Java
Collections

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Java Kurs

14. Juni 2018

Overview

Generics

Imagine the following:

We want to build a box class that will contain objects, but only of a type given as we call the constructor. Afterwards it should not take objects of another type. We would like to put anything in there.

Generics

```
1    public class Box {
2        private Object object;
3
4        public void set(Object object) { this.object = object; }
5        public Object get() { return object; }
6    }
7
8
```

Generics

```
1    public class Box<T> {
2        // T stands for "Type"
3        private T t;
4
5        public void set(T t) { this.t = t; }
6        public T get() { return t; }
7    }
8
9    Box<Integer> integerBox = new Box<Integer>();
10
11
```

Another example

```java
public class Pair<T> {
    private T first;
    private T second;

    public T getFirst() {return first;}
    public T getSecond() {return second;}
}
public class Pairs<S,T>{
    private Pair<S> firstPair;
    private Pair<T> secondPair;

    public Pair<T> getFirst() {return firstPair;}
    public <U,V> getSecond(Pair<U> u, Pair<V> v){...}
}

Pair<Integer> intPair = new Pair<Integer>();
Pair<Pair<Integer>> pairOfPairs = new Pair<Pair<Integer>>()
;
```

Mostly used in Collections (e.g. Sets, Maps of a certain type)

Wrapper Class

Primitive data types can not be elements in collections. Use wrapper classes like *Integer* instead.

boolean	Boolean
byte	Byte
char	Character
int	Integer
float	Float
double	Double
long	Long
short	Short

Wrapper Class

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Any questions?

Exercise

Create a simple vending machine for an arbitrary product. Implement:

- integer as size and a arbitrary type as product
- getItemCount()
- refill(int amount)
- buy(int amount)
- ...

Collections

Collections Framework

Java offers various data structures like **Sets**, **Lists** and **Maps**. Those structures are part of the collections framework.

Collections Framework

Java offers various data structures like **Sets**, **Lists** and **Maps**. Those structures are part of the collections framework.

- There are interfaces to access the data structures in an easy way
- There are multiple implementations for various needs
- Alternatively you can use your own implementations

Set

A set is a collection that holds one type of objects. A set can not contain one element twice. Like all collections the interface *Set* is part of the package `java.util`.

```java
import java.util.*;

public class TestSet {

    public static void main(String[] args) {
        Set<String> set = new HashSet<String>();

        set.add("foo");
        set.add("bar");
        set.remove("foo");
        System.out.println(set); // prints: [bar]
    }
}
```

Another UML diagram might be helpful right here.
In the following examples `import java.util.*;` will be omitted.

List

A list is an ordered collection.

The implementation `LinkedList` is a double-linked list.

```java
public static void main(String[] args) {

    List<String> list = new LinkedList<String>();

    list.add("foo");
    list.add("foo"); // insert "foo" at the end
    list.add("bar");
    list.add("foo");
    list.remove("foo"); // removes the first "foo"

    System.out.println(list); // prints: [foo, bar, foo]
}
```

Another UML diagram might be helpful right here.

How to find all these methods and hierarchies?

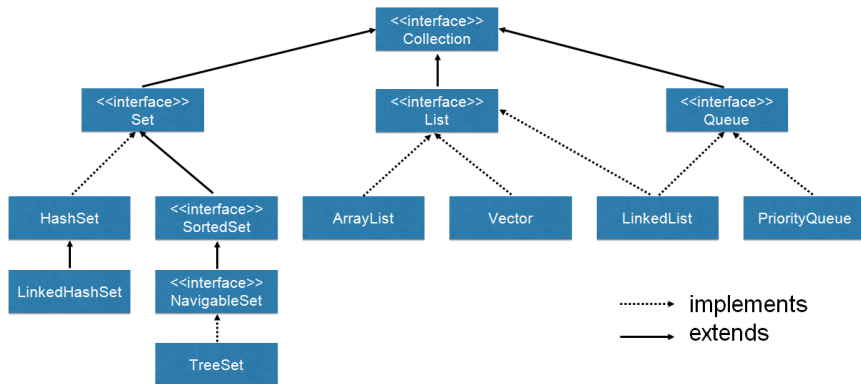Let's have a look at the official Java website!
https://docs.oracle.com/javase/8/docs/api/?java/util/Collections.html

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List Methods

some useful List methods:

void	add(int index, E element)	insert element at position index
E	get(int index)	get element at position index
E	set(int index, E element)	replace element at position index
E	remove(int index)	remove element at position index

some useful LinkedList methods:

void	addFirst(E element)	append element to the beginning
E	getFirst()	get first element
void	addLast(E element)	append element to the end
E	getLast()	get last element

For Loop

The for loop can iterate over every element of a collection:
```
for (E e : collection)
```

```java
    public static void main(String[] args) {

        List<Integer> list =
            new LinkedList<Integer>();

        list.add(1);
        list.add(3);
        list.add(3);
        list.add(7);

        for (Integer i : list) {
            System.out.print(i + " "); // prints: 1 3 3 7
        }
    }
```

Iterator

An iterator iterates step by step over a collection.

```java
public static void main(String[] args) {

    List<Integer> list = new LinkedList<Integer>();

    list.add(1);
    list.add(3);
    list.add(3);
    list.add(7);

    Iterator<Integer> iter = list.iterator();

    while (iter.hasNext()) {
        System.out.print(iter.next());
    }
    // prints: 1337
}
```

Iterator

A standard iterator has only three methods:

- `boolean hasNext()` - indicates if therer are more elements
- `E next()` - returns the next element
- `void remove()` - returns the current element

The iterator is instanced via `collection.iterator()` :

```
1    Collection<E> collection = new Implementation<E>;
2    Iterator<E> iter = collection.iterator();
3
```

Special iterators like *ListIterator* are more sophisticated.

Map

The interface *Map* is not a subinterface of *Collection*.
A map contains pairs of key and value. Each key refers to a value. Two keys can refer to the same value. There are not two equal keys in one map. *Map* is part of the package java.util.

```java
public static void main (String[] args) {

    Map<Integer, String> map =
        new HashMap<Integer, String>();

    map.put(23, "foo");
    map.put(28, "foo");
    map.put(31, "bar");
    map.put(23, "bar"); // "bar" replaces "foo" for key = 23

    System.out.println(map);
    // prints: {23=bar, 28=foo, 31=bar}
}
```

Key, Set and Values

You can get the set of keys from the map. Because one value can exist multiple times a collection is used for the values.

```java
public static void main (String[] args) {

    // [...] map like previous slide

    Set<Integer> keys = map.keySet();
    Collection<String> values = map.values();

    System.out.println(keys);
    // prints: [23, 28, 31]

    System.out.println(values);
    // prints: [bar, foo, bar]
}
```

Iterator

To iterate over a map use the iterator from the set of keys.

```java
public static void main (String[] args) {

    // [...] map, keys, values like previous slide
    Iterator<Integer> iter = keys.iterator();

    while(iter.hasNext()) {
        System.out.print(map.get(iter.next()) + " ");
    } // prints: bar foo bar

    System.out.println(); // print a line break

    for(Integer i: keys) {
        System.out.print(map.get(i) + " ");
    } // prints: bar foo bar
}
```

Nested Maps

Nested maps offer storage with key pairs.

```java
public static void main (String[] args) {

    Map<String, Map<Integer, String>> addresses =
        new HashMap<String, Map<Integer, String>>();

    addresses.put("Noethnitzer Str.",
        new HashMap<Integer, String>());

    addresses.get("Noethnitzer Str.").
        put(46, "Andreas-Pfitzmann-Bau");
    addresses.get("Noethnitzer Str.").
        put(44, "Fraunhofer IWU");
}
```

Maps and For Each

You can interate through the entry set of a map (available before Java 1.8)

```
1    Map<String, String> map = ...
2    for (Map.Entry<String, String> entry : map.entrySet()) {
3      System.out.println("Key: " + entry.getKey() +
4      ", value" + entry.getValue());
5    }
6
```

Overview

List	• Keeps order of objects
	• Easily traversible
	• Search not effective
Set	• No duplicates
	• No order - still traversible
	• Effective searching
Map	• Key-Value storage
	• Search super-effective
	• Traversing difficult

Exercise

- Create an array with 10 elements. Create a list and fill the list with the array elments. Create a set and fill the set with the list elments and create a map with the set elments as values and the index as key.
- Extend our vending machine with an internal storage
- Ask Tilman for the iterator