JAC444 / BTP400 Course Object-Oriented Software Development inJava

Classes

Segment 3 - Generics

Classes – Segment 3 – Generics

In this segment you will be learning about:

- Generics in Java – Abstraction over Types
- Generic Methods and Bounded Type Parameters
- Wildcards and Subtyping
- Type Erasure

Simple Box Class

```
/** Box class. */

public class Box {

    private Object o;

    public void add(Object o) {
       this.o = o;
    }

    public Object get() {
       return o;
    }
}

Box myBox = new Box();
myBox.add(new Integer(10));
Integer val = (Integer) myBox.get();
String str = (String) myBox.get();_java.lang.ClassCastException:
```

Defining Simple Generics

```
/** Generic Box class. */

public class Box<T> {

    private T t;

    public void add(T t) {
       this.t = t;
    }

    public T get() {
       return t;
    }
}
```

generic type declaration

formal type parameter

```
 Box<Integer> integerBox = new Box<Integer>();
 Box<Integer> integerBox = new Box<>();
```

Type Parameter and Type Argument

- The generics can be used in: classes, interfaces, methods, constructors:

```
public interface List<E> {
        void add(E x);
        Iterator<E> iterator();
}

public interface Iterator<E> {
        E next();
        boolean hasNext();
}
```

- Generic type declaration `List<E>` is called *parameterized type*

  `E` in `List<E>` is called type parameter
- `List<Integer>` the formal type parameter `E` is replaced by the *actual type argument* `Integer`

  `Integer` in `List<Integer>` is called type argument

Multiple Type Parameters

```
public interface Pair<K, V> {
    public K getKey();
    public V getValue();
}
public class OrderedPair<K, V> implements Pair<K, V> {
    private K key;
    private V value;

    public OrderedPair(K key, V value) {
     this.key = key;
     this.value = value;
    }
    public K getKey() { return key; }
    public V getValue() { return value; }
}
Pair<String, Integer> p1 = new OrderedPair<String, Integer>("Odd", 7);

OrderedPair<String, Box<Integer>> p =
            new OrderedPair<>("primes", new Box<Integer>(3));
```

Source: http://docs.oracle.com/javase/tutorial/java/generics/types.html

More Types

- Generic class can have multiple type parameters
- Type argument can be any user defined type

```
HashMap<String, Dog> map = new HashMap<String, Dog>();

   map.put(“bliss” new Dog(“myDog"));

   Dog d = map.get(“bliss”);
```

Generic method

- Type parameters can also be declared within method and constructor signatures to create *generic method*

- Type parameter's scope is limited to the method in which it is declared.

```
public <U> void inspect(U type) {

    System.out.println("Type parameter U is of Class: "
                        + type.getClass().getName());

}
```

Bounded Type Parameters

- Restriction on the type parameter

  `T` is upper bounded by `Integer`

```
public class NaturalNumber<T extends Integer> {
    private T n;
    public NaturalNumber(T n)  { this.n = n; }
    public boolean isEven() {
        return n.intValue() % 2 == 0;
    }
```

`intValue()` is the method from class `Integer`

Source: http://docs.oracle.com/javase/tutorial/java/generics/types.html

Wildcards

- Consider the problem of writing a routine that shows out all the elements from a Box

```
void showAll ( Box<Object> b ) {
   for (Object o : b)
     System.out.println(o);
}
```

- How could we invoke the method with `Box<String>` if `Box<String>` is not a subtype of a `Box<Object>`

- We define ***wildcard type*** as `?` and a `Box<?>` as a Box of unknown types

```
void showAll ( Box<?> b ) {
   for (Object o : b)
     System.out.println(o);
}
```

Type Erasure

- When a generic type is instantiated, the compiler translates those types by a technique called *type erasure*

- `Box<String>` is translated to type `Box`, which is called the *raw type*

- When mixing legacy code with generic code, you may encounter warning messages similar to the following:

```
Note: YourClass.java uses unchecked or unsafe operations.

Note: Recompile with -Xlint:unchecked for details.
```

Generic and Raw Types

```
public class MixedClass {
   public static void main(String[] args){
        Box<Integer> bi;
        bi = createBox();
   }
   /** Pretend that this method is part of an old library,
   written before generics. It returns Box instead of Box<T>.
   */
   static Box createBox() {
        return new Box();
   }
}
```

```
MixedClass.java:4: warning: [unchecked] unchecked conversion
found : Box
required: Box<java.lang.Integer>
                bi = createBox();
                             ^
1 warning
```

Upper/Lower Bounded Wildcards

- Upper/Lower-bounded wildcard is ? character

Upper-bounded: **<? extends Number>**

means any type that is at least a **Number** type

Lower-bounded: **<? super Integer>**

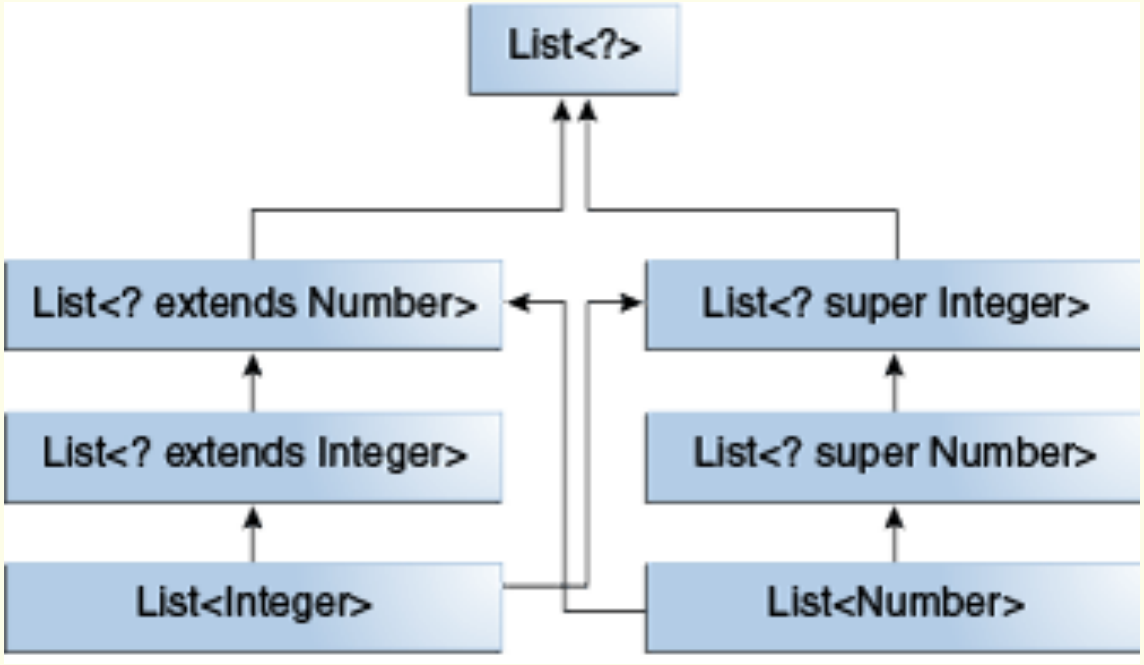
means any type that is a super type of an **Integer** type

```
double sumOfList(List<? extends Number> list) { ... }

List<Integer> listOfIntiger = Arrays.asList(1, 2, 3);
sumOfList(listOfIntiger);

List<Double> listOfDouble = Arrays.asList(1.2, 2.3);
sumOfList(listOfDouble);
```

Source: http://docs.oracle.com/javase/tutorial/java/generics/types.html

Wildcard and Subtypes

```
class A {} and class B extends A {}
A a = new B();    // - Polymorphism: OK

List<B> lb = new ArrayList();
List<A> la = lb;// - Collection Polymorphism: Compile-time error
```



Source: http://docs.oracle.com/javase/tutorial/java/generics/types.html