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.

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

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

    /* This... */         /* Is equivalent to... */         /* And thus to... */
    class Crate {
        public Crate() {
            super();
            setThingsUp();
        }
    }
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.

```java
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;
    }
}
```

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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:

```java
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**:

```java
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:

  ```java
  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:

```java
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,

```java
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?

```java
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:

```java
class MyBad extends Exception {
    public IntList errs;
    MyBad(IntList nums) { errs=nums; }
}
```

```java
try {
    ... e.errs ...
} catch (MyBad e) {
    ... e.errs ...
}
```