Conceptual Modeling

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BP Aspects

- Information
  - Conceptual modeling
    - UML Class diagrams
    - (Entity-Relationships)
- Process flow
  - Process modeling
    - UML Activity Diagrams
    - BPMN
- Interaction
  - Interaction modeling
    - Use cases

UML

- Unified Modeling Language
- Standardized by OMG
- Several diagrams
  - Class diagrams
  - Activity diagrams
  - Use Case diagrams
  - (Sequence diagrams)
  - (Statecharts)

Conceptual modeling

Process modeling

Functional modeling

Conceptual Modeling

CLASS DIAGRAM

Conceptual Modeling

- Construction of model
  - Providing an optimal description
  - From the stakeholders perspective

- Is the formalization phase after
  - Requirements elicitation and collection
  - Requirements analysis

Goal

- Capture
  - Main (abstract) concepts
  - Characteristics of the concepts
    - Data associated to the concepts
  - Relationships between concepts

Abstraction levels

Abstract	Concept Entity Class Category Type
Concrete	Instance Item Object Example Occurrence

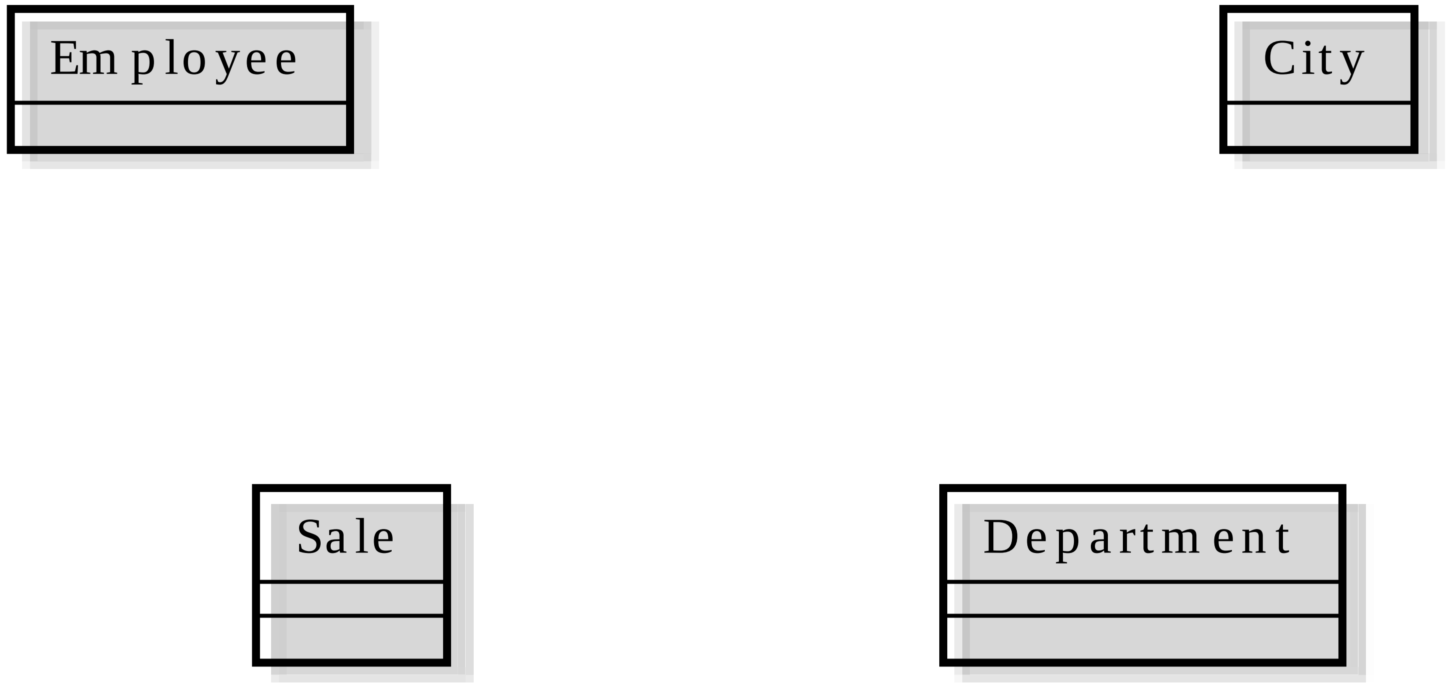
Model constructs

- Class
  - Object
- Attribute
- Association
  - Occurrence
  - Multiplicity
- Aggregation
- Association Class
- Generalization

Class

- A class represents a set of objects
  - Common properties
  - Autonomous existence
  - E.g. facts, things, people
- In an application for a commercial organization CITY, DEPARTMENT, EMPLOYEE, PURCHASE and SALE are typical classes.
  - Use a singular common noun

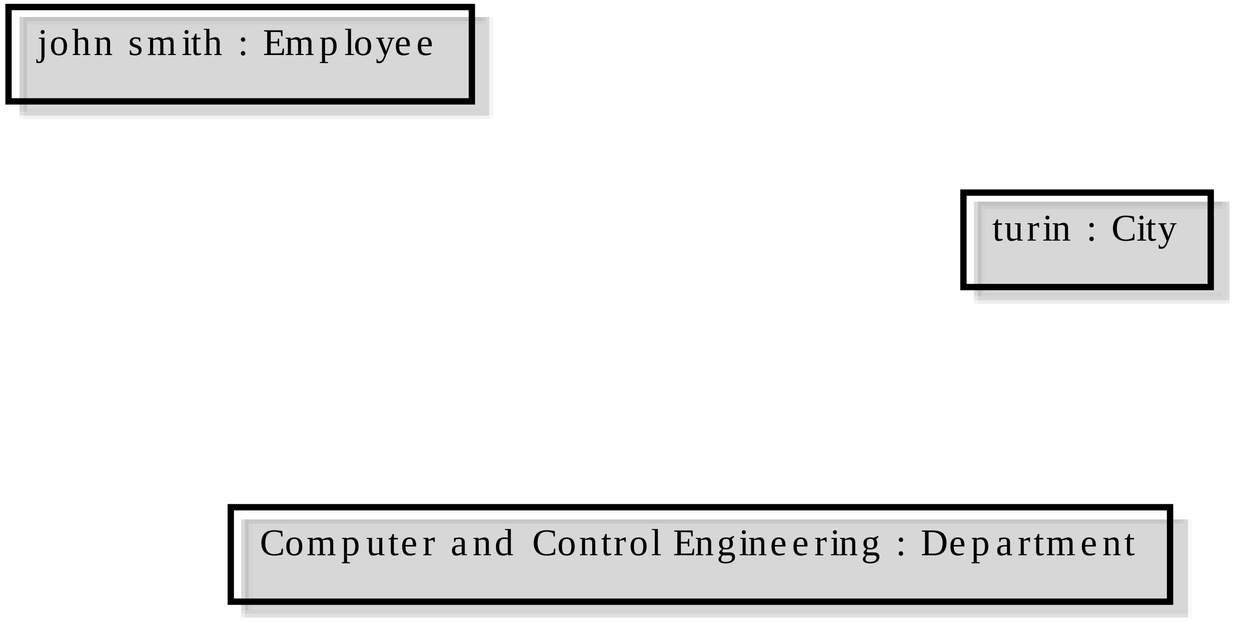
Class – Examples



Object

- Model of an item (physical or intangible within the software system)
  - ex.: a student, an exam, a window
- Characterized by
  - identity
  - attributes (or data or properties)
  - operations it can perform (behavior)
  - messages it can receive

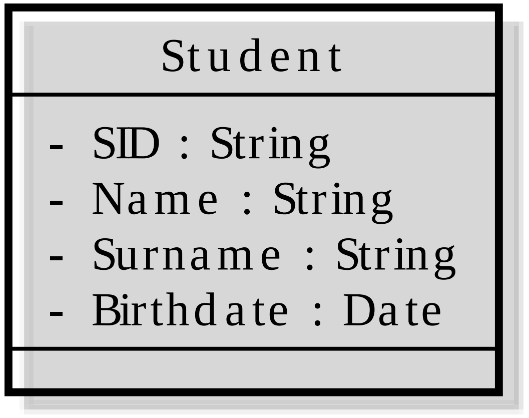
Object – Examples

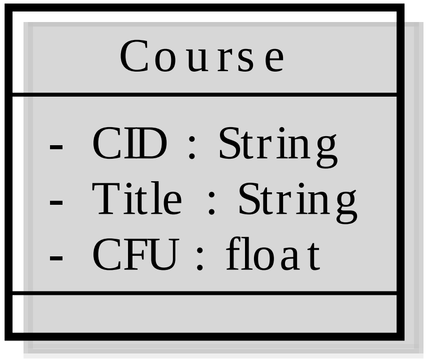


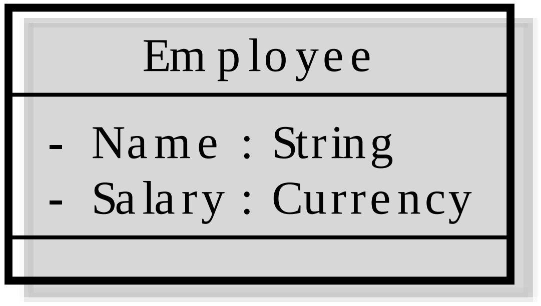
Attribute

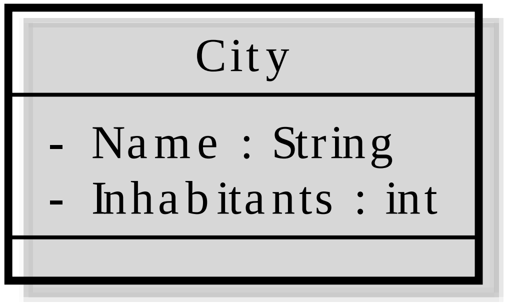
- Elementary property of a class
  - Name
  - Type
- An attribute associates to each object (occurrence of a class) a value of the corresponding type
  - Surname: String
  - ID: Numeric
  - Salary: Currency

Attribute – Example









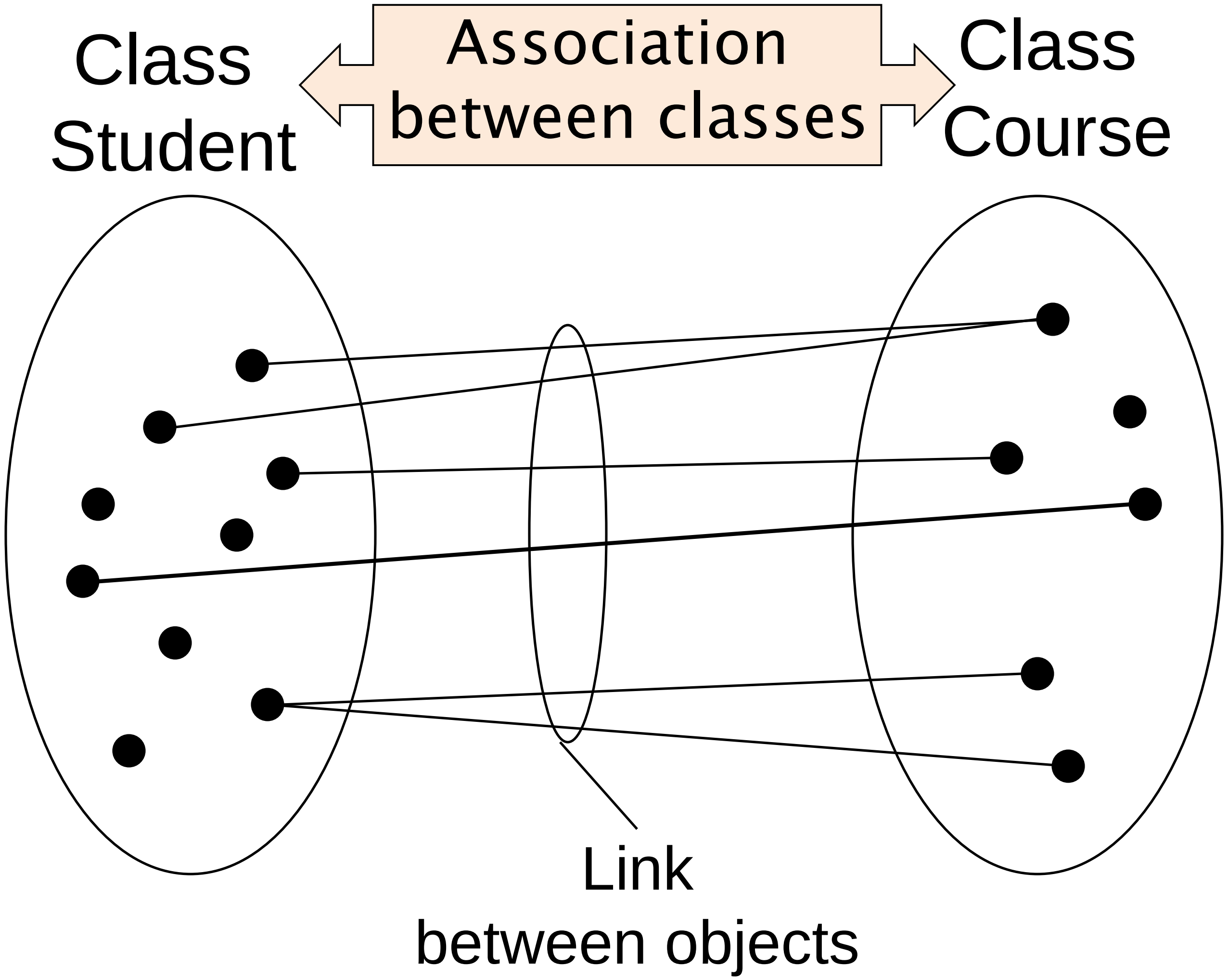
Attribute Types

Tipo	Descrizione
`int`	Numero intero
`double`	Numero reale (singola prec.)
`float`	Numero reale (doppia prec.)
`boolean`	Valore logico (V/F, Si/No)
`String`	Stringa di caratteri / Testo
`Date`	Data (giorno-mese-anno)
`Time`	Ora (ore:minuti:secondi)

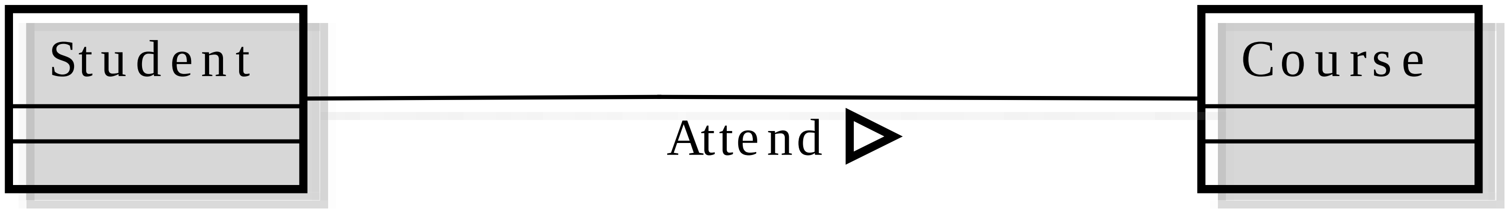
Association

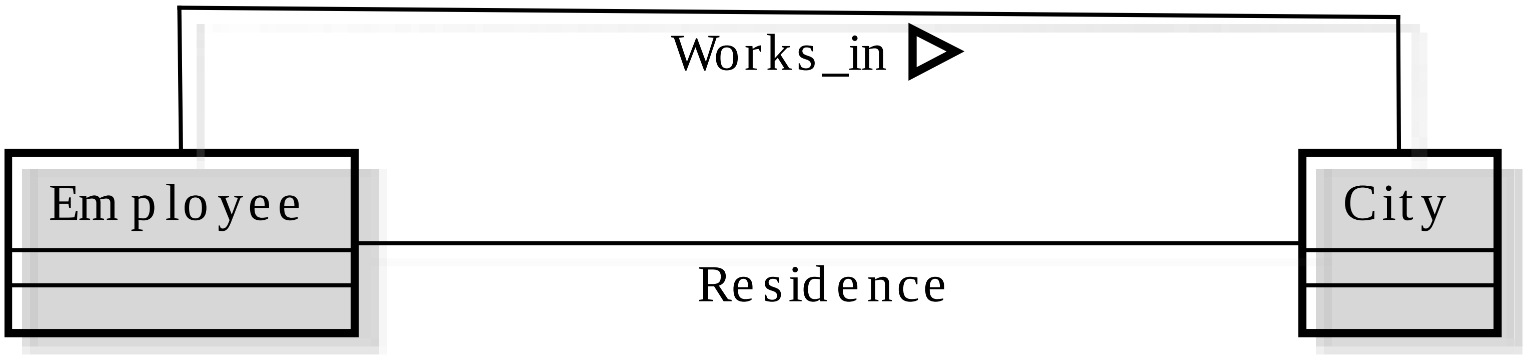
- Represent logical links between two classes.
- An occurrence of an association is an couple made up of occurrences of entities, one for each involved class
  - Residence can be an association between the classes City and Employee;
  - Exam can be an association between the classes Student and Course.

Associations

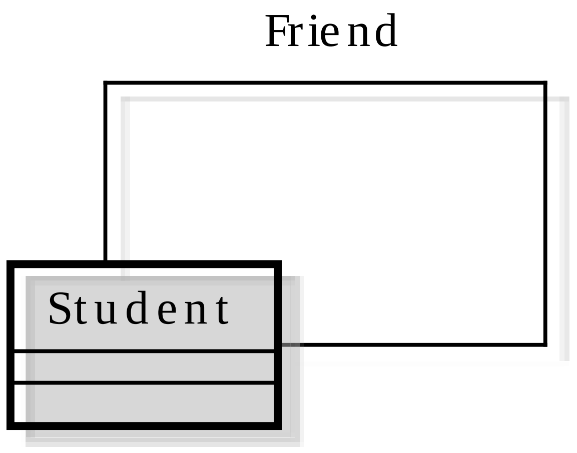


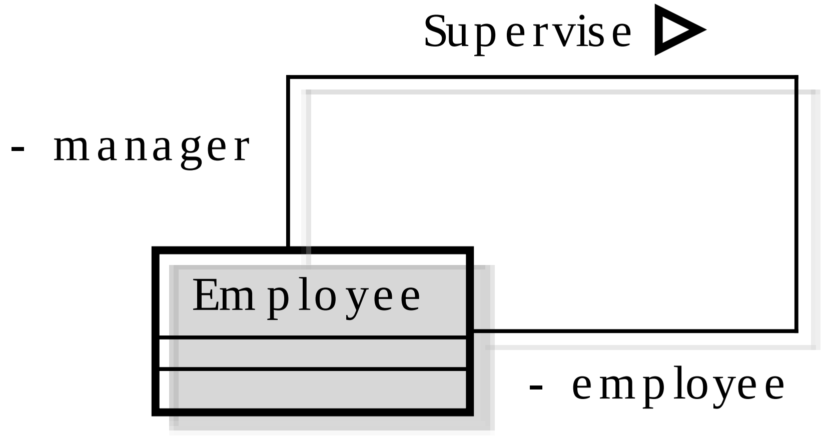
Association – Examples





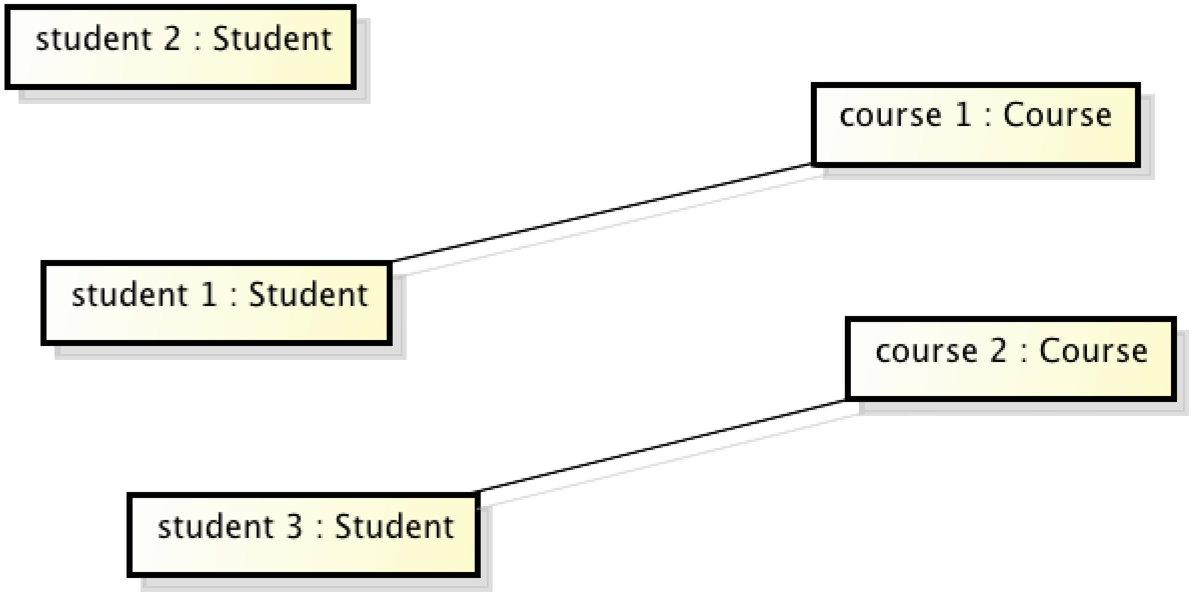
Recursive association–Samples





Link

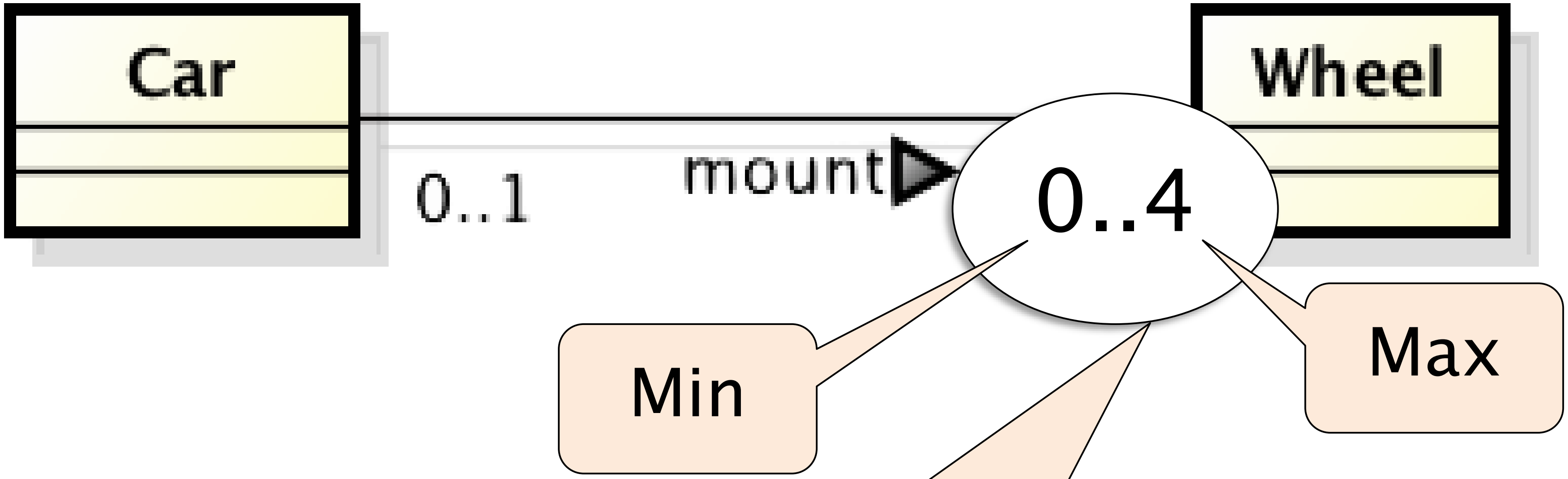
- Model of association between objects



Multiplicity

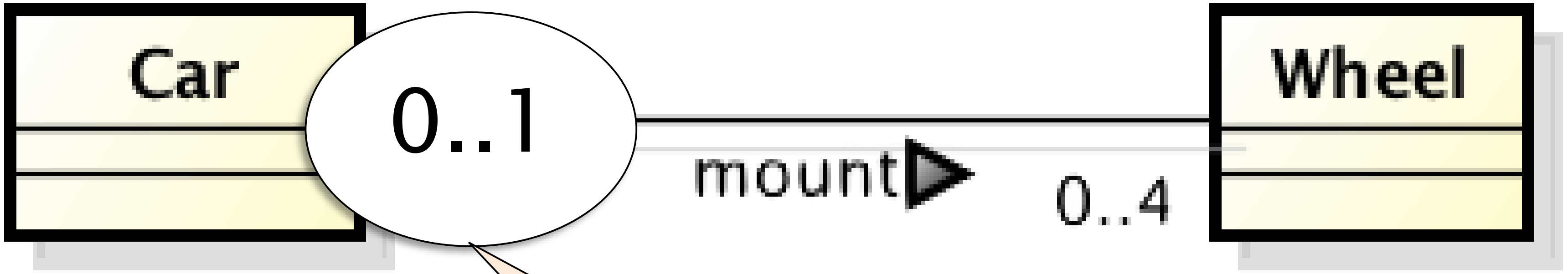
- Describe the maximum and minimum number of links in which a class occurrence can participate
  - Undefined maximum expressed as *
- Should be specified for each class participating in an association

Multiplicity – Example



A car can mount none, up to four wheels

Multiplicity – Example

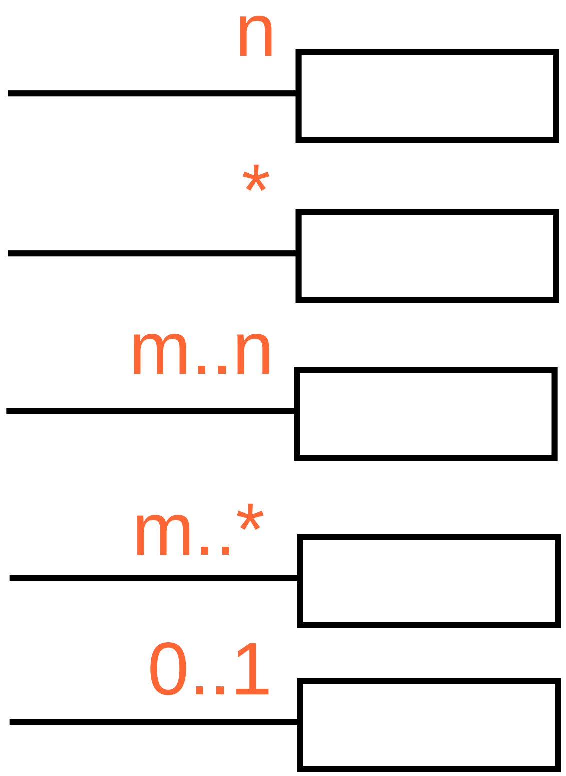


A wheel can be mounted on none or at most one car

Multiplicity

- Typically, only three values are used: 0, 1 and the symbol * (many)
- Minimum: 0 or 1
  - 0 means the participation is *optional,*
  - 1 means the participation is *mandatory;*
- Maximum: 1 or *
  - 1: each object is involved in at most one link
  - *: each object is involved in many links

Multiplicity



Exactly n

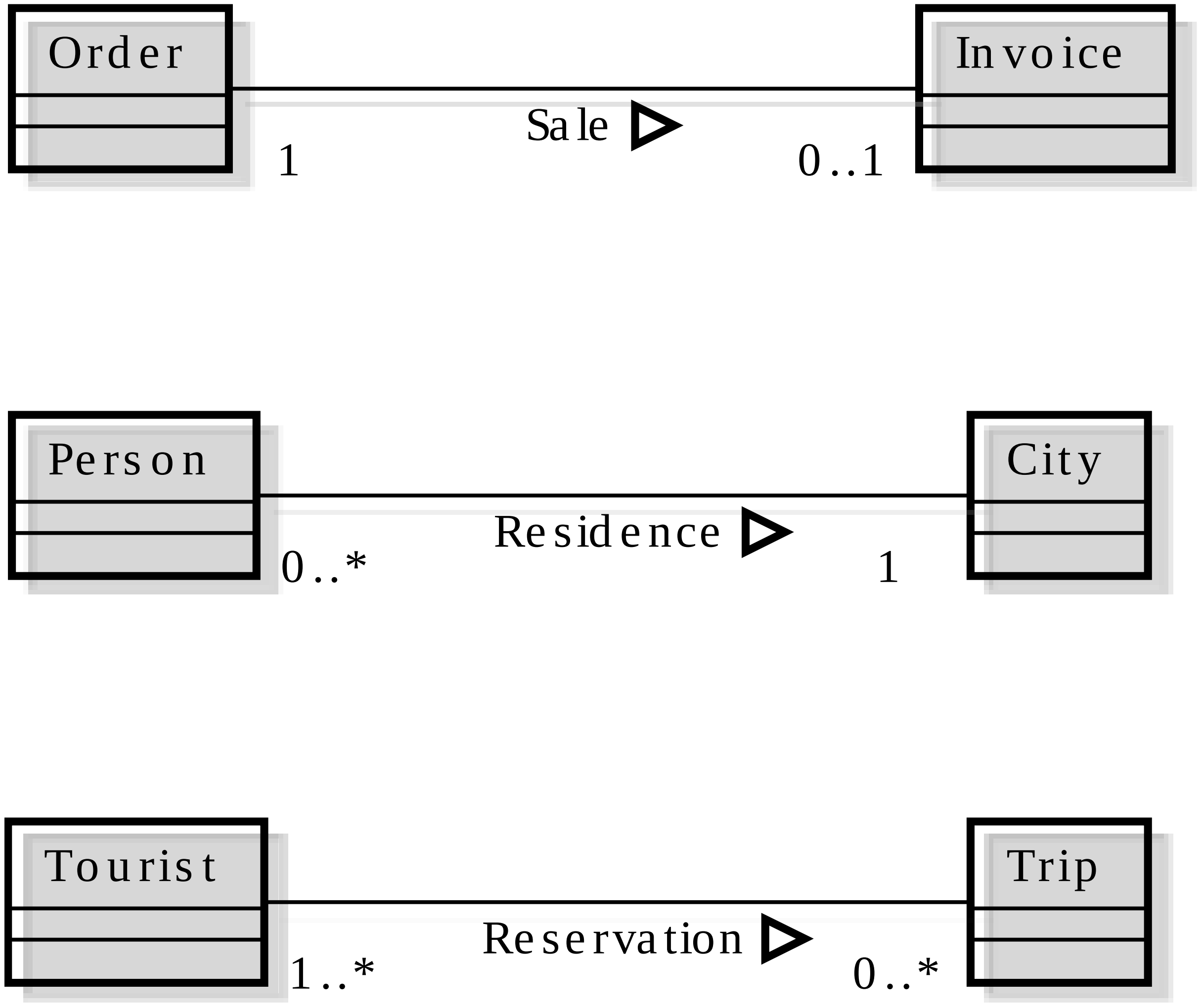
Zero or more

Between m and n (m,n included)

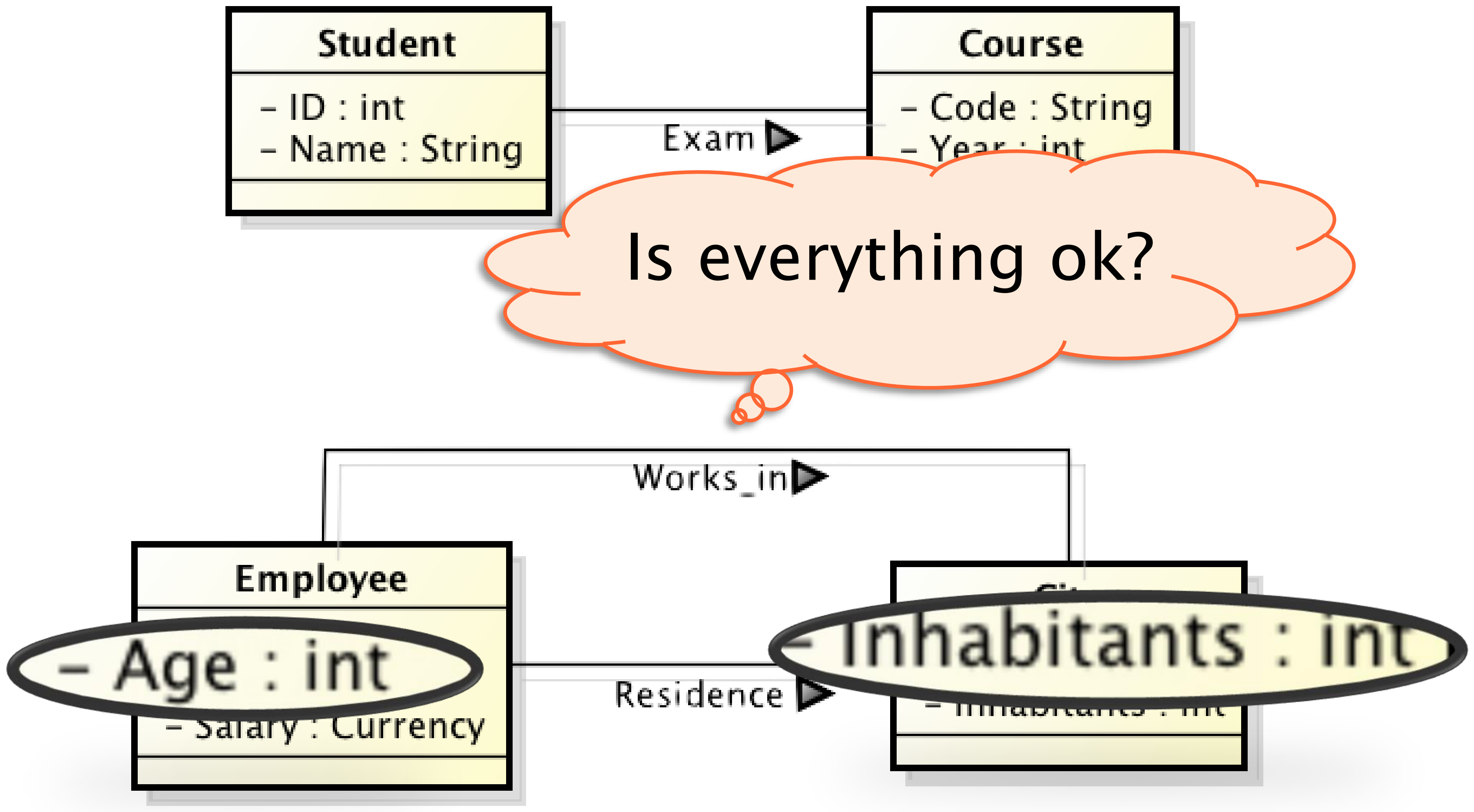
From m up

Zero or one (optional)

Multiplicity



Derived attributes



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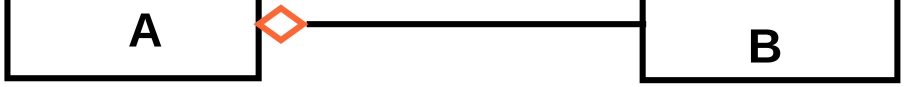
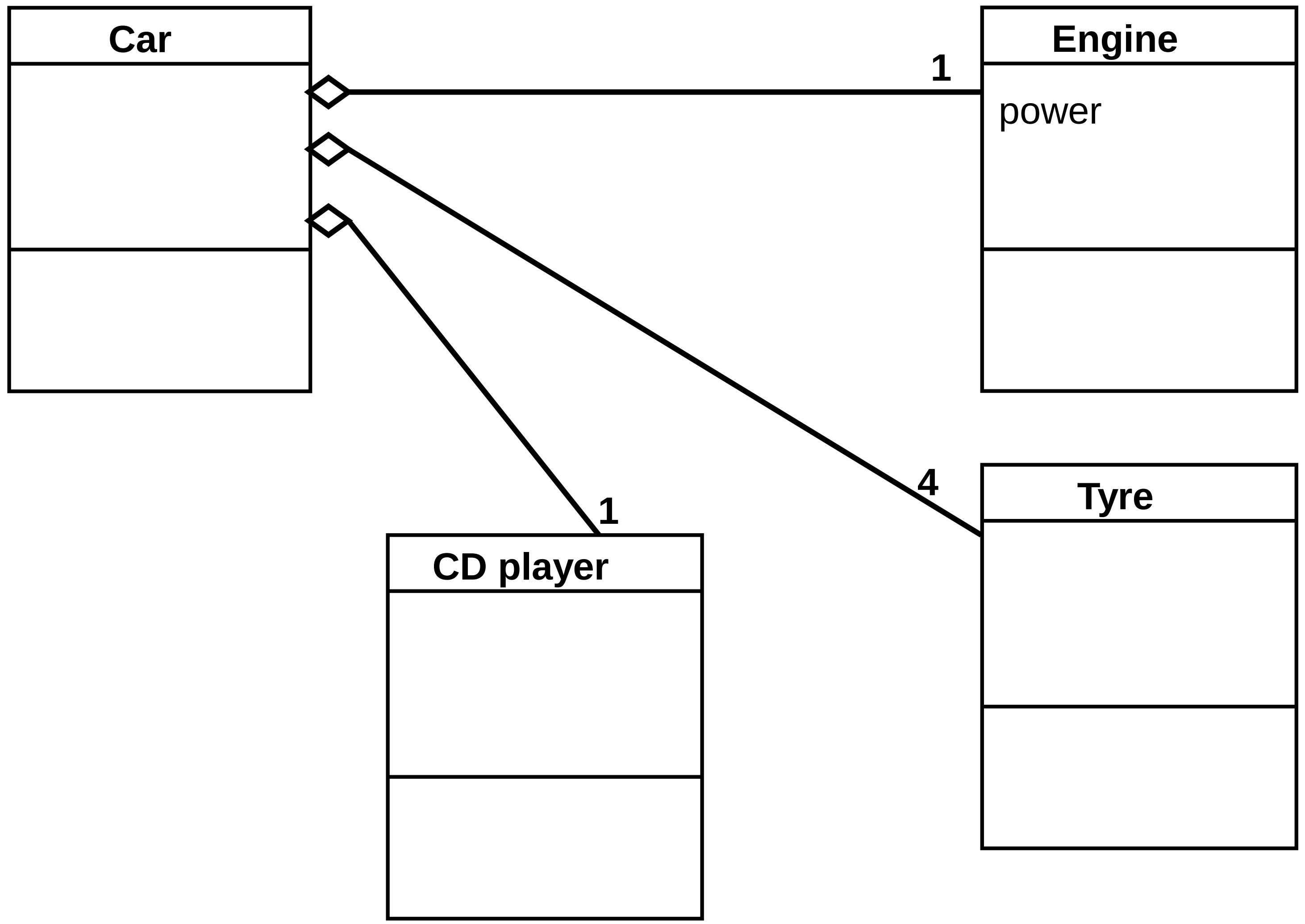
Aggregation

- B *is-part-of* A means that objects described by class B can be attributes of objects described by A

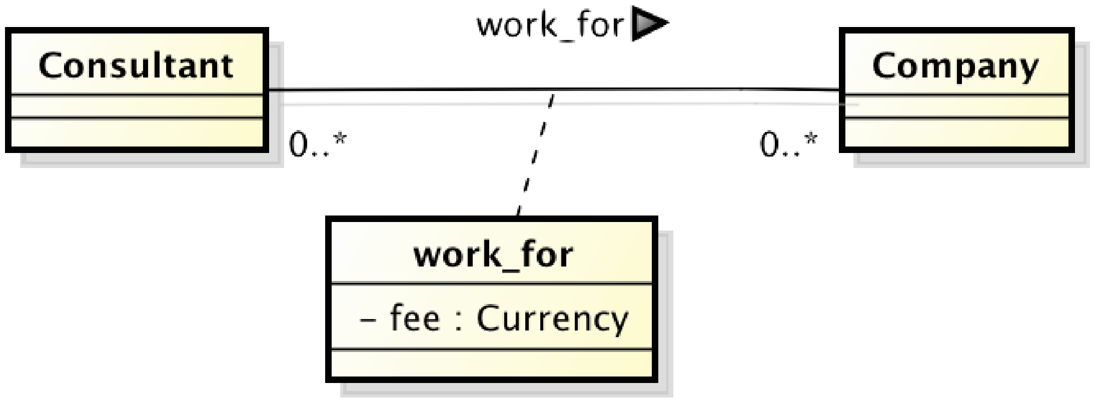


Example

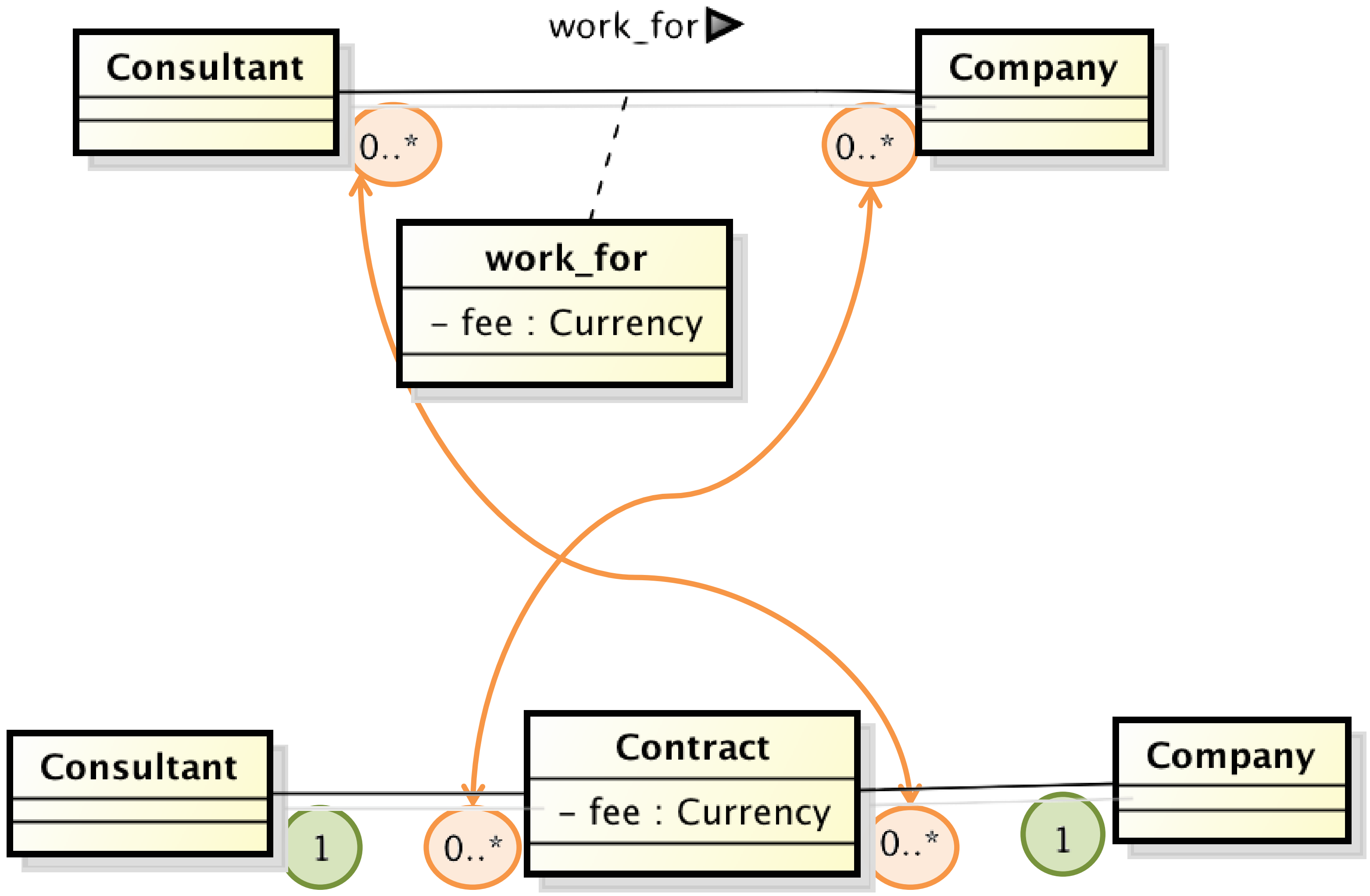


Association Class

- The association class define the attributes related to the association
- A link between two object includes
  - The two linked objects
  - The attributes defined by the association class



Association class – Equivalence



Association Class Limitations

- Association class
  - Fee is a function of consultant and company
  - fee (Consultant , Company)

- Intermediate class
  - Fee is a function of the contract
  - fee (Contract)

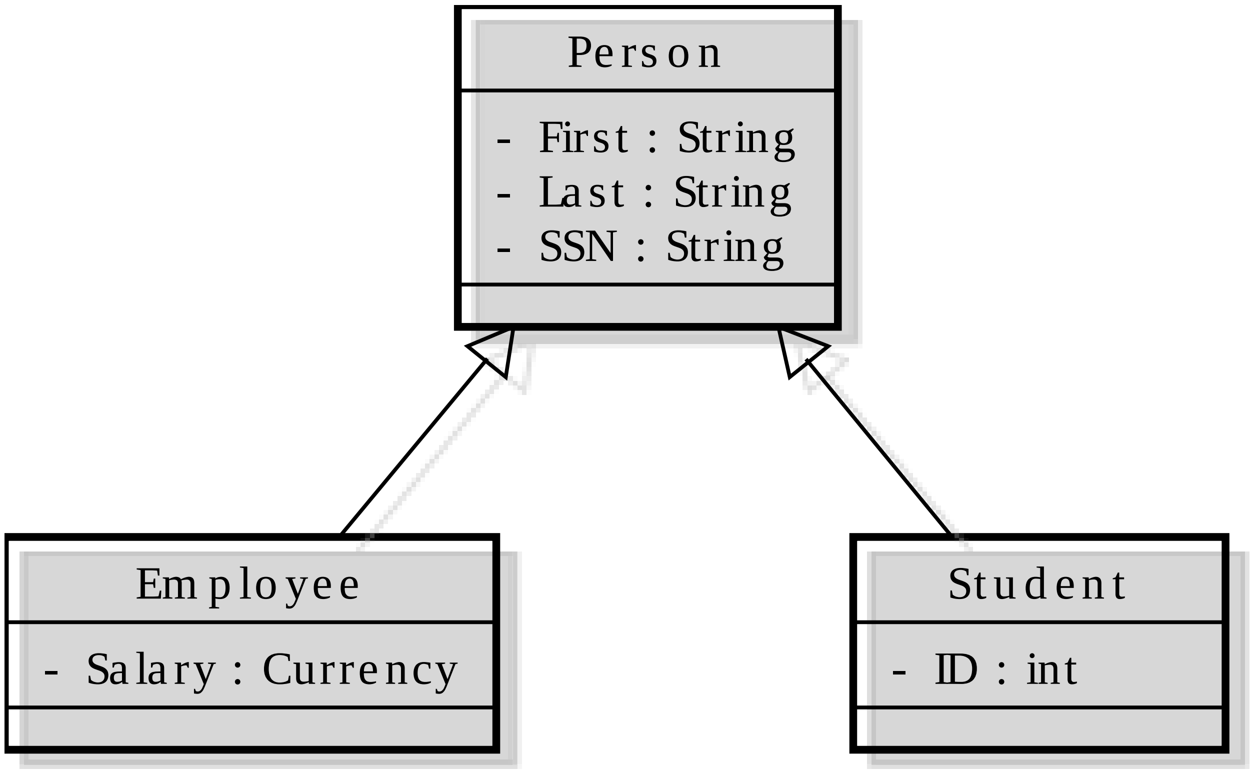
Association class limitation

- Case
  - Consultant working several times for the same Company
- Cannot be represented by association class
- Only representable through intermediate class

Specialization / Generalization

- B *specializes* A means that objects described by B have the same properties of objects described by A
- Objects described by A may have additional properties
- B is a special case of A
- A is a generalization of B (and possible other classes)

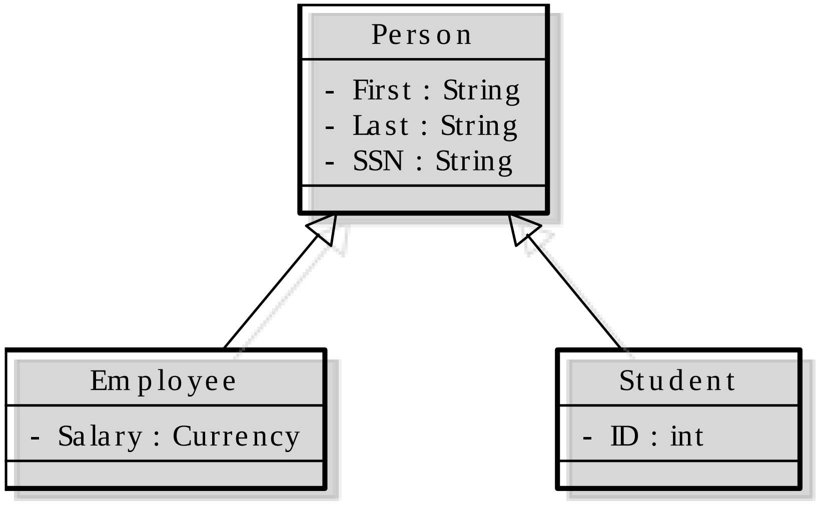
Generalization

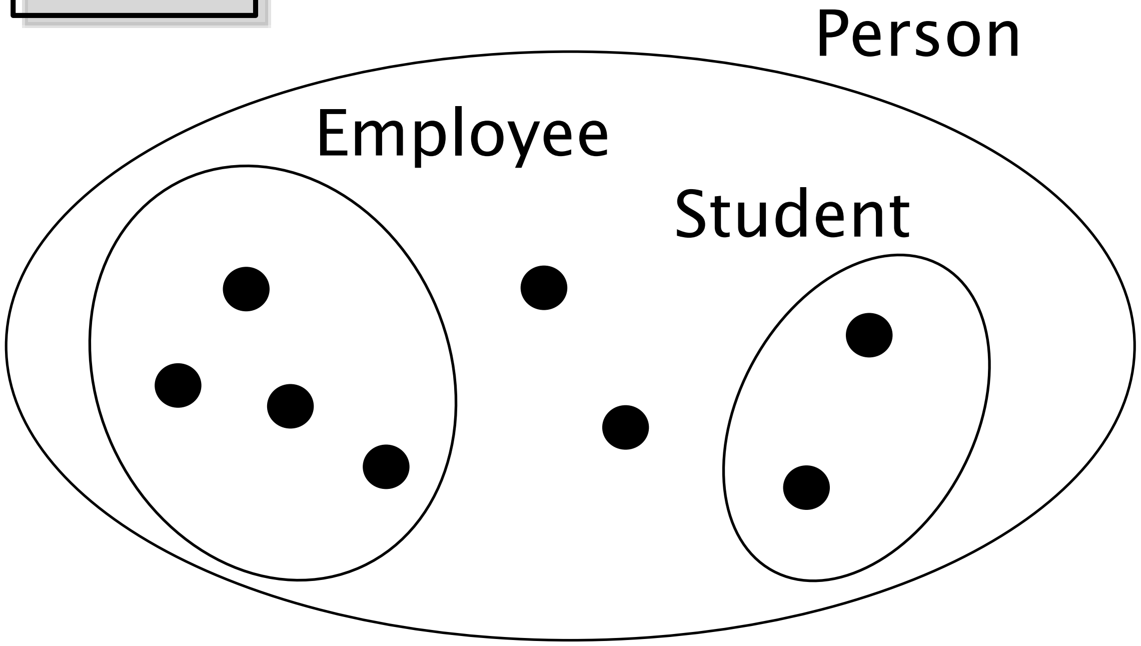


Inheritance terminology

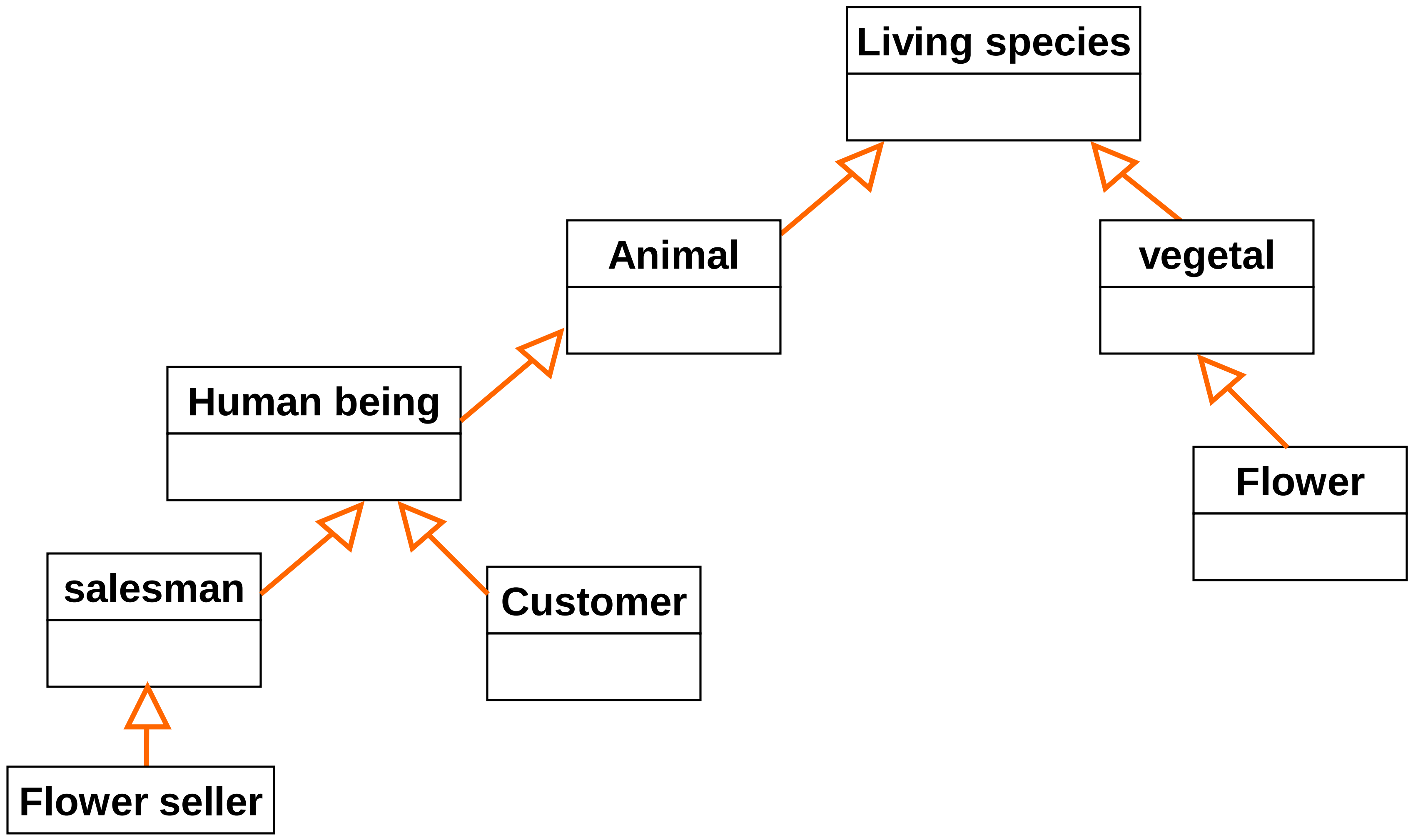
- Class one above
  - Parent class
- Class one below
  - Child class
- Class one or more above
  - Superclass, Ancestor class, Base class
- Class one or more below
  - Subclass, Descendent class, Derived class

Set-Specialization





Example of inheritance tree



Specialization types

- Totality
  - Total: derived classes form a partition
  - Partial
- Exclusion
  - Mutual exclusive: object cannot belong to two or more derived classes
  - Inclusive

NL Requirements Specification

- Requirements specifications are often written in natural language (NL)
  - At least in the first draft.
- NL is, by nature, subject to ambiguity and misinterpretation.
- Inaccuracies and ambiguous terms must be removed
  - Necessary an in-depth analysis of the specification document

Essential guidelines

- If a concept has significant properties and/or describes types of objects with an autonomous existence, it can be represented by a class.
- If a concept has a simple structure, and has no relevant properties associated with it, it is likely an attribute of a class.
- If a concept provides a logical link between two (or more) entities, it is convenient to represent it by means of an association.
- If one or more concepts are particular cases of another concept, it is convenient to represent them by means of a generalization.

Modeling strategies

- Top-down
  - Start with abstract concepts and perform successive refinements
- Bottom-up
  - Start with detailed concepts and proceed with integrating different pieces together
- Inside-out
  - Like bottom-up but beginning with most important concepts first
- Hybrid

Conceptual model quality

- Correctness
  - No requirement is misrepresented
- Completeness
  - All requirements are represented
- Readability
  - It is easy to read and understand
- Minimality
  - There are no avoidable elements

Example

- We wish to create a IS for a company that runs training courses. For this, we must store data about the trainees and the instructors.
- For each course participant (about 5000), identified by a code, we want to store the social security number, surname, age, gender, place of birth, employer’s name, address and telephone number, previous employers (and period employed), the courses attended (there are about 200 courses) and the final assessment of each course.
- We need also to represent the seminars that each participant is attending at present and, for each day, the places and times the classes are held. Each course has a code and a title and any course can be given any number of times. Each time a particular course is given, we will call it an ‘edition’ of the course. For each edition, we represent the start date, the end date, and the number of participants.
- If a trainee is a self-employed professional, we need to know his or her area of expertise, and, if appropriate, his or her title. For somebody who works for a company, we store the level and position held.
- For each instructor (about 300), we will show the surname, age, place of birth, the edition of the course taught, those taught in the past and the courses that the tutor is qualified to teach. All the instructors’ telephone numbers are also stored. An instructor can be permanently employed by the training company or can be freelance.

Requirement analysis

- Choose the appropriate level of abstraction
  - Identify the main concepts
- Construct a glossary of terms
- Identify synonyms and homonyms, and standardize terms
- Make cross-references explicit
- Standardize sentence structure
- Avoid complex phrases

Main concepts

- We wish to create a IS for a company that runs training course For this, we must store data about the trainee and the instructor
- For each course particpant (about 5000), identified by a code, we want to store the social security number, surname, age, gender, place of birth, employer's name, address and telephone number, previous employers (and period employed), the courses attended (there are about 200 courses) and the final assessment of each course.
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Glossary

Term	Description	Synonym	Links
Course	Course offered. Can have various editions.	Seminar	Instructor, Trainee
Trainee	Participant in a course. Can be an employee or self- employed.	Participant	Course, Employer
Instructor	Course tutor. Can be freelance.	Tutor	Course
Employer	Company by which a trainee is employed or has been employed.		Trainee

Standardize and simplify

- We wish to create a IS for a company that runs training courses. For this, we must store data about the trainees and the instructors.
- For each trainee ~~course participant~~ (about 5000), identified by a code, we want to store the social security number, surname, age, gender, place of birth, current employer ~~employer's name, address and telephone number~~, previous employers (and start date and the end date of period employed), the courses editions attended (there are about 200 courses) and the final assessment of each course. For each employer we store the name address and phone number.
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Example

Generic statements

We wish to create a IS for a company that runs training courses. For this, we must store data about the trainees and the instructors.

- For each employer we store the name, address, and phone number
- We need also to represent course editions and, for each day, the places and times the classes are held. Each course has a code and a title and any course can be given any number of times. Each time a particular course is given, we will call it an 'edition' of the course. For each edition, we represent the start date, the end date, and the number of participants.
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Example

Statements about Trainees

For each trainee (about 5000), identified by a code, we want to store the social security number, surname, age, gender, place of birth, current employer's, previous employers (and start date and end date of the period employed), the courses editions attended (there are about 200 courses) and the final assessment of each course edition.

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Statements about employers

For each employer we store the name, address, and phone number

- If a trainee is a self-employed professional, we need to know his or her area of expertise, and, if appropriate, his or her title. For somebody who works for a company, we store the level and position held.
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Example

- We wish to create a IS for a company that runs training courses. For this, we must store data about the trainees and the instructors.

Statements about Courses

Each course has a code and a title and any course can be given any number of times. Each time a particular course is given, we will call it an ‘edition’ of the course. We need also to record for each day, the places and times the classes are held. For each edition, we represent the start date, the end date, and the number of participants.

An instructor can be pe ployed by the training compa freelance.

Example

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Statements about types of employers

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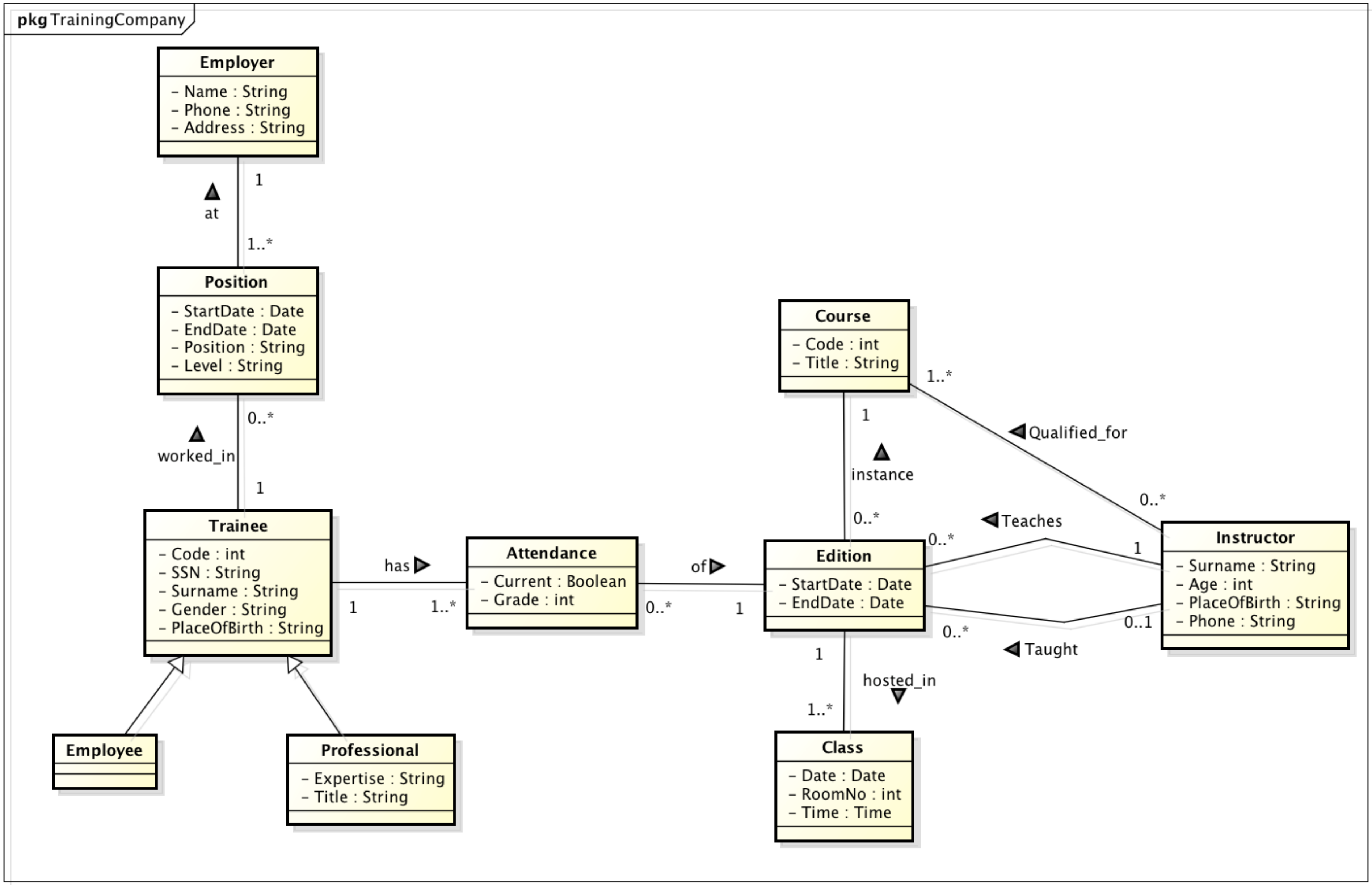
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Employer
- Name : String
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- Address : String
at
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Position
- StartDate : Date
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worked_in
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Trainee
- Code : int
- SSN : String
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Attendance
- Current : Boolean
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Employee
Professional
- Expertise : String
- Title : String
Course
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Qualified_for
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instance
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Edition
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- EndDate : Date
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Teaches
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Instructor
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- Age : int
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- Phone : String
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Taught
0..1
1
hosted_in
1..*
Class
- Date : Date
- RoomNo : int
- Time : Time

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