

## CSE 143 Java

### More About Inheritance

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## Topics for Today

- Protected members of classes
- Super in constructors and other methods
- Using "this" to run other constructors
- Overloading, constructors and "this"
- Overriding some common methods declared in Object – equals, compareTo, clone
- instanceof operator


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## Member Access in Subclasses

- **public**: accessible anywhere the class can be accessed
- **private**: accessible only inside the same class
  - Does *not* include subclasses – derived classes have no special permissions

- A new mode: **protected**   
accessible inside the defining class and all its subclasses

- Use protected for "internal" things that subclasses also are intended to access
- Consider this carefully – often better to keep private data private and provide appropriate (protected) set/get methods

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## Using Protected

- If we had declared the Employee instance variables protected, instead of private, then this constructor would be legal

```
public HourlyEmployee(String name, int id, double pay) {  
    // initialize inherited fields  
    this.name = name;  
    this.id = id;  
    // initialize local fields  
    this.payRate = pay;  
    this.hoursWorked = 0.0;  
}
```

- But it's still poor code [why?]

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## Super



- If a subclass constructor wants to run a superclass constructor, it can do that using the syntax

`super(<possibly empty list of argument expressions>)`

as the *first* thing in the subclass constructor's body

- Example:

```
public HourlyEmployee(String name, int id, double pay) {  
    super(name, id);  
    payRate = pay;  
    hoursWorked = 0.0;  
}
```

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## Constructor Rules

- Rule 1: If you do not write any constructor in a class, Java assumes there is a zero-argument, empty one  
`ClassName() {}`
  - If you write any constructor, Java does not make this assumption
- Rule 2: If you do not write `super(...)` as the first line of a constructor, the compiler will assume the constructor starts with `super();`
- Rule 3: When an extended class object is constructed, there must be a constructor in the parent class whose parameter list matches the explicit or implicit call to `super( ... )`
- Corollary: a constructor is always called at each level of the inheritance chain when an object is created

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## Another Use for Super

- In any subclass, `super.msg(args)` can be used to call the version of the method in the superclass, even if it has been overridden

- Can be done anywhere in the code – does not need to be at the beginning of the calling method, as for constructors

- Often used to create “wrapper” methods

```
/* Return the pay of this manager. Managers receive a 20% bonus */  
public double getPay() {  
    double basePay = super.getPay();  
    return basePay * 1.2;  
}
```



- Question: what if we had written “`this.getPay()`” instead?

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## Overriding and Overloading (Review)

- In spite of the similar names, these are very different
- **Overriding**: replacing an inherited method in a subclass

```
class One {  
    public int method(String arg1, double arg2) { ... }  
}  
class Two extends One {  
    public int method(String arg1, double arg2) { ... }  
}
```

  - Argument lists and results must match *exactly* (number and types)
  - Method called depends on actual (dynamic) type of the receiver

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## Overloading

- **Overloading:** a class may contain multiple definitions for constructors or methods with the same name, but different argument lists

```
class Many {  
    public Many() { ... }  
    public Many(int x) { ... }  
    public Many(double x, String s) { ... }  
    public void another(Many m, String s) { ... }  
    public int another(String[] names) { ... }  
}
```



- Parameter lists must differ in number and/or type of parameters  
Result types can differ only if the parameters differ
- Method calls are resolved automatically depending on number and (static) types of arguments – must be a unique best match

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## Overloaded Constructors and this

- Classes often have several related Constructors
  - Common pattern: some provide explicit parameters while others assume default values
- “this” can be used at the beginning of a constructor to execute another constructor in the same class
  - Syntax similar to super
  - Can have other statements in the constructor following the “this” call
  - Good practice – can provide a single implementation of code common to both constructors

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## Example: HourlyEmployee Constructors

```
/** Construct an hourly employee with name, id, and pay rate */  
public HourlyEmployee(String name, int id, double pay) {  
    super(name, id);  
    payRate = pay;  
    hoursWorked = 0.0;  
}  
  
// default pay for new hires  
private static double defaultPay = 17.42;  
  
/** Construct an hourly employee with name, id, and default pay rate */  
public HourlyEmployee(String name, int id) {  
    this(name, id, defaultPay);  
}
```

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## Comparing Objects

- *Object* defines a boolean function *equals* to test whether two objects are the same
- *Object*'s implementation just compares objects for identity, using `==`
  - This behavior is often not what you want
- Probably more appropriate concept of equality:
  - *obj1.equals(obj2)* should return true if *obj1* and *obj2* represent the “same value”
  - A class that wants this behavior must override *equals()*  
Somewhat tricky to do right – see Bloch, “Effective Java” (A-W, 2001) for a discussion

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## instanceof

- The expression `<object> instanceof <classOrInterface>` is true if the object is an instance of the given class or interface (or any subclass of the one given)
- One common use: checking types of generic objects before casting

```
/* Compare this Blob to another Blob and return true if equal, otherwise false */
public boolean equals(Object otherObject) {
    if (otherObject instanceof Blob) {
        Blob bob = (Blob) otherObject;
        .... compare this to bob and return appropriate answer ...
    } else {
        return false;
    }
}
```

- Overuse (or even use?) of instanceof is often a sign of bad design that doesn't use inheritance and overriding appropriately

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## Comparing The Order of Objects

- Many objects have a natural linear or total order
  - For any two values, one is always  $\leq$  the other
- A boolean comparison doesn't tell about relative order
- Type *Object* does not have a method for this kind of comparison (why not?)
- The most commonly used order comparison method has this signature:  
`int compareTo(Object otherObject)`
  - return negative, 0, or positive value to indicate  $<$ ,  $=$ ,  $>$
- The *Comparable* interface specifies this method
  - Examples of Comparable classes: String, Integer, Double, etc.

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## Sorting Lists of Objects

- `Collections.sort(aList)`
- `Arrays.sort(anArray)`
- These two static methods can sort any objects, as long as...
  - all list elements are Comparable (in the Java sense) and
  - all list elements really are comparable (in the usual sense)
- This is one motivation for giving classes a `compareTo` method
  - and using "implements Comparable"

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## Beyond compareTo

- What if you want to sort object is some way other than their defined `compareTo`?
  - Example: sort strings by length rather than alphabetical order
- What if you want to sort objects which are not Comparable?
  - Example: sort Color objects
- Possible solutions: all either inconvenient, undesirable, or impossible
  - change existing `compareTo` if it exists
  - add `compareTo` if it doesn't exist
  - make a subclass and override `compareTo`
  - write your own code for sorting

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## Comparator Objects

- A Comparator is an interface defining one method:
  - `int compare (Object obj1, Object obj2);`
  - returns value similar to `compareTo`, depending on whether `obj1 < obj2`, `obj1 equals obj2`, or `obj1 > obj2`
- There are versions of `Collections.sort` and `Arrays.sort` which let you pass in a Comparator as a parameter.
- The `compare` method of the Comparator is written to perform exactly the kind of comparison needed
- Completely independent of the objects' `compareTo` methods.

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## Copying Object and `clone()` [skipped Summer 2004]

- Review: what does  $A = B$  mean? (Hint: draw the picture)
- This behavior is not always desirable
- In Java, the `=` operator cannot be overridden
- Instead, a method to copy can be written
- `obj.clone()` should return a copy of `obj` with the "same" value
  - Object's implementation returns a new instance of the same class whose instance variables have the same values as `obj`
  - Object's implementation is protected
  - If a subclass needs to do something different, e.g. clone some of the instance variables too, then it should override `clone()`
- `clone` cannot be used at will...
  - Class must be marked as "Cloneable"

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## Main Ideas of Inheritance

- Main idea: use *inheritance* to relate similar classes
  - Better modeling
  - Supports writing polymorphic code
  - Avoids code duplication
- Other ideas:
  - Use *protected* rather than *private* for things that will be needed by subclasses
  - Use *overriding* to make changes to superclass methods
  - Use *super* in constructors and methods to invoke superclass operations

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