Collections
Part 2: Maps & Sets

Today's Objectives

- Map<T, T>: rules and limitations
- Map tasks:
  - Declaring and initialize a Map
  - Adding and Retrieving values from the Map using the Keys
  - Retrieving the Key set from a Map
  - Checking for Key uniqueness
  - Iterating through the Key-Value-Pairs
  - Removing items from the Map
- When to use
  - A Map vs. an Array or List
  - A List vs. a Map or Array
  - An Array vs. a List or Map
    (Data-types, Mutability, and Access Methods (index vs key) all come into play in the decision)

Introducing: Maps

Maps are used to store key value pairs. They are another form of in-memory data structures.

● Examples of key value pairs: dictionary entries (word -> definition), a phone book (name -> phone number), a list of employees (employee number -> employee name)

● Think of the keys as unique identifiers for a specific value

● We will focus on a type of unordered map called a HashMap.

Declaring a Map

Map declarations follow this pattern:

```java
import java.util.HashMap;
import java.util.Map;

public class MyClass {

    public static void main(String args[]) {

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

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Declaring a Map

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> `Map` and `HashMap` need to be imported from the `java.util` package.

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import java.util.HashMap;
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public class MyClass {

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

This indicates the key will be an `Integer` and the value will be a `String`.

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`Map` and `HashMap` need to be imported from the `java.util` package.

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Remember the `new` keyword creates an **instance** of a class.

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public class MyClass {

    public static void main(String args[]) {

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

`Map` and `HashMap` need to be imported from the `java.util` package.

We are creating a `HashMap` implementation of `Map`.

This indicates the key will be an `Integer` and the value will be a `String`.

Remember the `new` keyword creates an **instance** of a class.

Adding an Entry to a Map

The `put` method adds a key/value pair entry to the `Map`. The data types must match the declaration.

```
Map <Integer, String> myMap = new HashMap<>();
myMap.put(1, "Rick");
myMap.put(2, "Beth");
myMap.put(3, "Jerry");
myMap.put(4, "Summer");
myMap.put(4, "Winter");
```

Adding an Entry to a Map

The `put` method adds a key/value pair entry to the `Map`. The data types must match the declaration.

```
Map <Integer, String> myMap = new HashMap<>();
myMap.put(1, "Rick");
myMap.put(2, "Beth");
myMap.put(3, "Jerry");
myMap.put(4, "Summer");
myMap.put(4, "Winter");
```
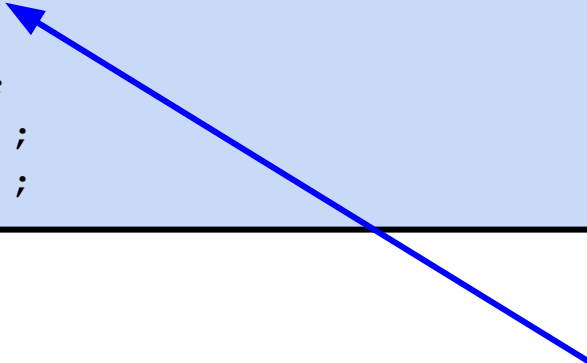
The `put` method call requires two parameters:

- The key: in this example it is of data type `Integer`.

- The value: in this example it is of data type `String`.

Adding an Entry to a Map

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```
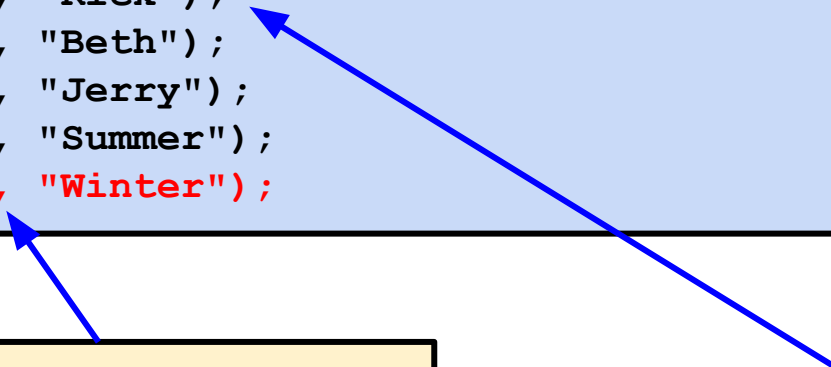
The `put` method call requires two parameters:

- The key: in this example it is of data type `Integer`.

- The value: in this example it is of data type `String`.

Here, we inserted an entry with a key of 1 and a value of Rick.

Adding an Entry to a Map

The `put` method adds a key/value pair entry to the `Map`. The data types must match the declaration.

```
Map <Integer, String> myMap = new HashMap<>();
myMap.put(1, "Rick");
myMap.put(2, "Beth");
myMap.put(3, "Jerry");
myMap.put(4, "Summer");
myMap.put(4, "Winter");
```

The `put` method call requires two parameters:

- The key: in this example it is of data type `Integer`.

- The value: in this example it is of data type `String`.

If we insert a **duplicate key**, the key's **value will be overwritten**!!! So in this case **key 4** would return **Winter**.

Here, we inserted an entry with a key of 1 and a value of Rick.

Retrieving a Value by Its Key

The `get` method returns the value associated with the key provided.

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

reservations.put("HY234-9234", "Rick");
reservations.put("HY234-4235", "Beth");
reservations.put("HY234-3234", "Jerry");

String name = reservations.get("HY234-9234");
System.out.println(name); // Prints Rick

String anotherName = reservations.get("AAI93-2345");
System.out.println(name); // Prints null
```
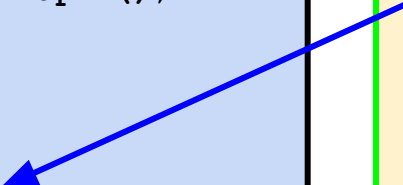
Retrieving a Value by Its Key

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reservations.put("HY234-9234", "Rick");
reservations.put("HY234-4235", "Beth");
reservations.put("HY234-3234", "Jerry");


String name = reservations.get("HY234-9234");
System.out.println(name); // Prints Rick

String anotherName = reservations.get("AAI93-2345");
System.out.println(name); // Prints null
```

- The `get` method requires one parameter, the key you are searching for.

Retrieving a Value by Its Key

The `get` method returns the value associated with the key provided.

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reservations.put("HY234-9234", "Rick");
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String name = reservations.get("HY234-9234");
System.out.println(name); // Prints Rick

String anotherName = reservations.get("AAI93-2345");
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- The `get` method requires one parameter, the key you are searching for.

- It will return the value associated with the key.

Retrieving a Value by Its Key

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```java
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reservations.put("HY234-3234", "Jerry");


String name = reservations.get("HY234-9234");
System.out.println(name); // Prints Rick

String anotherName = reservations.get("AAI93-2345");
System.out.println(name); // Prints null
```

- The `get` method requires one parameter, the key you are searching for.

- It will return the value associated with the key.

- If no keys match the parameter provided, it returns a `null`.

Checking if an Key Exists in a Map

The `containsKey` method returns a `boolean` indicating if the key exists in the `Map`.

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

reservations.put("HY234-9234", "Rick");
reservations.put("HY234-4235", "Beth");
reservations.put("HY234-3234", "Jerry");

System.out.println(reservations.containsKey("HY234-4235"))
;
// True
System.out.println(reservations.containsKey("AAAI-4235"));
// False
System.out.println(reservations.containsKey("Jerry"));
// False
```

Checking if an Key Exists in a Map

The `containsKey` method returns a `boolean` indicating if the key exists in the `Map`.

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

reservations.put("HY234-9234", "Rick");
reservations.put("HY234-4235", "Beth");
reservations.put("HY234-3234", "Jerry");

System.out.println(reservations.containsKey("HY234-4235"))
;
// True
System.out.println(reservations.containsKey("AAAI-4235"));
// False
System.out.println(reservations.containsKey("Jerry"));
// False
```

- The `containsKey` method requires one parameter, the key you are searching for.

- `containsKey` returns a `boolean`

Checking if an Key Exists in a Map

The `containsKey` method returns a `boolean` indicating if the key exists in the `Map`.

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reservations.put("HY234-9234", "Rick");
reservations.put("HY234-4235", "Beth");
reservations.put("HY234-3234", "Jerry");

System.out.println(reservations.containsKey("HY234-4235"))
;
// True
System.out.println(reservations.containsKey("AAAI-4235"));
// False
System.out.println(reservations.containsKey("Jerry"));
// False
```

- The `containsKey` method requires one parameter, the key you are searching for.

- `containsKey` returns a `boolean`

Note that in this example. `false` is returned because "Jerry" is not one of the keys in the `Map` (although it **IS** a value).

Finding the Number of Elements in a Map

The `size` method returns the number of key-value-pairs in the `Map`.

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

reservations.put("HY234-9234", "Rick");
reservations.put("HY234-4235", "Beth");
reservations.put("HY234-3234", "Jerry");

System.out.println(reservations.size()); // Prints 3
reservations.remove("HY234-3234");
System.out.println(reservations.size()); // Prints 2
```

Finding the Number of Elements in a Map

The `size` method returns the number of key-value-pairs in the `Map`.

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

reservations.put("HY234-9234", "Rick");
reservations.put("HY234-4235", "Beth");
reservations.put("HY234-3234", "Jerry");

System.out.println(reservations.size()); // Prints 3
reservations.remove("HY234-3234");
System.out.println(reservations.size()); // Prints 2
```

- The `size` method requires no parameters.

- It will return an integer, the number of key value pairs in the `Map`.

Getting a Map's Keys

We can get all the **Map**'s keys by using the **keySet()** method..

```
Set<String> keys = myMap.keySet();

for(String key : keys) {
    System.out.println("key: " + key);
}
```

Getting a Map's Keys

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for(String key : keys) {
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The `keySet()` method returns a collection of the type specified as the key in `Map<T, T>`

Getting a Map's KEys

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}
```

The `keySet()` method returns a collection of the type specified as the key in `Map<T, T>`

We can iterate through the key data using a for-each loop.
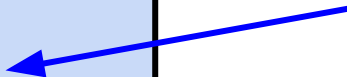
Iterating Using A Map's EntrySets

We can iterate through a **Map**'s Entries by using its **EntrySet**.

```
Map<Integer, String> myMap = new HashMap<Integer, String>();
myMap.put(1, "Hi");
myMap.put(100, "100%");
myMap.put(22, "Yay!");

for(Map.Entry<Integer, String> entry : myMap.entrySet() ) {
    Integer key = entry.getKey();
    String value = entry.getValue();
    System.out.println("key: " + key + " value: " + value);
}
```

The **Map**'s **entrySet()** method returns the **EntrySet**.

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The **Map**'s **entrySet()** method returns the **EntrySet**.

We can iterate through the **EntrySet** using a for-each loop with each entry returning an object of type **Map.Entry<T, T>**

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    String value = entry.getValue();
    System.out.println("key: " + key + " value: " + value);
}
```

The **Map**'s **entrySet()** method returns the **EntrySet**.

We can get the key and value from the **Entry** using its **getKey()** and **getValue()** methods

We can iterate through the **EntrySet** using a for-each loop with each entry returning an object of type **Map.Entry<T, T>**

Removing an Entry from a Map

The `remove` method removes an item from the `Map` using a key value.

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Map <String, String> reservations = new HashMap<>();

reservations.put("HY234-9234", "Rick");
reservations.put("HY234-4235", "Beth");
reservations.put("HY234-3234", "Jerry");

System.out.println(reservations.get("HY234-3234"));
// Prints Jerry
reservations.remove("HY234-3234");
System.out.println(reservations.get("HY234-3234"));
 // Prints null
```
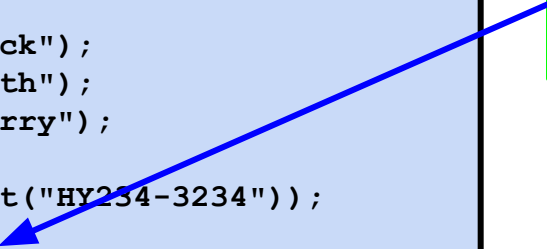
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reservations.put("HY234-3234", "Jerry");

System.out.println(reservations.get("HY234-3234"));
// Prints Jerry
reservations.remove("HY234-3234");
System.out.println(reservations.get("HY234-3234"));
 // Prints null
```

- The `remove` method requires one parameter, the key you are searching for.

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reservations.put("HY234-3234", "Jerry");


System.out.println(reservations.get("HY234-3234"));
// Prints Jerry
reservations.remove("HY234-3234");
System.out.println(reservations.get("HY234-3234"));
 // Prints null
```

- The `remove` method requires one parameter, the key you are searching for.

Note calling the `get` method with the key that was removed will now return `null` because the key is no longer in the `Map`.

Rules for Using Maps

`Maps` are used to store key value pairs.

- Do not use primitive types with `Map`s, use the Wrapper classes instead.

- Make sure there are no duplicate keys. If a key value pair is entered with a key that already exists, it will overwrite the existing one!

  - As a corollary of this rule, you are allowed one `null` in your key set before your data is changed in an unexpected manner

Introducing: Sets

A `Set` is also a collection of data.

- ● It differs from other collections we've seen so far in that no duplicate elements are allowed.

- ● It is also unordered.

Declaring a Set

The following pattern is used in declaring a set:

```java
import java.util.HashSet;
import java.util.Set;

public class MyClass {

    public static void main(String args[]) {

        Set<Integer> primeNumbersLessThan10 = new HashSet<>();
    }
}
```

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`Set` and `HashSet` need to be imported from the `java.util` package.

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`Set` and `HashSet` need to be imported from the `java.util` package.

This indicates the `Set` will contain `Integer`s.

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}
```

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This indicates the `Set` will contain `Integer`s.

Remember the `new` keyword creates an **instance** of a class.

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    }
}
```

`Set` and `HashSet` need to be imported from the `java.util` package.

This indicates the `Set` will contain `Integer`s.

Remember the `new` keyword creates an **instance** of a class.

We are creating a `HashSet` implementation of `Set`.

Adding an Element to a Set

The `add` method adds an element to the `Set`. The data type must match the declaration.
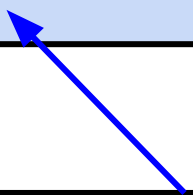
```
Set<Integer> primeNumbersLessThan10 = new HashSet<>();
primeNumbersLessThan10.add(2);
primeNumbersLessThan10.add(3);
primeNumbersLessThan10.add(5);
```

Adding an Element to a Set

The `add` method adds an element to the `Set`. The data type must match the declaration.

```
Set<Integer> primeNumbersLessThan10 = new HashSet<>();
primeNumbersLessThan10.add(2);
primeNumbersLessThan10.add(3);
primeNumbersLessThan10.add(5);
```

- `add` only requires one parameter: the data that is being added.

Adding an Element to a Set

The `add` method adds an element to the `Set`. The data type must match the declaration.

```
Set<Integer> primeNumbersLessThan10 = new HashSet<>();
primeNumbersLessThan10.add(2);
primeNumbersLessThan10.add(3);
primeNumbersLessThan10.add(5);
```

- `add` only requires one parameter: the data that is being added.

This example specifies that this is a `Set` of `Integer`s, so the integers 2, 3, and 5 are being added.

Checking If an Element is Contained in a Set

The `contains` method returns a `boolean` specifying if an element is part of the `Set`.

```java
Set<Integer> primeNumbersLessThan10 = new HashSet<>();
primeNumbersLessThan10.add(2);
primeNumbersLessThan10.add(3);
primeNumbersLessThan10.add(5);

System.out.println(primeNumberLessThan10.contains(5));
// true
System.out.println(primeNumberLessThan10.contains(4));
// false
```

Checking If an Element is Contained in a Set

The `contains` method returns a `boolean` specifying if an element is part of the `Set`.

```
Set<Integer> primeNumbersLessThan10 = new HashSet<>();
primeNumbersLessThan10.add(2);
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primeNumbersLessThan10.add(5);

System.out.println(primeNumberLessThan10.contains(5));
// true
System.out.println(primeNumberLessThan10.contains(4));
// false
```

- `contains` only requires one parameter: the data that we want to search for.

Checking If an Element is Contained in a Set

The `contains` method returns a `boolean` specifying if an element is part of the `Set`.

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Set<Integer> primeNumbersLessThan10 = new HashSet<>();
primeNumbersLessThan10.add(2);
primeNumbersLessThan10.add(3);
primeNumbersLessThan10.add(5);

System.out.println(primeNumberLessThan10.contains(5));
// true
System.out.println(primeNumberLessThan10.contains(4));
// false
```

- `contains` only requires one parameter: the data that we want to search for.

If the data specified by `contains` is found in the `Set`, `true` will be returned. Otherwise `false` will be returned.

Removing an Element from a Set

The `remove` method removes an element from a `Set`.

```
Set<Integer> primeNumbersLessThan10 = new HashSet<>();
primeNumbersLessThan10.add(2);
primeNumbersLessThan10.add(3);
primeNumbersLessThan10.add(5);

primeNumbersLessThan10.remove(5);
```

Removing an Element from a Set

The `remove` method removes an element from a `Set`.

```
Set<Integer> primeNumbersLessThan10 = new HashSet<>();
primeNumbersLessThan10.add(2);
primeNumbersLessThan10.add(3);
primeNumbersLessThan10.add(5);

primeNumbersLessThan10.remove(5);
```
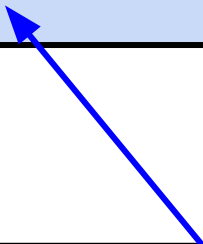
- `remove` only requires one parameter: the data that is being removed.

Removing an Element from a Set

The `remove` method removes an element from a `Set`.

```
Set<Integer> primeNumbersLessThan10 = new HashSet<>();
primeNumbersLessThan10.add(2);
primeNumbersLessThan10.add(3);
primeNumbersLessThan10.add(5);

primeNumbersLessThan10.remove(5);
```

- `remove` only requires one parameter: the data that is being removed.

This will remove the element that is the `Integer` 5.;

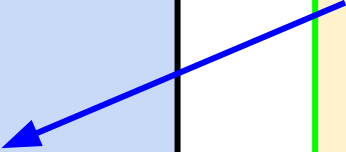# Checking the Number of Elements in a Set

Last but not least, **Set**s also have a **size** method.

```
Set<Integer> primeNumbersLessThan10 = new HashSet<>();
primeNumbersLessThan10.add(2);
primeNumbersLessThan10.add(3);
primeNumbersLessThan10.add(5);

System.out.println(primeNumbersLessThan10.size());
// 3
```

Checking the Number of Elements in a Set

Last but not least, `Set`s also have a `size` method.

```
Set<Integer> primeNumbersLessThan10 = new HashSet<>();
primeNumbersLessThan10.add(2);
primeNumbersLessThan10.add(3);
primeNumbersLessThan10.add(5);

System.out.println(primeNumbersLessThan10.size());
// 3
```

- No parameters are required.

Checking the Number of Elements in a Set

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Set<Integer> primeNumbersLessThan10 = new HashSet<>();
primeNumbersLessThan10.add(2);
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primeNumbersLessThan10.add(5);

System.out.println(primeNumbersLessThan10.size());
// 3
```

- No parameters are required.

- An integer is returned

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Last but not least, **Set**s also have a **size** method.

```
Set<Integer> primeNumbersLessThan10 = new HashSet<>();
primeNumbersLessThan10.add(2);
primeNumbersLessThan10.add(3);
primeNumbersLessThan10.add(5);

System.out.println(primeNumbersLessThan10.size());
// 3
```

- No parameters are required.

- An integer is returned.

This will the number of elements, which is 3.

Making the Decision: Arrays vs Lists vs Maps vs Sets

- Use **Arrays** when … you know the maximum number of elements, and you know you will primarily be working with primitive data types**.

- Use **Lists** when … you want something that works like an array, but you don't know the maximum number of elements.

- Use **Maps** when … you have key value pairs.

- Use **Sets** when … you know your data does not contain repeating elements.

   ** This "rule" is debatable in that you can declare Object[] arrays; they have their place but List<T> is far more common and meets the majority of use-cases.