Inheritance

Inheritance

- Many objects have a hierarchical relationship
  - Examples: zoo, car/vehicle, card game, airline reservation system
- Inheritance allows software design to take advantage of relationships, supporting reuse
- Supports the IS-A relationship
  - what's the HAS-A relationship?

Terminology

- Base class/Parent class/Superclass
  - defines generic functionality
- Derived class/Child class/Subclass
  - extends or specializes base class

Syntax

public class Student extends Person {…}

public class Derived extends Base{…}

```
public class Person {
   …
   void print();
}
```

```
public class Student extends Person {
   …
   void print();
}
```

Subclasses

- Inherit members of parent
- May implement new members
- May override members of parent

- Person
  - name
  - Person(String)
  - print()
  - getName()
- Student
  - major
  - Student(String, String)
  - print()
  - changeMajor(String)

Method Invocation

- Person – print, getName
- Student – print, changeMajor

```
Person p = new Person("Bob");
Student s = new Student("Alice", "CS");
s.getName();
p.print();
s.print();
p.changeMajor("Econ");
s.changeMajor("Econ");
```

Method Invocation

- Person – print, getName
- Student – print, changeMajor

```
Person p = new Person("Bob");
Student s = new Student("Alice", "CS");
s.getName(); //Person getName
p.print(); //Person print
s.print(); //Student print
p.changeMajor("Econ"); //ERROR
s.changeMajor("Econ"); //Student changeMajor
```

Subclasses

- Person
  - name
  - Person(String)
  - print()
  - getName()
- Student
  - major
  - Student(String, String)
  - print()
  - changeMajor(String)

Protected

- private members of parent not accessible to child class
- protected members accessible only to derived classes
- examples

```
public class Person {
   //will be accessible in Student
   protected String name;
}
```

Partial Overriding

```
//in Person class
void print() {…}

//in Student class
void print() {
   super.print();
   //super.methodName();
   …
}
```

More on *super*

```
public Person(String name) {
   this.name = name;
}

public Student(String name, String major) {
   super(name);
   //super(params);
   this.major = major;
}
```

Exercises

1. Implement and test the Person and Student classes.
   1. What happens when you try to invoke changeMajor on a Person object?

Shadowing Variables

- Variable (same name) declared in base class and derived class
- Generally, a bad idea
- Example: Student declares a String variable *name*

final

- Classes and methods can be defined with final modifier
  - final public class Student …
  - final public void print()…
- final classes cannot be extended
- final methods cannot be overridden

abstract

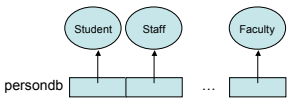
- abstract classes cannot be instantiated
- Declare abstract class using abstract keyword
  - public abstract class Person …
- Method can also be abstract
  - public abstract void print()
- A class with an abstract method must be declared abstract

Polymorphism

- *Many forms*
- A variable is polymorphic if it can refer to different types of objects at different times

Person p = new Person("Bob");
p = new Student("Sally", "History");

Example




```
Person[] persondb = new Person[10];
persondb[0] = new Student("Sally", "History");
persondb[1] = new Staff(…);
…
persondb[9] = new Faculty(…);
```

Dynamic Binding

- Determine which method is called based on object contents

```
class Person {
   void print();
}
class Student extends Person {
   void print();
}
```

Dynamic Binding

Person p = new Person(…);
Student s = new Student(…);
p.print(); //calls Person print()
p = s; //OKAY
p.print(); //calls Student print()
p.changeMajor(); //ERROR

Casting

```
Person p;
p = new Student(…);
Student s = (Student)p;

if(p instanceof Student)
  s = (Student)p;
```

- If cast is not successful, runtime error ClassCastException
- instanceof operator used to determine type

Example

Class1
1. f1
2. f2

Class2 extends Class1
3. f2
4. f3

```
Class1 c1 = new Class2();
Class2 c2 = new Class2();
c1.f3();
c1.f2();
c2 = (Class2)c1;
c2.f3();
```

Exercises

1. Implement the Staff and Faculty classes discussed.
2. Create a PersonDB class that contains an array of Person objects. Implement an addPerson method that adds a new Person object to the array and a printStudents method that prints ONLY the Student objects stored in the array.

Object base class

- All classes derive from Object
- Defines several methods that can be overridden
  - String toString()
  - boolean equals(Object)
  - Object clone()