Politecnico
di Torino

DBMG

Logical Design

Database Design

Logical Design

- Translation into the relational model
  - entity and many-to-many relationships
  - one-to-many relationships
  - one-to-one relationships
  - entities with external identifiers
  - ternary relationships

Logical design

Selection of the logical model

Relational model

Objective

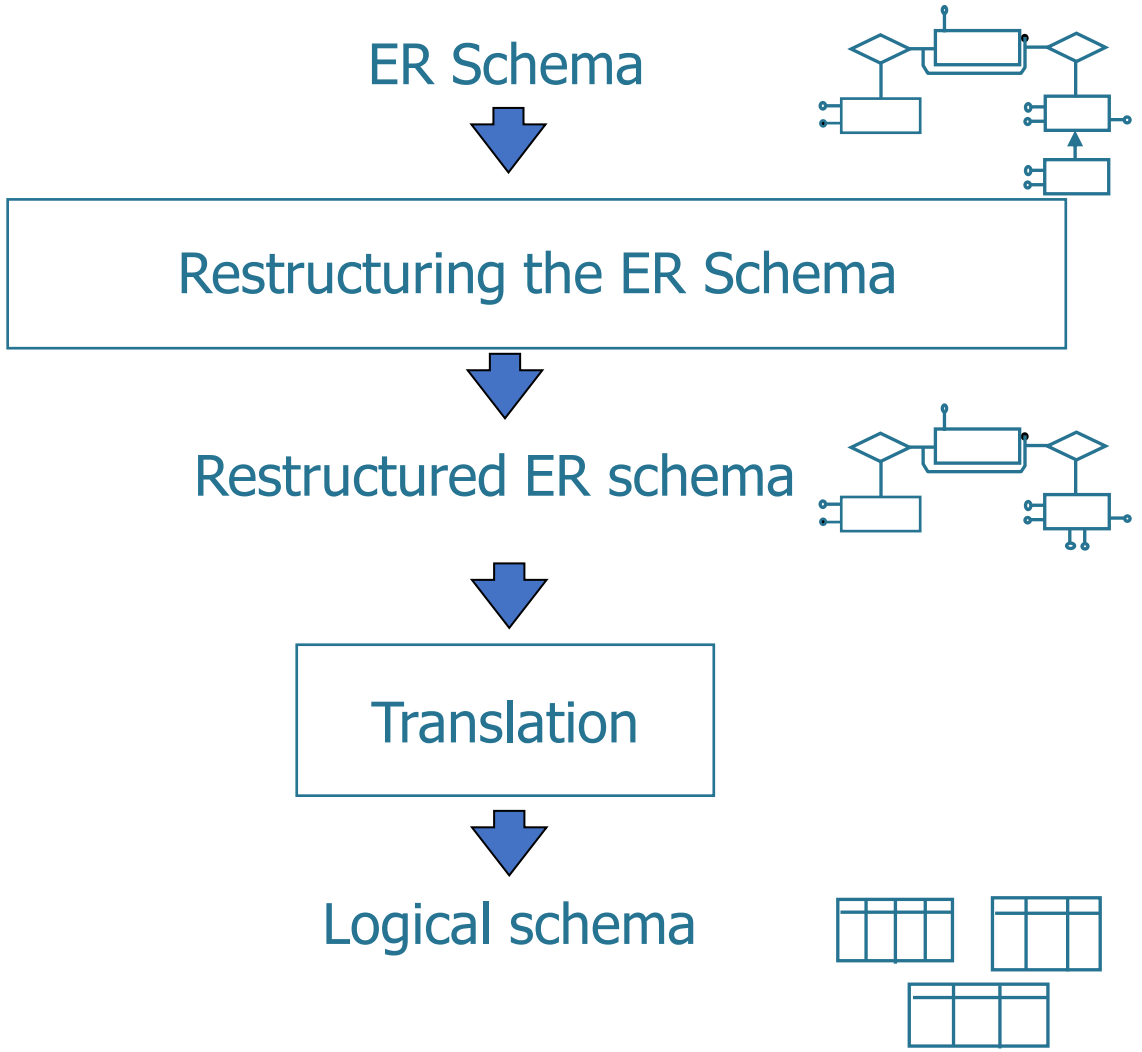
Definition of a relational logical schema corresponding to the starting ER schema

Important

Simplification of the ER schema to make it representable by the relational model

Optimization to increase the efficiency of queries

Logical design steps



Translation to the relational model

entities and many-to-many relationships

Translation to the relational model

- It is executed on the restructured ER schema
  - i.e., the schema without hierarchies, multivalued attributes and composite attributes
- Transformations
  - Each entity is translated into a table with the same attributes
  - For relationships we need to consider the maximum cardinality

Entity Translation

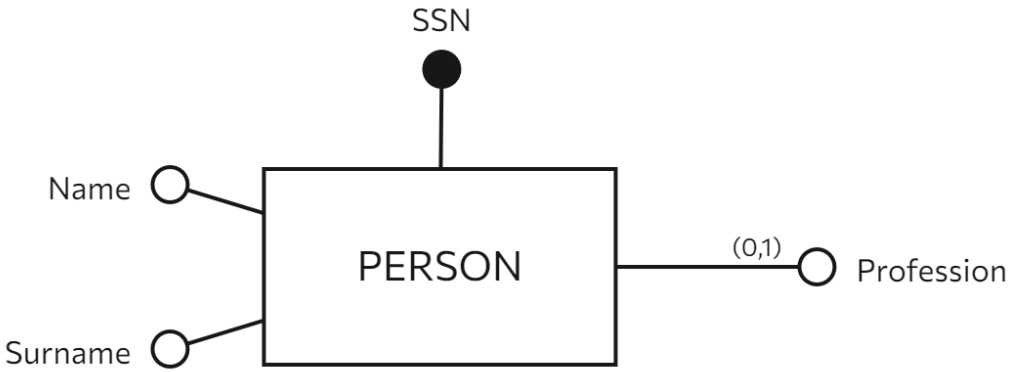
Translating the ER Schema into the Relational Model

Entity Translation

- Each entity corresponds to a table with the same attributes
  - the attributes of the entity constitute the schema of the table
- The identifier (simple or composite) of the Entity becomes the primary key of the table
- Optional Entity attributes are attributes that can be NULL
  - They are highlighted with "*" in the table schema

Entity

Conceptual model



Logical model

Person(<u>SSN</u>, Name, Surname, Profession*)

- Underlined primary key
- Optional attributes indicated with an asterisk

Relationship translation

Translating the ER Schema into the Relational Logic Model

Relationship translation

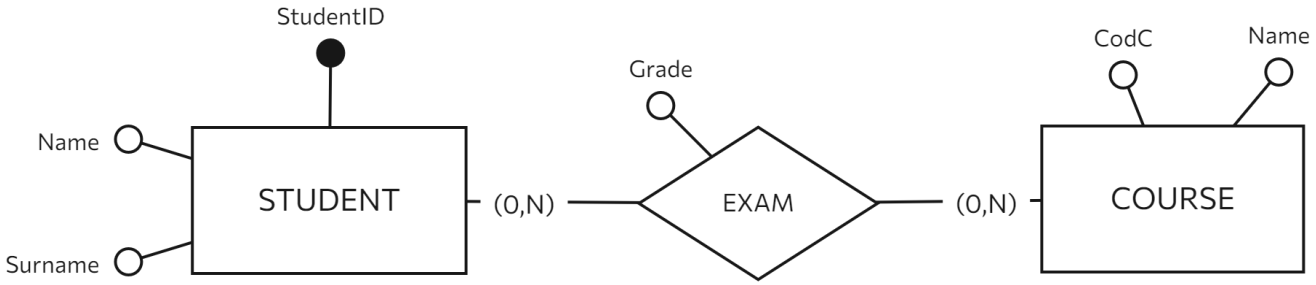
- To translate a relationship
  1. Step 1: The Entities participating in the Relationship are first translated
  2. Step 2: The Relationship is then translated
     - Different translation rules for binary and ternary Relationships
     - For a Binary Relationship, it is necessary to consider the maximum and minimum cardinality with which the Entities participate in the Relationship

Translation of Binary Relationships

Translating the ER Schema into the Relational Model

Many-to-many binary relationship

Conceptual model



Logical model

Student(StudentID, Name, Surname)

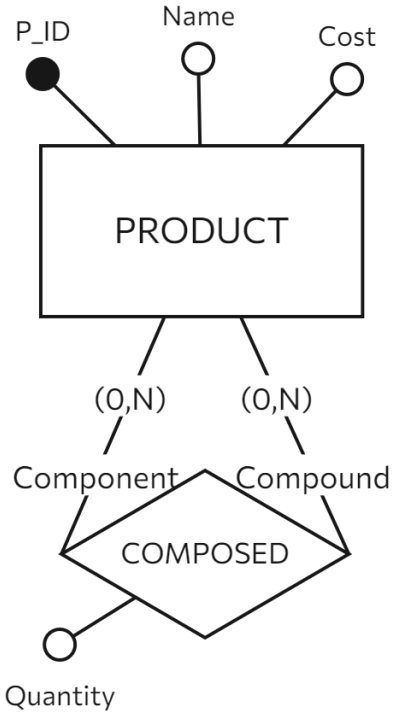
Course(CodC, Name)

Exam(StudentID, CodC, Grade)

- Each many-to-many relationship corresponds to a table
  - The primary key is the combination of the identifiers of the two linked entities
  - The attributes of the table that corresponds to the relationship can be renamed (required in case of recursive relationships)

Recursive many-to-many binary relationship

Modello concettuale



Logical model

Product (P_ID, Name, Cost)

Composed(CodCompound, CodComponent, Quantity)

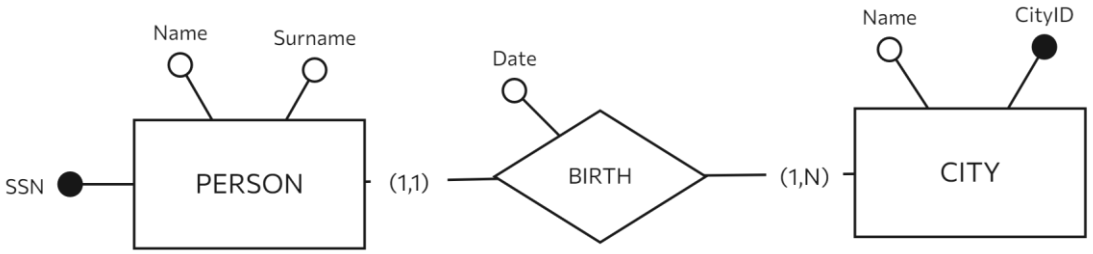
- Each many-to-many relationship corresponds to a table
  - The primary key is the combination of the identifiers of the two linked entities
  - The attributes of the table that corresponds to the relationship can be renamed (required in case of recursive relationships)

One-to-many binary relationship

- Two translation modes are possible
  - by means of attributes
  - by means of a new table

One-to-Many Binary Relationship: using attributes

Conceptual model



Logical model

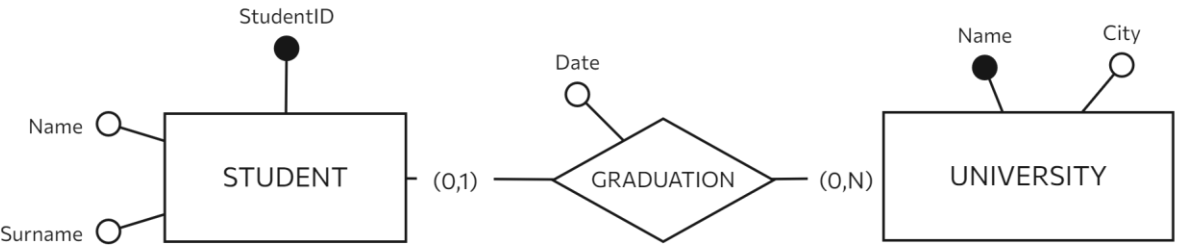
Person (SSN, Name, Surname, CityID, Date)

City (CityID, Name)

- It is used when participation of the entity that participates with a maximum cardinality of 1 is mandatory (minimum cardinality of 1)

One-to-many binary relationship: using attributes or a new table

Conceptual model



Logical model

Alternative 1: Translation using attributes

Student (StudentID, Name, Surname, NameUniv*, Date*)

University (Name, City)

Alternative 2: Translation using a new table

Student (StudentID, Name, Surname)

University (Name, City)

Graduation (StudentID, NameUniv, Date)

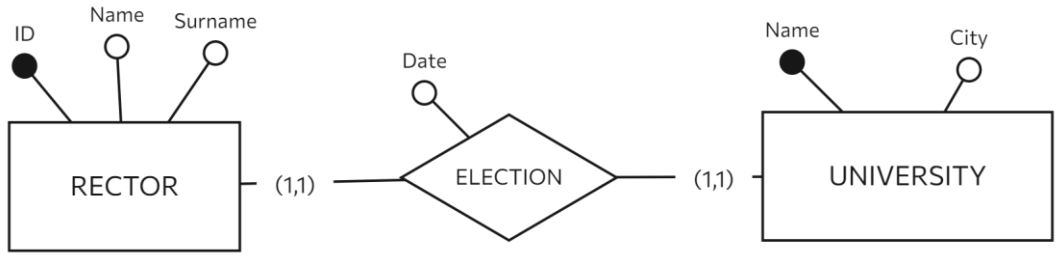
- It is used when participation of the entity that participates with a maximum cardinality of 1 is optional (minimum cardinality of 0)

One-to-one binary relationship

- Multiple translations are possible
  - depends on the value of the minimum cardinality

One-to-one binary relationship

Conceptual model



Logical model

Alternative 1

Rector (ID, Name, Surname, UnivName, Date)

University (Name, City)

Alternative 2

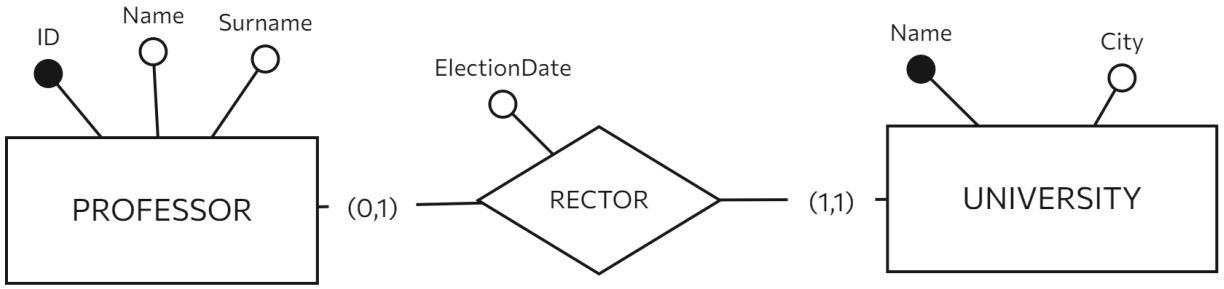
Rector (ID, Name, Surname)

University (Name, City, ID, Date)

- It is used when both entities participate with a maximum cardinality of 1 in the relationship, and participation is mandatory for both entities (minimum cardinality of 1)

One-to-one binary relationship

Conceptual model



Logical model

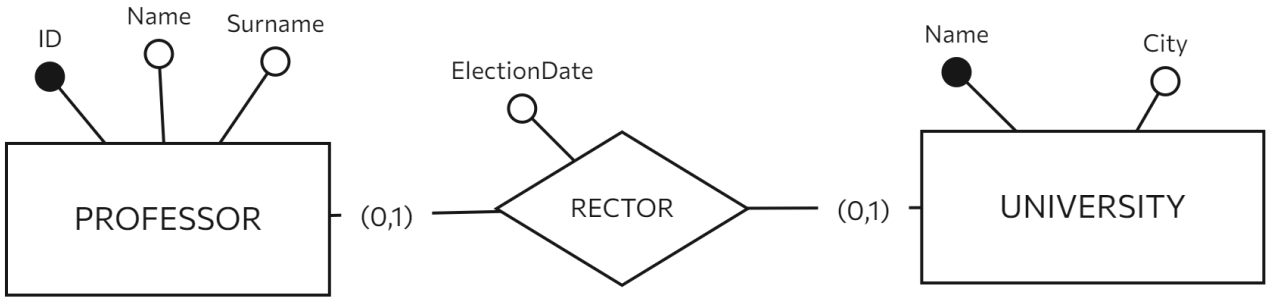
Professor (<u>ID</u>, Name, Surname)

University (<u>Name</u>, City, RectorID, ElectionDate)

- It is used when both entities participate with a maximum cardinality of 1 in the relationship, but participation is mandatory only for one entities (minimum cardinality of 1)

One-to-one binary relationship

Conceptual model



Logical model

Alternative 1

Professor (ID, Name, Surname)
University (Name, City)
Rector (RectorID, UniversityName, ElectionDate)

Alternative 2

Professor (ID, Name, Surname)
University (Name, City)
Rector (RectorID, UniversityName, ElectionDate)

Alternative 3

Professor (ID, Name, Surname)
University (Name, City, RectorID*, ElectionDate*)

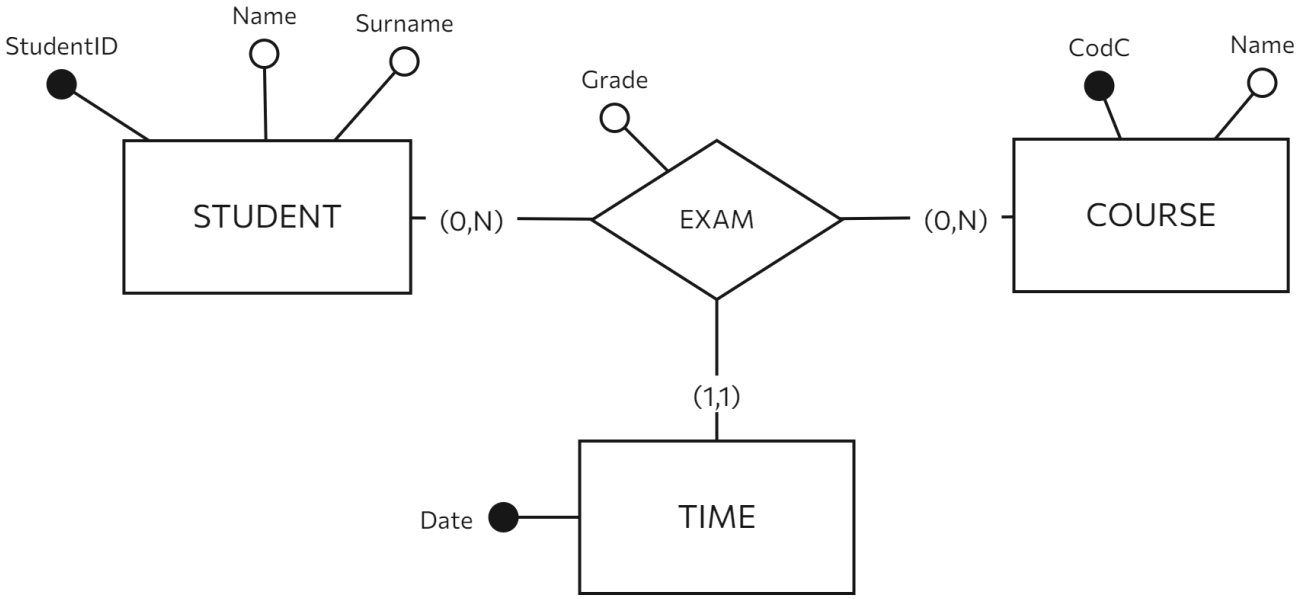
- It is used when both entities participate with a maximum cardinality of 1 in the relationship, and participation is optional for both entities (minimum cardinality of 0)

Translation of Ternary Relationships

Translating the ER Schema into the Relational Model

Ternary Relationship

Conceptual model



Logical model

Student(<u>StudentID</u>, Name, Surname)

Course(<u>CodC</u>, Name)

Time(<u>Date</u>)

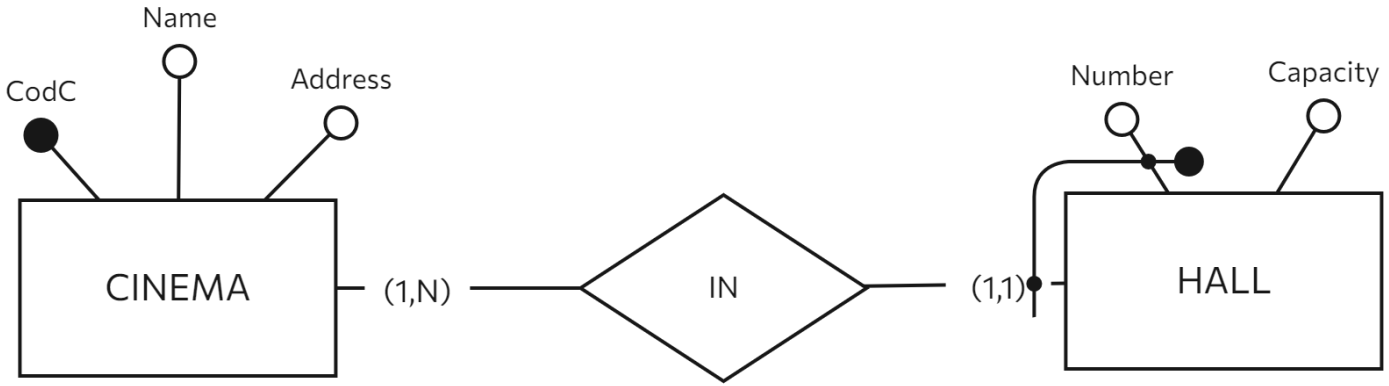
Exam(<u>StudentID</u>, <u>CodC</u>, <u>Date</u>, Mark)

Translating Entities with External Identifier

Translating the ER Schema into the Relational Model

Entities with an external identifier

Conceptual model



Logical model

Cinema (CodC, Name, Address)

Hall (Number, CodC, Capacity)

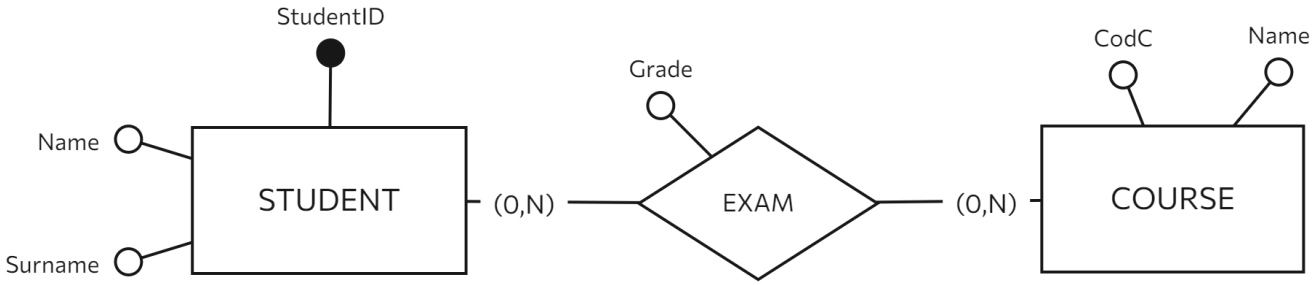
- The relationship is represented together with the identifier
- The relationship contributes to the definition of the weak entity identifier

Referential integrity constraints

Translating the ER Schema into the Relational Model

Referential integrity constraints

Conceptual model



Logical model

Student(StudentID, Name, Surname)

Course(CodC, Name)

Exam(StudentId, CodC, Grade)

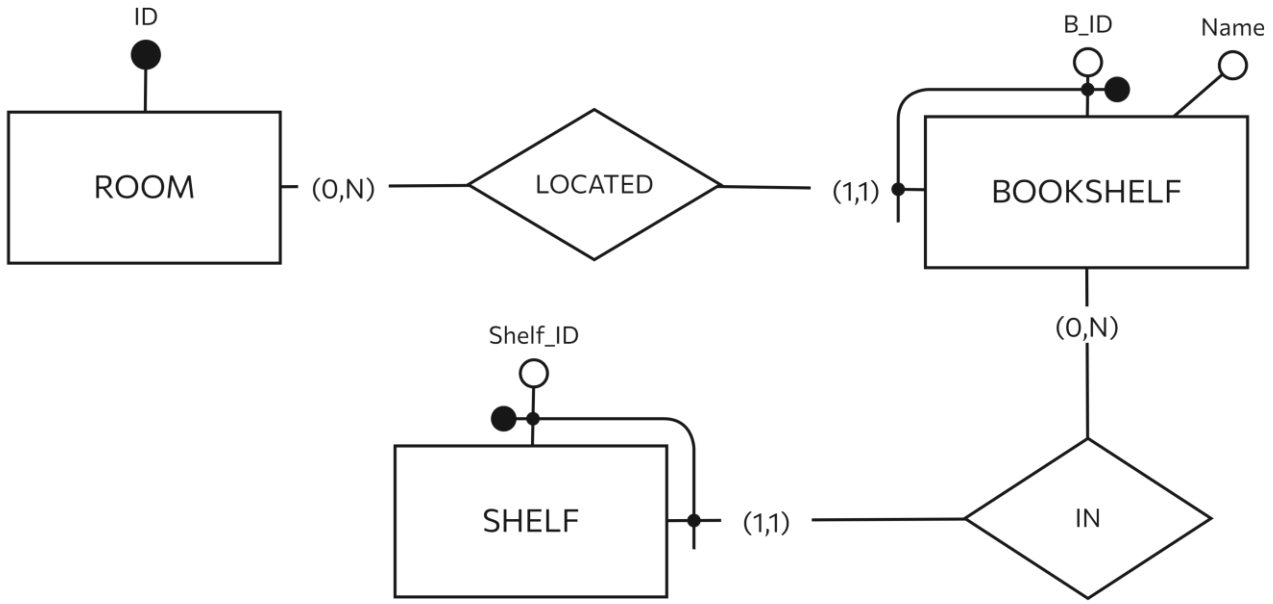
- Relationships Represent Referential Integrity Constraints

  Exam(StudentID) REFERENCES Student(StudentID)

  Exam(CodC) REFERENCES Course(CodC)

Referential integrity constraints

Conceptual model



Logical model

Room (<u>ID</u>)

Bookshelf (<u>*ID*</u>, <u>*B_ID*</u>, Name)

Shelf (<u>ID</u>, <u>*B_ID*</u>, <u>*Shelf_ID*</u>)

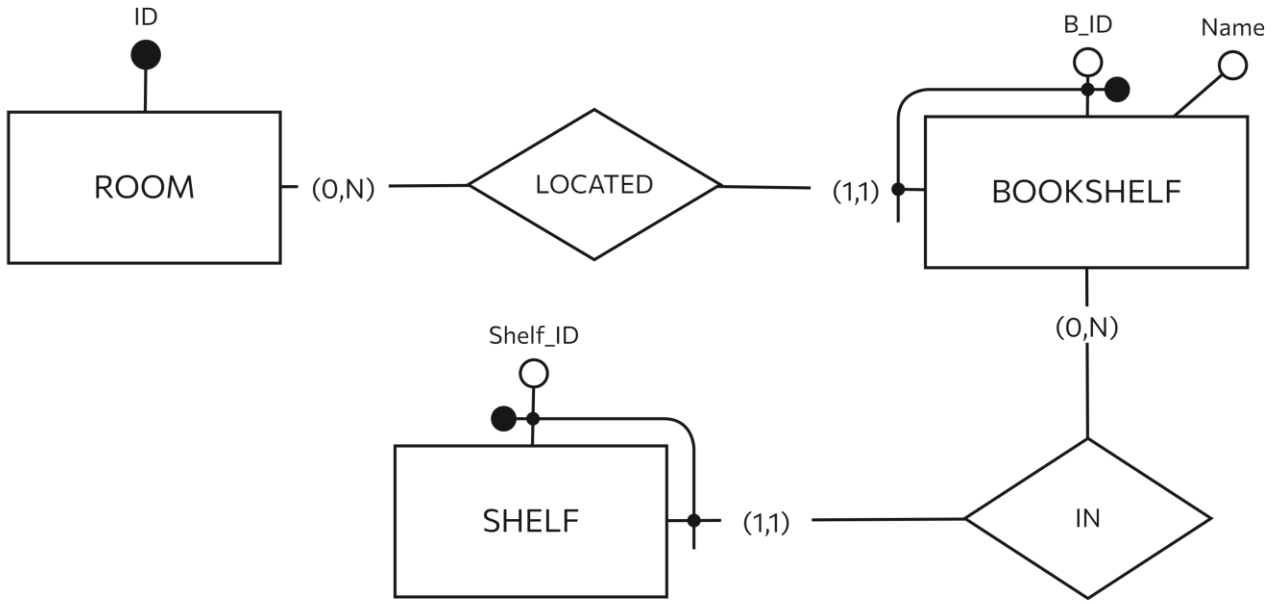
- If the referenced key consists of multiple attributes, the referential integrity constraint is imposed on the attribute set

  Bookshelf(ID) REFERENCES Room(ID)

  Shelf (ID, B_ID) REFERENCES Bookshelf (ID, B_ID)

Referential integrity constraints

Conceptual model



Logical model

Room (<u>ID</u>)

Bookshelf (<u>*ID*</u>, <u>*B_ID*</u>, Name)

Shelf (<u>ID</u>, <u>*B_ID*</u>, <u>*Shelf_ID*</u>)

- If the referenced key consists of multiple attributes, the referential integrity constraint is imposed on the attribute set

  Bookshelf(ID) REFERENCES Room(ID)
  Shelf (ID) REFERENCES Bookshelf (ID)
  Shelf(B_ID) REFERENCES Bookshelf (B_ID)

Wrong constraints!