

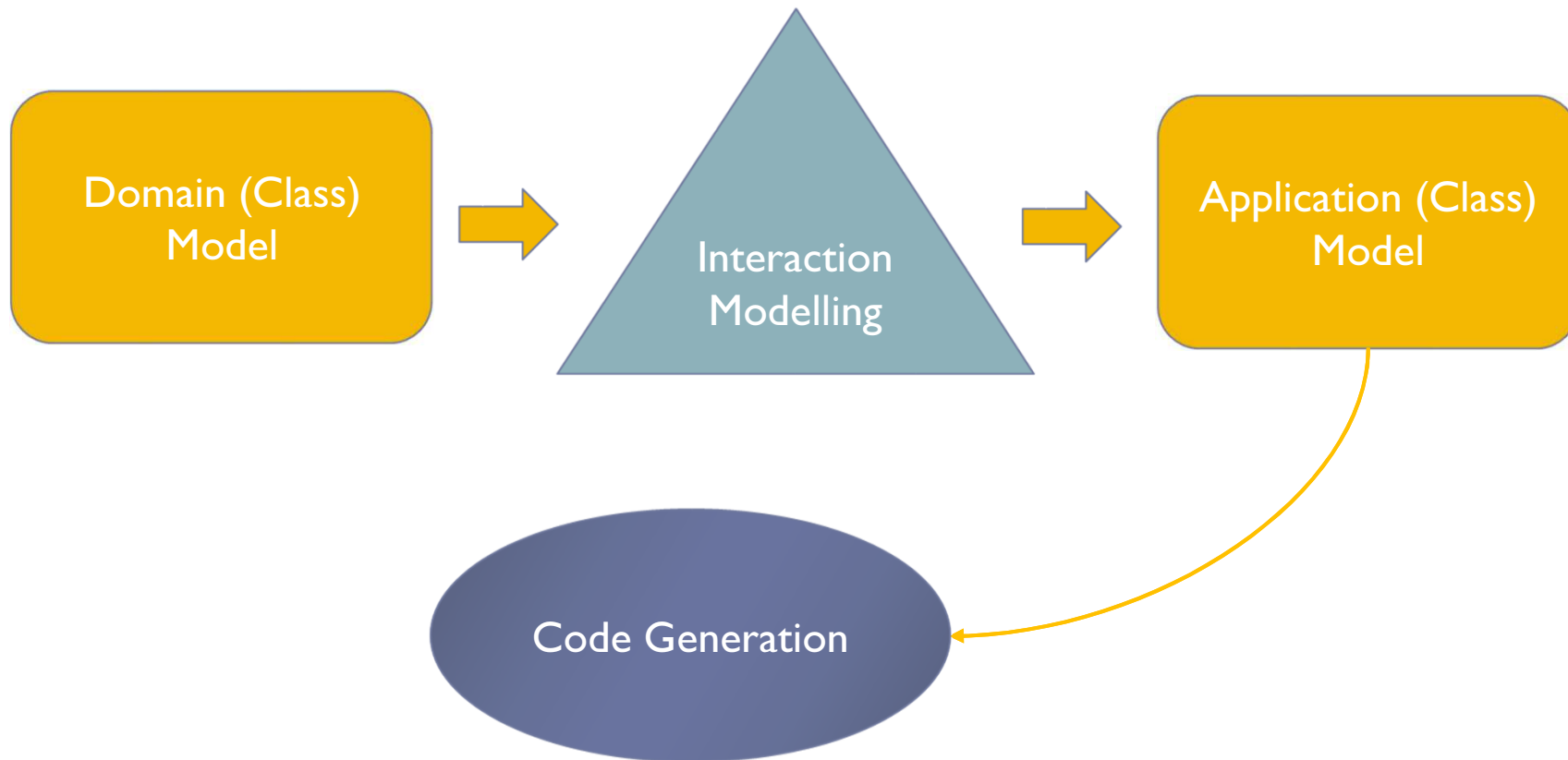


Class modeling (part2)

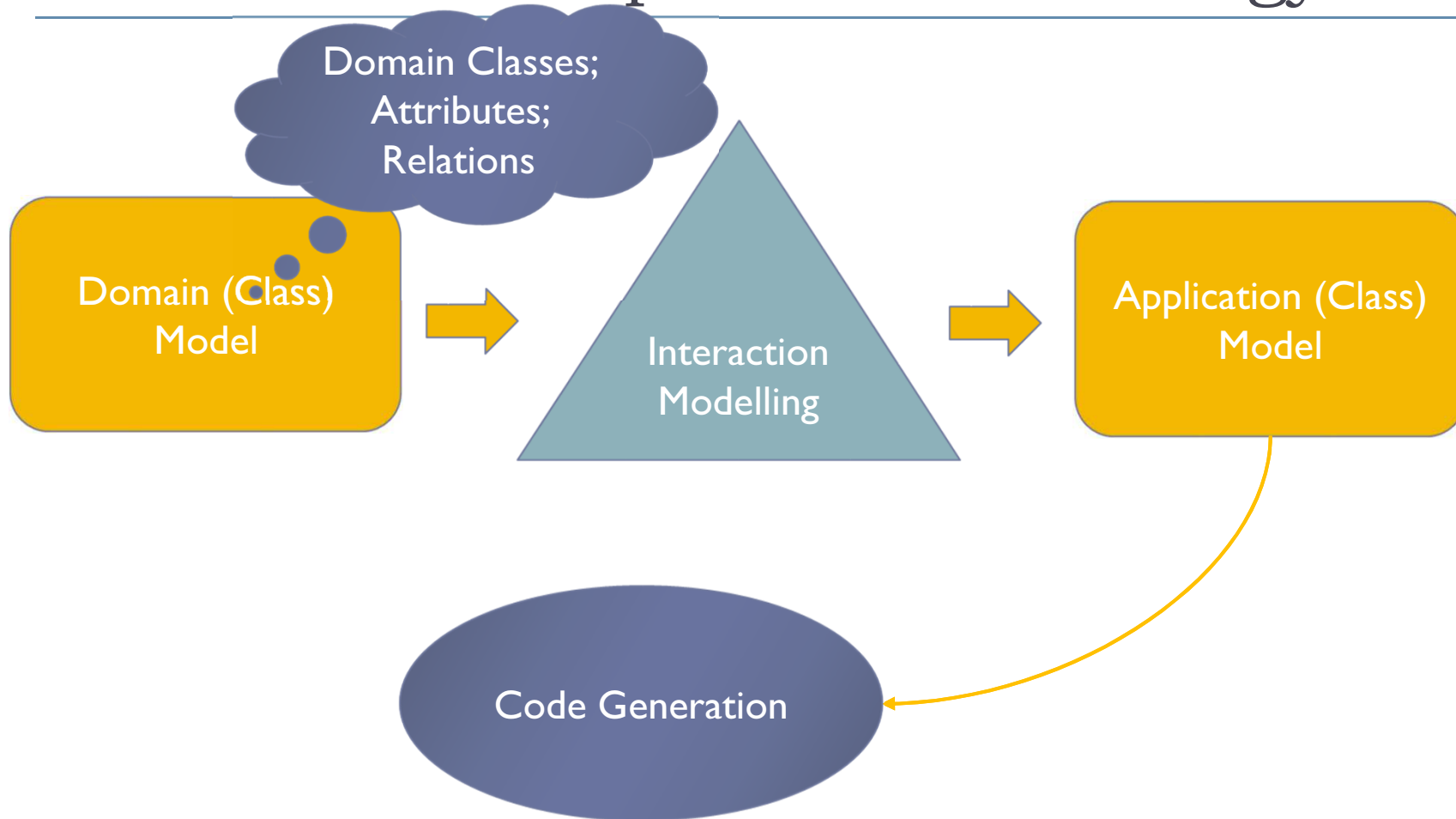
Fabrizio Maria Maggi

Institute of Computer Science

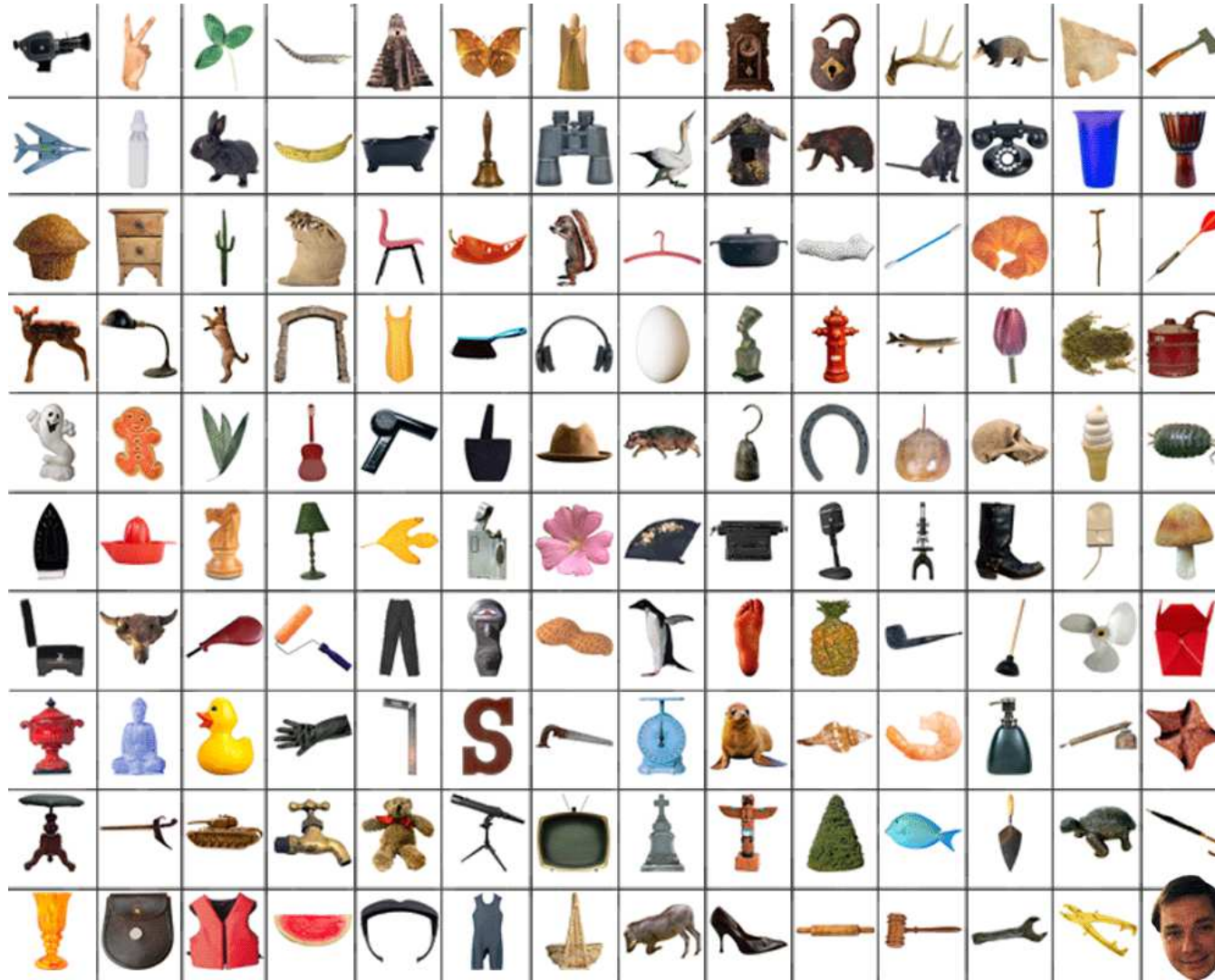
Software Development Methodology



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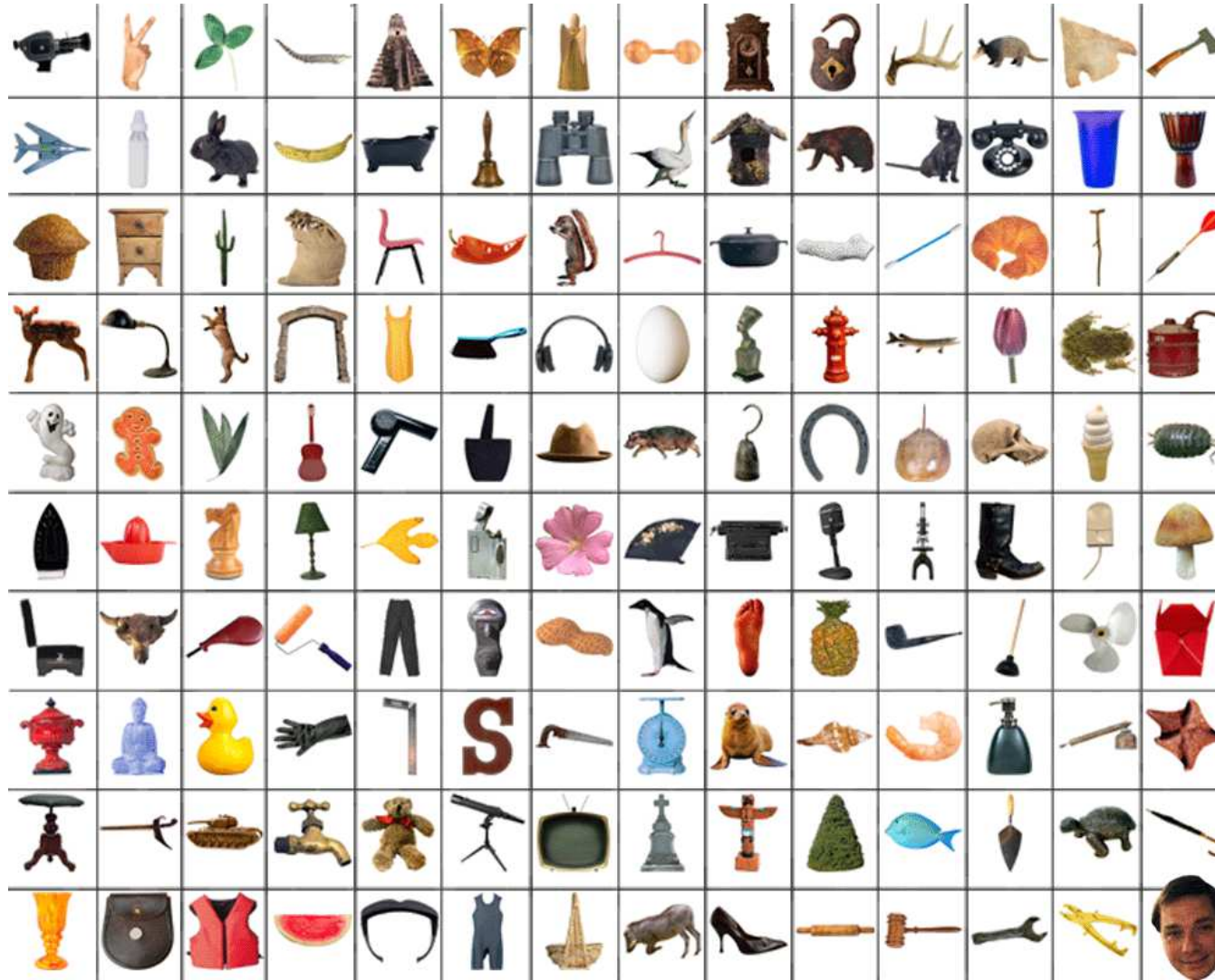


Domain (Class) Model



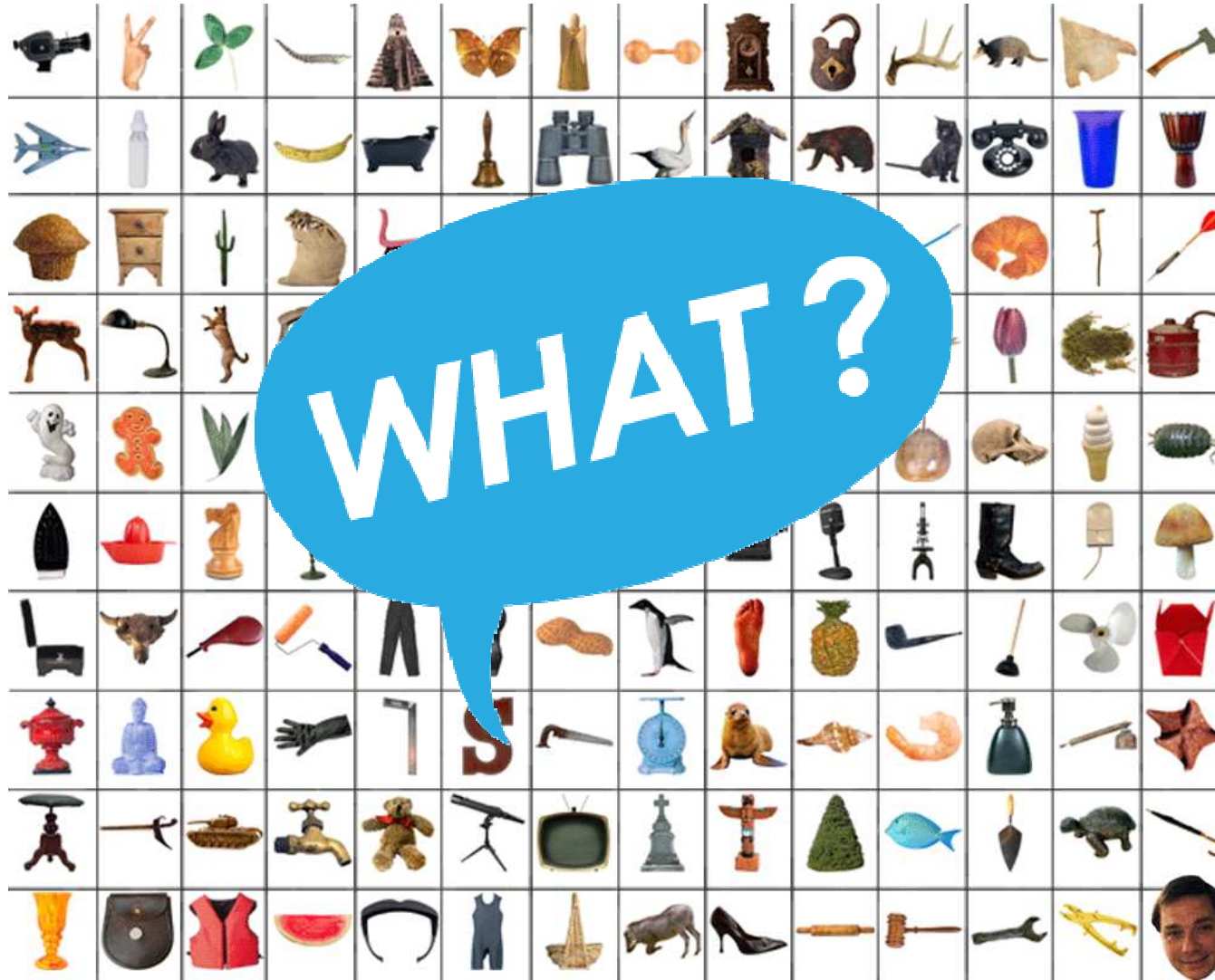
Domain (Class) Model

Domain Entities



Domain (Class) Model

Domain Entities



Domain (Class) Model



- ▶ To answer this question, the domain model provides classes with attributes and relations among them
- ▶ Operations are **not** specified

How to create Domain Models

Class Modelling

▶ Classes

- ▶ A class describes a group of objects with the same properties (attributes), behavior (operations), kinds of relationships and semantics
- ▶ Classes often appears as nouns in problem descriptions with users

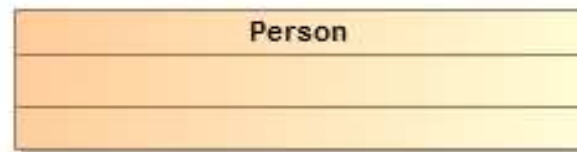
▶ Objects

- ▶ An object is a concept, abstraction or thing with identity that has a meaning for an application
- ▶ An object is an instance of a class

Class Diagrams

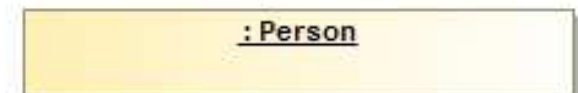
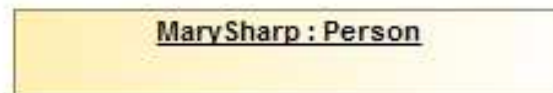
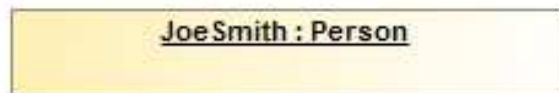
▶ Class

- ▶ UML notation: box with a class name



▶ Object

- ▶ UML notation: box with an object name followed by a colon and a class name. The object name and the class name are both underlined



Exercise 1: Domain Entities?

- ▶ Each company has a name. A company consists of departments. Each department has a name and is located in one or more offices. Each office is in a certain address. Each department has a manager and a set of employees. Each employee has a name and a title.

Exercise 1: Domain Entities?

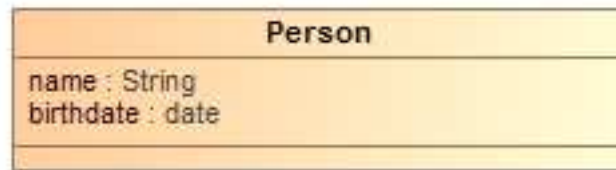
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Attributes and Values

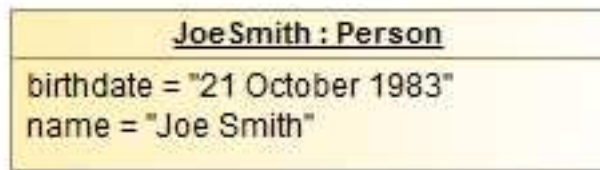
▶ Attribute

- ▶ An attribute is a named property of a class that describes a value held by each object of the class
- ▶ UML notation: attributes are listed in the second compartment of the class box. Optional details, such as type and default value, may follow each attribute



▶ Value

- ▶ A value is a piece of data
- ▶ UML notation: values are listed in the second compartment of the object box



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Characteristics of Domain Entities

Operations and Methods

▶ Operations

- ▶ An operation (function or procedure) may be applied by or to objects in a domain
- ▶ UML notation operations are listed in the third compartment of the class box



▶ Methods

A method is the implementation of an operation for a class

(Binary) Links and Associations

▶ Link

- ▶ A link is a physical or conceptual connection among objects
- ▶ UML notation: line between objects. A link can have a name (underlined)

▶ Association

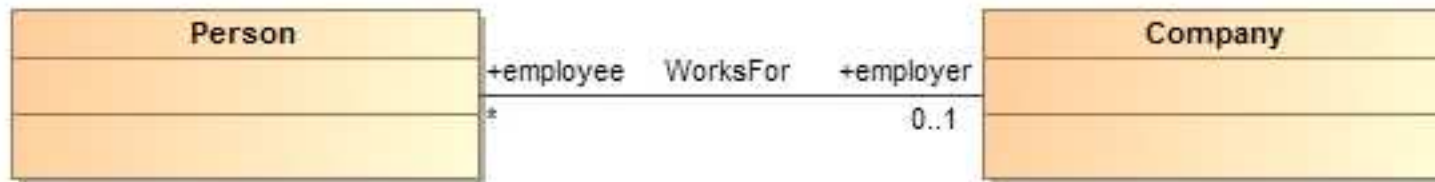
- ▶ An association is a description of a group of links with common structure and common semantics
- ▶ UML notation: line between classes. An association can have a name (not underlined)

Multiplicity

- ▶ Specifies the number of instances of one class that may relate to a single instance of an associated class
- ▶ UML notation: specified at the end of the association lines
 - ▶ Examples: “1” (exactly one); “3..5” (three to five, inclusive); “*” (many, zero or more)

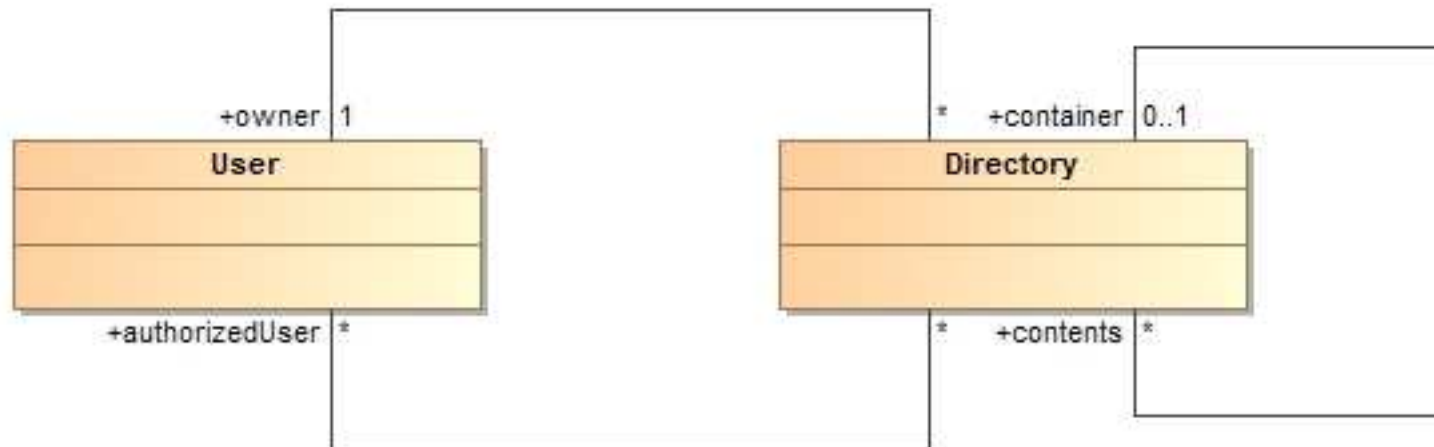
Association end names

- ▶ Association ends can be provided with a name as well as with a multiplicity

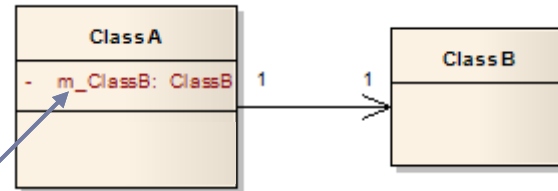


Association end names

- ▶ Association end names are necessary for associations between two objects of the same class. They can also distinguish multiple associations between a pair of classes
- ▶ Association end names as pseudo attributes



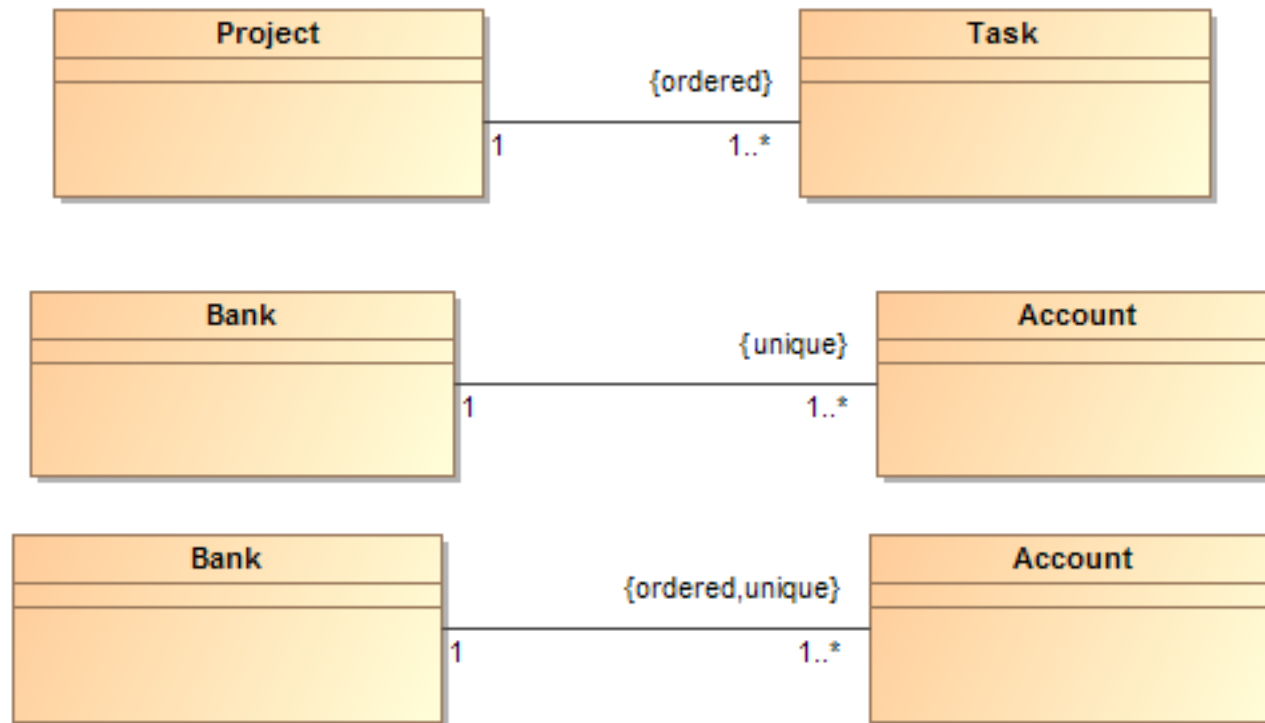
Associations as References



Association end name

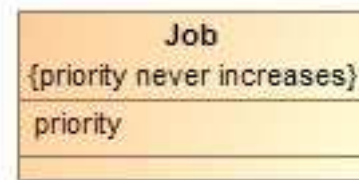
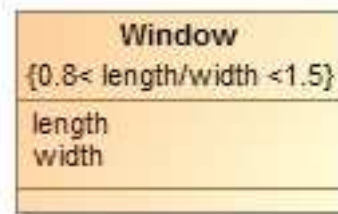
Constraints

- ▶ A constraint is a condition involving model elements, such as objects, classes, attributes, links, associations.
 - ▶ A constraint specifies limitations that implementers need to satisfy.



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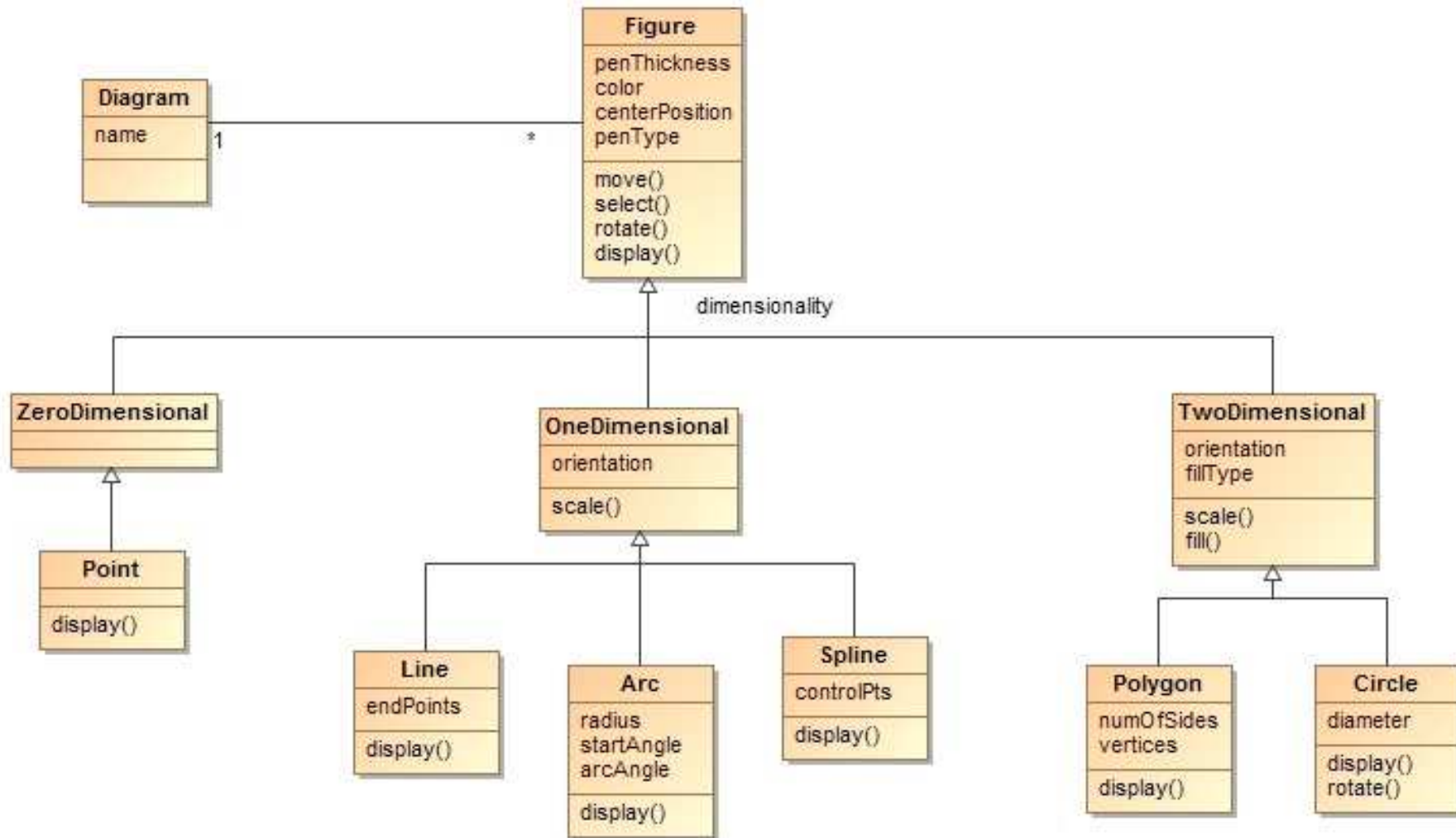
Generalization and Inheritance

- ▶ **Generalization** is the relationship between a class (superclass) and one or more variations of the class (subclasses)
 - ▶ The superclass holds common attributes, operations and associations. The subclasses add specific attributes, operations and associations (each subclass is said to inherit the features of its superclass)
 - ▶ Simple generalization organizes classes into a hierarchy
 - ▶ There can be multiple levels of generalizations
 - ▶ A large arrowhead denotes generalization. The arrowhead points to the superclass
- ▶ A **generalization set name** is an enumerated attribute that indicates which aspect of an object is being abstracted by a particular generalization

Ancestors and Descendants

- ▶ **Generalization is transitive across an arbitrary number of levels:**
 - ▶ An instance of a subclass is also instance of all its ancestor classes
 - ▶ An instance includes a value for every attribute of every ancestor class
 - ▶ An instance can invoke any operation of any ancestor class
 - ▶ Each subclass not only inherits all the features of its ancestors but add its own specific features as well

Generalization and Inheritance

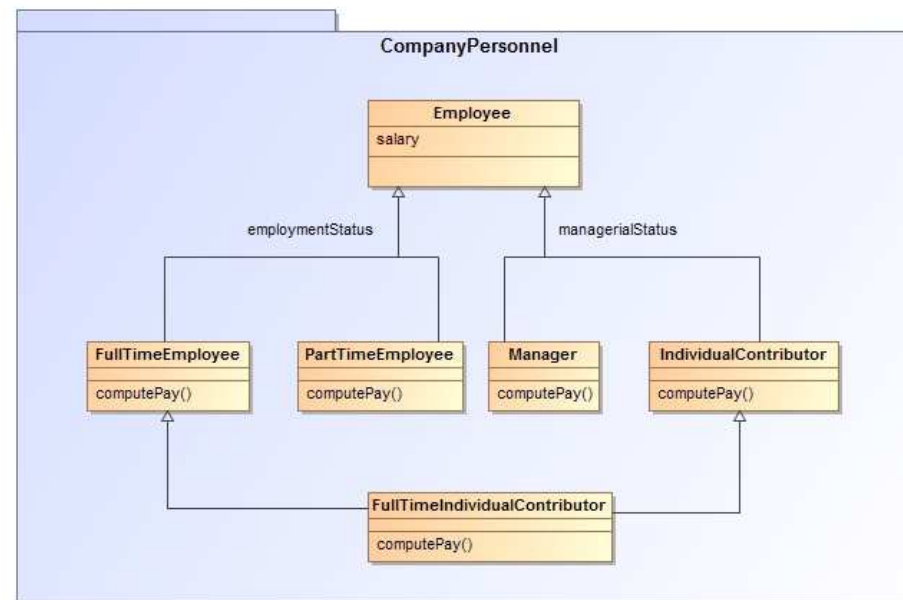


Use of Generalization

- ▶ **Polymorphism**
 - ▶ Increases the flexibility of software. You can add a new subclass to inherit the superclass behavior without disrupting existing code
- ▶ **Objects taxonomy**
 - ▶ Organizes objects on the basis of their similarities and differences
- ▶ **Reuse of code**
 - ▶ You can inherit code within your application as well as from past work

Packages

- ▶ You can fit a class model on a single page for many small and medium-sized problems
 - ▶ However it is often difficult to grasp the entirety of a large model.
- ▶ A package is a group of elements (classes, associations, and nested packages) with a common theme.
 - ▶ A package partitions a model making it easier to understand and manage,
- ▶ The UML notation for a package is a box with a tab:
 - ▶ The tab suggests the enclosed content, like a tabbed folder.



Exercise 1: Relations?

- ▶ Each company has a name. A company consists of departments. Each department has a name and is located in one or more offices. Each office is in a certain address. Each department has a manager and a set of employees. Each employee has a name and a title.

Exercise 2: Domain Entities?

- ▶ A school has a name and can have many students. A student is associated to a name, a student ID and a date of birth. Each student has to take a course but one student can take at most 6 courses. Each course has a title. For a course there is at least one student in the school who has taken the course. Each course has one professor. Each professor has a name and a room number. A professor can teach several courses.

Exercise 2: Attributes?

- ▶ A school has a name and can have many students. A student is associated to a name, a student ID and a date of birth. Each student has to take a course but one student can take at most 6 courses. Each course has a title. For a course there is at least one student in the school who has taken the course. Each course has one professor. Each professor has a name and a room number. A professor can teach several courses.

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Exercise 3: Domain Entities?

- ▶ The cinema booking system should store seat bookings for multiple theatres. A theatre has a name and an address. Each theatre has seats arranged in rows. Customers can reserve seats and are given a row number and seat number. They may request bookings of several adjacent seats. Each booking is for a particular show (i.e., the screening of a given movie at a certain time). Shows are at an assigned date and time, and scheduled in a theatre where they are screened. The system stores the customers telephone numbers.

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Exercise 4: Domain Entities?

- ▶ A paper reviewing system has several conferences. Each conference has a title and a year and is managed by a chair and a list of committee members. Committee members and chairs must be assigned to one, but possibly more conferences. They have a name and an affiliation. A conference has several submitted papers, but a paper can be submitted to only one conference. A paper is assigned to 3 reviewers taken from the committee members. A paper can be accepted rejected or under review. We also know the paper titles and list of authors with their names and affiliations.

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Exercise 5: Domain Entities?

- ▶ A library system is used to manage physical items borrowings in different libraries. Each library has a name and a digital catalog of library items – that can be of type book, CD or DVD. Each item in the catalog is identified by an ID. Items are barcoded. The purpose of barcoding is to link the barcoded physical item to the electronic record in the catalog. The barcode contains the item's ID, title and type. The system also contains a list of borrowers with their names, addresses and phone numbers. Each borrower can borrow several library items. Each borrowing has a borrowing date and a returning date.

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Exercise 6: Domain Entities?

- ▶ The customers use banking application of a bank to manage current and saving accounts of customers. Each account has an account number and an opening date. We assume that a customer at least has a current account. No customer can have more than one account of the same type. The bank also has a manager who has administrator privileges. In the application, a customer or a manager is represented by a user profile that contains the name, date of birth, username, password and role. The role can be either customer or manager. A manager cannot have any account.

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