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<th>UML crash course</th>
<th>What is UML?</th>
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<td><strong>The main questions</strong></td>
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<td>• What is UML?</td>
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<td>• Is it useful, why bother?</td>
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<td><strong>Standardizes the notation for modeling OO systems.</strong></td>
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What is UML?

- Unified Modeling Language.
- Developed in the mid 90’s, improved since.
- Unifies existing, disparate notations.
- Standardizes the notation for modeling OO systems.
- A collection of diagrams for different viewpoints:
  - Use case diagrams
  - Component diagrams
  - Class and Object diagrams
  - Sequence diagrams
  - Statechart diagrams
  - ...

Use case diagrams

“For reasons that remain a mystery to me, many people have focused on the stick figures and ellipses in use case writing since Jacobson's first book came out, and neglected to notice that use cases are fundamentally a text form.”


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Are UML diagrams useful?

**Communication**
- Forward design (before coding)
  - brainstorm ideas (on whiteboard or paper)
  - draft and iterate over software design

**Documentation**
- Backward design (after coding)
  - obtain diagram from code

**Code generation**
- Automatically derive code from diagrams

Code generation can be useful for skeletons.
Classes vs. objects

Class
- Grouping of similar objects.
  - Student
  - Car

- Abstraction of common properties and behavior.
  - Student: Name and Student ID
  - Car: Make and Model

Object
- Entity from the real world.
- Instance of a class
  - Student: Joe (4711), Jane (4712), …
  - Car: Audi A6, Honda Civic, …

UML class diagram: basic notation

MyClass

- attr1 : type
- attr2 : type
+ attr3 : type
~ bar(a:type) : ret_type
+ foo() : ret_type

Visibility
- private
~ package-private
# protected
+ public
UML class diagram: basic notation

<table>
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<tr>
<td>- attr1 : type</td>
</tr>
<tr>
<td># attr2 : type</td>
</tr>
<tr>
<td>+ attr3 : type</td>
</tr>
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Name

Attributes
<visibility> <name> : <type>

Methods
<visibility> <name>({param}*) : <return type>
<param> := <name> : <type>

Visibility
- private
~ package-private
# protected
+ public

Classes, abstract classes, and interfaces

MyClass
MyAbstractClass
<<interface>> MyInterface

Level of detail in a given class or interface may vary and depends on context and purpose.

UML class diagram: Inheritance

MyClass
<<interface>> MyInterface
SuperClass

public class MyClass extends SuperClass implements MyInterface
is-a relationship

public class MyClass extends SuperClass implements MyInterface
is-a relationship

Level of detail in a given class or interface may vary and depends on context and purpose.
UML class diagram: Aggregation and Composition

**Aggregation**
- Part
  - has-a relationship
  - Whole
- Existence of Part does not depend on the existence of Whole.
- Whole does not own Part.
- Part might be shared with other instances of Whole.

**Composition**
- Part
  - has-a relationship
  - Whole
- Part cannot exist without Whole.
- The lifetime of Part is controlled by Whole.
- Whole is the single owner of Part.

Aggregation or Composition?

Customer

Bank

Room

Building

What about class and students or body and body parts?
Inheritance vs. (Aggregation vs. Composition)

Person

Student

public class Student
    extends Person{
    public Student(){
        ...
    }
    ...
}

Simplified example: usually, a bank has more than one customer, and a building more than one room.

Inheritance or aggregation/composition?

ArrayList

Stack

Aggregation may also be possible (e.g., if a Stack is used as a different representation of an existing ArrayList).
UML class diagram: multiplicity

Each A is associated with exactly one B
Each B is associated with exactly one A

Each A is associated with any number of Bs
Each B is associated with exactly one or two As

UML class diagram: navigability

Navigability: not specified

Navigability: unidirectional
“can reach B from A”

Navigability: bidirectional

Summary UML

- Unified notation for modeling OO systems.
- Allows different levels of abstraction.
- Suitable for design discussions and documentation.
- Generating code from diagrams is challenging.

In this class, we will use UML class diagrams mainly for visualization and discussion purposes.