

CS61B Lecture #12: Additional OOP Details, Exceptions

Parent Constructors

- In lecture notes #5, talked about how Java allows implementer of a class to control all manipulation of objects of that class.
- In particular, this means that Java gives the constructor of a class the first shot at each new object.
- When one class extends another, there are two constructors—one for the parent type and one for the new (child) type.
- In this case, Java guarantees that *one of the parent's constructors is called first*. In effect, there is a call to a parent constructor at the beginning of every one of the child's constructors.
- You can call the parent's constructor yourself explicitly.

```
class Figure {  
    public Figure(int sides) {  
        ...  
    }...  
}
```

```
class Rectangle extends Figure {  
    public Rectangle() {  
        super(4);  
    }...  
}
```

Default Constructors

- By default, Java calls the “default” (parameterless) constructor if there is no explicit constructor called.

```
/* This... */  
class Thingy extends Rectangle {  
    public Thingy() {  
        setThingsUp();  
    }  
}
```

```
/* Is equivalent to... */  
class Thingy extends Rectangle {  
    public Thingy() {  
        super();  
        setThingsUp();  
    }  
}
```

- And it creates a default constructor for a class if no other constructor is defined for the class.

```
/* This... */  
class Crate {  
}
```

```
/* Is equivalent to... */  
class Crate {  
    public Crate() {  
    }  
}
```

```
/* And thus to... */  
class Crate {  
    public Crate() {  
        super();  
    }  
}
```

What Happens Here?

```
class Figure {  
    public Figure(int sides) {  
        ...  
    }  
}  
  
class Rectangle extends Figure {  
}
```

What Happens Here?

```
class Figure {
    public Figure(int sides) {
        ...
    }
}

class Rectangle extends Figure {
}
```

Answer: Compiler error. Rectangle has an implicit constructor that tries to call the default constructor in Figure, but there isn't one.

Using an Overridden Method

- Suppose that you wish to *add* to the action defined by a superclass's method, rather than to completely override it.
- The overriding method can refer to overridden methods by using the special prefix `super`.
- For example, you have a class with expensive functions, and you'd like a memoizing version of the class.

```
class ComputeHard {  
    int cogitate(String x, int y) { ... }  
}
```

```
class ComputeLazily extends ComputeHard {  
    int cogitate(String x, int y) {  
        if (don't already have answer for this x and y) {  
            int result = super.cogitate(x, y); // <<< Calls overridden function  
            memoize (save) result;  
            return result;  
        }  
        return memoized result;  
    }  
}
```

Trick: Delegation and Wrappers

- Not always appropriate to use inheritance to extend something.
- Homework gives example of a TrReader, which *contains* another Reader, to which it *delegates* the task of actually going out and reading characters.
- Another example: a class that instruments objects:

```
interface Storage {  
    void put(Object x);  
    Object get();  
}
```

```
class Monitor implements Storage {  
    int gets, puts;  
    private Storage store;  
    Monitor(Storage x) { store = x; gets = puts = 0; }  
    public void put(Object x) { puts += 1; store.put(x); }  
    public Object get() { gets += 1; return store.get(); }  
}
```

```
// ORIGINAL  
Storage S = something;  
f(S);
```

```
// INSTRUMENTED  
Monitor S = new Monitor(something);  
f(S);  
System.out.println(S.gets + " gets");
```

Monitor is called a *wrapper class*.

What to do About Errors?

- Large amount of any production program devoted to detecting and responding to errors.
- Some errors are external (bad input, network failures); others are internal errors in programs.
- When method has stated precondition, it's the client's job to comply.
- Still, it's nice to detect and report client's errors.
- In Java, we *throw exception objects*, typically:

```
throw new SomeException (optional description);
```

- Exceptions are objects. By convention, they are given two constructors: one with no arguments, and one with a descriptive string argument (which the exception stores).
- Java system throws some exceptions implicitly, as when you dereference a null pointer, or exceed an array bound.

Catching Exceptions

- A **throw** causes each active method call to *terminate abruptly*, until (and unless) we come to a **try** block.
- Catch exceptions and do something corrective with **try**:

```
try {  
    Stuff that might throw exception;  
} catch (SomeException e) {  
    Do something reasonable;  
} catch (SomeOtherException e) {  
    Do something else reasonable;  
}  
  
Go on with life;
```

- When *SomeException* exception occurs during "Stuff..." and is not handled there, we immediately "do something reasonable" and then "go on with life."
- Descriptive string (if any) available as `e.getMessage()` for error messages and the like.

Catching Exceptions, II

- Using a supertype as the parameter type in a **catch** clause will catch any subtype of that exception as well:

```
try {  
    Code that might throw a FileNotFoundException or a  
        MalformedURLException ;  
catch (IOException ex) {  
    Handle any kind of IOException;  
}
```

- Since `FileNotFoundException` and `MalformedURLException` both inherit from `IOException`, the **catch** handles both cases.
- Subtyping means that multiple **catch** clauses can apply; Java takes the first.
- Stylistically, it's nice to be more (concrete) about exception types where possible.
- In particular, our style checker will therefore balk at the use of `Exception`, `RuntimeException`, `Error`, and `Throwable` as exception supertypes.

Catching Exceptions, III

- There's a relatively new shorthand for handling multiple exceptions the same way:

```
try {  
    Code that might throw IllegalArgumentException  
    or IllegalStateException;  
catch (IllegalArgumentException|IllegalStateException ex) {  
    Handle exception;  
}
```

Exceptions: Checked vs. Unchecked

- The object thrown by **throw** command must be a subtype of `Throwable` (in `java.lang`).
- Java pre-declares several such subtypes, among them
 - `Error`, used for serious, unrecoverable errors;
 - `Exception`, intended for all other exceptions;
 - `RuntimeException`, a subtype of `Exception` intended mostly for programming errors too common to be worth declaring.
- Pre-declared exceptions are all subtypes of one of these.
- Any subtype of `Error` or `RuntimeException` is said to be *unchecked*.
- All other exception types are *checked*.

Unchecked Exceptions

- Intended for
 - Programmer errors: many library functions throw `IllegalArgumentException` when one fails to meet a precondition.
 - Errors detected by the basic Java system: e.g.,
 - * Executing `x.y` when `x` is null,
 - * Executing `A[i]` when `i` is out of bounds,
 - * Executing `(String) x` when `x` turns out not to point to a `String`.
 - Certain catastrophic failures, such as running out of memory.
- May be thrown anywhere at any time with no special preparation.

Checked Exceptions

- Intended to indicate exceptional circumstances that are not necessarily programmer errors. Examples:
 - Attempting to open a file that does not exist.
 - Input or output errors on a file.
 - Receiving an interrupt.
- Every checked exception that can occur inside a method must either be handled by a try statement, or reported in the method's declaration.
- For example,

```
void myRead() throws IOException, InterruptedException { ... }
```

means that myRead (or something it calls) *might* throw IOException or InterruptedException.

- Language Design: Why did Java make the following illegal?

```
class Parent {
    void f() { ... }
}

class Child extends Parent {
    void f () throws IOException { ... }
}
```

Good Practice

- Throw exceptions rather than using print statements and `System.exit` everywhere,
- ...because response to a problem may depend on the *caller*, not just method where problem arises.
- Nice to throw an exception when programmer violates preconditions.
- Particularly good idea to throw an exception rather than let bad input corrupt a data structure.
- Good idea to document when methods throw exceptions.
- To convey information about the cause of exceptional condition, put it into the exception rather than into some global variable:

```
class MyBad extends Exception {  
    public IntList errs;  
    MyBad(IntList nums) { errs=nums; }  
}  
  
try {...  
} catch (MyBad e) {  
    ... e.errs ...  
}
```