Class modelling (part1)

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(these slides are derived from the book "Object-oriented modeling and design with UML")

UML and OO approaches

Unified Modeling Language (**UML**) is a standardized, general-purpose modeling language. UML includes a set of graphic notation techniques to create visual models of object-oriented (OO) software-intensive systems

- An OO approach includes 4 aspects:
  - Identity
    - Data organized into discrete distinguishable entities (***objects***)
  - Classification/Abstraction
    - Objects with the same attributes and operations are grouped into a ***class***
    - Each object is said to be an ***instance*** of its class
  - Inheritance
    - Sharing of attributes and operations (***features***) among classes based on a hierarchical relationship
    - A superclass has general information that subclasses refine and elaborate
  - Polymorphism
    - The same operation may behave differently for different classes

OO development

[Brooks-95]
The hard part of software development is the manipulation of his *essence*, owing the inherent complexity of the problem, rather than the *accidents* of its mapping into a particular language.

- A clean design in a precise notation
  - facilitates integration, maintenance, enhancement and the entire software lifecycle
  - provides useful documentation
- Design flaws that surface during implementation are more costly to fix than those that are found earlier
- A premature focus on implementation restricts design choices and leads to an inferior product

UML models

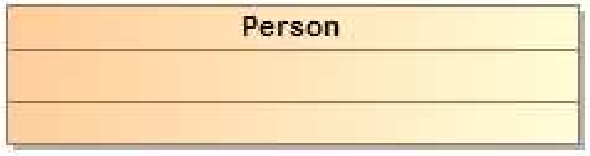
- Class model
  - Static structure of objects and their relationships
  - ***Class diagrams***
    - Nodes are classes and arcs are relationships among classes
- Interaction model
  - How the objects in a system cooperate to achieve broader results
  - ***Use cases***
    - Describe the functionalities of a system
    - Are elaborated with ***sequence diagrams*** (object interactions and time sequence of their interaction) and ***activity diagrams*** (processing steps)
- State model
  - Aspects of an object that change over time
  - ***State diagrams***
    - Nodes are states and arcs are transitions between states caused by events

Class modelling

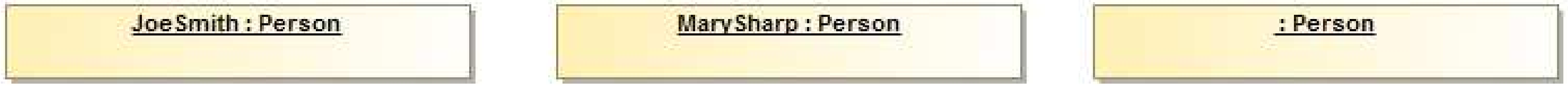
- Classes
  - A class describes a group of objects with the same properties (attributes), behavior (operations), kinds of relationships and semantics
  - Classes often appears as nouns in problem descriptions with users
- Objects
  - An object is a concept, abstraction or thing with identity that has a meaning for an application
  - An object is an instance of a class

Class diagrams

- Class
  - UML notation: box with a class name

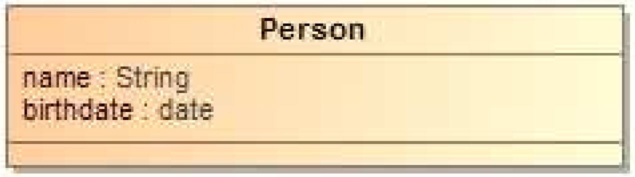


- Object
  - UML notation: box with an object name followed by a colon and a class name. The object name and the class name are both underlined

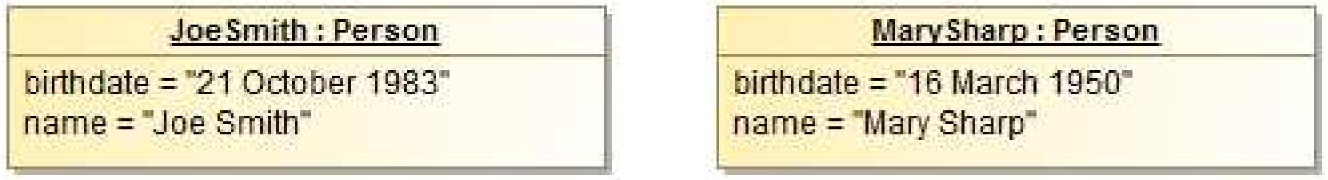


Attributes and values

- 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

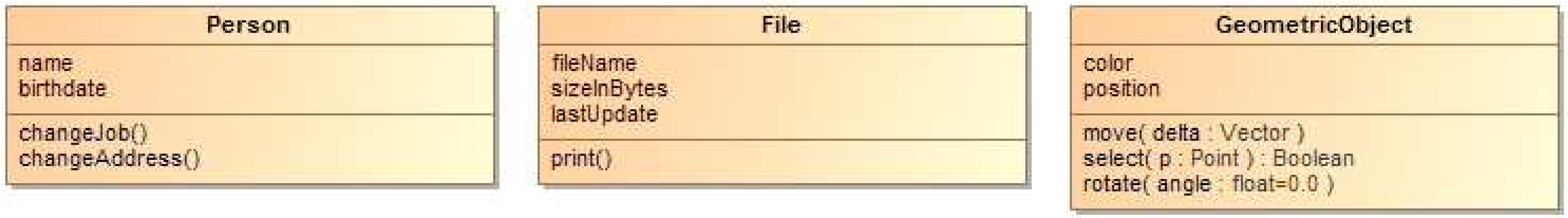


- Value
  - A value is a piece of data
  - UML notation: values are listed in the second compartment of the object box



Operations and methods

- Operation
  - An operation is a function or procedure that may be applied by or to objects in a class
  - UML notation: operations are listed in the third compartment of the class box



- Method
  - A method is the implementation of an operation for a class

Visibility for attributes and operations

+	public
#	protected
-	private
~	package

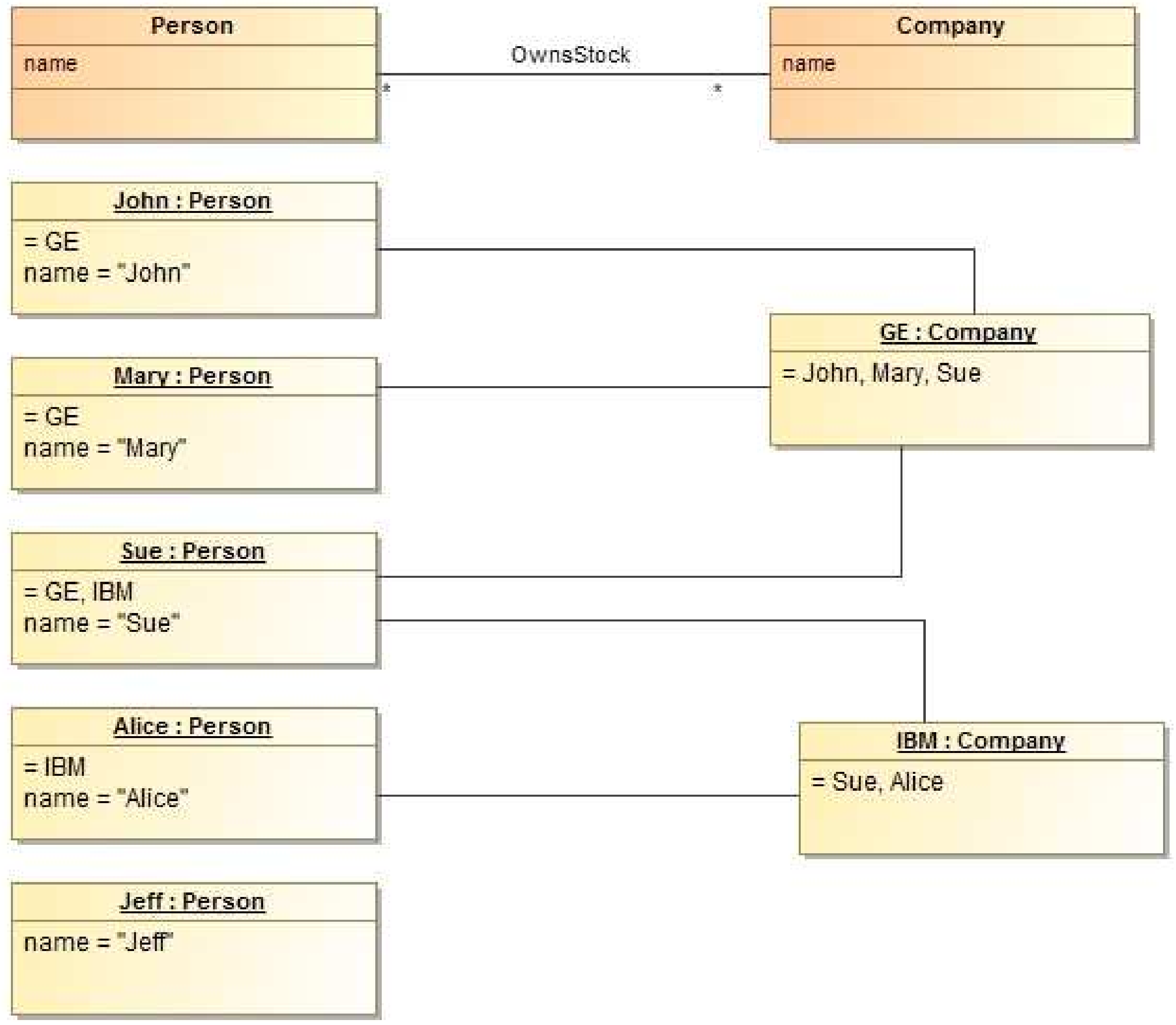
(Binary) links and associations

- 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)

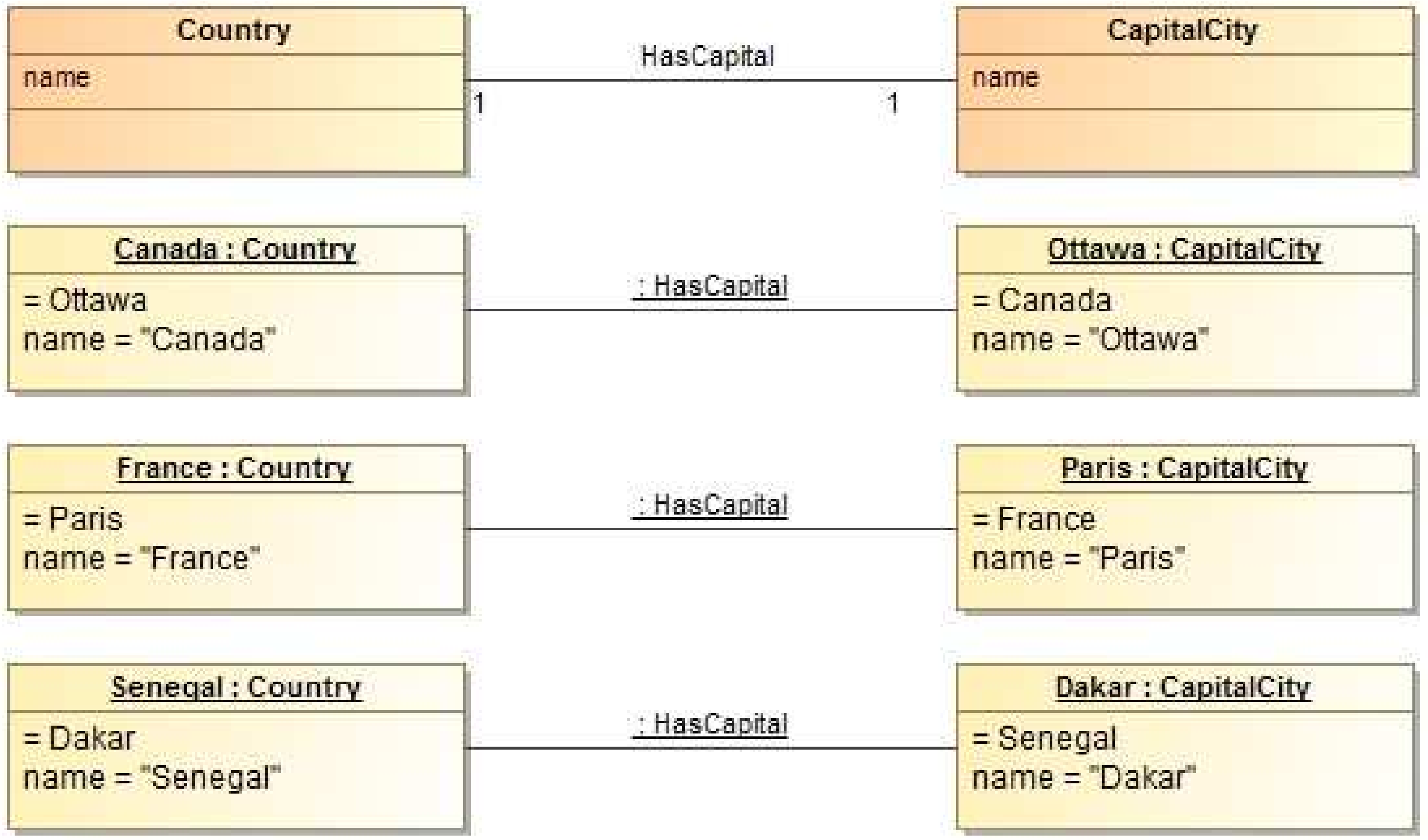
Multiplicity

- 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)

Multiplicity many-to-many

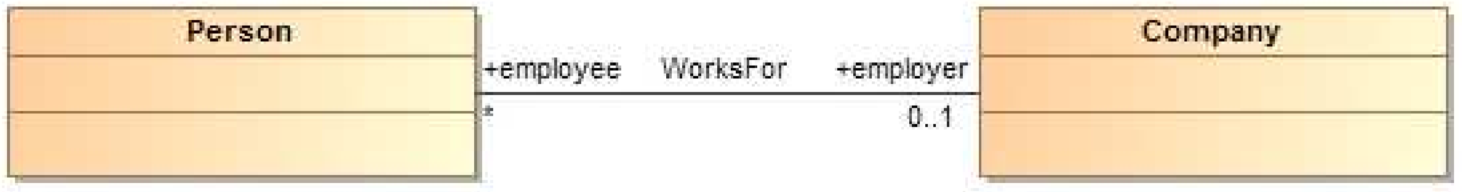


Multiplicity one-to-one



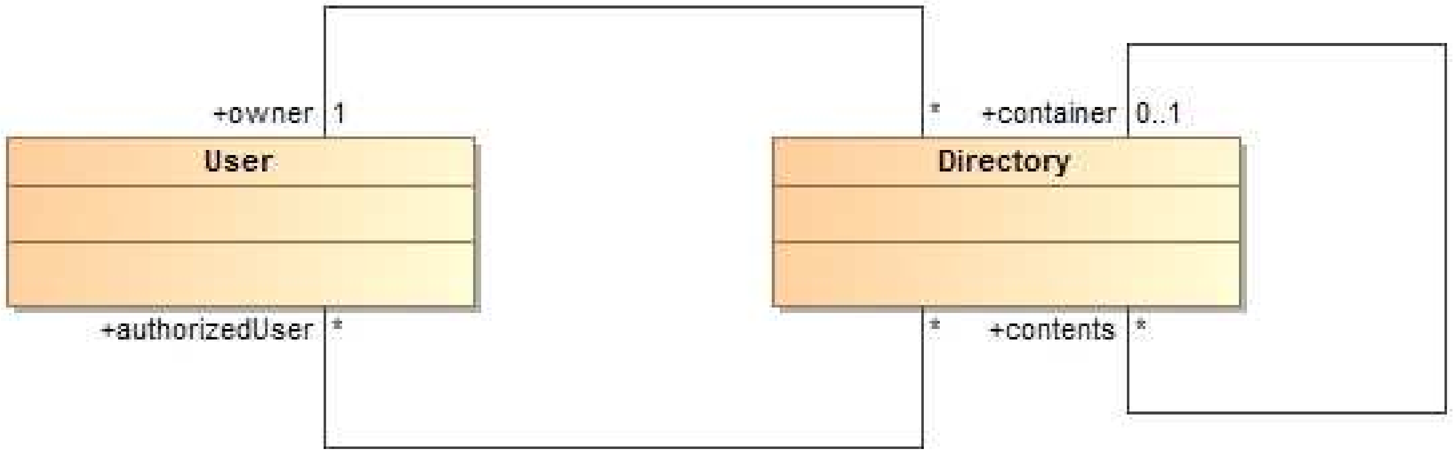
Association end names

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



Association end names

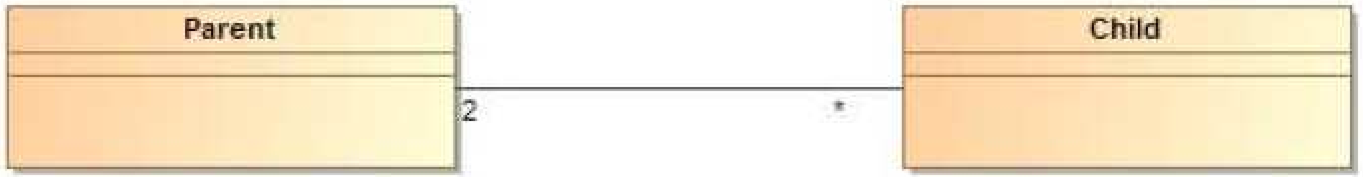
- Association end names are necessary for associations between two objects of the same class. They can also distinguish multiple associations between a pair of classes
- Association end names as pseudo attributes



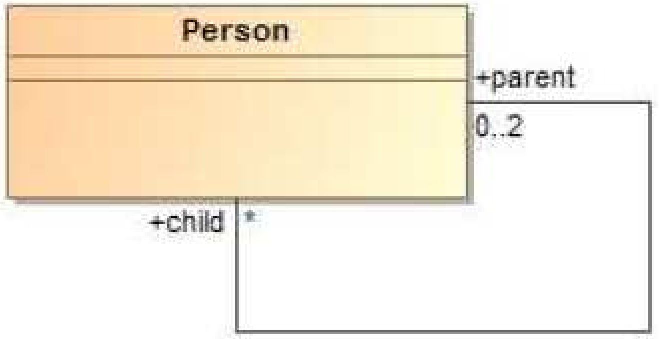
Association end names

- Use association end names to model multiple references to the same class

Wrong

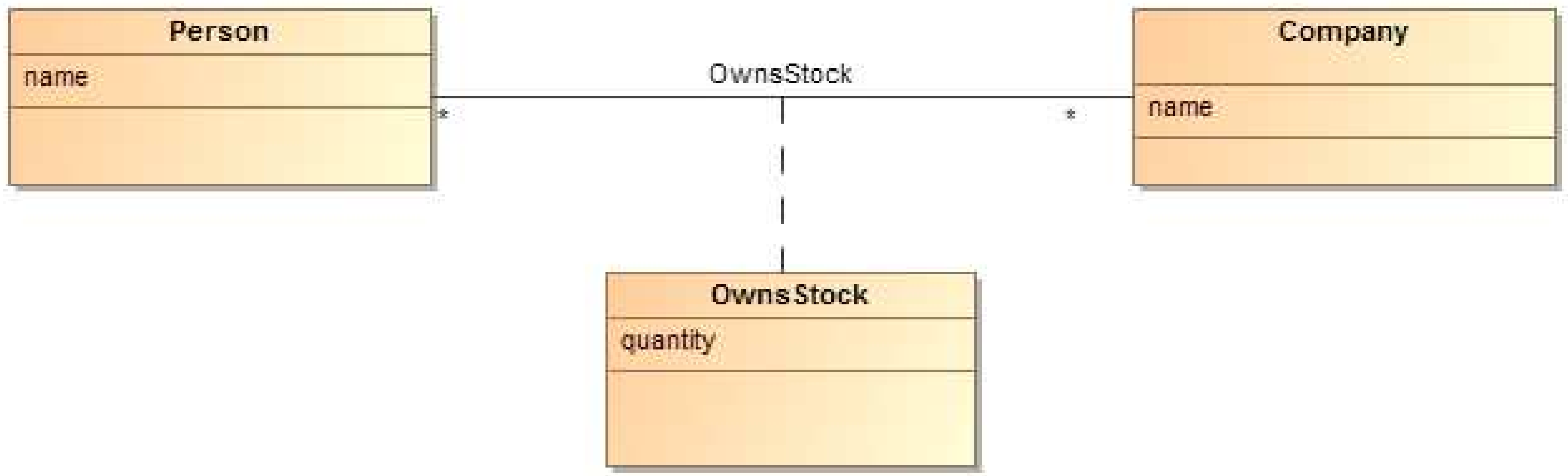


Correct



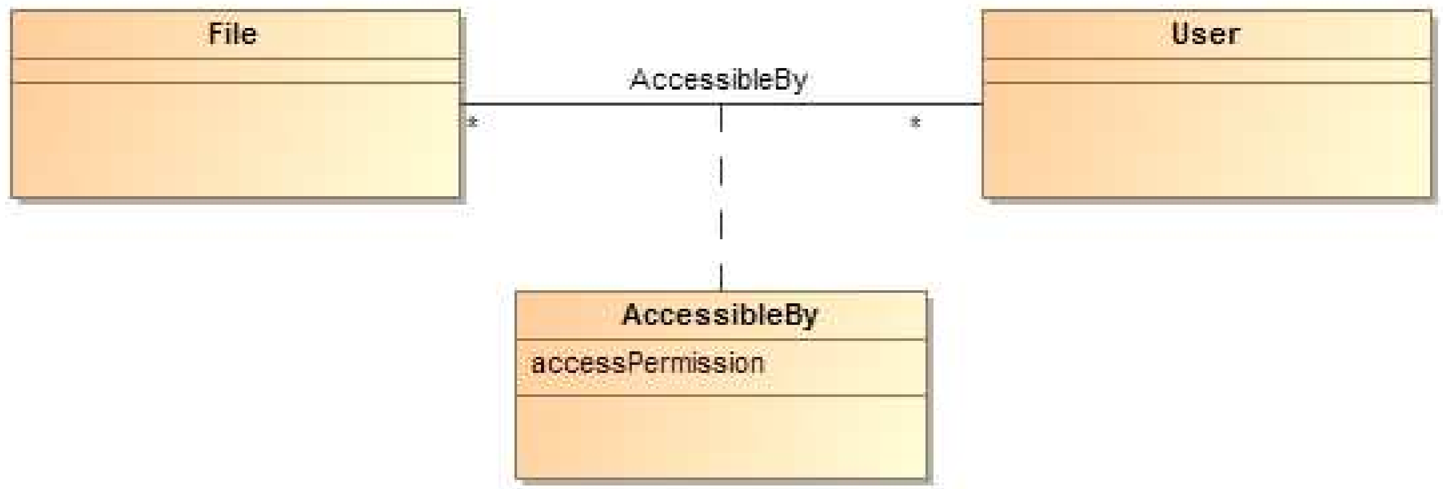
Association classes

- An association class is an association that is also a class
- Like a class, an association class can have attributes and operations and participate in associations
- UML notation: class box attached to the association by a dashed line



Association classes for many-to-many associations

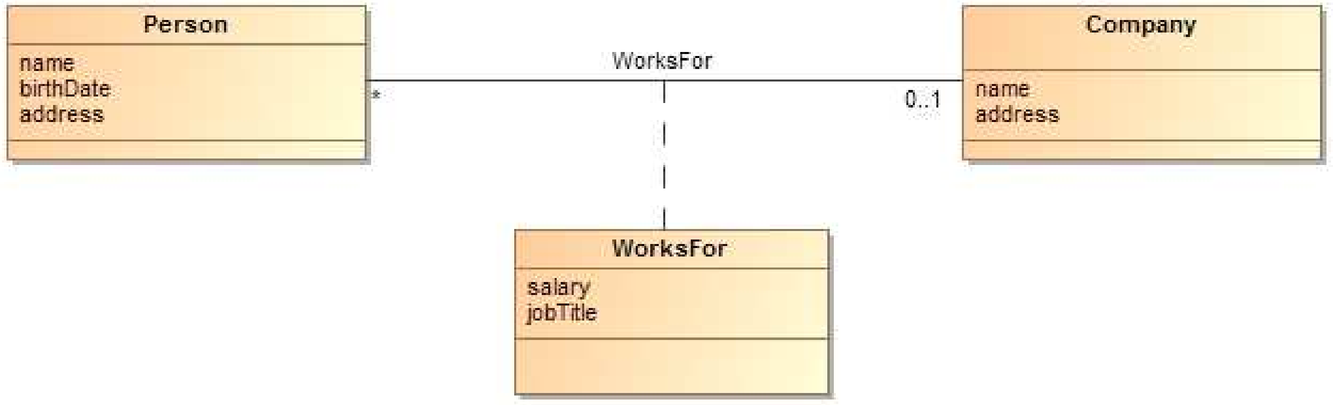
- Many-to-many associations provide a compelling rationale for association classes
- Attributes for such associations belong to the link and cannot be ascribed to either object



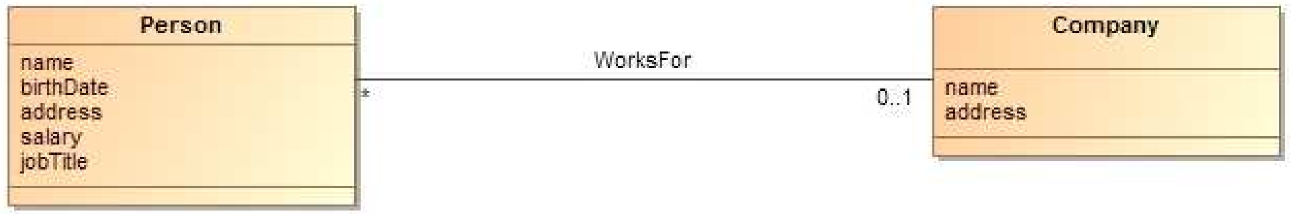
Association classes for many-to-many associations

- In theory, it is possible to fold attributes for one-to-one and one-to-many associations into the class opposite to a “one” end
- In practice, you should not fold such attributes in a class because the multiplicity of the association might change

Preferred



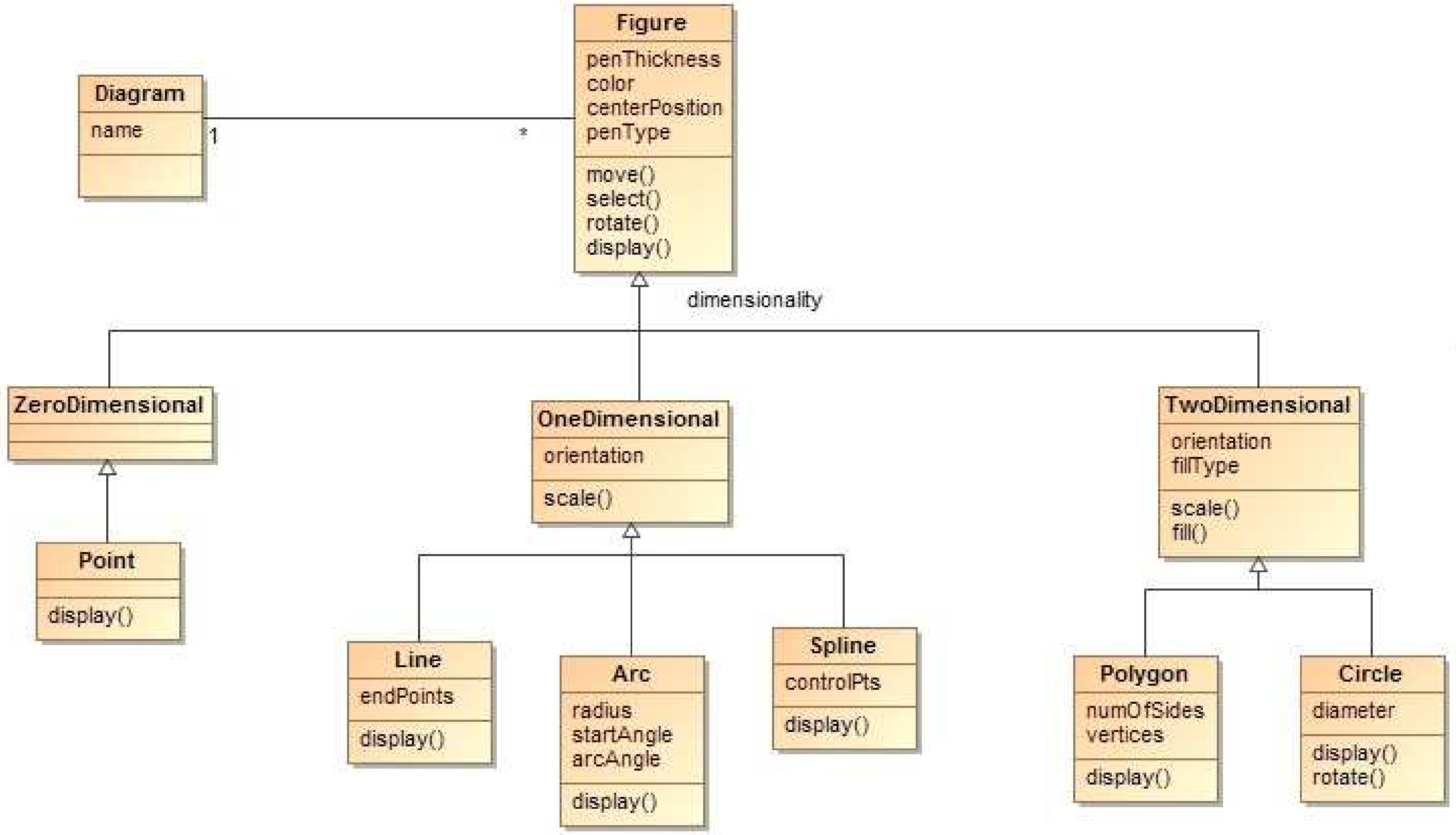
Discouraged



Generalization and Inheritance

- ***Generalization*** is the relationship between a class (<u>superclass</u>) and one or more variations of the class (<u>subclasses</u>)
  - 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
  - l

Generalization and Inheritance



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

Use of Generalization

- Polymorphism
  - Increases the flexibility of software. You can add a new subclass to inherit the superclass behavior without disrupting existing code
    - Overriding features
- 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