - Check the mapping cardinalities:
    - For ***many-to-many relationships***, the minimal primary key is:
      - Both sides can have multiple relationships, hence the superkey set is the minimal primary keys, i.e.

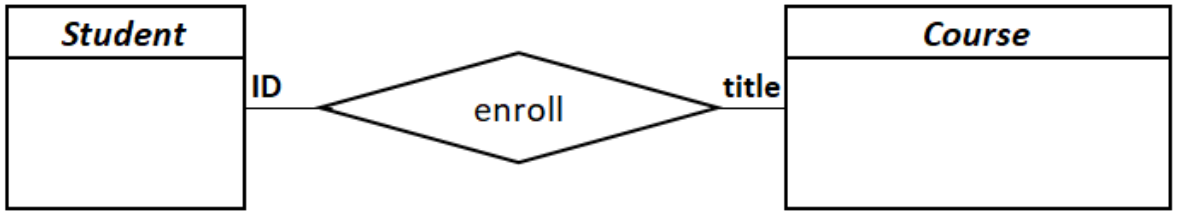
$$\textbf{primary-key}(E_1) \cup \textbf{primary-key}(E_2) \cup \cdots \cup \textbf{primary-key}(E_n)$$

    - Example: Each CS Sophomore student is enrolled in Database Systems, Object-Oriented Programming and Digital Logic Design courses
    - This is a many-to-many relationship



MINIMAL PRIMARY KEY OF RELATIONSIP SETS

- **Case 1**: ***Relationship set has no descriptive attributes***
  - Check the mapping cardinalities:
    - In this example, there are no descriptive attributes, so the ***superkeys*** set will be {**ID**, **courseID**}
    - But is this the minimal primary key of relationship set? For many-to-many relationship, superkeys set will be its minimal primary key
    - Therefore, here the minimal primary key would be: **{ID, courseID}**
    - Both these attributes are necessary to describe the enrollment, as only student ID or course ID will not be sufficient individually to represent this relationship



MINIMAL PRIMARY KEY – EXAMPLES

- Activity Sheet:
  - Attempt **Question 11**

MINIMAL PRIMARY KEY – EXAMPLES

- Activity Sheet **Question 11** Solution:
  - **ER Model Q11 Solution**