Databases

Lecture 13

Conceptual Modeling

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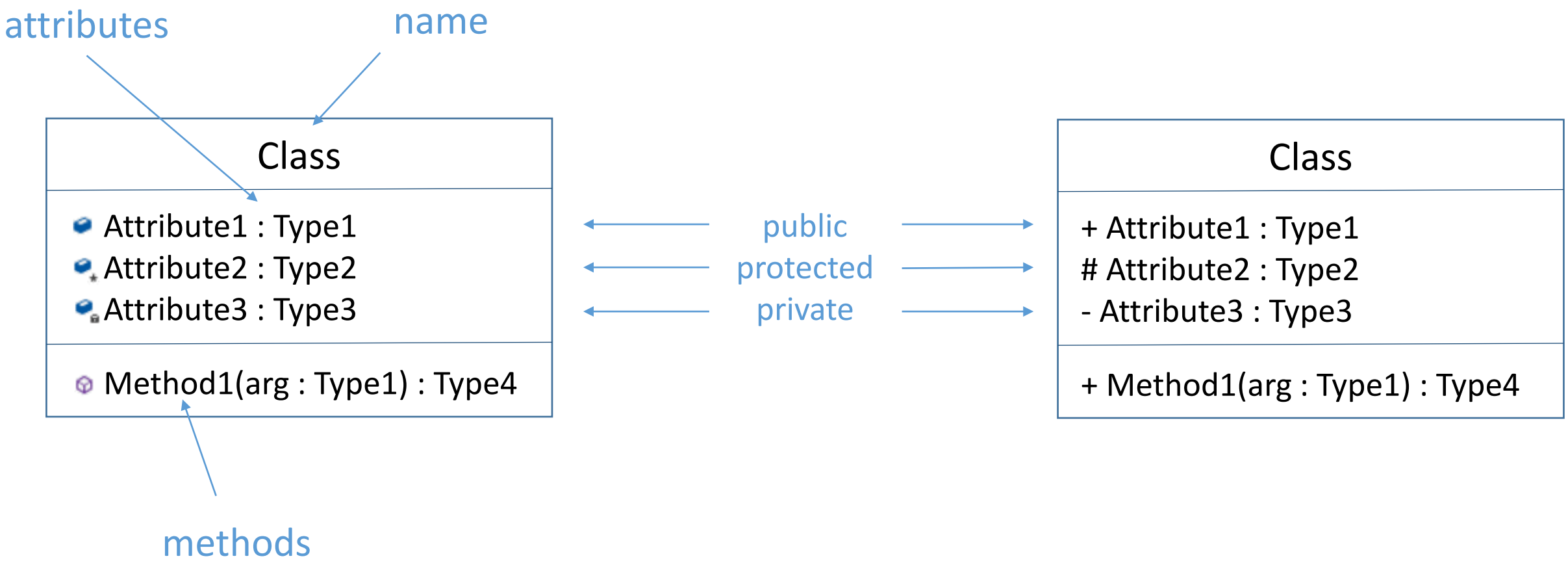
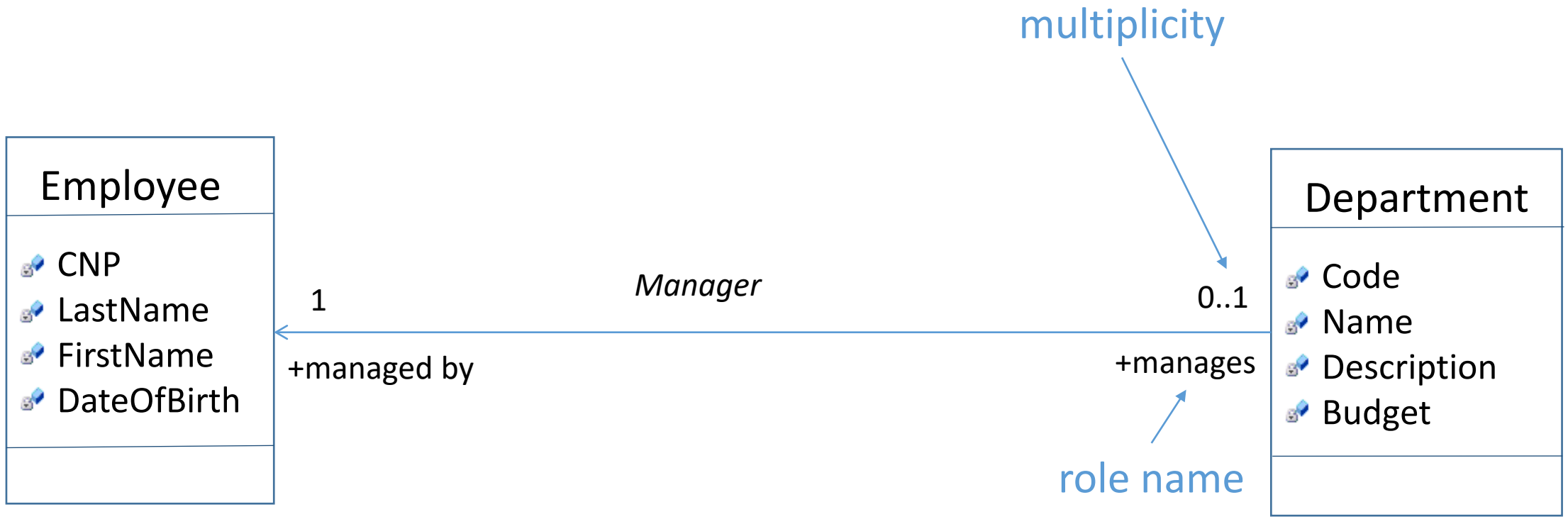
- database design - stages
  - requirements analysis
    - what data will the DB store?
    - what are the main operations to be supported?
    - what apps will be powered by the DB?
  - conceptual DB design
    - high level description of data and integrity constraints
  - logical DB design
    - translate the conceptual DB design to a DB schema in terms of the model supported by the DBMS (e.g., relational)
  - schema refinement
    - normalization
    - eliminate redundancy and associated problems

- database design - stages
  - physical DB design
    - create indexes
    - redesign parts of the schema

- UML class diagram
  - classes

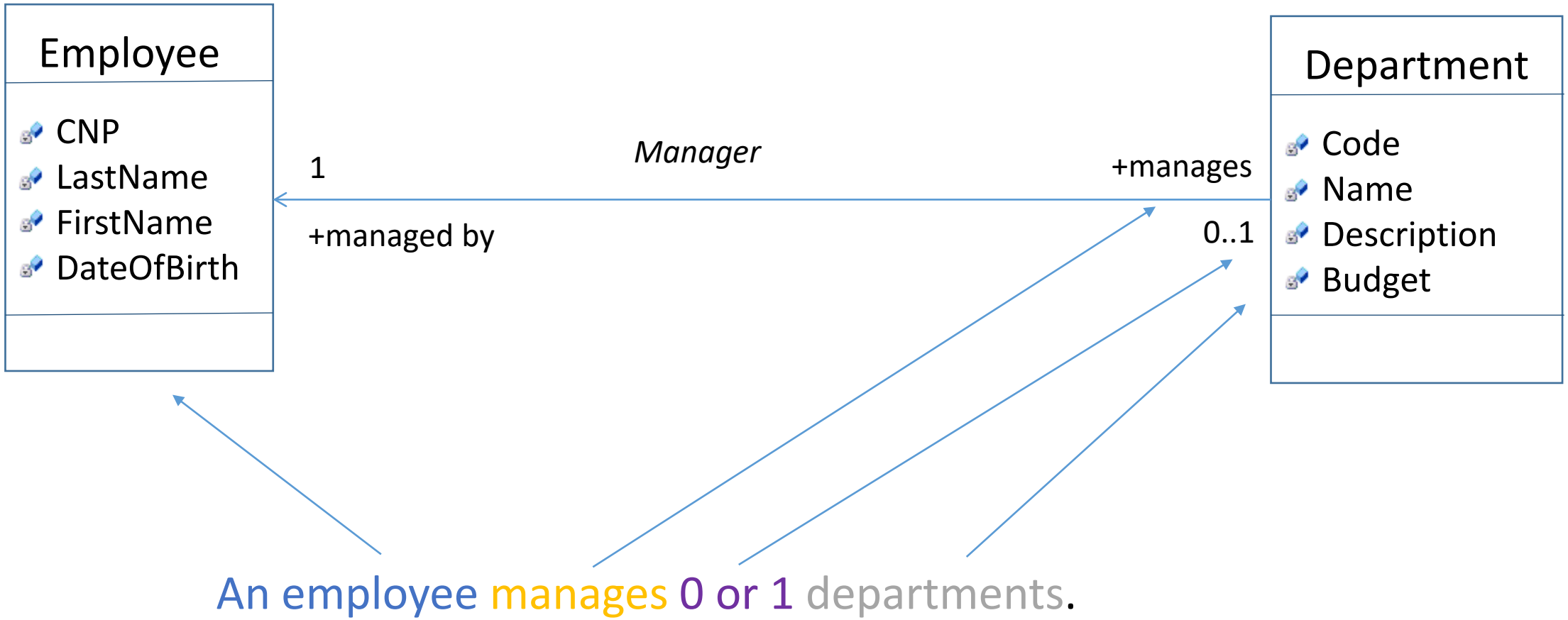


- UML class diagram
  - associations

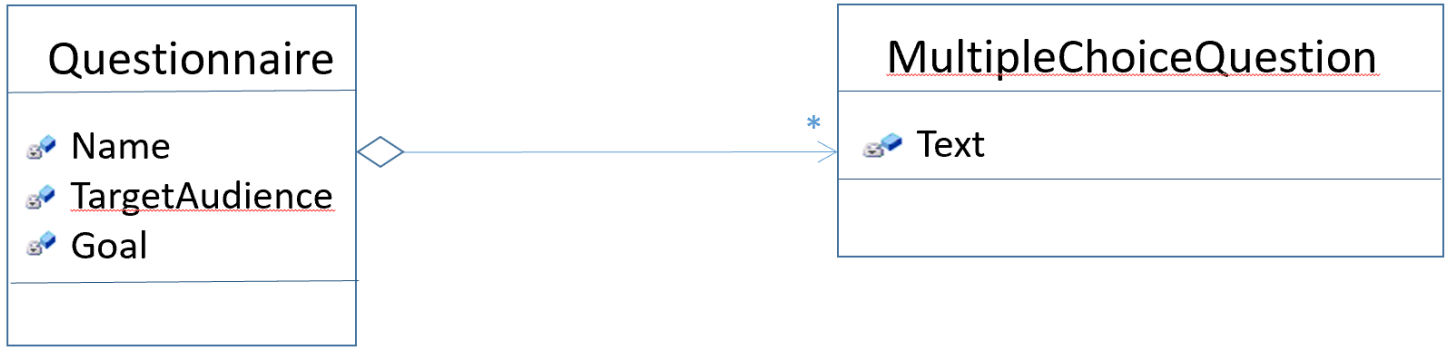


  - navigability – unidirectional, bidirectional
  - multiplicity – examples
    - 0..1
    - 5
    - 0..*
    - 7..10

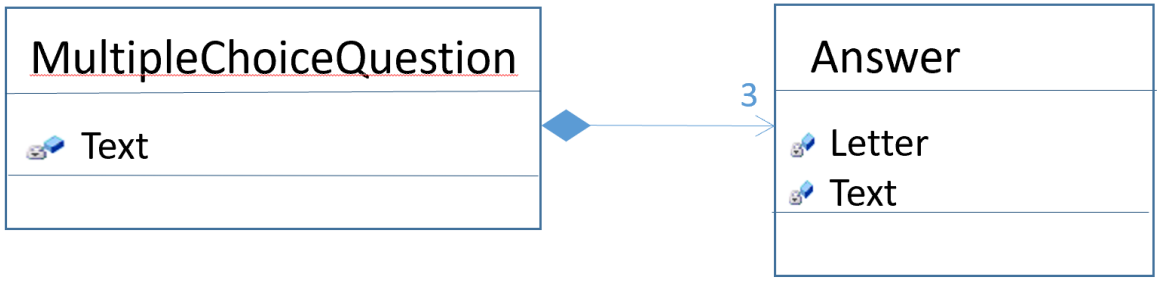
- UML class diagram
  - associations



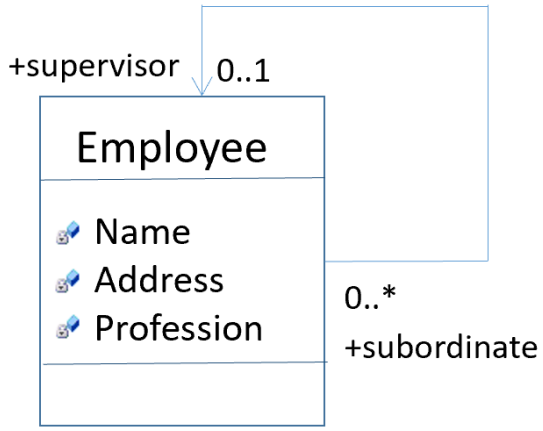
- UML class diagram
  - aggregation



  - composition

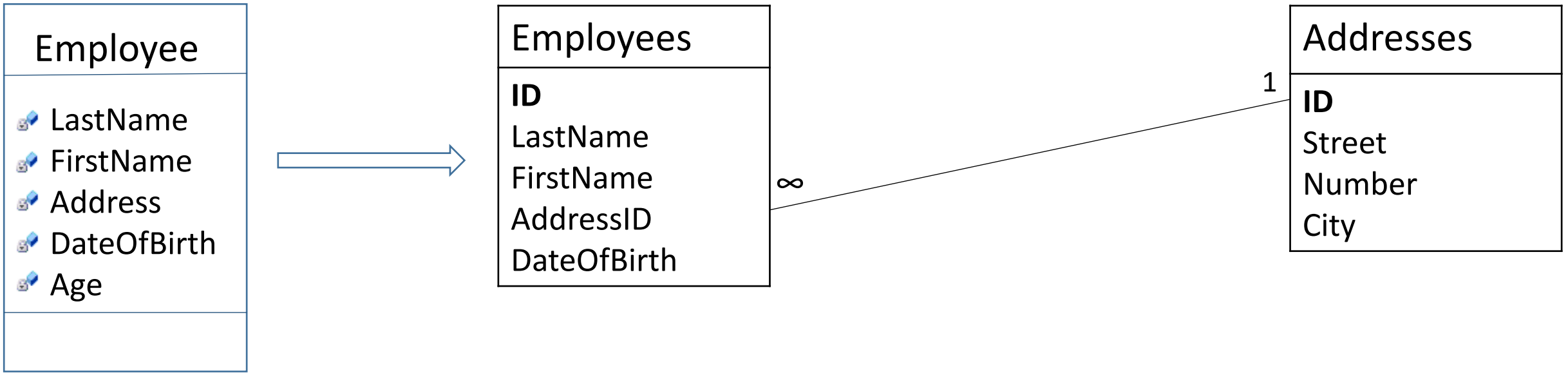


  - reflexive association



- conceptual model => relational database
- 1:1 mapping, i.e., classes become tables
- drawbacks
  - one could create too many tables
    - too many tables => too many join operations
  - necessary tables could be omitted; m:n associations require a third table (join table)
  - inheritance is not properly handled

- class -> table



- the plural of the class name becomes the name of the table
- simple class attributes become table fields
- composite attributes become tables
- derived attributes are not mapped to table fields
- surrogate keys are added

- class -> table
  - surrogate key
    - key that isn't obtained from the domain of the modeled problem
  - when possible, use integer keys that are automatically generated by the DBMS
    - easy to maintain - the responsibility of the system
    - efficient approach (fast queries)
    - simplified definition of foreign keys
  - possible approach
    - surrogate key name: *ID*
    - foreign key name: *<SingularTableName>ID*

- mapping simple associations
- 1 : 0..1
  - create 1 table per class
  - the key of the *1* table (i.e., table at the *1* end of the association) becomes a foreign key in the 2nd table
  - usually, only one key is automatically generated (the one corresponding to the *1* table)

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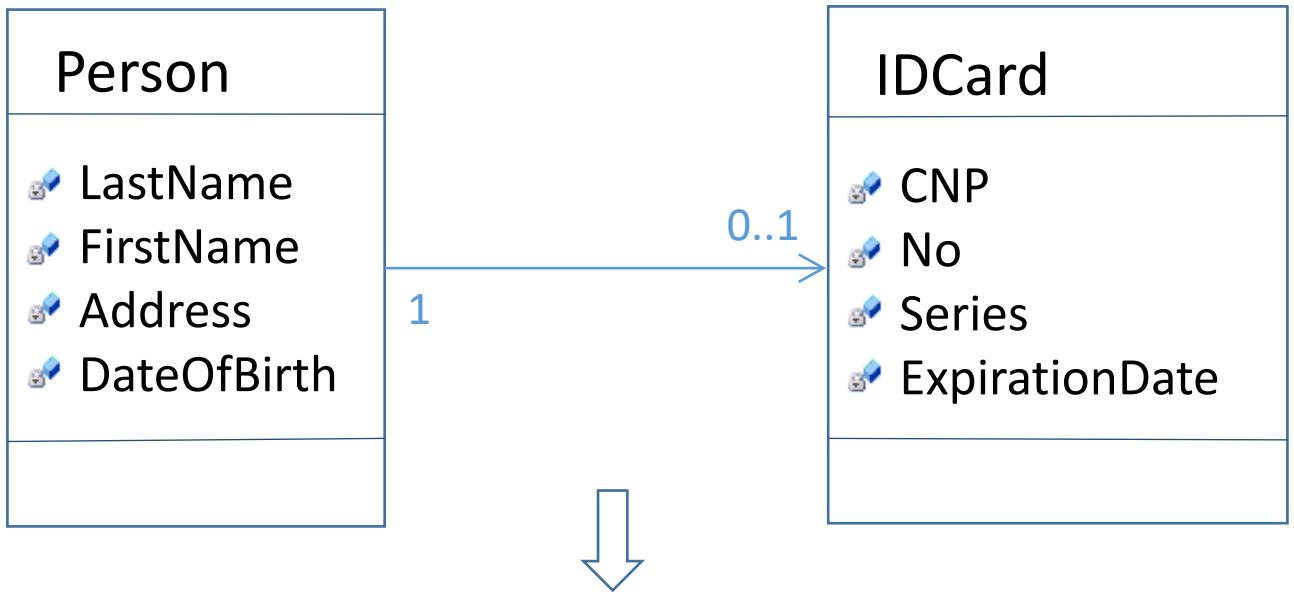
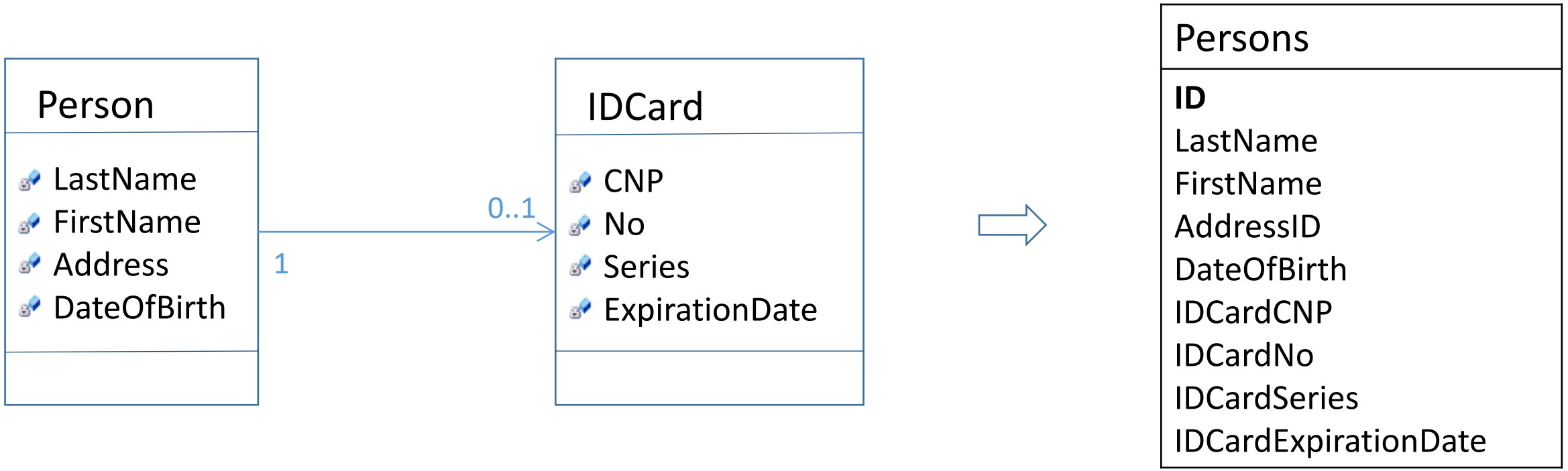
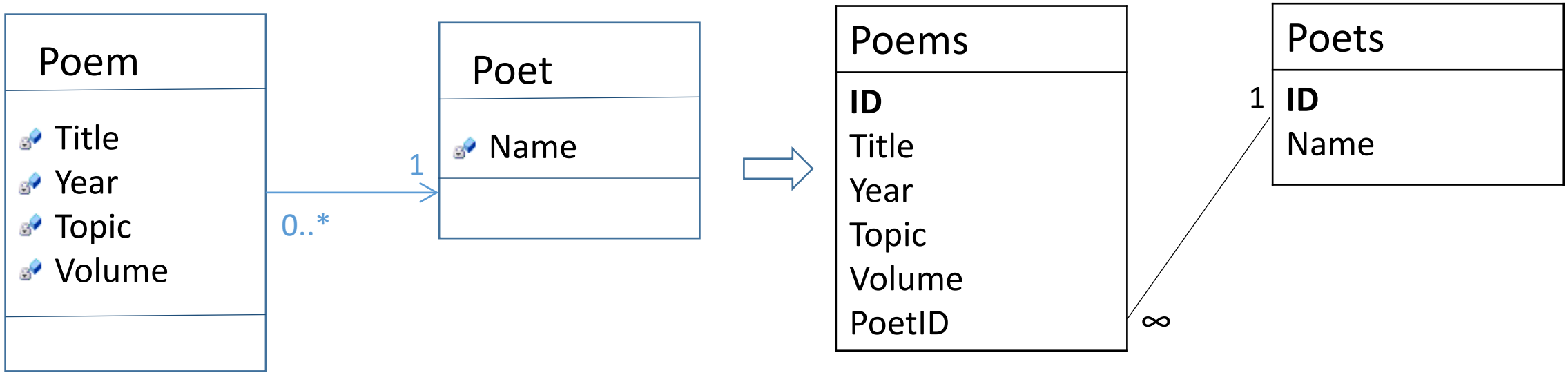
- mapping simple associations
- 1 : 0..1



- mapping simple associations
- 1 : 1
  - create 1 table containing the attributes of both classes
  - this approach can also be used for 1 : 0..1 associations (when only a few objects in the 1st class are not associated with objects in the 2nd class)



- mapping simple associations
- one-to-many
  - create 1 table / class
  - the key of the *1* table becomes a foreign key in the 2nd table



- mapping simple associations
- many-to-many
  - create one table / class
  - create an additional table, i.e., the *join table*
  - the primary keys of the 2 initial tables become foreign keys in the join table
  - the primary key of the join table:
    - composite, containing the 2 foreign keys
    - surrogate key
  - the name of the join table is usually a combination of the names of the 2 initial tables (not mandatory)
  - if an association class exists, its attributes become fields in the join table

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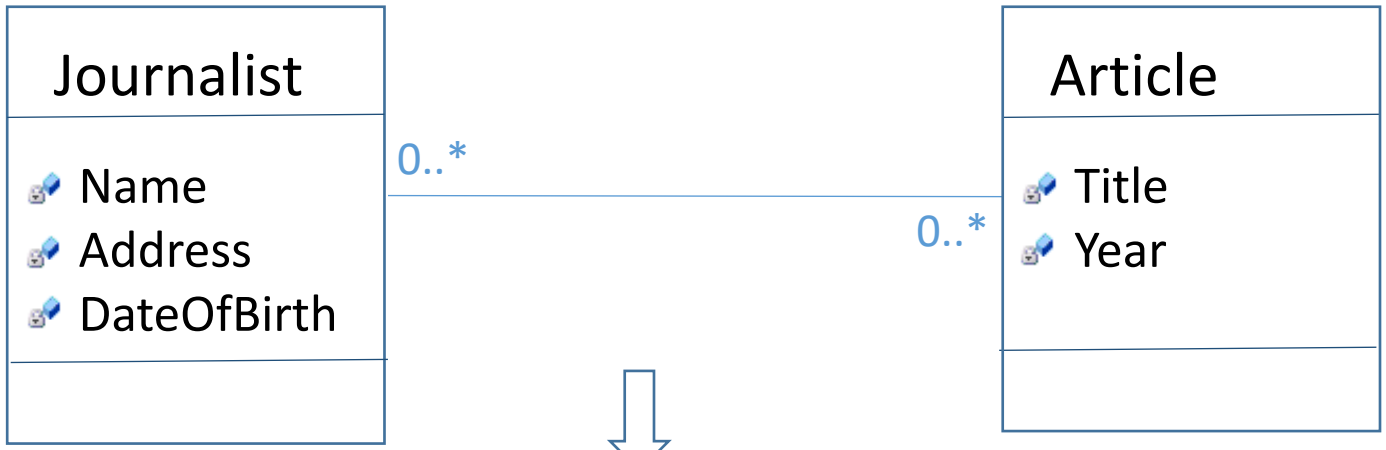
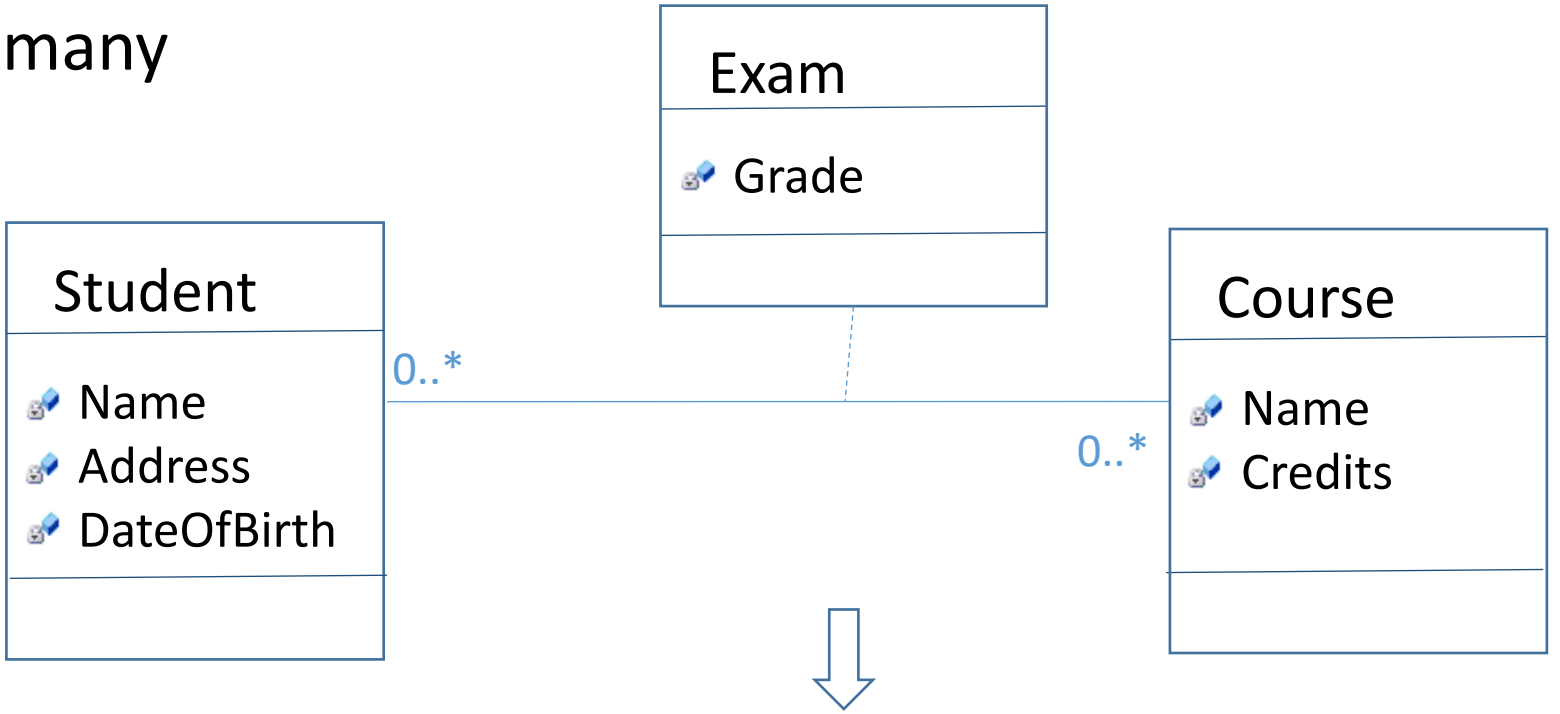
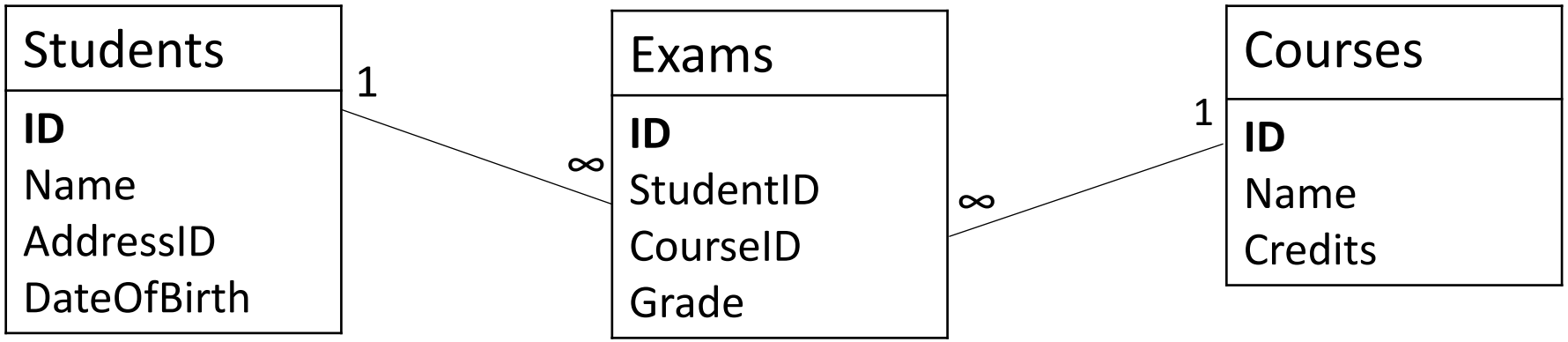
- mapping simple associations
- many-to-many



- mapping simple associations
- many-to-many





- mapping inheritance
- a1
  - create one table / class
  - create one view / superclass-subclass pair
  - it generates the largest number of objects (tables, views)
  - flexibility - no impact on existing tables / views when adding other subclasses
  - possible performance problems – every access requires a join through the view
  - can be used when the number of records is relatively small (so performance is not a concern)

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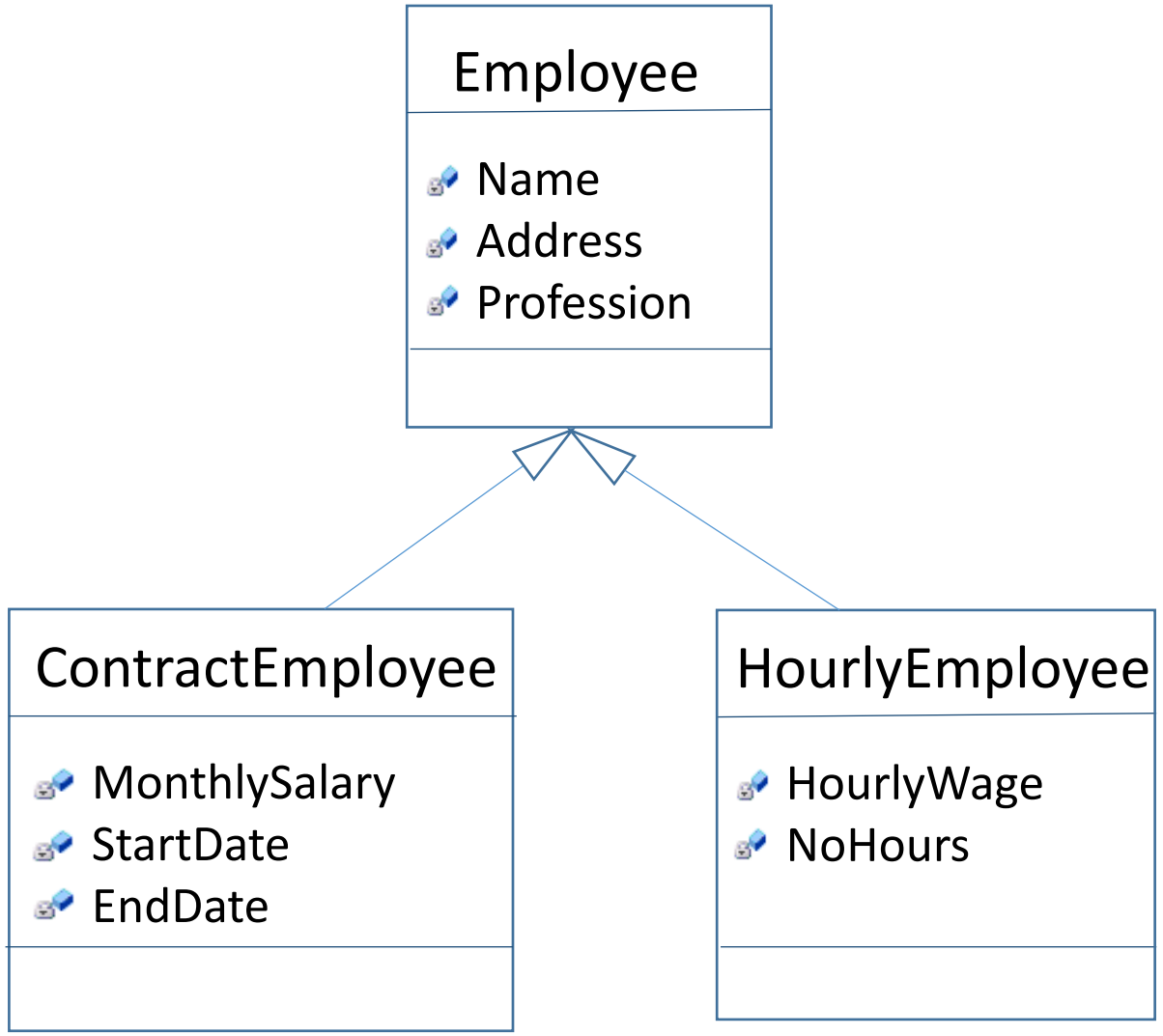
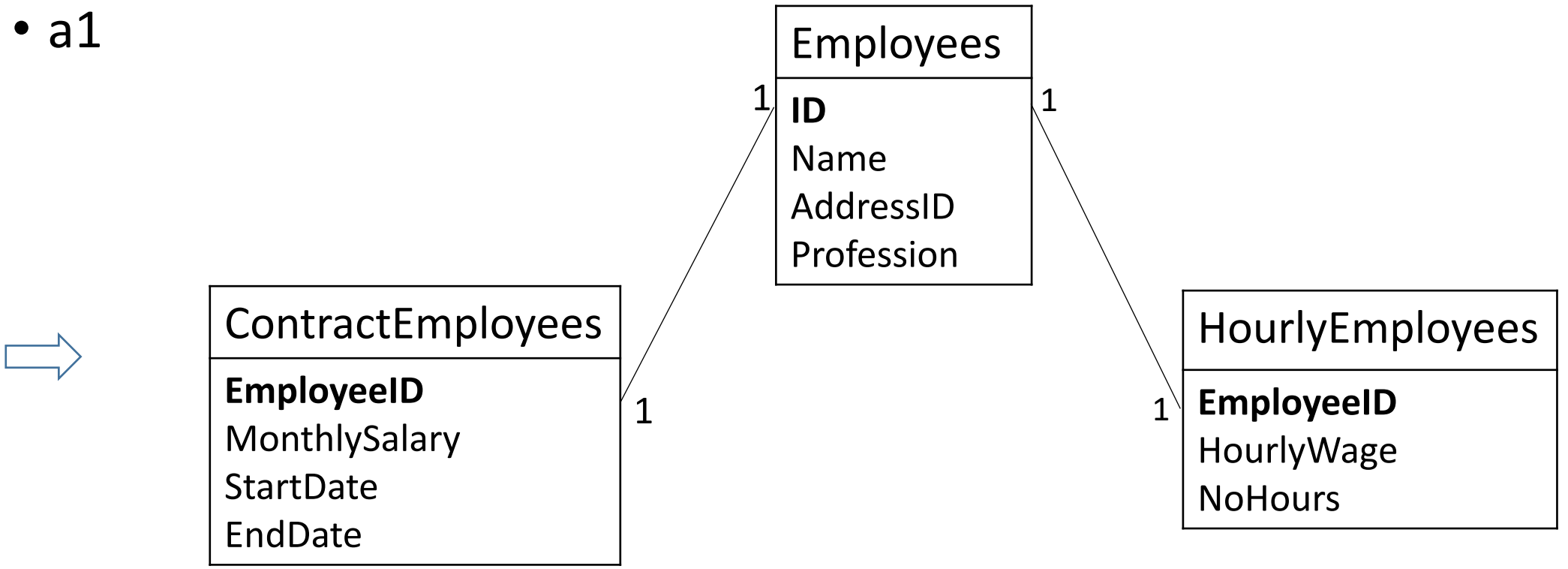
- mapping inheritance
- a1



- mapping inheritance
- a1




```
CREATE VIEW ContractEmployeesComplete(...)
AS
  SELECT Employees.*, MonthlySalary, StartDate, EndDate
  FROM Employees INNER JOIN ContractEmployees
    ON Employees.ID = EmployeeID
```

- mapping inheritance
- a2
  - create one table for the superclass
    - the attributes of the subclasses become fields in the table
    - it generates the smallest number of objects
    - optionally, a subclasses table and a view / subclass can be added
    - usually – best performance
    - when adding a subclass, the existing structure has to be changed
    - "artificial" increase of used space

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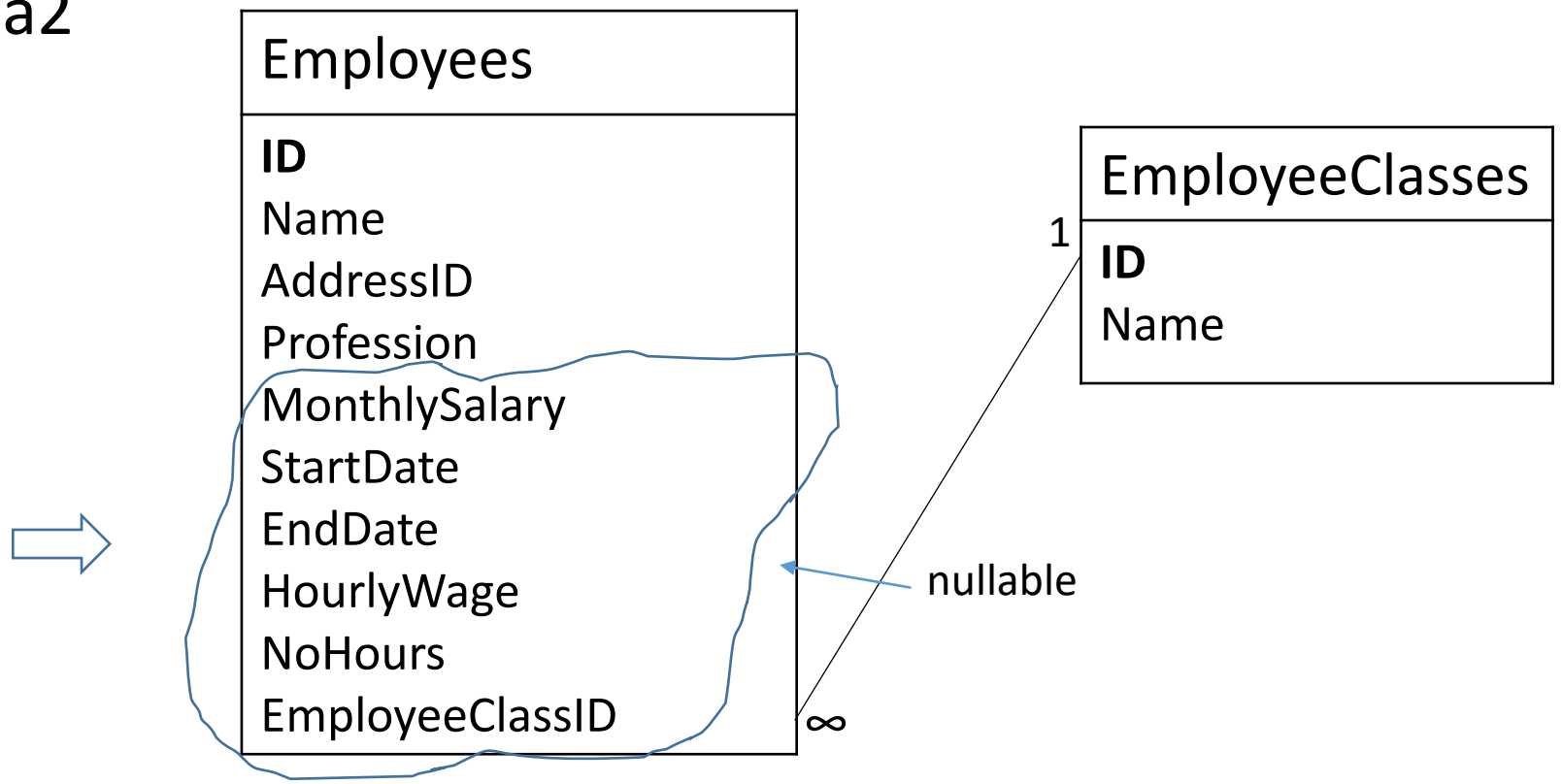
- mapping inheritance
- a2



EmployeeClasses

ID	Name
1	Unknown
2	ContractEmployee
3	HourlyEmployee

```
CREATE VIEW ContractEmployees(...)
AS
   SELECT ID, Name, AddressID, Profession, MonthlySalary, StartDate,
     EndDate
   FROM Employees
   WHERE EmployeeClassID = 2
```

- mapping inheritance
- a3
  - create one table / subclass
    - the attributes of the superclass become fields in each of the created tables
    - satisfactory performance
    - subclasses can be subsequently added without affecting existing tables
    - changing the structure of the superclass impacts all existing tables

->

- mapping inheritance
- a3

ContractEmployees
ID
Name
AddressID
Profession
MonthlySalary
StartDate
EndDate

HourlyEmployees
ID
Name
AddressID
Profession
HourlyWage
NoHours

- mapping aggregation / composition
  - similar to mapping simple associations
  - fixed number of *parts* in a *whole* => can declare the same number of foreign keys in the *whole* table
  - composition - ON DELETE CASCADE option (not required for aggregation)

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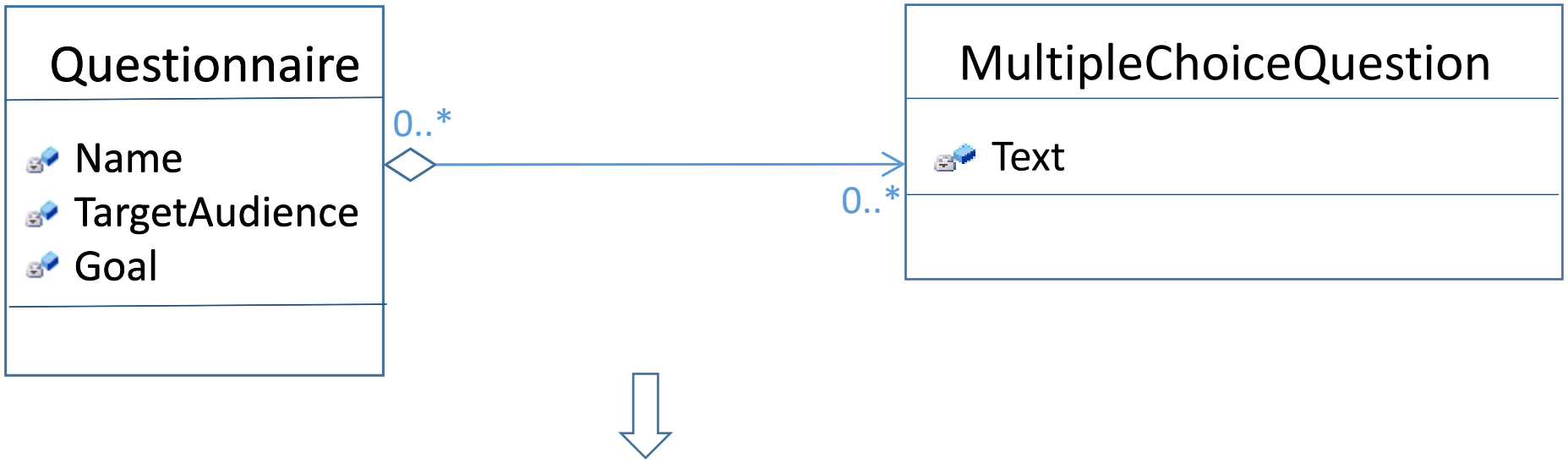
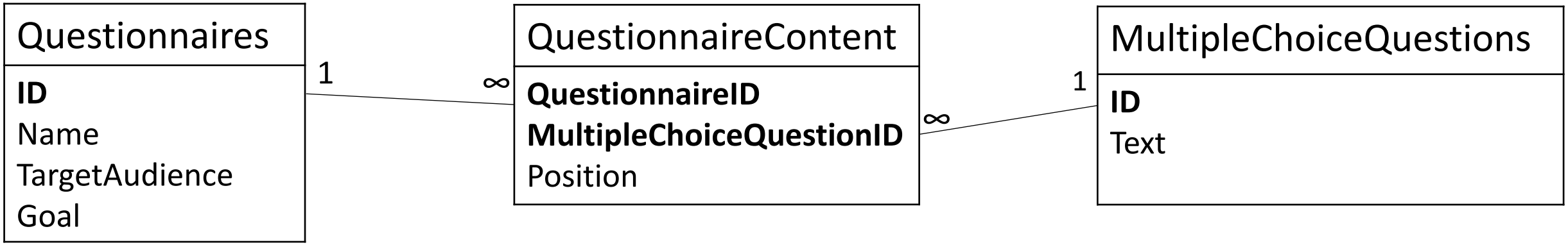
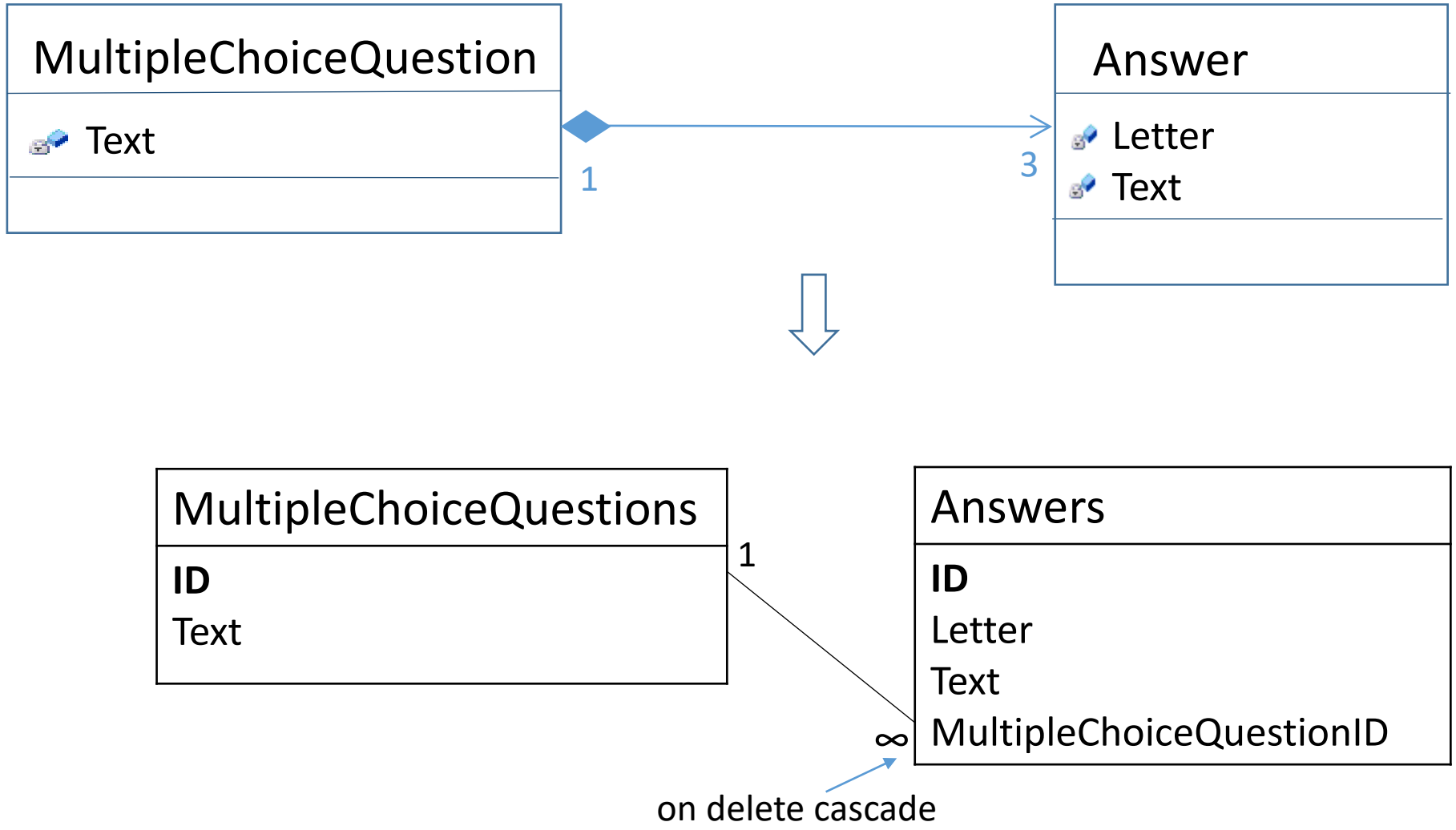
- mapping aggregation / composition



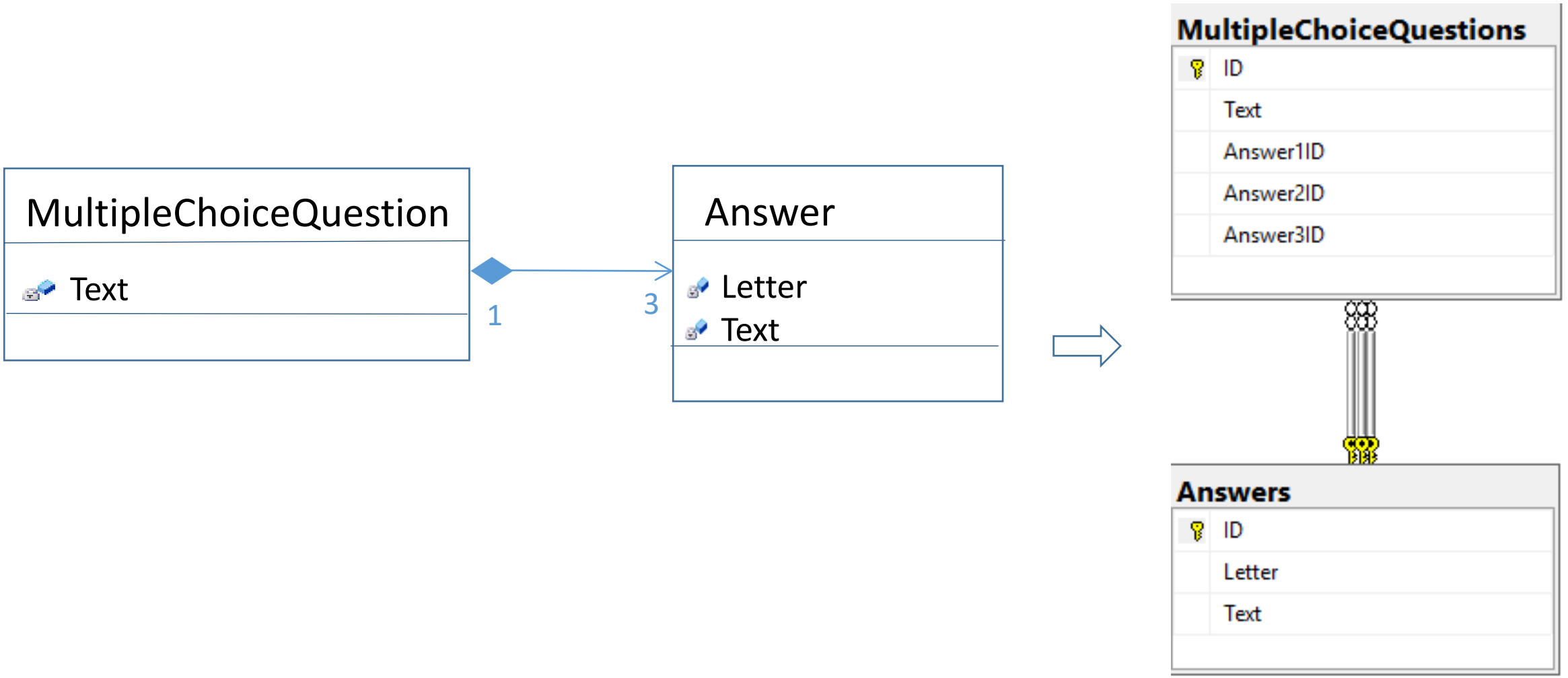


- obs. a questionnaire can also have open answer questions, etc.

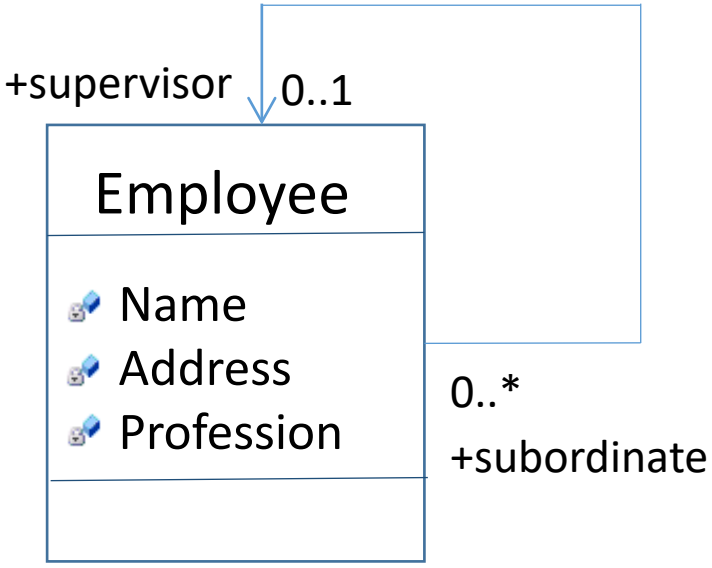
- mapping aggregation / composition

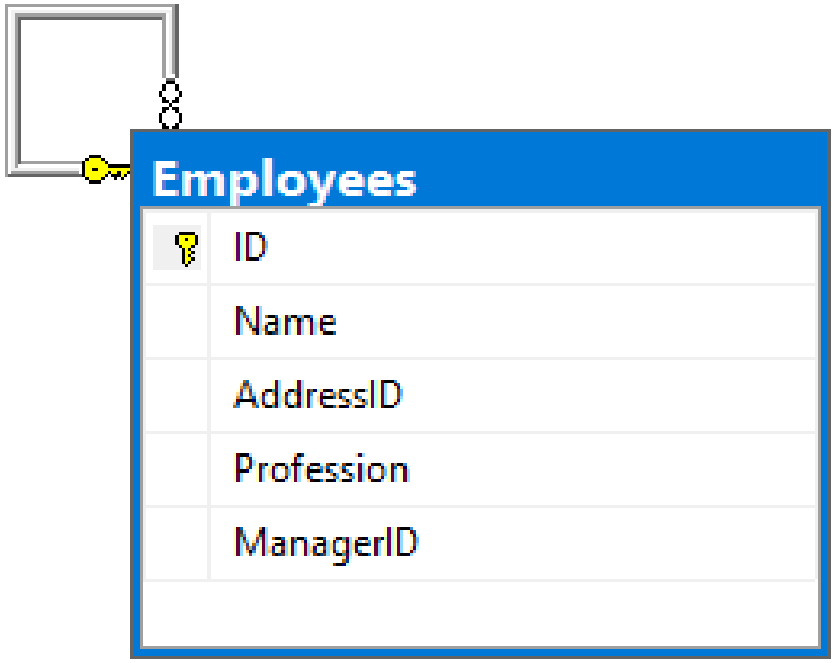


- mapping aggregation / composition

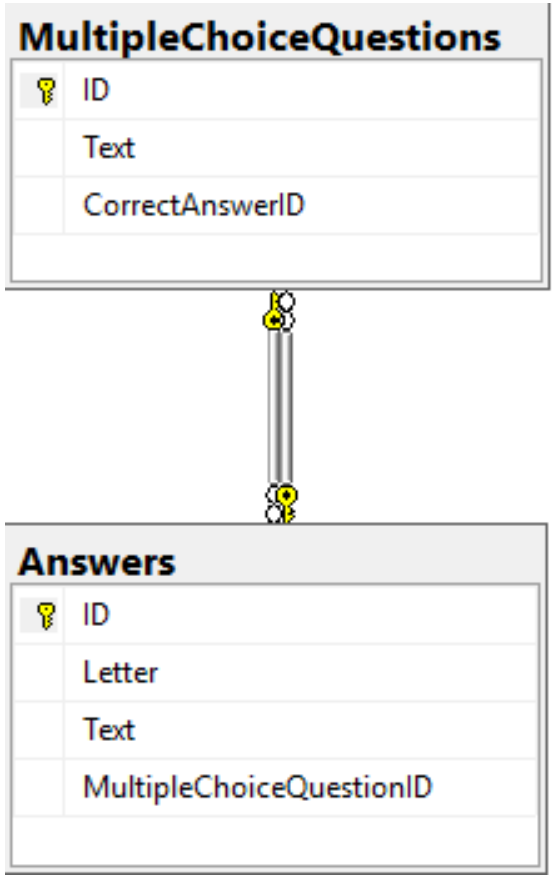


- mapping reflexive associations
- add a new field, referencing the same table (recursive relationship)
- ON DELETE CASCADE - error





Obs. 2 different tables, each with a foreign key referencing the other one, ON DELETE CASCADE - error



References

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