

Class Diagrams

Ferd van Odenhoven

Fontys Hogeschool voor Techniek en Logistiek

May 27, 2015

Objects and classes

Basis concepts

- **Object**

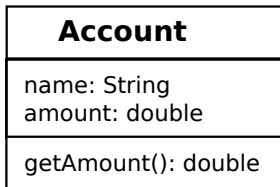
- A selfcontained thing that exists in reality or in mind
- encapsulation
- Provides services: has responsibilities

- **Class**

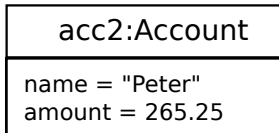
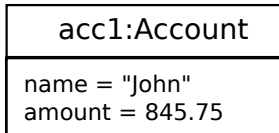
- **Description** of objects with corresponding properties of a certain kind
- Determines attributes and operations
- Has objects as its real instances

Objects and classes

Class:



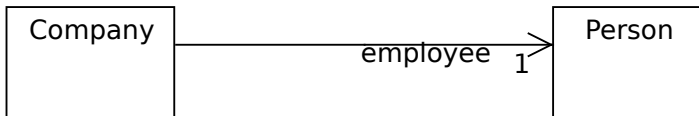
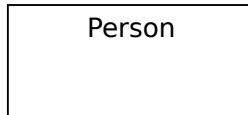
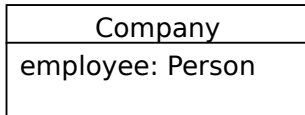
Objects:



Modeling and Analysis

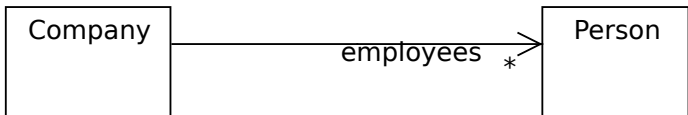
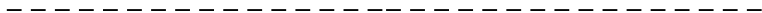
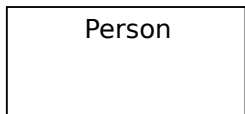
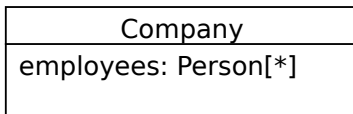
- In the analysis phase the approach is *sketchy*, because the domain is still under investigation
- In the analysis phase we construct the **Domain model!**
- In this phase many changes occur in the class diagram: classes are being changed or removed and new classes are added. Associations too are still not in their final state.
- Hence we do not yet add methods/operations to the classes in these premature class diagrams!
- We restrict ourselves to find the properties of the domain classes.

Example: a company has an employee



These two diagrams are equivalent

Example: a company has employees



These two diagrams are equivalent
The multiplicity [*] has no relation to array!

Modeling and Analysis: domain model

- A textual description can be a good starting point for a domain analysis. Every noun is a candidate for a new class.
- A property of a class can be added as a member or an association.
- If the property or attribute is itself a domain object, we prefer the association! Certainly in a domain model.
- CRC cards may be used to decide on the responsibilities of each class.
- Important use case scenario's are tested on the class diagram using sequence diagrams. Adjustments to the classdiagram are still possible!

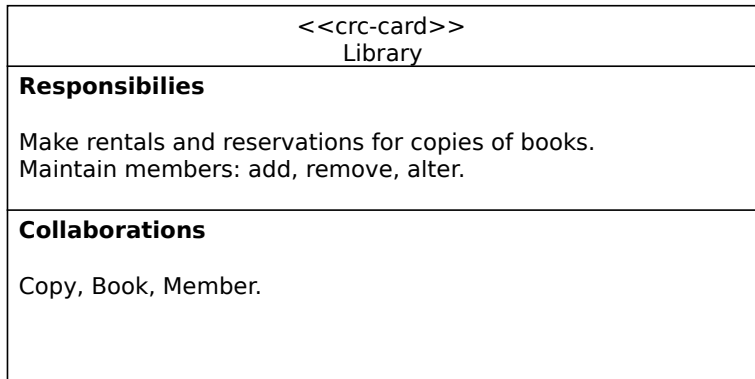
CRC-cards

A CRC-card looks as follows :

Class:	Nr:
Responsibilities:	Collaborations:

Table : CRC-cards can help in dividing the responsibilities over the relevant classes.

Example crc card for library

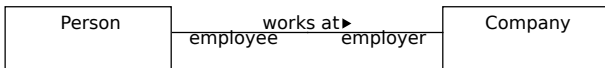


In umlet you can find the template for this card in de mod1 palette.

Associations

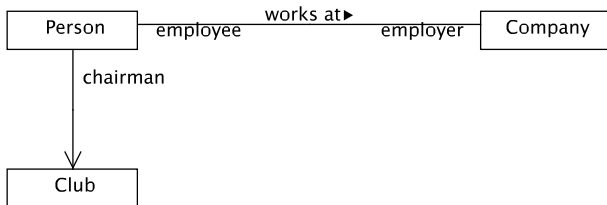
Structural relationship between two classes

- Fact: *A person works at a company.*
- Arrowhead after text on association indicates reading direction and only that!
- More associations between two classes are allowed.
- Role names at the classes : 'employee' & 'employer'.



Associations and roles

- Objects can have different roles (association end)
- Direction of an association:
 - Association: in general both objects know each other
 - but: associations can be forced in one direction (must use open arrow head →)



Dependency

- Model element describing which class is dependent of some other class.
- Also showing more associations between two classes.

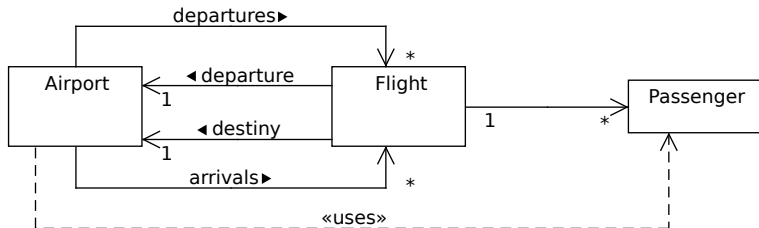
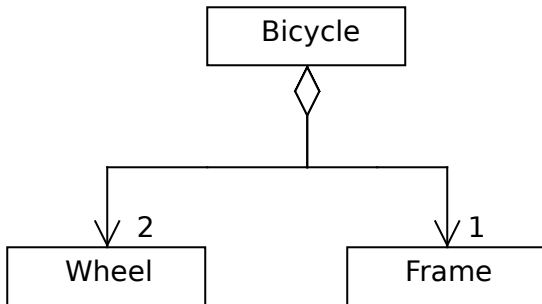


Figure : Dependency relation:
 dashed arrow and stereotype with keyword 'uses'.

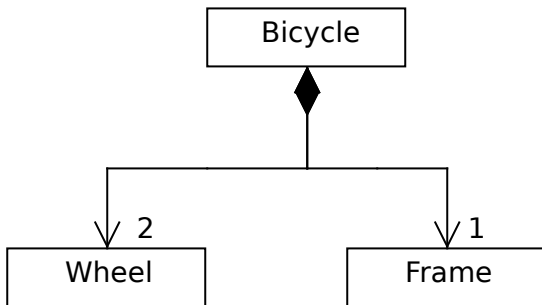
Aggregation (only semantic meaning)

- Aggregation: an association showing that classes are part of another class (**white** lozenge).
- Instances of the parts classes can also exist on their own.



Composition (use only when necessary)

- Composition: an association depicting that classes are part of another class (**black** lozenge).
- Instances of the parts-of class **cannot** exist on their own : 'Life-Time Dependency'



Multiplicity

Shows the number of possible instances of an associated class.
 Directions of association and label are independent!



It is recommended to add text label to an association in a domain model.

An example: the new Library

The renewed textual description.

- The public library Venlo has four locations: Belfeld, Tegelen, Blerick en Venlo. To borrow a book, one must be member of the library. Membership is valid for one year, starts at the month of subscription and one obtains a member card. Membership fees: no fee under 16 year, 10 € for ages 16-17 and 35 € for ages 18 and up. Students pay 30 €.
- With a subscription every member can make use of the central library, as well as the locations at Blerick, Belfeld, Tegelen. Books, audio cassettes, magazines, video tapes, dvd disks, cd-roms and daisy-rom can be borrowed. There are no fees for lending books or other media and there is no limit on the number of items per year. The maximum numbers of media items is 25 at any time.

An example: the new Library

- The lending period for media is three weeks. So called sprinters have a lendingperiod of two weeks.
- Extending a lending period can be done twice per item.
- There is no fee for making reservations.
- Extension of the lending period is **not** possible if a reservation has been made for the specific media item. If a book has been brought back after the lending period has expired, a fine of 20 cents per day is charged.
- Lending media or extending the lending period is not possible if the members's debt at the library is larger than 25 euros.

Books and copies.

- Fact: The author 'Joseph O'Connor' has written a book with the title 'Star of the Sea'.
- The library possesses 5 copies of that book.

We do need this trivial fact for our domain analysis.



Figure : *What would be the direction of the association?*

- What to do if more data of the publisher are relevant?

Books and copies.

- We see an example of a class diagram with two classes. For each class the attributes are given.
- A relation between the two classes is present. In this case it is an *association*. The association has a name and is to be interpreted from left to right.
- At the endings of the association the *multiplicity* has been added. Read along the direction of the association: several (*) copies of one (1) book.

Library.

- The library owns many book copies. This is also a one (1) to many (*) association, but a different one.
- The library owns the books. Therefore it should be looked upon as a *container object*.

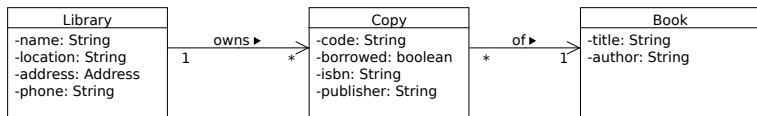


Figure : A library has copies of a book.

Library.

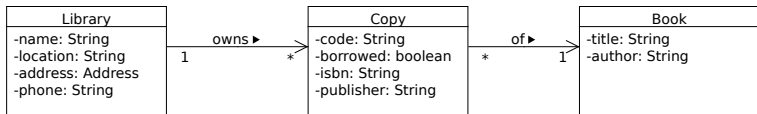


Figure : The library administrates copies, to every copy there belongs exactly one book.

- All copies of a book have a reference to the book they belong to.
- In an object diagram we see e.g. three book copy objects of the same book, each of these objects has its own reference to the same book object.

Object diagram

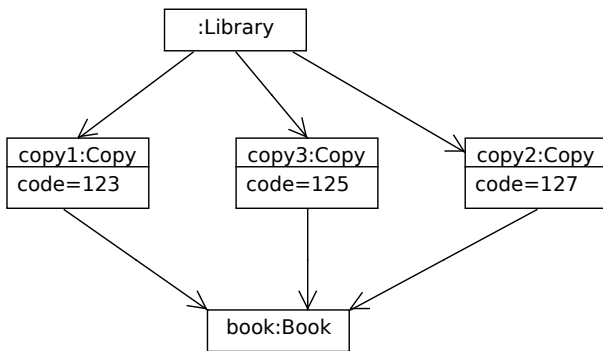
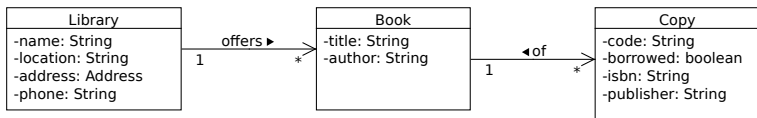


Figure : Example of an object diagram for the domain model of the previous slide.

Library, alternative modeling.

- A library could also be seen as an institution offering a number of books of which copies can be lendend. Each copy belongs to a book.
- As an example we could get the following model:

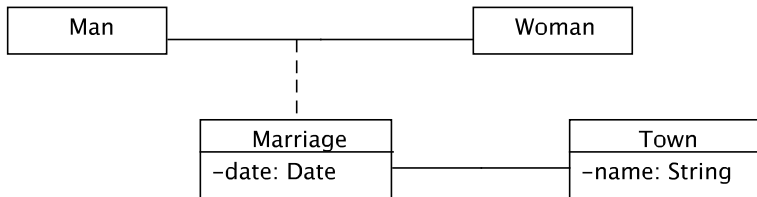
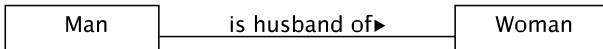


- The book class now manages the copies of the book.
- Better said: the library manages the book copies over the book class.

Association class

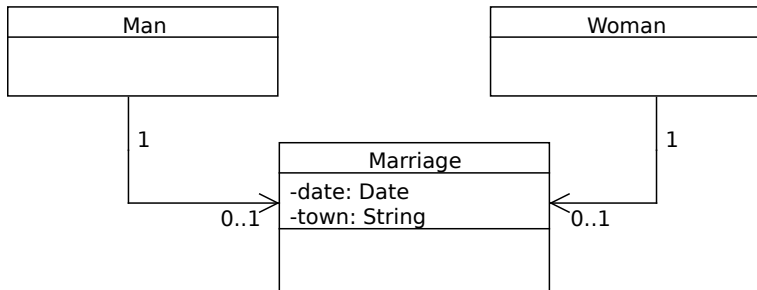
Association class: a class in connection with an association

- if the association has an attribute or
- if the association has an operation



Classical class model marriage

First attempt to import the association class in the class diagram.



There are of course more possibilities!

More general class model marriage

Man and woman are persons. The introduction of a **Person** class is obvious. The new class diagram, with the possibility of a marriage.

