Associations and Aggregation in Class Diagram

Classes and Relationships

- Relationships among classes
  - Association
  - Weak Aggregation
  - Strong Aggregation
  - Generalization
  - Dependency
  - Constraints

Classes and Relationships

Class	Relationship
• A daisy is a kind of flower	Sharing connection – daisies and roses are both kinds of flowers – bright colored petals, fragrance, etc. Daisy IS_A Flower
• A rose is a (different) kind of flower	Sharing connection – daisies and roses are both kinds of flowers ... Rose IS_A Flower
• Red roses and yellow roses are both kinds of roses	Semantic connection – red roses and yellow roses are more alike than are daisies & roses Red Rose IS_A Rose, Yellow Rose IS_A Rose
• A petal is a part of both kinds of flowers	Semantic connection – daisies and roses are more closely related than are petals & flowers Flower HAS_A Petal
• Ladybugs eat certain pests such as aphids, which may be infesting certain kinds of flowers	Symbiotic connection – Ladybugs protect flowers from certain pests Semantic Dependency

Are Roses and Candles related? – Both decorate dinner tables

Source: *Object-Oriented Analysis and Design – With Applications* by Grady Booch et. al. (3rd Ed, 2007)

Classes and Association

- Semantic Dependencies
  - Most general and most semantically weak
  - Bidirectional by default
  - Often refined over the analysis process

Early relationship

Refined to IS_A

Early relationship

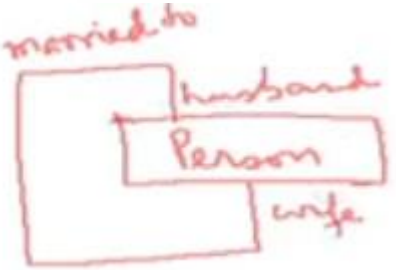
Refined to HAS_A

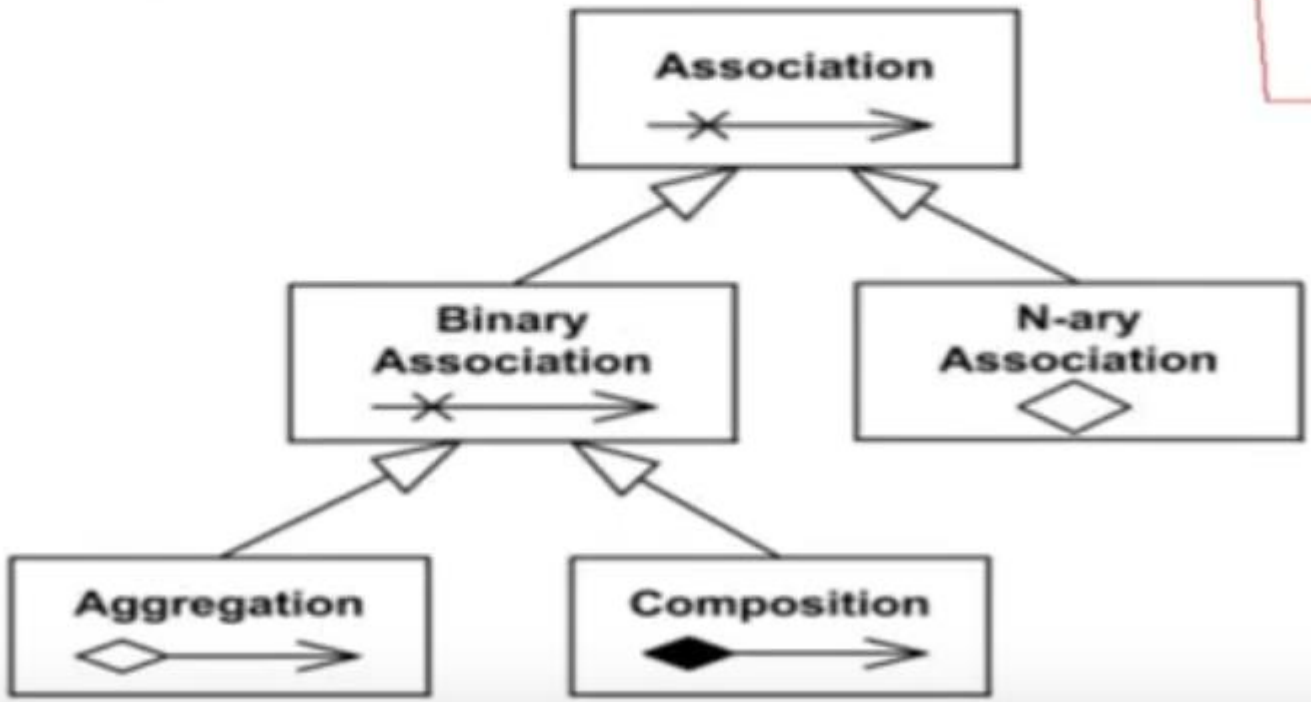
Early relationship

Refined to ?

Association Notations

- An association icon (a line connector with label – association name) connects multiple classes and denotes a logical connection
- Associations can be binary of N-ary
- A class may have association to itself (Reflexive)



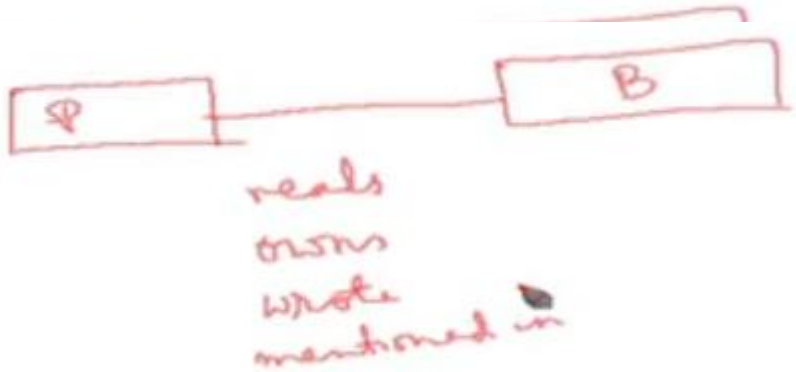


Association Notations

We show an association below between a Professor and a Book

An association has three main concepts

- Association End
- Navigability
- Association Arity



Source: *UML 2.5 Diagrams Overview*: http://www.uml-diagrams.org/uml-25-diagrams.html (17-Aug-16)

Association Notations

- Association End
  - Association end is a connection between the line depicting an association and the icon depicting the connected classifier
  - The association end name is commonly referred to as role name
  - The role name is optional and suppressible

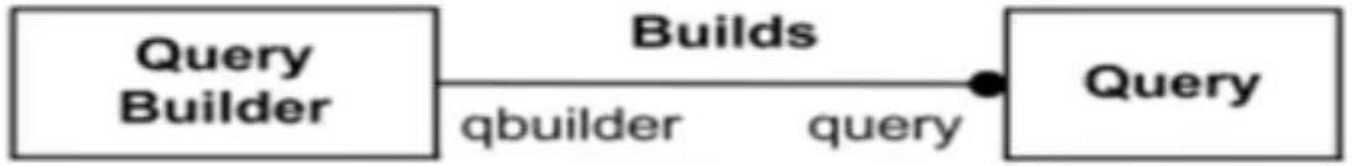
Professor "playing the role" of author is associated with textbook end typed as Book.

  - Professor can have multiple roles, like author of some Books or an editor.

Source: *UML 2.5 Diagrams Overview*: http://www.uml-diagrams.org/uml-25-diagrams.html (17-Aug-16)

Association Notations

- Association End
  - Association end could be owned either by end class or association itself
  - Ownership of association ends by an associated classifier may be indicated graphically by a small filled circle (aka dot)



Association end query is owned by classifier QueryBuilder and

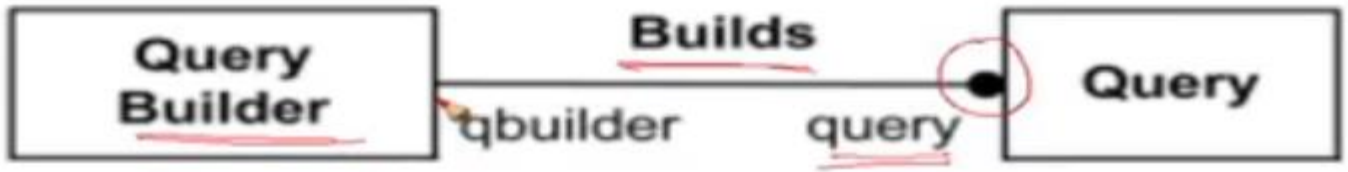
association end qbuilder is owned by association Builds itself

Source: *UML 2.5 Diagrams Overview*: http://www.uml-diagrams.org/uml-25-diagrams.html (17-Aug-16)

Association Notations

- Association End

- Association end could be owned either by end class or association itself
- Ownership of association ends by an associated classifier may be indicated graphically by a small filled circle (aka dot)



Association end query is owned by classifier QueryBuilder and association end qbuilder is owned by association Builds itself

Source: *UML 2.5 Diagrams Overview*: http://www.uml-diagrams.org/uml-25-diagrams.html (17-Aug-16)

Association Notations

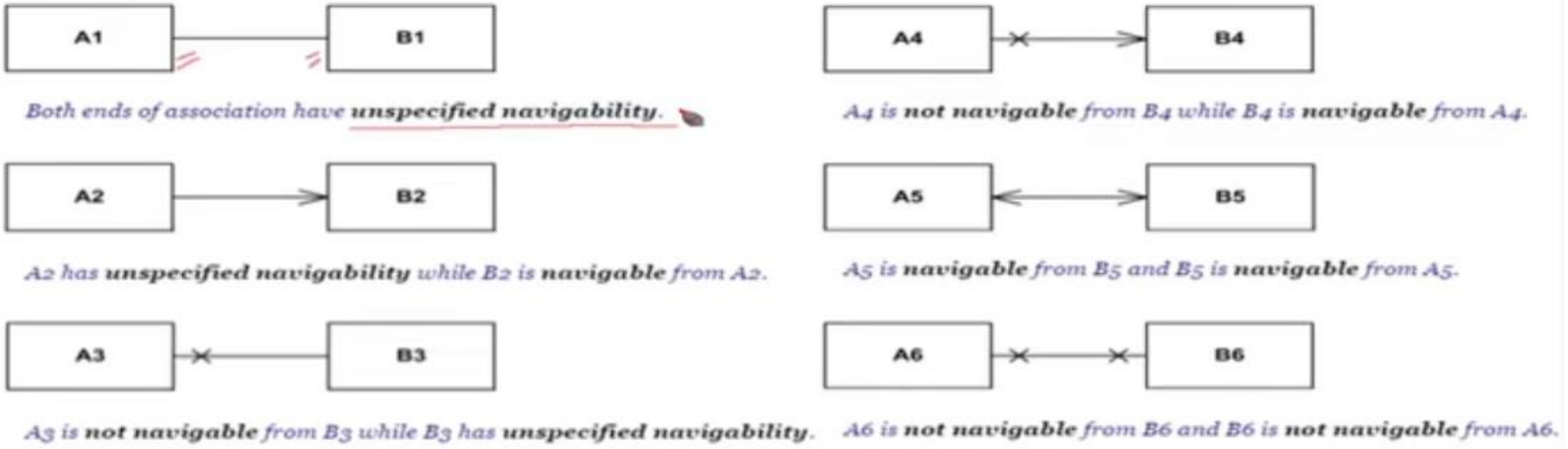
- Navigability

  - End property of association is navigable from the opposite end(s) of association if instances of the classes at this end of the link can be accessed efficiently at run-time from instances at the other ends of the link
  - Navigable end is indicated by an open arrowhead on the end of an association
  - Not navigable end is indicated with a small x on the end of an association

Source: *UML 2.5 Diagrams Overview*: http://www.uml-diagrams.org/uml-25-diagrams.html (17-Aug-16)

Association Notations

- Navigability



Source: *UML 2.5 Diagrams Overview*: http://www.uml-diagrams.org/uml-25-diagrams.html (17-Aug-16)

Association Notations

- Association Arity

Each association has specific arity as it could relate two or more classes

- **Binary association** relates two typed instances
- It is normally rendered as a solid line connecting two classifiers, or a solid line connecting a single classifier to itself (the two ends are distinct)
- The line may consist of one or more connected segments

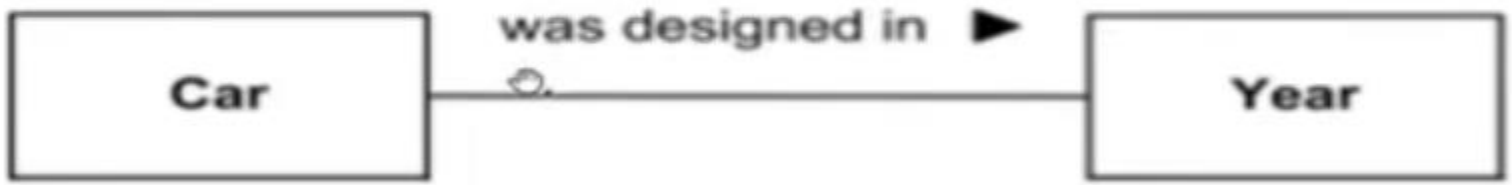
Job and Year classes are associated

Source: *UML 2.5 Diagrams Overview*: http://www.uml-diagrams.org/uml-25-diagrams.html (17-Aug-16)

Association Notations

- Association Arity

  - A small solid triangle could be placed next to or in place of the name of binary association (drawn as a solid line) to show the order of the ends of the association
  - The arrow points along the line in the direction of the last end in the order of the association ends

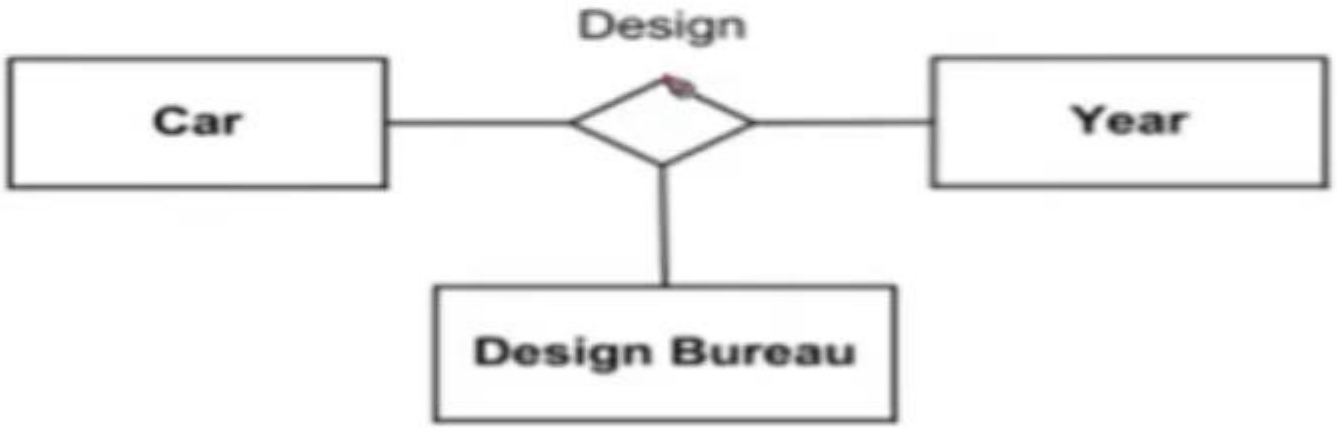


Order of the ends and reading: Car - was designed in - Year

Source: *UML 2.5 Diagrams Overview*: http://www.uml-diagrams.org/uml-25-diagrams.html (17-Aug-16)

Association Notations

- Association Arity
  - **N-ary association** may be drawn as a diamond (larger than a terminator on a line) with a solid line for each association end connecting the diamond to the classifier that is the end's type
  - N-ary association with more than two ends can only be drawn the following way

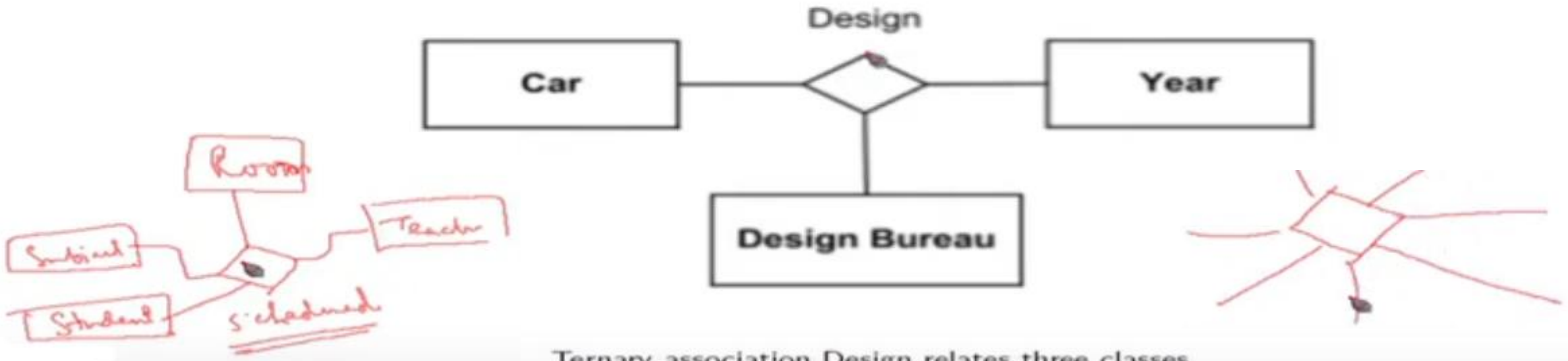


Ternary association Design relates three classes

Source: *UML 2.5 Diagrams Overview*: http://www.uml-diagrams.org/uml-25-diagrams.html (17-Aug-16)

Association Notations

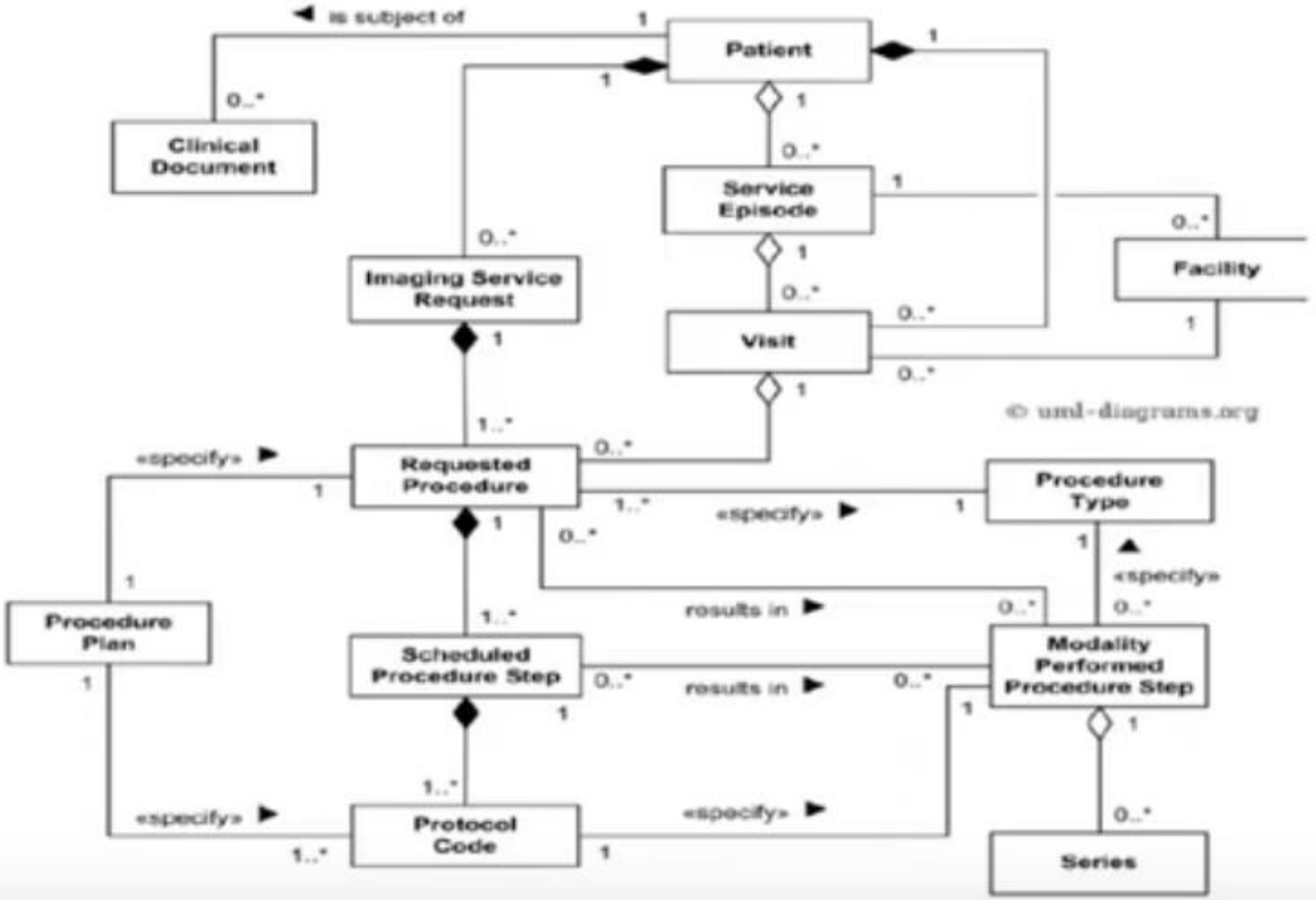
- Association Arity
  - **N-ary association** may be drawn as a diamond (larger than a terminator on a line) with a solid line for each association end connecting the diamond to the classifier that is the end's type
  - N-ary association with more than two ends can only be drawn the following way



Ternary association Design relates three classes

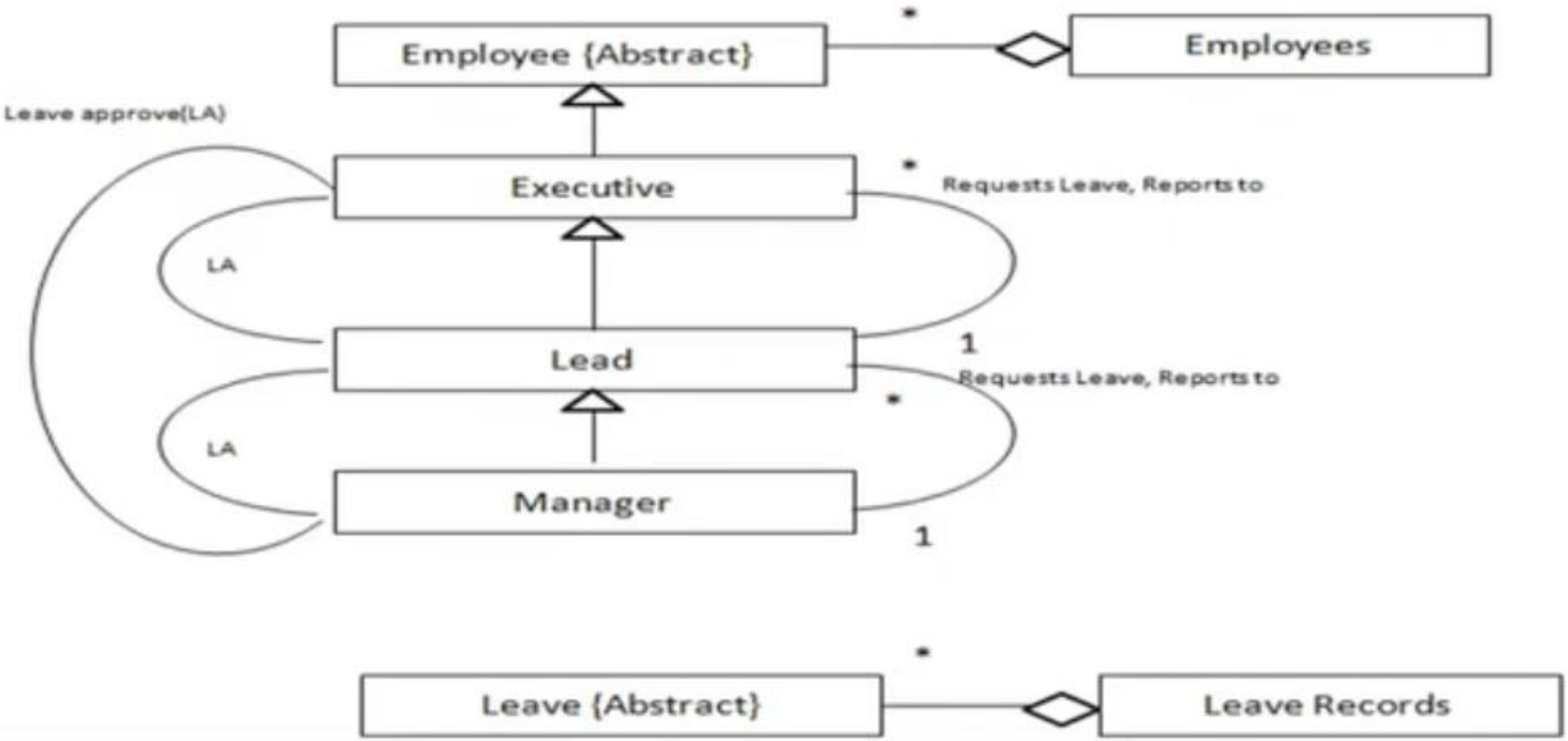
Source: *UML 2.5 Diagrams Overview*: http://www.uml-diagrams.org/uml-25-diagrams.html (17-Aug-16)

Associations- Health-Care organization Model



Source: *UML 2.5 Diagrams Overview*: http://www.uml-diagrams.org/uml-25-diagrams.html (17-Aug-16)

Associations in Leave Management System



Aggregation (HAS_A)

- Whole / Part relationships
  - Say, we model Flower HAS_A Petal
  - Flower contains many Petals
  - Flower is the Whole, Petal is the Part
  - Depicted as:

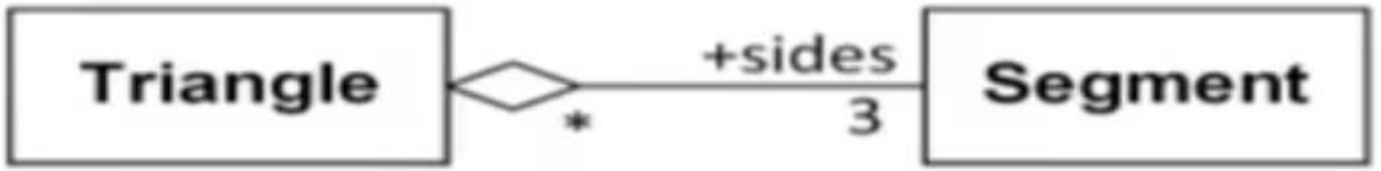
  - Physical Containment – Composition / Strong Aggregation
- Member relationship
  - Say, we model Library HAS Users
  - Library enrolls many Users
  - Library does not contain the Users
  - Depicted as:

  - Conceptual Containment – Weak Aggregation

Weak Aggregation

Weak Aggregation

- Weak aggregation is depicted as an association decorated with a hollow diamond at the aggregate end of the association line



Triangle has 'sides' collection of three line Segments

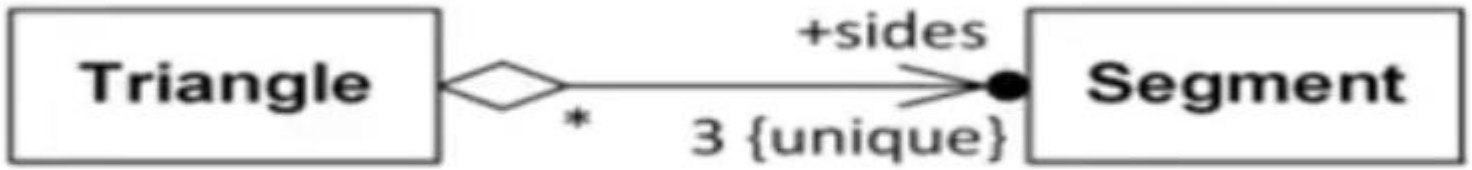
Each line Segment could be part of none, one, or several triangles

Source: *UML 2.5 Diagrams Overview*: http://www.uml-diagrams.org/uml-25-diagrams.html (17-Aug-16)

Weak Aggregation

Weak Aggregation

- Weak aggregation could be depicted together with navigability and association end ownership



Triangle has 'sides' collection of three unique line Segments.
Line segments are navigable from Triangle.

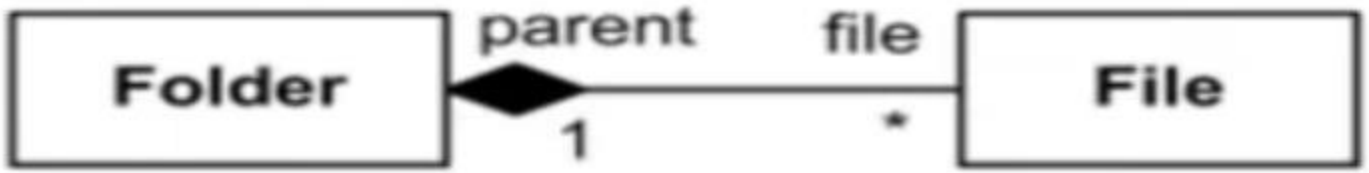
Association end 'sides' is owned by Triangle, not by association itself

Source: *UML 2.5 Diagrams Overview*: http://www.uml-diagrams.org/uml-25-diagrams.html (17-Aug-16)

Strong Aggregation (Composition)

Strong Aggregation

- Strong aggregation (Composition) is depicted as a binary association decorated with a filled black diamond at the aggregate (whole) end

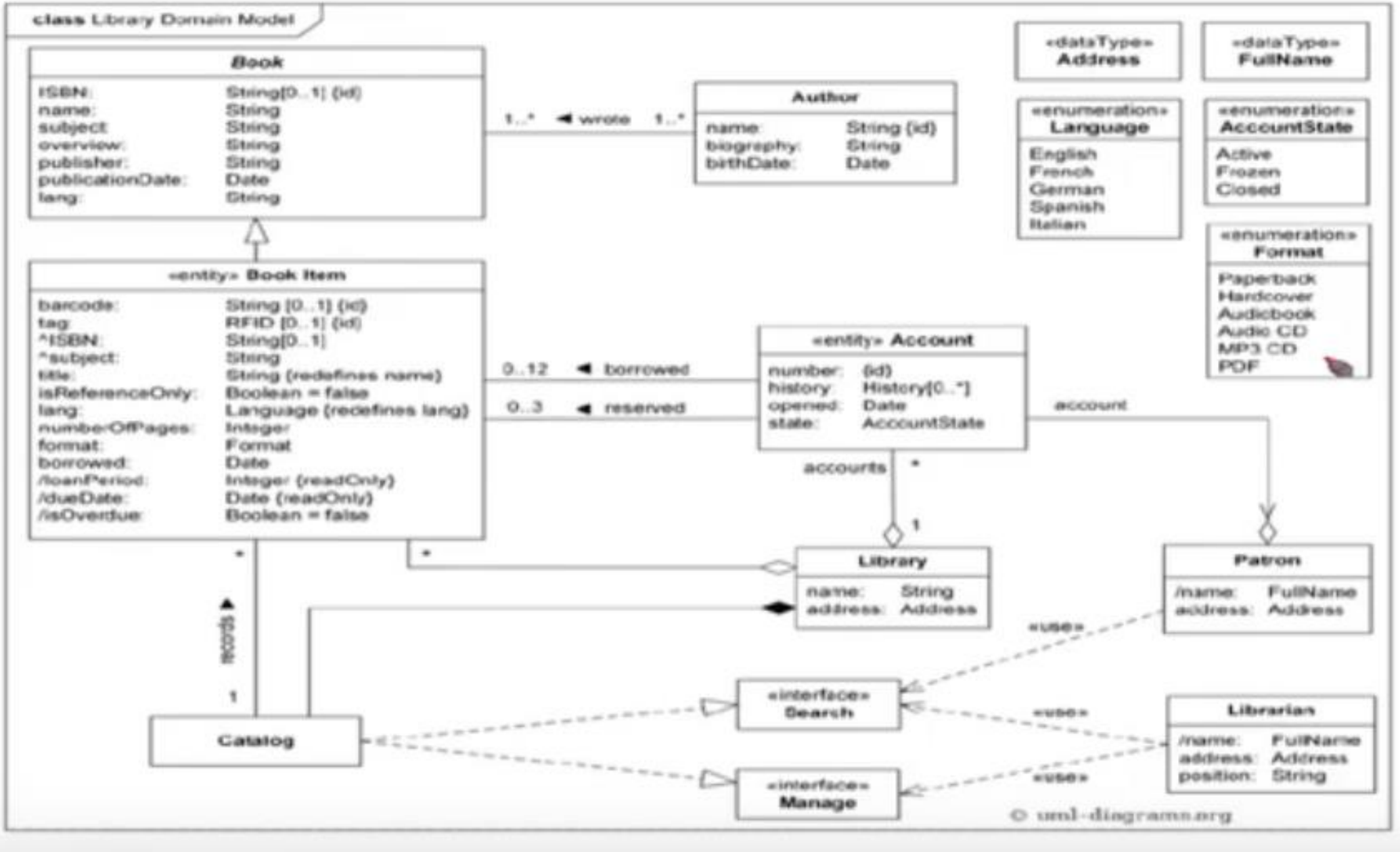


Folder could contain many files, while each File has exactly one Folder parent

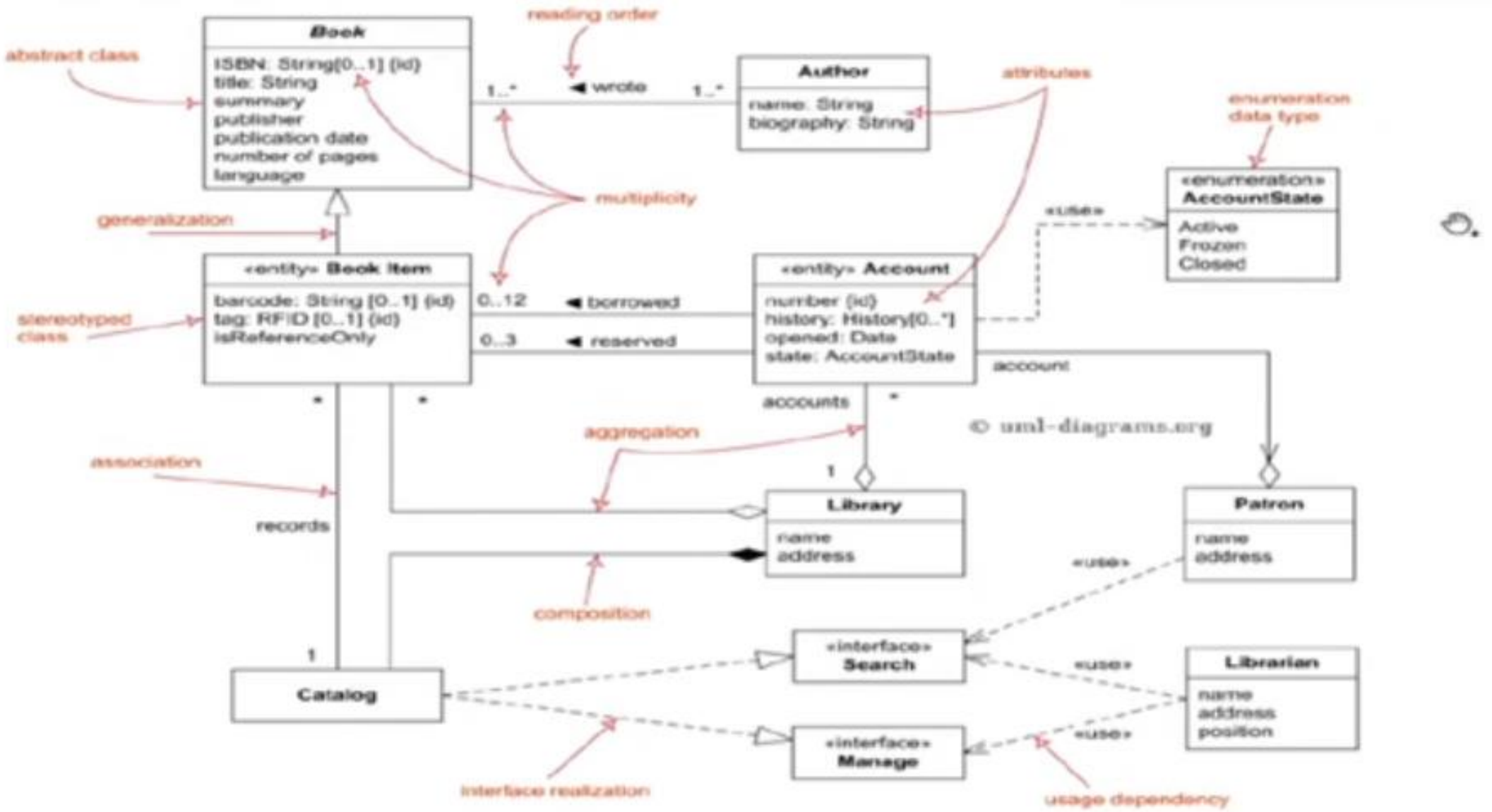
If Folder is deleted, all contained Files are deleted as well

Source: *UML 2.5 Diagrams Overview*: http://www.uml-diagrams.org/uml-25-diagrams.html (17-Aug-16)

Domain Model for Library Management System



Domain Model for Library Management System



Domain diagram overview - classes, interfaces, associations, usage, realization, multiplicity.

Summary

- Association Relationships among classes are discussed
- Weak Aggregation and Strong Aggregation are important binary associations

Reference

- Source: NPTEL **Object-Oriented Analysis and Design, by**

Prof. Partha Pratim Das Prof. Samiran Chattopadhyay Prof. Kausik Datta

IIT Kharagpur

- https://nptel.ac.in/courses/106105153