♦ Java immutable objects interview questions & answers

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Best Practice: “Classes should be immutable unless there’s a very good reason to make them mutable….If a class cannot be made immutable, limit its mutability as much as possible.” — by Joshua Bloch

Q1. What is an immutable object?

Q2. Immutable objects are objects whose state (the object’s data) cannot change after construction. Examples of immutable objects from the JDK include String and wrapper classes like Integer, Double, Character, etc.

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Q2.How do you create an immutable type?

A2.

1. Make the class **final** so that it cannot be extended or use static factories and keep the constructors private.

```
1 public final class MyImmutable { … }
```

2. Make the fields private and final.

```
1 private final int[ ] myArray;
```

3. Don't provide any methods that can change the state of the immutable object in any way from outside the object – not just *setXXX* methods, but any methods which can change the state.

4. The "**this**" reference is not allowed to escape during construction from the immutable class, and the immutable class should have exclusive access to fields that contain references to other mutable objects like arrays, collections and mutable classes like Date by:

a) Declaring the mutable references as private.
b) Not returning or exposing the mutable references to the caller. This can be done by defensively copying the objects by deeply cloning them.

Example: satisfying the above conditions

```
1   public class User {
2      private final String firstName; //final, and
3      private final String lastName;  //final, and
4
5      // constructor is private
6      private User(String firstName, String lastNa
7          this.firstName = firstName;
8          this.lastName = lastName;
9      }
10
11     //factory method
12     public static User getInstance(String firstN
13         return new User(firstName, lastName);
14     }
```

```
15
16      //only getters, no setters
17
18      public String getFirstName() {
19          return firstName;
20      }
21
22      public String getLastName() {
23          return lastName;
24      }
25
26  }
```

Q3. Is the following class immutable?

```
1  import java.util.Arrays;
2
3  public final class MyImmutable {
4
5      private final Integer[ ] myArray;
6
7      public MyImmutable(Integer[ ] anArray) {
8            this.myArray = anArray;
9      }
10
11     public Integer[ ] getMyArray( ) {
12         return myArray;
13     }
14
15     //....equals(), hashCode(), etc
16
17     @Override
18     public String toString() {
19         return Arrays.toString(myArray);
20     }
21 }
```

A3. No. The above class is **not immutable** as it fails **#4** condition where the “myArray” reference can escape, and mutated from outside as demonstrated below.

```
1  public class MyImmutableTest {
2
3      public static void main(String[] args) {
4          Integer[] array1 = {1,2,3};
5          MyImmutable mi = new MyImmutable(array1)
6          System.out.println("before modifying: "
7
8          mi.getMyArray()[2] = 4; //change 3 to 4
9          System.out.println("after modifying: " +
10     }
11 }
```

Output:

```
1 before modifying: [1, 2, 3]
2 after modifying: [1, 2, 4]
```

FIX: "myArray" reference is deeply copied, and can't escape

```
1  import java.util.Arrays;
2
3  public final class MyImmutable {
4
5      private final Integer[] myArray;
6
7      public MyImmutable(Integer[] anArray) {
8          this.myArray = anArray.clone(); //cloned
9      }
10
11     public Integer[] getMyArray() {
12         return myArray.clone(); // cloned array
13     }
14
15     // ....equals(), hashCode(), etc
16
17     @Override
18     public String toString() {
19         return Arrays.toString(myArray);
20     }
21 }
```

If you run the "MyImmutableTest" again,

```
1 before modifying: [1, 2, 3]
2 after modifying: [1, 2, 3]
3
```

Q4. What are the advantages of immutable objects?
A4.

1) Immutable classes can greatly simplify programming by freely allowing you to cache and share the references to the immutable objects without having to defensively copy them or without having to worry about their values becoming stale or corrupted.

2) Immutable classes are inherently thread-safe and you do not have to synchronize access to them to be used in a multi-threaded environment. So there are no chances for negative

performance consequences as multiple threads can share the same instance.

3) Eliminates the possibility of data becoming inaccessible when used as keys in HashMaps or as elements in Sets. These types of errors are hard to debug and fix.

4) Eliminates the need for class invariant check once constructed.

5) Allow hashCode( ) method to use lazy initialization, by caching its return value.

6) Cloning is not required.

7) Simpler to construct, use, and test due to its deterministic state.

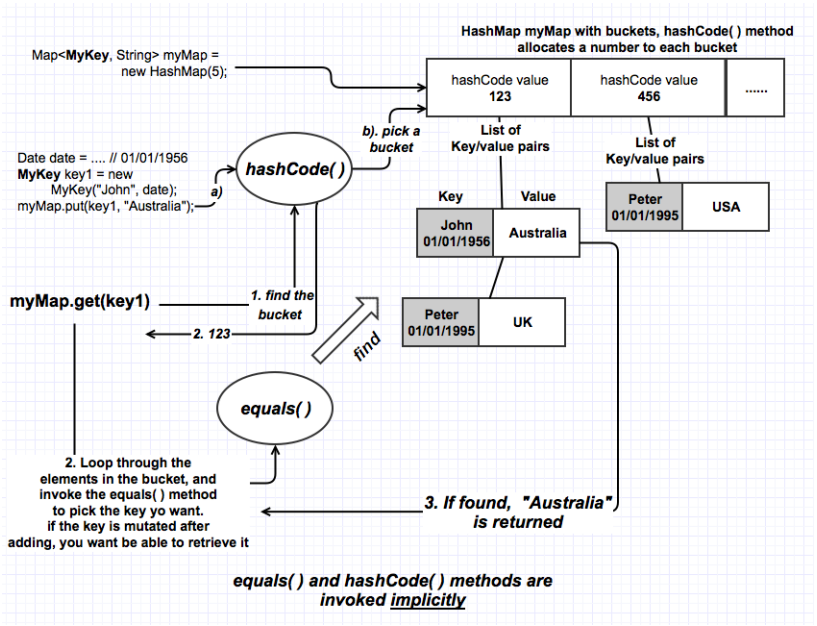
Q5. Why is it a best practice to implement the user defined key class as an immutable object?
A5. Immutable objects generally make the best map keys as the keys cannot be modified once they have been added to the Map. In general *String*, *Integer*, or *Long* are used as keys, which are immutable objects. If you define your own key class, make sure that they are immutable. Otherwise, if the keys are accidentally modified after adding to a Map, you will never be able to retrieve the stored value as the key values have been changed. This is a common pitfall many Java developers, especially beginners fall for.

Example:

Immutable key class

```
1
2  import java.util.Date;
3
4  public final class MyKey {
5
6      private final String name;
7      private final Date myDate;
8
9      public MyDiary(Date aDate) {
```

```
10          this.myDate = new Date(aDate.getTime( ))
11      }
12
13      public Date getDate( ) {
14          return new Date(myDate.getTime( )); //de
15      }
16
17      public String getName( ) {
18          return name; //String is immutable
19      }
20
21      //...equals( ), hashCode(), etc
22  }
23
```



hashCode( ) Vs. equals( )

As shown, when Maps are used in Java, the **equals( )** *and* ***hashCode( )*** methods are implicitly invoked. If these methods are incorrectly implemented or the keys are modified once added to the map, then unpredictable behavior will be experienced, and these behaviors are harder to debug. The hashCode( ) and equals( ) methods are implicitly invoked to determine where the key is stored, and to retrieve the value for a particular key respectively. More than one key/value pairs can be stored in the same bucket.

The *hashCode( )* method does not give a unique value each time. Its duty is to spread out the numbers so that your key value pairs get spread out in multiple buckets. So, always remember this.

The *hashCode( )* method is used to store the key/value in a bucket, and both the hashCode() and equals() methods are called to retrieve the stored key/value. If they are implemented inconsistently or the key is mutated, then the stored object cannot be retrieved as the returned values of these methods will vary in between different invocations. To be more specific, the hashCode( ) method is called to determine the key index (aka the bucket) of the array, and the equals( ) method is called to retrieve the exact key from the list of keys belonging to that particular key index (or bucket) as the same bucket will be holding multiple keys linked to multiple values. Remember the contract between these two methods?

"If 2 objects are equal, they must return the same hashCode( ) value, but the reverse is not true. Which means, if 2 objects return the same hashCode( ) value does not mean that those 2 objects are equal( )".

Q6. How would you defensively copy a Date field in your immutable class?

A6.

```
1  public final class MyDiary {
2
3      private final Date myDate;
4
5      public MyDiary(Date aDate) {
6          this.myDate = new Date(aDate.getTime( ))
7      }
8
9      public Date getDate( ) {
10         return new Date(myDate.getTime( )); //de
11     }
12 }
13
14
```

Q7. How will you prevent the caller from adding or removing elements from a collection of pets?

A7.

```
1
2  import java.util.ArrayList;
3  import java.util.Collections;
4  import java.util.List;
```

```
5
6  public class PetCage {
7      private final List<Pet> pets;
8
9      public PetCage(List<Pet> pets) {
10           this.pets = Collections.unmodifiableLi
11     }
12
13     public List<Pet> getPets( ) {
14           return pets;
15     }
16 }
17
```

It ensures that you cannot add or remove pets. However, there is no guarantee that the pets are also immutable. To make this instance fully immutable, the Pet instance itself must be immutable or use the decorator pattern as a wrapper around each of the pets to make them also immutable. For example, The *Integer* **wrapper class provides immutability to mutable primitive int value** . You could also defensively deep copy the list of pets in the constructor and getPets( ) method.

Q8. How about data that needs to be mutable, but less frequently? Is there any way to obtain the benefits of immutability with the added benefit of thread-safety for data that changes less frequently?
A8. The **Copy-On-Write** collections like *CopyOnWriteArrayList* and *CopyOnWriteArraySet* classes introduced from JSE 5.0 util.concurrent package are good examples of how to harness the power of immutability whist permitting occasional modifications for infrequently changing data. CopyOnWriteArrayList behaves much like the ArrayList class, except that when the list is modified, instead of mutating the underlying array, a new array is created and the old array is discarded. CopyOnWriteArrayList is designed for cases where:

— reads hugely outnumber writes.
— the array is small (or writes are very infrequent).
— the caller genuinely needs the functionality of a list rather than an array.

When you obtain an iterator, which holds a reference to the underlying array, the array referenced by the iterator is

effectively immutable and therefore can be traversed without synchronization or risk of concurrent modification. This eliminates the need to either clone the list before traversal or synchronize on the list during traversal. If reads are much more frequent than insertions or removals, which is the case very often, the Copy-on-Write collections and *ConcurrentHashMaps*offer better performance and development convenience. The development convenience is provided not needing to deal with synchronization, deep cloning, or "ConcurrentModificationException". The ConcurrentModificationException is generally thrown by an ArrayList, HashSet, or a HashMap implementation when you try to remove an object from a collection while iterating over it.

Q8. Can builder design pattern be used to create immutable objects?
A8. Yes.

Q9. Can you give a builder design pattern example to create immutable objects?
A9. **Example**: Builder pattern and immutability in Java.

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