Principles of Software Construction: Objects, Design and Concurrency

Mutability and Java Potpourri

15-214

toad

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Administrivia

- Charlie's office hours moved to Sunday this week only:
  - Sunday 12:00 to 2:00 p.m., Wean 5101

Key concepts from Tuesday

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- java.lang.Object behavioral contracts
  - Challenges of inheritance
- Java Exceptions

Key concepts for today

- Mutability
- Java potpourri
  - The `static` keyword
  - Inner classes
  - Scope and variable shadowing
  - Java Generics

One possible `String` implementation

```
public class String {
    private char value[];
    …
    public void concat(String s) {
        char newValue[] = new char[value.length + s.value.length];
        for (int i = 0; i < value.length; ++i) {
            newValue[i] = value[i];
        }
        for (int i = 0; i < s.value.length; ++i) {
            newValue[value.length+i] = s.value[i];
        }
        value = newValue;
    }
    public void replace(char old, char new) {
        for (int i = 0; i < value.length; ++i) {
            if (value[i] == old) {
                value[i] = new;
            }
        }
    }
}
```

Another possible `String` implementation

```
public class String {
    private final char value[];
    …
    public String concat(String s) {
        char newValue[] = new char[value.length + s.value.length];
        for (int i = 0; i < value.length; ++i) {
            newValue[i] = value[i];
        }
        for (int i = 0; i < s.value.length; ++i) {
            newValue[value.length+i] = s.value[i];
        }
        return new String(newValue);
    }
    public String replace(char old, char new) {
        char newValue[] = new char[value.length];
        for (int i = 0; i < value.length; ++i) {
            newValue[i] = value[i];
            if (value[i] == old) {
                newValue[i] = new;
            }
        }
        return new String(newValue);
    }
}
```

Mutability and immutability

- Data is *mutable* if it can change over time. Otherwise it is *immutable*.
  - Variables declared as `final` are enforced to be immutable
    - …but data they reference can still be mutable

```
final List<Integer> vals = new ArrayList<Integer>();

vals.add(42);  // OK even though it changes the list

               // Not OK because it changes vals:
vals = new ArrayList<Integer>();
```

Advantages: Mutability vs. Immutability

Immutable advice

- Make your classes and fields immutable if possible
  - Make all data `private` and `final`
  - Guarantee exclusive access to your data
    - Defensively copy your data
    - Don't leak your data
  - Don't provide public mutator methods
  - Make your classes `final`

Key concepts for today

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- Java potpourri
  - The `static` keyword
  - Inner classes
  - Scope and variable shadowing
  - Java Generics

Static data and methods

- A property is *static* if it is associated with the class (as opposed to being associated with an instance of the class)
  - A.k.a. *class* fields and methods
- Examples
  - A simple `Counter` example
  - The `main` method – why is this static?
  - The `java.lang.String valueOf` methods

Inner classes in Java

- Classes can be defined inside other classes, or even inside class methods
  - e.g., A `LinkedList.Node` class accessible only from within a `LinkedList` class:

```
public class LinkedList {
  private static class Node {
    public int val;
    public Node next;
    public Node(int v, Node n) {
      val = v;
      next = n;
    }
  }
  Node head;
  // …
}
```

Variable shadowing in Java

- Variable shadowing: when a name within some program inner scope matches a name in some outer scope
  - e.g.,

```
public class Dog {
  String name;
  public Dog (String name) {
    this.name = name;
  }
}
```

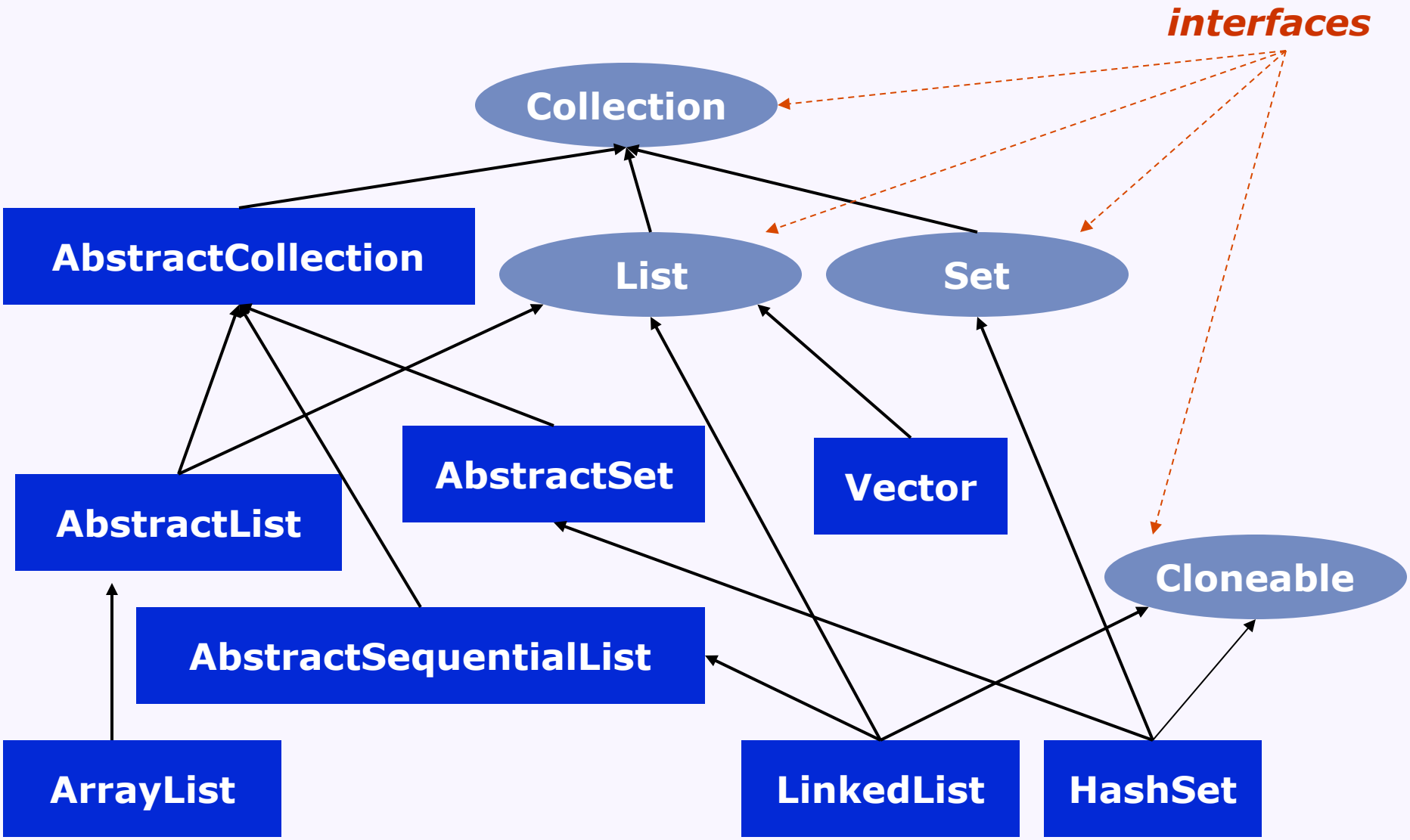
- Java has class variables, instance variables, and local variables
  - Local variables may shadow instance or class variables
  - A subclass's variables may shadow superclass variables

Inner scopes in Java

- Curly braces define a new scope
  - e.g.,

```
public void printAsInt(String s) {
   try {
     Integer x = Integer.valueOf(s);
   } catch (NumberFormatException e) {
     // we ignore the exception
   }
   System.out.println(x);  // x is undefined
 }                         // in this scope
```

Recall the Java Collection API (excerpt)



Consider the `java.util.Stack`

```
public class Stack {

     public void push(Object obj) { … }

     public Object pop() { …}

}
```

- Some possible client code?:

```
Stack stack = new Stack();
String s = “Hello!”;
stack.push(s);
String t = stack.pop();
```

Consider the `java.util.Stack`

```
public class Stack {

     public void push(Object obj) { … }

     public Object pop() { …}

}
```

- Some possible client code:

```
Stack stack = new Stack();
String s = “Hello!”;
stack.push(s);
String t = (String) stack.pop();
```

To fix the type error

Type polymorphism via Java Generics

- The java.util.Stack instead
  - A stack of some type *T*:

```
public class Stack<T> {
    public void push(T obj) { … }
    public T pop() { … }
}
```

- Improves typechecking, simplifies(?) client code:

```
Stack<String> stack = new Stack<String>();
String s = “Hello!”;
stack.push(s);
String t = stack.pop();
```

Next week: design and testing