UML

The Basics of the Unified Modeling Language

The Basics of the Unified Modeling Language

- What is UML?
- UML Diagrams
- Review of Class Diagrams
- Tools and Resources

What is UML?

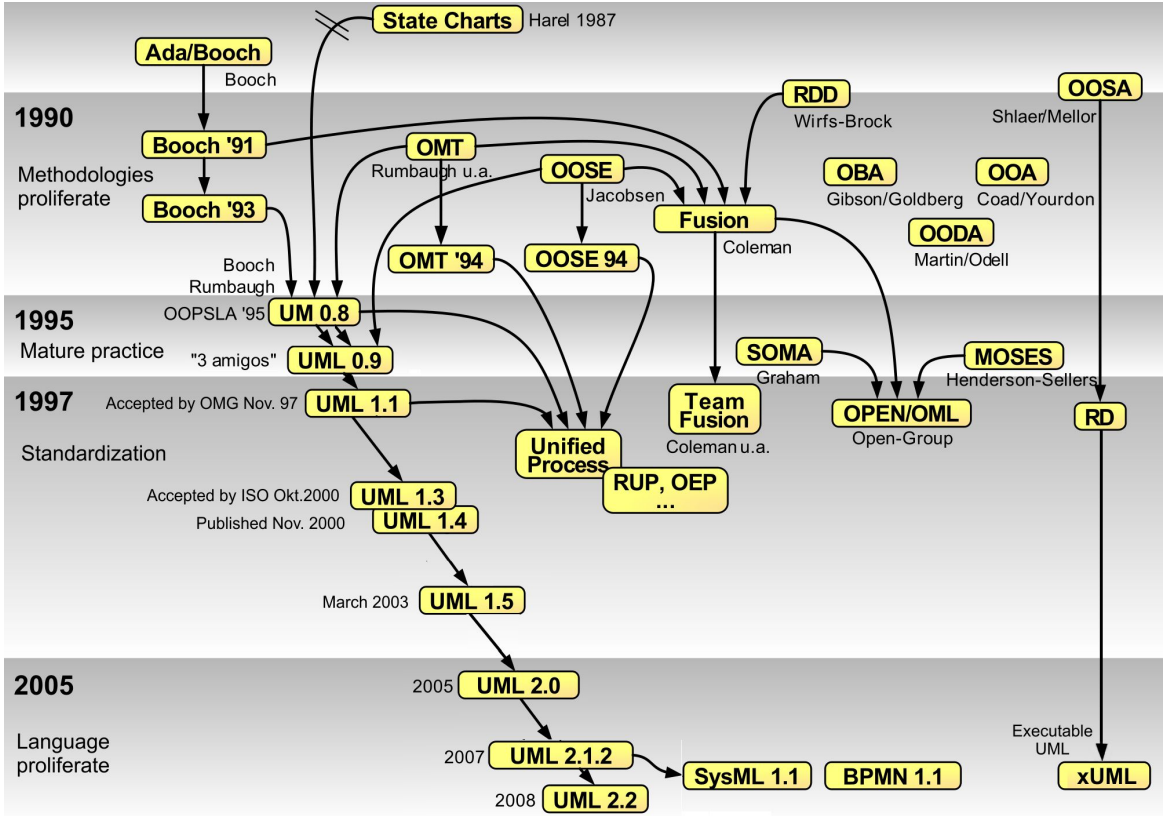
- UML stands for Unified Modeling Language
  - **Unified**: It brings together several techniques and notations for design, and has been standardized (first by the Object Management Group in 1997 and then by the International Organization for Standardization in 2005)
  - **Modeling**: It describes a software system and its design at a high level of abstraction
  - **Language**: It provides the means to communicate this design in a logical, consistent, and comprehensible fashion

What is UML?

- Goals of UML
  - Enable the modeling of object-oriented designs
  - Visually depict various aspects of the overall design of a solution
  - Provide extensibility and specialization mechanisms to extend core concepts
  - Be independent of particular programming languages and development processes
  - Support higher-level development concepts such as collaborations, frameworks, patterns, and components

What is UML?

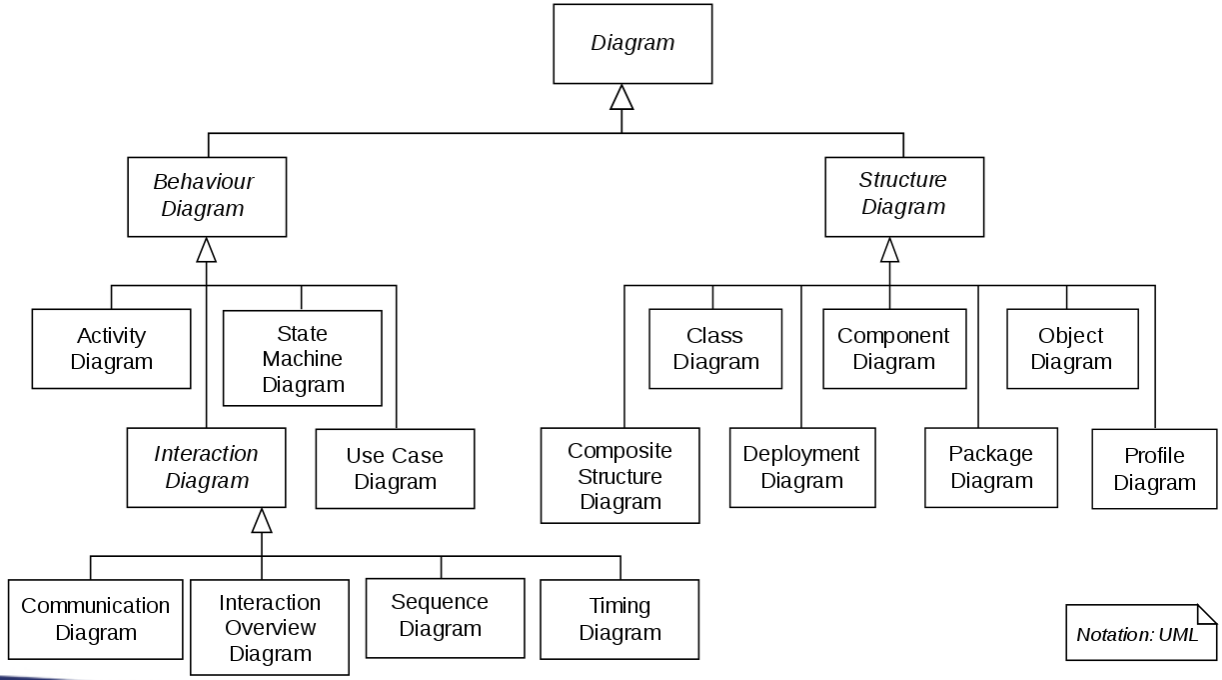
- Brief history of UML
  - Object-oriented modeling languages began appearing between mid-1970 and the late 1980s
  - By the mid-1990s, there were dozens of options and variants; the space was cluttered and confusing to developers
  - It became necessary to create a unified approach with general acceptance to allow things to move forward
  - These efforts ultimately produced UML


State Charts
Harel 1987
Ada/Booch
Booch
1990
Booch '91
Booch '93
Methodologies proliferate
OMT
Rumbaugh u.a.
OOSE
Jacobsen
RDD
Wirfs-Brock
OOSA
Shlaer/Mellor
OBA
Gibson/Goldberg
OOA
Coad/Yourdon
Fusion
Coleman
OODA
Martin/Odell
OMT '94
OOSE 94
Booch
Rumbaugh
1995
OOPSLA '95
UM 0.8
Mature practice
"3 amigos"
UML 0.9
SOMA
Graham
MOSES
Henderson-Sellers
1997
Accepted by OMG Nov. 97
UML 1.1
Team Fusion
Coleman u.a.
OPEN/OML
Open-Group
RD
Standardization
Unified Process
RUP, OEP ...
Accepted by ISO Okt.2000
UML 1.3
Published Nov. 2000
UML 1.4
March 2003
UML 1.5
2005
2005
UML 2.0
Language proliferate
2007
UML 2.1.2
SysML 1.1
BPMN 1.1
Executable UML
xUML
2008
UML 2.2

UML Diagrams

- Each UML diagram allows developers and customers to view a software system from different perspectives and from different levels of abstraction
- Some examples:
  - Structure diagrams (class, component, object, …)
  - Behaviour diagrams (use case, activity, …)
  - Interaction diagrams (sequence, timing, …)

UML Diagrams



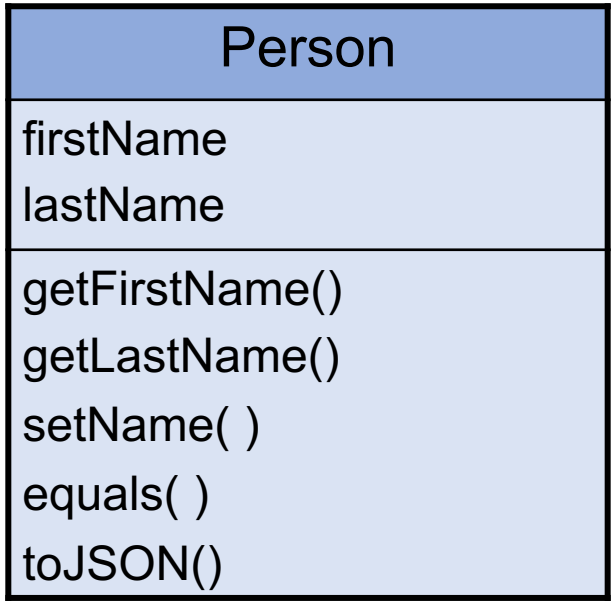
Review of Class Diagrams

- Class diagrams are widely used to describe the types of objects in a software system, their relationships, and constraints on their relationships
- In early stages of development, class diagrams might be incomplete, but are then refined and filled out as development proceeds
  - Some classes might be missing
  - Classes might be missing optional elements or details
- This is particularly the case in agile development …

Review of Class Diagrams

- Each class in a class diagram is represented by a rectangle divided into three sections:
  - **Name** of the class
  - **Attributes** of the class (the data members of the class, including both variables and constants)
  - **Operations** of the class (equivalent to member functions/methods)

Review of Class Diagrams

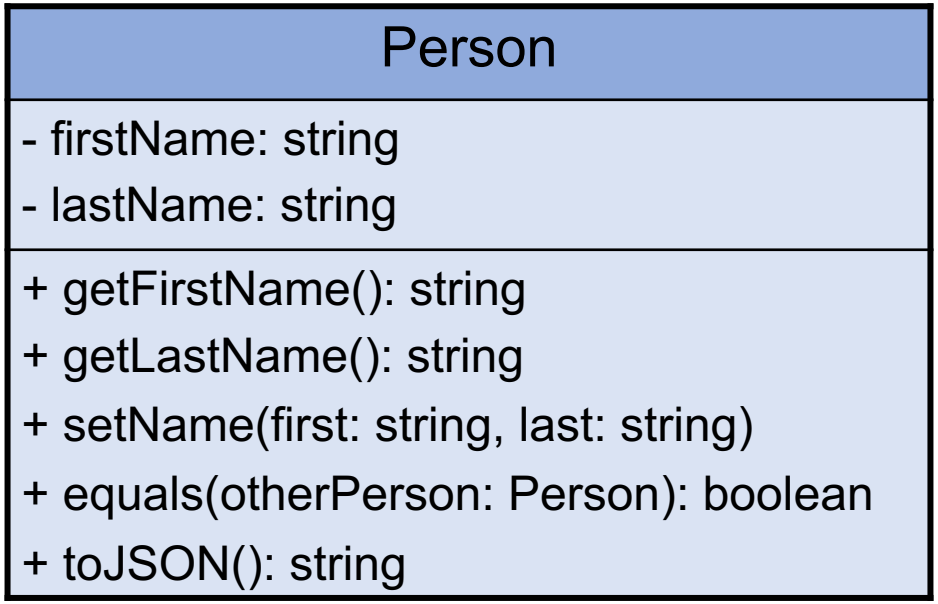


Review of Class Diagrams

- Attributes and operations may include:
  - Visibility: public (+), protected (#), or private (-)
  - Type of attribute or operation
  - Multiplicity of attribute (how many of this are there)
  - Parameter list for operations
  - Other properties of attributes or operations
- Including this information is of the form:

  visibility variable_name: type
  visibility variable_name: type multiplicity = default_value {property}
  visibility method_name(parameter_list): return_type {property}

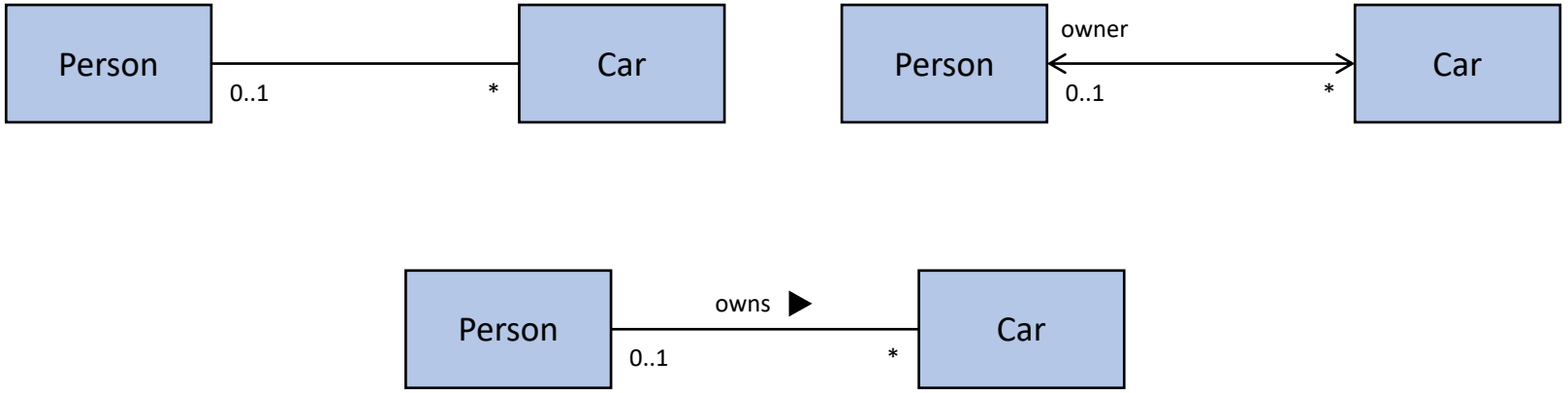
Review of Class Diagrams



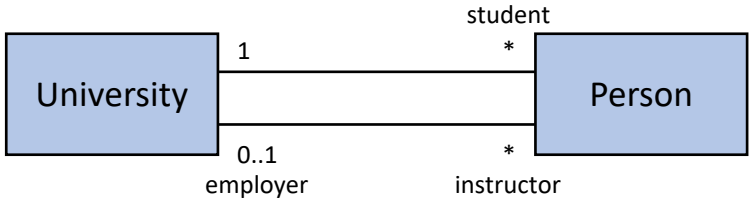
Review of Class Diagrams

- **Associations** represent relationships between classes
  - Indicated with a solid line between the classes
  - Arrowheads are used to indicate the direction of the association; both unidirectional and bidirectional associations are possible
  - Can be annotated with a name for the association or roles that the classes play in the association
  - Can also include cardinalities to include the number of entities that can be involved with in the association, including one-to-one, one-to-many (1..*), many-to-many (*..*), zero-to-many (0..*), and so on

Review of Class Diagrams



Review of Class Diagrams

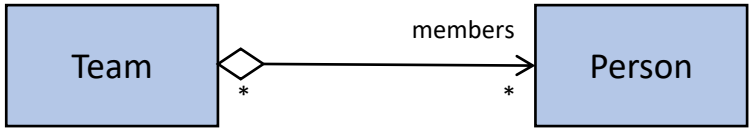


Review of Class Diagrams

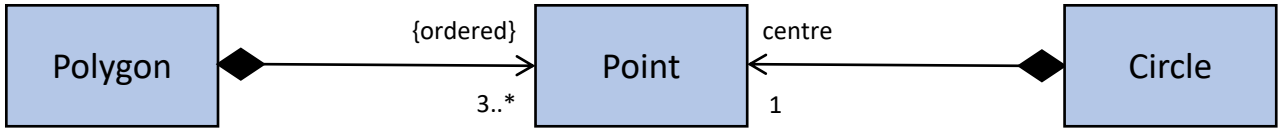
- Two special forms of association are **aggregation** and **composition**
  - Aggregation (indicated by a hollow diamond) indicates a part-of relationship, but such parts are non-essential and can exist independent of the aggregate
  - Composition (indicated by a filled diamond) indicates that something is an essential and integral component of something else
    - Instances of a component may only have a single owner; sharing is not allowed
    - Components cannot exist independent of their owner
    - Components live or die with their owner

Review of Class Diagrams

Aggregation:

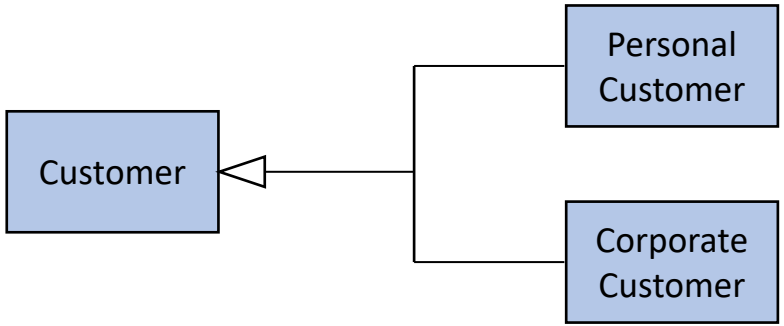


Composition:



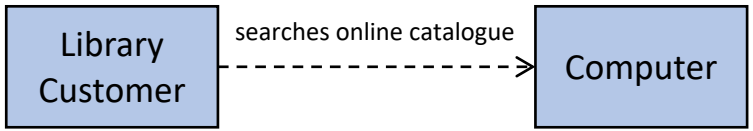
Review of Class Diagrams

- **Generalization** is another form of relationship supported by UML
  - This is used to capture the object-oriented concept of inheritance
  - In other words, it allows you to indicate that one class is derived from another class, creating parent-child relationships between classes



Review of Class Diagrams

- A **dependency** between two classes exists if changes to one class might induce changes to or otherwise impact the other class
  - There are many types of dependency, including use, calling, creation, and so on
  - The broken line used to indicate the dependency can be labelled with a message to provide details on the dependency



Review of Class Diagrams

- UML class diagrams can also contain many other general programming or object-oriented concepts and constructs
  - Notes and comments
  - Enumerations
  - Interfaces and abstract classes
  - Templates
  - Qualified associations
  - Association classes

Tools and Resources

- Many software tools exist to assist in the construction of the various types of UML diagrams
  - Microsoft Visio
  - IBM Rational Rose, Software Architect, …
  - draw.io
  - …
- For a reasonably decent list of UML tools, check out:
  - https://en.wikipedia.org/wiki/List_of_Unified_Modeling_Language_tools

Tools and Resources

- UML Distilled (now in its third edition) by Martin Fowler is an excellent resource for all things UML
- You can also get some good information on UML straight from the OMG at uml.org
- Time permitting, we will come back to look at some of UML's other diagrams later in the course …