

00 Analysis



Digital Skills & Jobs

Topics

- Domain Model
- Concept Identification
- Association Identification
- Attribute Identification
- Generalization Pitfall
- Remarks on the Domain Model
- Domain Model Evolution
- Modeling Roles

Analysis

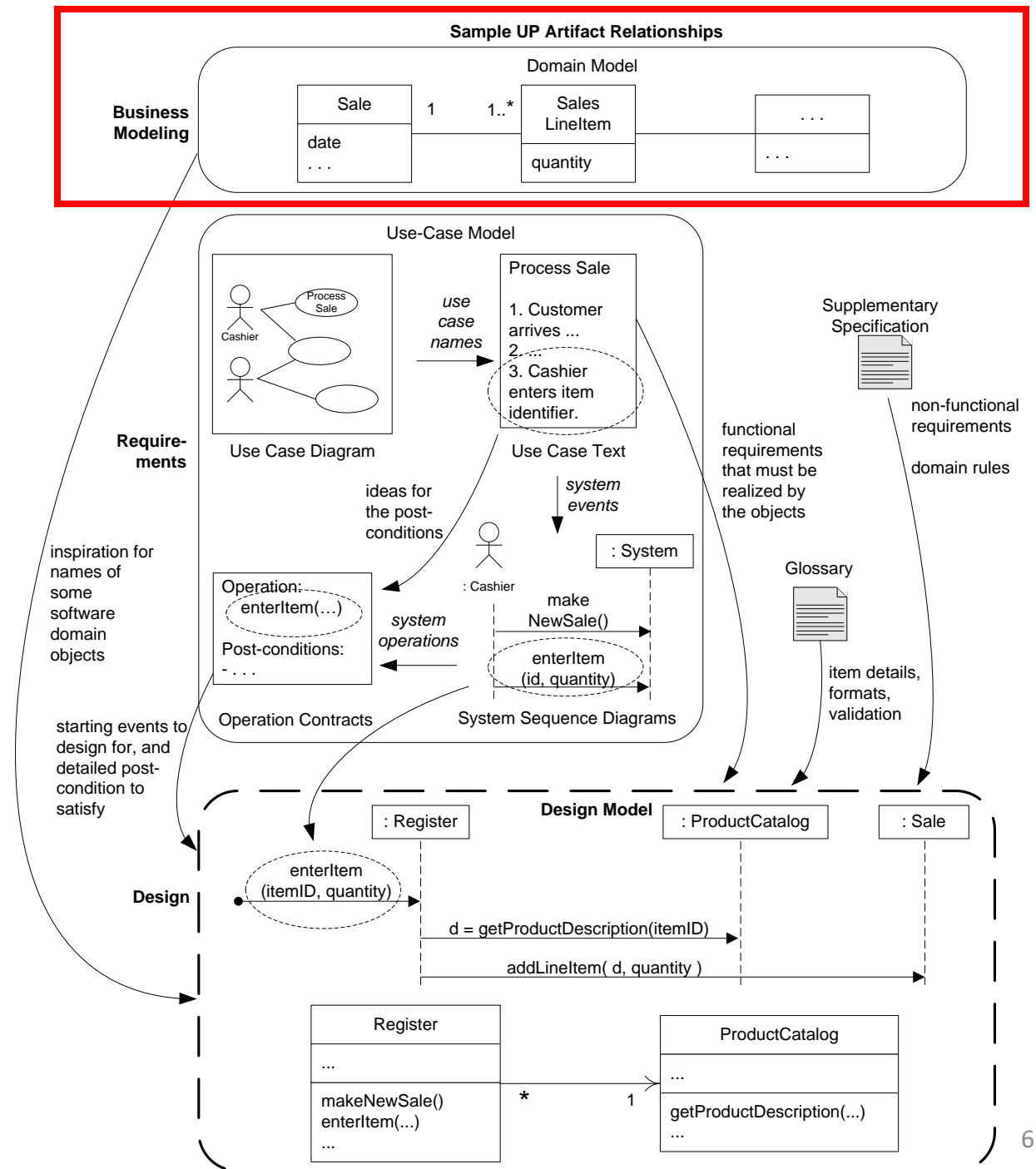
Analysis

- It implies:
 - Acquiring domain/business knowledge
 - Understanding the domain/business
 - Reasoning about the domain/business
- Analysis oriented by:
 - **Objects → OO Analysis**
 - (Processes or Activities → Not covered in this course)

OO Analysis

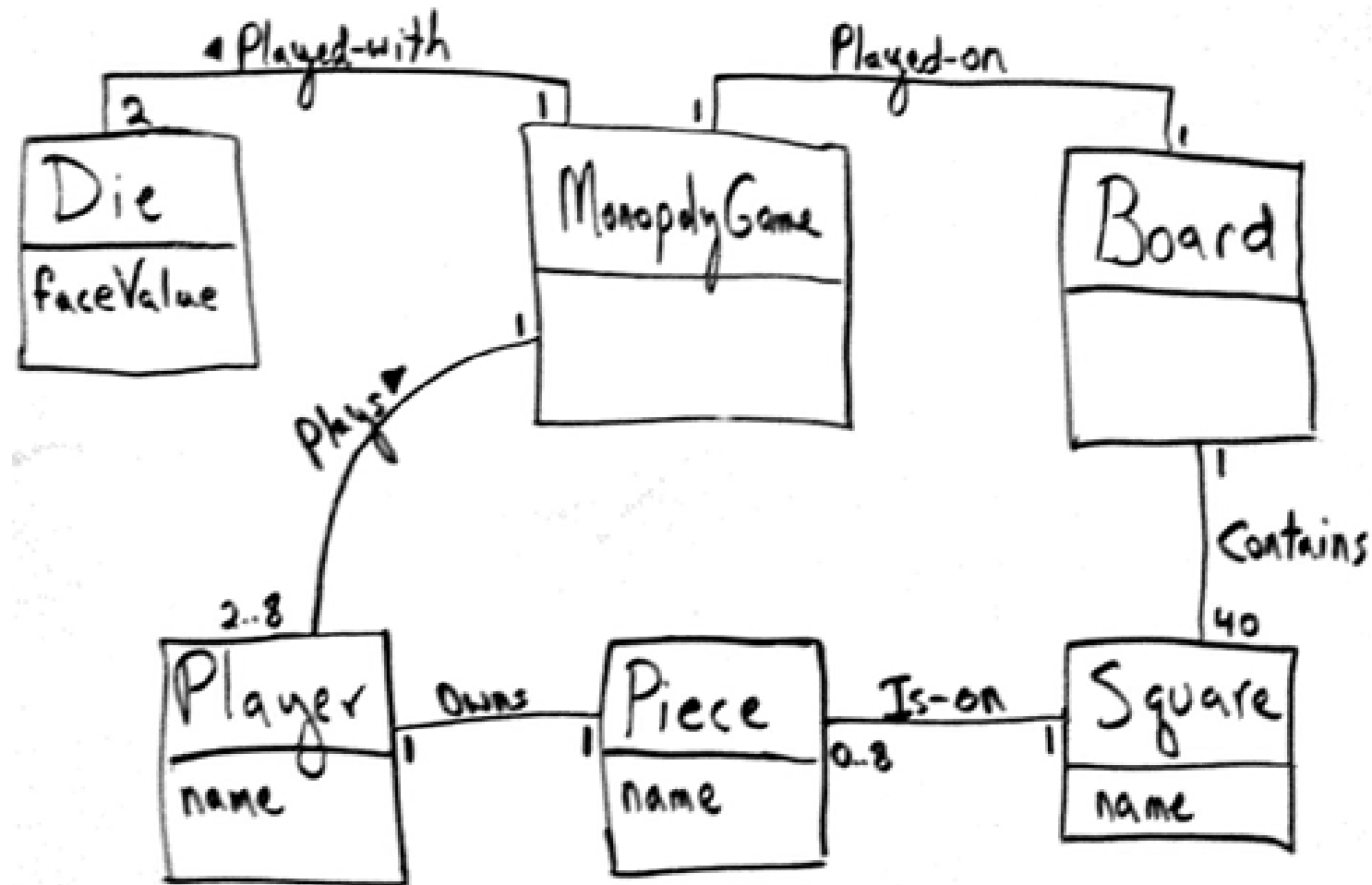
- Note: Requirements Engineering is **not** an OO discipline/activity
- Which are the domain concepts/objects?
- Described in a domain (object) model
 - Classifying domain elements/concepts
 - Finding relationships between domain concepts
 - **Goal:** to narrow the representational gap between **requirements** and **design**

Artifacts Overview

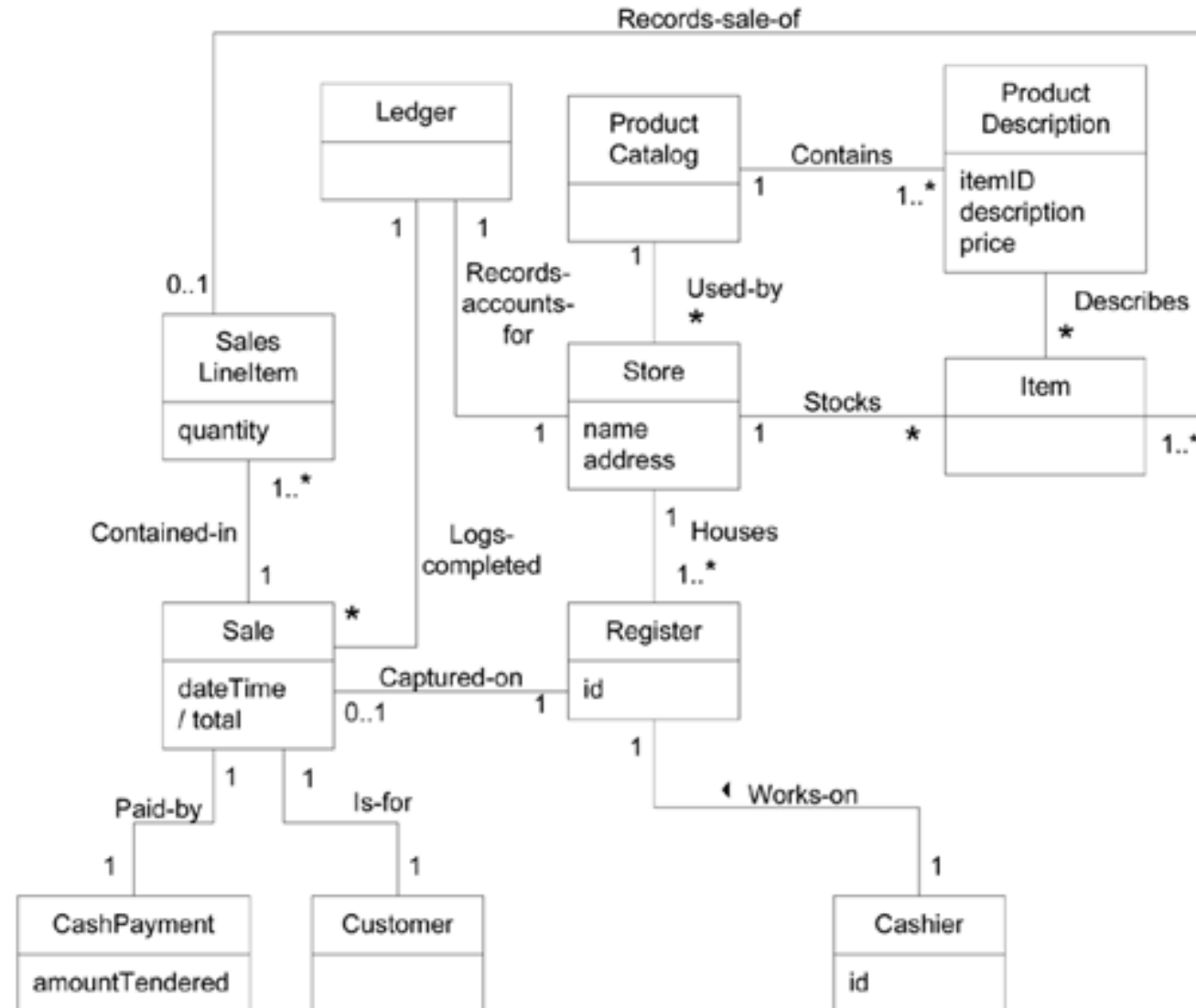


Domain (Object) Model

Example 1: Monopoly Game



Example 2: NextGen POS



Domain (Object) Model (DM)

- Artifact of the “Business Modeling” discipline
- UML visual representation of conceptual classes or real objects in the domain of interest
 - Later, they **may or may not** become software elements
 - Conceptual classes \approx Business concepts/entities
- Input data
 - Descriptive domain artifacts. E.g.:
 - Project **Specification Document**
 - **Use Case Model** (from the Requirements Engineering activity)
 - 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
 - Relationships between concepts
 - They are dependent on what matters for the specific problem
 - E.g. Student **is enrolled** in Course, Course **takes place as part of** Program
- **Attributes**
 - Data values that (partially) characterize an object
 - Typically, something that is expressed numerically, by text or by a date
 - E.g. Student **number**, **name** or **birthdate**

Conventions (1/2)

- Concept names
 - Start with a capital letter
 - In the singular
- Attribute names
 - Start with a lowercase letter

Conventions (2/2)

- Association names

- Start with a lowercase letter
- Chosen so that:

Concept1 association name Concept2

is a sentence with meaning

- Reading direction

- From left to right and top to bottom
- Otherwise, the reading direction must be indicated in the association

Concepts

How to identify concepts?

- Use a **Class Category List**
 - Focus on business information needs
- Look for **nouns** in sentences
 - **Linguistic analysis** of input data (e.g. Project Specification Document)
 - Results in a list of **candidate conceptual classes**
 - **Attention:**
 - do not apply a mechanical mapping of nouns to concepts
 - pay attention to the ambiguity of the words
- Modify/reuse existing models
 - There are templates for the most common domains like sales, stocks, finance, healthcare, etc.
 - (not covered in this course)

Class Category List

- (Business) Transactions
- Transaction line items
- Products or Services related to a Transaction or Transaction line item
- Transaction Records
- 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)

Many Labs

- Textual descriptions of the domain, particularly the **nouns** used, are useful in identifying conceptual classes

Identify nouns for which you want to keep record.

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)

Many Labs

- List of candidate conceptual classes obtained from the textual descriptions (e.g. Project Specification Document)

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

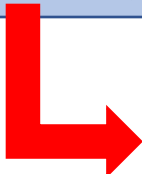
Identifying Conceptual Classes (3/6)

Many Labs

- The information collected during the **Requirement Engineering activity** contributes to enrich the list of candidate conceptual classes

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**



cf. next slide

Identifying Conceptual Classes (4/6)

Many Labs

Expected
Requirements
Engineering
Output

1. Requirements Engineering

1.1. User Story Description

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

1.2. Customer 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: Which data characterizes a parameter category?

Answer: Simply consider a **code**, a **description** and an **NHS identifier**

Question: Which business rules apply to such data?

Answer: ...

1.3. Acceptance Criteria

- **AC1:** Code must be unique, having 4 to 8 characters.
- **AC2:** Description cannot be empty and must have a maximum of 40 characters.
- **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:** a code, a description and an NHS identifier
- **Selected data:** n/a

Output Data

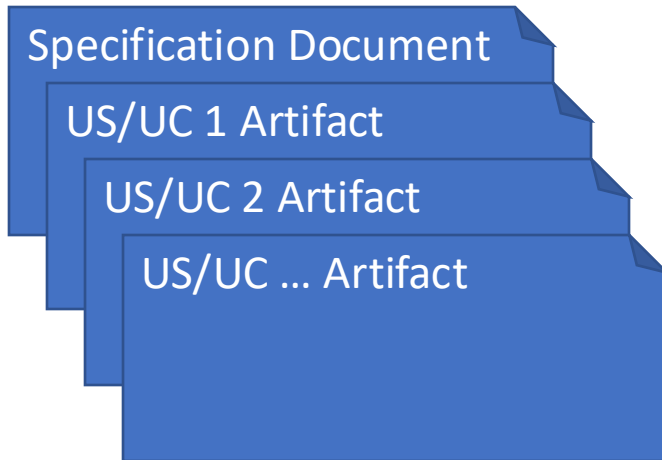
- (In)Success of the operation

1.6. System Sequence Diagram (SSD)

...

Identifying Conceptual Classes (5/6)

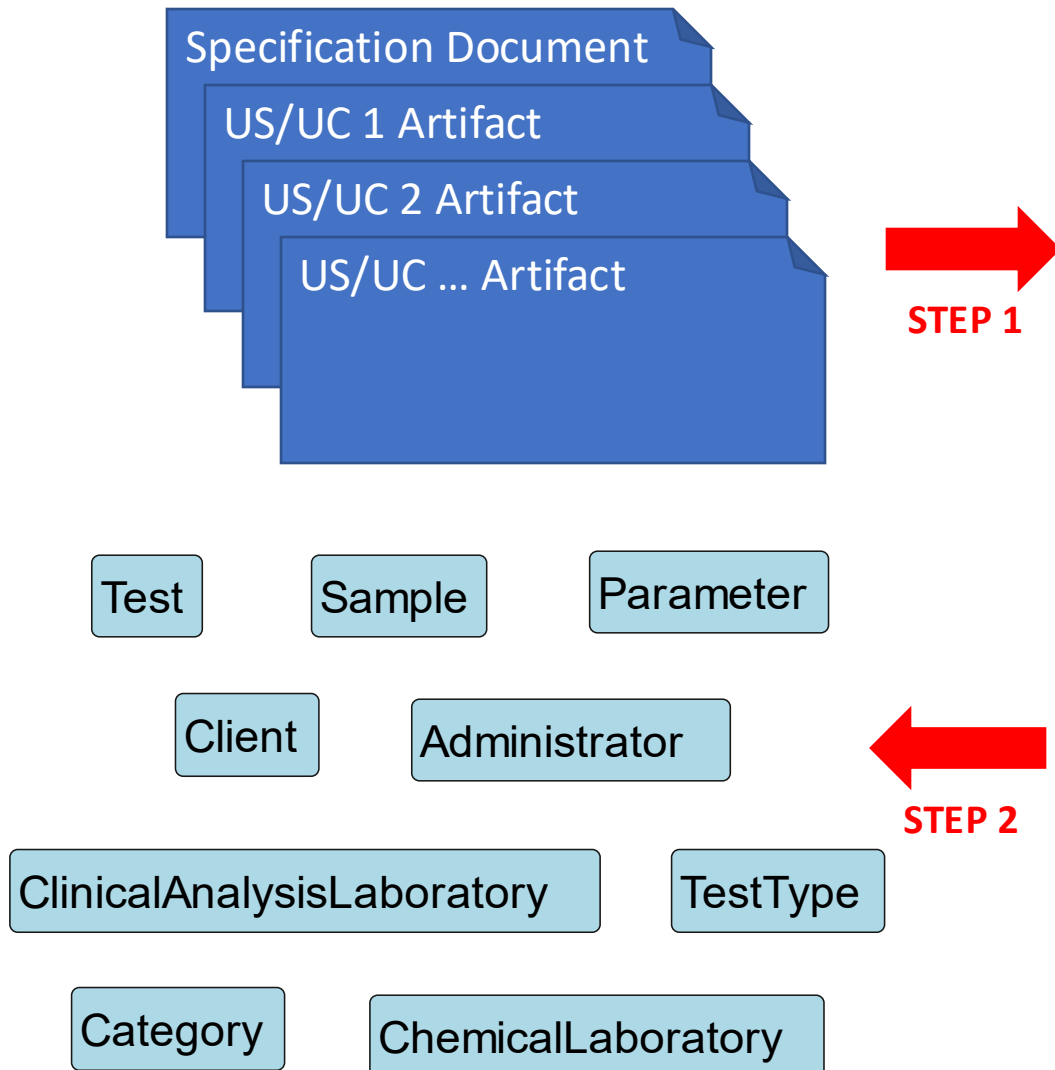
Many Labs



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

Identifying Conceptual Classes (6/6)

Many Labs



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

Associations

How to identify associations?

- An association is a relationship between objects.
- Use a **List of Common Associations**, such as:
 - 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 **verbs** that relate two conceptual classes. E.g.:
 - “[...] registration of any interested **organization**, to be able to **publish tasks** [...]”
 - “[...] **employees** are responsible for **specifying** and cataloging **tasks**”

Identifying Associations (1/2)

Many Labs

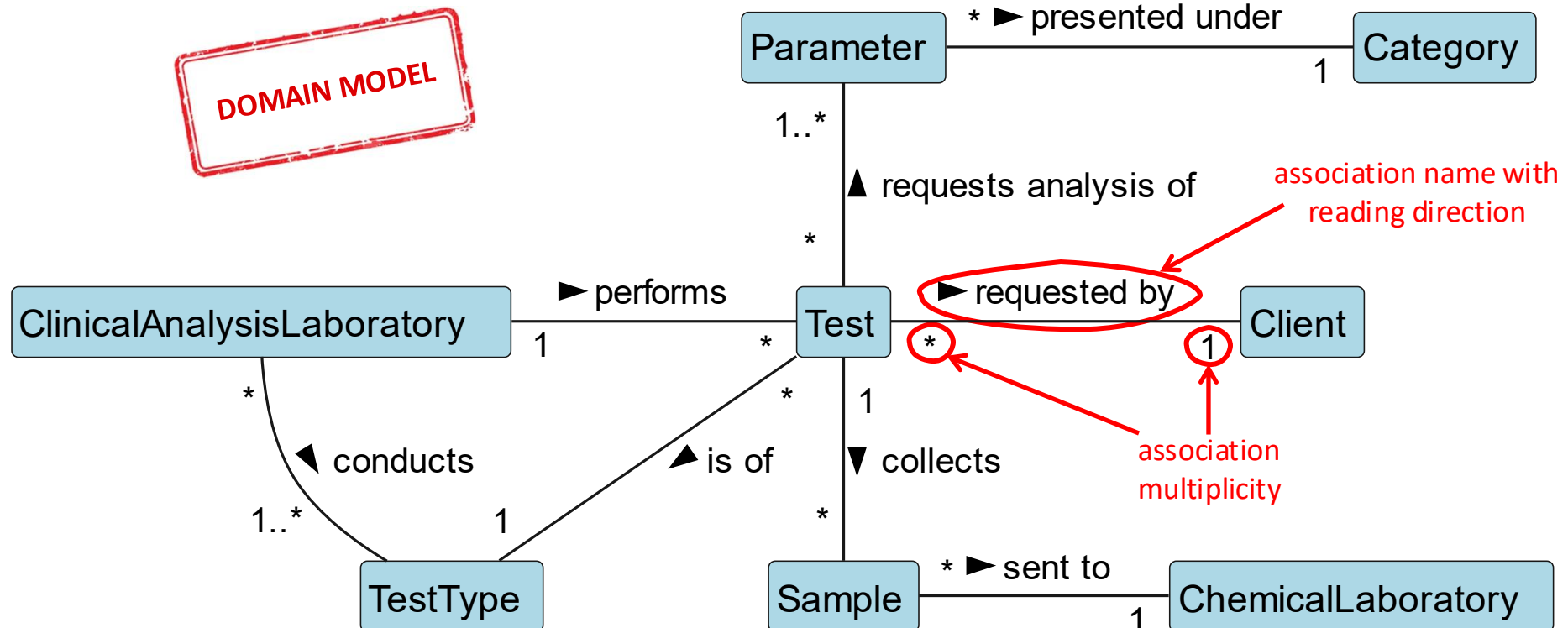
- Capture candidate associations

Concept A	Association	Concept B
<ul style="list-style-type: none">• Test	<ul style="list-style-type: none">• requests analysis of• requested by• is of• collects	<ul style="list-style-type: none">• Parameter• Client• TestType• Sample
<ul style="list-style-type: none">• Parameter	<ul style="list-style-type: none">• presented under	<ul style="list-style-type: none">• Category
<ul style="list-style-type: none">• ClinicalAnalysisLaboratory	<ul style="list-style-type: none">• performs• conducts	<ul style="list-style-type: none">• Test• TestType
...

Identifying Associations (2/2)

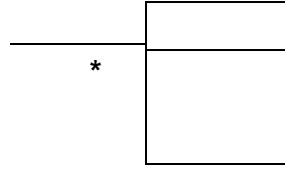
Many Labs

- Add multiplicity to associations and represent them in a diagram

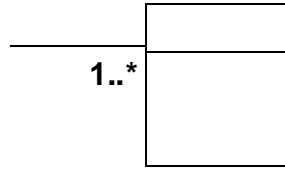


Multiplicity – Examples and Meaning

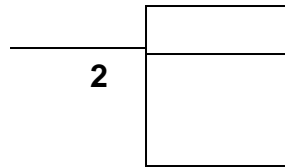
- Zero or more



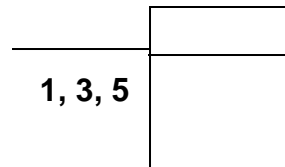
- One or more



- Exactly two

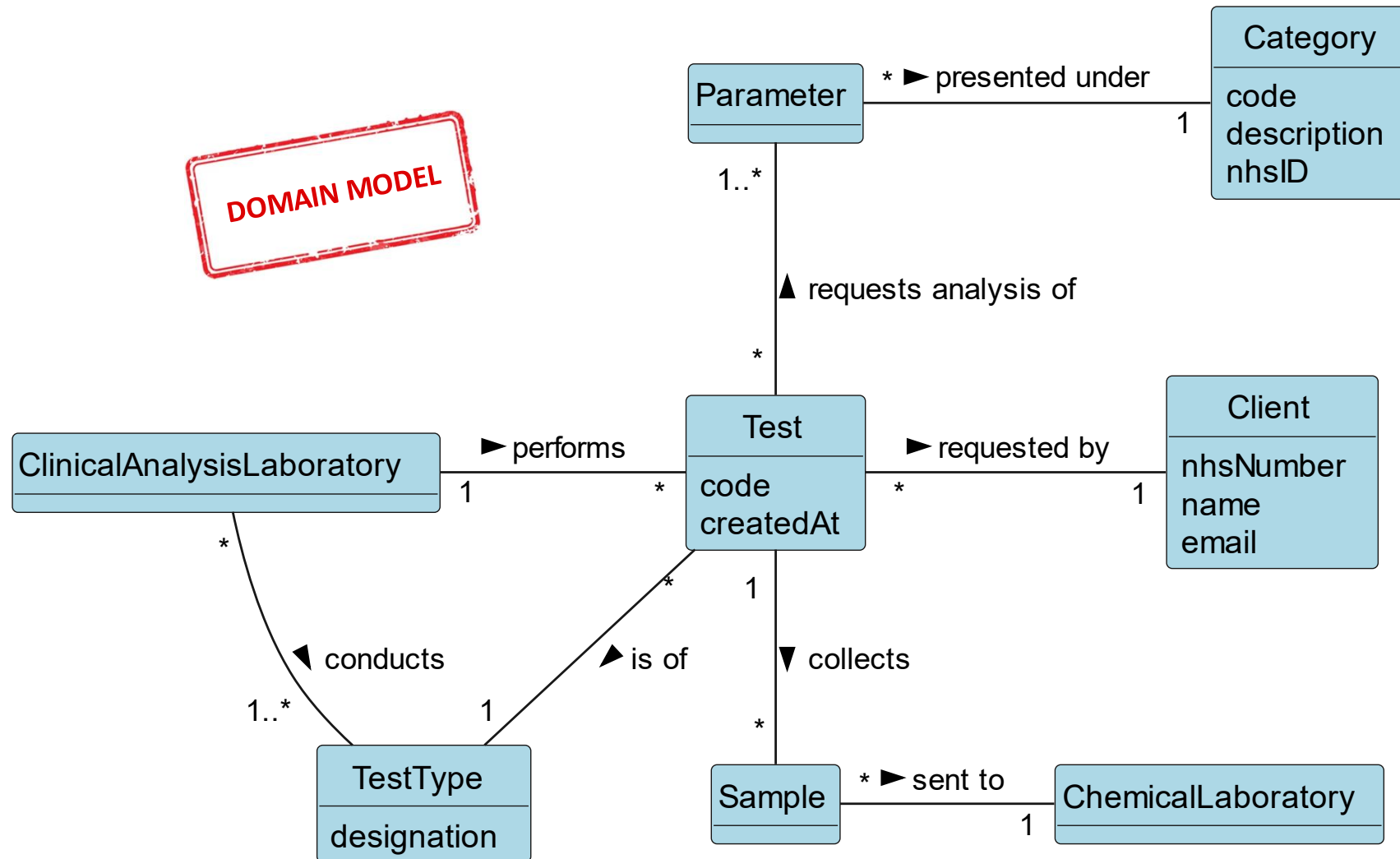


- One or three or five



Identifying Attributes

Many Labs



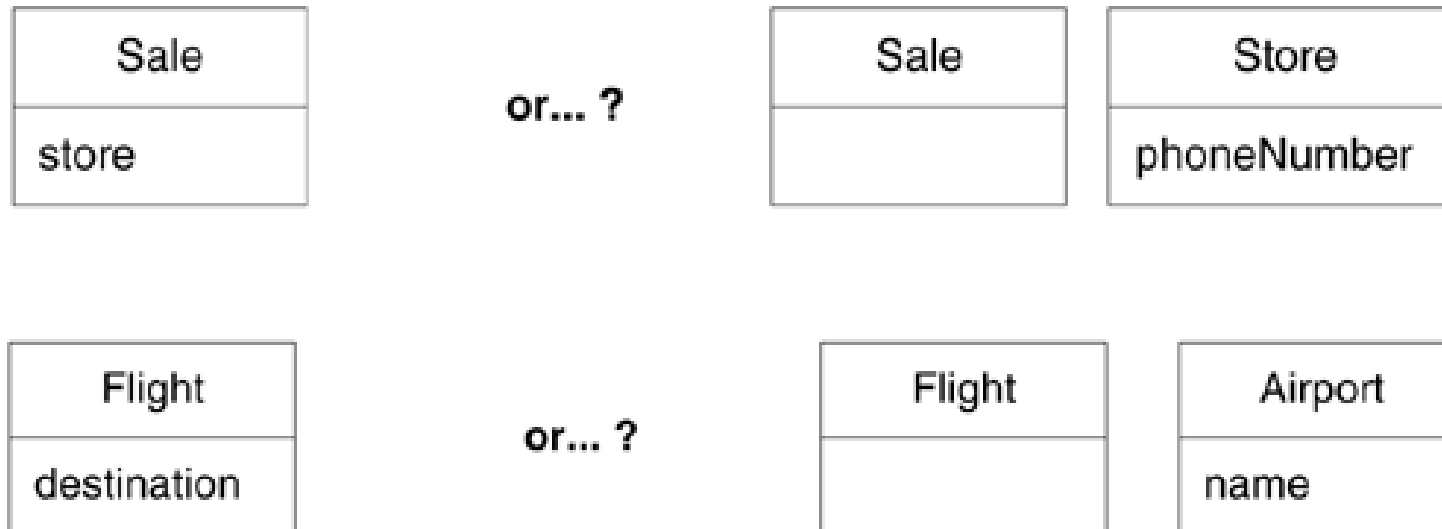
Attributes

How to identify attributes?

- Preferably they should be of a **simple and primitive type**
 - E.g. number, (unstructured) text, date, time, boolean
- Attributes should be represented as conceptual classes if:
 - the “attribute” consists of separate sections (i.e. has a structure)
 - E.g.: **address** consists of a street, a number, a postal code and a country
 - it has associated operations or behaviors
 - it has other attributes
 - it is an abstraction of one or more types
 - E.g. **barcode** is an abstraction of EAN (European Article Number) or UPC (Universal Product Code)
- **Attention:** sometimes, for readability reasons, highly experienced teams omit some of these concepts. However, **for beginners** this is discouraged and should be avoided.

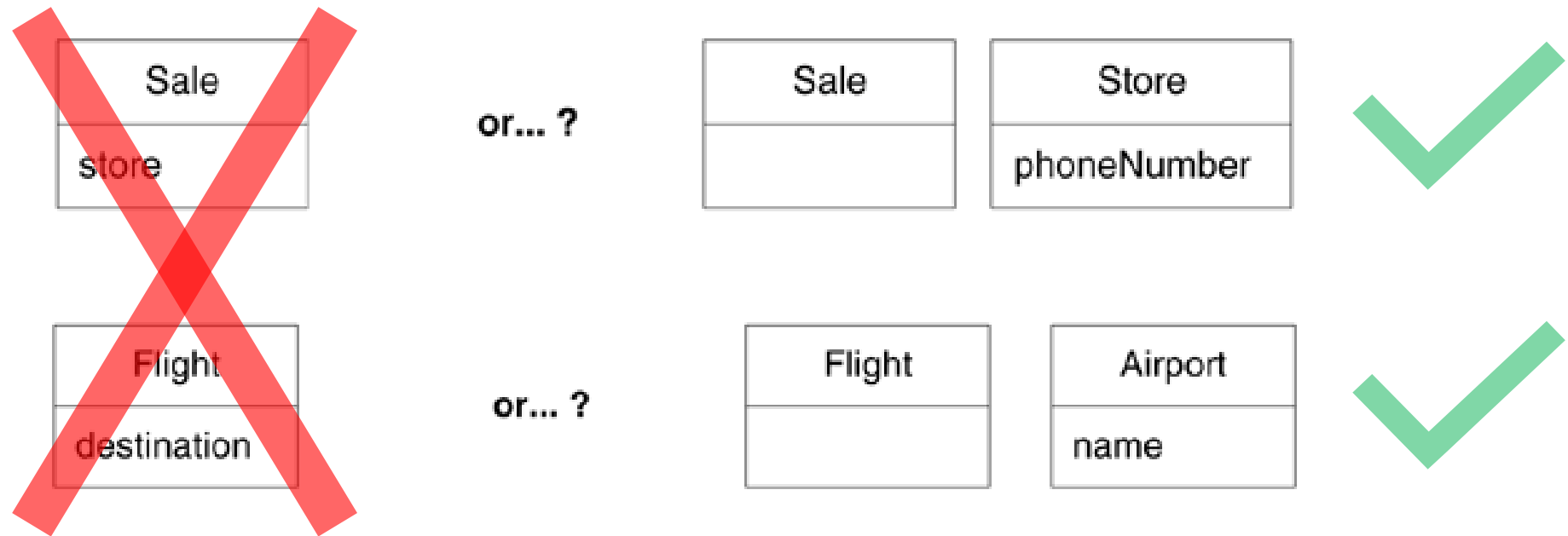
Attribute or Concept? (1/2)

- Representing as an attribute something that should be represented as a conceptual class



Attribute or Concept? (2/2)

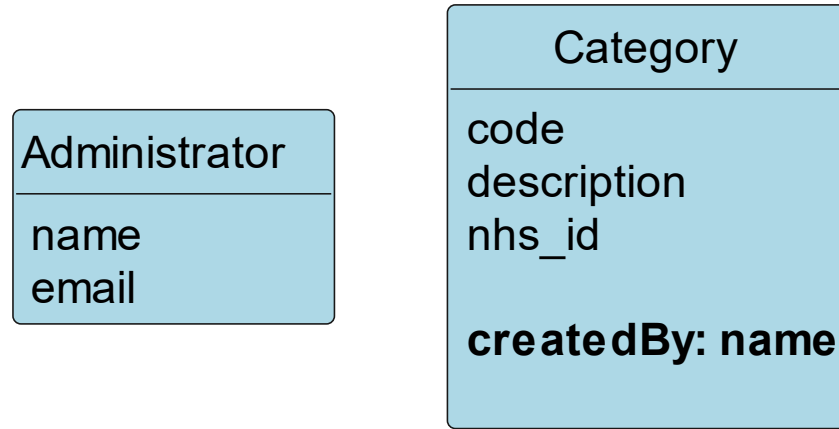
- Representing as an attribute something that should be represented as a conceptual class



If, in the real world, attribute **A** is not thought of as a number or text, then **A** is most likely a conceptual class and not an attribute.

Attribute or Association? (1/2)

- Attribute

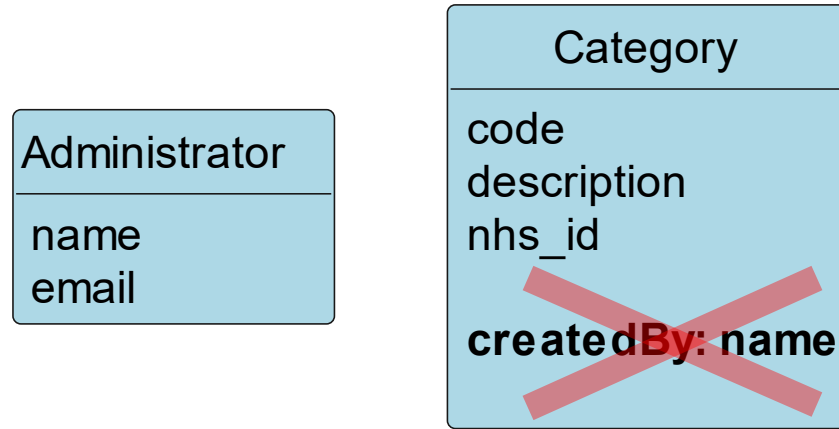


- Association

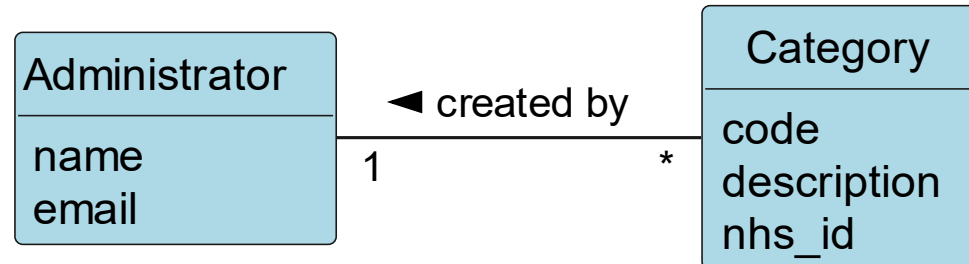


Attribute or Association? (2/2)

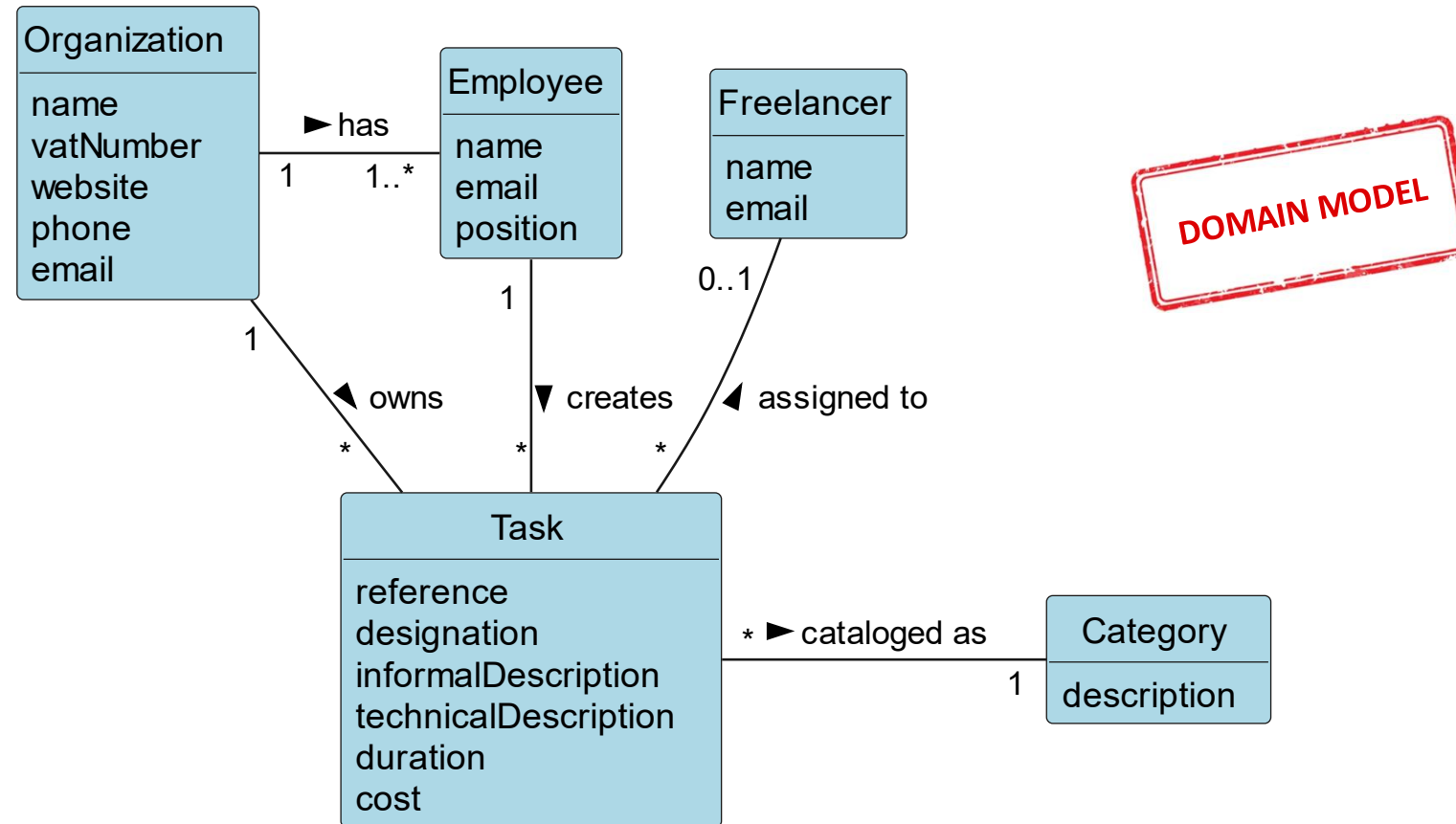
- Attribute



- Association



Identifying Attributes

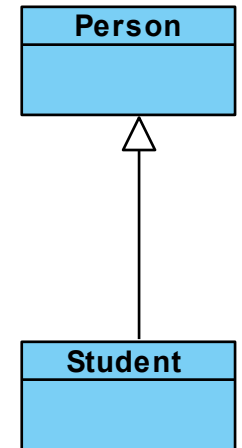


Are there any attribute that should be represented as a concept?
Which one(s)?

Generalization Pitfall

Generalization – Conceptual 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; *subclass* – Student

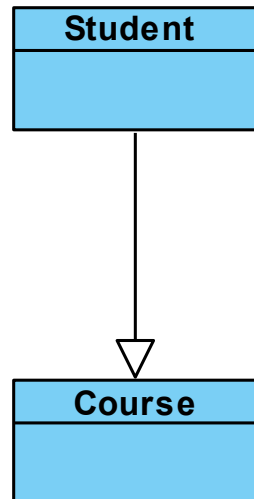


When it is useful to create conceptual subclasses?

1. Does the subclass have any **additional attributes**?
 2. Does the subclass have any **additional associations**?
 3. Is the subclass somehow **handled/operated differently** than the superclass?
 4. Does the subclass represent something animated (e.g. an animal) that **behaves differently** from the superclass?
- Creating conceptual subclasses can be useful if the answer to at least one of these questions is “yes”.

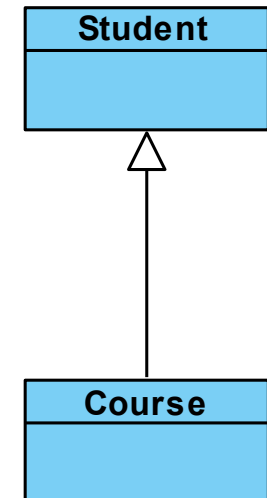
Generalization – Student and Course (1/2)

- Is there a hierarchical relationship between Student and Course or vice-versa?



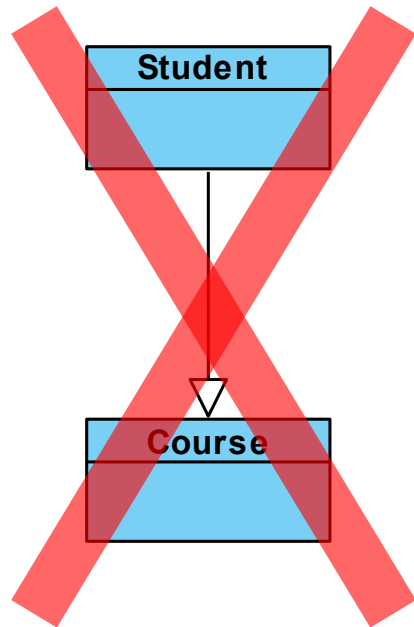
- Is 100% of the definition of the conceptual superclass applicable to the subclass?
- Does the “is a” relationship holds between such classes? **A Student is a Course?**

- Is 100% of the definition of the conceptual superclass applicable to the subclass?
- Does the “is a” relationship holds between such classes? **A Course is a Student?**



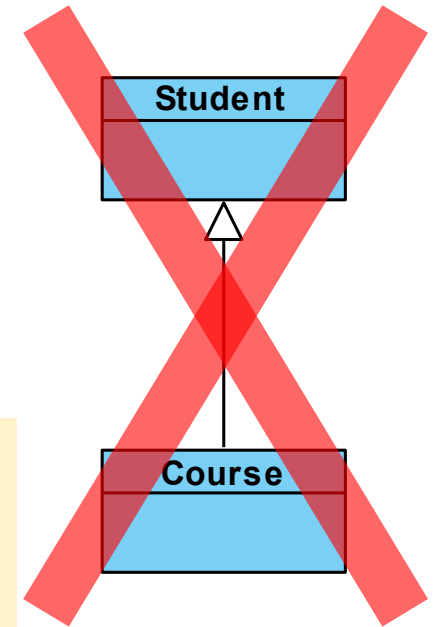
Generalization – Student and Course (2/2)

- Is there a hierarchical relationship between Student and Course or vice-versa?



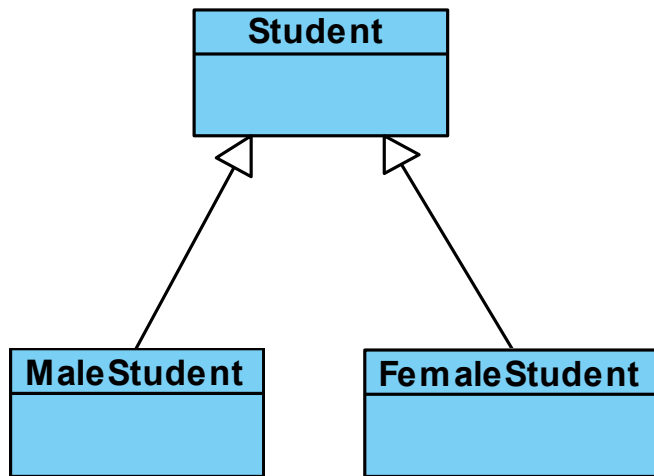
- Is 100% of the definition of the conceptual superclass applicable to the subclass?
- Does the “is a” relationship holds between such classes? **A Student is a Course?**

- Is 100% of the definition of the conceptual superclass applicable to the subclass?
- Does the “is a” relationship holds between such classes? **A Course is a Student?**



Generalization – Male/Female Student (1/2)

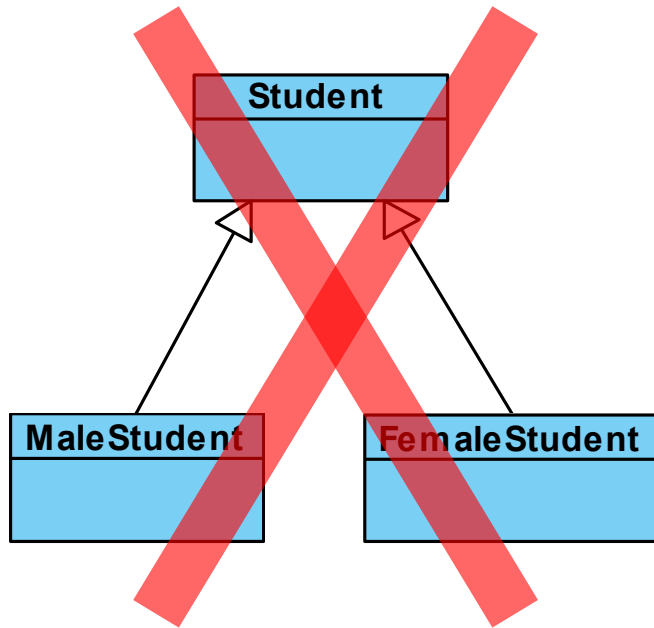
- Is there a hierarchical relationship between Student and MaleStudent or FemaleStudent?



1. Does the subclass have any **additional attributes**?
2. Does the subclass have any **additional associations**?
3. Is the subclass somehow **handled/operated differently** than the superclass?
4. Does the subclass represent something animated (e.g. an animal) that **behaves differently** from the superclass?

Generalization – Male/Female Student (2/2)

- Is there a hierarchical relationship between Student and MaleStudent or FemaleStudent?



1. Does the subclass have any **additional attributes**?
2. Does the subclass have any **additional associations**?
3. Is the subclass somehow **handled/operated differently** than the superclass?
4. Does the subclass represent something animated (e.g. an animal) that **behaves differently** from the superclass?

Generalization should be evaluated considering the domain/business context.

Remarks on the Domain Model

Only One Model per Domain?

Is My Domain Model (DM) Correct?

- There is not just one DM that is the correct one
 - **Different DM may be correct**
 - They are all approximations to the domain we are trying to understand
- DM should be seen as a **tool**:
 - **to understand the domain**
 - **to communicate:**
 - with the SW client
 - within the development team
- DM is useful when it:
 - captures abstractions and essential information needed to understand the domain, in the context of current requirements
 - assists people understand concepts, terminology and domain relationships

Last Check and Remarks

- Check your Domain Model 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 input data captured as attributes and/or associations between concepts?
 - Some data will be saved as attributes of one or more (new) objects
 - Other data is used to establish/delete objects and/or associations between objects
 - Can you find all 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? Then, you're probably on the right track...

Domain Model Evolution

Scrum Project

Domain Model Evolution in a Scrum Project

- Sprint 1
 - Goal: broad and comprehensive understanding of the domain/business
 - Main Inputs:
 - Project Specification document
 - Requirement Engineering artifacts
 - Conversations with the SW Client
- Sprints 2 to 4
 - 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:
 - Requirement Engineering artifacts
 - Conversations with the SW Client

A 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?
 - Have new concepts emerged?
 - What are the new concepts?
 - How do they relate/associate with previously known concepts?
 - What are the attributes of the new concepts?
- The Domain Model should be **revised/updated** in every sprint
- The knowledge resulting from the new requirements must be reflected in the Domain Model

Modeling Roles

Scenarios to Think About

*Platform for
Outsourcing Tasks*

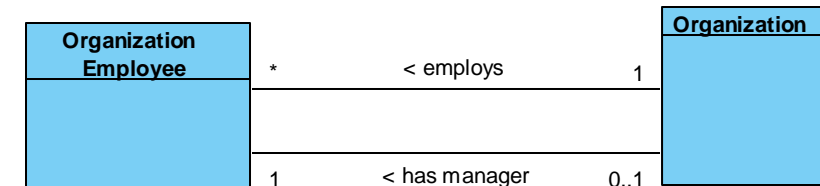
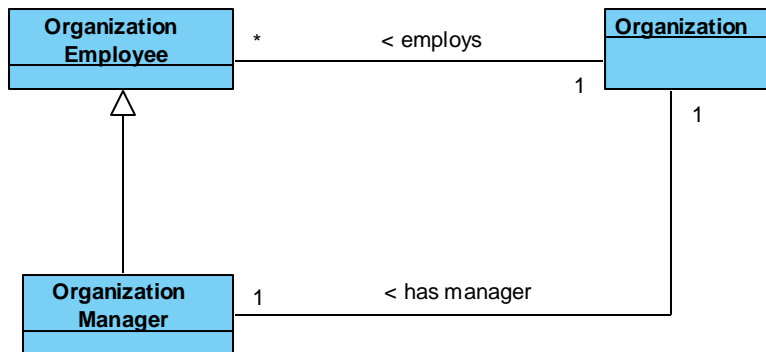
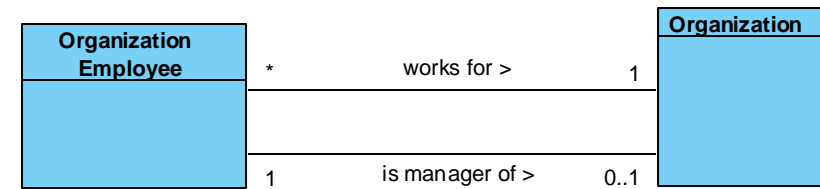
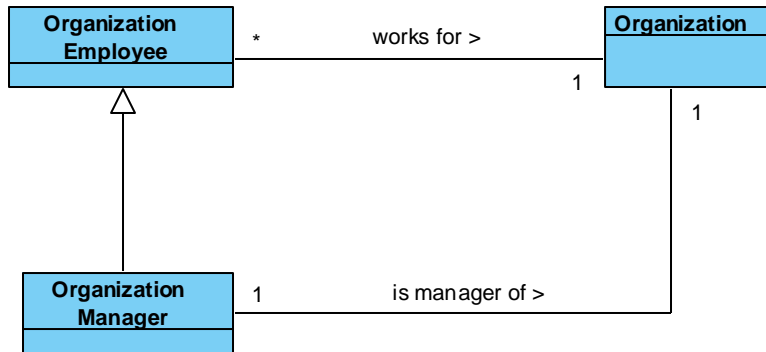
- Excerpts from the Project Specification Document

The platform is expected to be accessed by several users with different roles, such as:

- **Administrative:** these are responsible for managing the platform.
- **Organization Manager:** person appointed as manager of the organization when registering such organization on the platform; it is assumed to be an employee of that organization, being responsible for specifying other employees of the same organization on the platform.
- **Organization Employee:** someone acting on behalf of a particular organization; employees are responsible for specifying and cataloging tasks for later publication by the organization.
- **Freelancers:** people who propose to carry out tasks published by organizations.

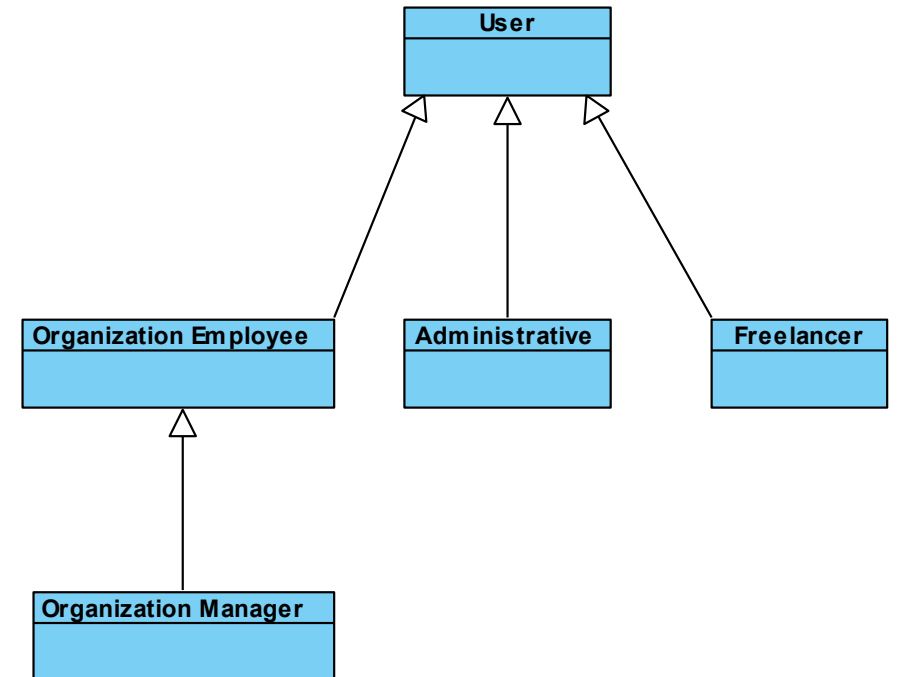
First scenario

- Considering the current domain/business, **which alternative is more suitable?**



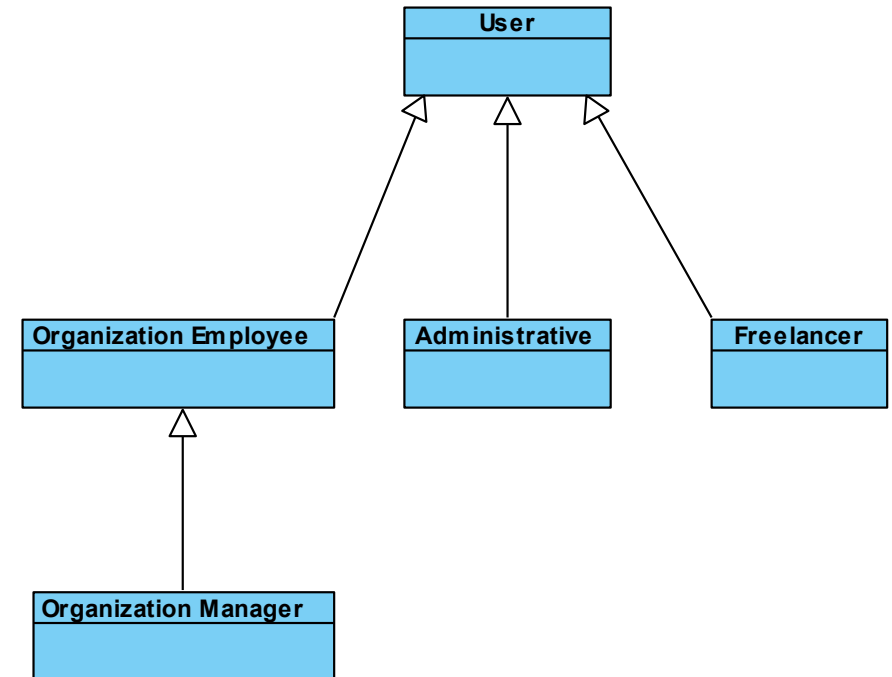
Second scenario (1/2)

- Considering the current domain/business, **can the same user be Administrative and Freelancer?** Does this model support it?



Second scenario (2/2)

- Considering the current domain/business, **can the same user be Administrative and Freelancer?** Does this model support it?
- Answer: **No!** Two distinct objects would be needed to represent the same real-world user.
- More about Modeling Roles in the *References & Bibliography* section



Generalization – OO Analysis vs. OO Design

- The use of generalization in the Domain Model (i.e. in Analysis) does not imply its adoption in the SW Design or Coding
 - There are other approaches (e.g. the use of interfaces)
- In OO Design, other situations for applying generalization (or polymorphism) can be identified (e.g. *implements* vs. *extends*)

References & Bibliography

- Larman, Craig; Applying UML and Patterns; Prentice Hall (3rd ed.); ISBN 978-0131489066
- Modeling Roles
(<https://objectdiscovery.com/solutions/publications/roles>)