Chapter 5 Java Collection

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https://wdsseu.github.io/java/

Content

- Arrays
- Collection
  - ArrayList
  - LinkedList
- Map
  - HashMap
- Iterator

Array

- Declaration and Assignment of an Array:

```
int[] a = new int[10];
for(int i=0; i<a.length; i++){
      a[i] = i*2;
}
...
String[] b = {"Hello", "World!"};

int[] b = new int[2]{1,5};
int[] b = new int[]{1,5};
```

Array Operation

- Traverse (遍历)
- Min / Max
- Sum / Average / Length
- Search
- Sort
- Equal Judgment

Array

- java.util.Arrays provides some static methods
  - Binary Search

```
String[] str = {"Kobe", "Tmac", "Lebron"};
Arrays.sort(str);
System.out.println(Arrays.binarySearch(str, "Tmac"));
```

  - Quick Sort

```
String[] str = {"Kobe", "Tmac", "Lebron"};
Arrays.sort(str);
System.out.println(Arrays.toString(str));
```

Think

- How to write a case-insensitive binarySearch?
- OR, how to write a case-insensitive quick sort?

```
String[] str = {"Kobe", "Tmac", "Lebron"};
Arrays.sort(str);
System.out.println(Arrays.binarySearch(str, "kobe"));
```

static <T> int	**binarySearch**(T[] a, T key, **Comparator**<? super T> c) Searches the specified array for the specified object using the binary search algorithm.

- How to get all hit elements in binary search?

static int	**binarySearch**(**Object**[] a, int fromIndex, int toIndex, **Object** key) Searches a range of the specified array for the specified object using the binary search algorithm.

```java
public class CaseInsensitiveTest {

    String[] str = {"Tmac", "kobe", "Lebron"};

    public void run(){
        Arrays.sort(str);
        System.out.println("The content of this array:" + Arrays.toString(str));
        Arrays.sort(str, new CaseInsensitiveComparator());
        System.out.println("Case-insensitive sorting results:" + Arrays.toString(str));
        System.out.println("Case-sensitive search result:" + Arrays.binarySearch(str, "Kobe"));
        System.out.println("Case-insensitive search result:" + Arrays.binarySearch(str, "Kobe",
                new CaseInsensitiveComparator()));
    }

    public static void main(String[] args){
        CaseInsensitiveTest test = new CaseInsensitiveTest();
        test.run();
    }
}
```

```java
public class CaseInsensitiveComparator implements Comparator<String> {

    @Override
    public int compare(String arg0, String arg1) {
        return arg0.toLowerCase().compareTo(arg1.toLowerCase());
    }
}
```

Array

- copyOf / copyOfRange

```
String[] str = {"Kobe", "Tmac", "Lebron"};
String[] anotherStr = Arrays.copyOfRange(str, 0, 1);
System.out.println(Arrays.toString(anotherStr));
```

- fill

```
String[] str = new String[10];
Arrays.fill(str, "Kobe");
System.out.println(Arrays.toString(str));
```

Array

- toString
- hashCode
- equals

```
String[] str1 = new String[10];
String[] str2 = new String[10];
Arrays.fill(str1, "Kobe");
Arrays.fill(str2, "Kobe");
System.out.println(Arrays.hashCode(str1));
System.out.println(Arrays.hashCode(str2));
System.out.println(Arrays.equals(str1, str2));
System.out.println(Arrays.toString(str1));
```

```
<terminated> ArrayTest [Java Application] C:\Program Files\Java\jre6\bin\javaw.exe (2009-10-
103841569
103841569
true
[Kobe, Kobe, Kobe, Kobe, Kobe, Kobe, Kobe, Kobe, Kobe, Kobe]
```

equals() vs. deepEquals()


```
public class DeepEqual {

    public static int[][] a=new int[][] {{0},{1,2,3,5,4}};
    public static int[][] b=new int[][] {{0},{1,2,3,5,4}};

    public static void main(String[] args) {
        System.out.println(Arrays.equals(a, b));
        System.out.println(Arrays.deepEquals(a, b));
        System.out.println(a.equals(b));
    }
}
```

More about Arrays.equals()


```
static int[][] a=new int[][] {{0},{1,2,3,5,4}};
static int[][] b=new int[][] {{0},{1,2,3,5,4}};

static String[][] c=new String[][] {{"Hello"},{"Tom","Kate"}};
static String[][] d=new String[][] {{"Hello"},{"Tom","Kate"}};

static Person tom_1 = new Person("Tom", 18);
static Person kate_1 = new Person("Kate", 20);
static Person jerry_1 = new Person("Jerry", 20);

static Person tom_2 = new Person("Tom", 18);
static Person kate_2 = new Person("Kate", 20);
static Person jerry_2 = new Person("Jerry", 20);

static Person[][] e=new Person[][] {{tom_1},{kate_1, jerry_1}};
static Person[][] f=new Person[][] {{tom_1},{kate_1, jerry_1}};

static Person[][] g=new Person[][] {{tom_1},{kate_1, jerry_1}};
static Person[][] h=new Person[][] {{tom_2},{kate_2, jerry_2}};
```

What is the result for

(1) a vs. b

(2) c vs. d

(3) e vs. f

(4) g vs. h

```
Arrays.equals(a, b));
Arrays.deepEquals(a, b));
a.equals(b));
```

Pay attention

a.equals(b)

$\neq$

Arrays.equals(a,b)

About Hash Algorithm

> 哈希算法将任意长度的二进制值映射为较短的固定长度的二进制值，这个小的二进制值称为哈希值。哈希值是一段数据唯一且极其紧凑的数值表示形式。如果散列一段明文而且哪怕只更改该段落的一个字母，随后的哈希都将产生不同的值。要找到散列为同一个值的两个不同的输入，在计算上是不可能的，所以数据的哈希值可以检验数据的完整性。一般用于快速查找和加密算法。

来自百度百科 http://baike.baidu.com/view/273836.htm

More about Arrays

- deepHashCode();
- deepToString();
- parallelSort();
- toString();

Array

- Shortage of Array
  - Fixed-length
  - Complex for insert and delete
  - ??? How to insert and delete?

Collections

- Variable Length
- A Relation Between Key and Value
- More ways to visit values
- Java Collection Framework in java.util

集合框架

- Collection<E> (集合)
  - Set<E> // non-repeat
    - SortedSet<E> // sorted
  - List<E> // sequential, repeatable
  - Queue<E> // FIFO
- Map<K,V> (映射)
  - HashMap<K,V> //unsorted
  - SortedMap<K,V> // sorted
- Iterator<E> (迭代器)

Collection - ArrayList

- Sequential and Linear (线性表)
- Use Array as Backend (动态数组)
- Variable Length
- Methods:
  - add(Object element) / remove(Object element)
  - add(int index, Object element) / remove(int index)
  - get(int index) / set(int index)
  - indexOf(Object o)
  - clear() / isEmpty()
  - Size() / toArray()

Attention

- Get the number of elements:
  - For Arraylist

```
ArrayList list = new ArrayList();
list.add("Kobe");
System.out.println(list.size());
```

  - For Array

```
String[] list = new String[10];
System.out.println(list.length);
```

List - ArrayList

- ArrayList Creation // notice the capacity of ArrayList

```
ArrayList<String> list = new ArrayList<String>()  //初始化时initial capacity为10;
ArrayList<String> list = new ArrayList<String>(100)  //指定initial capacity;
list.ensureCapacity(10000)  //修改capacity
```

List - ArrayList

- Methods:

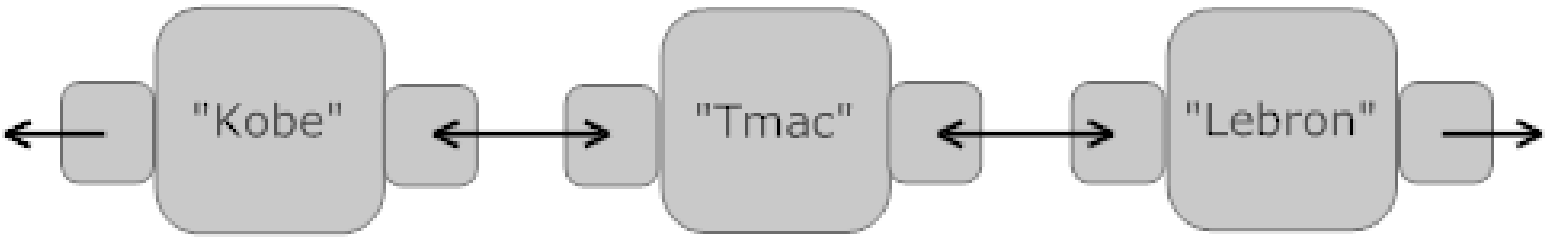
```
list.add("Kobe");  //增加
list.add("Tmac");  //增加
list.remove("Tmac");  //删除
list.remove(0);  //删除
list.clear();  //清空
list.add("Lebron"); //增加
list.contains("Lebron");  //是否包含某元素？true
list.get(0); //访问
list.set(0, "Kobe"); //修改
list.indexOf("Kobe"); //查找
list.isEmpty();   //false
Iterator<String> it = list.iterator(); //返回迭代器
```

List - ArrayList

- Feature
  - Efficient in random access of elements
  - May enlarge backend array when append new elements (can be partly solved by setting initial capacity)
  - Not efficient for insertion (may cause the movement of elements)
  - Waste of space (solved by trimToSize)

List - LinkedList

- Implemented by co-reference of neighbors
- No capacity
- Each Element stores:
  - A reference to the previous element
  - A reference to the succeeded element
  - The value



List - LinkedList

- Methods

```
list.add("Kobe");  //增加
list.addFirst("Tmac");  //在首部增加
list.addLast("Lebron");  //在尾部增加
list.addLast("Paul"); //在尾部增加
list.removeFirst(); //在首部删除
list.removeLast(); //在尾部删除
list.add(1, "Tmac"); //插入
```

List - LinkedList

- Feature
  - Do not cause the reassignment of memory
  - Efficient for add / delete / insert
  - Not efficient for random access (need traverse from head)

Lab Work: Performance Evaluation

- ArrayList <String>vs. LinkedList<String>
- Both List have 1000 elements
- 10000 runs
  - get(i), where i from 0-1000
  - Traverse all the elements: iteration
  - Insert 100000 elements in the middle
  - Delete one by one

```
LinkedList<String> list = new LinkedList<String>();
list.add("kobe");
list.add("Tmac");
list.add("Lebron");
Iterator<String> iterator = list.iterator();
while(iterator.hasNext()){
    System.out.println(iterator.next());
}
```

Performance Benchmark

	ArrayList	LinkedList
get(ms)	172	3297
iteration(ms)	813	328
insert(ms)	140	16
remove(ms)	4625	15

Map - HashMap

- HashMap - a Mapping Between Key and Value
- Example: Student ID - Name

学号	姓名
71108501	Tom
71108502	Mike
71108503	Peter
...	...

- Feature: Search a value by key efficiently

Map - HashMap

- Methods

```
HashMap<Integer, String> map = new HashMap<Integer, String>();
map.put(71108501, "Tom"); //增加
map.put(71108502, "Mike"); //增加
map.put(71108503, "Peter"); //增加
String name = map.get(71108502); //查找
map.remove(71108503);//删除
Set keySet = map.keySet(); //获取所有的key
Collection valueSet = map.values(); //获取所有的value
Set entrySet = map.entrySet(); //获取所有的entry
```

?? Why use Set as the return type??

Iterator

- Iterator for the Traverse of Collection
- There is an iterator() Method in Collection
  - Each implemented class of Collection should implemented iterator()
  - Each implemented class of Collection can be traversed using iterator()
- Methods in Iterator:
  - hasNext()
  - next()

Example for LinkedList


```
LinkedList<String> list = new LinkedList<String>();
list.add("kobe");
list.add("Tmac");
list.add("Lebron");
Iterator<String> iterator = list.iterator();
while(iterator.hasNext()){
    System.out.println(iterator.next());
}
```

Example of HashMap

- Using Iterator to traverse HashMap

```
HashMap<Integer, String> map = new HashMap<Integer, String>();
map.put(71108501, "Tom"); //增加
map.put(71108502, "Mike"); //增加
map.put(71108503, "Peter"); //增加
/* 遍历 */
Iterator<Integer> it = map.keySet().iterator();
while(it.hasNext()){
        Integer key = it.next();
        String value = map.get(key);
        System.out.println("Key:" + key + " value:" + value);
}
```

For-each loop

- For Loop:
  - for(int i=0; i<10; i++)
- For-each Loop
  - ArrayList list = new…
  - for(int i: list)
  - For-each loop means "for each element in a collection …"

```
int[] array = {1,2,3};
for(int i=0; i<array.length; i++){
    System.out.println(array[i]);
}

int[] array = {1,2,3};
for(int i:array){
    System.out.println(i);
}

Collection<Integer> col;
// col 初始化
for(int i:col){
    System.out.println(i);
}
```

Lab Work: ATM 2.0

- Persistent Multi-user ATM
- MVC architecture
  - View: ATM
  - Controller: Bank
  - Model: User
- In the Bank class
  - Use a HashMap to store all users;
  - Use a DataInput(Output)Stream or ObjectInput(Output)Stream for persistence.

Self-study

- Java Class Library
  - java.lang – Java Language Related
  - java.io – Input and Output
  - java.math – Mathematical Calculation
  - java.net – Network Programming
  - java.nio – New I/O
  - java.text – Text Processing
  - java.util – Useful Tookkit （Collection, Date, Time, etc.）

Self-study

- Java Utility
  - Formatter //create formatted text
  - Observer/Observable //Observer design principle
  - Math and Random //generation of random numbers
  - Timer/TimerTask //Timer and Scheduler
- Readings: Chapter 22

Forecast

- Significance of Generic Type
- Definition of Generic Type
- Usage of Generic Type