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Object Oriented Programming with Java

08 – Generics & Collections

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What are generics?

- Allows to specify a generic implementation for class, interface or method
- Generic parameters can be defined at compile time using angle brackets (<>)
- Used mostly in collections

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Defining generics

- Defining a generic class

```
class Rental<T>{
        T item;
}
```

- Defining generic interfaces

```
interface List<E>{}
```

- Defining generic methods

```
public <U> void rentout(U item){…}
```

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Calling generics

- Regarding the definitions on the previous slide:

```
Rental<Car> rentalCar = new Rental<Car>();
Rental<House> rentalHouse = new Rental<House>();

Car subaru = new Car();
rentalCar.rentout(subaru);

House myHouse = new House();
rentalHouse.rentout(myHouse);
```

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Constraining Generic Definition

- Generics can be defined as to be extended from a certain class or interface

```
class Rental<T extends Vehicle>{
        T item;
}
```

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Wildcards

- We use wildcards to broaden usage of generic types. Code below only accepts items of type Object, no subtypes

```
public void setRental(Rental<Object> rental){…}
```

- By using <?> wildcard we can extend the scale of the parameter

```
public void setRental(Rental<?> rental){…}
```

- We can also add a constraint to the wildcard

```
public void setRental(Rental<? extends Vehicle> rental){…}
//or
public void setRental(Rental<? super Car){…}
```

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WildCards with Collections

- If we define a method taking a collection as parameter like below:

```
public void addAnimal(ArrayList<Animal> animals){
        animals.add(new Dog());
}
```

- If we pass an ArrayList<Dog> into the method we get a compiler error. We can do it as shown below:

```
public void addAnimal(ArrayList<? extends Animal> animals){
        animals.add(new Dog());
}
```

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Generic Methods

- We have seen the first usage of generic methods → using a generic class
- The second usage is defining a generic method free of a generic class:

```
public <C1 extends Car, C2 extends C1> void buyCar(C1 car, C2 oldCar)
{…}
```

- Usage:

```
//FamilyCar and SportsCar are subclasses of Car
Car myBrand = new Car();
FamilyCar volvo = new FamilyCar();
SportsCar porsche = new SportsCar();
Dealer carDealer = new Dealer();
//buy a new car trading the old one
carDealer.buyCar(myBrand, volvo);
```

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Case Study – Custom List

- Create your own custom list using the generic types
- Items can be added and returned from an index using the custom list
- For more please visit:

http://download.oracle.com/javase/tutorial/java/generics/index.html

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Java Collections Framework

- The Collections Framework consists of interfaces and their implementations..
- A *collection* is a *container* or *object* that groups multiple objects into a single unit
- By implementing some interfaces by provided by Sun Microsystems you can develop your own collections

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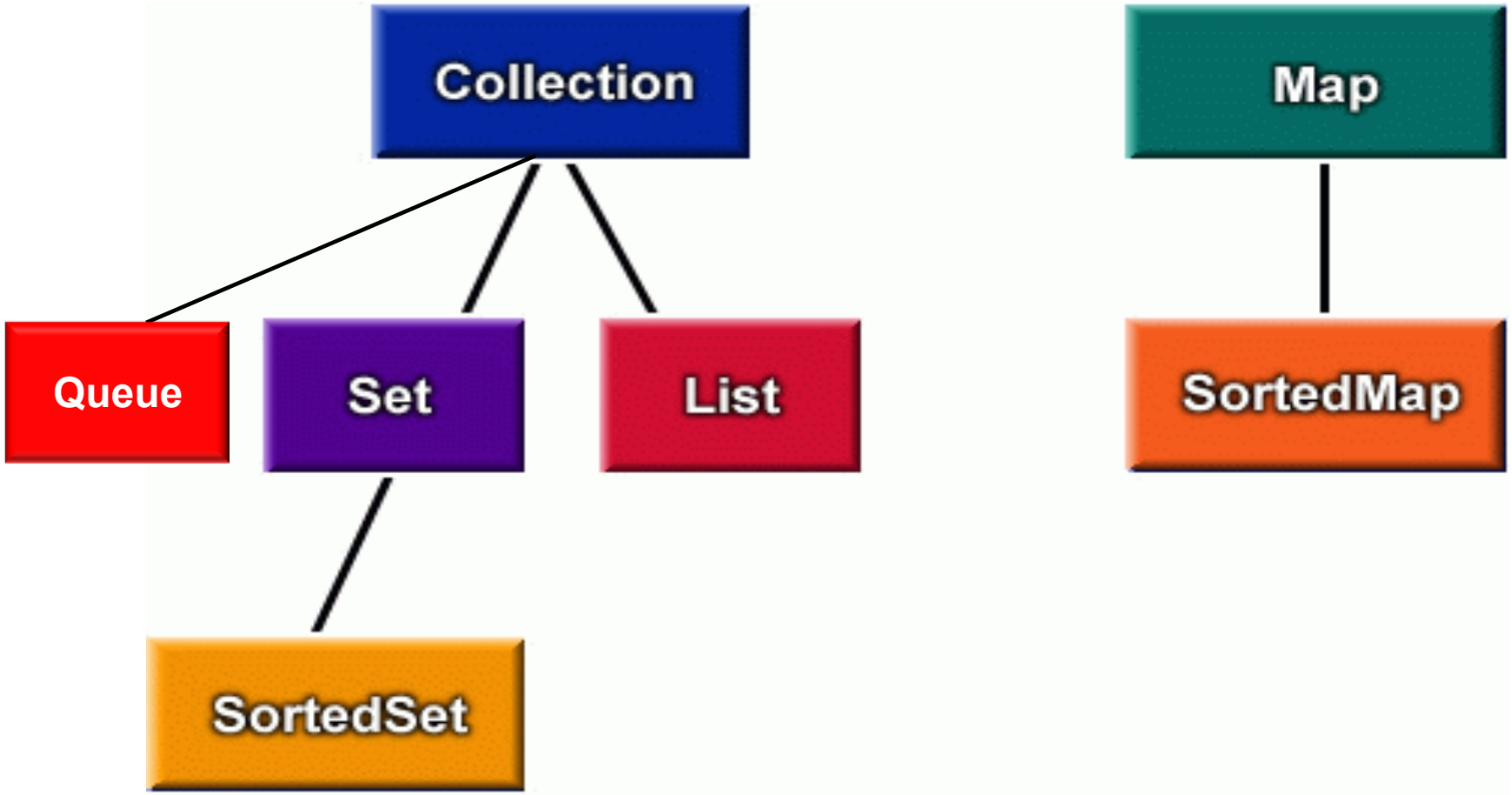
Collections Interfaces



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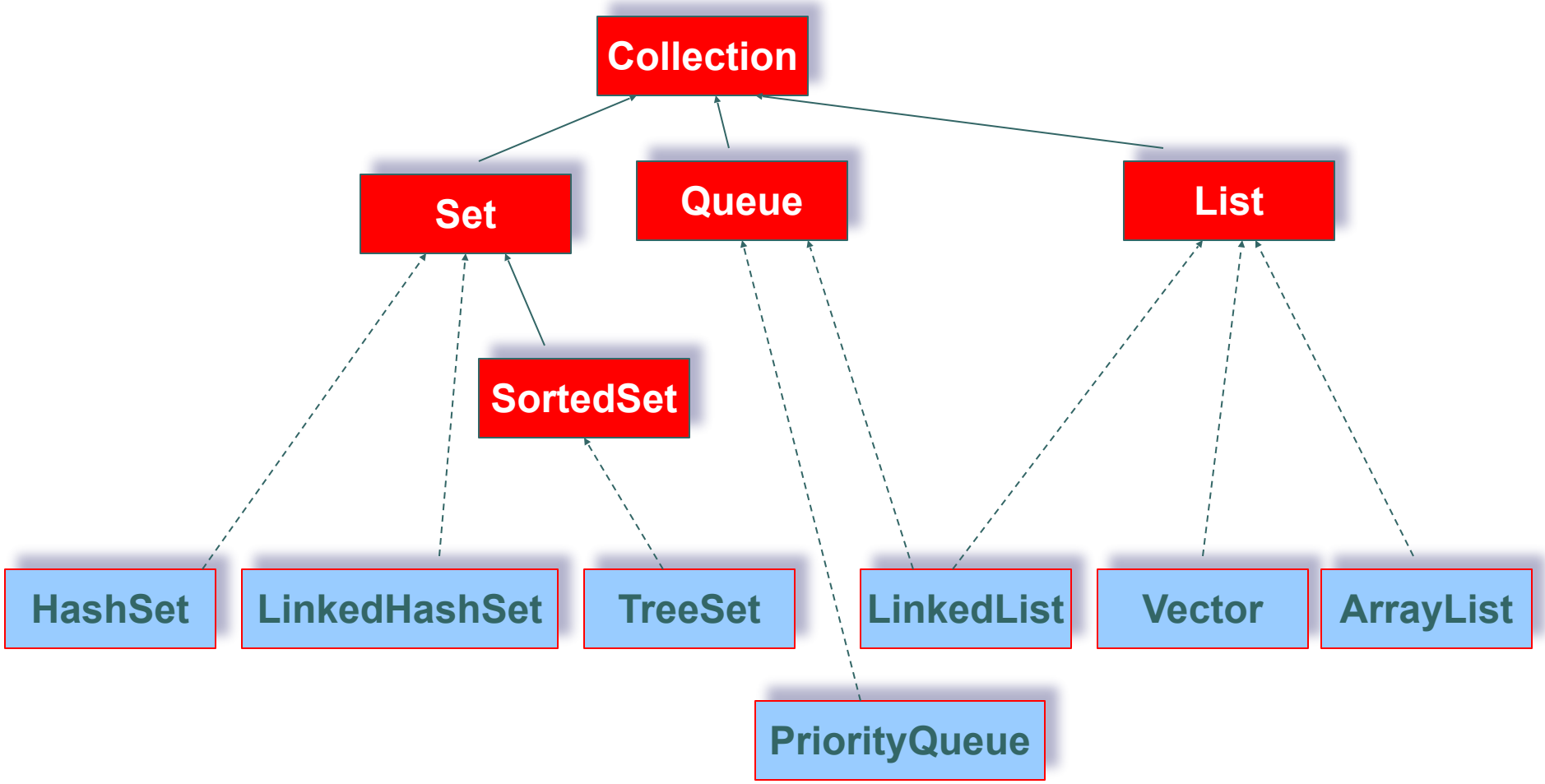
Collection Implementation Classes



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Collection Interfaces

- **Collection :** Basic set of methods for working with data structures
  - No ordering
  - May contain duplicate elements
  - Has no direct implementation class
- **List *extends Collection* :**
  - Elements kept in inserted order
  - Any element can be accessed by using index no (using ***get()*** method)
  - Can be searched (using ***contains()*** method)
  - May contain ***null*** elements
  - Implementation classes are ; ***LinkedList,Vector,ArrayList***

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Collection Interfaces

- **Set** ***extends Collection*** **:** A collection that has no duplicate elements
  - Can be searched (using ***contains()*** method)
  - No duplicate elements (no pair elements)
  - May contain one ***null*** element (at most)
  - Elements not kept in inserted order unless LinkedHashSet used
  - Implementation classes are ; ***HashSet, LinkedHashSet***
- **SortedSet** ***extends Set*** **:**
  - Has all features of Set
  - Elements kept sorted
  - Implementation classes is; ***TreeSet***

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Queue

- ***Queue*** ***extends Collection :*** A collection that supports ordering on FIFO basis
  - Has extra methods in addition to Collection interface's, Deque is an intermediate interface
  - Implementation: LinkedList (implements Queue), ArrayDeque (implements Deque)
    - add(e) → offer(e)
    - remove() → poll()
    - element() → peek()

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Concrete Classes from List

- **ArrayList** (Basic one, fast indexing)
- **Vector** (Syncronized slower than ArrayList)
- **LinkedList** (addFirst & addLast, slow indexing)

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Concrete Classes from Set

- **HashSet** (Basic one)
- **LinkedHashSet** (Guaranties the insertion order)
- **TreeSet** (extends SortedSet)
- Notes:
  - Sets get use of the hashCode() and equals() methods to catch duplicates, these methods can be overridden
  - For objects to be able to be sorted by the TreeSet, they should implement Comparable interface and override compareTo() method

hashCode() and Comparable Interface - Example

```
public class Student implements Comparable {
        int number;
        public Student(int no) {
                this.number = no;
        }
        @Override
        public int compareTo(Object o) {
                if(this.number==((Student)o).number){
                        return 0;
                }else if(this.number>((Student)o).number){
                        return 1;
                }else{
                        return -1;
                }
        }
        @Override
        public int hashCode() {
                return this.number;
        }
        @Override
        public boolean equals(Object obj) {
                if(this.number == ((Student)obj).number){
                        return true;
                }else{ return false;}
        }
}
```

for student objects to be sortable compareTo() method should be overridden
return 0 : compared object same
-1: compared object larger than me
1: compared object smaller than me

for non duplicates in sets both methods must be overridden, now students with the same number will be accepted as same objects

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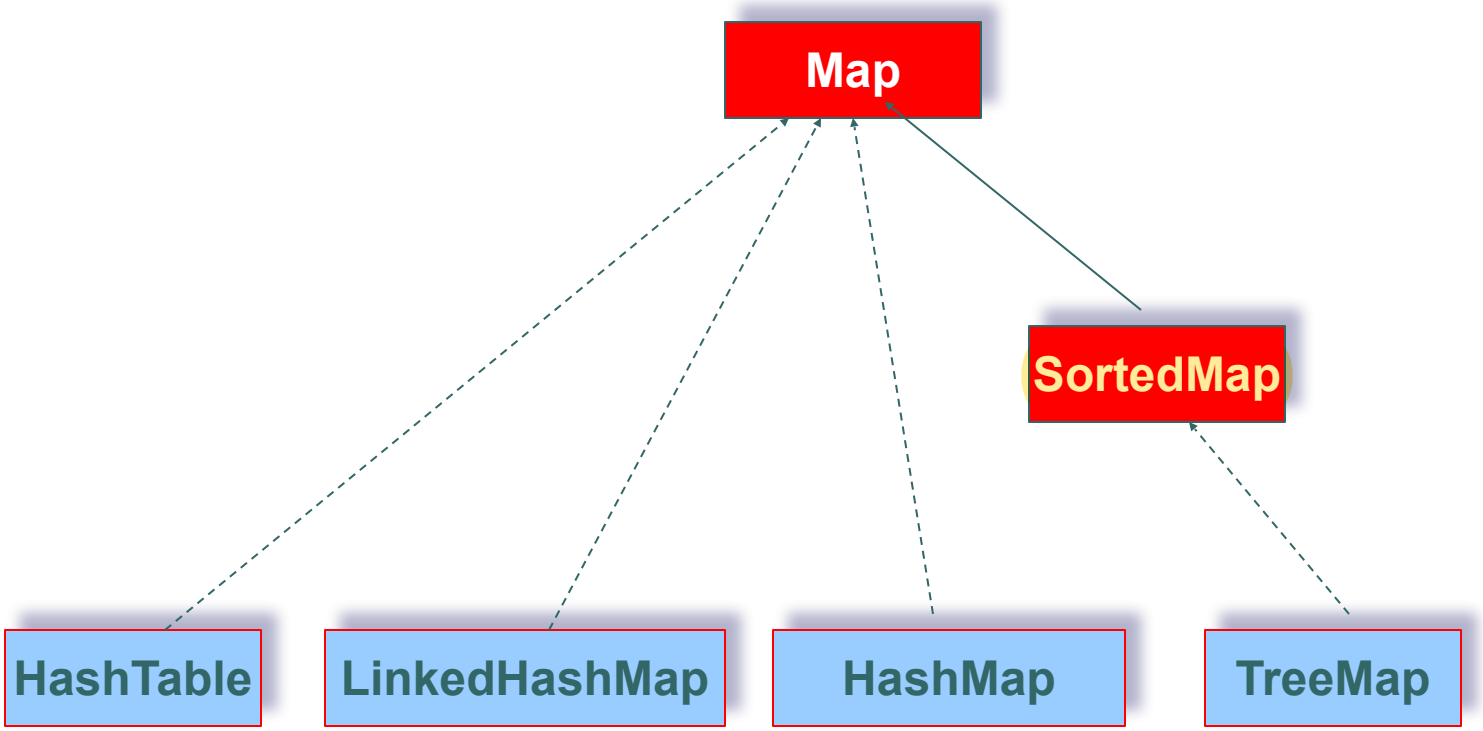
Map Implementation Classes



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Map Interfaces

- **Map** ***does NOT extend Collection*** **:** An object that maps keys to values
  - No duplicate keys
  - Values can be accessed rapidly by using keys
  - Implementation classes are ; **HashTable,HashMap,LinkedHashMap**
- **SortedMap** *extends Map* **:**
  - Has all features of Map
  - Keys are kept sorted (natural order or Comparable interface)
  - Implementation class is ; **TreeMap**

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Map Concrete Classes

- **HashMap** (Basic one may not be ordered)
- **LinkedHashMap** (Guaranties the insertion order)
- **HashTable** (*Syncronized* , do not allow null keys or values)
- **TreeMap** (extends SortedMap so keys are sorted by natural order)

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Map Example

- We use put() method in order to add elements to a map
- to iterate over a map, first we can get an iterator object from [map].keySet() which returns a set of keys or we can just use an enhanced for with the set of keys

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

                    HashMap<Integer, String> myMap = new HashMap<Integer, String>();
                    myMap.put(1322, "Ali");
                    myMap.put(2332, "Ahmet");
                    myMap.put(3442, "Mehmet");

                    Set myKeySet = myMap.keySet();

                    for (Iterator iterator = myKeySet.iterator(); iterator.hasNext();) {
                              int key = (Integer)iterator.next();
                              System.out.println(myMap.get(key));
                    }
          }
```

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Deque Interface

- A collection that can be used as a stack or a queue
  - It means a "double-ended queue" (and is pronounced "deck").
  - A queue provides FIFO (first in, first out) operations: – add(e) and remove() methods
  - A stack provides LIFO (last in, first out) operations: – push(e) and pop() methods

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Stack with Deque: Example

```
1 public class TestStack {
2         public static void main(String[] args){
3                 Deque<String> stack = new ArrayDeque<>();
4                 stack.push("one");
5                 stack.push("two");
6                 stack.push("three");
7
8                 int size = stack.size() - 1;
9.               while(size>=0){
10.               System.out.println(stack.pop());
11                 size--;
12                }
13        }
14 }
```

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Arrays Class - Sorting an Array

- We can sort an array using Arrays class's sort() method

```
String[] isimler = {"Zeynep","Mustafa","Ahmet","Vedat","Ali"};

System.out.println(Arrays.toString(isimler));
Arrays.sort(isimler);

        System.out.println("After Array Sort");

        for(String isim : isimler)
        {
                System.out.println(isim);
        }
```

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Arrays Class - From Array to List

- We can convert an array to a list by using Arrays class's asList() method

```
String[] isimler = {"Zeynep","Mustafa","Ahmet","Vedat","Ali"};

List isimlist =   Arrays.asList(isimler);

      for (int i = 0; i < isimlist.size(); i++) {
      System.out.println((String)isimlist.get(i));
      }
```

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Static Methods of Collections Class

- Consists of static methods that operate on or return collections
- can shuffle, sort, reverse… collcections

```
String[] isimler = {"Zeynep","Mustafa","Ahmet","Vedat","Ali"};
              List isimlist =   Arrays.asList(isimler);
              Collections.shuffle(isimlist);
              for (int i = 0; i < isimlist.size(); i++) {
              System.out.println((String)isimlist.get(i));
              }
```

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Case Study: Occurrences of Words

- Write a program that calculates the frequencies of words in a text and displays the words and their number of occurrence in an alphabetical order.