CMSC 132: OBJECT-ORIENTED PROGRAMMING II

Inheritance Introduction

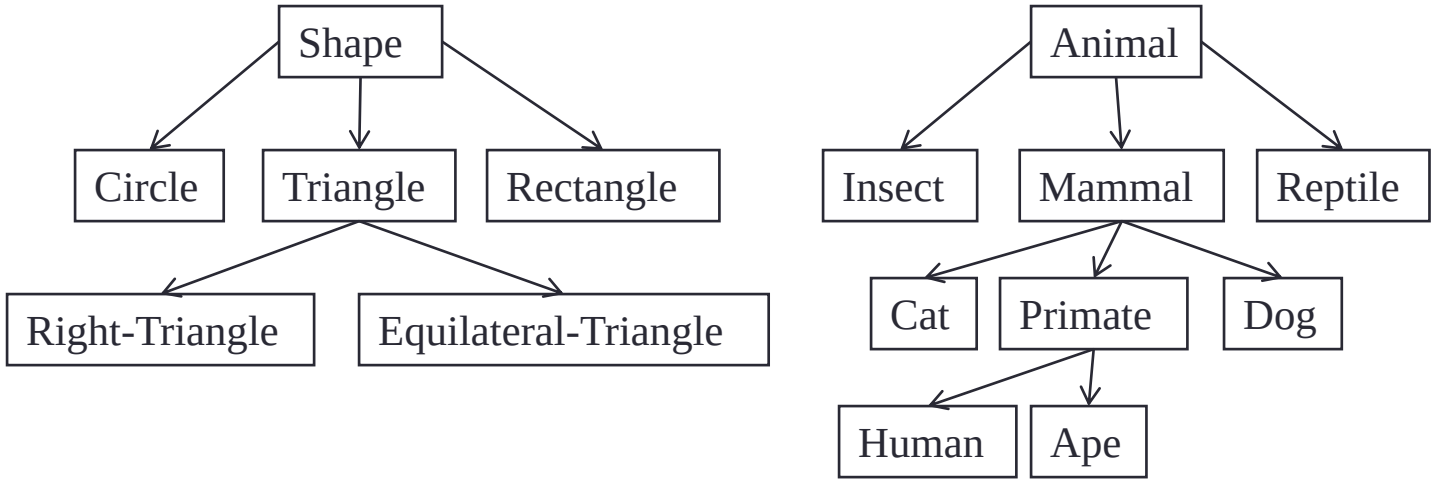
Department of Computer Science
University of Maryland, College Park

Announcements

- Make sure you check your projects results in the submit server
- Do not wait until the day of the project to try submitting your project
  - Submission problems are not a valid excuse for a project extension
- Remember we take academic integrity matters seriously

Inheritance

- **Inheritance:** is the process by which one new class, called the **derived class**, is created from another class, called the **base class**
  - The **derived class** is also called: **subclass** or **child class**
  - The **base class** is also called: **superclass** or **parent class**
- **Motivation**: In real life objects have a hierarchical structure:



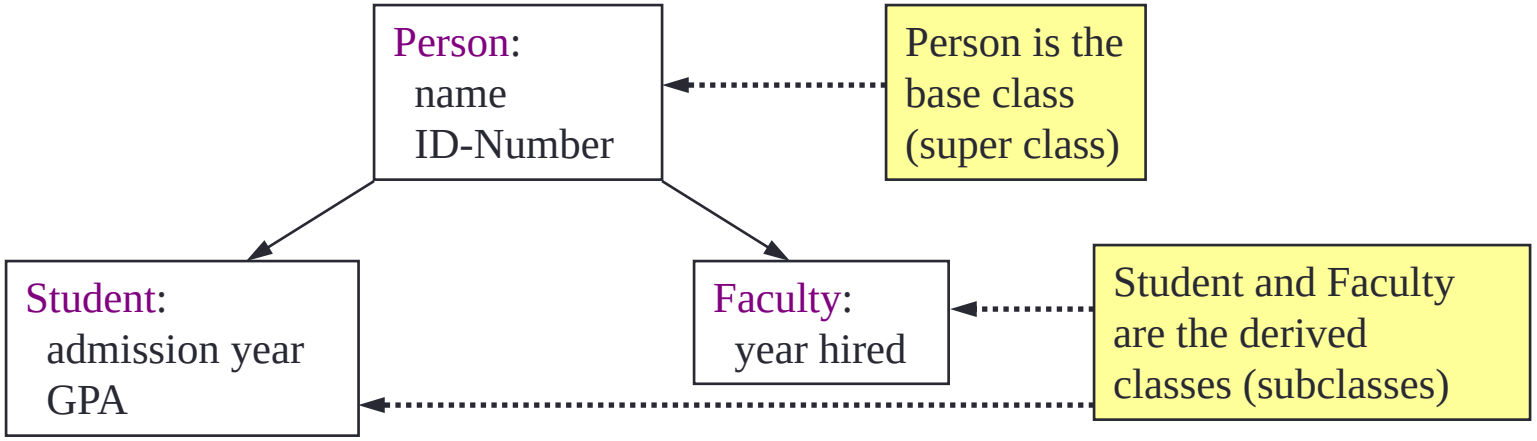
- We want to do the same with our program objects

Inheritance

- **Object Inheritance**: What does inheritance mean within the context of object-oriented programming?
- Suppose a **derived class**, **Circle**, comes from a **base class**, **Shape**:
  - Circle should have **all the instance variables** that Shape has.
    (E.g., Shape stores a color, and thus, Circle stores a color.)
  - Circle should have **all the methods** that Shape has (E.g.,
    Shape has an accessor, getColor( ), and thus, Circle has getColor( ).)
  - Circle is allowed to define **new instance variables** and **new methods** that are particular to it:
    - **(New) Circle Instance variables**: Center, radius.
    - **(New) Methods**: draw( ), getArea( ), getPerimeter( )
- **Code reuse**: Code/Data that is common to all the derived classes can be stored in the base class. This allows us to **avoid code duplication**, and so makes development and maintenance easier

University Database

- We derive two classes, Student and Faculty from Person. Each class inherits all the data and methods from **Person**, and adds data and methods that are particular to its particular function



- **Student**: In addition to name and ID, has **admission year** and **GPA**
- **Faculty**: In addition to name and ID, has the **year they were hired**
- The above diagram is referred to as an **inheritance tree/hierarchy**

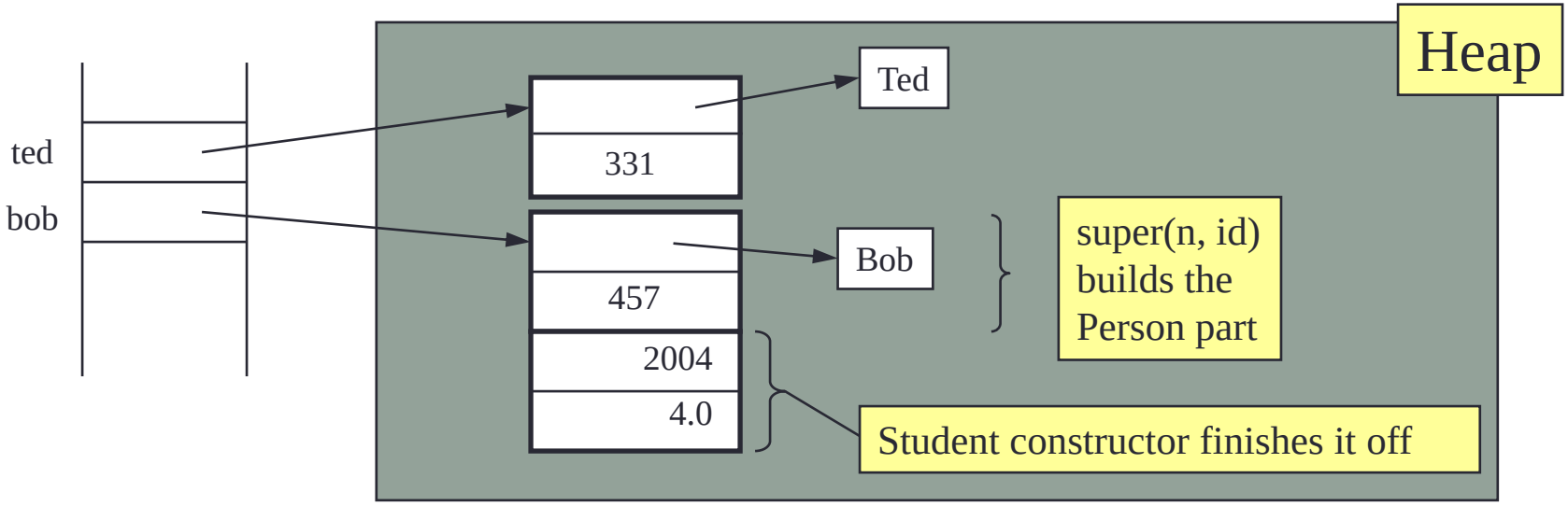
extends and super

- **extends**: To specify that **Student** is a **derived class** (subclass) of **Person** we add the descriptor “extends” to the class definition:
  - **public class Student extends Person { … }**
- Notice that a **Student** class
  - Inherits everything from the **Person** class
  - A Student IS-A Person (wherever a Person is needed, we can use a Student)
- **super( )**: When initializing a new **Student** object, we need to initialize its **base class** (or **super class**). This is done by calling **super(…)**. For example, **super(name, id)** invokes the constructor **Person(name, id)**
  - super(…) must be the **first statement** of your constructor
  - If you **do not** call super( ), Java will automatically invoke the base class’s **default constructor**
  - What if the base class’s default constructor is **undefined**? **Error**
  - You must use “**super(…)**”, not “**Person(…)**”.
- **Example: university package**

Memory Layout and Initialization Order

- When you create a new derived class object:
  - Java allocates space for **both** the **base class** instance variables and the **derived class** variables
  - Java initializes the **base class variables first**, and then initializes the derived class variables **(what explains why super() should appear first)**
- **Example**:

```
Student bob = new Student( "Bob", 457, 2004, 4.0);
Person ted = new Person( "Ted", 331);
```



Inheritance

- **Inheritance:** Since **Student** is derived from **Person**, a **Student** object can invoke any of the **Person** methods, it **inherits** them

```
Student bob = new Student( "Bob", 457, 2004, 4.0 );
String bobsName = bob.getName( ) );
bob.setName( "Robert" );
System.out.println( "Bob's new info: " + bob.toString( ) );
```

bob is a Student, but by inheritance we can invoke Person methods

- **A Student "is a" Person**:
  - By inheritance a **Student** object is also a **Person** object. We can use a **Student** reference anywhere that a **Person** reference is needed

```
Person robert = bob;          // Okay: A Student is a Person
```

  - We cannot reverse this. (A Person need not be a Student.)

```
Student bob2 = robert;        // Error! Cannot convert Person to Student
```

Overriding Methods

- **New Methods**: A derived class can define **entirely new** instance variables and new methods (e.g. hireYear and getHireYear())
- **Overriding ("redefining", changing what is does)**: A derived class can also **redefine existing** methods

```
public class Person {
    …
    public String toString() { … }
}
public class Student extends Person {
    …
    public String toString() { … }
}

Student bob = new Student( "Bob", 457, 2004, 4.0);
System.out.println("Bob's info: " + bob.toString());
```

The base class defines the method toString( )

The derived class can redefine this method.

Since bob (below) is of type Student, this invokes the Student toString( )

Overriding and Overloading

- Don't confuse method **overriding** with method **overloading**

  Overriding ("redefining"): occurs when a derived class defines a method with the **same name** and **parameters** as the base class

  Overloading: occurs when two or more methods have the **same name**, but have **different parameters** (different signature)

  Example:

```
public class Person {
    public void setName(String n) { name = n; }
    …
}
public class Faculty extends Person {
    public void setName(String n) {
        super.setName("The Evil Professor " + n);
    }
    public void setName(String first, String last) {
        super.setName(first + " " + last);
    }
}
```

The base class defines a method setName( )

Overriding: Same name and parameters; different definition.

Overloading: Same name, but different parameters.

Overriding Variables: Shadowing

- **We can override methods, can we override instance variables too?**
- **Answer**: Yes, it is possible, but **not recommended**
  - Overriding an instance variable is called **shadowing**, because it makes the base instance variables of the base class inaccessible (we can still access it explicitly using **super.varName**). You are creating a new variable with the same name

```
public class Person {
    String name;
    // …
}
```

```
public class Staff extends Person {
    String name;
    // …  name refers to Staff's name
}
```

  - This can be **confusing** to readers, since they may not have noticed that you redefined **name**. **Better to just pick a new variable name**

super and this

- **super**: refers to the base/super class object
  - We can invoke any base class constructor using **super(…)**
  - We can access data and methods in the base class (**Person**) through **super**. E.g., toString( ) and equals( ) invoke the corresponding methods from the **Person** base class, using **super.toString( )** and **super.equals( )**
- **this**: refers to the current object
  - We can refer to our own data and methods using "**this.**"
  - In a class, we can invoke one constructor from another constructor using **this(…)**. As with the **super** constructor, this can only be done **within a constructor**, and must be the **first statement** of the constructor. Example:

```
public Toy(Toy toy ) {
    this(toy.name, toy.releasedYear);
}
```

- Can super() and this() calls appear simultaneously in a constructor?