Java Application Design

Threads and RTTI

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Synchronized Section

synchronized (object) { // }

- The key is in an object, not in the code.
  Case Study: Crunch2.java

1. There is a key in every object.
2. To execute synchronized() block, the thread need to get the key in the object. Once the key is got, the object does not have the key.
3. If the key were not in the object when the thread wants to exec. synchronized(), the thread is to be stall until the key returns to the object.
4. The key is to be returned to the object when the thread leave the synchorized() block.

How to protect data?

- synchronized() is not to protect the data, but to guarantee there is only one thread at a time.

Tips to protect data:

1. Private data
2. All access to the data is synchronized
3. The key is in the data itself

Nested synchronized

- Nested synchronized is safe in Java

```
synchronized(a) {
    synchronized(a) {
    }
}

synchronized(a) {
    f();
}
```

Synchronized method

```
void f() {
   synchronized(this) {
      ...
   }
}

synchronized void f() {
}
```

Avoiding Deadlocks

Step	Thread 1	Thread 2
1	`synchronized (object1) {`	`synchronized (object2) {`
2	`// do something here`	`// do something here`
3		
4		
5	`synchronized (object2) {`	`synchronized (object1) {`
6	`// do something here`	`// do something here`
	`}`	`}`
	`}`	`}`

Wait for Thread 2 to release the lock on `object2`

Wait for Thread 1 to release the lock on `object1`

Communication among threads

- PipedInputStream/PipedOutputStream
  Case Study: Pipe.java

Producer and consumer

- is a pattern that one thread produces data and the other one read it. There must be a shared variable for transportation and a flag to indicate the data is valid or has been read.

Case Study: FlagComm.java

Wait() & notify()

- wait() and notify() of Object
  Every object can have a thread pool. A thread can call wait() to join the pool and call notify() to leave the pool.
  Case Study: WaitComm.java

Class Class

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Among the methods contained in Object are the following:

```
public boolean equals(Object x) {…}

public String toString( ) {…}

public Class getClass(Object x)  {…}

public int hashCode( )  {…}

protected Object clone(Object x)  {…}

public void wait( )  {…}                    //used in multithreading

public void notify( ) {…}                    //used in multithreading
```

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We will examine the first five of these methods in more detail.

Class Object

Method equals( )

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In class String – equals( ) is overridden to test whether the two String objects have the same value.

```
String s1 = “A string”;
String s2 = “A” + new String(“ string”);
System.out.println(“Strings s1 and s2 have same reference: ”+s1==s2);

System.out.println(“Strings s1 and s2 have same value: ”+s1.equals(s2));
```

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System.out.println(“Strings s1 and s2 have same reference: ”+s1==s2);
```

false

```
System.out.println(“Strings s1 and s2 have same value: ”+s1.equals(s2));
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Method toString( )

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Consider the following example

```
class ShowObject {
    private int val1, val2;
    public ShowObject(int v1, int v2) {val1 = v1; val2 = v2;}
    public static void main(String [ ] args) {
        ShowObject theObj = new ShowObject(24, 12);
        System.out.println("the output is "+theObj);
    }
}
```

Class Object

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```

the output is ShowObject@107077e

Class Object

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Note in the previous example that the call to

System.out.println(“some string ”+ theObj)

Results in a call to the method toString( ) in class ShowObject that is inherited from Object.

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Whenever methods print( ) or println( ) are passed an Object as an argument, they will use the object’s toString( ) method to formulate the output string.

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pubic static void main (String [ ] args) {
    ShowObject obj1 = new ShowObject(24, 12);
    ShowObject obj2 = new ShowObject(24, 12);
    System.out.println("hash code for obj1: "+obj1.hashCode( ));
    System.out.println("hash code for obj2: "+obj2.hashCode( ));
}
```

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8187137

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    System.out.println("hash code for obj2: "+obj2.hashCode( ));        28050664
}
```

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A good hash function is one that uniformly distributes the keys into the range of integer values that index the hash table. For most applications, the programmer will need to override hashCode( ) derived from the base class Object.

If the programmer chooses to override method hashCode( ) in a particular class, he or she must supply

1. **Supply a (private) hash function that maps attributes of the object into integer values.**
2. **Choose some attribute or attributes of the class that form the domain of the hash function.**

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- **Unless method clone( ) is overriden, a derived class will inherit clone( ) from Object, but the method is protected and not accessible to a client – therefore no clones of objects of that class can be created.**

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- **Unless method clone( ) is overriden, a derived class will inherit clone( ) from Object, but the method is protected and not accessible to a client – therefore no clones of objects of that class can be created.**
- **To allow clients to create clones of objects of a particular class, method clone( ) will have to be overridden and made public.**
- **Once clone( ) is made public in a class, it is public also for any classes derived from that class.**

Class Object

Method clone( )

There are three important rules to follow if you are going to override clone( ) in a class you are creating.

1. (Virtually) Always call super.clone( ) -- the base class clone( ) method performs the bitwise duplication of the derived class object. (If the attributes are all primitive types it is safe to not call super.)

2. Make your clone( ) method public

3. Implement the Cloneable interface

   •To determine whether an instance of an object can be cloned

   if (myReference instanceof Cloneable) {..}

   •Cloneable is an "empty interface" with no methods to implement. It acts as a "flag" identifying that an object can be cloned.

Class Object

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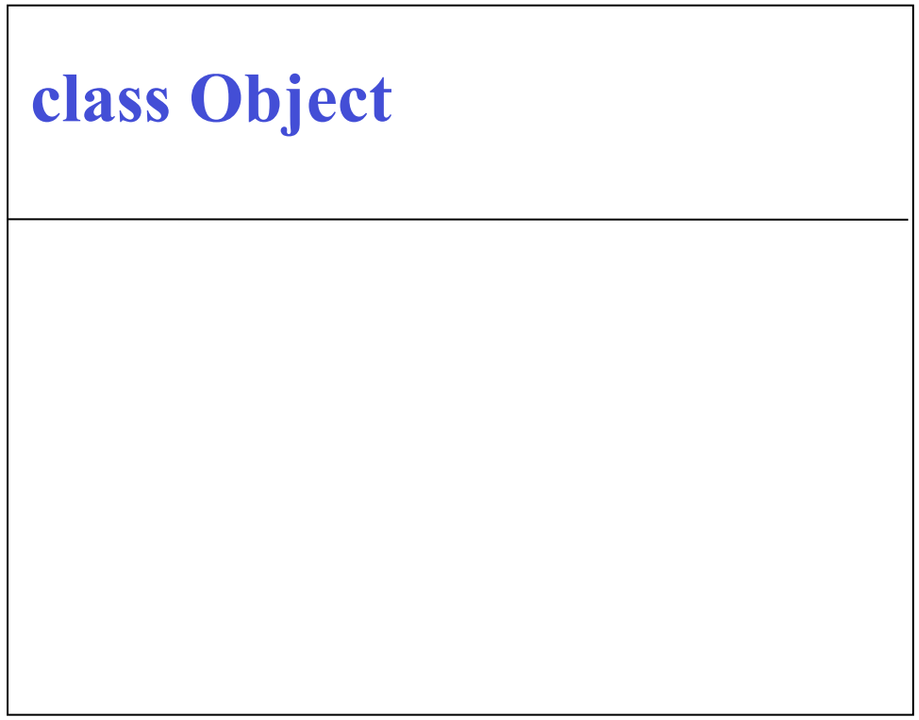

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private int myInt; //primitive type

private YourThing aThing; //object

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protected Object clone( ) {
   //perform bitwise copy
}

//other methods
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public Object clone ( ) {
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Declare a *MyThing* object that will become the clone you return

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class MyThing extends Object
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class MyThing extends Object
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//data attributes
private int  myInt;  //primitive type
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public Object clone ( ) {
    MyThing result = null;
```

Class Object

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class MyThing extends Object
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//data attributes
private int  myInt;  //primitive type
private YourThing  aThing; //object

public Object clone ( ) {
    MyThing result = null;
    result = (MyThing)super.clone( );
```

Class Object

Method clone( )

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```

A call to clone( ) in the base class makes a bitwise copy of the attributes of the MyThing object. Method clone() in the base class is protected—hence accessible to derived classes.

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private int  myInt;  //primitive type
private YourThing  aThing; //object

public Object clone ( ) {
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Class Object

Method clone( )

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class Object

protected Object clone( ) {
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A cast is performed to down cast the Object returned by the clone( ) method in Object to a MyThing object before assigning it to result.

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private int  myInt;  //primitive type
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public Object clone ( ) {
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    result = (MyThing)super.clone( );
    result.aThing = (YourThing)
            result.aThing.clone( );
    return result;
}
```

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Here we assume the object attribute is Cloneable, and we convert the bitwise copy done in the call to super – that only copies a handle to an object – into a "deep copy" of the object itself by calling the object's own clone( ) method.

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Class Object

Method clone( )

Some frequently used Java library classes are not cloneable.

- **The wrapper classes (Integer, Double, etc.) do not override method clone( ) and hence cannot be cloned.**

- **String and StringBuffer classes are not Cloneable.**

- **Standard Containers, such as *arrayList*, can be cloned, but a shallow copy of their contents is made because it cannot be certain that those contained objects can be cloned.**

Class Object

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Method clone( ) – an example

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Method clone( ) – an example

A Box is an unordered collection of objects of fixed size.

```
public class Box implements Cloneable {
    protected Object [ ] box;
    protected int size;
    public Box(int bsize) {
        box = new Object[bsize];
        size = 0;
    }
    public Object clone ( ) {
        Box  result = null;
        try {
            result = (Box)super.clone( );
        } catch (CloneNotSupportedException e) {System.out.println(e); }
        for (int i = 0; i < box.length; i++)  //override bitwise copy if possible
            if (box[i]  instanceof Cloneable)       { result.box[i] = box[i].clone( ); }
        return result;
    }
}
```

Class Object

Method clone( ) – an example

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        return result;
    }
}
```

You need to enclose the call to super.clone inside a try block

Class Object

Method getClass( )

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Method getClass( )

This method is useful when you have a container holding objects of a base class (such as Shape) some or all of which are instances of a derived class (such as Circle or Rectangle). The method getClass( ) allows one to determine which kind of an object each is, and determine whether a particular down cast is appropriate.

This method is inherited from the base class Object and should never be overridden in any derived class.

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Class Object

Method getClass( ) -- Example

Let Shape be an abstract class and Circle and Rectangle concrete classes that extend Shape.

```
public static void main (String [ ] args) {
    Shape [ ] shapeList = new Shape [3];
    shapeList[0] = new Circle(5.0);
    shapeList[1] = new Rectangle(3.0, 4.0);
    shapeList[2] = new Circle(6.0);
    for (int i = 0; i < shapeList.length; i++) {
        Class c = shapeList[i].getClass( );
        if (c.equals(Circle.class))
            System.out.println("I can be cast as a Circle");
        else if (c.equals(Rectangle.class))
            System.out.println("I can be cast as a Rectangle");
    }
}
```

Class Object

Method getClass( ) -- Example

Let Shape be an abstract class and Circle and Rectangle concrete classes that extend Shape.

```
public static void main (String [ ] args) {
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    shapeList[2] = new Circle(6.0);
    for (int i = 0; i < shapeList.length; i++) {
        Class c = shapeList[i].getClass( );
        if (c.equals(Circle.class))
            System.out.println("I can be cast as a Circle");
        else if (c.equals(Rectangle.class))
            System.out.println("I can be cast as a Rectangle");
    }
}
```

Find out to which class each object in shapeList belongs

Class Object

Method getClass( ) -- Example

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    for (int i = 0; i < shapeList.length; i++) {
        Class c = shapeList[i].getClass( );
        if (c.equals(Circle.class))
            System.out.println("I can be cast as a Circle");
        else if (c.equals(Rectangle.class))
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    }
}
```

Find out to which class each object in shapeList belongs

Knowing the class that an object belongs to allows the client programmer to down cast the object and send messages to methods particular to that derived class.

RTTI

The idea of run-time type identification (RTTI) seems fairly simple at first: it lets you find the exact type of an object when you have a handle to only the base type.

Class object

- The Class object is used to create all of the "regular" objects of your class. Each time you write a new class, a single Class object is also created (and stored, appropriately enough, in an identically named .class file). At run time, when you want to make an object of that class, the Java Virtual Machine (JVM) that's executing your program first checks to see if the Class object for that type is loaded. If not, the JVM loads it by finding the .class file with that name.
- Case Study: SweetShop.java

- The output of this program for one JVM is:
  - inside main Loading Candy
  - After creating Candy
  - Loading Gum
  - After Class.forName("Gum")
  - Loading Cookie
  - After creating Cookie

The Class Object

- Class literals also provide a reference to the Class object
  - *E.g.* `Gum.class`
- Each object of a primitive wrapper class has a standard field called TYPE that also provides a reference to the Class object
  - http://java.sun.com/j2se/1.3/docs/api/java/lang/Boolean.html

Instance of

- Java 1.1 has added the isInstance method to the class Class.
- Case Study: PetCount3.java

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Class Object

Method getClass( )

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← Alternatively (but equivalently) use the isInstance( ) method of an object with a class parameter

RTTI mothods

- **Case Study: ToyTest.java**

Reflection: run-time class information

- Where to use Reflection?
  - Component-based programming in which you build projects using Rapid Application Development (RAD) in an application builder tool.
    - To provide the ability to create and execute objects on remote platforms across a network. This is called Remote Method Invocation (RMI) and it allows a Java program (version 1.1 and higher) to have objects distributed across many machines.
- Case Study: ShowMethods.java

Get Filed Value

To print the names of the ViolinNote fields as well as their current values in the particular ViolinNote object referenced by note:

```
Field fields[] = c.getFields(); try {
 for(int i = 0; i < fields.length; i++) {
  System.out.print(fields[i].getName() + " =
  ");
  System.out.println(fields[i].getInt(note))
  ;
 }
} catch(Exception e) {
}
```

Invoke Method

```
note = new Note();
c = note.getClass();
Method meth = c.getMethod("play",
null);
meth.invoke(note, null);
```

串行化和RTTI

- 反串行化回来的对象为什么还是能用的?