Sets and Maps

Java Collections API – Sets and Maps

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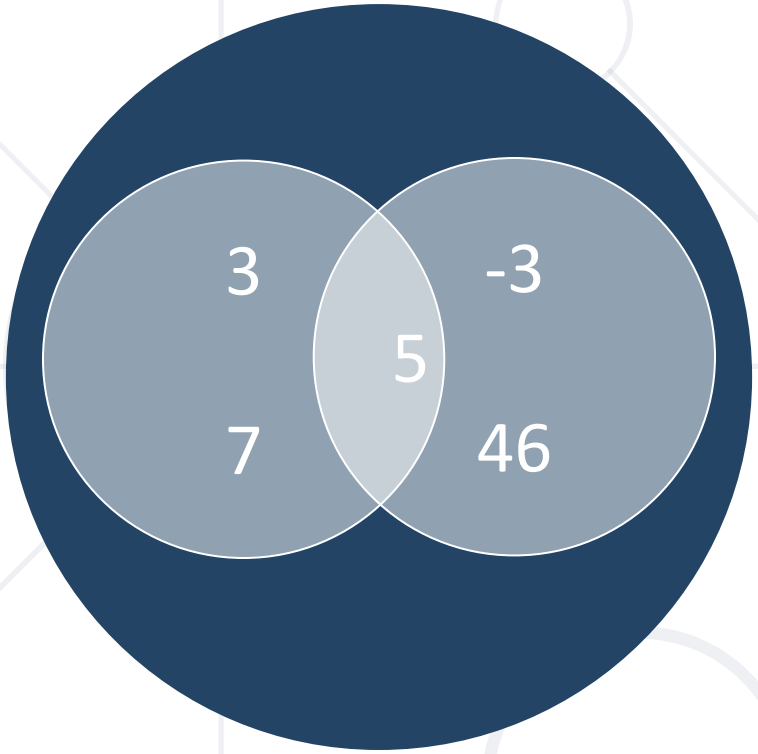


Sets

`HashSet<E>`, `TreeSet<E>` and `LinkedHashSet<E>`

Sets in Java

- A set keeps unique elements
- Provides methods for **adding** / **removing** / **searching** elements
- Offers very fast performance
- Types:
  - `HashSet<E>`
    - Does not guarantee the constant order of elements over time
  - `TreeSet<E>`
    - The elements are ordered incrementally
  - `LinkedHashSet<E>`
    - The order of appearance is preserved

Methods

- Initialization:

```
Set<String> hash = new HashSet<String>();
```

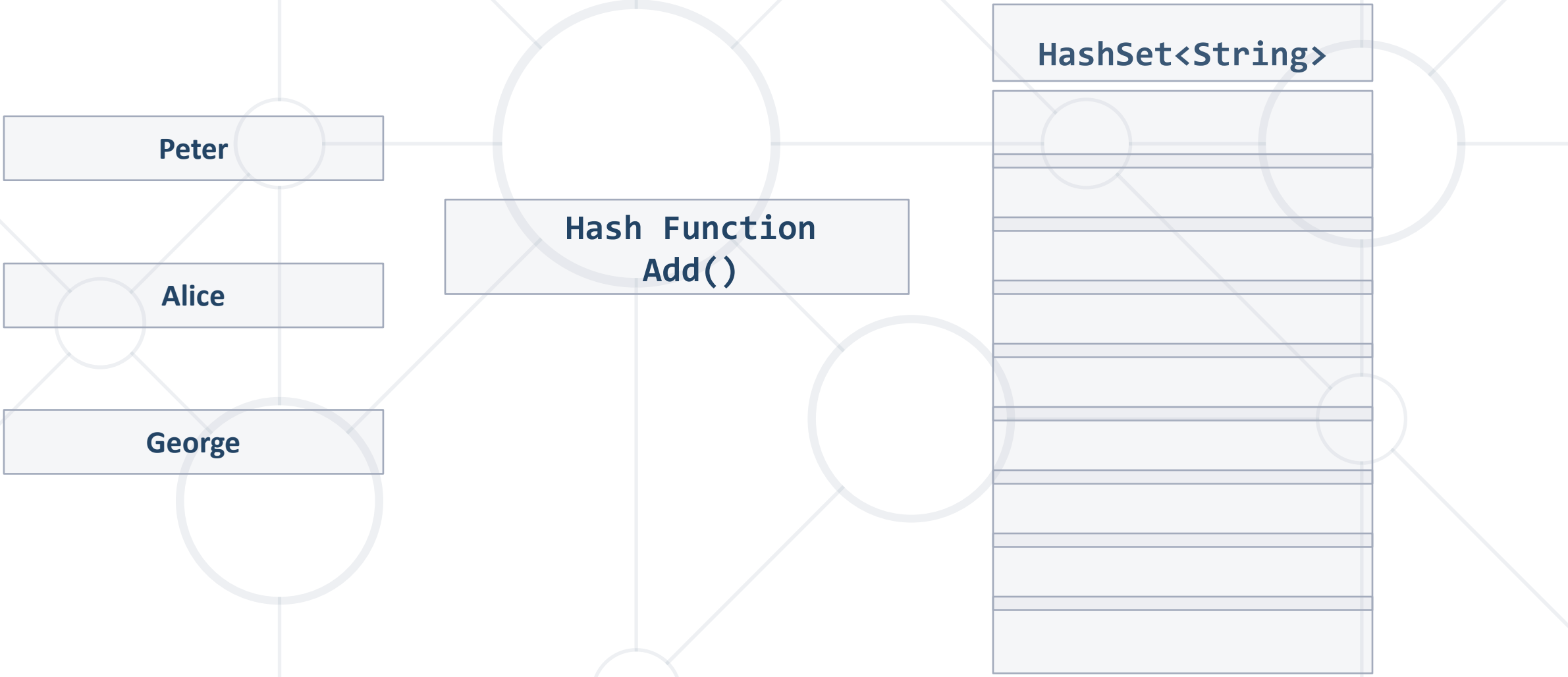
- For easy reading you can use diamond inference syntax:

```
Set<String> tree = new TreeSet<>();
```

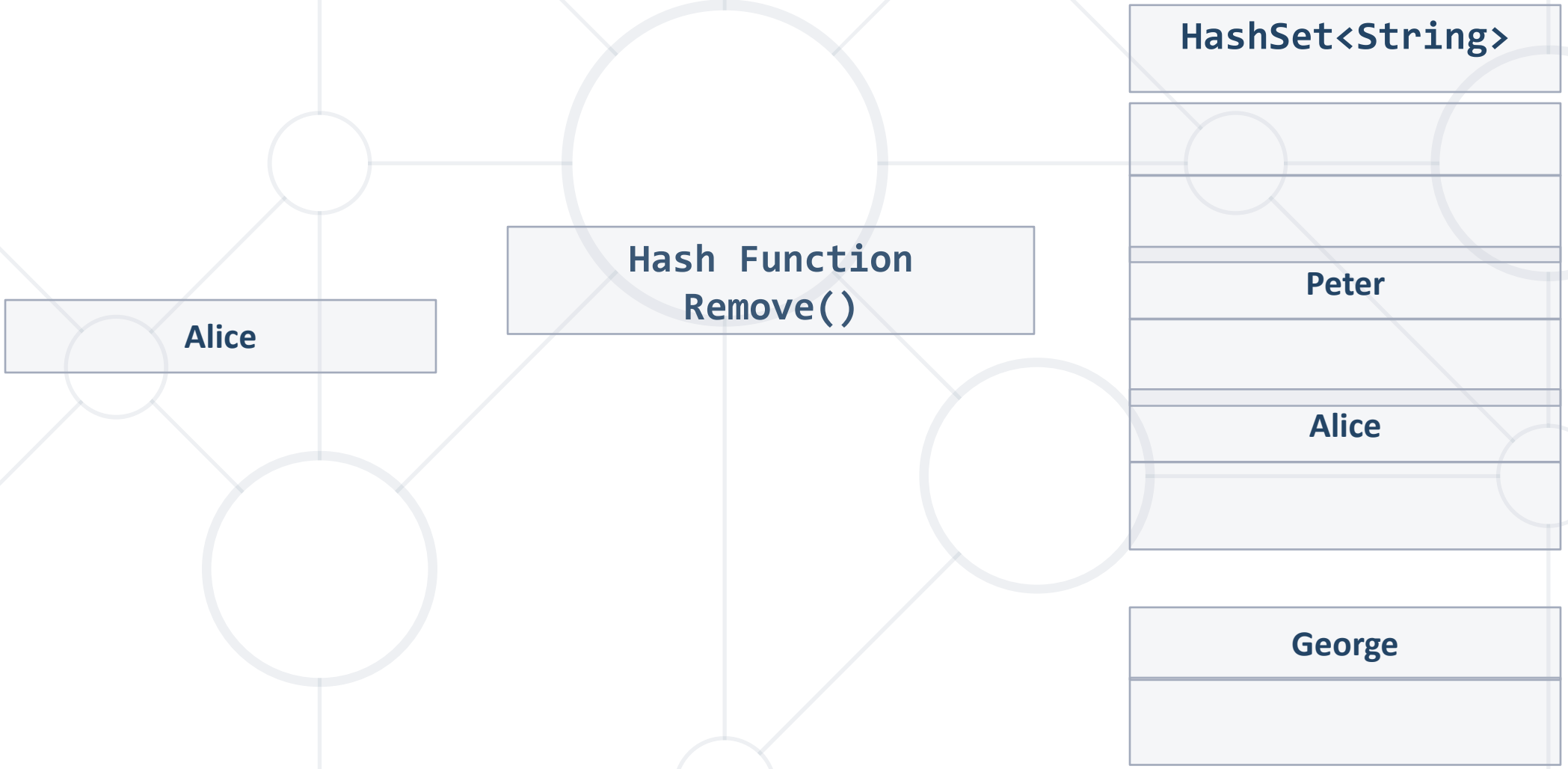
- `.size()`
- `.isEmpty()`

```
Set<String> hash = new HashSet<>();
System.out.println(hash.size());      // 0
System.out.println(hash.isEmpty());   // True
```

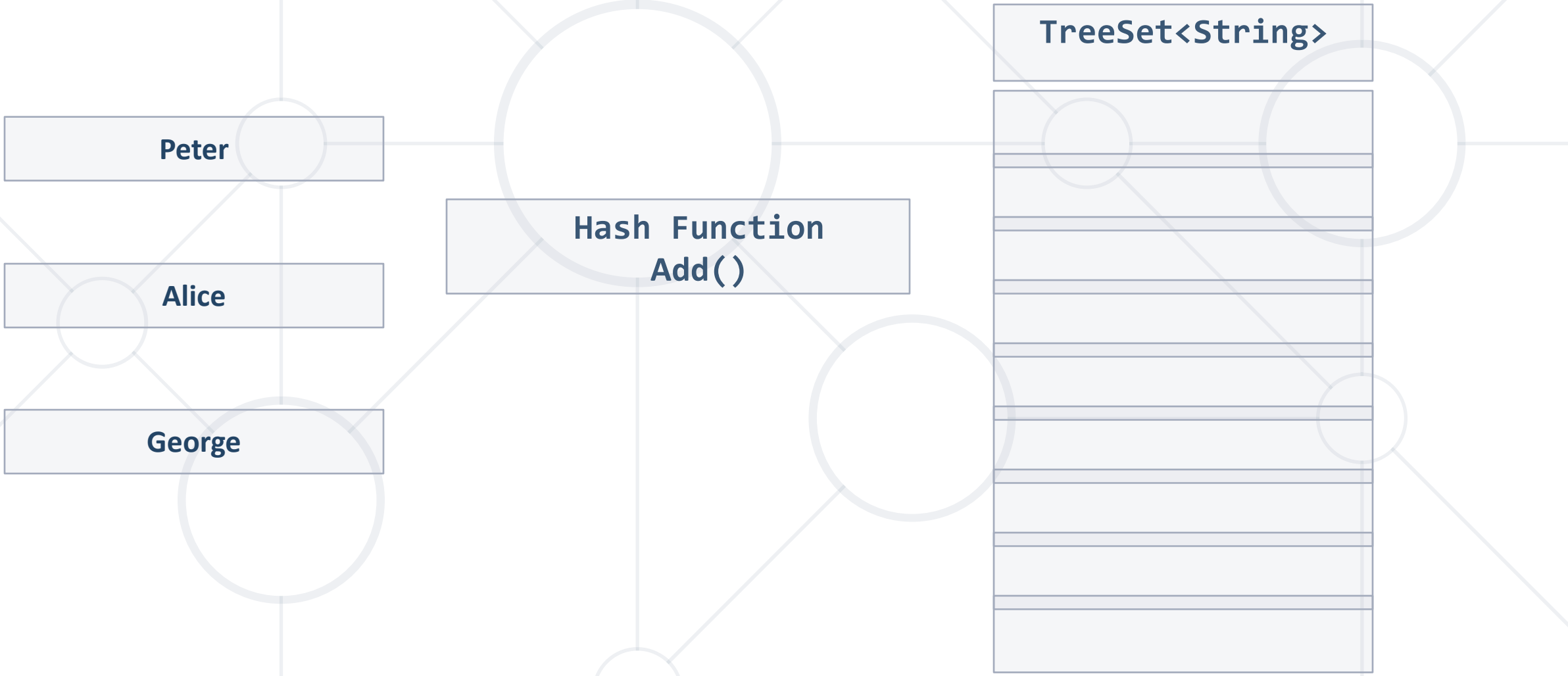
HashSet<E> – Add()



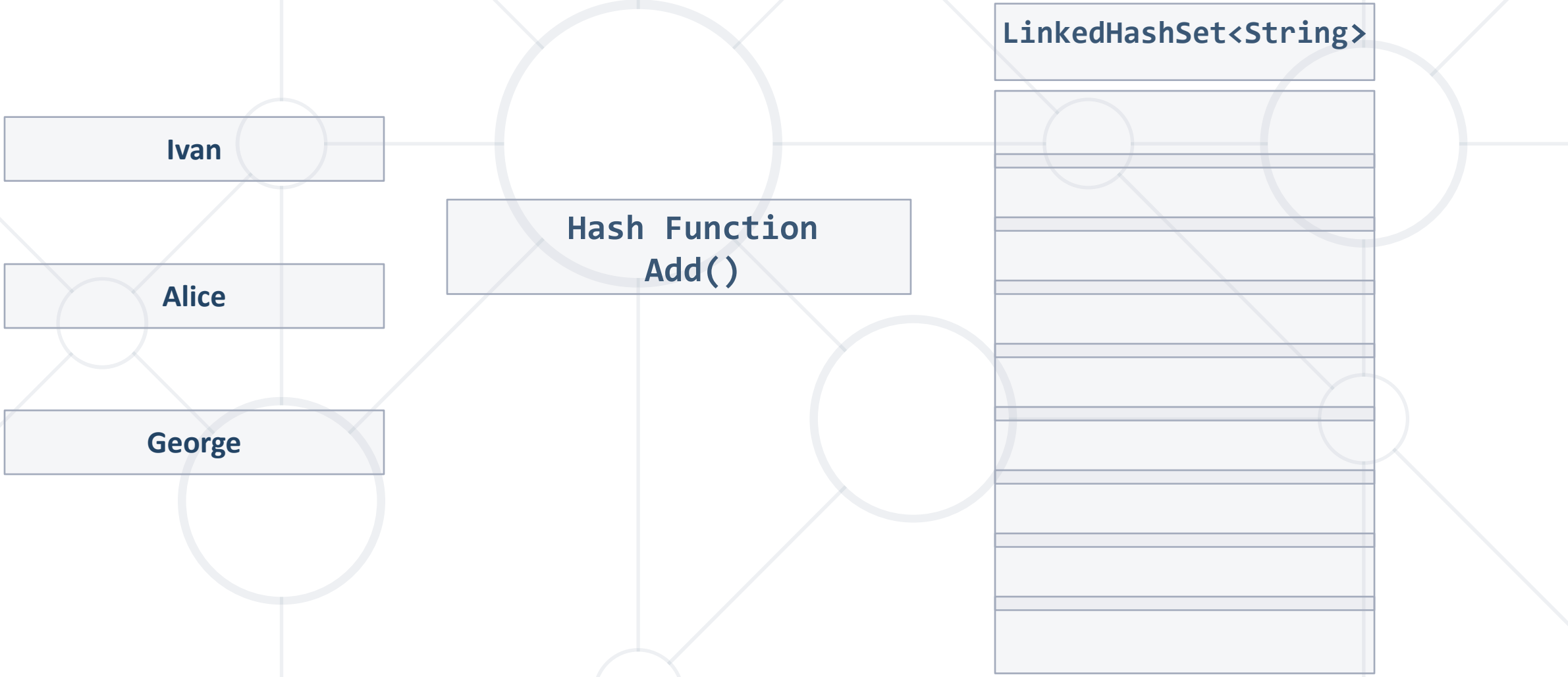
HashSet<E> – Remove()



TreeSet<E> – Add()

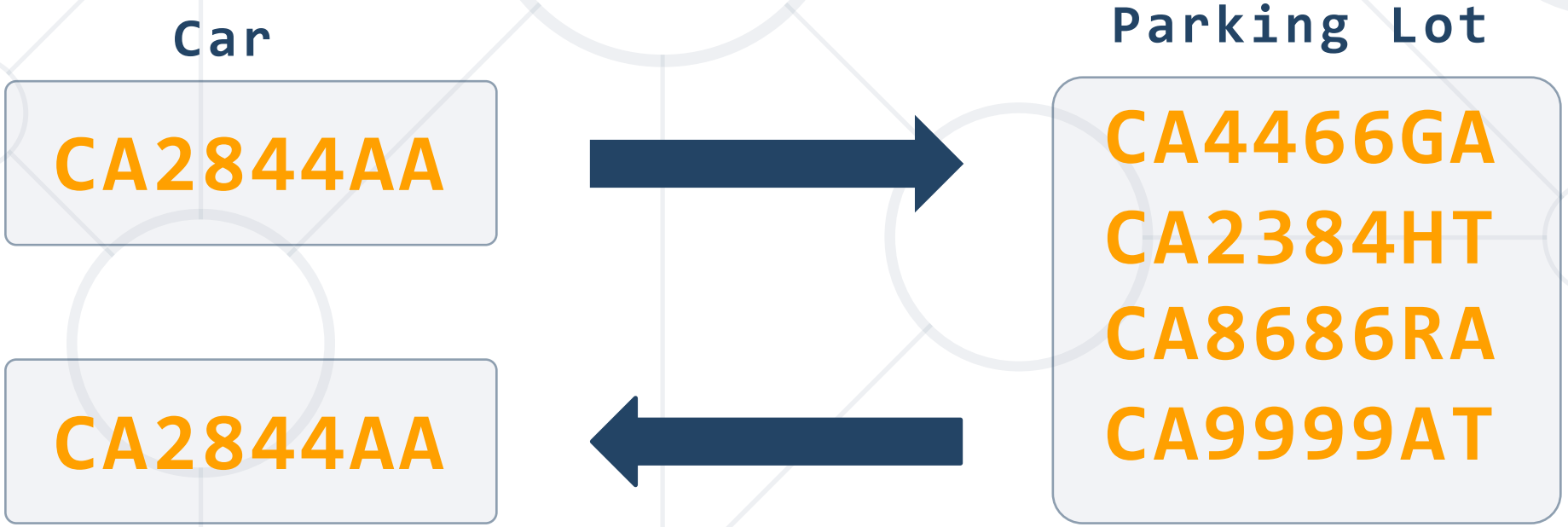


LinkedHashSet<E> – Add()



Problem: Parking Lot

- Write a program that:
  - Adds car number for every car that enters the parking lot
  - Removes car number when the car goes out



Check your solution here: https://alpha.judge.softuni.org/contests/sets-and-maps-advanced-lab/1462

Solution: Parking Lot

```
LinkedHashSet<String> parkingLot = new LinkedHashSet<>();
while(true)
  String input = sc.nextLine();
  if (input.equals("END"))
    break;
  else
    String[] reminder = input.split(", ");
    if (reminder[0].equals("IN"))
      parkingLot.add(reminder[1]);
    else
      parkingLot.remove(reminder[1]);
```

Check your solution here: https://alpha.judge.softuni.org/contests/sets-and-maps-advanced-lab/1462

Problem: SoftUni Party

- Guests are two types:
  - **Regular**
  - **VIPs** – their tickets start with digit
- Until **PARTY** command, you will receive guest invitations
- Until **END** command, you will receive a second list with guests that actually came to the party
- Find how many guests didn't come to the party
- Print all guests that didn't come (VIPs first)

Reservation List

```
7IK9Yo0h
9NoBUajQ
Ce8vwPmE
SVQXQCbc
```

Solution: SoftUni Party

```
Set<String> vip = new TreeSet<>();
Set<String> regular = new TreeSet<>();
String guestId = scanner.nextLine();

while (!guestId.equals("PARTY")) {
  if (Character.isDigit(guestId.charAt(0)))
    vip.add(guestId);
  else
    regular.add(guestId);
  guestId = scanner.nextLine();
}

// TODO: Remove the guests who came to the party
// TODO: Print results
```

Return true or false

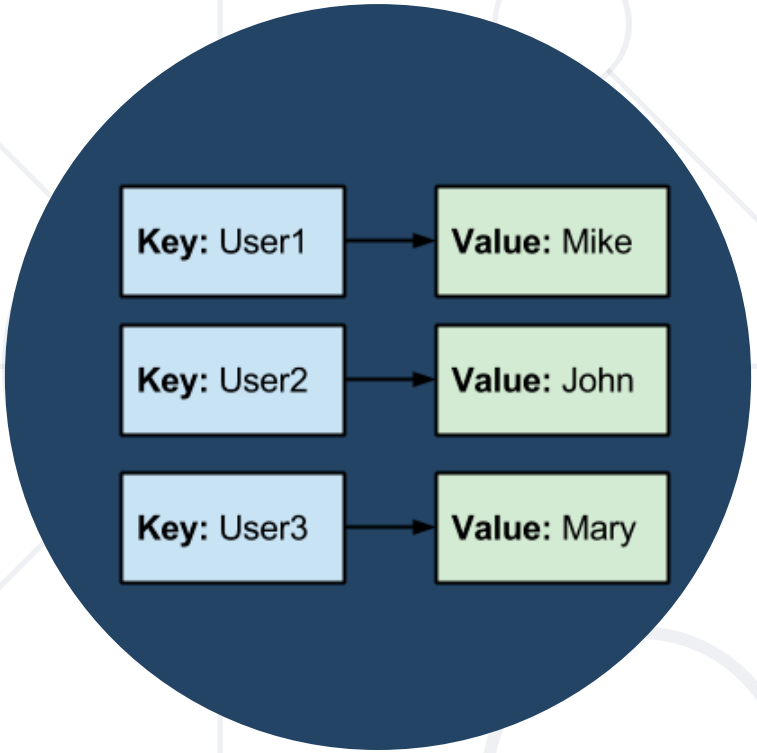
Problem: "Voina" – Number Game

- Create a game that is played by two players:
  - Each one **has 20 unique numbers** (read from the console, separated with space)
  - Every round each player **bets his first number** from the deck
  - Player with a bigger number wins and places both numbers **at the bottom** of his deck
  - A game ends after **50 rounds** or when a player has **0 numbers**

Check your solution here: https://alpha.judge.softuni.org/contests/sets-and-maps-advanced-lab/1462

Solution: "Voina" – Number Game

```
LinkedHashSet<Integer> firstPlayer = getPlayerNumbers();
LinkedHashSet<Integer> secondPlayer = getPlayerNumbers();
for (int i = 0; i < 50; i++) {
  int firstNumber = firstPlayer.iterator().next();
  firstPlayer.remove(firstNumber);
  // TODO: get top number for second player
  if (firstNumber > secondNumber) {
     firstPlayer.add(firstNumber);
     firstPlayer.add(secondNumber);
  } else if (secondNumber > firstNumber)
     // TODO: finish logic about second player win or draw
}
// TODO: print result
```



Associative Arrays

Associative Arrays (Maps)

- **Associative arrays** are arrays indexed by keys
  - Not by the numbers 0, 1, 2, …
- Hold a set of pairs **<key, value>**
- **Traditional**

key	0	1	2	3	4
value	8	-3	12	408	33

- **Associative array**

key	value
John Smith	+1-555-8976
Lisa Smith	+1-555-1234
Sam Doe	+1-555-5030

Methods

- Initialization

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

Type of keys

Type of values

- `.size()`
- `.isEmpty()`

```
Map<String, Integer> hash = new HashMap<>();
System.out.println(hash.size());      // 0
System.out.println(hash.isEmpty());   // True
```

HashMap<K, V> – Put()

Hash Function

Put()

HashMap<String, String>

Key

Value

HashMap<K, V> – Remove()

Peter

Hash Function
Remove()

Looping Through Maps – Example

```
Map<String, Integer> vehicles = new HashMap<>();
vehicles.put("BMW", 5);
vehicles.put("Mercedes", 3);
vehicles.put("Audi", 4);
vehicles.put("BMW", 10);
for(String key: vehicles.keySet())
  System.out.println(key + " - " + vehicles.get(key));
```

Override first value

Return set of all keys

Return value for key

```
Audi - 4
Mercedes - 3
BMW - 10
```

Problem: Count Real Numbers

- Write a program that **counts** in a given array of **double** values the number of occurrences of each value

-2.5	4	3	-2.5	-5.5	4	3	3	-2.5	3

```
-2.5 -> 3
4.0 -> 2
3.0 -> 4
-5.5 -> 1
```

Solution: Count Real Numbers

```
LinkedHashMap<Double, Integer> result = new LinkedHashMap<>();
for (Double number : input) {
  if (!result.containsKey(number)) {
    result.put(number, 1);
  } else {
    result.put(number, result.get(number) + 1);
  }
}
for (Double key : result.keySet()) {
  System.out.println(key + " -> " + result.get(key));
}
```

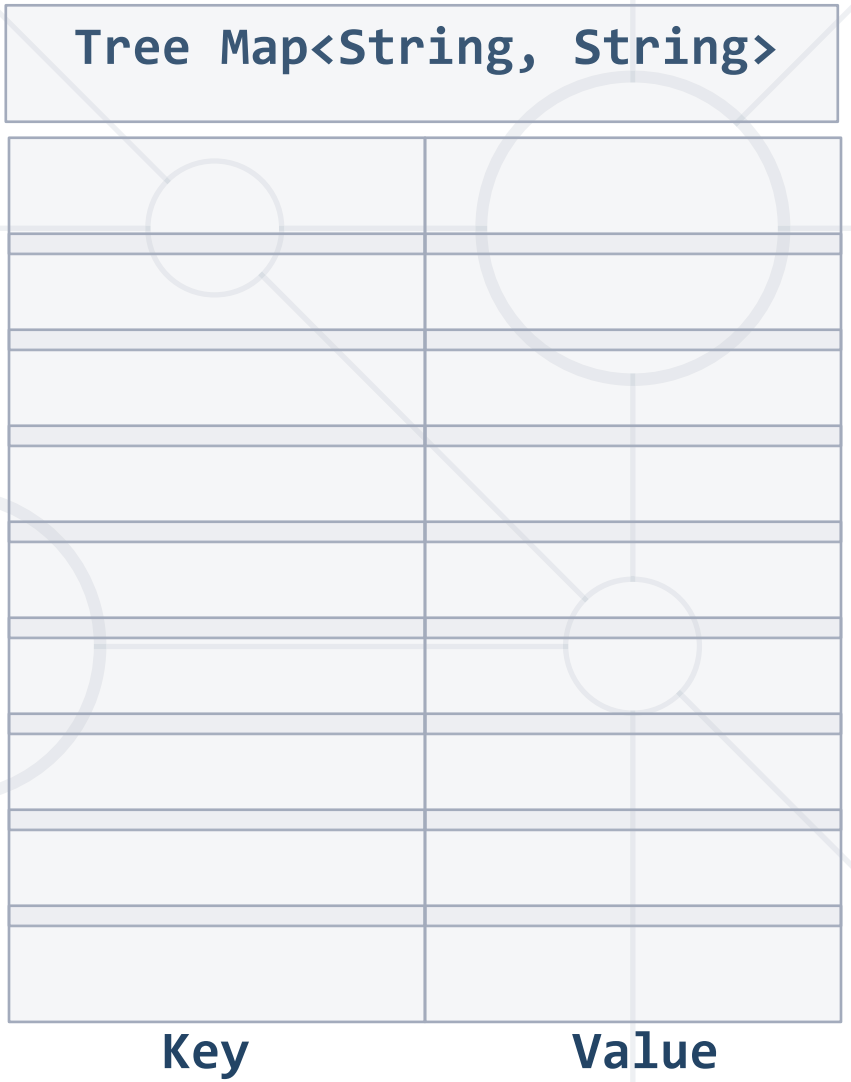
Check your solution here: https://alpha.judge.softuni.org/contests/sets-and-maps-advanced-lab/1462

TreeMap<K, V> – Put()

Peter	+359 888 123 987

TreeMap Function

Put()



Problem: Academy Graduation

- Write a program that:
  - Reads a list of students and their score for some courses
  - Prints on the console sorted list with average score for each student

Student	Java Advanced	Java OOP
George	3.75	5
Maria	4.25	6
Peter	6	4.5

Student	Average
George	4,375
Maria	5,125
Peter	5,25

Check your solution here: https://alpha.judge.softuni.org/contests/sets-and-maps-advanced-lab/1462

Solution: Academy Graduation

```
TreeMap <String,Double[]> graduationList = new TreeMap<>();
for (int i = 0; i < numberOfStudents; i++) {
  String name = scanner.nextLine();
  String[] scoresStrings = scanner.nextLine().split(" ");
  Double[] scores = new Double[scoresStrings.length];

  for (int j = 0; j < scoresStrings.length; j++) {
    scores[j] = Double.parseDouble(scoresStrings[j]);
  }
  graduationList.put(name, scores);
}
// TODO: print results
```

Check your solution here: https://alpha.judge.softuni.org/contests/sets-and-maps-advanced-lab/1462

HashMap<K, V>, TreeMap<K, V>, LinkedHashMap<K, V>

- `size()` - the number of key-value pairs
- `keySet()` - a set of unique keys
- `values()` - a collection of all values
- Basic operations - `put()`, `remove()`, `clear()`
- Boolean methods:
  - `containsKey()` - checks if a key is present in the Map
  - `containsValue()` - checks if a value is present in the Map

Sorting Collections

- Using `sorted()` to sort collections:

```
nums = nums.stream()
            .sorted((n1, n2) -> n1.compareTo(n2))
            .collect(Collectors.toList());
```

Ascending (Natural) Order

```
nums = nums.stream()
            .sorted((n1, n2) -> n2.compareTo(n1))
            .collect(Collectors.toList());
```

Descending Order

Sorting Collections by Multiple Criteria

- Using `sorted()` to sort collections by multiple criteria:

```
Map<Integer, String> products = new HashMap<>();
products.entrySet()
        .stream()
        .sorted((e1, e2) -> {
            int res = e2.getValue().compareTo(e1.getValue());
            if (res == 0)
                res = e1.getKey().compareTo(e2.getKey());
            return res; })
        .forEach(e -> System.out.println(e.getKey() + " " + e.getValue()));
```

Second criteria

Terminates the stream

Sorting in Ascending Order by Value

```
Map<String, Integer> mp = new HashMap<>();
        mp.put("Aries", 1);
        mp.put("Taurus", 2);
        mp.put("Gemini", 3);
Map<String, Integer> resultMap = mp.entrySet()
                .stream()
                .sorted(Map.Entry.<String, Integer>comparingByValue())
                .collect(Collectors.toMap(Map.Entry::getKey,
                                Map.Entry::getValue,(e1, e2) -> e1, Linked
HashMap::new));
```

Using Functional ForEach

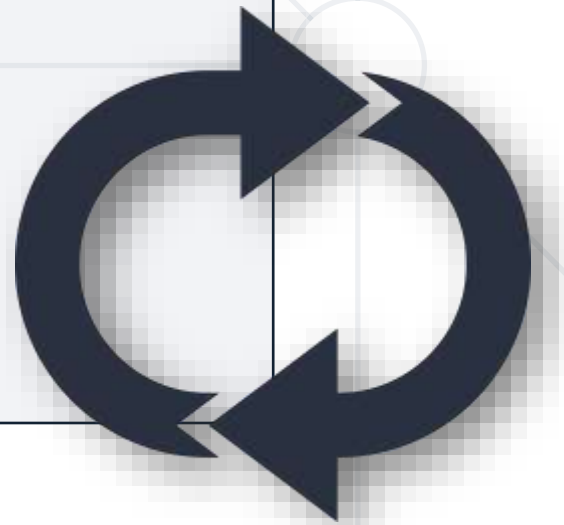
```
Map<String, ArrayList<Integer>> arr = new HashMap<>();
arr.entrySet().stream()
    .sorted((a, b) -> {
      if (a.getKey().compareTo(b.getKey()) == 0) {
        int sumFirst = a.getValue().stream().mapToInt(x -> x).sum();
        int sumSecond = b.getValue().stream().mapToInt(x -> x).sum();
        return sumFirst - sumSecond;
      }
      return b.getKey().compareTo(a.getKey());
    })
```

Second criteria

Descending sorting

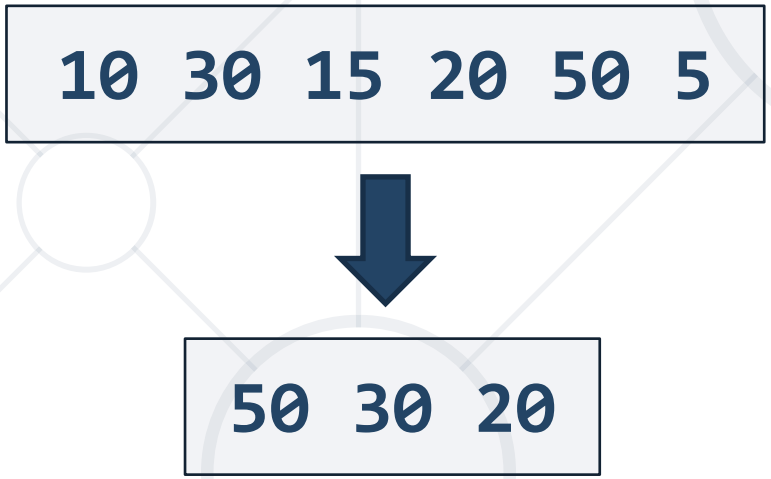
Using Functional ForEach

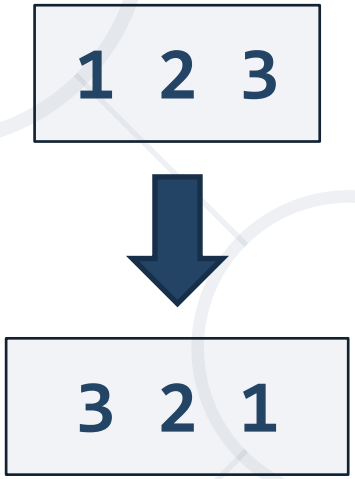
```
.forEach(pair -> {
  System.out.println("Key: " + pair.getKey());
  System.out.print("Value: ");
  pair.getValue().sort((a, b) -> a.compareTo(b));
  for (int num : pair.getValue()) {
    System.out.printf("%d ", num);
  }
  System.out.println();
});
```

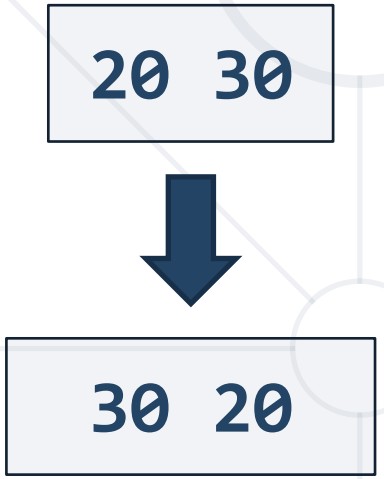


Problem: Largest 3 Numbers

- Read a list of numbers
- Print the largest 3, if there are less than 3, print all of them







Check your solution here: https://alpha.judge.softuni.org/contests/sets-and-maps-advanced-lab/1462

Solution: Largest 3 Numbers

```
List<Integer> nums = Arrays
                .stream(sc.nextLine().split(" "))
                .map(e -> Integer.parseInt(e))
                .sorted((n1, n2) -> n2.compareTo(n1))
                .limit(3)
                .collect(Collectors.toList());
for (int num : nums) {
            System.out.print(num + " ");
        }
```

Check your solution here: https://alpha.judge.softuni.org/contests/sets-and-maps-advanced-lab/1462

Summary

- HashSet<E>, TreeSet<E> and LinkedHashSet<E> hold unique elements and are very fast
- HashMap<K, V>, TreeMap<K, V> and LinkedHashMap<K, V> are associative arrays where a value is accessed by its key

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