




Mapping from ER Models to Relational Models



Prerequisites for This Section

Readings:

-  **Required:** Connolly and Begg, sections 15.1

Assessments

-  Multiple-Choice Quiz 5



Section Objectives

In this section you will learn:

- ① The two major distinctions between the ER models and the relational models are:
 - I. in a relational schema, relationships are represented *implicitly* through primary and foreign keys of participating entities.
 - II. in a relational schema, columns of relations *cannot* be multi-valued or composite.
- ② A nine-step algorithm attempts to minimize the need for joins and NULL values when defining relations



Distinctions Between ER Constructs and Relational Ones

- ✿ The two major distinctions are:
- ① In a relational schema, **relationships** are represented *implicitly* through primary and foreign keys of participating entities.
 - ② In a relational schema, columns of relations *cannot* be multi-valued or composite. **Composite attributes** are replaced with their simple component ones, and **multi-valued attributes** are stored in a separate relation.



Correspondence Between ER Constructs and Relational Ones

ER Construct	Relational Construct
entity	table
1:1 or 1:N relationship	Foreign key (or a table to capture the relationship)
M:N relationship	"relationship" table and 2 foreign keys
n-ary relationship type	"relationship" table and 'n' foreign keys
simple attribute	column
composite attribute	set of simple component columns
multi-valued attribute	table and foreign key
value set	domain
key attribute	primary (or secondary) key



A Nine-step Mapping Algorithm

- ✿ Step one – strong entity E
- ✿ Step two – weak entity W associated with only one 1:1 relationship
- ✿ Step three – weak entity W associated with a 1:N or M:N relationship
- ✿ Step four – binary 1:1 relationship R
- ✿ Step five – binary 1:N relationship R
- ✿ Step six – N-ary relationship (including binary N:M relationship) R
- ✿ Step seven – multi-valued attribute A
- ✿ Step eight – specialization with disjoint subclasses
- ✿ Step nine – specialization with overlapping subclasses



Step One

- ✿ For each strong entity E:
 - ✦ Create a new table.
 - ✦ Include as its columns, all the simple attributes and simple components of the composite attributes of E.
 - ✦ Identify the primary key and the alternate keys. Do not include any multi-valued attribute as a key. If the only unique field of an entity is a multi-valued attribute, introduce an artificial primary key field.

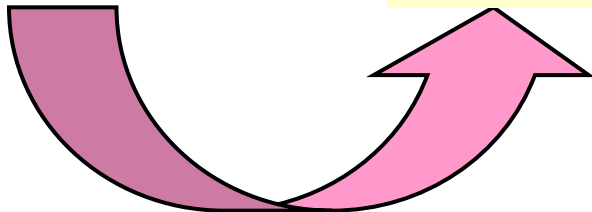


Example of Step One

Staff
staffNo{PK}
name
fName
lName
position
sex
DOB

Staff (staffNo, fName, lName, position, sex, DOB)

Primary Key staffNo





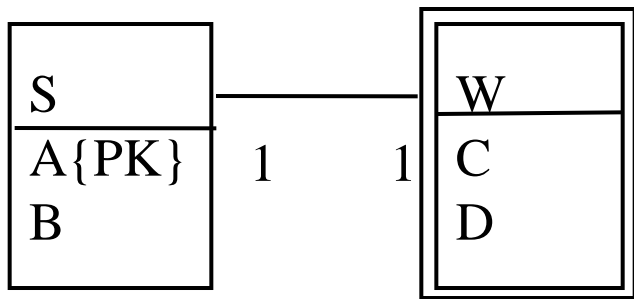
Step Two

- ✚ For each weak entity W that is associated with only one 1:1 identifying owner relationship:
 - ✚ Identify the table T of the owner entity type.
 - ✚ Include as columns of T , all the simple attributes and simple components of the composite attributes of W .



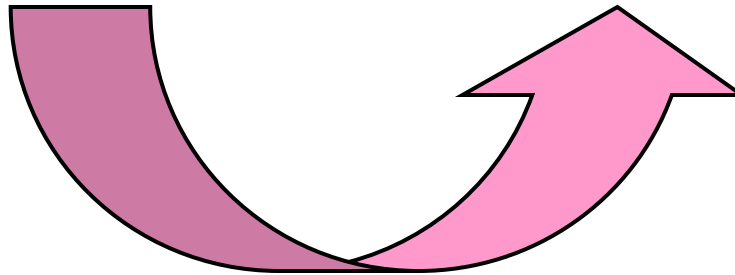
Example of Step Two

- Create one table from both owner entity and weak entity



SW(A, B, C, D)
Primary Key A

S(A, B)
Primary Key A





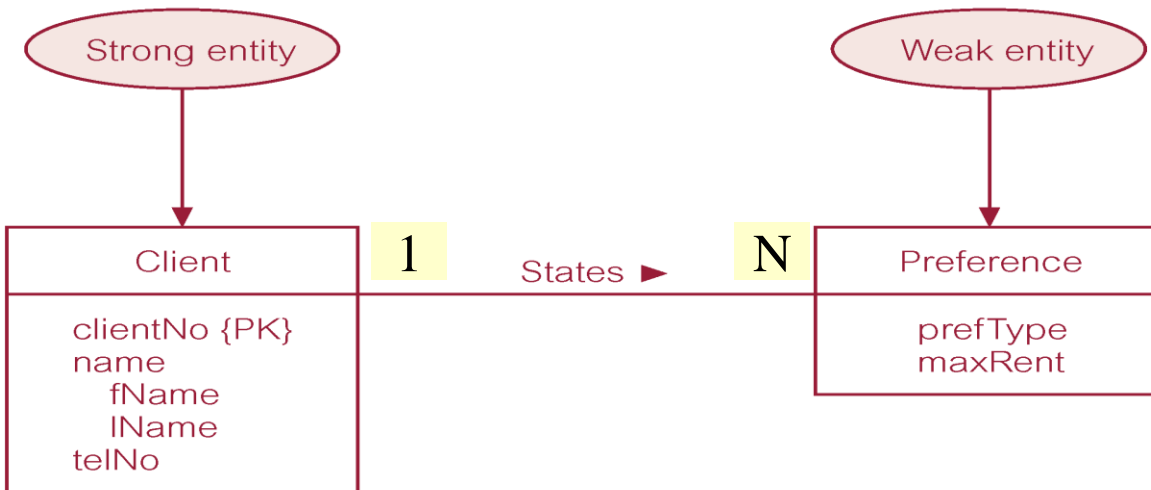
Step Three

- ✿ For each weak entity W that is associated with a 1:N or M:N identifying relationship, or participates in more than one relationship:
 - ✦ Create a new table T .
 - ✦ Include as its columns, all the simple attributes and simple components of the composite attributes of W .
 - ✦ Form the primary key of T as follows:
 - ① In the case of a 1:N owner relationship, by including as a foreign key in T , the primary key of the owner entity. The primary key of T is the combination of W 's partial key and the foreign key.
 - ② In the case of an M:N owner relationship, create a new column that will hold unique values. (In this case, the association between the weak entity and its owner entity will be specified in Step 6.)



① Example of Step Three--- in Case of 1:N

- Create a table for the weak entity, and the primary key is partially derived from the owner entity.



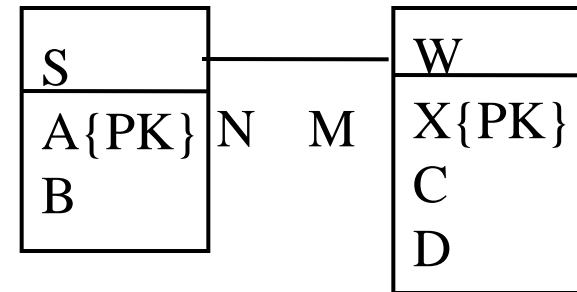
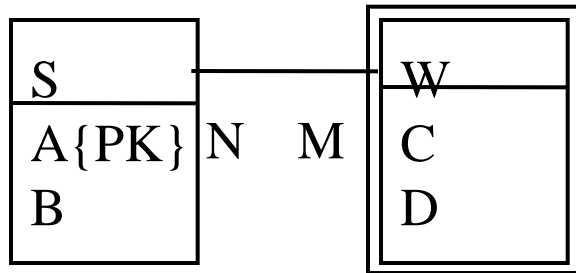
Client(clientNo, fName, lName, telNo)
Primary Key staffNo

Preference (clientNo, prefType, maxRent)
Primary Key clientNo, prefType
Foreign Key clientNo References Client (clientNo)



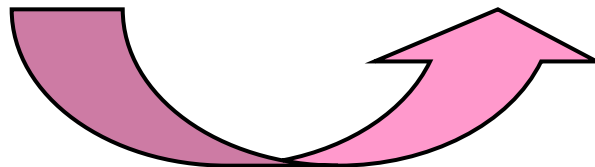
② Example of Step Three--- in Case of M:N

- ✿ Create a table for the weak entity and create a primary key for it.



S(A, B)
Primary Key A

W(X, C, D)
Primary Key X



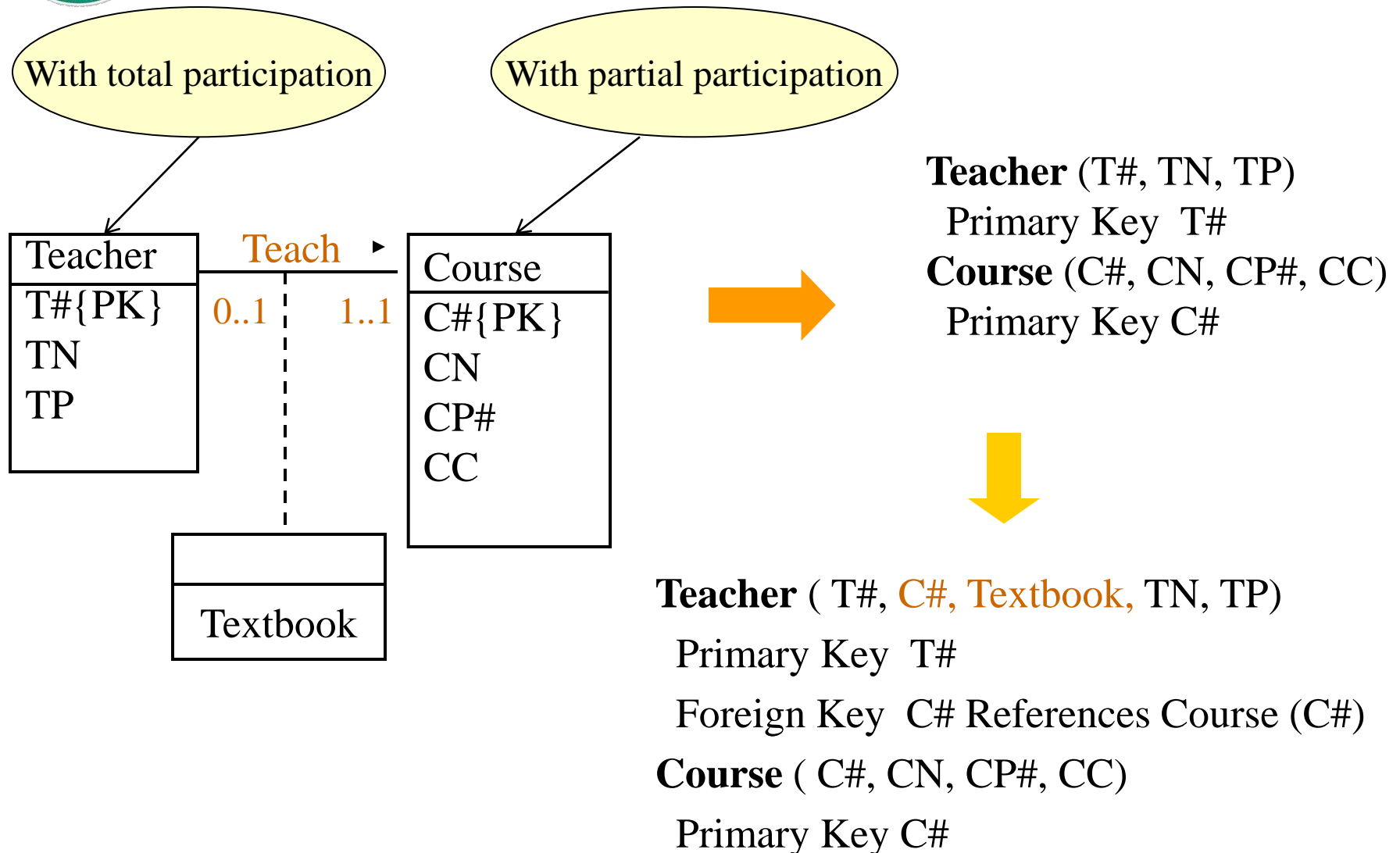


Step Four

- ✚ For each binary 1:1 relationship R:
 - ✚ Identify the tables S and T of the participating entity types.
 - ✚ Choose S (preferably the one with total participation).
 - ✚ Include as a foreign key in S, the primary key of T.
 - ✚ Include as Columns of S, all the simple attributes and simple components of the composite attributes of R.



Example of Step Four





Step Five

- ❖ For each binary 1:N relationship R:
 - ❖ Identify the table S (at the *N-side*) and T of the participating entities.
 - ❖ Include as a foreign key in S, the primary key of T.
 - ❖ Include as columns of S, all the simple attributes and simple components of composite attributes of R.



Example of Step Five



Staff (staffNo)

Primary Key staffNo

PropertyForRent (propertyNo)

Primary Key propertyNo

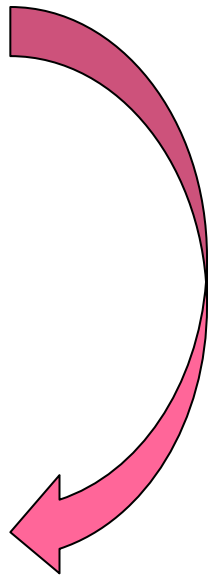
Staff (staffNo)

Primary Key staffNo

PropertyForRent (propertyNo, staffNo)

Primary Key propertyNo

Foreign Key staffNo References Staff (staffNo)





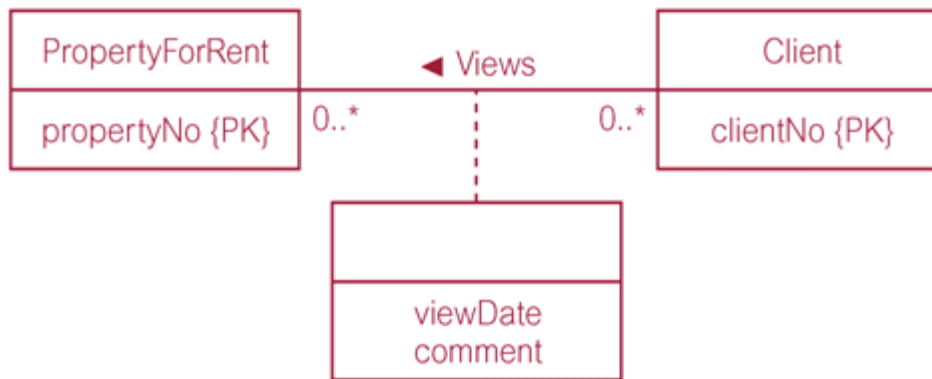
Step Six

- ✿ For each N-ary relationship (including binary N:M relationship) R:
 - ✦ Create a new table T.
 - ✦ Include as columns of T, all the simple attributes and simple components of composite attributes of R.
 - ✦ Include as foreign keys, the primary keys of the participating (strong or weak) entity types.
 - ✦ Specify as the primary key of T, the list of foreign keys.



Example of Step Six – for N:M Relationship

For binary N:M relationship R



Client (clientNo, fName, lName, telNo, prefType, maxRent, staffNo)

PropertyForRent (propertyNo, street, city, postcode, type, rooms, rent)

Primary Key clientNo Foreign Key staffNo references Staff(staffNo)

Primary Key propertyNo

Viewing (clientNo, propertyNo, dateView, comment)

Primary Key clientNo, propertyNo

Foreign Key clientNo references Client(clientNo)

Foreign Key propertyNo references PropertyForRent(propertyNo)



Example of Step Six – for N-ary Relationship

For N-ary relationship



Staff (staffNo, fName, lName, position, sex, DOB, supervisorStaffNo)

Primary Key staffNo

Foreign Key supervisorStaffNo **references** Staff(staffNo)

Branch (branchNo, street, city, postcode)

Primary Key branchNo

Client (clientNo, fName, lName, telNo, prefType, maxRent, staffNo)

Primary Key clientNo

Foreign Key staffNo **references** Staff(staffNo)

Registration (clientNo, branchNo, staffNo, dateJoined)

Primary Key clientNo, branchNo, staffNo

Foreign Key branchNo **references** Branch(branchNo)

Foreign Key clientNo **references** Client(clientNo)

Foreign Key staffNo **references** Staff(staffNo)



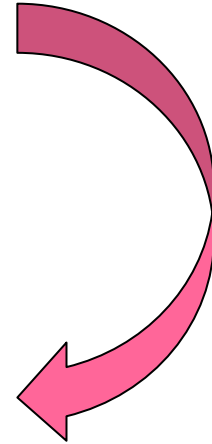
Step Seven

- ✚ For each multi-valued attribute A:
 - ✚ Create a new table T.
 - ✚ Include as columns of T, the simple attribute or simple components of the attribute A.
 - ✚ In table T, include as a foreign key, the primary key of the entity or relationship type that has A.
 - ✚ Specify as the primary key of T, the foreign key and the columns corresponding to A.



Example of Step Seven

Branch
branchNo{PK}
address
street
City
postcode
telNo[1..3]



Post **branchNo** into Telephone

Branch (branchNo, street, city, postcode)
Primary Key branchNo

Telephone (telNo, branchNo)
Primary Key telNo

Foreign Key branchNo **references** Branch(branchNo)

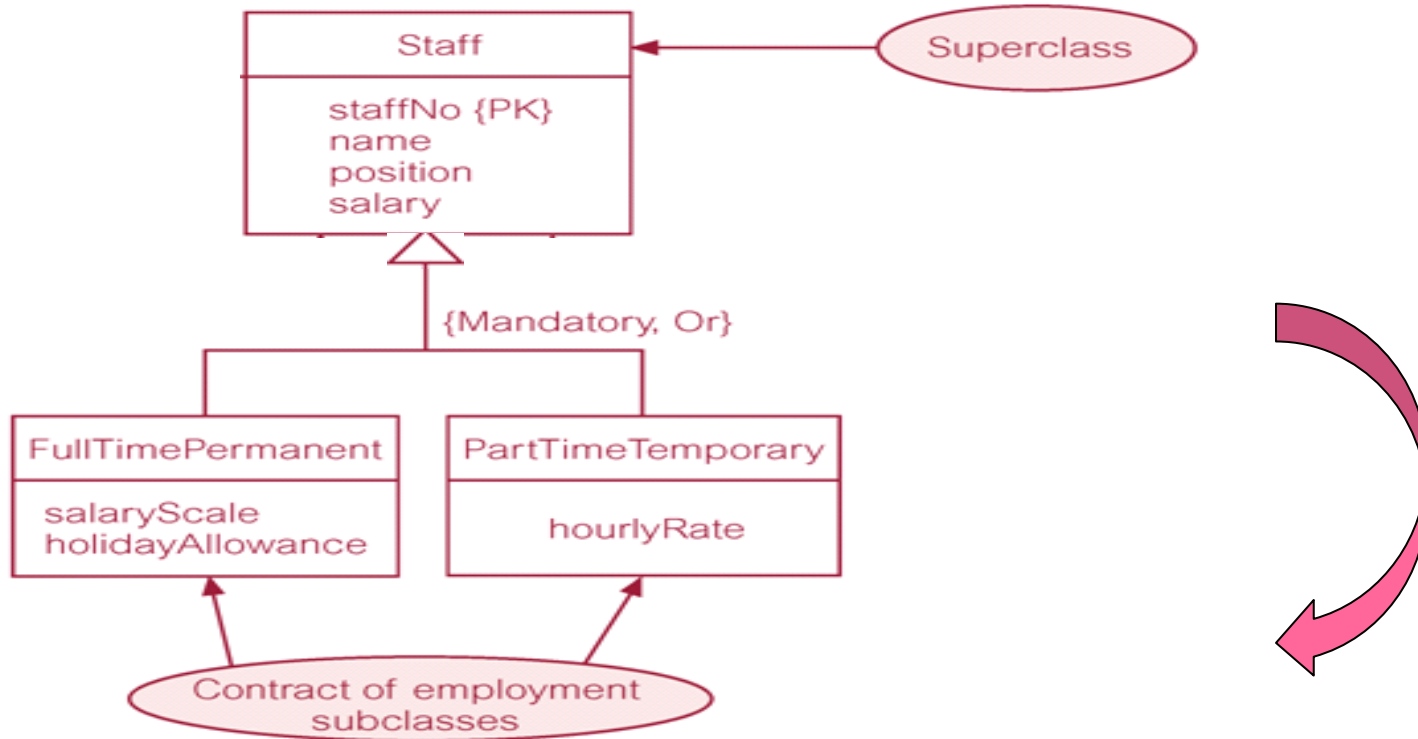


Step Eight

- ⊗ For each specialization with **mandatory participation constraint and disjoint constraint** -- {Mandatory, Or}:
 - ⊠ Create a new table T_i for each subclass S_i .
 - ⊠ Include as columns of T_i , the simple attributes and simple component attributes of the superclass.
 - ⊠ Include as columns of T_i , the simple attributes and simple component attributes specific to S_i .
 - ⊠ Identify the primary key.



Example of Eight



FullTimePermanent (staffNo, name, position, salary, salaryScale, holidayAllowance)
Primary Key staffNo

PartTimeTemporary (staffNo, name, position, salary, hourlyRate)
Primary Key staffNo

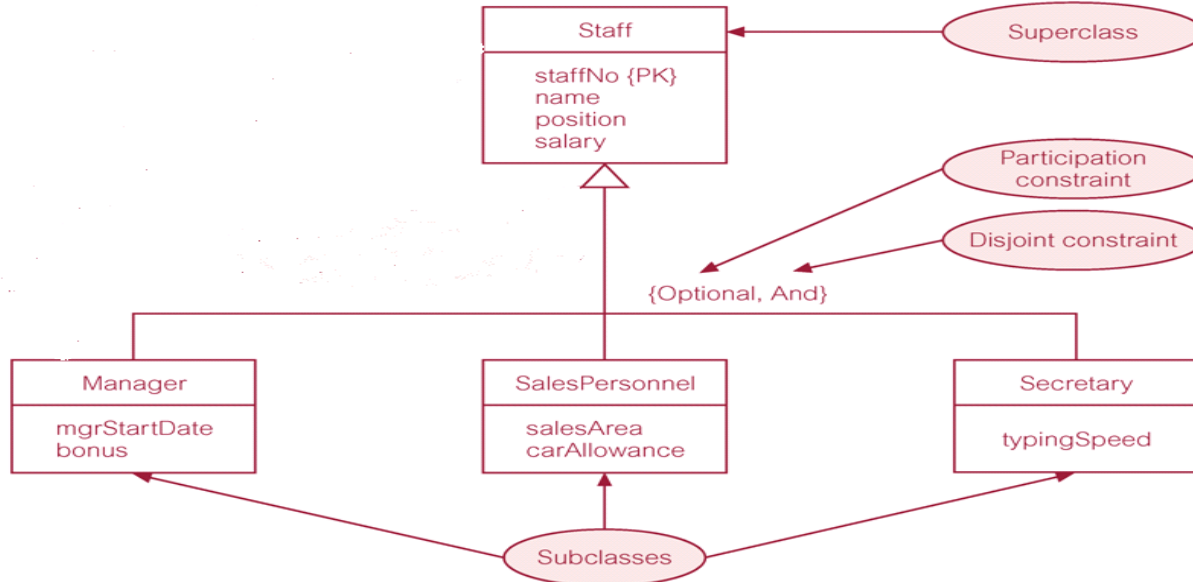


Step Nine

- ✿ For each specialization with **overlapping subclasses or with optional participation constraint and disjoint constraint**:
 - ✦ Create a new table O for the superclass.
 - ✦ Include as columns of O , the simple attributes and the simple component attributes of the superclass.
 - ✦ Identify its primary key and alternate keys.
 - ✦ Create a new table T_i for each subclass S_i .
 - ✦ Include as columns of T_i , the simple attributes and simple component attributes specific to S_i .
 - ✦ Include as a foreign key in T_i (to be part of the primary key of T_i), the primary key of O .



Example of Step Nine



Staff (staffNo, name, position, salary)

Primary Key staffNo

Manager (managerNo, mgrStartDate, bonus, staffNo)

Primary Key managerNo

Foreign Key staffNo References Staff (staffNo)

SalesPersonnel (salesPersonnelNo, salesArea, carAllowance, staffNo)

Primary Key salesPersonnelNo

Foreign Key staffNo References Staff (staffNo)

Secretary (secretaryNo, typingSpeed, staffNo)

Primary Key secretaryNo

Foreign Key staffNo References Staff (staffNo)



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 - I. in a relational schema, relationships are represented *implicitly* through primary and foreign keys of participating entities.
 - II. in a relational schema, columns of relations *cannot* be multi-valued or composite.
- ② A nine-step algorithm attempts to minimize the need for joins and NULL values when defining relations



Questions?





Assignments

Exercise 5



Prerequisites for This Section

Readings:

- ❑ **Required:** Connolly and Begg, sections 13.1–13.4 (in third edition, sections 13.1–13.3).
- ❑ **Required:** Connolly and Begg, sections 13.5–13.9 (in third edition, sections 13.4–13.8, and 13.10).
- ❑ **Optional:** Connolly and Begg, sections 14.1–14.4 (in third edition, sections 13.9 and 13.11). .

Assessments

- ❑ Multiple-Choice Quiz 6