Class modelling (part3)

Fabrizio Maria Maggi
Institute of Computer Science
Association classes

- An association class is an association that is also a class
- Like a class, an association class can have attributes and operations and participate in associations
- UML notation: class box attached to the association by a dashed line
Association classes (instantiations)

- Exam
  - date = "03-05-2019"
  - name = "Algebra"

- Participation
  - grade = "C"

- Student
  - name = "Michael"

- Exam
  - date = "05-01-2018"
  - name = "Algebra"

- Participation
  - grade = "A"

- Student
  - name = "Paul"

- Participation
  - grade = "C"

- Student
  - name = "Michael"
Association classes

- Alternative representations in case of multiplicity one-to-many
Association classes

- Alternative representations in case of multiplicity one-to-many
Association classes

- What about the case of many-to-many?

 EQUIVALENT?
Association classes

- What about the case of many-to-many?

EQUIVALENT?
Association classes

- PREFERABLE.
Association classes

- **PREFERABLE.** What if the multiplicity changes?
Since it is not possible to have two links of the same association between the same two objects, there can be only one instance of the association class between any two participating objects.
Association classes

- NOT POSSIBLE (Participation is a link and it is not possible to have two links of the same association between the same two objects)
NOT POSSIBLE (Participation is a link and it is not possible to have two links of the same association between the same two objects)
POSSIBLE

- **Exam**
  - date = "05-01-2018"
  - name = "Algebra"

- **Participation**
  - grade = "A"

- **Student**
  - name = "Paul"

- **Participation**
  - grade = "C"

- **Student**
  - name = "Michael"
Association classes

POSSIBLE

- : Exam
date = "05-01-2018"
name = "Algebra"

- : Participation
grade = "A"

- : Student
name = "Paul"

- : Exam
date = "03-05-2019"
name = "Algebra"

- : Participation
grade = "C"
Association classes

POSSIBLE

- Exam
  - date = "05-01-2018"
  - name = "Algebra"

- Participation
  - grade = "A"

- Student
  - name = "Paul"

- Exam
  - date = "03-05-2019"
  - name = "Algebra"

- Participation
  - grade = "C"

- Student
  - name = "Michael"
The same person **CANNOT** be employed by the same company in different years (Employment is a link and it is not possible to have two links of the same association between the same two objects)
Class or Association Class?

- The same person **CAN** be employed by the same company in different years
POSSIBLE (Employment is a class now and not a link)
Exercise 1

(a) In a system to manage employments of people in companies, a person can be employed in different companies, in each company only with one specific role.

(b) In a system to manage employments of people in companies, a person can be employed in different companies. In each company the person can cover different roles.
Exercise 2

In an online system to deal with flight bookings, each flight has a departure airport and an arrival airport and it is characterized by a date and a flight number. Each airport has a name and is located in a city. A flight has a plane (characterized by a model and a serial number) and a list of passengers each occupying a seat in the plane. A flight is managed by only one airline and has 2 pilots.
3.20 (6) Prepare a class model to describe undirected graphs. An undirected graph consists of a set of vertices and a set of edges. Edges connect pairs of vertices. Your model should capture only the structure of graphs (i.e., connectivity) and need not be concerned with layout such as location of vertices or lengths of edges. Figure E3.10 shows a typical undirected graph.

Figure E3.10 Sample undirected graph
Question 1

- In what type of diagram a connection between the same two nodes is not necessarily unique? How would you represent the connection in this case?
Qualified Associations

- What is the meaning of this association?
- How can we implement it?
- Is this a realistic representation?
Qualified Associations

- It is possible to define qualifiers for one-to-many and many-to-many associations
- A qualifier selects among the target objects, reducing the multiplicity from many to one
- How can we implement a qualified association?
Exercise 4

In an online system to enroll students in University courses, each course has a unique course ID, a title, a start date and a duration. Each student has a unique student ID, a name and a birth date. A student can be enrolled in different courses and a course can be attended by several students. Each course is taught by only one professor who has a name and can teach several courses.
Enumerations

- An enumeration is a data type that has a finite set of values.
- Enumeration is a data type: you can declare an enumeration by listing the keyword enumeration in angle quotes (<< >>) above the enumeration name in the top section of a box. The second section lists the enumeration values.
- Do not use generalization to capture the values of an enumerated attribute:
  - An enumeration is a list of values.
  - Introduce generalization only when at least one subclass has significant attributes, operations, or associations that do not apply to the superclass.
Enumerations
Enumerations

Card

suit : Suit
rank : Rank

«enumeration»

Suit

spades
clubs
hearts
diamonds

«enumeration»

Rank

ace
king
queen
...
Enumerations

Monday, Tuesday, Wednesday,…

January, February, March,…

Spring, Summer,…
Question 2: Enumeration?

- A paper reviewing system has several conferences. Each conference has a title and a year and is managed by a chair and a list of committee members. Committee members and chairs must be assigned to one, but possibly more conferences. They have a name and an affiliation. A conference has several submitted papers, but a paper can be submitted to only one conference. A paper is assigned to 3 reviewers taken from the committee members. A paper can be accepted rejected or under review. We also know the paper titles and list of authors with their names and affiliations.
Exercise 5

In a system for handling shipments of products in an online bookshop, there can be three different types of items: book, greeting card, stationery item. A book has a title and a list of authors with names. A greeting card has a brand. A stationery item can be a pen, a pencil or a notebook. Each shipment has a priority that can be standard, high, or express.
You can specify if an attribute is single or multivalued, mandatory or optional.
Derived data

- A derived element is a function of one or more elements, which in turn can be derived.
- The notation for a derived element is a slash in front of the element name.
- The constraint that determines the derivation must be shown.
Abstract classes

- An abstract class is a class that has no direct instances but whose descendants classes have direct instances.
- A concrete class is a class that is instantiable.
- A concrete class may have abstract subclasses, but they in turn must have concrete descendants: only concrete classes can be leaf classes in an inheritance tree.
- In the UML notation an abstract class name is listed in an italic font (or using {abstract} near the class name).
Abstract classes

```
Employee
  yearToDateEarnings
  computePay()

FullTimeEmployee
  weeklyRate
  computePay()

PartTimeEmployee
  hourlyRate
  computePay()
```
Abstract operations

- Abstract classes can be used to define methods that can be inherited by subclasses.
- Abstract classes can define the signature of an operation without supplying a corresponding method.

Abstract operations:

- An abstract operation defines the signature of an operation for which each concrete subclass must provide its own implementation.
- An abstract operation is designated by italics or the keyword `{abstract}`.
Abstract operations
Exercise 7

A shape is characterized by horizontal position, vertical position, fill type, fill color, line type and line color. A Rectangle is a shape with a length and a width. A triangle is a shape with a base and a height. Both have an operation to compute the area of the shape.