More generic questions. Suppose we have the following classes defined:

```java
class Shape { … }
class Circle extends Shape { … }
class Rectangle extends Shape { … }
```

Now suppose we have a program that contains the following objects and list:

```java
Object o;
Shape s;
Circle c;
Rectangle r;
List<? extends Shape> les;
les.add(s);
les.add(c);
c = les.get(0);
s = les.get(0);
o = les.get(0);
```

```java
List<? super Shape> lss;
lss.add(s);
lss.add(c);
c = lss.get(0);
s = lss.get(0);
o = lss.get(0);
```

---

We discussed several patterns during the quarter. For reference, here is a list of some of them:

- Creational: Factory, Singleton, Builder, Prototype, Interning, Flyweight
- Structural: Adapter, Composite, Decorator, Flyweight, Proxy
- Behavioral: Interpreter, Observer, Iterator, Strategy, Model-View-Controller, Visitor

For each of the following situations, write down the name of the design pattern that would be an appropriate solution to the given design problem. You do not need to justify your answer—just pick the best one. If more than one pattern seems appropriate, pick the best match or most specific one.

---

a) You have a set of objects that is unlikely to change, but the set of operations on them is likely to change. You want to keep the code for each operation together in a single module.

   Visitor/Procedural

b) You have a class with a many optional parameters, and want to avoid creating a large number of constructors.

   Builder (partial credit for Factory)

c) You have a Point class whose interface uses polar coordinates and you want to provide a wrapper so it can be used to implement a version of Point that uses rectangular coordinates.

   Adapter
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d) You want to wrap a library class that manages data connections so that it logs connection attempts as they occur.

Decorator (partial credit for Proxy)

e) You want to save memory costs of creating many duplicate objects of a class which has only a few distinct abstract values.

Interning (partial credit for Factory, Flyweight)

f) When new objects of your class are created the new objects should actually have a more appropriate subtype.

Factory

---

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```java
/** A tic-tac-toe game */
public class TicTacToe {
    // instance variables omitted

    /** Initialize a new game object */
    public TicTacToe() {
    }

    /** Print the state of the game board on System.out */
    public void printGame() {
    }

    /** Read the player's next move from the keyboard * and update the game to reflect that move. */
    public void getPlayerMove() {
    }

    /** Calculate the computer's next move and print it on * System.out */
    public void computerMove() {
    }

    /** Calculate the computer and user's current scores * and print them on System.out */
    public void printScores() {
    }

    /** Reset the game back to the same initial state it had * when it was created */
    public void resetGame() {
    }
}
```

---

Fall 2013 Q2

What is (are) the major design flaw(s) in the above design? A brief couple of sentences should be enough to get the point across.

The major design flaw is that the game logic and user interface have been jumbled together in a single class. These need to be separated, particularly if we ever hope to be able to replace the user interface with a different one without a major rewrite.

---

Fall 2013 Q2

Describe how you would refactor (change) the initial design to improve it. Briefly sketch the class(es) and methods in your design, and what each of them do. You do not need to provide very much detail, but there should be enough so we can tell how you've rearranged the design, what the major pieces are, and how they interact.

The important thing that the application should be split using the MVC pattern to separate the game logic from the interface

Model: game logic. Operations would include the following from the original code:
- Create a new game model
- Record a new player move
- Calculate a new move for the computer
- Return the current user and computer scores to the caller
- Return the current state of the game board to the caller
- Reset the game board to start a new game

Viewer/Controller (likely a single module in a console text-based game):
- Process initialize and reset commands from the user
- Read player moves and call the model to update the game state
- Display computer moves
- Display current contents of the game board and current scores

The viewer/controller and the model would likely use some form of the Observer pattern to communicate.
We would like to modify this code to change it into a generic method that works with any sorted array whose elements have type Comparable<T> (i.e., the elements can be ordered using the compareTo method). Mark the code above to show the changes needed to turn this into a generic method.

```java
/** Search a sorted array of integers for a given value
 * @param a Array to be searched
 * @param x Value to search for in array a
 * @return If x is found in a, return largest i such that a[i]==x. Return -1 if x not found in a
 * @requires a!=null & a is sorted in non-decreasing order (i.e., a[0]<=a[1]<=...<=a[a.length-1])
 */
public static int bsearch(int[] a, int x) {
    int L = -1;
    int R = a.length;
    // inv: a[0..L] <= x && a[R..a.length-1] > x && a[L+1..R-1] not examined
    while (L+1 != R) {
        int mid = (L+R)/2;
        if (a[mid] <= x)
            L = mid;
        else // a[mid] > x
            R = mid;
    }
    if (L >= 0 && a[L] == x)
        return L;
    else
        return -1;
}
```

```java
public static <T extends Comparable<T>> int bsearch(T[] a, T x) {
    int L = -1;
    int R = a.length;
    // inv: a[0..L] <= x && a[R..a.length-1] > x && a[L+1..R-1] not examined
    while (L+1 != R) {
        int mid = (L+R)/2;
        if (a[mid].compareTo(x) <= 0)
            L = mid;
        else // a[mid] > x
            R = mid;
    }
    if (L >= 0 && a[L].compareTo(x) == 0)
        return L;
    else
        return -1;
}
```

There’s something fishy about this question. Suppose we have the following class hierarchy:

```java
class Creature extends Object { }
class Fish extends Creature {
    /** Return the weight of this Fish */
    public float getWeight() { return ...; }
}
class Salmon extends Fish { }
class Haddock extends Fish { }
class Tuna extends Fish { }
Class Creature does not have a getWeight method. Class Fish implements that method and all of its subclasses inherit it.
```

Write a static method collectionWeight whose parameter can be any Java Collection containing Fish objects (including objects of any Fish subclass(es)). Method collectionWeight should return the total weight of all the Fish in the Collection, using getWeight to determine the weight of each individual Fish.

Hints: Method collectionWeight will need a proper generic type for its parameter. Java Collections are things like Lists and Sets that implement the Iterable interface. They do not include things like Maps, which are not simple collections of objects.
Using wildcards:

```java
public static float collectionWeight(Collection<? extends Fish> f) {
    float totalWeight = 0;
    for (Fish fish: f)
        totalWeight += fish.getWeight();
    return totalWeight;
}
```

Or without wildcards:

```java
public static <T extends Fish> float collectionWeight(Collection<T> f) {
    float totalWeight = 0;
    for (T fish: f)
        totalWeight += fish.getWeight();
    return totalWeight;
}
```

A large project can be built either bottom-up starting with modules that do not depend on others and that provide infrastructure for modules higher up, or top-down, starting at the top layer and adding lower-level modules as the project progresses.

Fall 2013 Q9

Give one advantage of a top-down development strategy over a bottom-up one. (But be brief about it!)

Problems with global design and implementation decisions can be found earlier in the project, when they are (much) less expensive and easier to fix. There is usually better visibility. Clients can see that progress is being made and partially-built systems are easier to demonstrate and try earlier.

Give one advantage of a bottom-up development strategy over a top-down one. (And be brief about this, too!)

Efficiency and feasibility problems tend to get uncovered earlier. For example, it is easier to discover that the hardware or infrastructure won't be able to provide the required performance or satisfy other required constraints. Bottom-up can require building less non-deliverable scaffolding code, although this is not necessarily a major advantage.

Final Topics

- First half of the quarter – code reasoning, specifications, ADTs, AFs and RIs, testing, equality and hashing
- Exceptions and Assertions
- Subtypes and Subclasses
- Generics
- Debugging
- Design Patterns
- GUIs
- System Integration

** Disclaimer: This list is not comprehensive!!!**