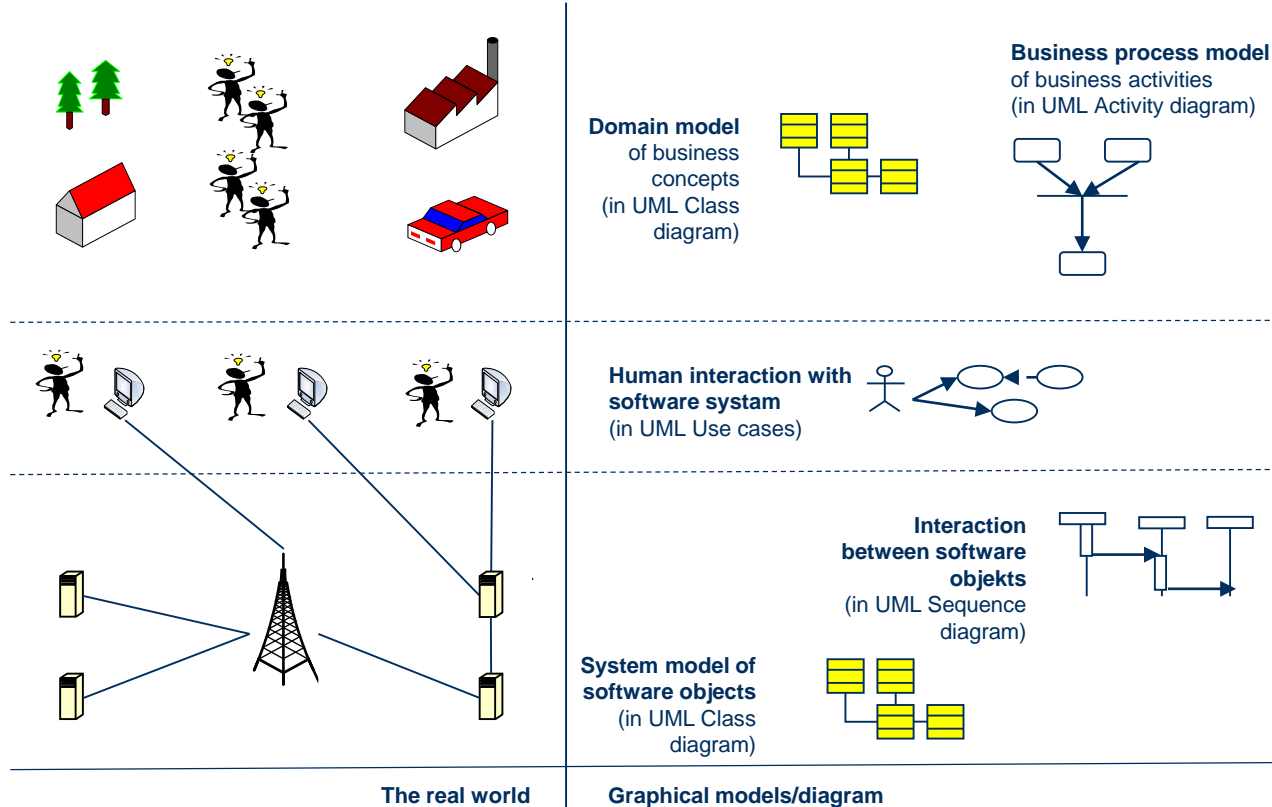# Conceptual modelling

Erik Perjons
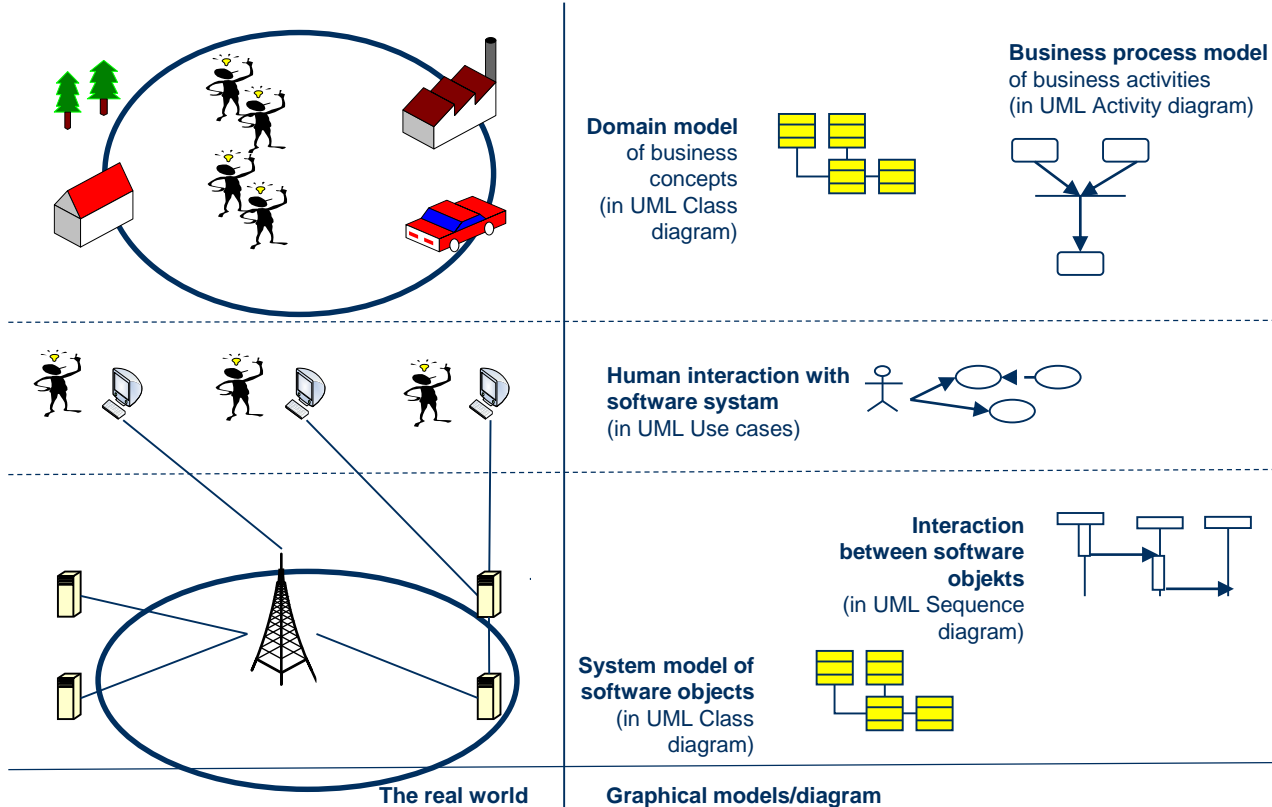
Questions to answer

- What is a concept?

- What is a conceptual model?

- Why do we create conceptual models?

- What is classification and generalization?
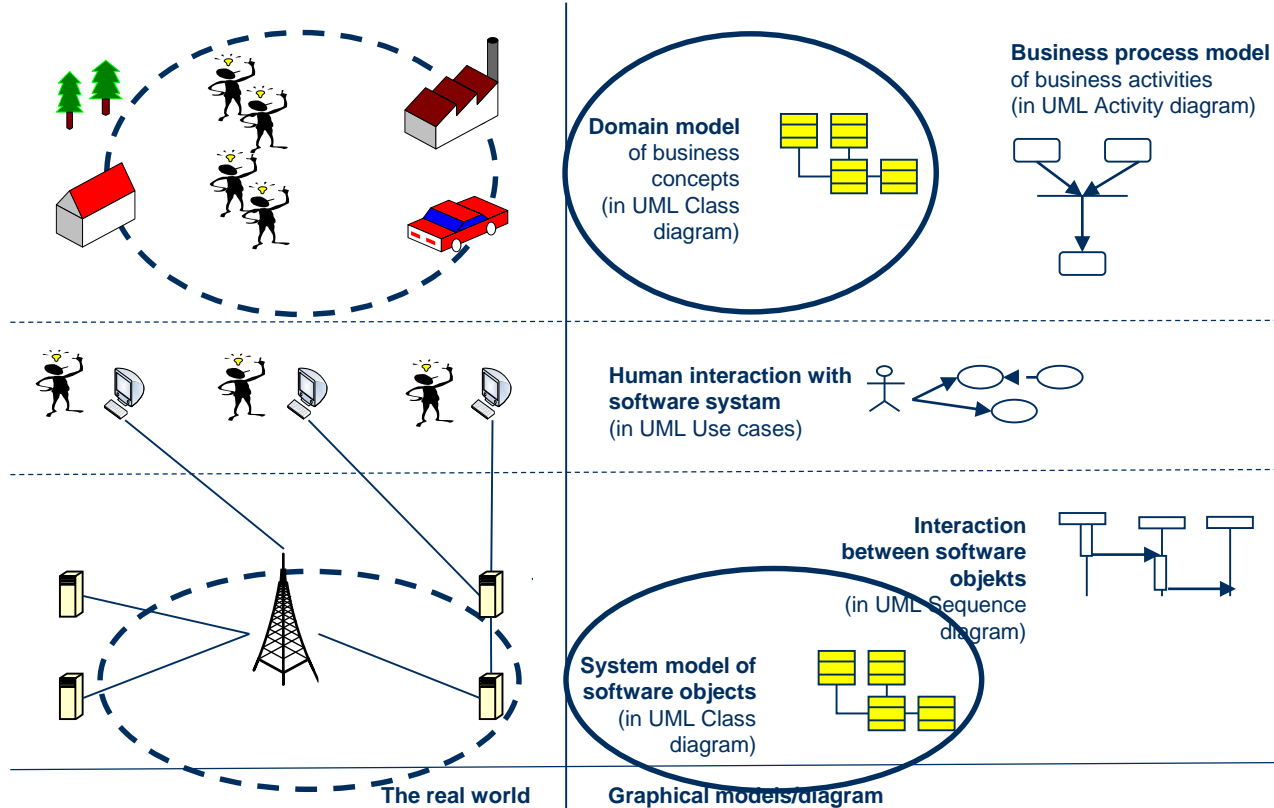
Concepts and Models

Real World and Models

Domain model of business concepts (in UML Class diagram)

Business process model of business activities (in UML Activity diagram)

Human interaction with software systam (in UML Use cases)

Interaction between software objekts (in UML Sequence diagram)

System model of software objects (in UML Class diagram)

The real world | Graphical models/diagram

Concepts (in Real World)

Domain model of business concepts (in UML Class diagram)

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The real world

Graphical models/diagram

Concepts (in the Real World)

Concept

- A concept is how we think about things or what we mean. A concept can be seen as thought unit or a mental view.

Concept

Term

- A term is a representation of a concept

- A term can be seen as a sign for the concept, for example, in form of a word, a group of words (phrase), or symbol
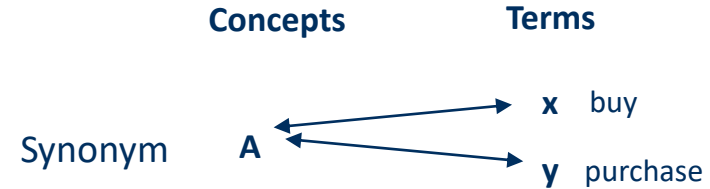
Term

```
"Computer"
```
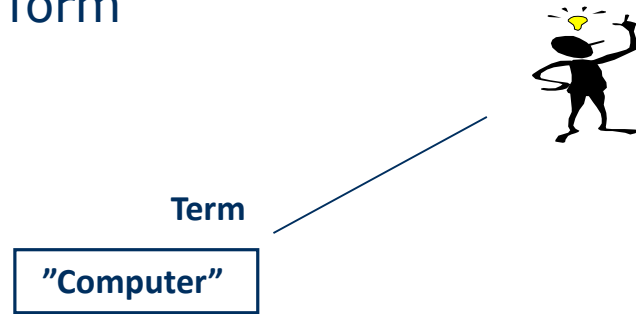
The Relation between Concept and Term

- In order to express a concept, a term is needed

- If the relationship between the term and the concept is ambiguous, interpretation problem can emerge.

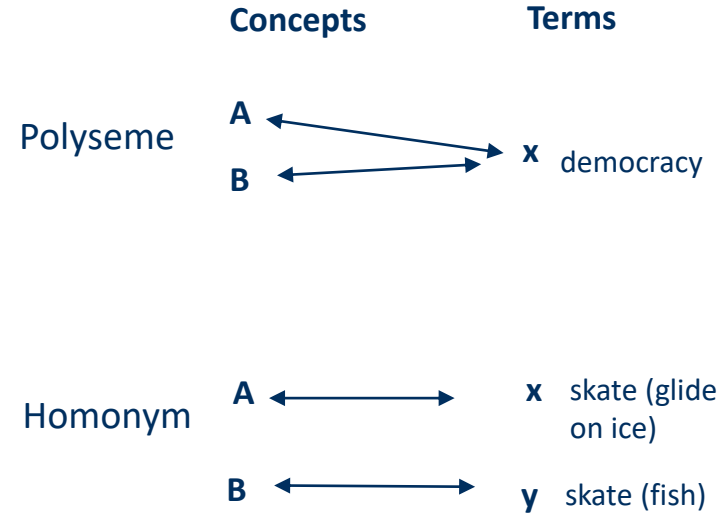- The existence of synonyms, polysemes, and homonyms can cause such problems

Concept

Term

"Computer"
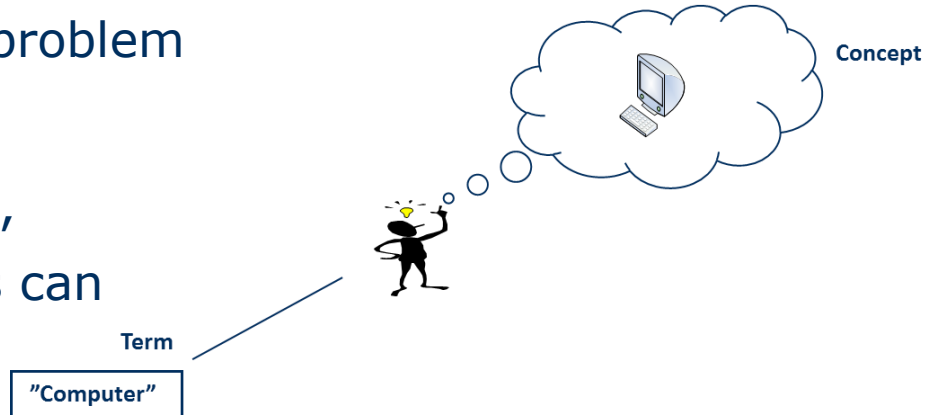
Synonym

- Synonym - is a term that means the same as another term in the same language (such as "buy" and "purchase", "big" and "large")

Concepts   **Terms**

Synonym   **A**   **x**   buy

                     y   purchase

Polyseme and Homonym

- Polyseme – is a term that have different but related meanings ("democracy" – different meaning in different economic systems, "service-oriented development")

- Homonym – is two terms with the same spelling or sound and have different meanings
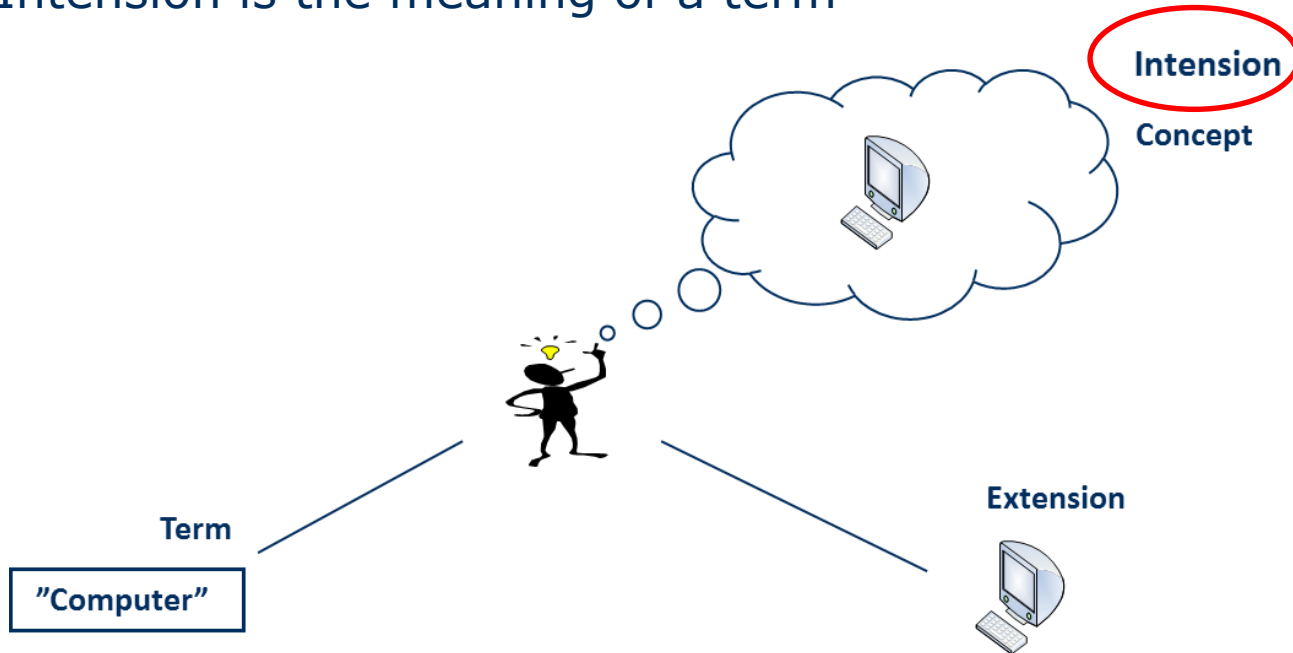
Concepts   **Terms**

Polyseme   A
               B   x   democracy

Homonym   A   x   skate (glide on ice)
               B   y   skate (fish)

Extension

- Extensions is the thing to which the concept (meaning) correspond, such as a physical thing

Concept

Extension

Term

"Computer"
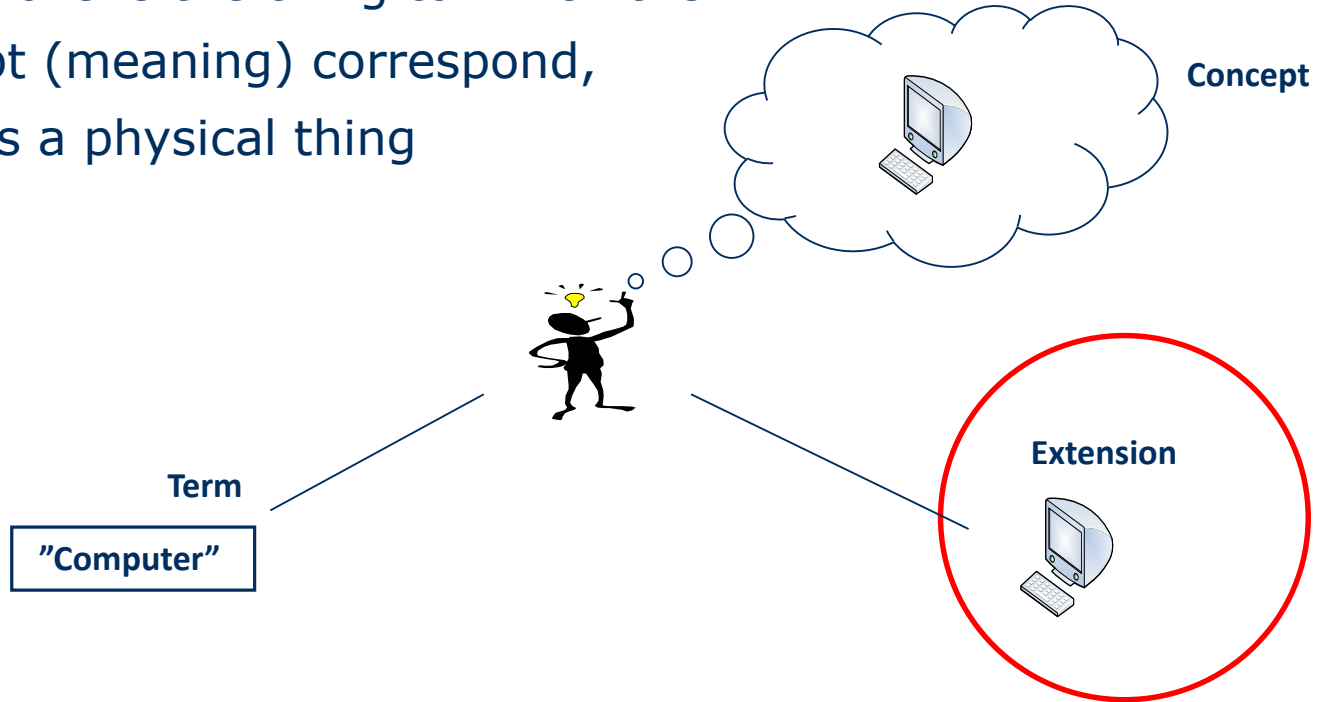
Intension

- Intension is the meaning of a term

Intension

Concept

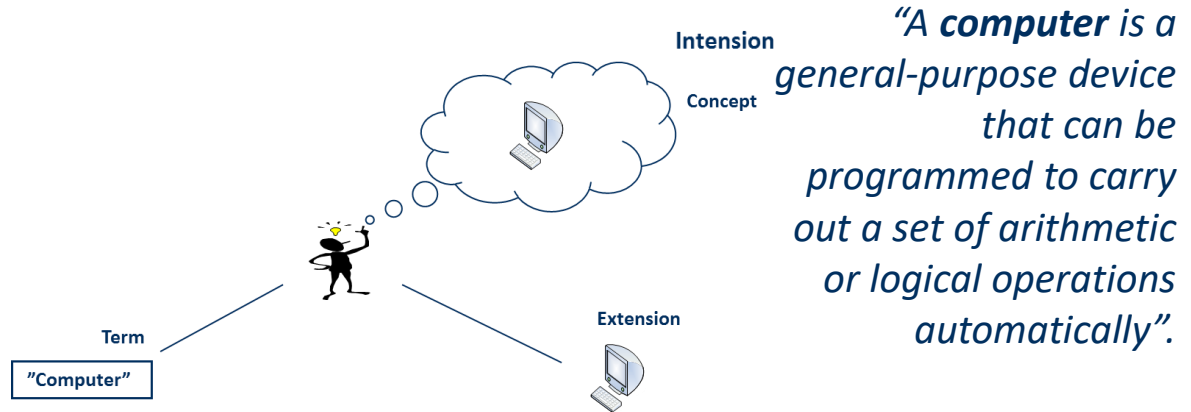Extension

Term

"Computer"

Definitions

- A **definition** is a statement of the meaning of a term

- Use definitions to limit possible interpretations of a term

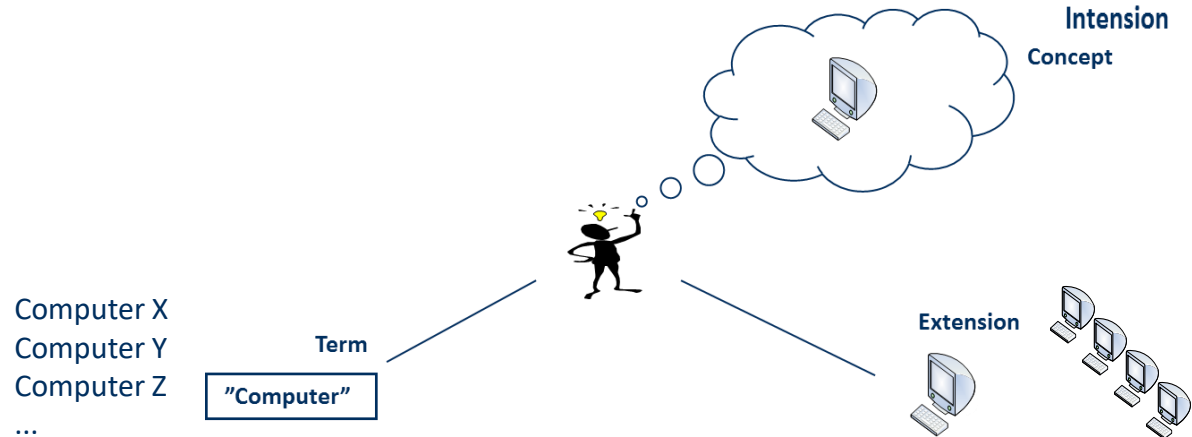- Definitions can be extensional or intensional

Intensional Definitions

- Intensional definition – specifies the characteristics of the concept that a term represent. For example, a *"bachelor"* is a *man that is unmarried,* and a *"computer"* is *....*

Intension

Concept

*"A **computer** is a general-purpose device that can be programmed to carry out a set of arithmetic or logical operations automatically".*

Term

"Computer"

Extension

Extensional Definitions

- Extensional definition – lists every thing in the extension that falls under the definition. For example, if the term to define is "computer" you need to list all computers, or the term is "bachelor" you need to list all unmarried men in the world

Intension
Concept

Extension

Computer X
Computer Y
Computer Z
...

Term

"Computer"

Guidlines for definitions

- **Use intensional definitions** and not extensional definitions if possible

- Start the intensional definition by using the expression **"X is ..."** or **"X means ..."** where X is replaced by the term to be defined and the "..." is the definition (*bachelor* is *a man that is unmarried*)

- Use the genus-differentia method when defining a term using an intensional definition

Genus-differentia method

- Exempel: A witness is a <u>person</u> that <u>tesify under oath at a trial</u>

- The genus-differentia method means that a term is defined by using both:

  1) the category (called genus) to which the *item* is suppose belongs to (such as person), and

  2) the characteristica that separate the *item* from other *items* in the same category (called differentia)

Concept-Term-Extension

- The Context-Term-Extension figure is similar to the Semiotic/Semantic Triangle

Intension
Meaning
Thought

Concept

Expression
Symbol

Term

"Computer"

Extension

Referent
Thing
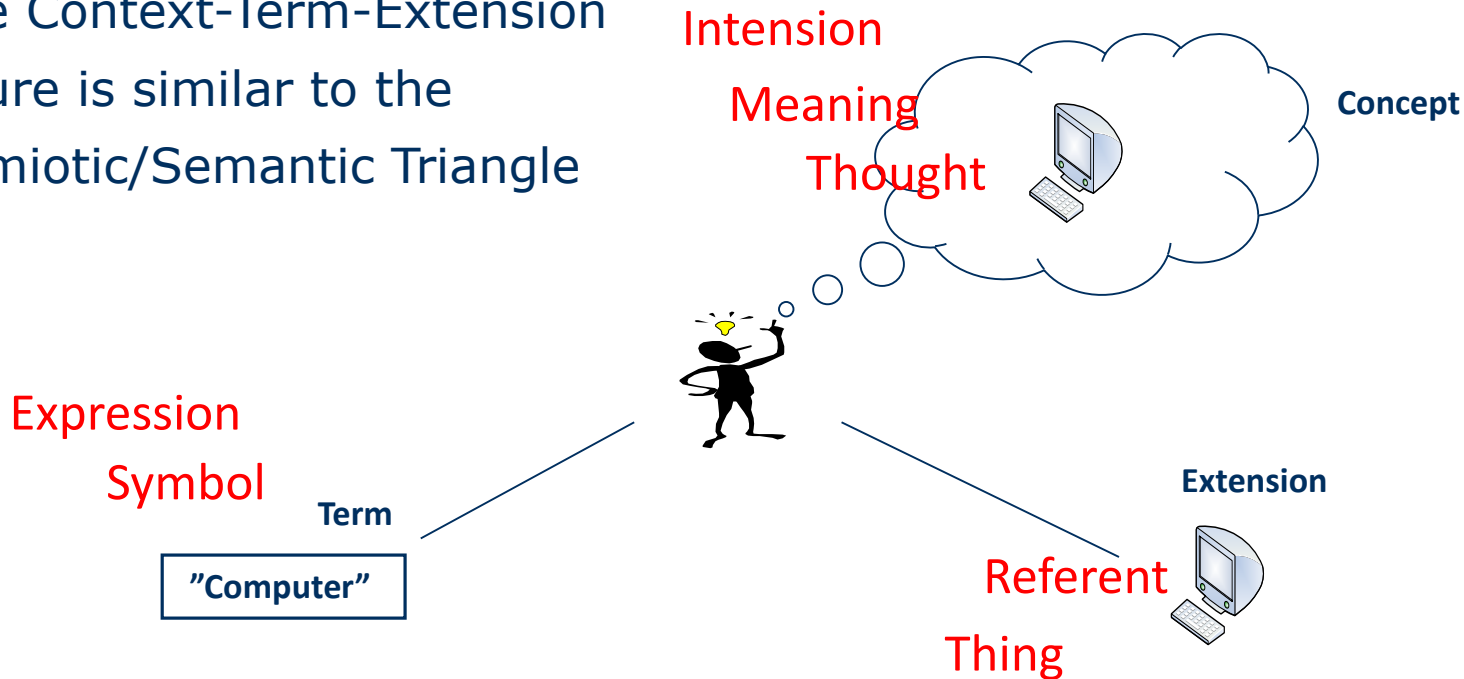
Conceptual Models

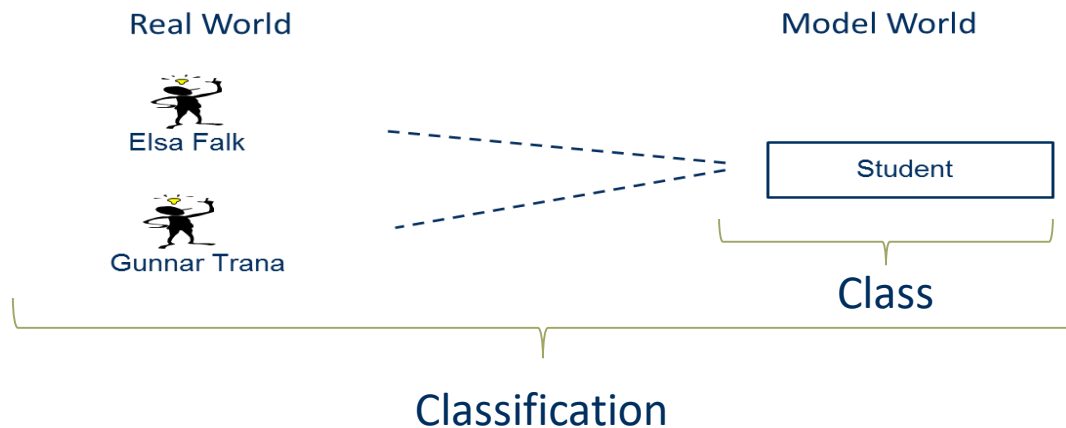# Modelling Instances

Real World

Model World

Elsa Falk

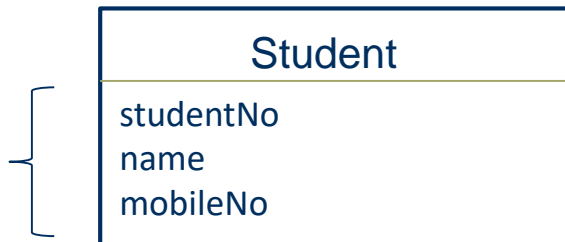Elsa Falk

Gunnar Trana

Gunnar Trana

Modelling a Group of Instances

- Modelling a **group of instances into a class** is called **classification**

- Classification means (in practice) that properties that are common are highlighted and properties that differs between the instances are disregared (for example, gender, hair colour, etc)

Real World

Elsa Falk

Gunnar Trana

Model World

Student

Class

Classification

Modelling Attributes of Class

Properties
/Characteristics
/Attibute

Student
studentNo
name
mobileNo

Creating Objects from the Class

- The class can be **used as a template** for **creating model instances** – often called **objects**. This "procedure" can be called **instantiation**

Student

studentNo
name
mobileNo

Elsa Falk:Student

studentNo=100123
Name=Elsa Falk
mobileNo=070-112233

Gunnar Trana:Student

studentNo=100204
Name=Gunnar Trana
mobileNo=070-223344
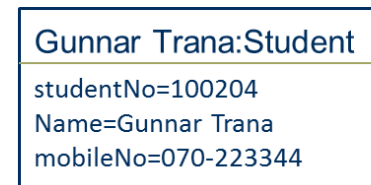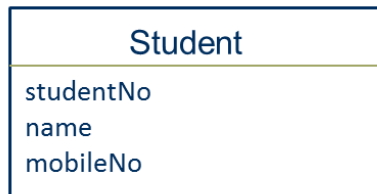
Modelling Class and Objects

Real World

Model World

Elsa Falk

Gunnar Trana

Student

studentNo
name
mobileNo

Elsa Falk:Student

studentNo=100123
Name=Elsa Falk
mobileNo=070-112233

Gunnar Trana:Student

studentNo=100204
Name=Gunnar Trana
mobileNo=070-223344

Classification

Class

Instansiation

Object

Class and Association Structure

- Relationships between classes are also modelled, creating a diagram/model

- Relationships between classes are called associations in UML

- The diagram/model can be seen as a "class and association structure"

Student
studentNo name mobileNo

registers for

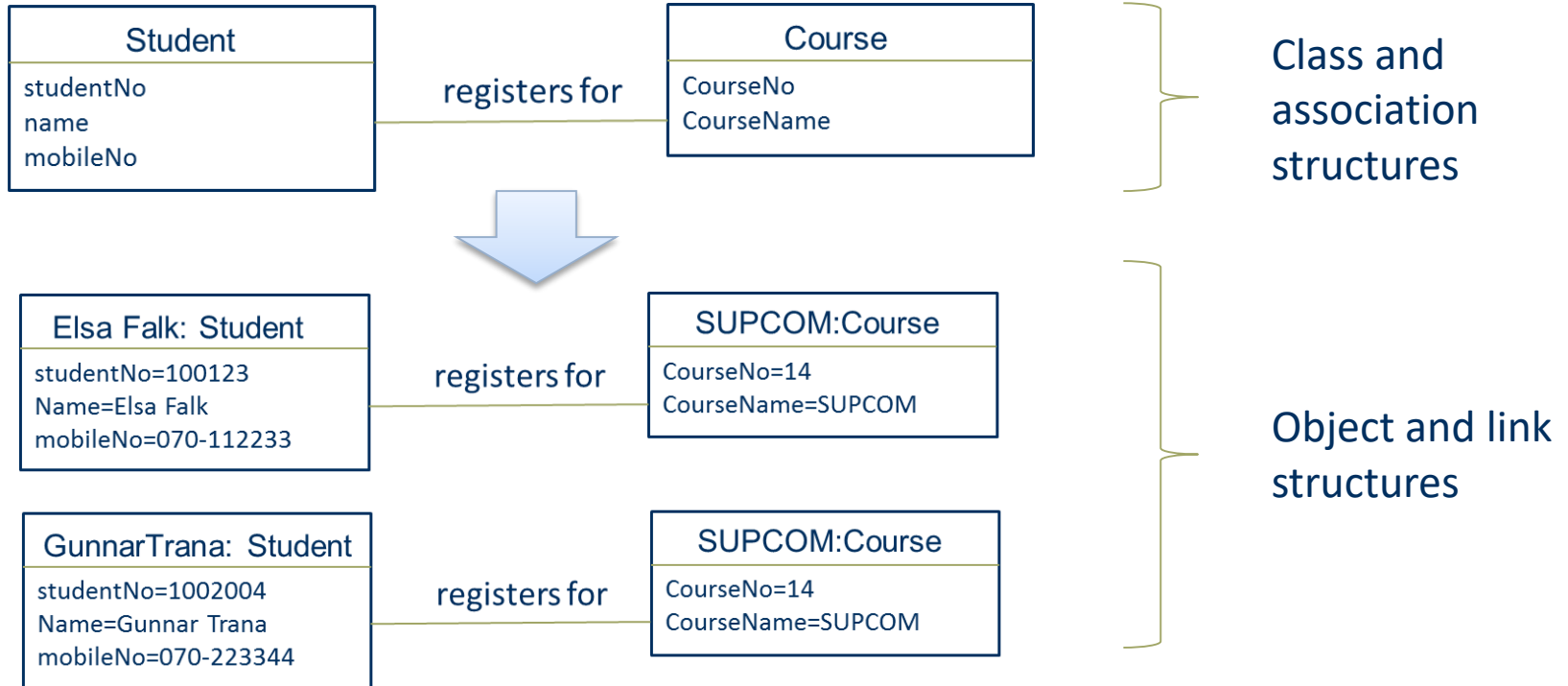| Course |
| --- |
| CourseNo
CourseName |

Class and Association Structure
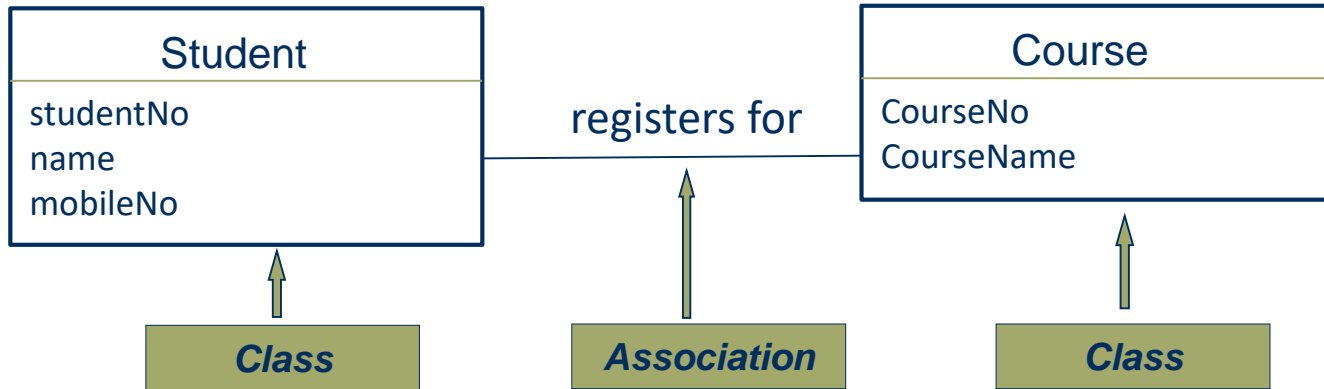
Class and Association Structure

- A class and association structure can be seen an **information structure**, constraining what objects and links are possible to create/instansiate

Student
studentNo
name
mobileNo

registers for

Course
CourseNo
CourseName

Creating Object and Link structures

Student
studentNo
name
mobileNo

registers for

Course
CourseNo
CourseName

Class and association structures

Elsa Falk: Student
studentNo=100123
Name=Elsa Falk
mobileNo=070-112233

registers for

SUPCOM:Course
CourseNo=14
CourseName=SUPCOM

GunnarTrana: Student
studentNo=1002004
Name=Gunnar Trana
mobileNo=070-223344

registers for

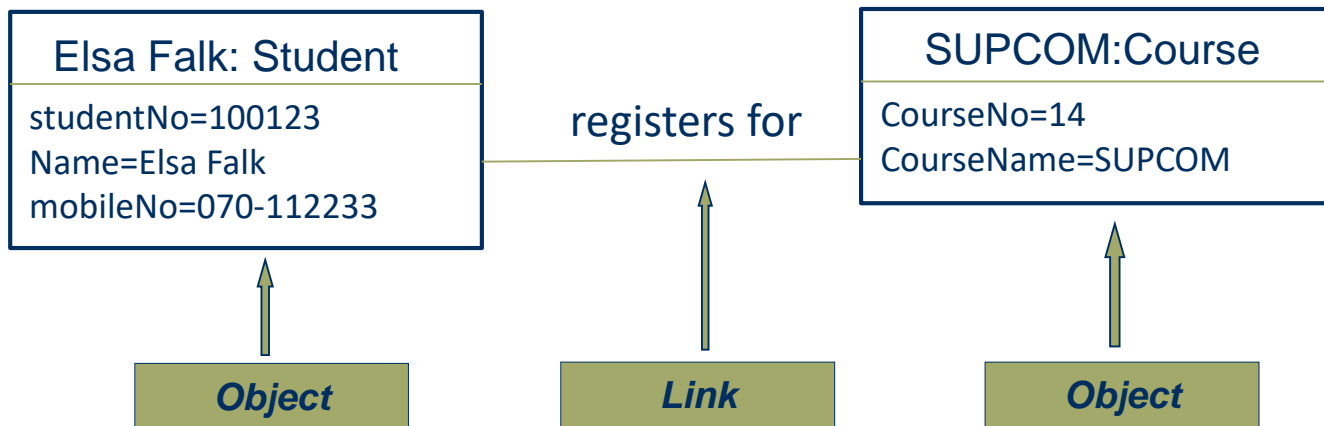| SUPCOM:Course |
|---|
| CourseNo=14 |
| CourseName=SUPCOM |

Object and link structures

Object and Link structures

- Object and link structures (compare SBVR's individual facts) are usually not modelled, but could be:

Elsa Falk: Student
studentNo=100123
Name=Elsa Falk
mobileNo=070-112233

registers for

SUPCOM:Course
CourseNo=14
CourseName=SUPCOM

Object and Link structures

- Object and link structures (compare SBVR's individual facts) are usually not modelled, but could be:

Elsa Falk: Student		SUPCOM:Course
studentNo=100123 Name=Elsa Falk mobileNo=070-112233	registers for	CourseNo=14 CourseName=SUPCOM

Object　　　**Link**　　　**Object**

Classification and Generalization

Back to the Real World: Classification

- **Classification** is grouping of instances.

- It means (in practice) that attributes that differs between the instances are disregared (for example, gender, hair colour) and and properties that are in common are highlighted

Woman (Class)   Student (Class)

Anna Svan   Elsa Falk   Gunnar Trana
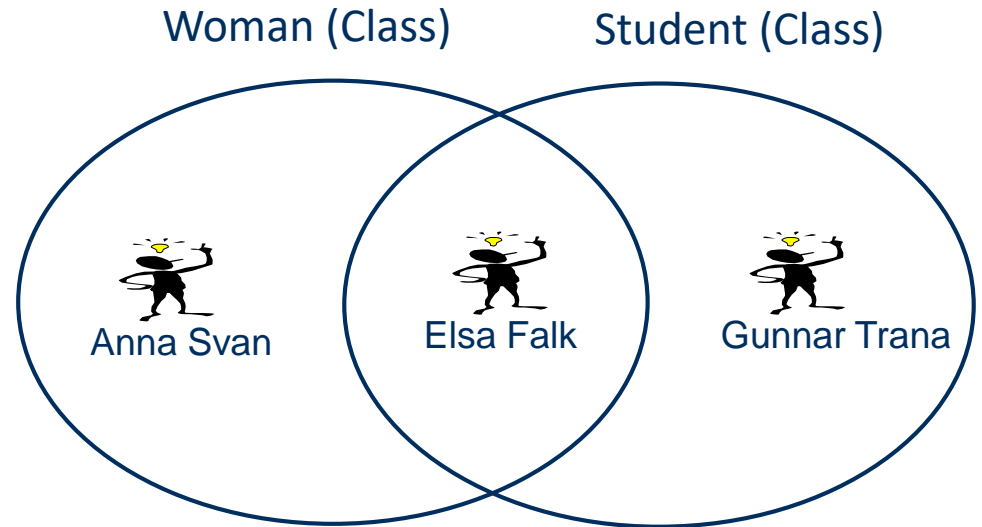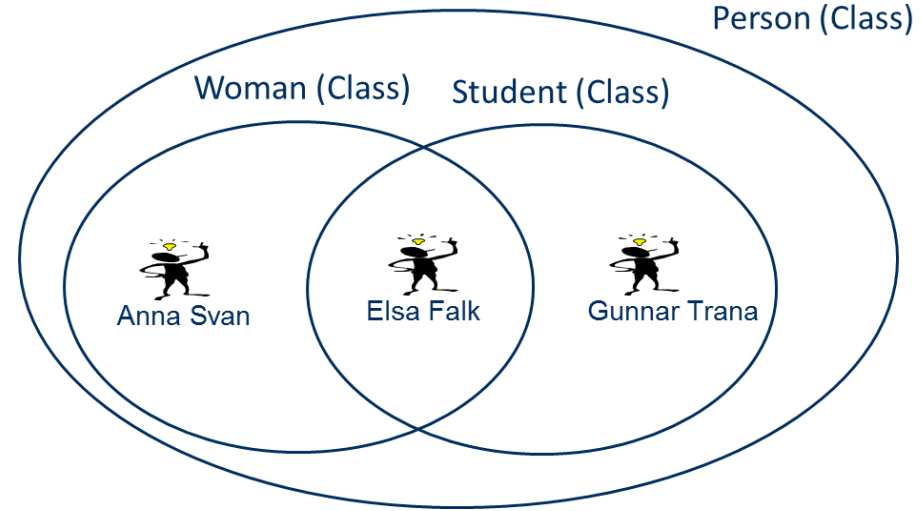
Generalization

- Generalizering are grouping of classes, where classes totally include others
- The opposite to generalization is specialization
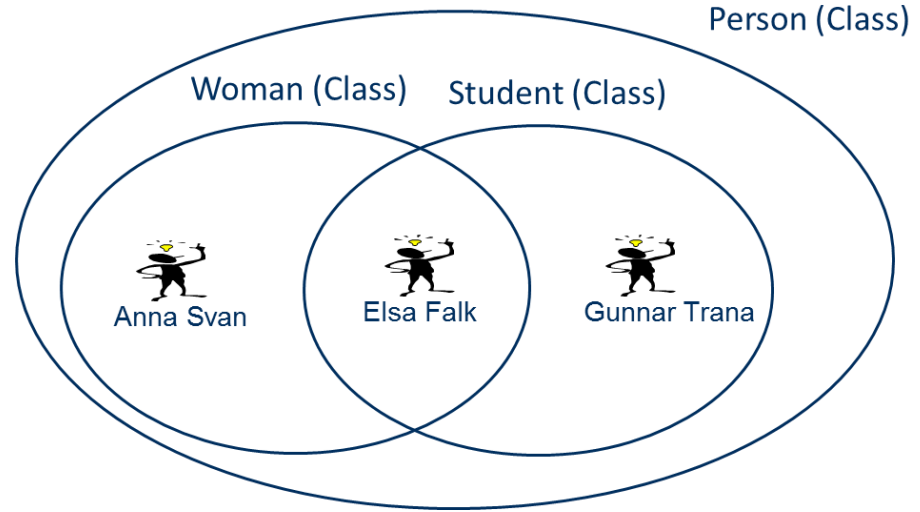
- Person is a generalization of Woman and Student
- Woman and Student are specializations of Person

Generalization Test

- To test if a relationship between two classes is a generalizering/ specialization relationship: Ask if all instances in a specialized (sub) class are included in the generalized (super) class – if "yes" it is a generalizering/ specialization relationship

Question: Is Woman a generalization of Student?
Answer: No, there are instances of Student that ar not instances of Woman

Modelling generalization in UML

Real World

The Model World
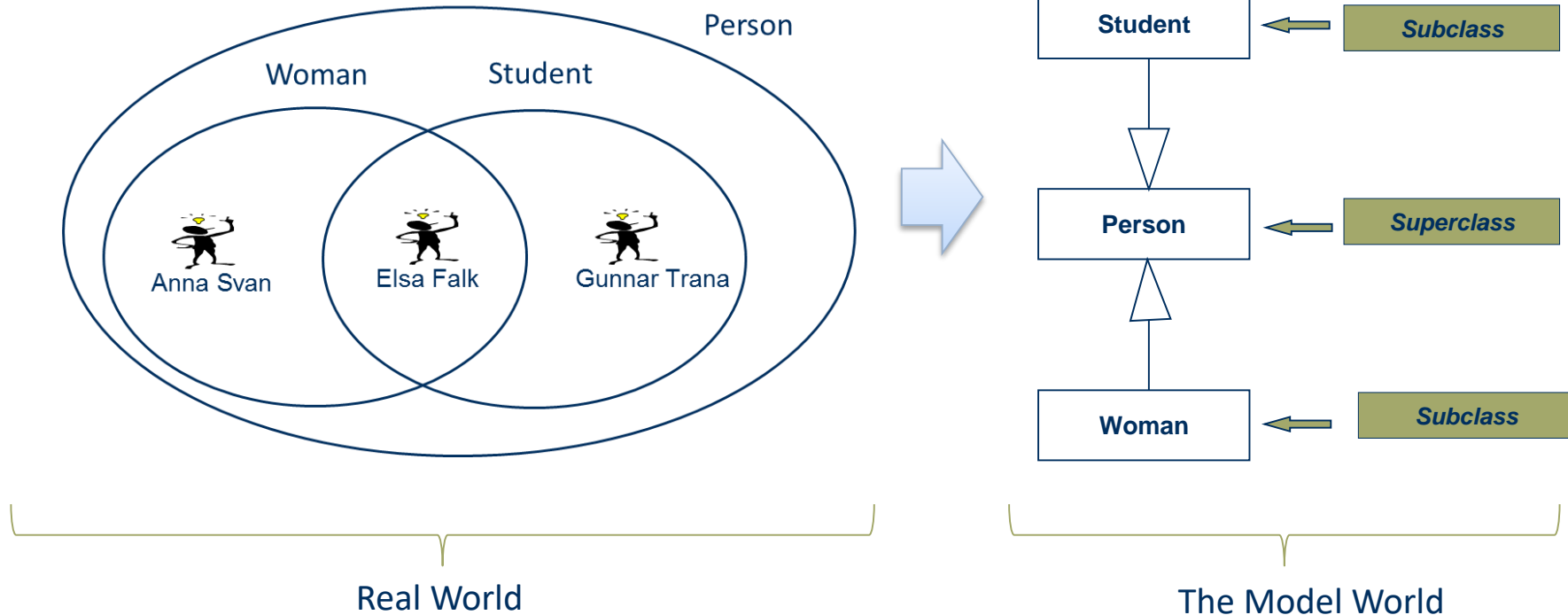
Why Conceptual Modelling?

- To **specify terms and concepts that are - or should be - used in a organization**. Thereby, support the **development of a common vocabulary,** which will support communication within the organization

- To **specify terms and concepts for an information system** so that the system use the same terms and concepts as the people in the organization, thereby **supporting business and IT alignment**

Why Conceptual Modelling?

- To be used as a **first step as developing a database system or a Java program** (or a programme of some other programming language). The conceptual model can be also be used by model driven development tools to automatically generate part of the database schema or Java code

- To **support integration between departments, organizations, information systems,** by specifying the differences between terms and concepts used

Questions to answer

- What is a concept?

- What is a conceptual model?

- Why do we create conceptual models?

- What is classification and generalization?