ΕΘΝΙΚΟ ΜΕΤΣΟΒΙΟ ΠΟΛΥΤΕΧΝΕΙΟ
Σχολή Ηλεκτρολόγων Μηχανικών και Μηχανικών Υπολογιστών
Τεχνολογία Λογισμικού, 7ο/9ο εξάμηνο 2018-2019

Τεχνολογία Λογισμικού

Ν.Παπασπύρου, Αν.Καθ. ΣΗΜΜΥ, nickie@softlab.ntua,gr

Β.Βεσκούκης, Αν.Καθ. ΣΑΤΜ, v.vescoukis@cs.ntua,gr

Κ.Σαΐδης, ΠΔ 407, saiko@softlab.ntua.gr

Εισαγωγή στη UML (1/2)

Unified Modeling Language

OMG Standard, Object Management Group

- Based on work from Booch, Rumbaugh, Jacobson

UML is a modeling language to express and design documents, software, systems and more

- Created with OO analysis and design,
  but has evolved to cover more than software systems
- UML is NOT a methodology, process, etc
- Independent of implementation language

Unified Modeling Language

Open Standard, Graphical notation for Software Systems, from initial conception to detailed design, across the entire software lifecycle

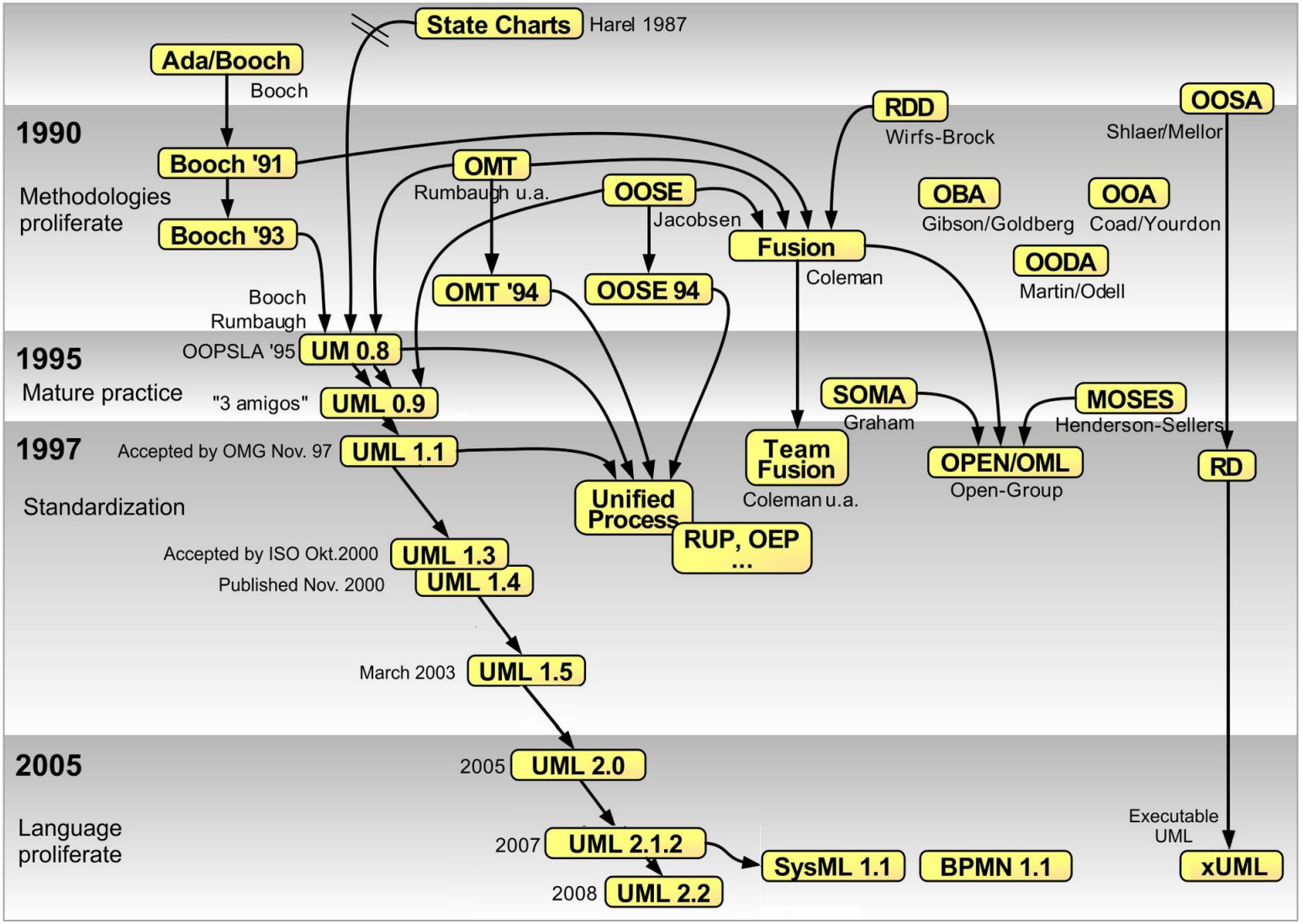
- specification
- visualization
- construction
- documentation

Support understanding of software to customers and developers

Support for diverse application areas

Based upon experience and needs of the user community

History


State Charts
Harel 1987
Ada/Booch
Booch
1990
Booch '91
Methodologies
proliferate
Booch '93
OMT
Rumbaugh u.a.
OOSE
Jacobsen
RDD
Wirfs-Brock
OOSA
Shlaer/Mellor
OBA
Gibson/Goldberg
OOA
Coad/Yourdon
Fusion
Coleman
OODA
Martin/Odell
OMT '94
OOSE 94
Booch
Rumbaugh
1995
Mature practice
OOPSLA '95
UM 0.8
"3 amigos"
UML 0.9
SOMA
Graham
MOSES
Henderson-Sellers
1997
Accepted by OMG Nov. 97
UML 1.1
Team
Fusion
Coleman u.a.
OPEN/OML
Open-Group
RD
Standardization
Unified
Process
RUP, OEP
...
Accepted by ISO Okt.2000
Published Nov. 2000
UML 1.3
UML 1.4
March 2003
UML 1.5
2005
2005
UML 2.0
Language
proliferate
2007
UML 2.1.2
SysML 1.1
BPMN 1.1
Executable
UML
xUML
2008
UML 2.2

UML concepts

Systems, Models, Views

- A model is an abstraction describing a subset of a system
- A view depicts selected aspects of a model
- A notation is a set of graphical or textual rules for depicting views
- Views and models of a single system may overlap each other

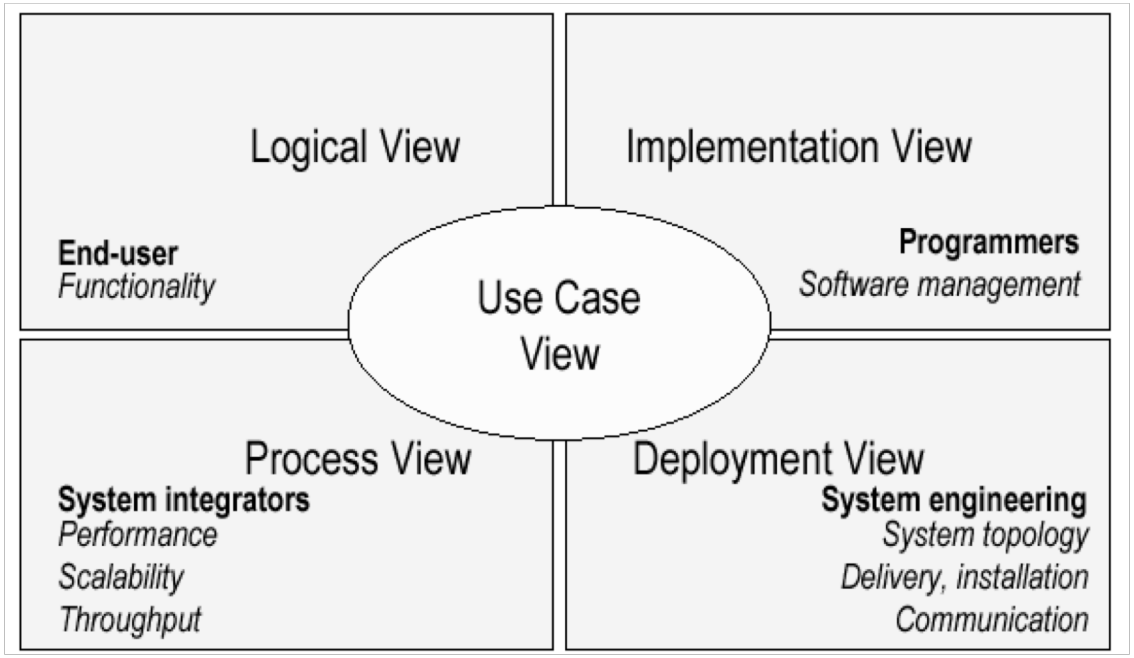
Example

- System: Aircraft
- Models: Flight simulator, scale model
- Views: All blueprints, electrical wiring, fuel system

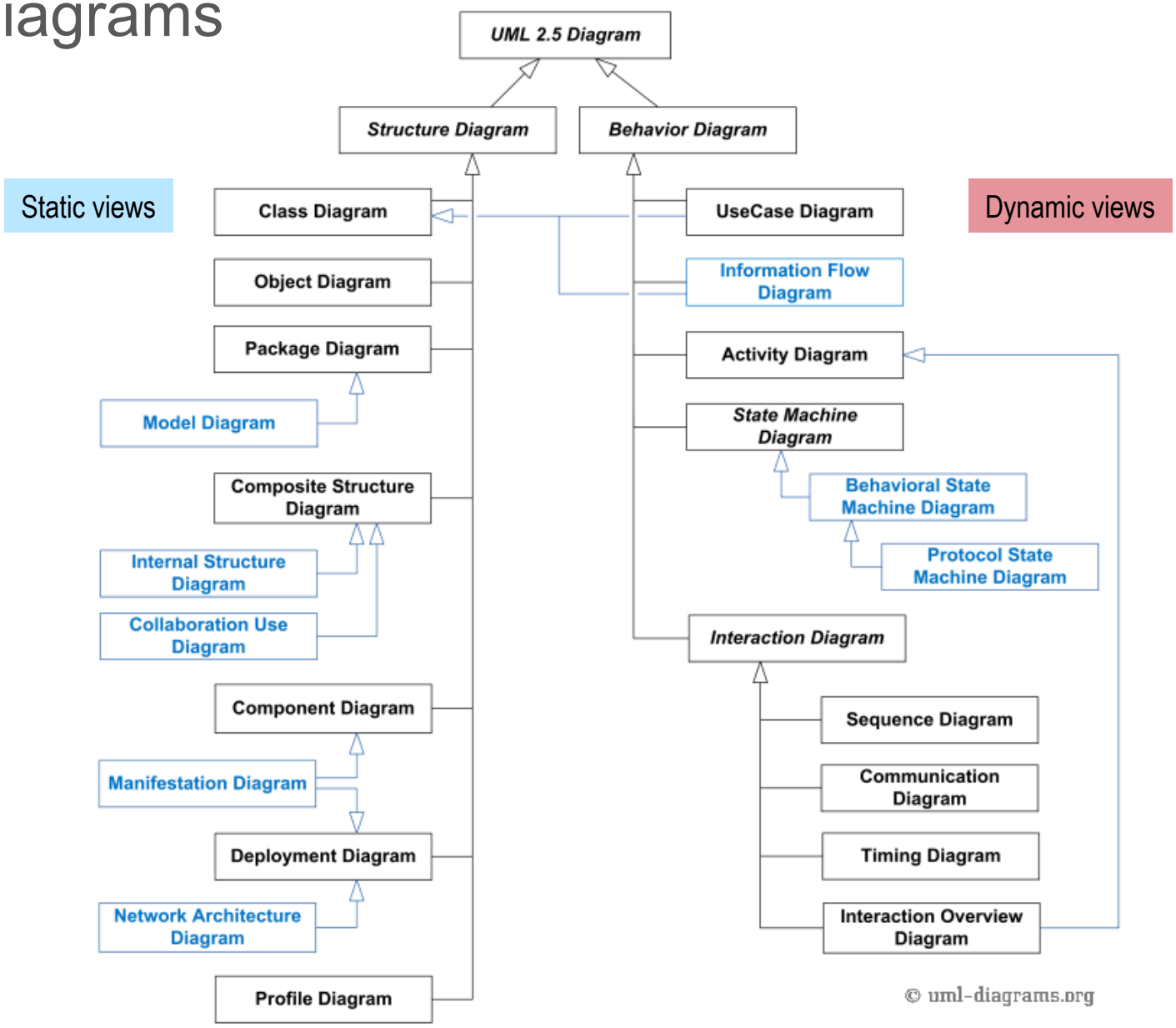
UML models, views, diagrams

UML defines many diagrams, each of which is a view into a model

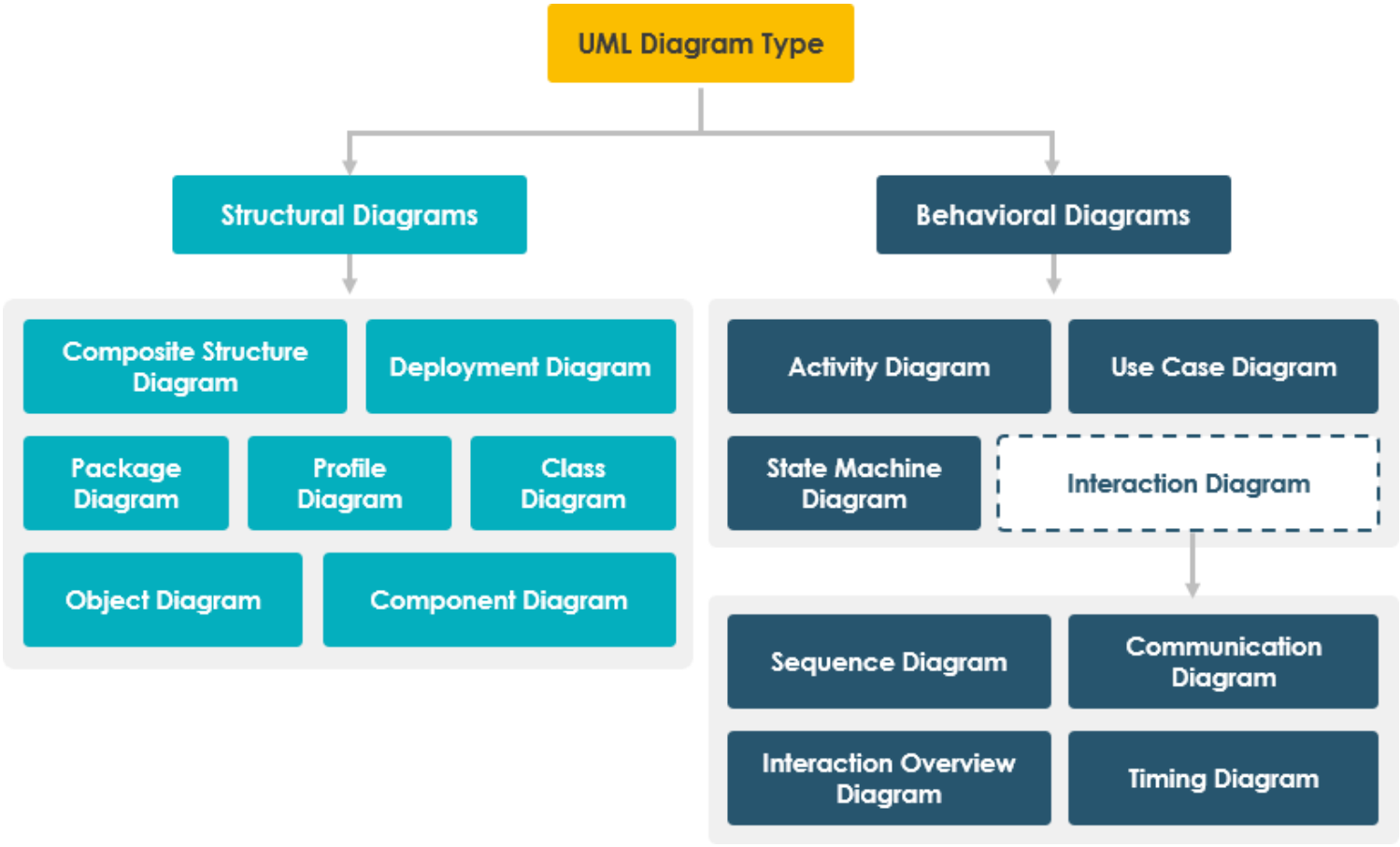
- Diagram presented from the aspect of a particular stakeholder
- Provides a partial representation of the system
- Is semantically consistent with other views



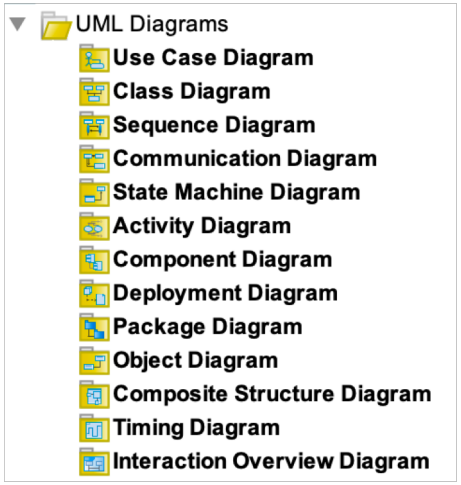
UML diagrams



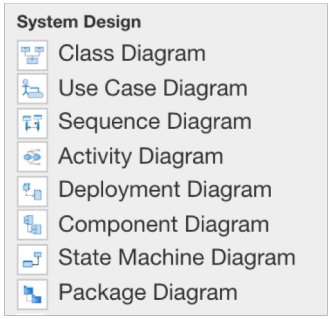
UML diagrams



Visual Paradigm CE



Visual Paradigm online



UML views: focus on what's needed

Not all systems require all views

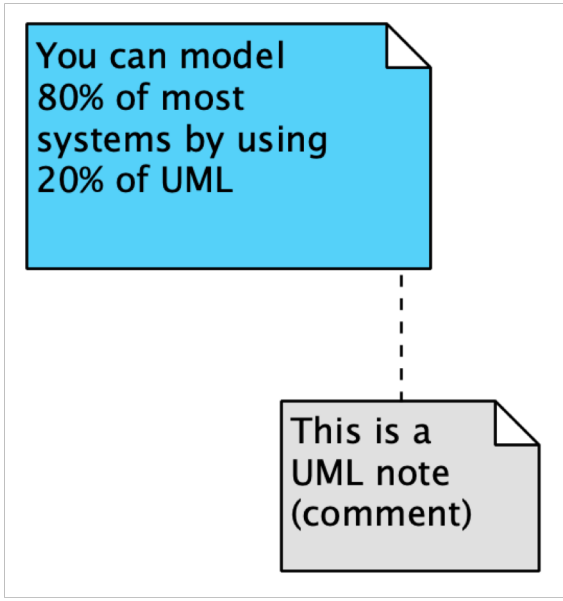
- Single execution node: drop deployment view
- Single process: drop process view
- Very small program: drop implementation view

A system might need additional views

- Data view, security view, …

Identification of "useful" views depends on the context and intended use of the UML model of a system

- Communication with the client
- System specification
- System design



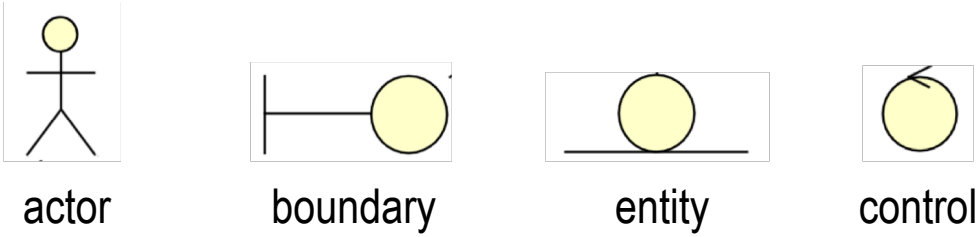
A key concept: stereotypes

Stereotype:
A mechanism for extending the vocabulary (and thus, the expressive power) of UML

Why extend the vocabulary?

- Ecosystem- / stack- / framework- specific terminology
- Comprehensive architecture visualization

Use with measure!



Basic UML modeling

Use Cases

- Capture requirements

Domain Model

- Capture process, key classes

Design Model

- Capture details and behaviors of use cases and domain objects
- Add classes that do the work and define the architecture

Basic UML modeling

Use Case Diagrams

Class Diagrams / Package Diagrams

Interaction Diagrams

- Sequence Diagrams
- Collaboration (a.k.a. Communication Diagrams)

Activity Diagrams / State Transition Diagrams

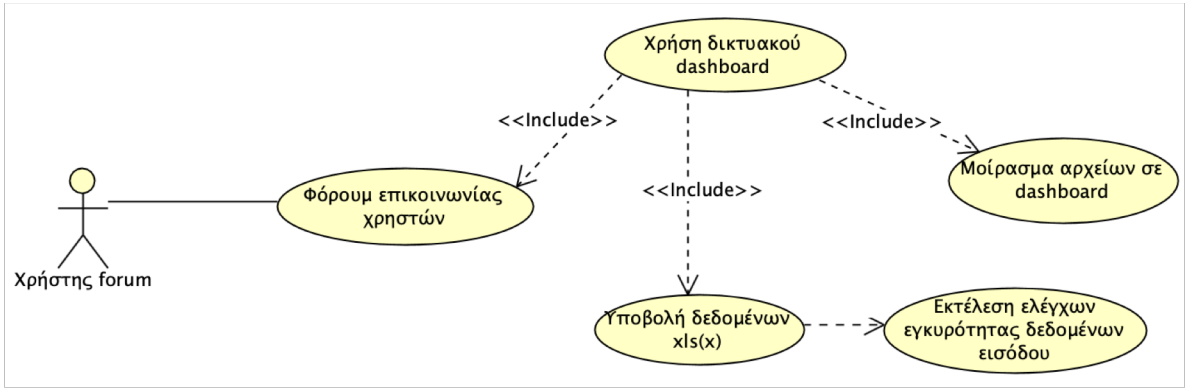
Component Diagrams / Deployment Diagrams

Use Case diagrams

What is a Use Case – key concepts

- **Use cases** represent a sequence of interaction(s) for a type of functionality
- **Actors** represent roles. A role is a type of user of the system, and can even be another system (external system)
- Used during requirements elicitation to represent external behavior

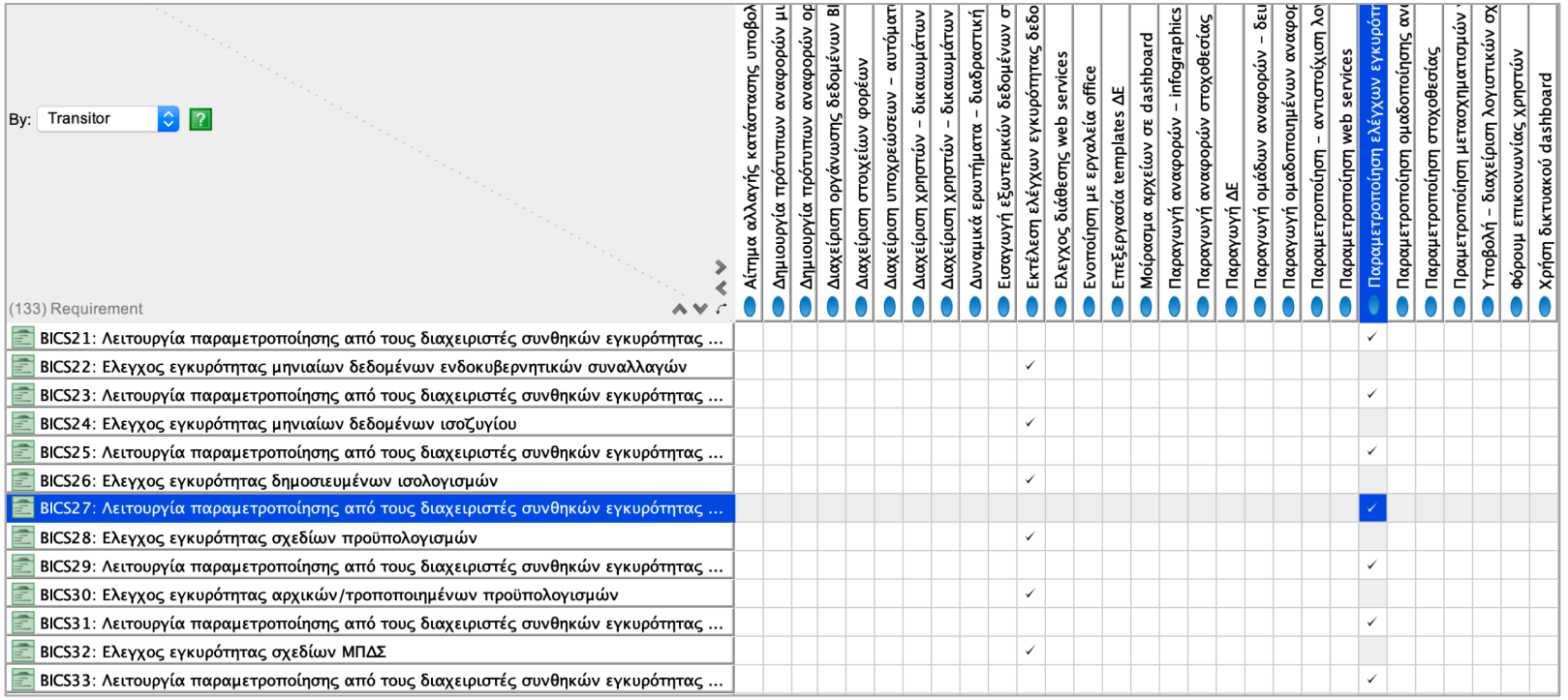
The use case model is the set of all use cases. It is a complete description of the functionality of the system and its environment



Use cases vs. Requirements

A Use Case usually groups some requirements together in the context of an interaction of the system with some external entity.

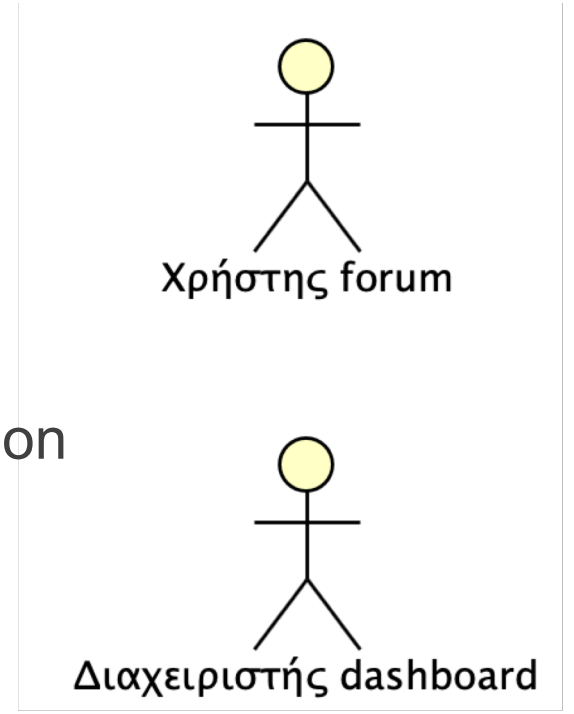
The granularity of the requirements' definition determines the level of grouping requirements in use cases



Use Cases and Actors

An actor models an external entity which communicates with the system and triggers some of its functionality:

- User
- External system
- Physical environment



An actor has a unique name and an optional description

Examples:

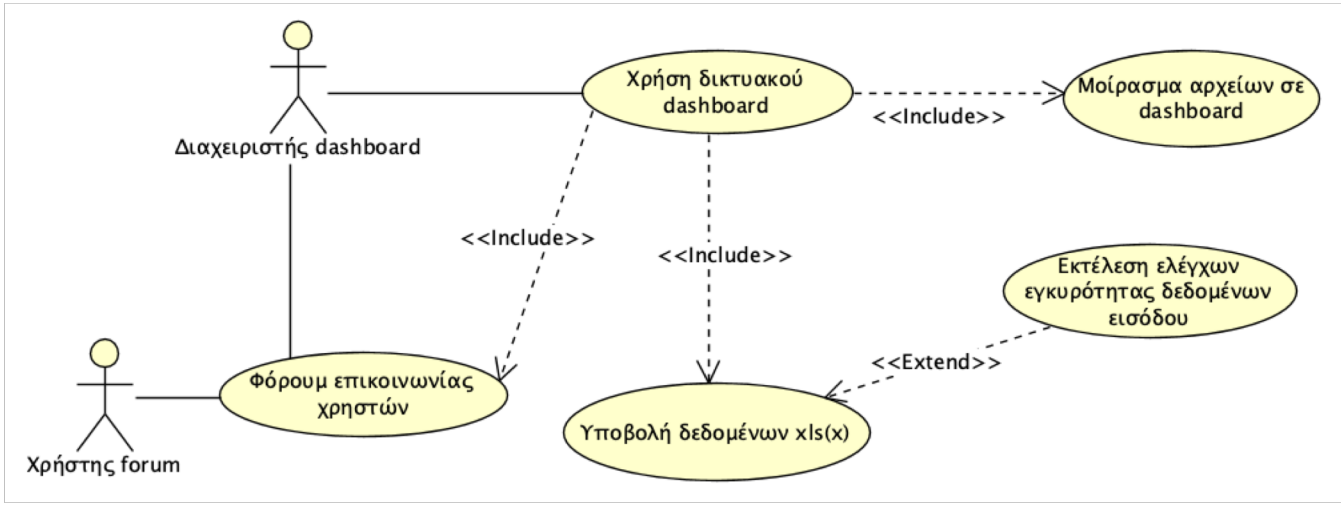
- Passenger: A person issuing a ticket
- GPS device: Provides the system with GPS coordinates

Use Cases and Actors

A use case represents a class of functionality provided by the system as an event flow

A use case consists of:

- Unique name
- Participating actors
- Entry conditions
- Flow of events
- Exit conditions
- Special requirements



Use Case: example

Unique name

- Υποβολή δεδομένων xls(x)

Participating actors

- Διαχειριστής dashboard

Entry conditions

- xls(x) file is available; server has enough disk space free

Flow of events

- User drags file to designated area; file is uploaded to the server

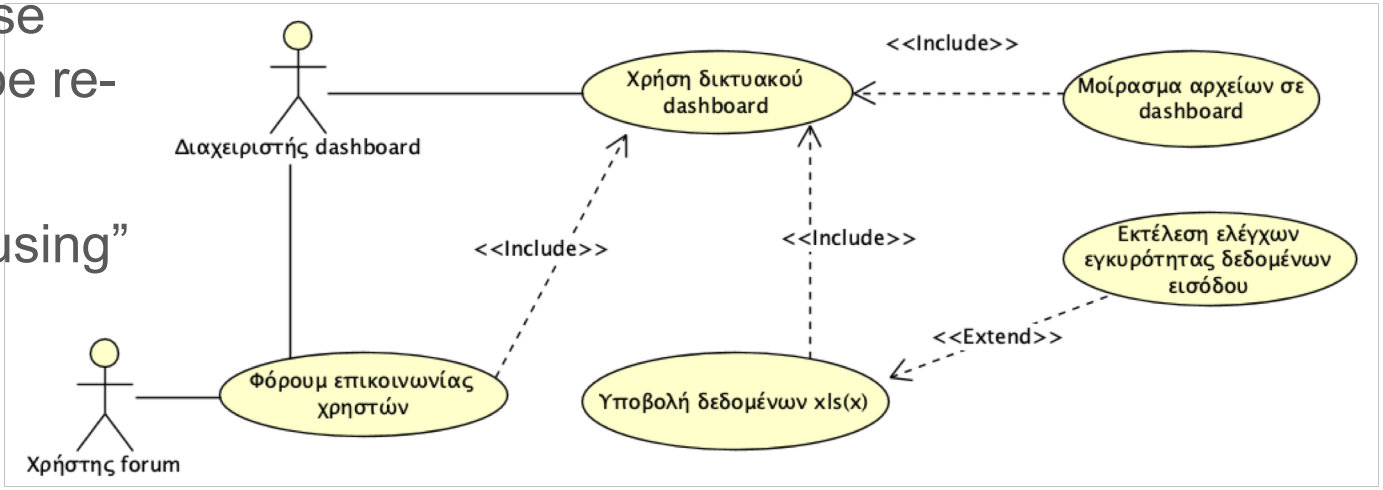
Exit conditions

- File is saved on the server

Use Case diagrams: <<include>> and <<extend>>

Include:

- Behavior that has been factored out of the Use Case, so that it can be re-used
- Arrow points to the ”using” Use Case



Extends

- Exceptional, rarely invoked Use Cases
- Arrow points to the extended Use Case

Use Case Diagrams are useful for…

Determining requirements

- New use cases often generate new requirements as the system is analyzed and the design takes shape.

Communicating with clients

- Their notational simplicity makes use case diagrams a good way for developers to communicate with clients.

Generating test cases

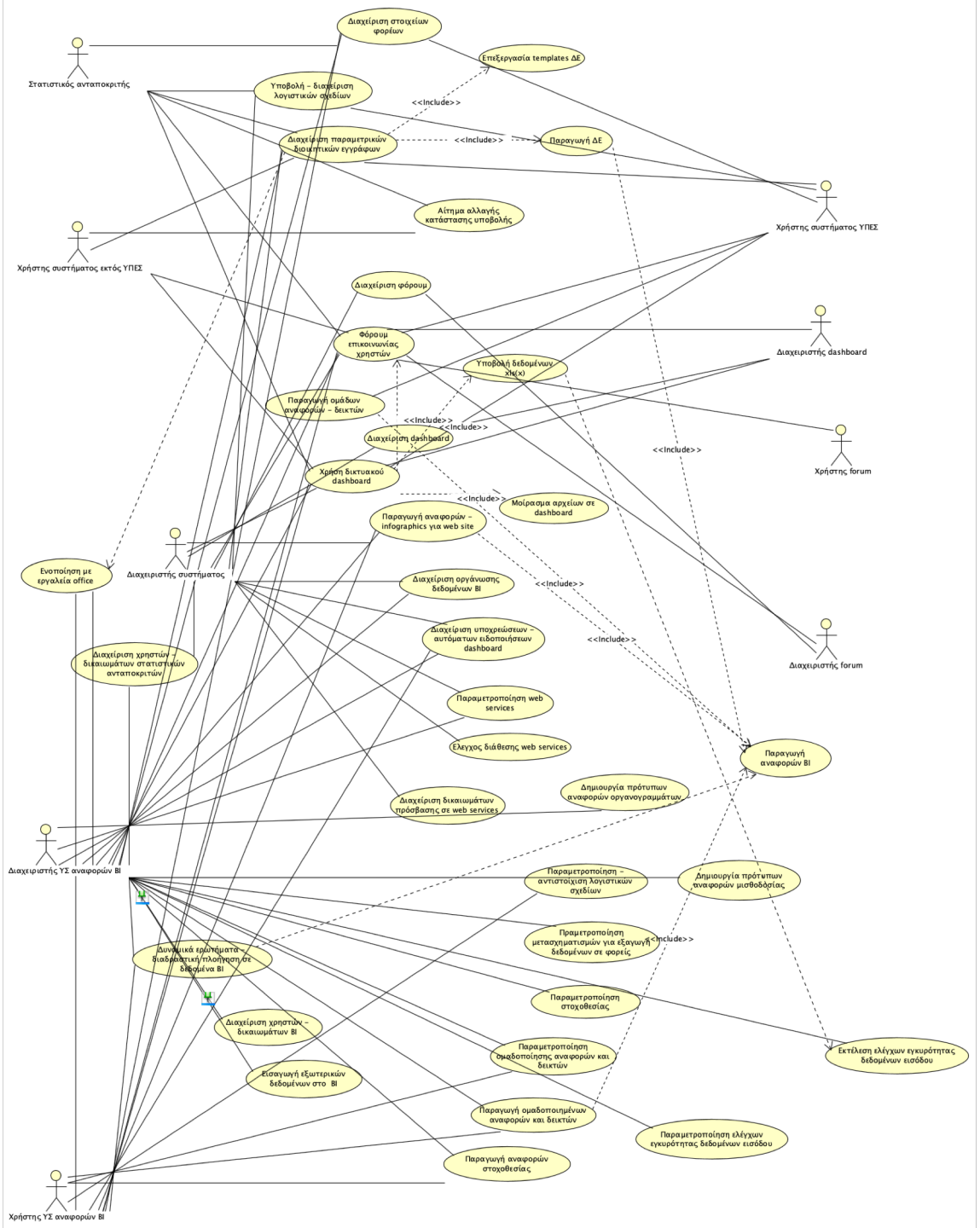
- The collection of scenarios for a use case may suggest a suite of test cases for those scenarios.

Use case descriptions provide the info needed: not use case diagrams!

All use cases need to be described for the model to be useful.

Use Case Diagrams

A complete Use Case model (diagram)



Class Diagrams

A Class Diagram…

Gives an overview of a system by showing its classes and the relationships among them.

- class diagrams are static
- they display what interacts but not what happens when interactions occur

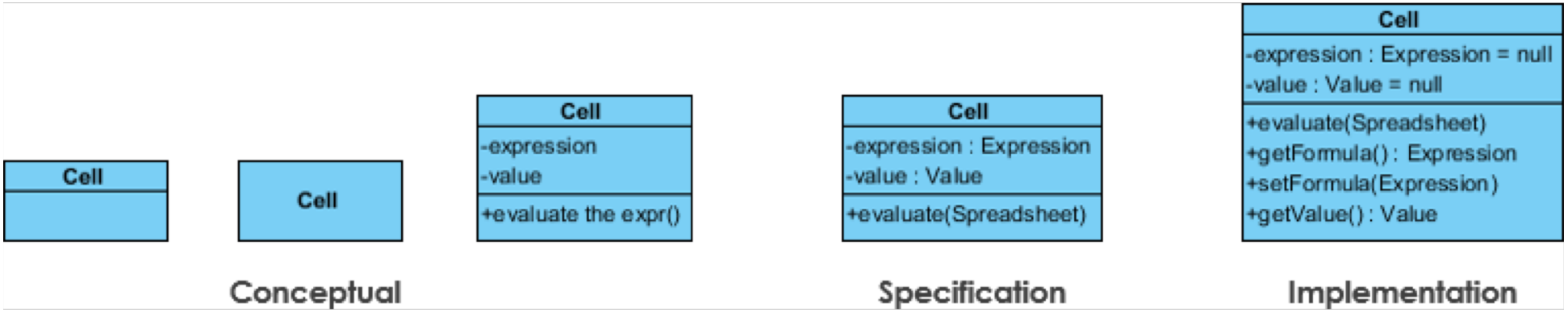
Also shows attributes and operations of each class

Good way to describe the overall architecture of system components

Class Diagram: Perspectives

We draw Class Diagrams under three perspectives

- Conceptual
  - Software independent
  - Language independent
- Specification
  - Focus on the interfaces of the software
- Implementation
  - Focus on the implementation of the software



Classes: Not Just for Code

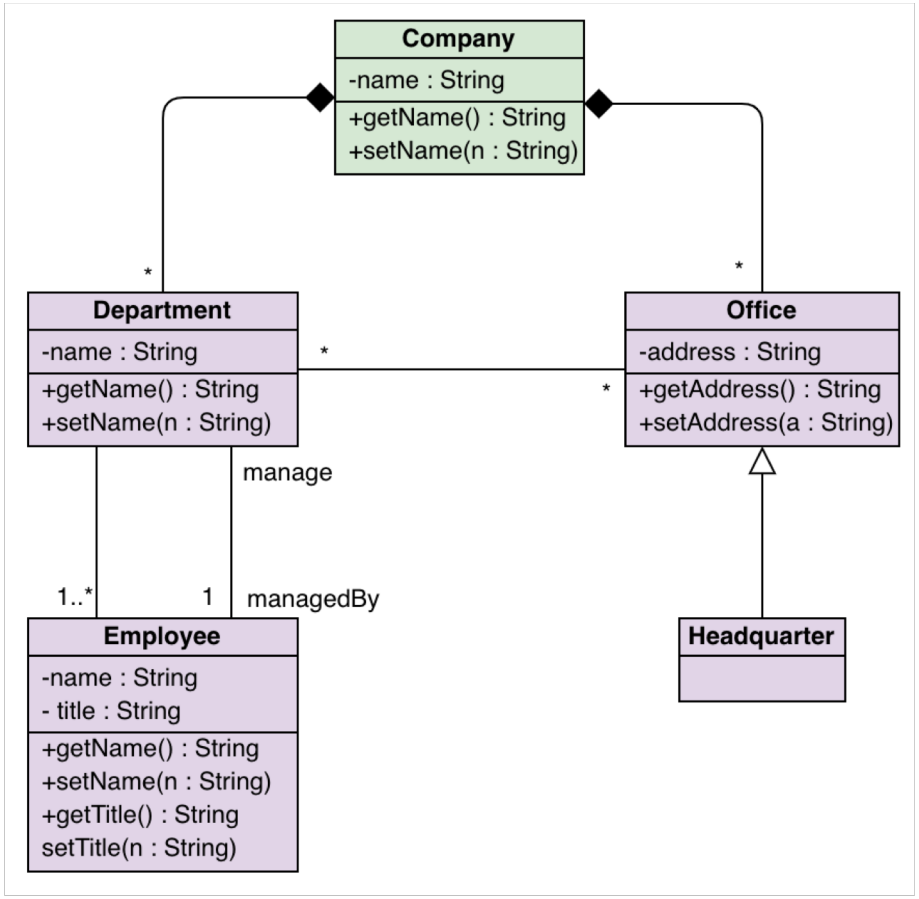
A class represent a concept

A class encapsulates state (attributes) and behavior (operations).

Each attribute has a type.

Each operation has a signature.

The class name is the only mandatory information.

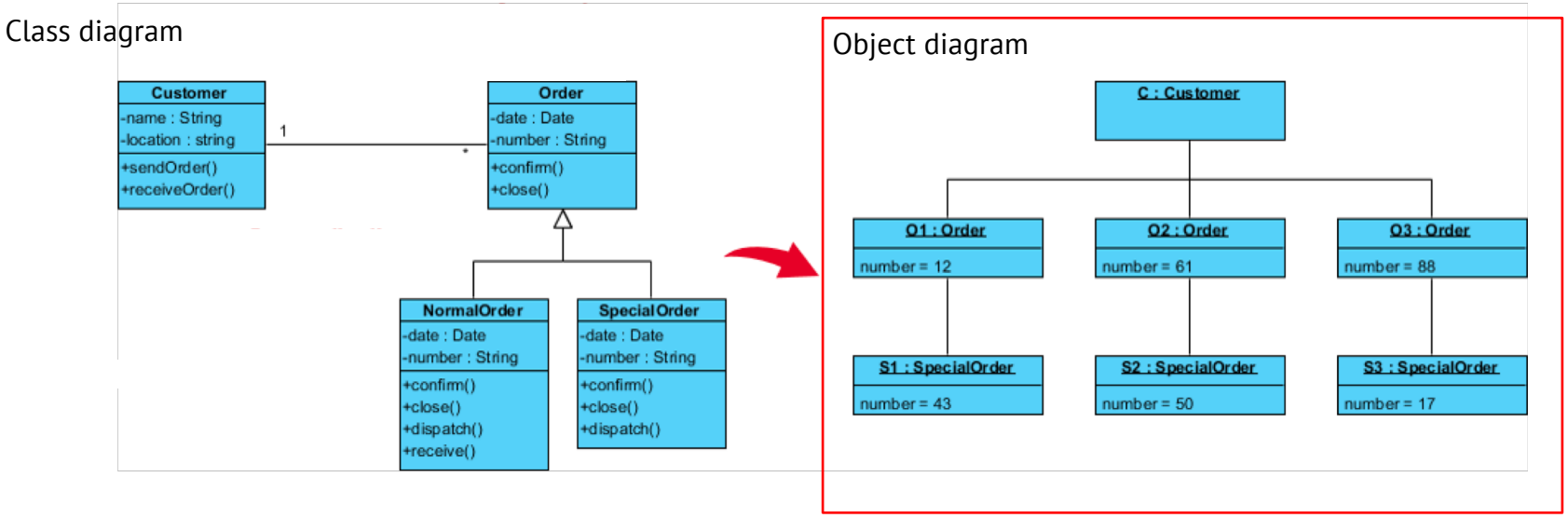


Instances

An ***instance*** represents a phenomenon (= a specific object).

The name of an instance is underlined and can contain the class of the instance.

The attributes are represented with their values.



UML Class Notation

A class is a rectangle divided into three parts

- Class name
- Class attributes (i.e. fields, variables)
- Class operations (i.e. methods)

Modifiers

- Private: -
- Public: +
- Protected: #
- Static: Underlined (i.e. shared among all members of the class)

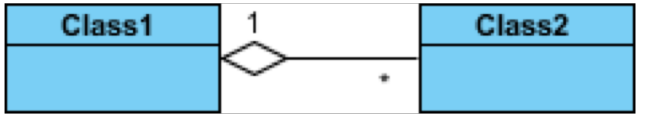
Abstract class: name in italics

UML Class Notation: Relationships

Association

- A relationship between instances of two classes, where one class must know about the other to do its work, e.g. client communicates to server
- Indicated by a straight line or arrow

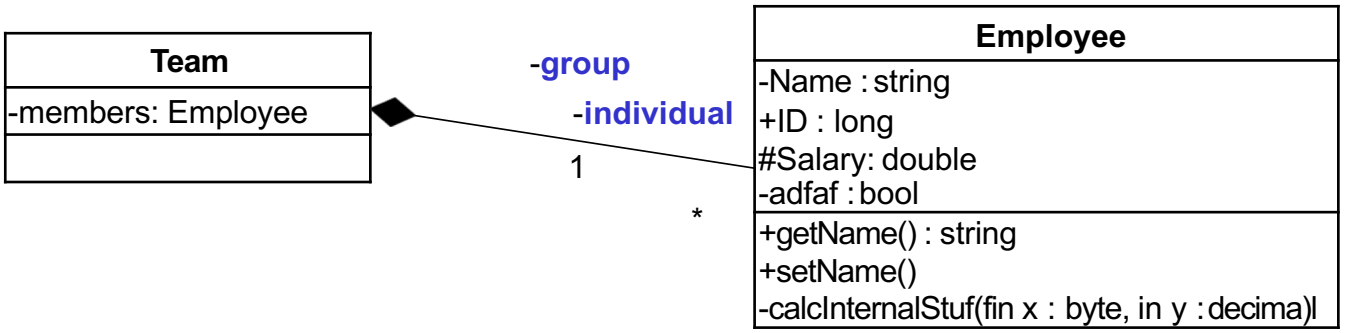
Aggregation



- An association where one class belongs to a collection
- Indicated by an empty diamond on the side of the collection
- Members can exist independently of the aggregate ("parent")
  e.g.: students exist even if there is no class scheduled

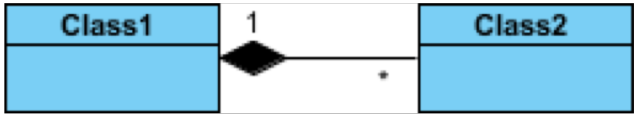
Association Details

Can assign names to the ends of the association to give further information



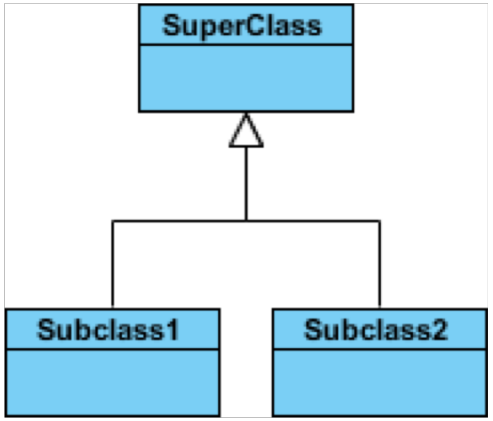
UML Class Notation

Composition



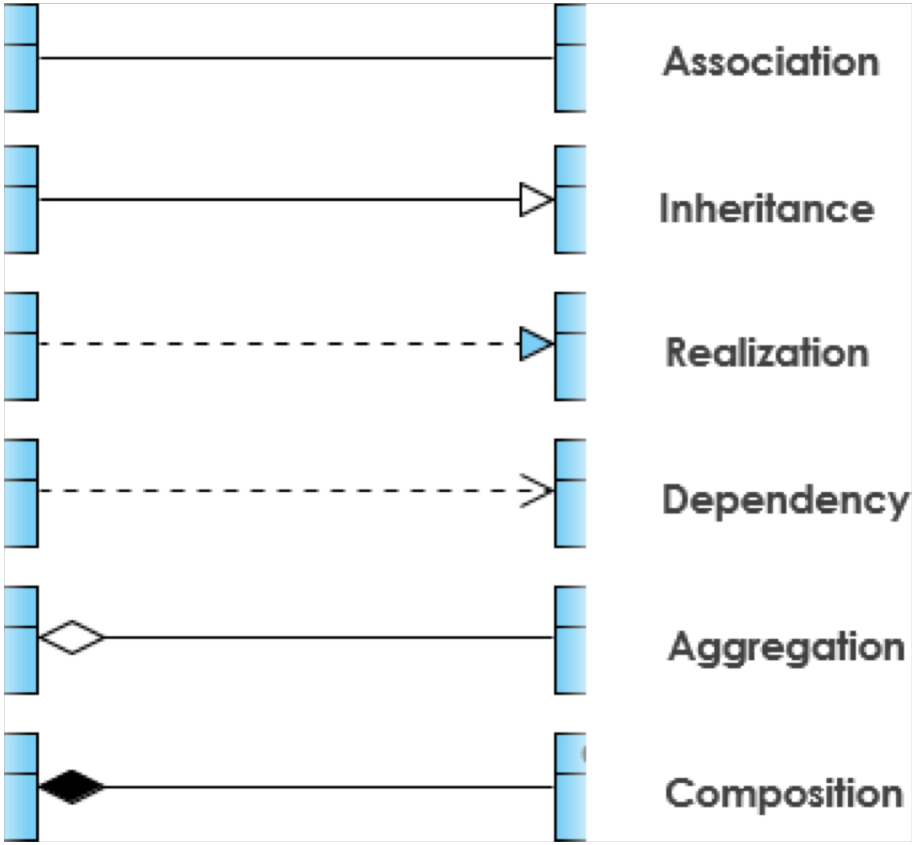
- Strong form of Aggregation
- Lifetime control: components cannot exist without the aggregate (e.g.: parts of an aircraft)
- Indicated by a solid diamond on the side of the collection

Inheritance



- Inheritance represents a "is-a" relationship
- Key element of object orientation
- Indicated by a hollow arrowhead pointing to the superclass ("parent")

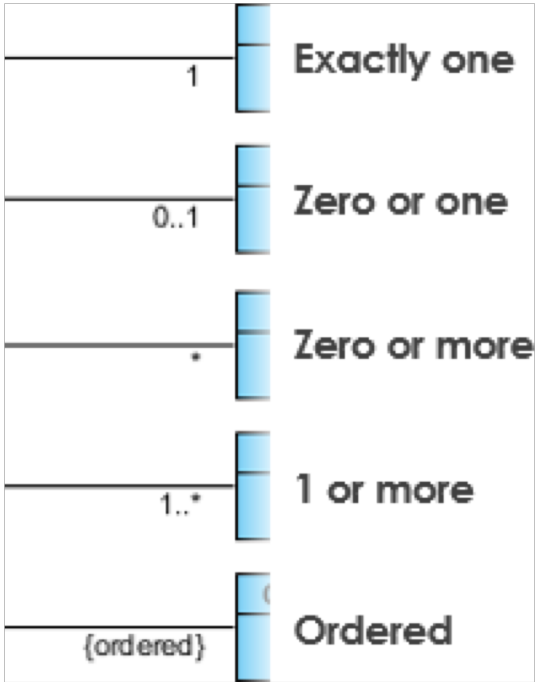
UML Class diagram notation



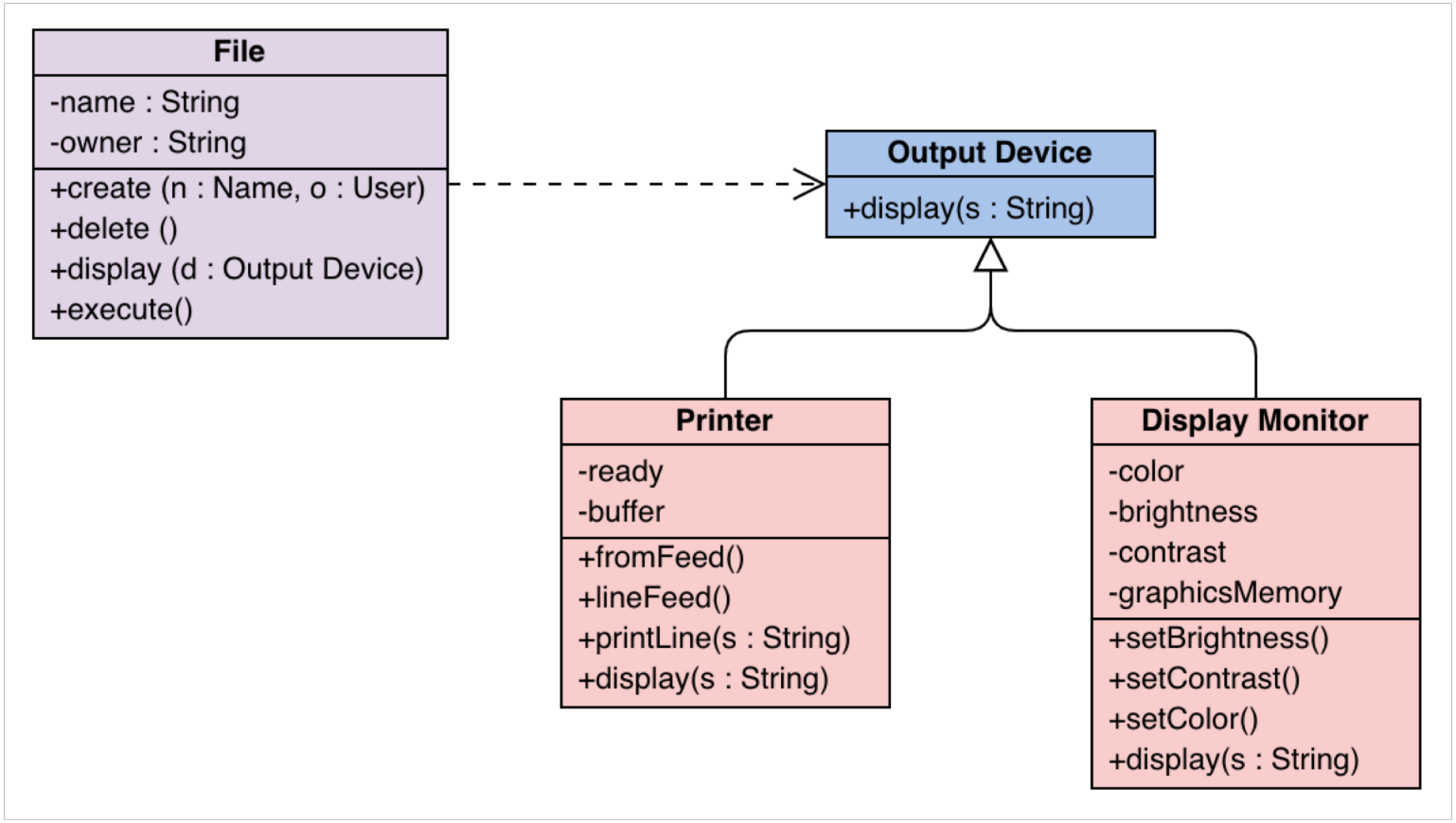
UML Multiplicities

Links on associations to specify more details about the relationship

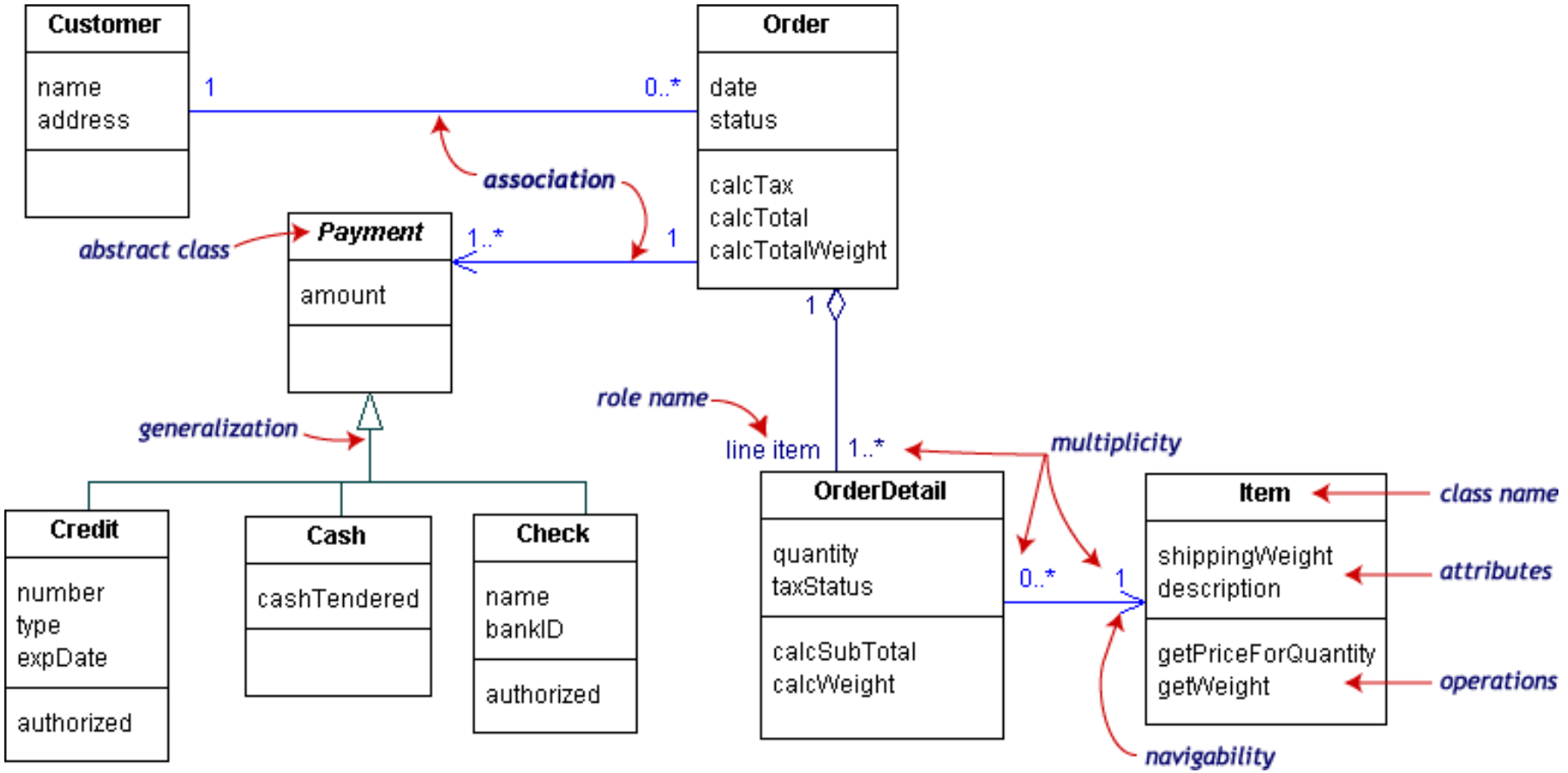
Multiplicities	Meaning
0..1	zero or one instance. ***n . . m*** indicates ***n*** to ***m*** instances.
0..* *or* *****	zero to unlimited instances
1	exactly one instance
1..*	at least one instance

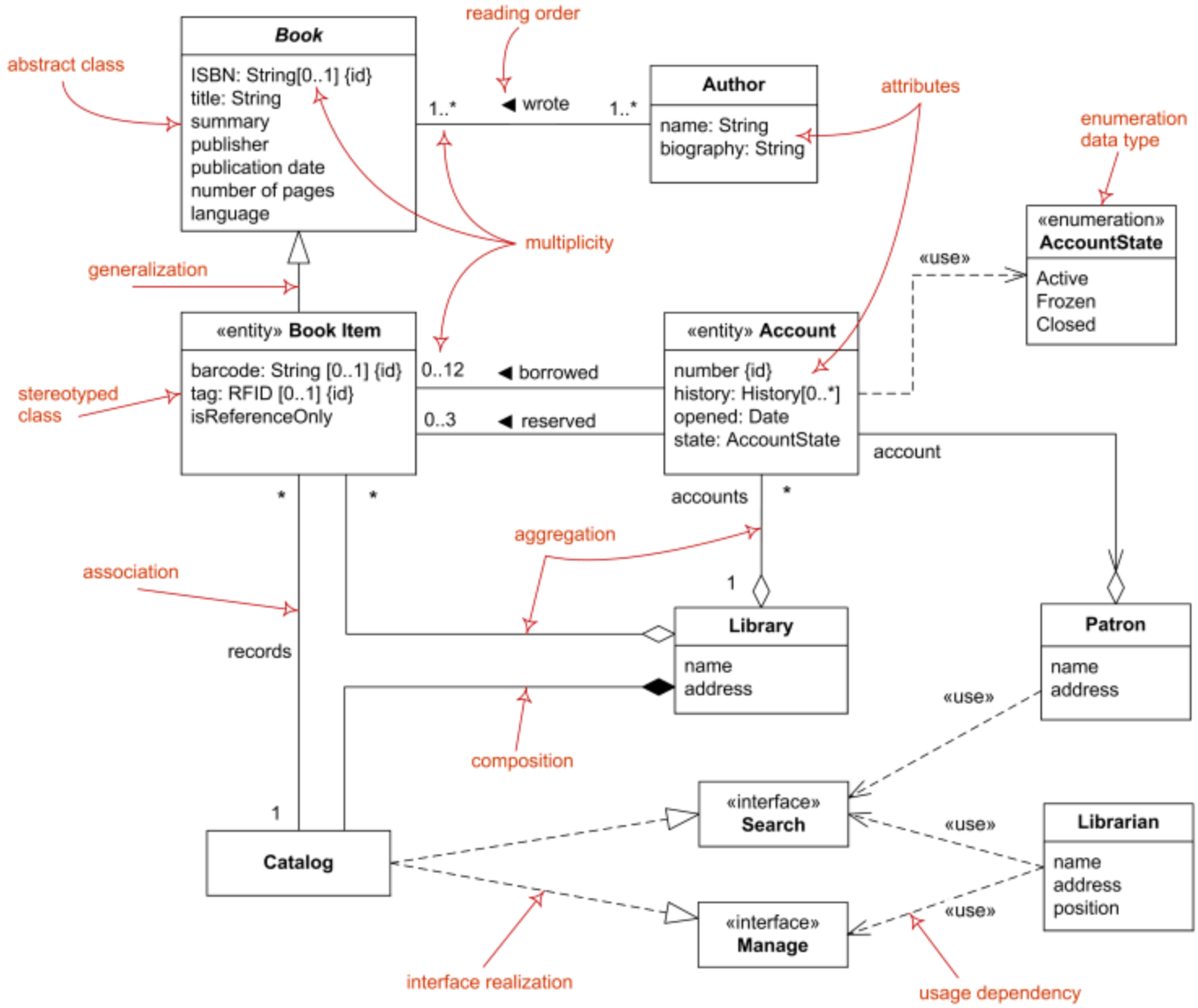


UML Class Diagram example



UML Class Diagram Example

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publication date
number of pages
language
abstract class
reading order
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1..*
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biography: String
attributes
enumeration
data type
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generalization
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stereotyped
class
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borrowed
0..3
reserved
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history: History[0..*]
opened: Date
state: AccountState
account
*
*
accounts
*
aggregation
association
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Library
name
address
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«use»
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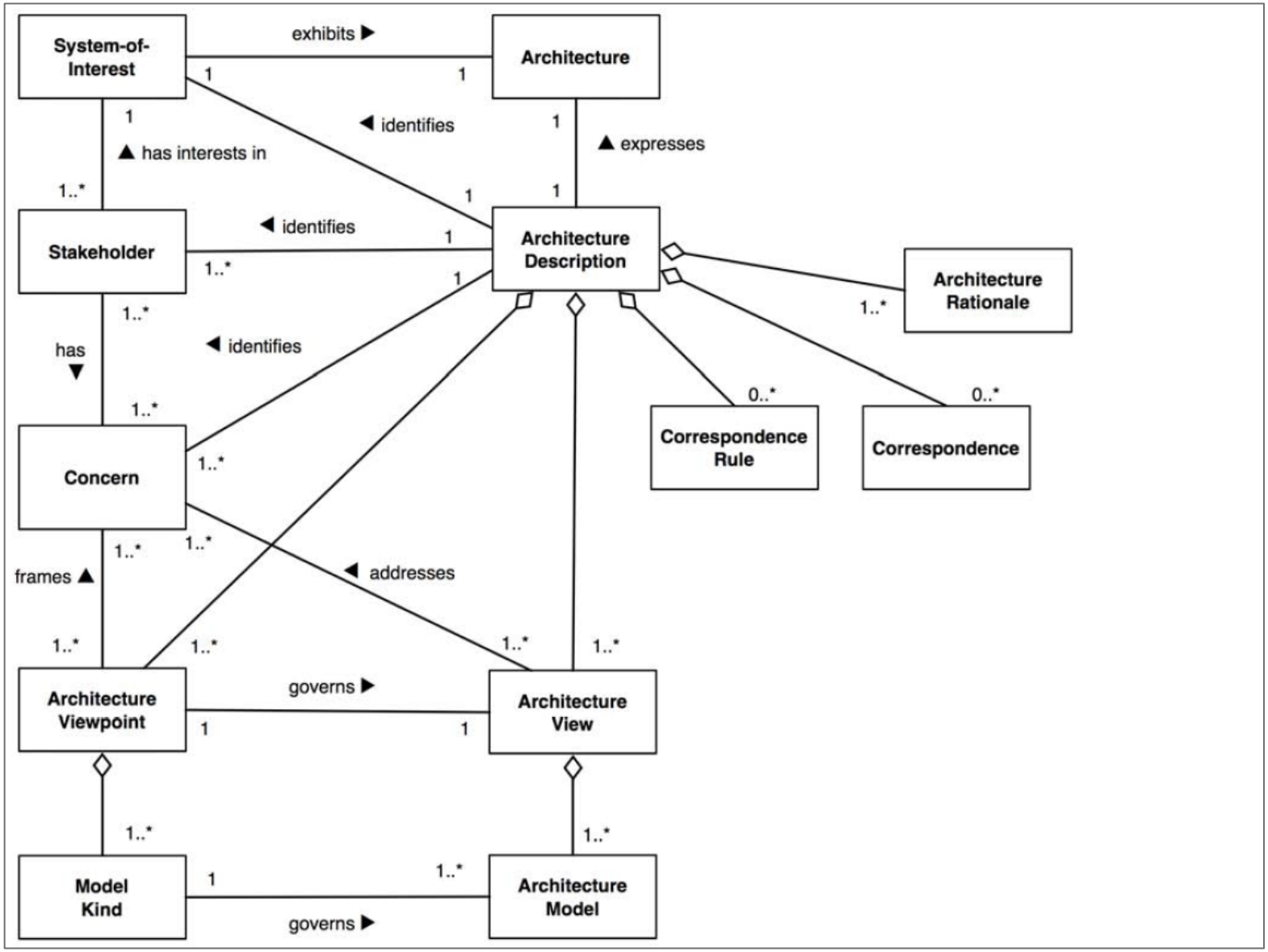
«interface»
Search
«use»
Librarian
name
address
position
Catalog
«interface»
Manage
«use»
interface realization
usage dependency

Class diagram: Software architecture



Class diagram: OCG Simple Features Std