COMP 250

Lecture 29

interfaces

Nov. 18, 2016

ADT (abstract data type)

ADT's specify a set of operations, and allow us to ignore implementation details. Examples:

- list
- stack
- queue
- binary search tree
- priority queue (heap)
- hash map
- graph

Java API

API = application program *interface*

Gives class methods and some fields, and comments on what the methods do. e.g.

https://docs.oracle.com/javase/7/docs/api/java/util/LinkedList.html

Java `interface`

- reserved word (don't confuse with "I" in API)
- like a class, but only the method signatures are defined

Example: List interface

```
interface  List<T>  {
      void          add(T)
      void          add(int,  T)
      T             remove(int)
      boolean       isEmpty()
      T             get( int )
      int           size()
                :
}
```

https://docs.oracle.com/javase/7/docs/api/java/util/List.html

```
class  ArrayList<T>   implements  List<T> {

      void          add(T)          { …. }
      void          add(int,  T)    {  ….  }
      T             remove(int)     {  ….  }
      boolean       isEmpty()       {  ….  }
      T             get( int )      {  ….  }
      int           size()          {  ….  }
            :
}
```

Each of the List methods are implemented.
(In addition, other methods may be defined and implemented.)

```
class  LinkedList<T>   implements  List<T> {

      void          add(T)          { …. }
      void          add(int,  T)    {  ….  }
      T             remove(int)     {  ….  }
      boolean       isEmpty()       {  ….  }
      T             get( int )      {  ….  }
      int           size()          {  ….  }
            :
}
```

Each of the List methods are implemented.
(In addition, other methods may be defined and implemented.)

Example: how are Java interface's used ?

```
List<String>      list;

list = new ArrayList<String>();
list.add("hello");

list = new LinkedList<String>();
list.add( new String("hi") );
```

Example: how are Java interface's used ?

```
void  someUsefulMethod(    List<String>    list ){
      :
   list.add("hello");
      :
   list.remove( 3 );
}
```

The method can be called with a LinkedList or an ArrayList as the parameter.

Example: user defined interface

```
interface  Shape {
    double  getArea();
    double  getPerimeter();
}

class   Rectangle  implements  Shape{
        :
}

class   Circle  implements  Shape{
        :
}
```

```
class   Rectangle  implements  Shape{

    double  height,  width;

    Rectangle(  double h,  double w ){
            height = h;   weight = w;
    }

    double   getArea(){   return height * width;   }

    double   getPerimeter(){   return 2*(height + width);  }

}
```

```
class   Circle  implements  Shape{

    double  radius;

    Circle(  double r ){
            radius = r;
    }

    double   getArea(){   return   MATH.PI * radius * radius; }

    double   getPerimeter(){
                                return    2*MATH.PI * radius }

}
```

```
Shape     s  =   new  Rectangle( 30, 40 );

          s  =   new   Circle(  2.5  );
```

See Assignment 4 for a similar example….

Java `Comparable` interface

Suppose you want to define an ordering on instances of some class, and possibly allows some instances to be "equal".

Sorting, binary search trees, priority queues (heaps) each *require* a well defined ordering (" < ").

Java `Comparable` interface

```
interface  Comparable<T> {
      int   compareTo( T   t );
}
```

e.g. The class String implements Comparable<String>.

Q: What does that mean?

Java `Comparable` interface

T implements Comparable<T>

T t1, t2;

Java API *recommends* that t1.compareTo(t2) returns:

0,	if t1.equals(t2) returns true
positive number,	if t1 > t2
negative number,	if t1 < t2

Example: Rectangle

Q: When are two Rectangle objects equal ?

A: Their heights are equal and their widths are equal.

Q: How can we define a compareTo() method for ordering Rectangle objects ?

```
class   Rectangle  implements  Shape,   Comparable{

    boolean  equals(  Rectangle  r ) {
        return  (this.height ==  r.height) && (this.width == r.width);
    }

    int   compareTo(  Rectangle r ){
         double   diff =  this.getArea()  - r.getArea();     // arbitrary

        if  (diff > 0)
            return  1;
        else  if  (diff ==  0.0)
                    return 0;
        else  return  -1;
    }
}       //      not consistent with Java API recommendation
```

```
class  Rectangle  implements  Shape,  Comparable{

    boolean  equals(  Rectangle  r ) {
        return  this.getArea()  ==  r.getArea();
    }

    int  compareTo(  Rectangle r ){
         double  diff =  this.getArea()  - r.getArea();     // arbitrary

        if  (diff > 0)
            return  1;
        else  if  (diff ==  0.0)
                    return 0;
        else  return  -1;
    }
}       //      Consistent with Java API recommendation
```

Q: If a class implements Comparable, then why would we need an equals() method ?

A1: Every class has an equals() method.

The default is that o1.equals(o2) if o1 and o2 are the same object, i.e. "==".

A2: The equals() method is called by Java library methods, so you can't just rely on compareTo().

Java `Iterator` interface

Motivation 1: we often want to visit all the objects in some collection. But sometimes this is awkward to do.

e.g. LinkedList<T>.get(i)

BST_Node<T>.getSuccessor() // not covered

Java `Iterator` interface

Motivation 2: We sometimes want to have multiple "iterators".

Analogy: Multiple TA's grading a collection of exams.

Java `Iterator` interface

```
interface  Iterator<T> {
        boolean   hasNext();
        T         next();        // returns current and
                                 //  advances to next

        void      remove();   // optional
}
```

Example: Singly linked lists

```
private class  SLL_Iterator<T> implements Iterator<T>{   // the client doesn't need
                                                          to know the name.
        private SNode<T>    cur;

        SLL_Iterator( SLinkedList<T> list){          //   constructor
                cur = list.getHead();
        }

        public boolean hasNext() {
                return (cur != null);
        }

        public T next() {
                SNode<T> tmp = cur;
                cur = cur.getNext();
                return tmp.getElement();
        }
}
```

Java `Iterator` interface

Q: Who constructs the Iterator object for a collection ?

A: The collection does it .

e.g. LinkedList, ArrayList, HashSet …

How ?

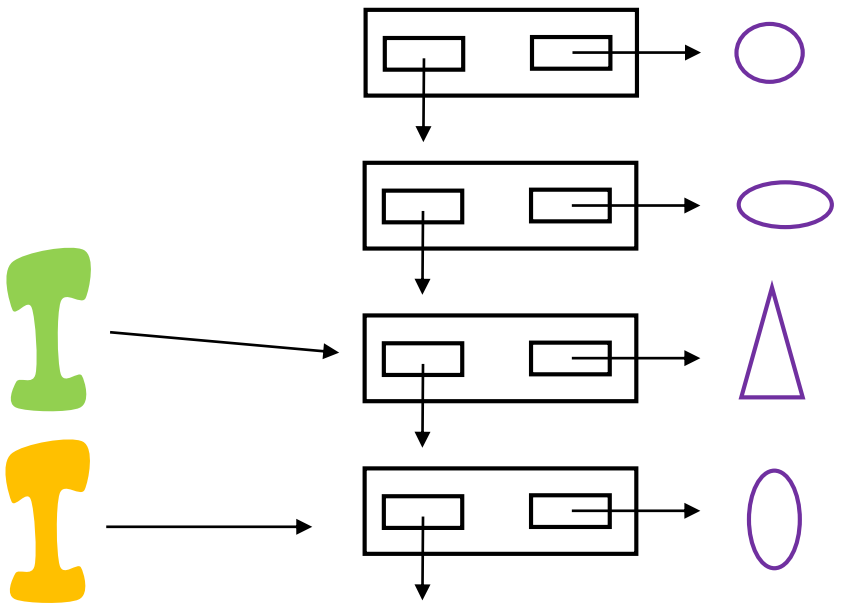
Java `Iterable` interface

```
interface  Iterable<T> {
        Iterator<T>   iterator();
}
```

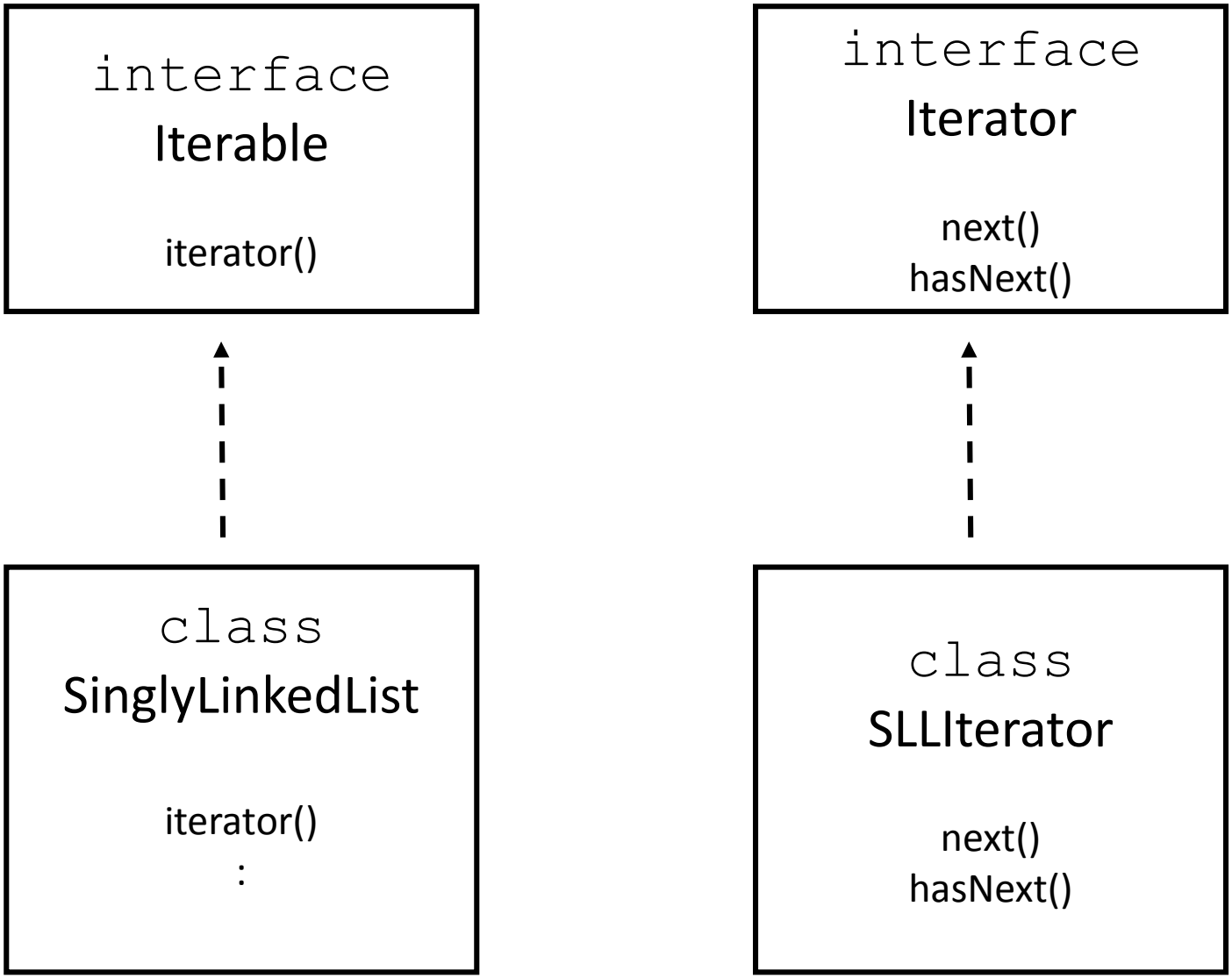
If a class implements Iterable, then the class has an iterator() method.

```
LinkedList<Shape>   list;
Shape   s;
        :
Iterator<Shape>   iter1  =  list.iterator();
Iterator<Shape>   iter2  =  list.iterator();
```

```
s = iter1.next()

s = iter2.next()

s = iter1.next()

s = iter2.next()

s = iter2.next()
```



The iterators iterate over LinkedList nodes, not Shapes.
The next() method returns Shapes.



The iterator() method calls the constructor of the SLLIterator class.

ASIDE: Java enhanced for loop

For any class that implements Iterable..

Example:

```
LinkedList<String>      list  =  new  LinkedList<String>();
        ....

for (String   s   :   list)  {
    System.out.println( s );
}
```