

Java

Collections

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Overview

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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

```
1 public class Pair<T> {
2     private T first;
3     private T second;
4
5     public T getFirst() {return first;}
6     public T getSecond() {return second;}
7 }
8 public class Pairs<S,T>{
9     private Pair<S> firstPair;
10    private Pair<T> secondPair;
11
12    public Pair<T> getFirst() {return firstPair;}
13    public <U,V> getSecond(Pair<U> u, Pair<V> v){...}
14 }
15
16 Pair<Integer> intPair = new Pair<Integer>();
17 Pair<Pair<Integer>> pairOfPairs = new Pair<Pair<Integer>>()
18 ;
```

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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boolean	Boolean
byte	Byte
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int	Integer
float	Float
double	Double
long	Long
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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`.

```
1  import java.util.*;
2
3  public class TestSet {
4
5      public static void main(String[] args) {
6          Set<String> set = new HashSet<String>();
7
8          set.add("foo");
9          set.add("bar");
10         set.remove("foo");
11         System.out.println(set); // prints: [bar]
12     }
13 }
14
```

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.

```
1 public static void main(String[] args) {  
2  
3     List<String> list = new LinkedList<String>();  
4  
5     list.add("foo");  
6     list.add("foo"); // insert "foo" at the end  
7     list.add("bar");  
8     list.add("foo");  
9     list.remove("foo"); // removes the first "foo"  
10  
11     System.out.println(list); // prints: [foo, bar, foo]  
12 }  
13
```

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!

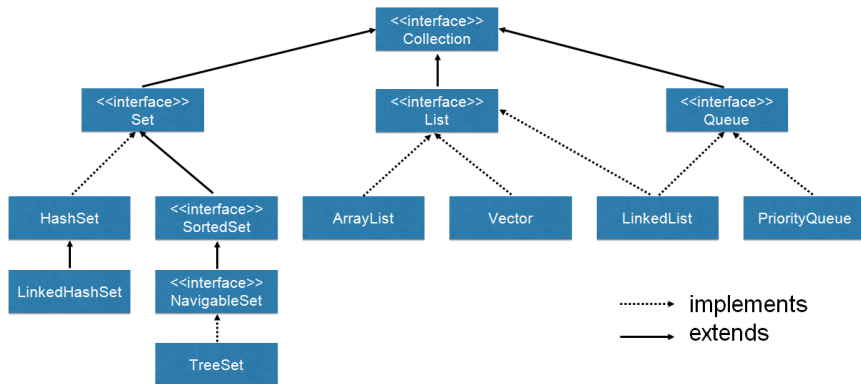
<https://docs.oracle.com/javase/8/docs/api/?java/util/Collections.html>

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Collection Interface



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)

```
1 public static void main(String[] args) {  
2  
3     List<Integer> list =  
4         new LinkedList<Integer>();  
5  
6     list.add(1);  
7     list.add(3);  
8     list.add(3);  
9     list.add(7);  
10  
11     for (Integer i : list) {  
12         System.out.print(i + " "); // prints: 1 3 3 7  
13     }  
14 }  
15
```

Iterator

An iterator iterates step by step over a collection.

```
1 public static void main(String[] args) {  
2  
3     List<Integer> list = new LinkedList<Integer>();  
4  
5     list.add(1);  
6     list.add(3);  
7     list.add(3);  
8     list.add(7);  
9  
10    Iterator<Integer> iter = list.iterator();  
11  
12    while (iter.hasNext()) {  
13        System.out.print(iter.next());  
14    }  
15    // prints: 1337  
16 }  
17
```

Iterator

A standard iterator has only three methods:

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

The iterator is instantiated 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`.

```
1 public static void main (String[] args) {  
2  
3     Map<Integer, String> map =  
4         new HashMap<Integer, String>();  
5  
6     map.put(23, "foo");  
7     map.put(28, "foo");  
8     map.put(31, "bar");  
9     map.put(23, "bar"); // "bar" replaces "foo" for key = 23  
10  
11     System.out.println(map);  
12     // prints: {23=bar, 28=foo, 31=bar}  
13 }  
14
```

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.

```
1 public static void main (String[] args) {  
2  
3     // [...] map like previous slide  
4  
5     Set<Integer> keys = map.keySet();  
6     Collection<String> values = map.values();  
7  
8     System.out.println(keys);  
9     // prints: [23, 28, 31]  
10  
11    System.out.println(values);  
12    // prints: [bar, foo, bar]  
13 }  
14
```

Iterator

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

```
1 public static void main (String[] args) {
2
3     // [...] map, keys, values like previous slide
4     Iterator<Integer> iter = keys.iterator();
5
6     while(iter.hasNext()) {
7         System.out.print(map.get(iter.next()) + " ");
8     } // prints: bar foo bar
9
10    System.out.println(); // print a line break
11
12    for(Integer i: keys) {
13        System.out.print(map.get(i) + " ");
14    } // prints: bar foo bar
15 }
16
```

Nested Maps

Nested maps offer storage with key pairs.

```
1 public static void main (String[] args) {  
2  
3     Map<String, Map<Integer, String>> addresses =  
4         new HashMap<String, Map<Integer, String>>();  
5  
6     addresses.put("Noethnitzer Str.",  
7         new HashMap<Integer, String>());  
8  
9     addresses.get("Noethnitzer Str.").  
10         put(46, "Andreas-Pfitzmann-Bau");  
11     addresses.get("Noethnitzer Str.").  
12         put(44, "Fraunhofer IWU");  
13 }  
14
```


Maps and For Each

You can iterate 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	<ul style="list-style-type: none">• Keeps order of objects• Easily traversible• Search not effective
Set	<ul style="list-style-type: none">• No duplicates• No order - still traversible• Effective searching
Map	<ul style="list-style-type: none">• 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 elements. Create a set and fill the set with the list elements and create a map with the set elements as values and the index as key.
- Extend our vending machine with an internal storage
- Ask Tilman for the iterator