COMP 3311
DATABASE MANAGEMENT SYSTEMS

TUTORIAL 2
RELATIONAL MODEL AND RELATIONAL DATABASE DESIGN

RELATIONAL MODEL

- A set of relation schemas define a relational database.

- Tables show the instances of relation schemas.

Relational Model		Representation	Notation
Relation	⇔	table	$R(A_1, A_2, \ldots, A_n)$
Attribute	⇔	column	A_i
Domain	⇔	type and range of attribute values	$dom(A_i)$
Tuple / Record	⇔	row	
Attribute value	⇔	value in table cell	

E-R TO RELATION SCHEMA REDUCTION: OVERVIEW

We need to reduce:

generalizations / specializations	⟹	inheritance, coverage
attributes	⟹	composite, multivalued
entities	⟹	strong, weak
relationships	⟹	degree (unary, binary)
	⟹	constraints (cardinality, participation, inclusion)

Cardinality/participation constraints in the E-R model reduce to referential integrity constraints in the relational model.

E-R TO RELATION SCHEMA REDUCTION:
REFERENTIAL INTEGRITY ACTIONS

If relation **T** contains the primary key k_S of relation **S** as a foreign key fk_S, which can be specified as the foreign key constraint

foreign key (fk_S) references **S**(k_S)

then the value of fk_S in a tuple of **T** must either be equal to the value of the primary key k_S of a tuple in **S** or be entirely null.

To enforce this constraint, the following actions are required.

For E-R model total participation

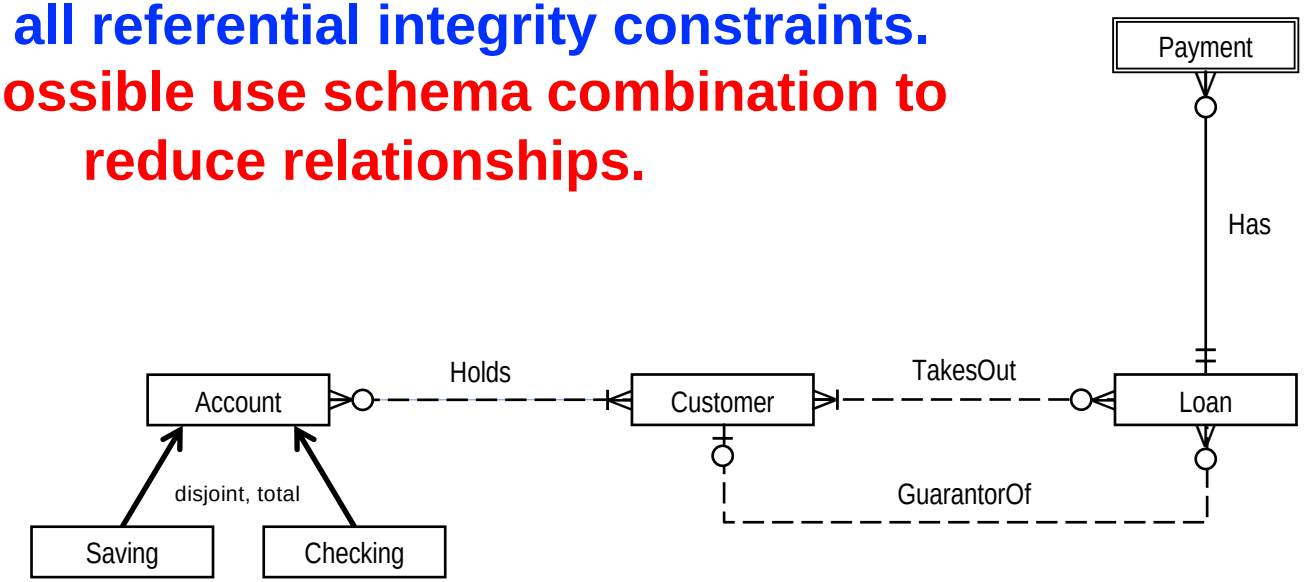
on delete cascade - Delete all tuples with foreign key values in **T** that match the primary key value of the deleted tuple in **S**.

For E-R model partial participation

on delete set null - Set to null the foreign key value of all tuples in **T** whose foreign key value matches the primary key value of the deleted tuple in **S**.

EXERCISE 1: BANK APPLICATION

Reduce the bank E-R schema to relation schemas.
Specify all referential integrity constraints.
Where possible use schema combination to reduce relationships.



Customer
id name address street city state {phoneNo}

Account
accountNo balance

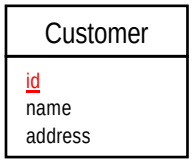
Saving
interestRate

Checking
overdraft

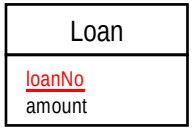
Loan
loanNo amount

Payment
paymentNo date amount

EXERCISE 1: REDUCE STRONG ENTITIES



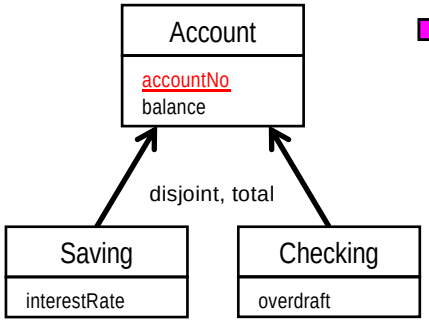
Customer(id, name, address)



Loan(loanNo, amount)

EXERCISE 1: REDUCE GENERALIZATIONS

Option 1: Reduce *all entities* to relation schemas.



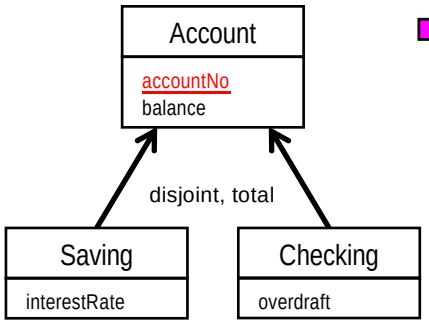
Account(accountNo, balance)

Saving(accountNo, interestRate)
foreign key (accountNo) references Account(accountNo)
on delete cascade

Checking(accountNo, overdraft)
foreign key (accountNo) references Account(accountNo)
on delete cascade

Which option to select?

Option 2: Reduce *only subclass entities* to relation schemas.



Saving(accountNo, balance, interestRate)

Checking(accountNo, balance, overdraft)

Select Option 1 since Account has a relationship to other entities and all the subclass entities have their own attributes.

EXERCISE 1: REDUCE COMPOSITE/MULTIVALUED ATTRIBUTES

Composite attributes: address

Option 1: single attribute

Customer(id, name, address, {phoneNo})

Option 2: separate attributes

Customer(id, name, street, city, state, {phoneNo})

Which option to select?

Which option to select will depend on the requirements of the application. Here we subsequently use option 1.

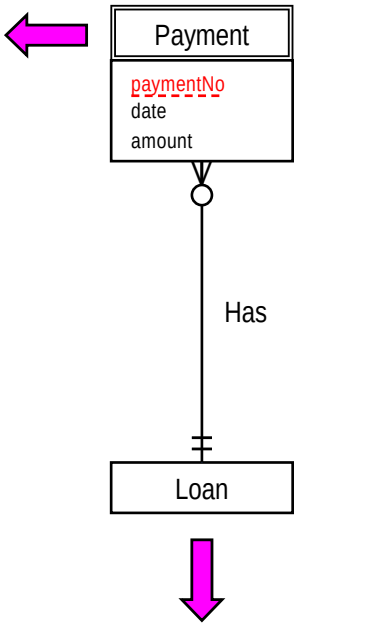
Multivalued attributes: phoneNo

CustomerPhone(id, phoneNo)
foreign key (id) references Customer(id)
on delete cascade

EXERCISE I: REDUCE WEAK ENTITIES

Payment entity

Payment(loanNo, paymentNo, date, amount)
foreign key (loanNo) references Loan(loanNo)
on delete cascade



How do we reduce this entity?

⟹ Create a relation from Payment and include loanNo, the key of Loan, as a foreign key.

What is the key of this relation?

What is the foreign key constraint?

What is the referential integrity action?

Loan(loanNo, amount)

EXERCISE I: REDUCE 1:N RELATIONSHIPS

GuarantorOf between **Customer** and **Loan** (using schema combination)

Customer(id, name, address)

Loan(loanNo, amount, id)
foreign key (id) references Customer(id)
on delete set null

Which relation do we use?

⟹ Loan (Add id, the key of the Customer relation, as a foreign key.)

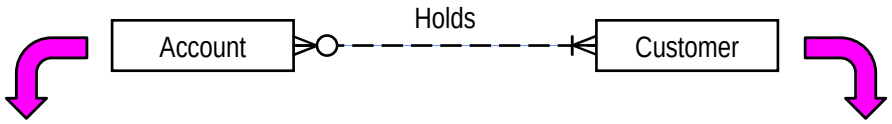
What is the referential integrity action?

The referential integrity action is determined by the participation constraint of the entity into which the foreign key is placed.

- partial: on delete set null
- total: on delete cascade

EXERCISE I: REDUCE N:M RELATIONSHIPS

Holds relationship between Account and Customer



Account(accountNo, balance)

Customer(id, name, address)

Holds(accountNo, id)
foreign key (accountNo) references Account(accountNo)
on delete cascade
foreign key (id) references Customer(id)
on delete cascade

How do we reduce this relationship?

⟹ Create a relation, Holds, with the key, accountNo, of the Account relation and the key, id, of the Customer relation.

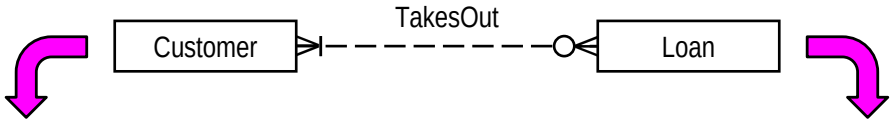
What is the key of the relation?

What are the referential integrity actions?

For a relation that represents a relationship, the referential integrity action is always on delete cascade.

EXERCISE I: REDUCE N:M RELATIONSHIPS

TakesOut relationship between **Customer** and **Loan**



Customer(id, name, address)

Loan(loanNo, amount)

TakesOut(id, loanNo)
  foreign key (id) references Customer(id)
    on delete cascade
  foreign key (loanNo) references Loan(loanNo)
    on delete cascade

How do we reduce this relationship?

⟹ Create a relation, TakesOut, with the key, id, of the Customer relation and the key, loanNo, of the Loan relation.

EXERCISE 1: BANK APPLICATION REDUCTION

Account(accountNo, balance)

Saving(accountNo, interestRate)
foreign key (accountNo) references Account(accountNo)
on delete cascade

Checking(accountNo, overdraft)
foreign key (accountNo) references Account(accountNo)
on delete cascade

Customer(id, name, address)[1]

CustomerPhone(id, phoneNo)
foreign key (id) references Customer(id)
on delete cascade

Payment(loanNo, paymentNo, date, amount)
foreign key (loanNo) references Loan(loanNo)
on delete cascade

Loan(loanNo, amount, id)
foreign key (id) references Customer(id)
on delete set null

Holds(accountNo, id)
foreign key (accountNo) references
Account(accountNo)
on delete cascade
foreign key (id) references Customer(id)
on delete cascade

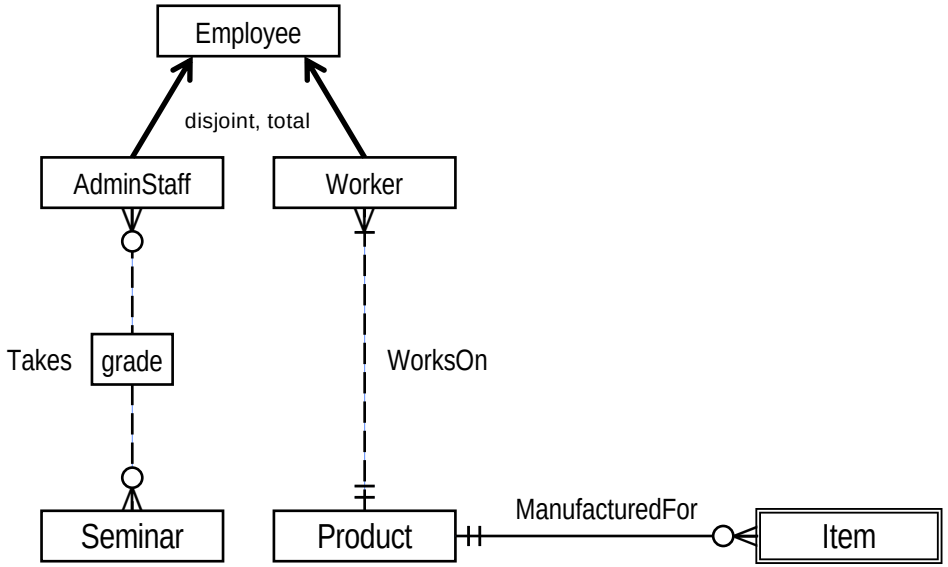
TakesOut(id, loanNo)
foreign key (id) references Customer(id)
on delete cascade
foreign key (loanNo) references Loan(loanNo)
on delete cascade

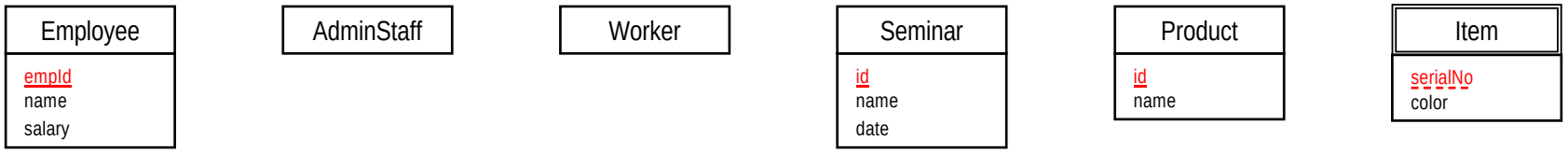
1. Using option 1 for address composite attribute.

You must upload your completed exercise sheet to Canvas by **11 p.m. today.**

EXERCISE 2: FACTORY APPLICATION

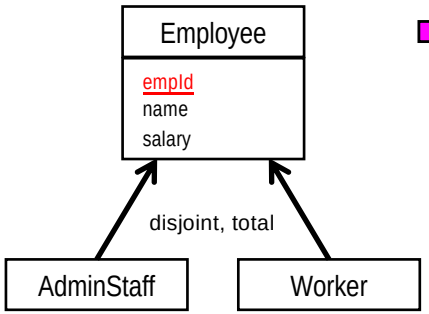
Reduce the factory E-R schema to relation schemas.
Specify all referential integrity constraints.
Where possible, use schema combination to reduce relationships.





EXERCISE 2: REDUCE GENERALIZATION

Option 1: Reduce all entities to relation schemas.



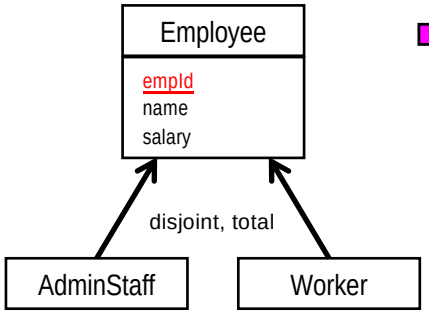
Employee(empId, name, salary)

AdminStaff(empId)
foreign key (empId) references Employee(empId)
on delete cascade

Worker(empId)
foreign key (empId) references Employee(empId)
on delete cascade

Which option to select?

Option 2: Reduce only subclass entities to relation schemas.



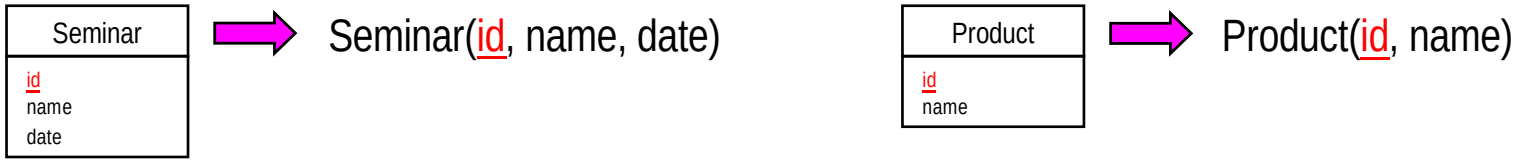
AdminStaff(empId, name, salary)

Worker(empId, name, salary)

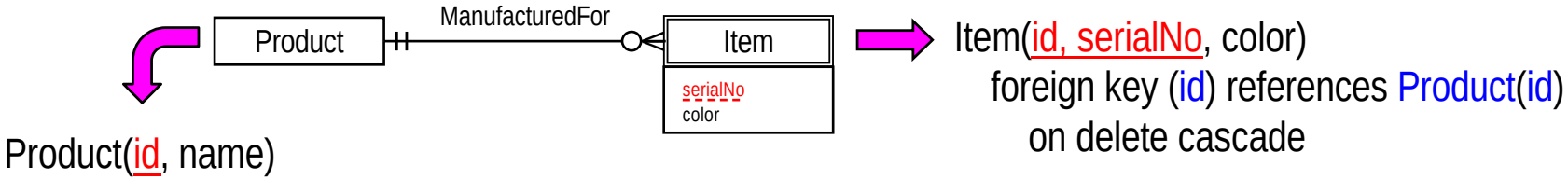
Select Option 2 since Employee has no relationships to other entities, the subclasses have no attributes and the generalization is disjoint and total.

EXERCISE 2: REDUCE ENTITY TYPES

Strong Entities



Weak Entities



How do we reduce this entity?

⟹ Create a relation from Item that includes the key, id, of the Product relation.

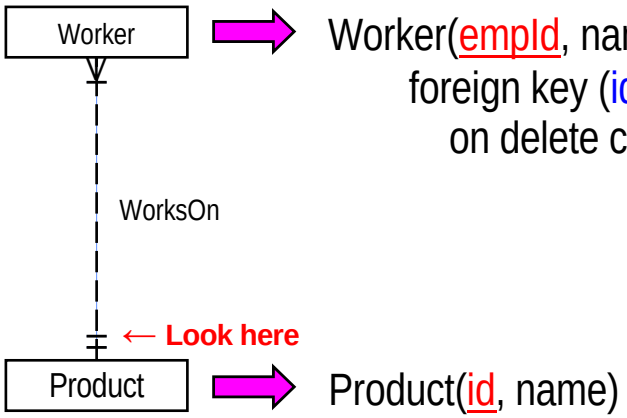
What is the key of this relation?

What is the foreign key constraint?

What is the referential integrity action?

EXERCISE 2: REDUCE 1:N RELATIONSHIPS

WorksOn relationship between **Worker** and **Product**



Worker(empId, name, salary, id)
foreign key (id) references Product(id)
on delete cascade

Product(id, name)

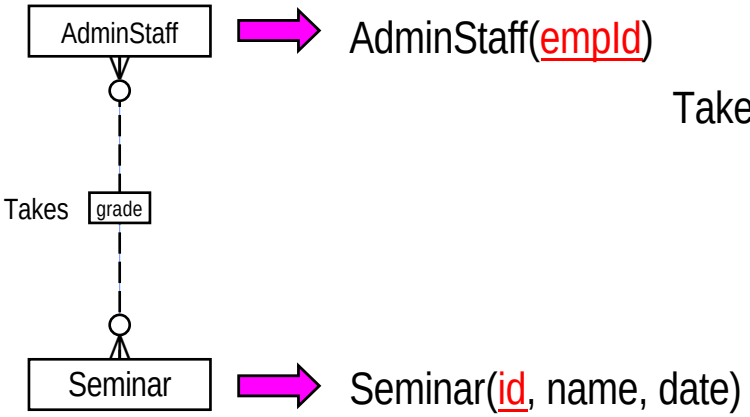
Which relation do we use?

⟹ Worker (Add the key, id, of the Product relation as a foreign key.)

What is the referential integrity action?

EXERCISE 2: REDUCE N:M RELATIONSHIPS

Takes relationship between **AdminStaff** and **Seminar**



AdminStaff(empId)

Takes(empId, id, grade)
foreign key (empId) references AdminStaff(empId)
on delete cascade
foreign key (id) references Seminar(id)
on delete cascade

Seminar(id, name, date)

How do we reduce this relationship?

⟹ Create a relation Takes with the key of AdminStaff and Seminar.

Anything else?

⟹ Add the attribute grade.

EXERCISE 2: FACTORY APPLICATION REDUCTION

AdminStaff(empId, name, salary)

Worker(empId, name, salary, id)
foreign key (id) references Product(id)
on delete cascade

Seminar(id, name, date)

Product(id, name)

Item(id, serialNo, color)
foreign key (id) references Product(id)
on delete cascade

Takes(empId, id, grade)
foreign key (empId) references AdminStaff(empId)
on delete cascade
foreign key (id) references Seminar(id)
on delete cascade