INDUSTRIAL EDUCATION
Nakhon Pathom Rajabhat University

ER-to-Relational Mapping Algorithm and Normalization

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Lesson Objectives

- Students should be able to accurately explain the concept of integrity constraints in databases.
- Students should be able to correctly transform an E-R diagram into relational schemas according to database design principles.
- Students should be able to explain the meaning and objectives of database normalization.
- Students should be able to correctly perform normalization processes including First Normal Form (1NF), Second Normal Form (2NF), and Third Normal Form (3NF).

Source:Iamsiriwong, O. (2008). Database systems. Bangkok: SE-ED Education.

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Data Integrity Rule

Data integrity constraints consist of three fundamental rules that ensure the accuracy and consistency of data within a database system. These rules include entity integrity, domain integrity, and referential integrity, which collectively maintain reliable relationships and valid data values in relational databases.

Source:Iamsiriwong, O. (2008). Database systems. Bangkok: SE-ED Education.

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Data Integrity Rule

Entity Integrity

Entity Integrity is a fundamental principle in relational database design that ensures every relation has a primary key. This rule guarantees that all attributes defined as a primary key must not contain NULL values, allowing each tuple to be uniquely identified. If a tuple has a NULL value in its primary key, the uniqueness of that tuple cannot be determined, which violates the entity integrity constraint. Therefore, database systems enforce this rule by preventing primary key attributes from having NULL values. Because of this function, Entity Integrity is sometimes also referred to as Key Integrity.

```
CREATE TABLE Student (
  StudentID INT NOT NULL,
  StudentName VARCHAR(100) NOT NULL,
  CourseID INT NOT NULL,
  PRIMARY KEY (StudentID),
  FOREIGN KEY (CourseID) REFERENCES Course(CourseID)
);
```

Source:Iamsiriwong, O. (2008). Database systems. Bangkok: SE-ED Education.

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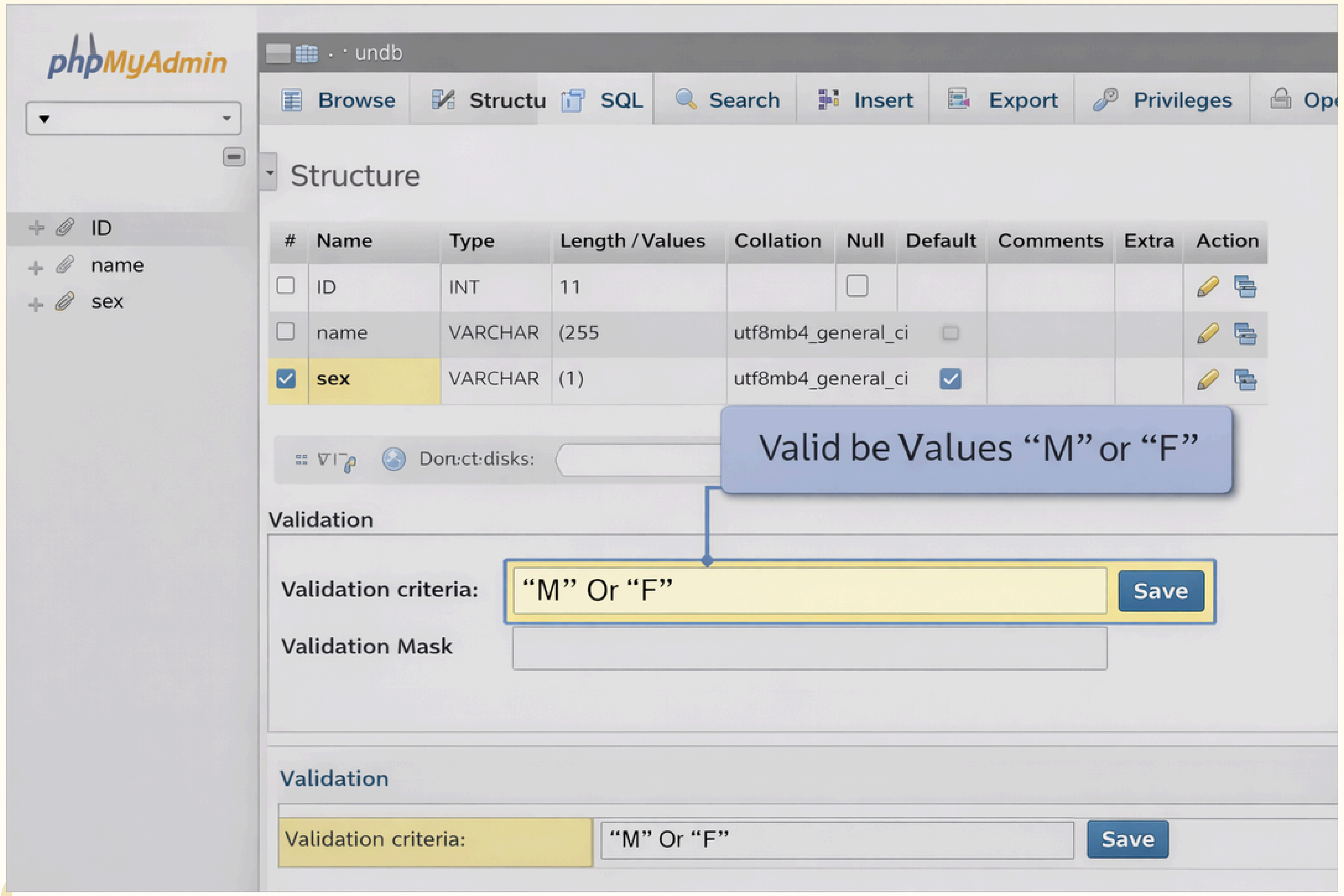
Data Integrity Rule

Domain Integrity



The image illustrates the configuration of a data validation rule in the phpMyAdmin table design interface to enforce Domain Integrity. In this example, the attribute sex is defined with a data type of VARCHAR(1), and a validation rule is applied to restrict its values to either "M" or "F" only. This constraint ensures that only predefined and valid values can be stored in the attribute, preventing invalid or inconsistent data from being entered into the database. By limiting the range of acceptable values, the database system maintains data accuracy and consistency according to the principle of Domain Integrity.

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Data Integrity Rule

Referential Integrity

Referential Integrity is a rule that maintains consistency between related relations in a relational database. It states that when a relation contains a foreign key, the value of that key must correspond to an existing primary key value in another relation. This rule ensures that references between tables remain valid and that relationships among data are preserved. In managing data changes under referential integrity, there are three possible cases that may occur when the referenced data is updated or deleted.

Restricted

This rule does not allow modification of a key value if that key is still being referenced or used by other relations.

Nullify

This rule allows a foreign key attribute to store NULL values.

Cascades

This rule allows modification of a primary key value, but the corresponding foreign keys in other relations that reference this key will be automatically updated

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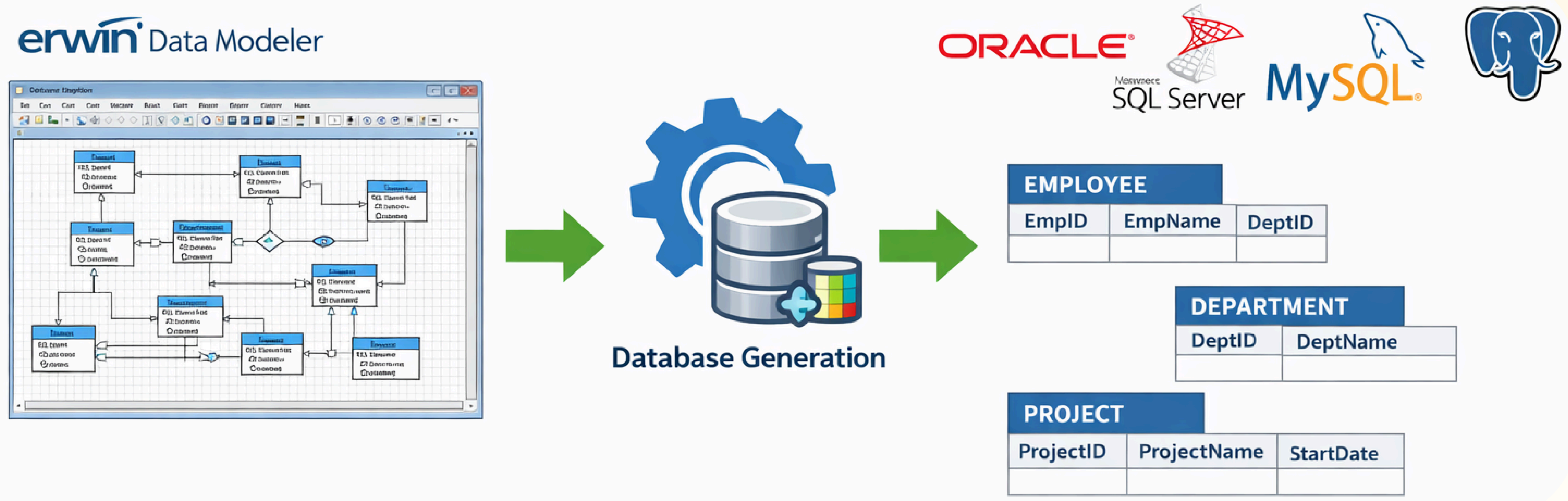
ER-to-Relational Mapping Algorithm

Logical database design is the process of transforming an E–R or EER diagram, which has been developed during the conceptual database design phase, into a relational schema. CASE tools often include functions that automatically support this transformation. However, converting an E–R diagram into relations manually is still important, and CASE tools may sometimes be used to assist this process for three main reasons: (1) some CASE tools cannot transform data models that contain complex relationships, (2) having more than one method for solving a problem is beneficial, and (3) manual conversion may be required when a higher standard and quality of work are expected.



Source: Iamsiriwong, O. (2008). Database systems. Bangkok: SE-ED Education.

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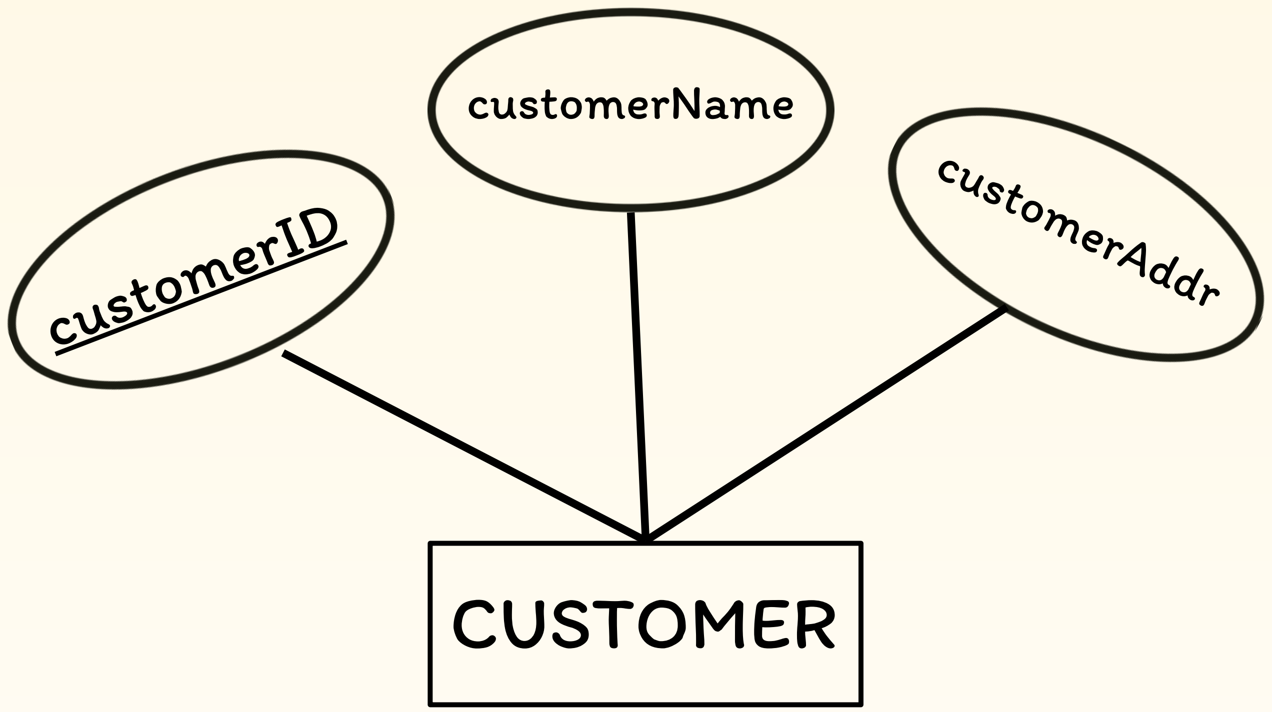
ER-to-Relational Mapping Algorithm

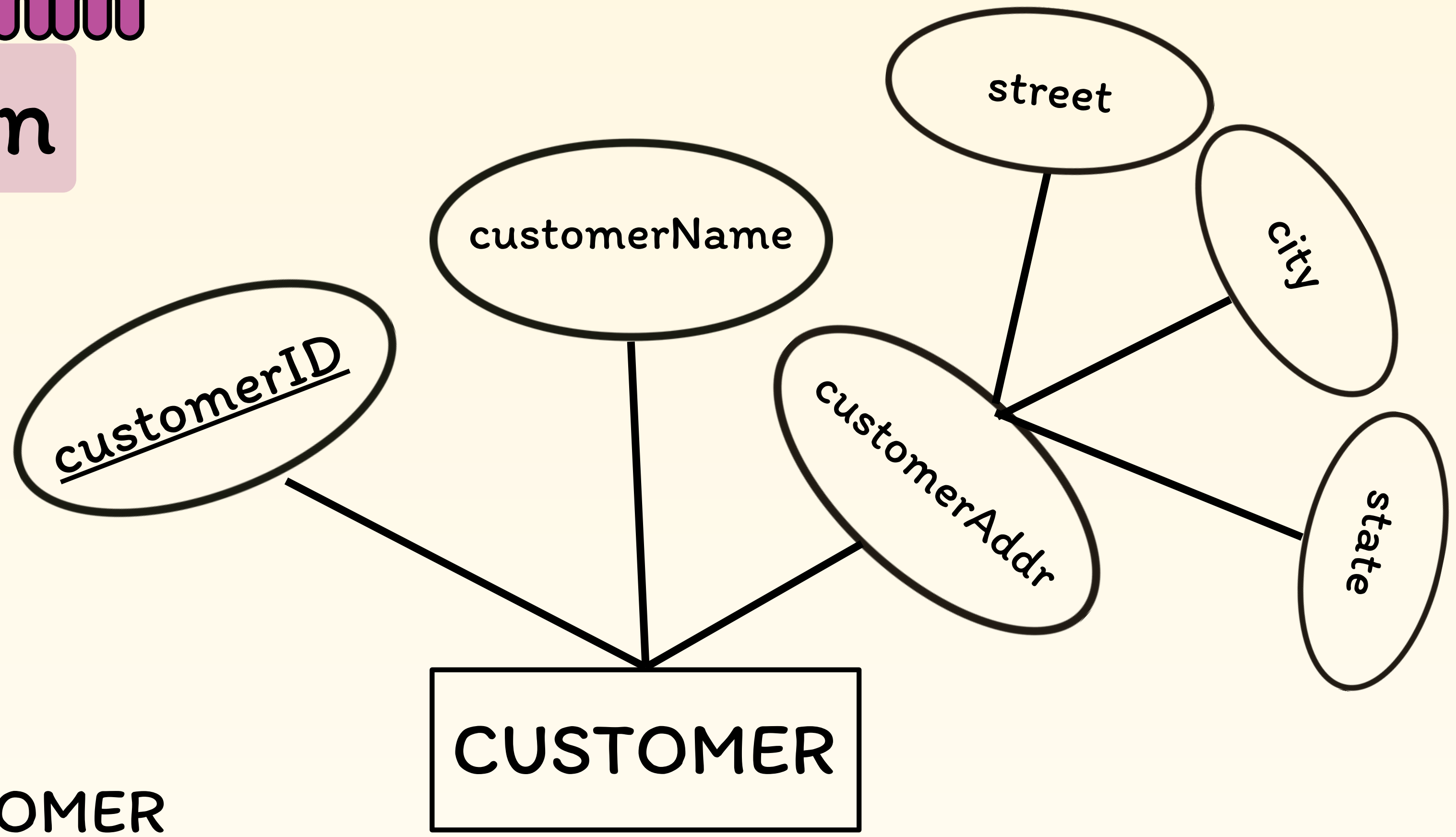
Mapping Strong Entity to a Relation



CUSTOMER

customerID	customerName	customerAddr

The strong entity CUSTOMER is transformed into a relational schema.



CUSTOMER

customerID	customerName	street	city	state

The transformation of composite attributes into simple attributes.

Source:Iamsiriwong, O. (2008). Database systems. Bangkok: SE-ED Education.

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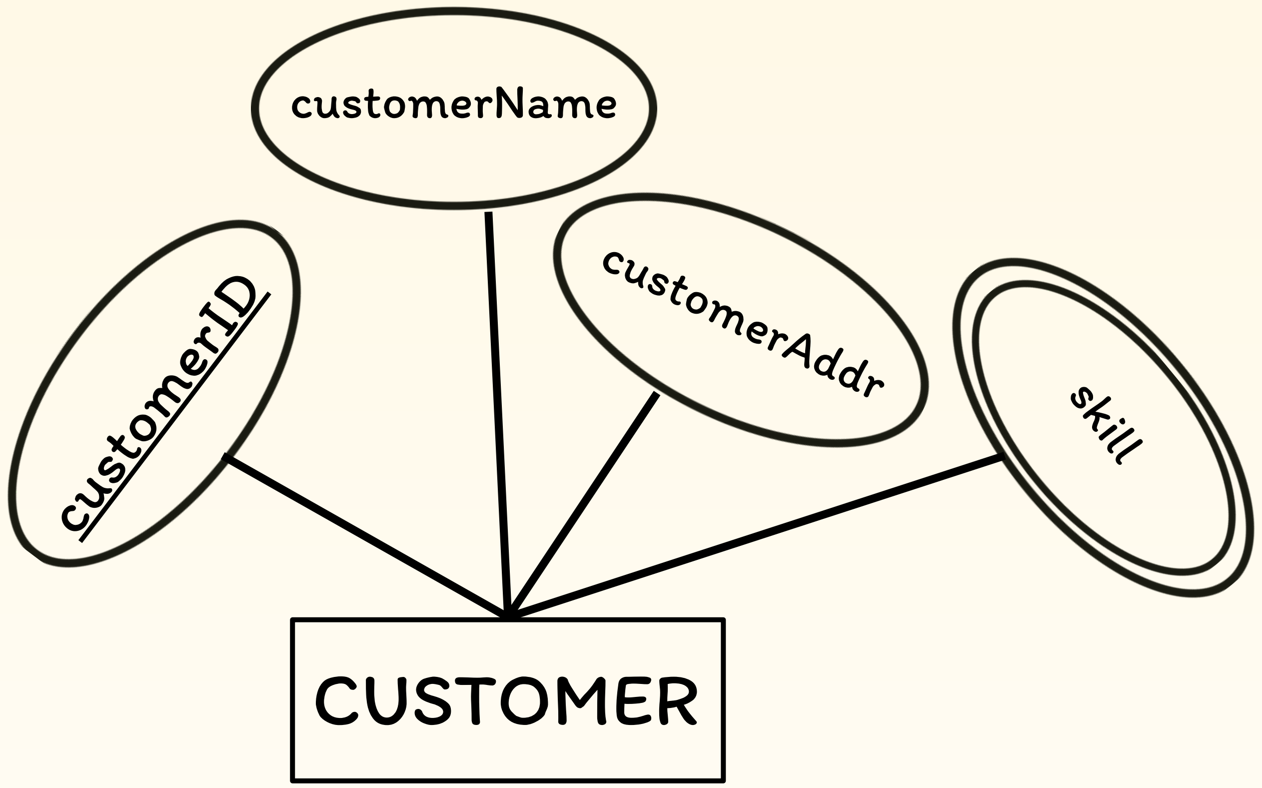
ER-to-Relational Mapping Algorithm

Mapping Multivalued Attributes to a Relation



CUSTOMER

customerID	customerName	customerAddr

CUSTOMER_SKILL

customerID	skill

Source: Iamsiriwong, O. (2008). Database systems. Bangkok: SE-ED Education.

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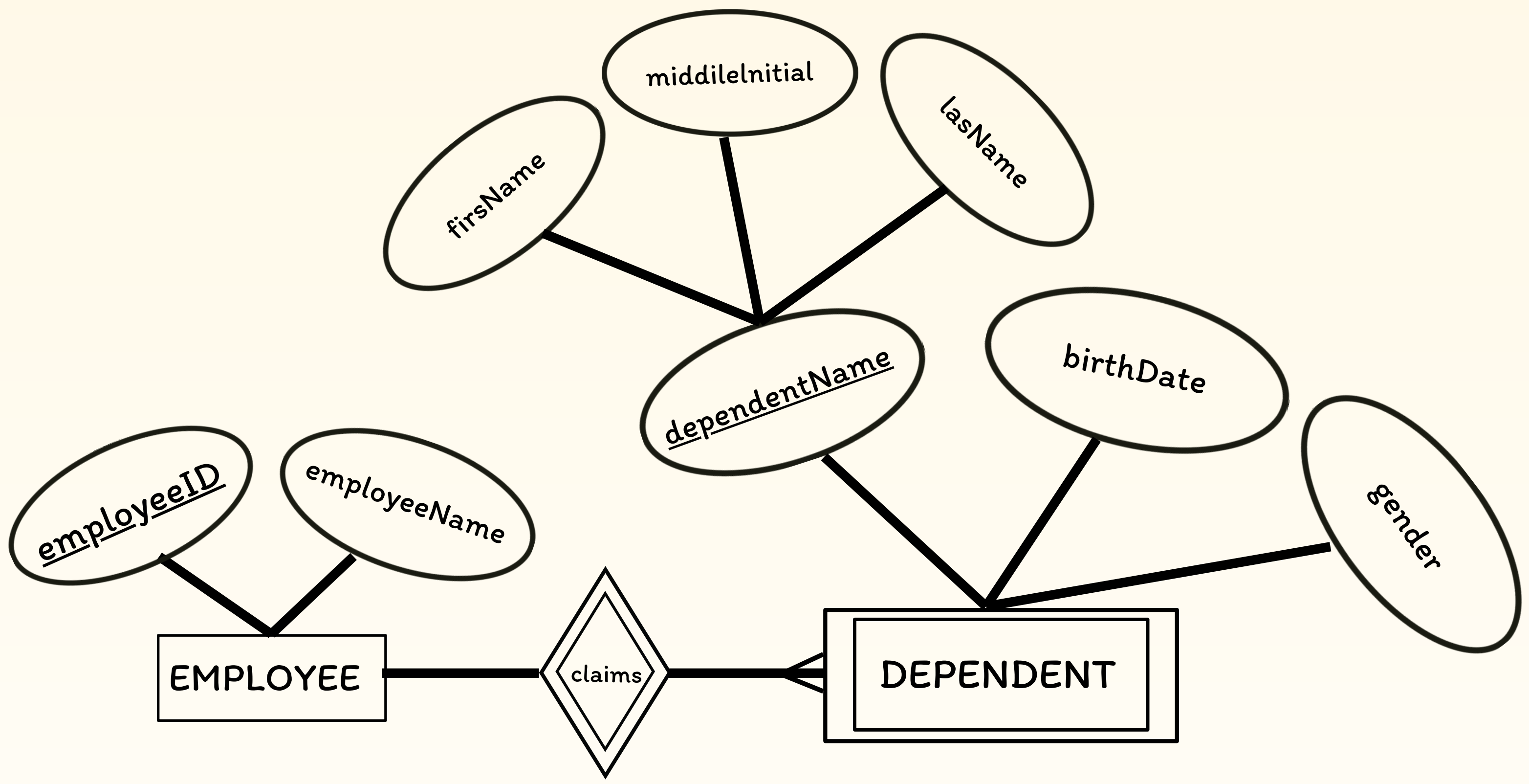
ER-to-Relational Mapping Algorithm

Mapping Weak Entity to a Relation



EMPLOYEE

employeeID	employeeName

DEPENDENT

firstName	middlelnitial	lastname	employeeID	birthDate	gender

Source:Iamsiriwong, O. (2008). Database systems. Bangkok: SE-ED Education.

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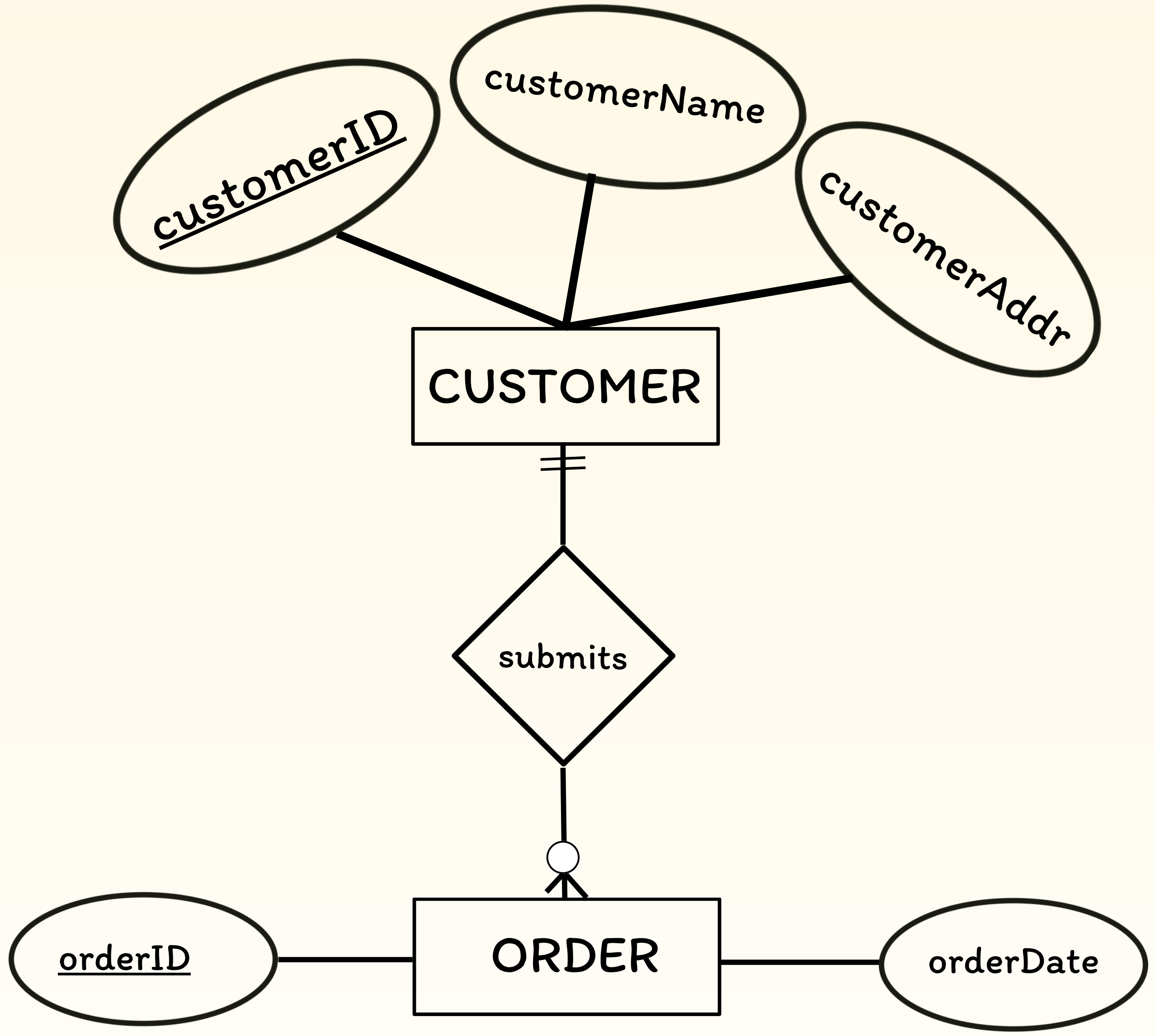
ER-to-Relational Mapping Algorithm

The transformation of binary relationships into relational schemas.

1:M



CUSTOMER

customerID	customerName	customerAddr

ORDER

orderID	orderDate	customerID

Source:Iamsiriwong, O. (2008). Database systems. Bangkok: SE-ED Education.

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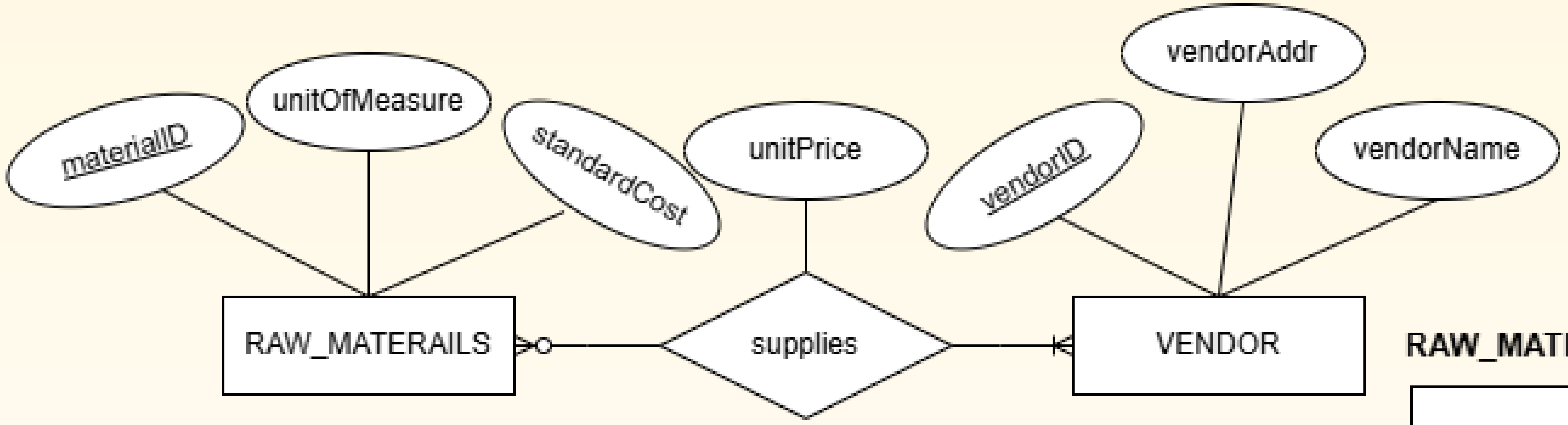
ER-to-Relational Mapping Algorithm

Transformation of a Binary Many-to-Many Relationship M:N



RAW_MATERAILS

materialID	standardCost	unitOfMeasure

QUOTE

materialID	vendorID	unitPrie

VENDOR

vendorID	vendorName	vendorAddr

Source:Iamsiriwong, O. (2008). Database systems. Bangkok: SE-ED Education.

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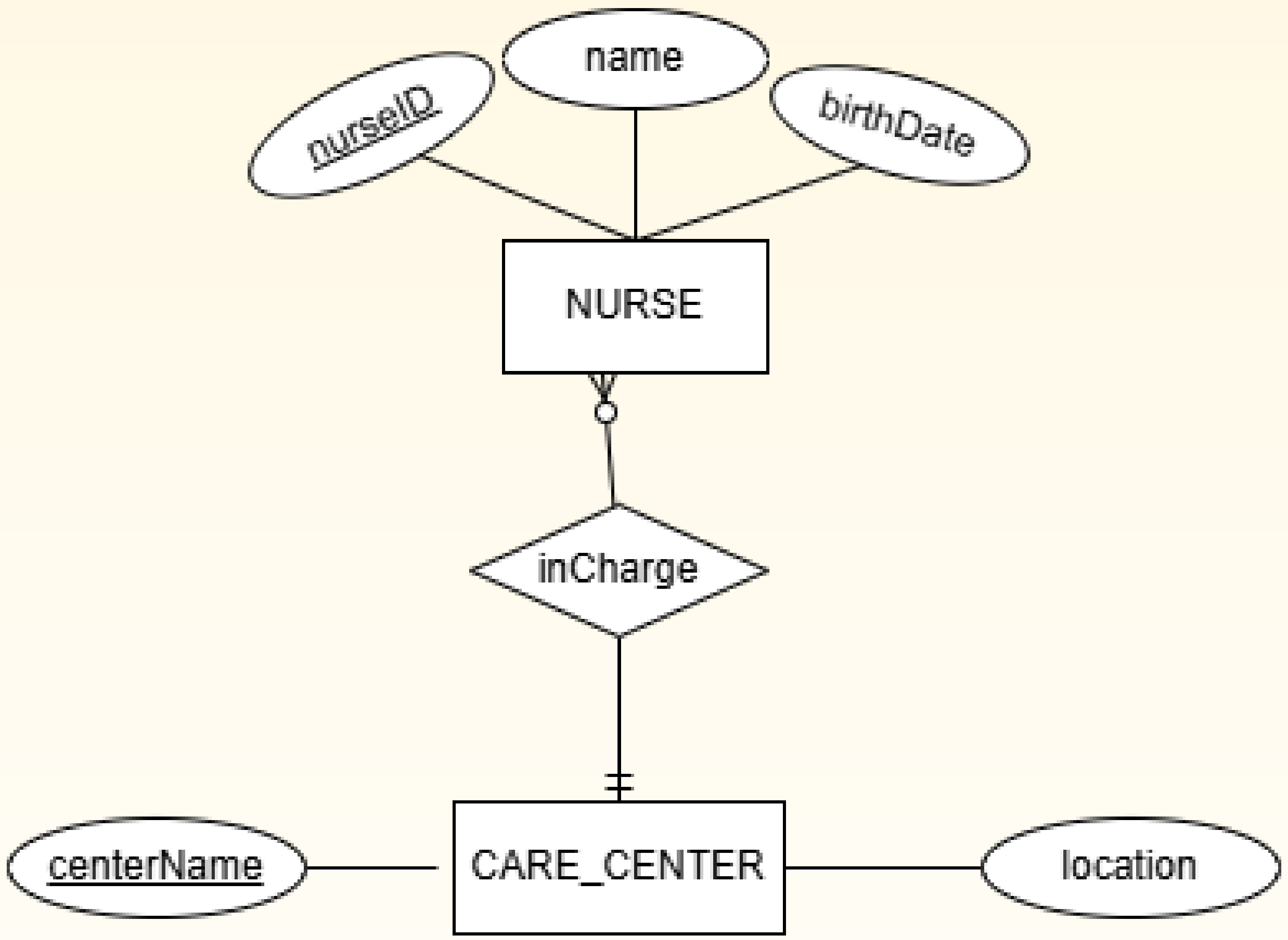
ER-to-Relational Mapping Algorithm

Transformation of a Binary One-to-One Relationship 1:1



NURSE

nurseID	name	birthDate

CARE_CENTER

centerName	location	nurseInCharge	dateAssigned

Source: Iamsiriwong, O. (2008). Database systems. Bangkok: SE-ED Education.

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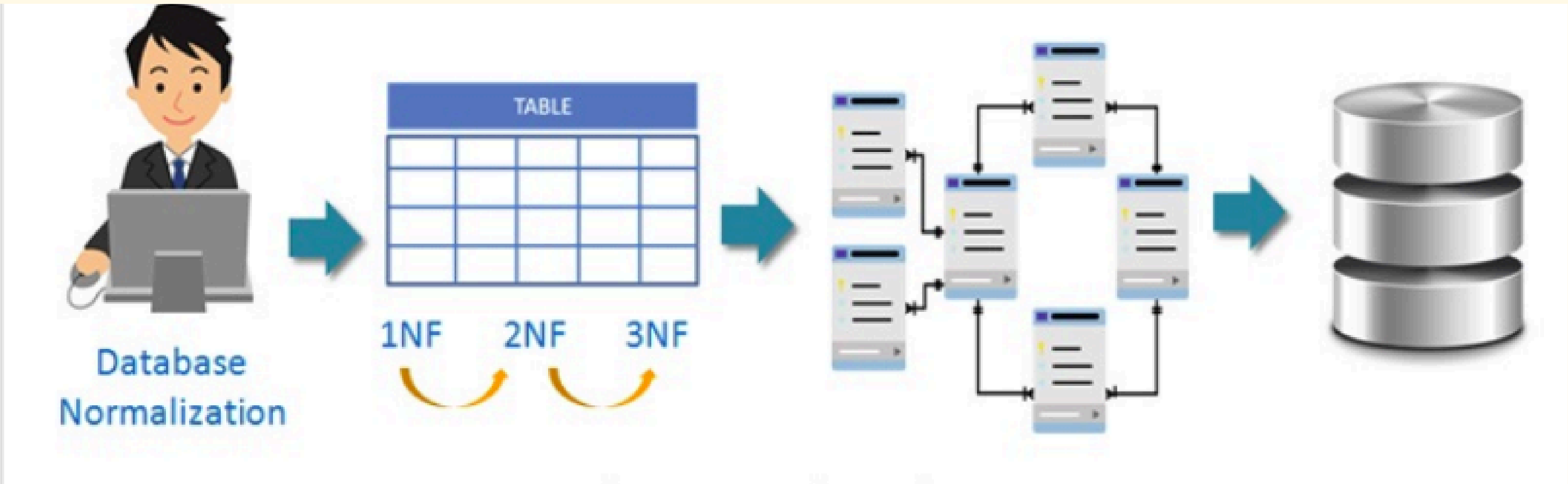
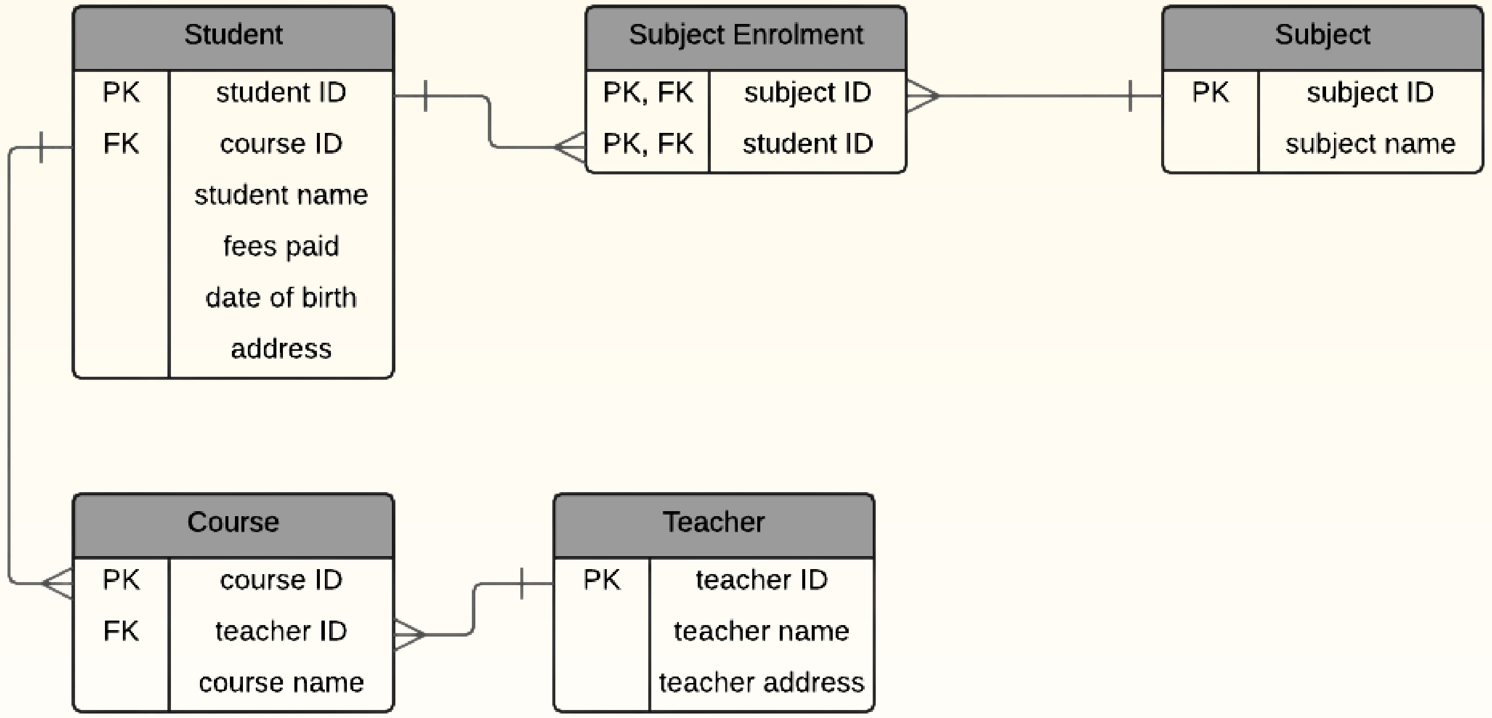
Nomalization





Source:Iamsiriwong, O. (2008). Database systems. Bangkok: SE-ED Education.

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Nomalization...

First Normal Form (1NF)

A table is in 1NF if:

- Each column contains atomic values
- No repeating groups
- Each record can be uniquely identified

Source:Iamsiriwong, O. (2008). Database systems. Bangkok: SE-ED Education.

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Nomalization...

Second Normal Form (2NF)

A table is in 2NF if:

- It is already in 1NF
- No partial dependency
- Non-key attributes depend on the entire primary key

Source:Iamsiriwong, O. (2008). Database systems. Bangkok: SE-ED Education.

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Nomalization...

Third Normal Form (3NF)

A table is in 3NF if:

- It is already in 2NF
- No transitive dependency
- Non-key attributes depend only on the primary key

Source: Iamsiriwong, O. (2008). Database systems. Bangkok: SE-ED Education.

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Nomalization...

Benefits of Normalization

- Reduces data redundancy
- Improves data integrity
- Simplifies database maintenance
- Supports efficient database design

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Entity Relationship Modeling

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