COMP 249: Object Oriented Programming II

Tutorial 5:

Unified Modeling Language (UML)

Introduction to UML

- UML is a software design tool that can be used within the context of any OOP language

- UML is a graphical language used for designing and documenting OOP software

UML

- Pseudocode is a way of representing a program in a linear and algebraic manner.
  - It simplifies design by eliminating the details of the programming language syntax.
- Graphical representation systems for program design have also been used.
  - *Flowcharts* and *structure diagrams* for example.
- *Unified Modeling Language* (*UML*) is yet another graphical representation formalism.
  - UML is designed to reflect and be used with the OOP philosophy.

History of UML

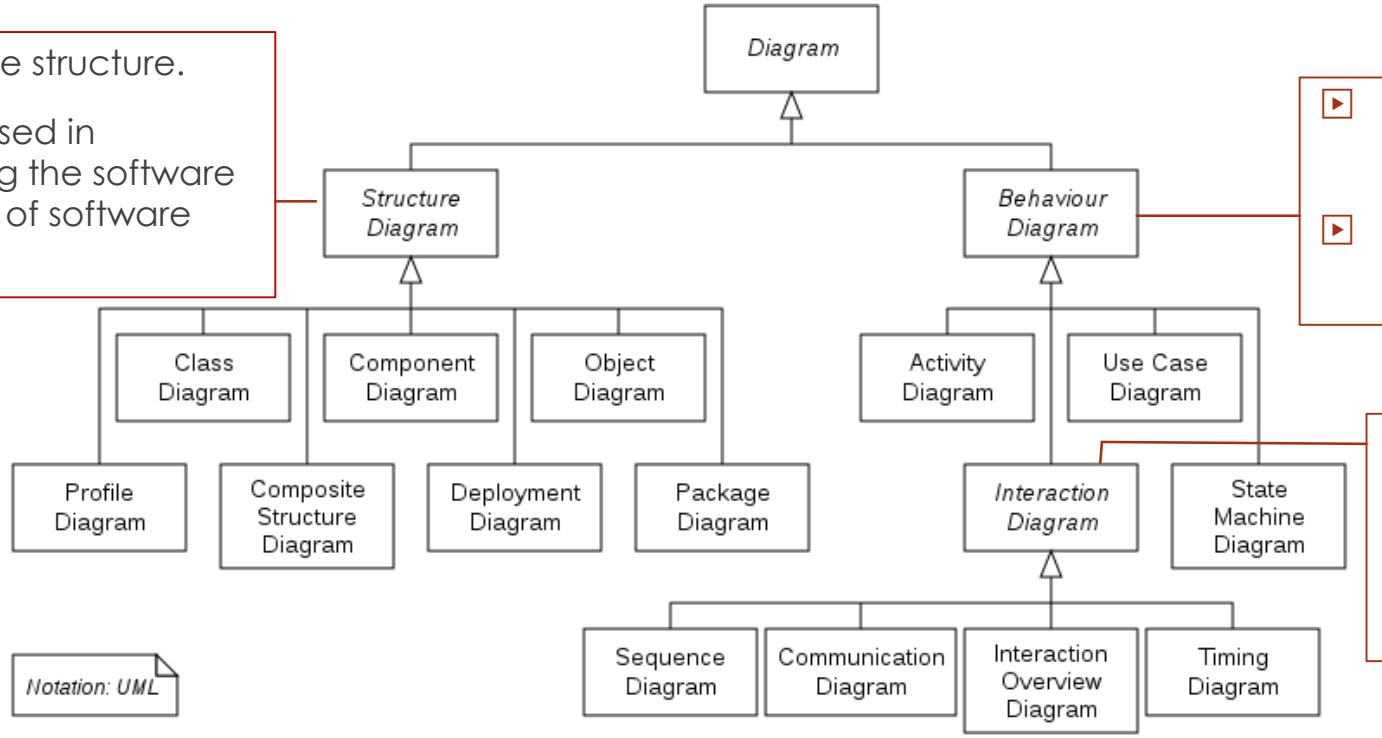
- As OOP has developed, different groups have developed graphical or other representations for OOP design.

- In 1996, Brady Booch, Ivar Jacobson, and James Rumbaugh released an early version of UML.
  - Its purpose was to produce a standardized graphical representation language for object-oriented design and documentation.

- Since then, UML has been developed and revised in response to feedback from the OOP community.
  - Today, the UML standard is maintained and certified by the Object Management Group (OMG).

UML Diagrams

- Represent the structure.
- Extensively used in documenting the software architecture of software systems.



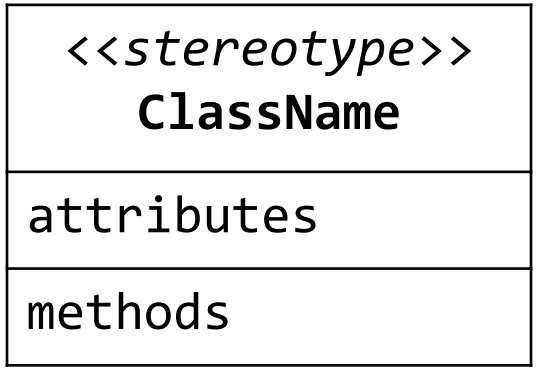
- Emphasize what must happen in the system being modeled.
- Extensively used to describe the functionality of software systems.

- Emphasize the flow of control and data among the things in the system being modeled.
- May show how objects communicate with each other (i.e. sequence diagram.

UML Class Diagrams (1)

- Classes are central to OOP, and the *class diagram* is the easiest of the UML graphical representations to understand and use

- A class diagram is divided up into three sections
  - The top section contains the class name and applicable stereotypes (*<<abstract>>*, *<<interface>>*...)
  - The middle section contains its data members
  - The bottom section contains its methods



UML Class Diagrams (2)

- The data specification for each piece of data in a UML diagram consists of its name, followed by a colon, followed by its type

- Each name is preceded by a character that specifies its access type (visibility):
  - A minus sign (-) indicates private access
  - A plus sign (+) indicates public access
  - A sharp (#) indicates protected access
  - A tilde (~) indicates package access

Marker	Visibility
+	public
-	private
#	protected
~	package

UML Class Diagrams (3)

- Each method in a UML diagram is indicated by the name of the method, followed by its parenthesized parameter list, a colon, and its return type

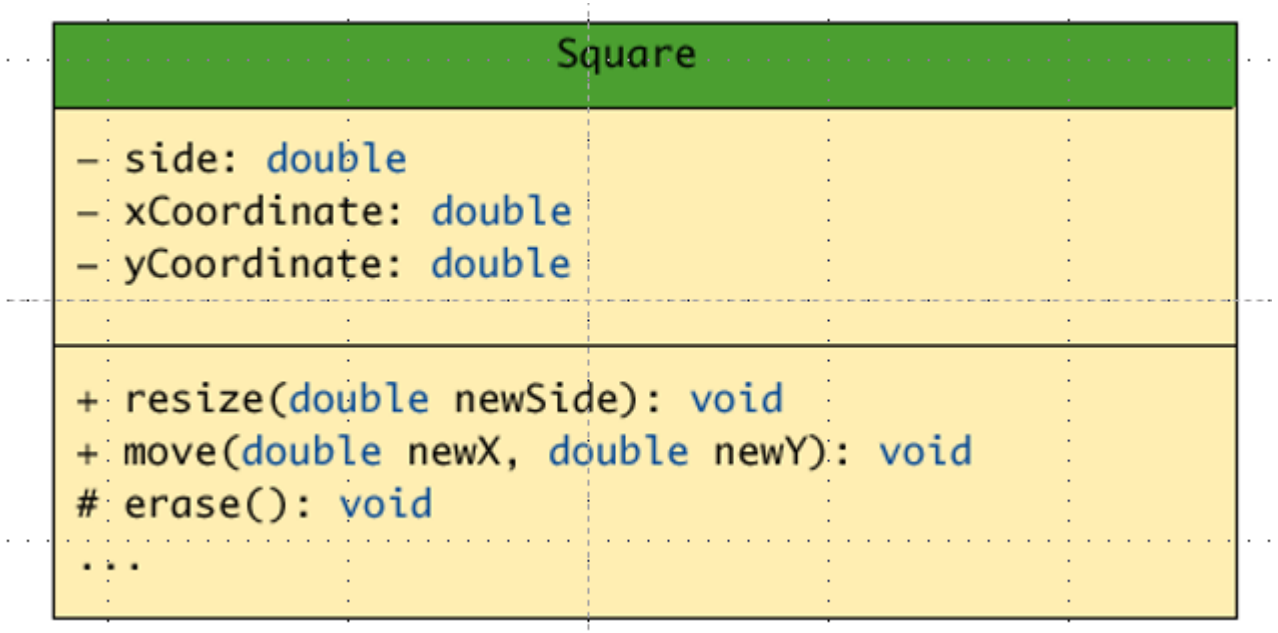
- The access type of each method is indicated in the same way as for data

UML Class Diagrams (4)

- A class diagram do not need to give a complete description of the class
  - If a given analysis does not require that all the class members be represented, then those members are not listed in the class diagram
  - Missing members (those irrelevant to the current description) are indicated with an ellipsis (three dots)

UML Class Diagrams (5)

An example of a UML class Diagram:

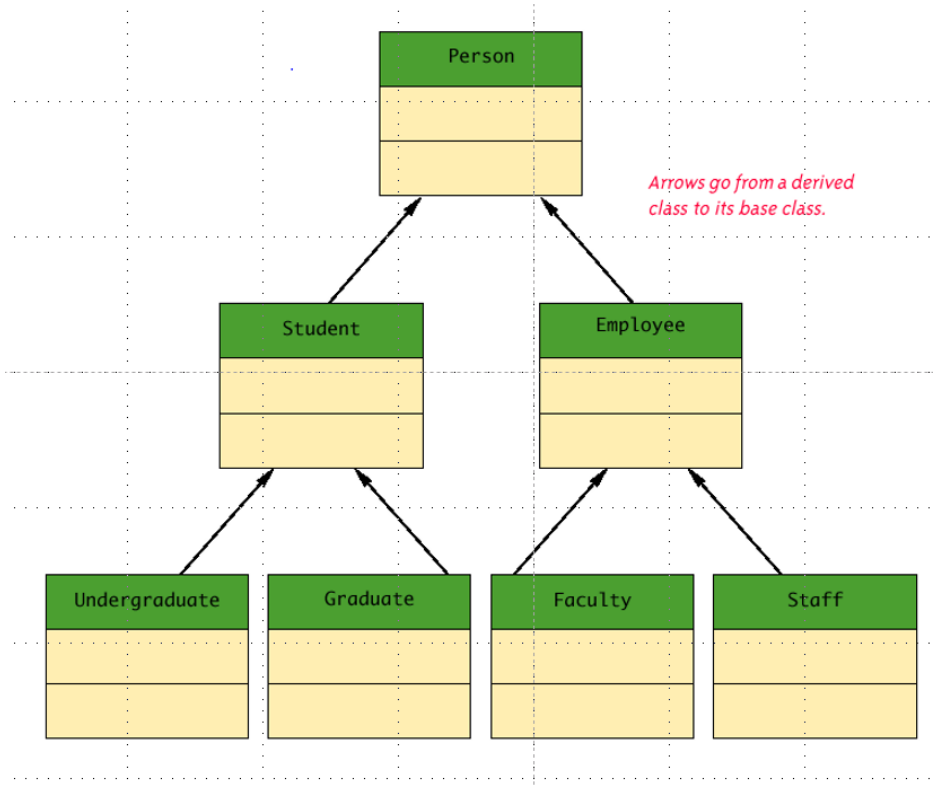


Class Interactions (1)

- Rather than show just the interface of a class, class diagrams are primarily designed to show the interactions among classes
- UML has various ways to indicate the information flow from one class object to another using different sorts of annotated arrows
- UML has annotations for class groupings into packages, for inheritance, and for other interactions
- In addition to these established annotations, UML is extensible

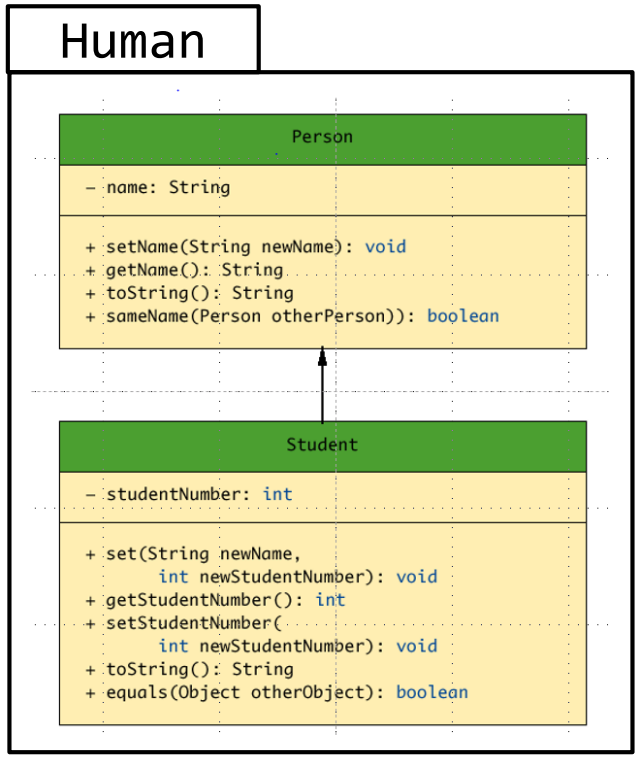
Class Interactions (2)

- To represent inheritance between classes:
  - Each base class is drawn above its derived class(es)
  - An upward pointing arrow is drawn between them to indicate the inheritance relationship. The arrows also help in locating method definitions.



Class Interactions (3)

- Packages can be represented in a class diagram by a rectangle with the package name
- All the member classes are placed within the rectangle



Software tools

Many software tools can be used to draw UML diagrams such as:

- Microsoft Visio
- Smart Draw
- ObjectAid plugin for Eclipse

Some tools are available online:

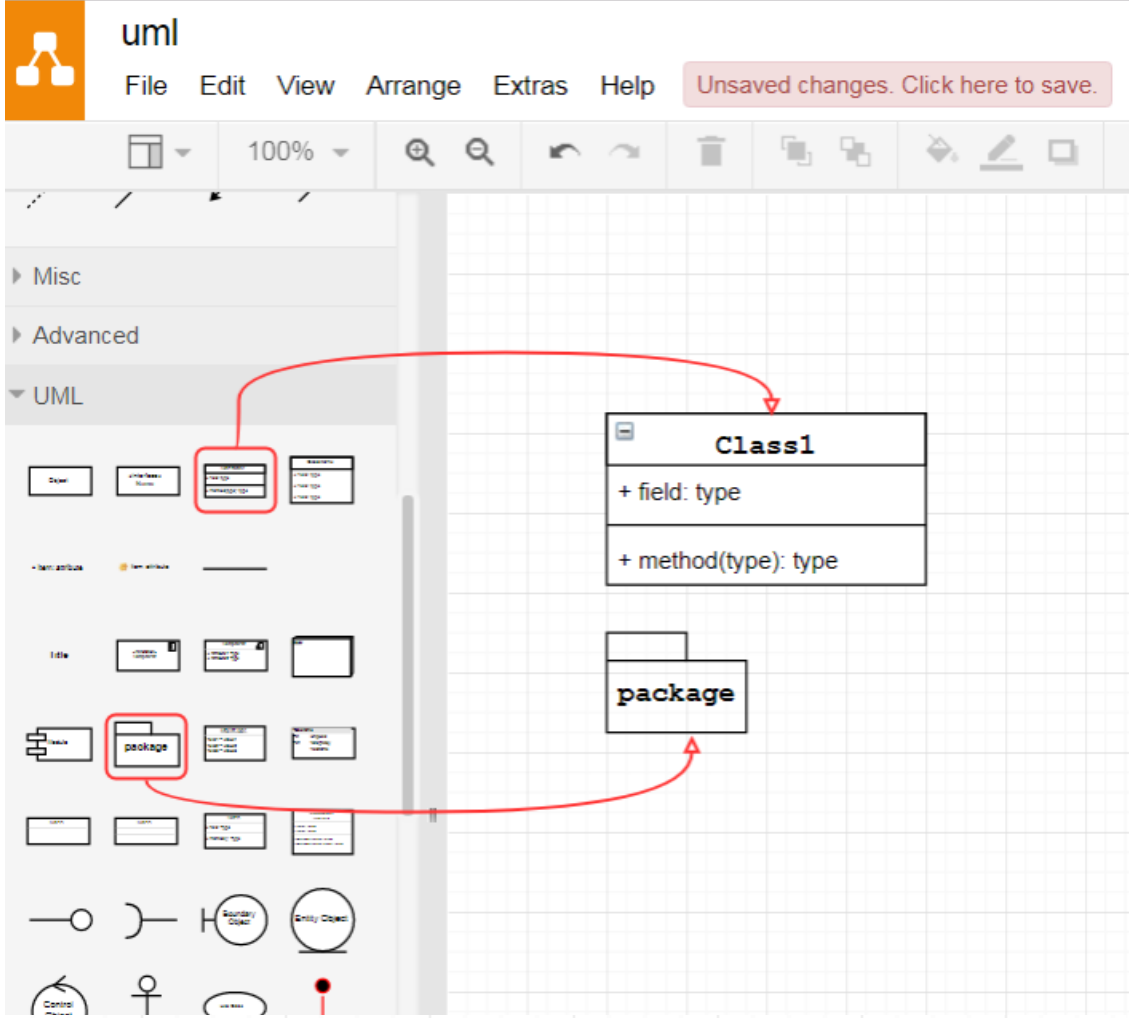
- draw.io (`https://www.draw.io/`)

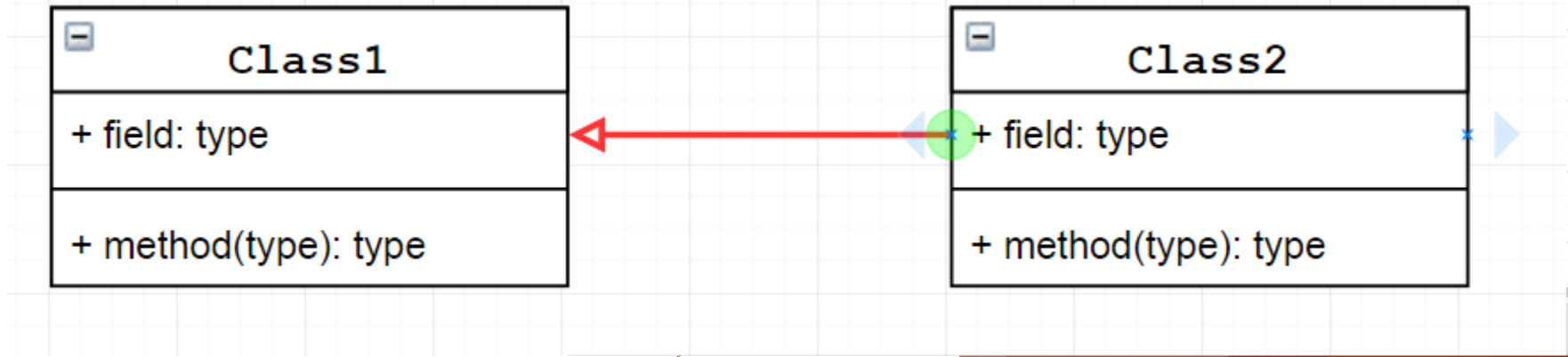
Using draw.io

Use the UML drop-down menu.

Most of the common shapes are already defined.

By hovering over a shape and dragging a corner over to another shape, you can create connectors, which can then be used to represent inheritance and other associations.





Thank you!