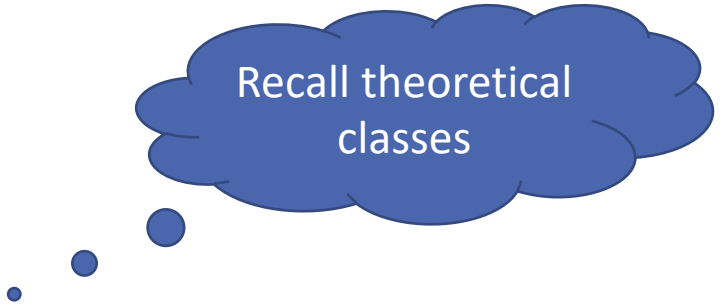
OO Analysis

Topics

- Concept Identification
- Association Identification
- Association Multiplicity
- Attribute Identification
- Generalization
- Only ONE Model per Domain?
- Evolution

OO Analysis

OO Analysis Overview

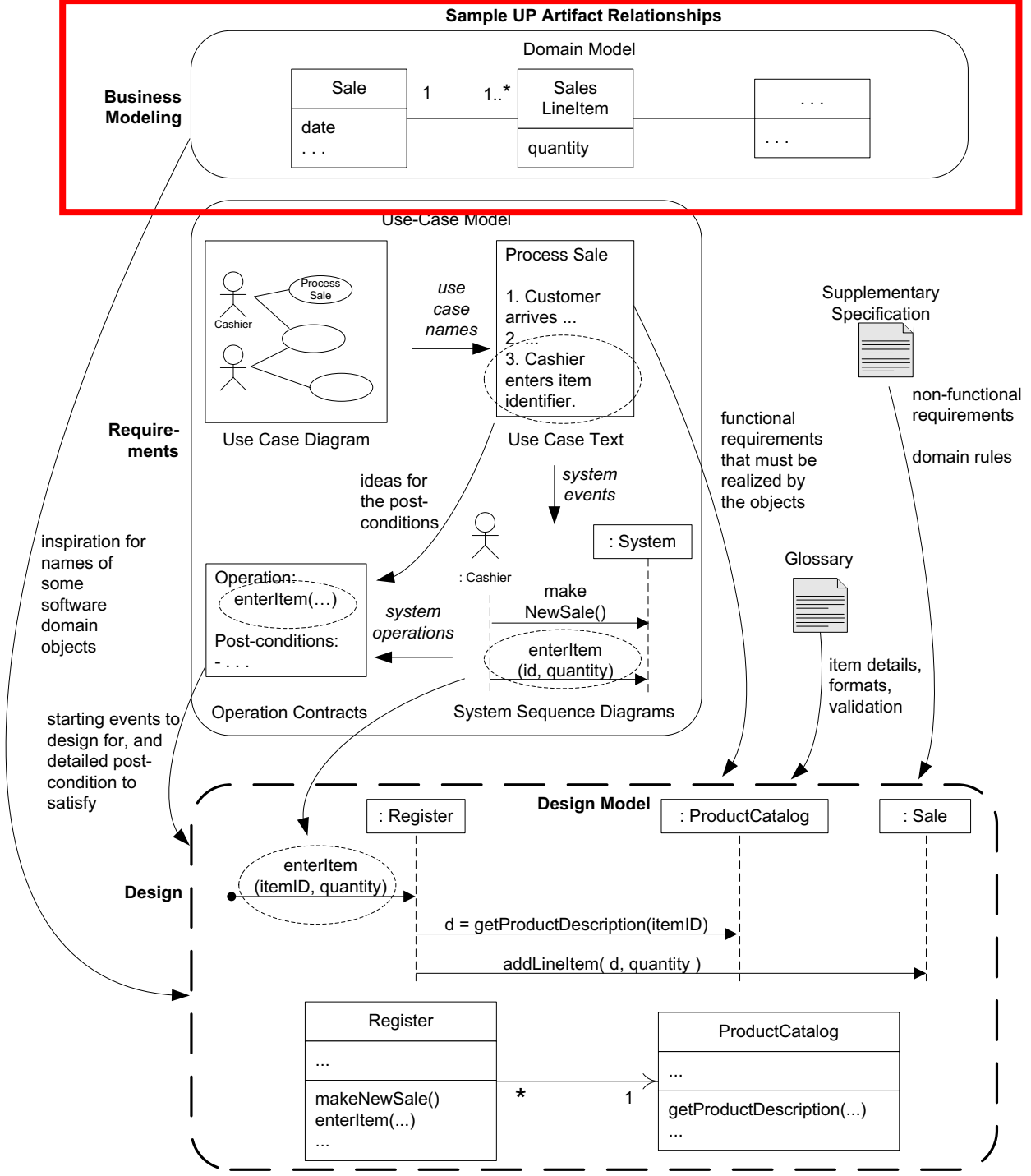


- Note: Requirements Engineering is not an OO discipline/activity

- Which are the domain concepts/objects?

- Described in a domain (object) model
  - Classifying domain elements/concepts
  - Finding relationships between domain concepts
  - Goal: to narrow the representational gap between **requirements** and **design**

Artifacts Overview

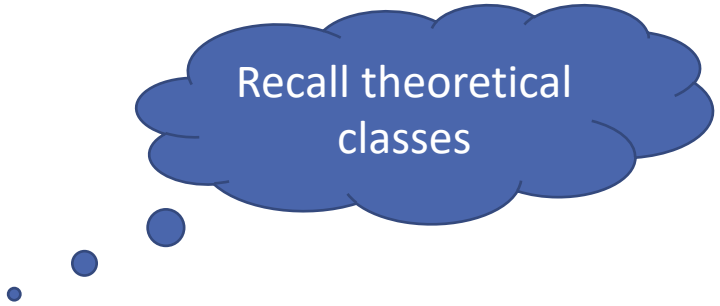


Domain (Object) Model

Domain (Object) Model

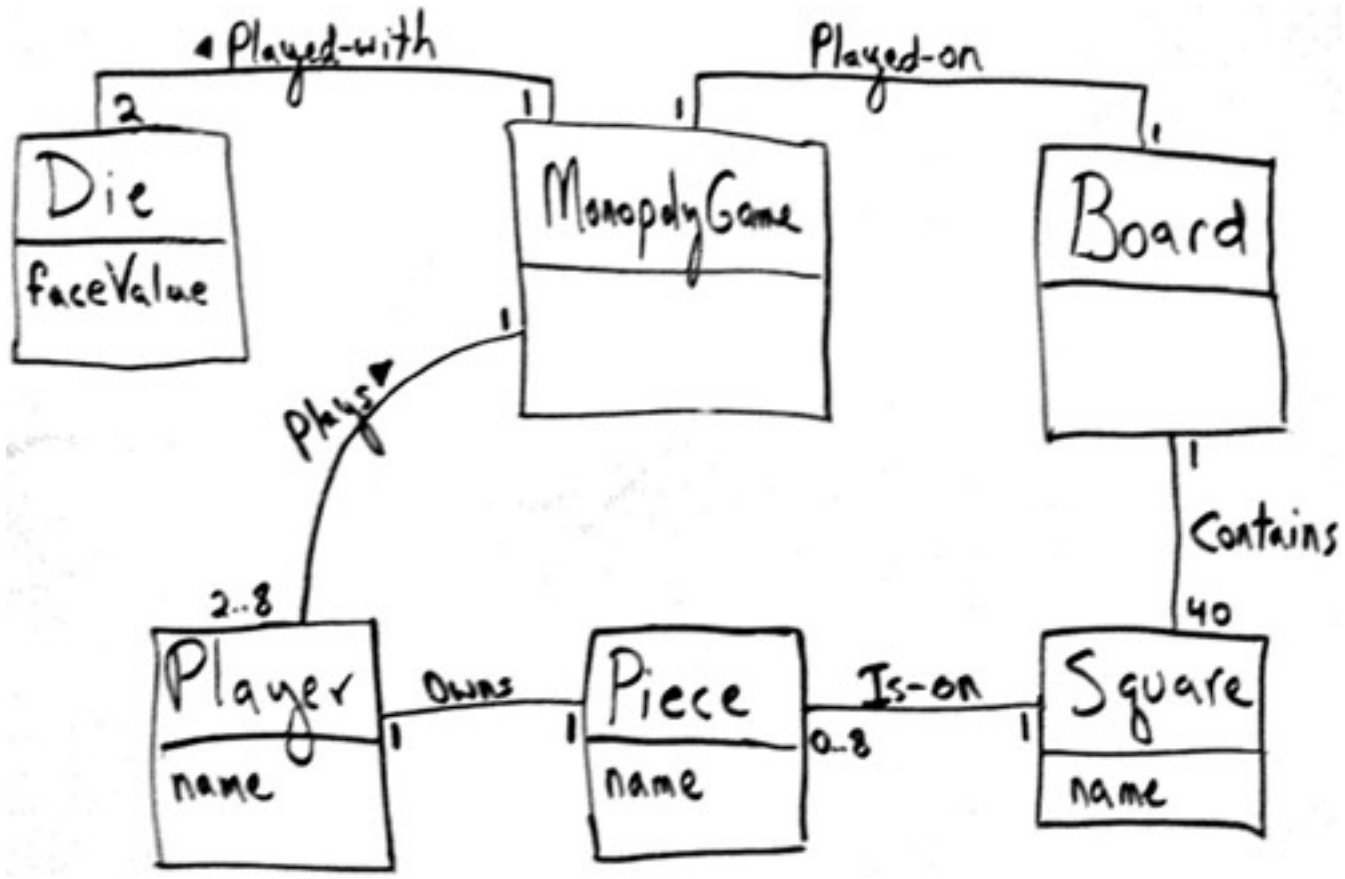
- UML visual representation of conceptual classes or real objects in the domain of interest
  - Subsequently, they may or may not become software elements
  - Conceptual classes ≈ Entities/Business concepts
- Input data:
  - Descriptive domain artifacts. E.g.:
    - Project Specification document
    - Use-Cases Model (including User Stories)
    - Supplementary Specification document
  - Conversations with the SW client

Elements of the Domain Model



- **Concepts** (or conceptual classes)
  - Typically, something more complex than a number or text
  - E.g., Student, Course, Program
- **Associations** between concepts
  - Are relationships between concepts
  - Are dependent on what matters for the specific problem
  - E.g., Student is enrolled in Course; Course takes place as part of Program
- **Attributes**
  - It is a data value that (partially) characterizes an object
  - Typically, something that is expressed numerically or by a text or by a date
  - E.g., A Student's number, name and birth date

Domain Model Example – Monopoly Game (partial)



Concept Identification

How to identify conceptual classes?

- Use a common **Category List**
  - Focus on business information needs
  - Results in a list of candidate conceptual classes

- Identification of **nouns** in sentences
  - Linguistic analysis of input data
  - Results in a list of candidate conceptual classes
  - Warning: do not apply a mechanical mapping of nouns to concepts; pay attention to the ambiguity of the words

- Modify/reuse existing models
  - There are for the most common domains like sales, stocks, finance, health, etc.
  - (not covered in ESOFT)

Common Category List

- (Business) Transactions
- Transaction line items
- Products or Services related to a Transaction or Transaction line
- Transaction Records/Registers
- Roles of People or Organizations
- Places
- Noteworthy Events
- Physical objects
- Descriptions of things
- Catalogs
- Containers of things
- Elements of containers
- (Other) Organizations
- Other (External) Systems
- Records of finance, work, contracts, legal matters
- Financial instruments
- Documents mentioned/used to perform some work

Identifying Conceptual Classes (1/6)

- Textual descriptions of the domain are useful in the identi
  conceptual classes, namely the **nouns** used

Identify nouns for which we want to keep records

Many Labs is a company that operates in the English market, it has headquarters in London and has a network of **clinical analysis laboratories** in England where analysis of blood (samples are collected) are performed, as well as Covid-19 tests. In England, *Many Labs* has exclusivity for Covid-19 tests throughout the territory, which means that no other company can perform this **type of testing**. All *Many Labs* clinical analysis laboratories perform clinical blood tests, and a subset of these laboratories also performs Covid-19 tests.

The set of *Many Labs* clinical analysis laboratories form a network that covers all England, and it is responsible for collecting **samples** and interacting with **clients**. The samples collected by the network of **laboratories** are then sent to the **chemical laboratory** located in the company's headquarters and the **chemical analysis** are performed there.

Identifying Conceptual Classes (2/6)

- Candidate conceptual classes list from the textual descriptions. E.g.:

Category	Candidate Classes
Noteworthy Events	Chemical Analysis
Descriptions of things	Type of Test
Places	Clinical Analysis Laboratory Chemical Laboratory
Transactions	Test
Transaction line items	Sample
Roles of People or Organizations	Client
Products or Services related to a Transaction or Transaction line	
Catalogs	
(Other) Organizations	
Containers	
Financial instruments	
etc.	

Identifying Conceptual Classes (3/6)

Blood tests are frequently characterized by measuring several **parameters** which for presentation/reporting purposes are organized by **categories**. […]
Despite being out of scope, the system should be developed having in mind the need to easily support other kinds of tests (e.g., urine). Regardless, such tests rely on measuring one or more parameters that can be grouped/organized by categories.

US11: As an **administrator**, I want to specify a new parameter category.

Conversations with SW Client

Process performed in the Requirements Engineering activity

UC 11 Create Parameter Category

1. *The **administrator** starts the definition of a new **parameter category**.*
2. *The system requests the required data (i.e., code, description, and NHS id).*
3. *The administrator types the requested data.*
4. *The system validates and presents the data to the administrator, asking her/him to confirm.*
5. *The administrator confirms.*
6. *The system records the data and informs the administrator of the operation's success.*

cf. next slide

Identifying Conceptual Classes (4/6)

Expected Requirements Engineering Output

1. Engineering Requirements

1.1. User Story Description

As an **administrator**, I want to specify a new **parameter category**.

1.2. Specifications and Clarifications

From the Specifications Document:

- "Blood tests are frequently characterized by measuring several **parameters** which for presentation/reporting purposes are organized by categories. For example, parameters such as the number of Red Blood Cells (RBC), White Blood Cells (RBC) and Platelets (PLT) are usually presented under the blood count (Hemogram) category."
- "Regardless, such tests rely on measuring one or more parameters that can be grouped/organized by categories."

From the client clarifications:

- Question: What are the data that characterize a parameter category?
  - Answer: Simply consider a code, a description and an NHS identifier
- Question: What are the business rules applicable to such data?
  - Answer: …

1.3. Acceptance Criteria

- AC1: Code must be unique having 4 to 8 chars
- AC2: Description cannot be empty and has, at maximum, 40 chars
- AC3: NHS identifier is not mandatory

1.4. Found out Dependencies

No dependencies were found.

1.5. Input and Output Data

Input Data

- **Typed data:** code, description and NHS identified
- **Selected data:** (none)

Output Data

- (In)Success of the operation

1.6. System Sequence Diagram

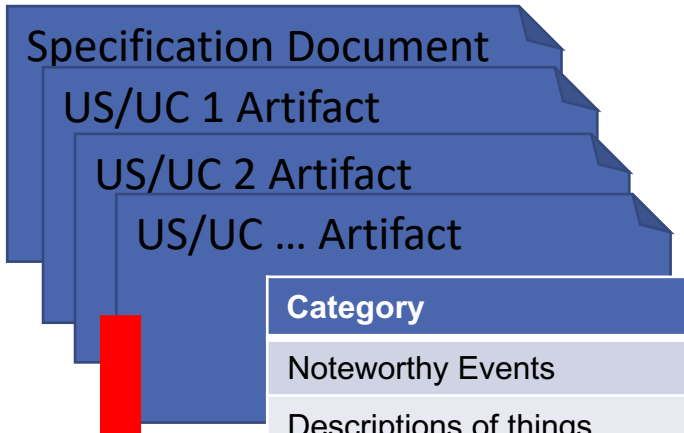
…

Identifying Conceptual Classes (5/6)

- Information gathered during Requirement Engineering contributes to enrich the list of candidate conceptual classes

Category	Candidate Classes
Noteworthy Events	Chemical Analysis
Descriptions of things	Type of Test, **Category**
Places	Clinical Analysis Laboratory Chemical Laboratory
Transactions	Test
Transaction line items	Sample
Roles of People or Organizations	Client, **Administrator**
Products or Services related to a Transaction or Transaction line	**Parameter**
Catalogs	
(Other) Organizations	
Containers	
Financial instruments	
etc.	

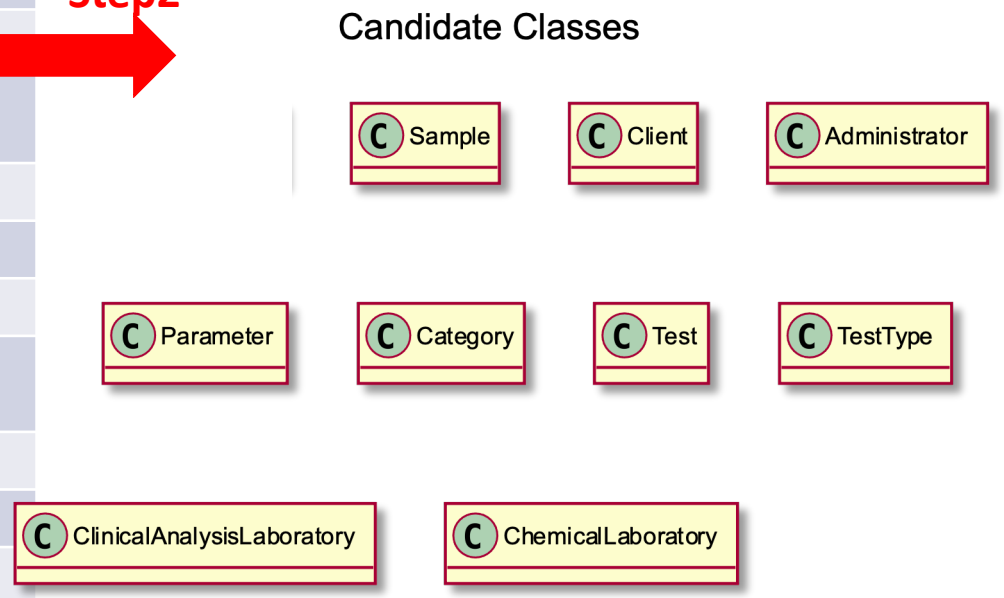
Identifying Conceptual Classes (6/6)



Step1

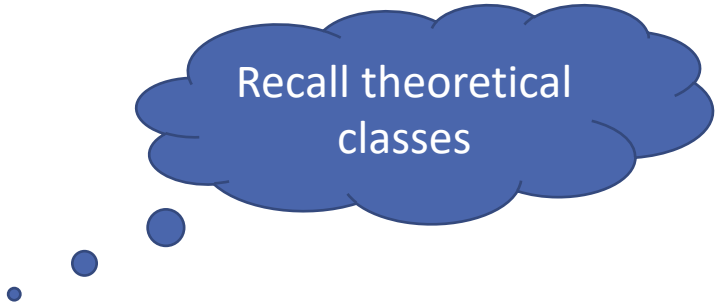
Category	Candidate Classes
Noteworthy Events	Chemical Analysis
Descriptions of things	Type of Test, **Category**
Places	Clinical Analysis Laboratory Chemical Laboratory
Transactions	Test
Transaction line items	Sample
Roles of People or Organizations	Client, **Administrator**
Products or Services related to a Transaction or Transaction line	**Parameter**
Catalogs	
(Other) Organizations	
Containers	
Financial instruments	
etc.	

Step2



Association Identification

Identifying Associations (1/3)



- An association is a relationship between objects from the List of Common Associations where:
  - A is physically (or logically) part of B
  - A is physically (or logically) contained in B
  - A is a description of B
  - A is known / captured / recorded by B
  - A uses or manages B
  - A is related to a transaction of B
  - etc.
- Focus on the **verbs** relating two conceptual classes. E.g.,
  - "[…] parameters which for presentation/reporting purposes are **organized** by categories."
  - "[…] parameters that can be **grouped/organized** by categories."

Identifying Associations (2/3)

- Most important associations are those that need to be remembered. E.g.:
  - `Parameter` ***`presented under`*** `Category`
  - `Category` ***`created by`*** `Administrator`
  - `Test` ***`requested by`*** `Client`

Identifying Associations (3/3)

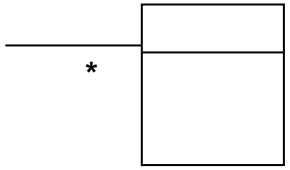
- Candidate associations captured through a table. E.g.:

Concept A	Association	Concept B
Parameter	• presented under	• Category
Category	• created by	• Administrator
Test	• requested by • is of	• Client • TestType
…	• …	• …

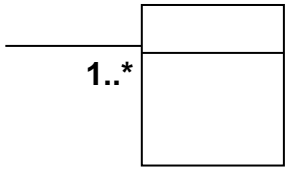
Association Multiplicity

Multiplicity – Examples and Meaning

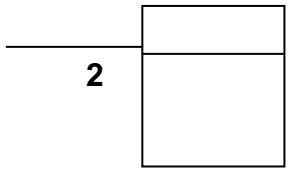
- Zero or more



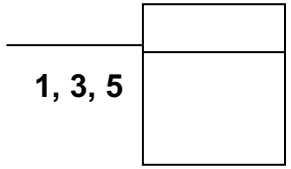
- One or more



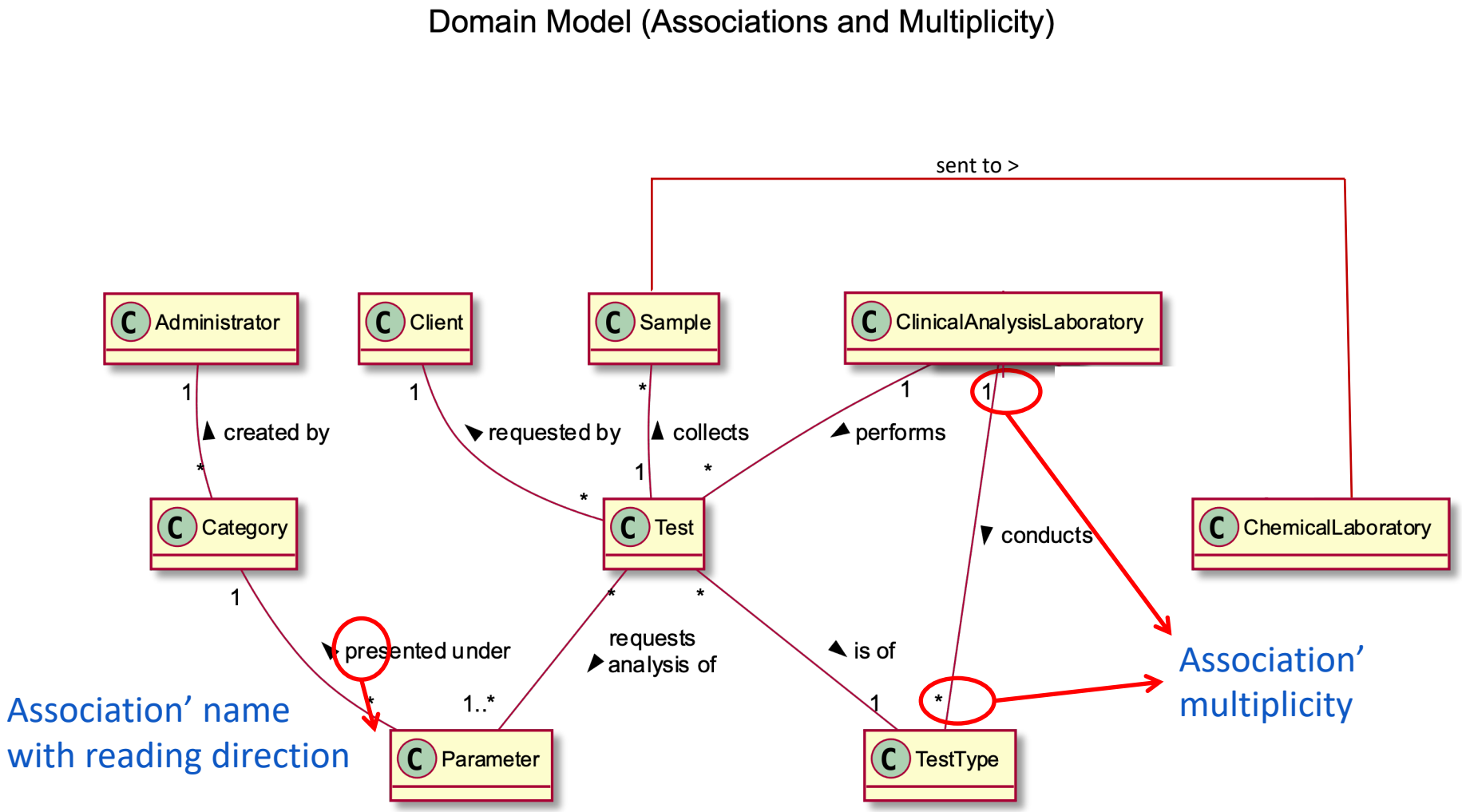
- Exactly two



- One or three or five

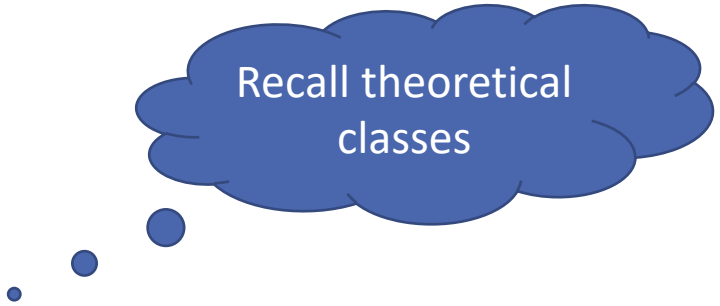


Multiplicity on Associations



Attribute Identification

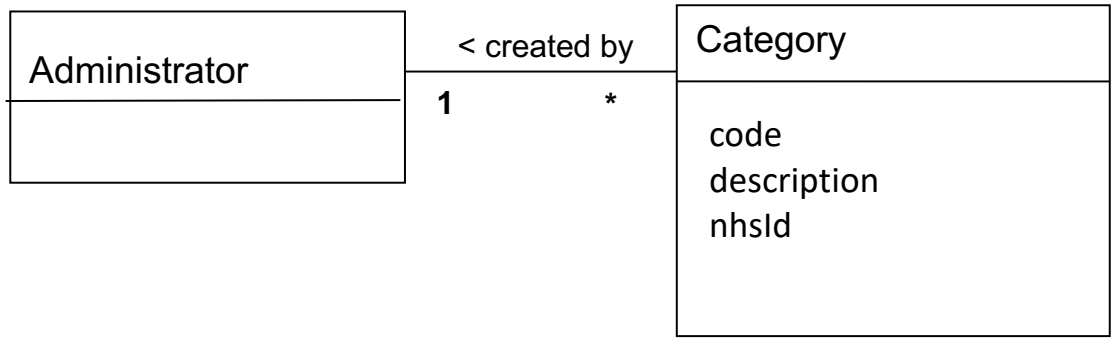
Identifying Attributes



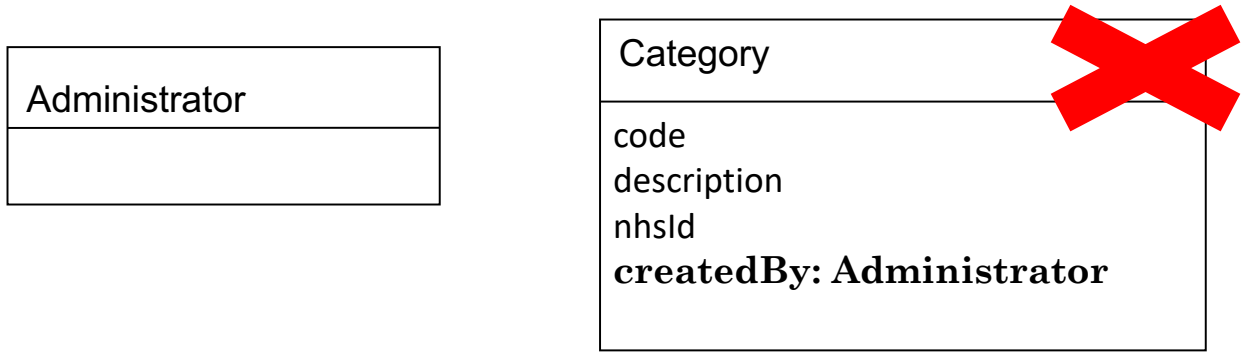
- Preferably they must be of simple and primitive types
  - E.g.: Boolean, date, number, (unstructured) text, time
- Attributes must be represented as conceptual classes if:
  - The “attribute” consists of separate sections (i.e., it has structure)
    - E.g.: Address: street, number, postal code, country
  - Has other attributes
  - It is an abstraction of one or more types
    - E.g.: Barcode: UPC, EAN
  - Warning: sometimes, for readability reasons, high experimented teams omit some of these concepts. However, for beginners this is discouraged and must be avoided.

Association or Attribute?

- Association



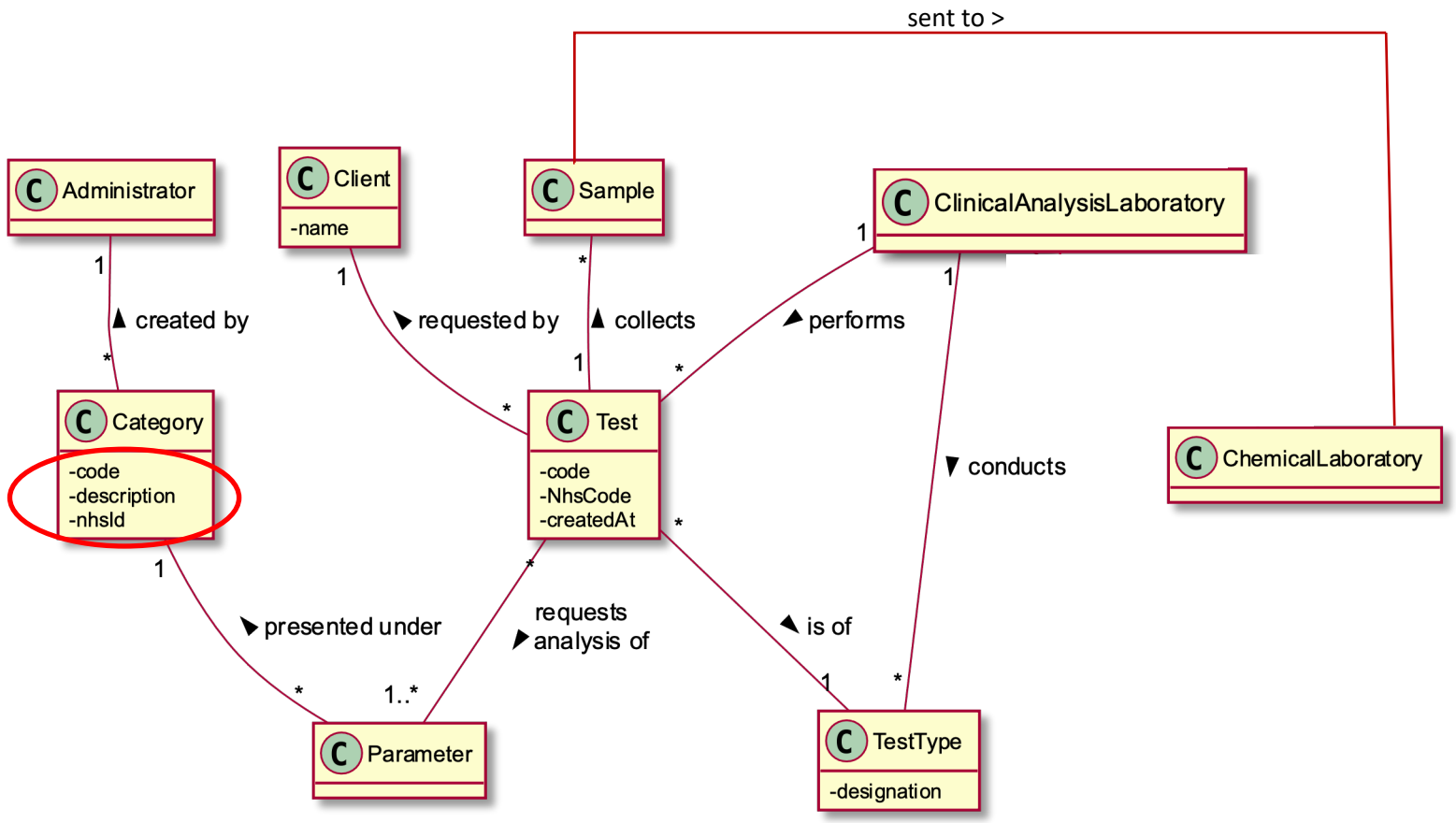
- Attribute



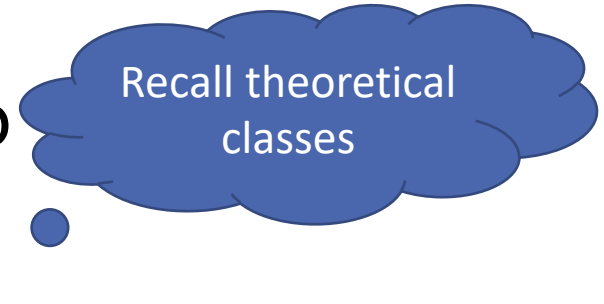
If in the real world the attribute X is not thought of as a number or text then X is probably a conceptual class and not an attribute.

Identifying Attributes - Example

Domain Model (Partial with some Attributes)



Is My Domain Model (DM) Correct?



- There is not only one DM that is the right one
  - Different DM might be correct
  - All are approximations to the domain that we are trying to understand
- DM should be seen as a tool
  - To understand the domain
  - To communicate with
    - The SW client
    - The development team
- DM is useful when
  - Captures abstractions and essential information needed to understand the domain in the context of current requirements
  - Assists people in understanding concepts, terminology and domain relationships

Domain Model throughout the Project Sprints

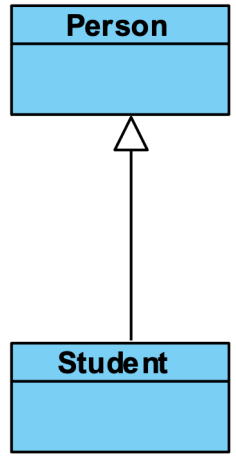
- Sprint A
  - Goal: broad and comprehensive understanding of the domain/business
  - Main Inputs:
    - Project Specification document
    - Conversations with the SW Client
- Sprint B, C and D
  - Goal: deeper and more comprehensive understanding of the domain/business regarding the sprint backlog (i.e., User Stories to develop during the sprint)
  - Main Inputs:
    - Engineering Requirements artifacts
    - Conversations with the SW Client
- Domain Model should be **revised/updated** in every sprint
  - Reflect the knowledge resulting of the new requirements into the DM

Generalization

Generalization – Conceptual Classes

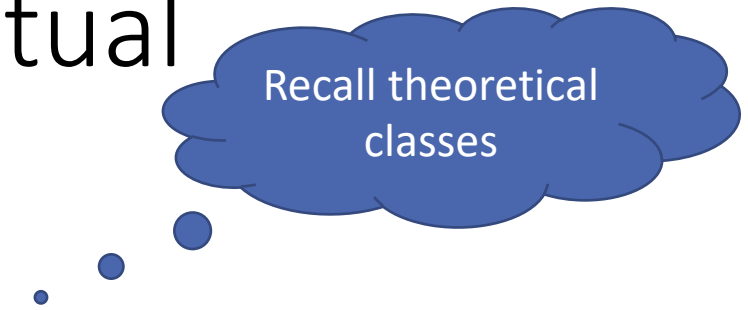
Recall theoretical classes

- Is there a generalization-specialization class hierarchy relationship between two conceptual classes?



- The semantic of this kind of relationship is "***is a***"
  - E.g.: A Student ***is a*** Person
- The subclass inherits the properties (attributes, operations and associations) of the superclass, and may add others
  - E.g.: Superclass: Person
  - E.g.: Subclass: Student

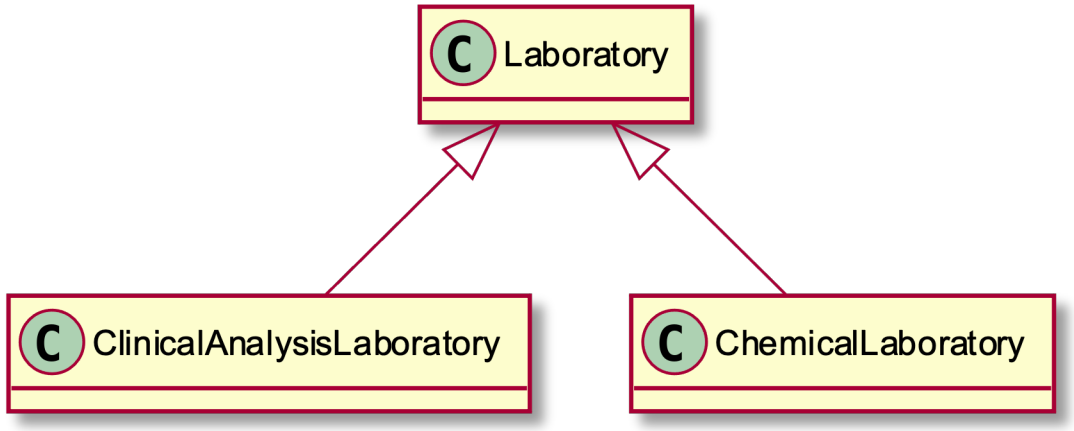
When it is useful to create conceptual subclasses?



- Has the subclass any **additional attribute?**
- Has the subclass any **additional association?**
- Is the subclass somehow **handled/operated differently** from the superclass?
- Does the subclass represent something animated (e.g., an animal) that **behaves** differently from the superclass?

- It might be useful if at least on one of the above questions the answer is “yes”.

Generalization – Example

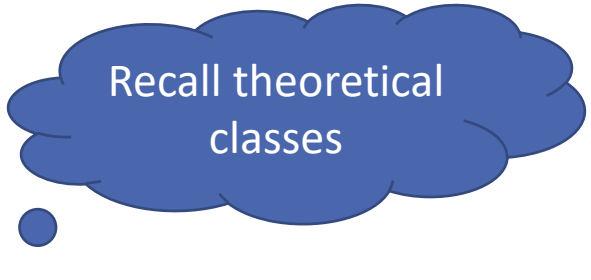


- Does it make sense?
  - Probably, yes…
- But is it useful?
  - No!? Yes!? Maybe!?
  - Why?

- Has the subclass any additional attribute?
- Has the subclass any additional association?
- Is the subclass somehow handled/operated differently from the superclass?
- Does the subclass represent something animated (e.g., an animal) that behaves differently from the superclass?

Take decisions guided by the business context in-hands and NOT by your common sense.

Generalization – Heads up!
OO Analysis vs. OO Design



- The use of generalization in the Domain Model does not implies its adoption in design and code of the software
  - There are other approaches
  - E.g.: use of interfaces

- In OO Design, other situations to apply generalization (or polymorphism) can be identified
  - Extends vs. Implements

Only ONE Model per Domain?

Is My Domain Model (DM) Correct?

- There is not only one DM that is the right one
  - Different DM might be correct
  - All are approximations to the domain that we are trying to understand
- DM should be seen as a tool
  - To understand the domain
  - To communicate with
    - The SW client
    - The development team
- DM is useful when
  - Captures abstractions and essential information needed to understand the domain in the context of current requirements
  - Assists people in understanding concepts, terminology and domain relationships

Last Check and Remarks

- Check your DM against each User Story / Use Case
  - Are all the concepts involved in the US/UC represented in the DM?
    - Objects being created, modified or deleted
  - Are all the associations between concepts represented in the DM?
    - Association/relationships being created/modified/deleted between objects
  - Is all the input data captured as concepts' attributes and/or associations?
    - Some data will be saved as attributes of one or more (new) objects
    - Other data is used to established/delete objects and/or associations between objects
  - Can you find all the output data?
    - E.g.: Lists of objects meeting some criteria
  - Did you find anything missing?
    - YES! → Revise/complete your DM
    - NO! → Are you sure? Really? So, probably you are in the right path…

Evolution

New Sprint – What to do now?

- What is the impact of the new requirements on the Domain Model?
  - Do they cause any changes to existing concepts and associations?
  - Did new concepts emerge? If so...
  - What are the new concepts?
  - How do they relate / associate with previously known concepts?
  - What are the attributes of the new concepts?

- Domain Model should be **revised/updated** in every sprint
  - Reflect the knowledge resulting of the new requirements into the DM

References & Bibliography

- Larman, Craig; Applying UML and Patterns; Prentice Hall (3rd ed.); ISBN 978-0131489066
- Mossé, Francis; “Modeling Roles”; Available on https://objectdiscovery.com/solutions/publications/roles/index.html