Java

Collections

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Java Kurs

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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

```
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
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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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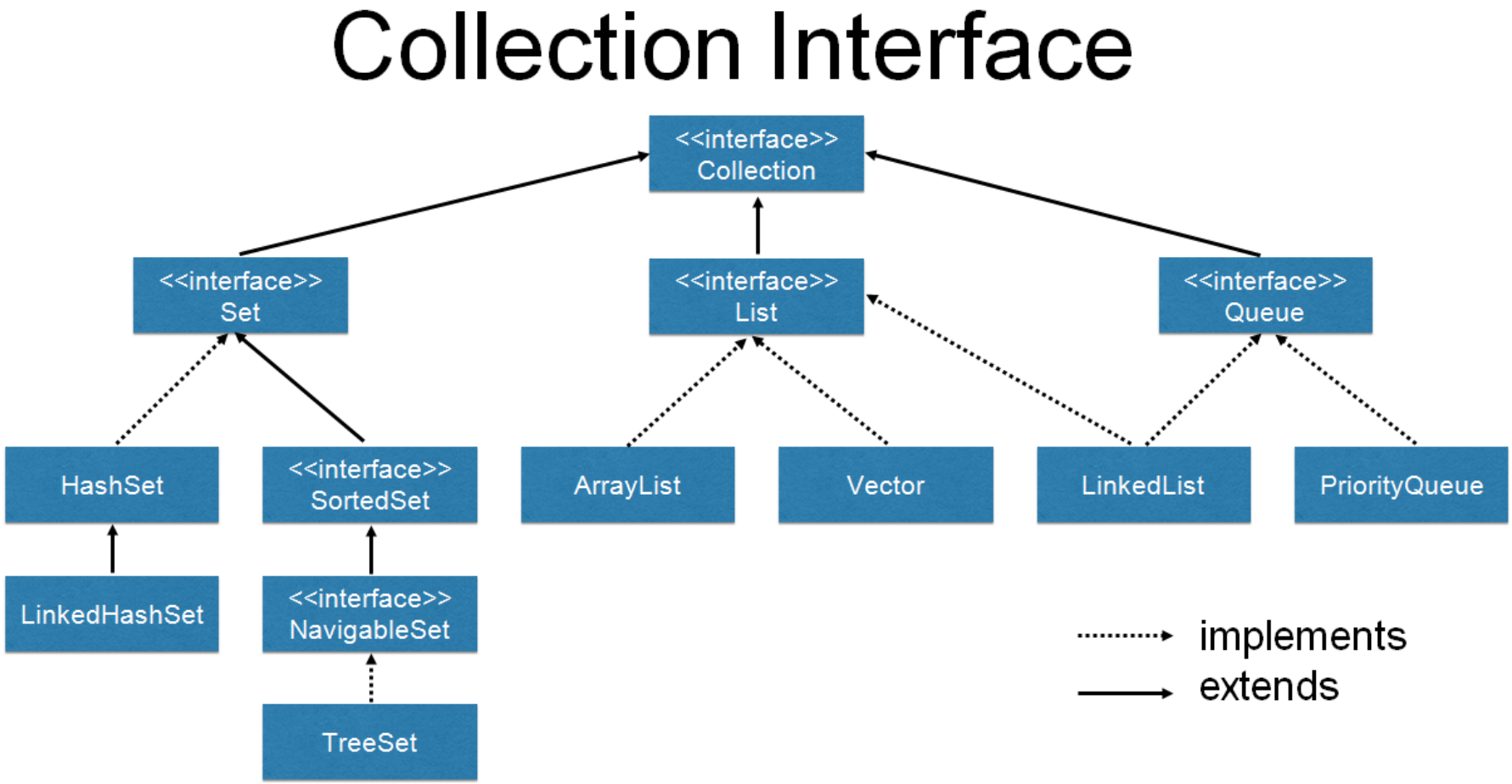

List Methods

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 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`.

```
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 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