

Core Java

equals() method

- Non-final method of java.lang.Object class.
 - public boolean equals(Object other);
- Definition of Object.equals():

```
public boolean equals(Object obj) {  
    return (this == obj);  
}
```

- To compare the object contents/state, programmer should override equals() method.
- This equals() must have following properties:
 - Reflexive: for any non-null reference value x, x.equals(x) should return true.
 - Symmetric: for any non-null reference values x and y, x.equals(y) should return true if and only if y.equals(x) returns true.
 - Transitive: for any non-null reference values x, y, and z, if x.equals(y) returns true and y.equals(z) returns true, then x.equals(z) should return true.
 - Consistent: for any non-null reference values x and y, multiple invocations of x.equals(y) consistently return true or consistently return false, provided no information used in equals comparisons on the objects is modified.
 - For any non-null reference value x, x.equals(null) should return false.
- Example:

```
class Employee {  
    // ...  
    @Override  
    public boolean equals(Object obj) {  
        if(obj == null)  
            return false;  
  
        if(this == obj)  
            return true;  
  
        if(! (obj instanceof Employee))  
            return false;  
  
        Employee other = (Employee) obj;  
        if(this.id == other.id)  
            return true;  
        return false;  
    }  
}
```

Garbage collection

- Garbage collection is automatic memory management by JVM.
- If a Java object is unreachable (i.e. not accessible through any reference), then it is automatically released by the garbage collector.
- An object become eligible for GC in one of the following cases:

- Nullify the reference.

```
MyClass obj = new MyClass();  
obj = null;
```

- Reassign the reference.

```
MyClass obj = new MyClass();  
obj = new MyClass();
```

- Object created locally in method.

```
void method() {  
    MyClass obj = new MyClass();  
    // ...  
}
```

- GC is a background thread in JVM that runs periodically and reclaim memory of unreferenced objects.
- Before object is destroyed, its `finalize()` method is invoked (if present).
- One should override this method if object holds any resource to be released explicitly e.g. file close, database connection, etc.

```
class MyClass {  
    private Connection con;  
    public MyClass() throws Exception {  
        con = DriverManager.getConnection("url", "username", "password");  
    }  
    // ...  
    @Override  
    public void finalize() {  
        try {  
            if(con != null)  
                con.close();  
        }  
        catch(Exception e) {
```

```

    }
}
class Main {
    public static void method() throws Exception {
        MyClass my = new MyClass();
        my = null;
        System.gc(); // request GC
    }
    // ...
}

```

- GC can be requested (not forced) by one of the following.
 - `System.gc();`
 - `Runtime.getRuntime().gc();`
- JVM GC internally use Mark and Compact algorithm.
- GC Internals: <https://www.oracle.com/webfolder/technetwork/tutorials/obe/java/gc01/index.html>

Marker interfaces

- Interface that doesn't contain any method declaration is called as "Marker interface".
- These interfaces are used to mark or tag certain functionalities/features in implemented class. In other words, they associate some information (metadata) with the class.
- Marker interfaces are used to check if a feature is enabled/allowed for the class.
- Java has a few pre-defined marker interfaces. e.g. `Serializable`, `Cloneable`, etc.
 - `java.io.Serializable` -- Allows JVM to convert object state into sequence of bytes.
 - `java.lang.Cloneable` -- Allows JVM to create copy of the class object.

Cloneable interface

- Enable creating copy/clone of the object.
- If a class is `Cloneable`, `Object.clone()` method creates a shallow copy of the object. If class is not `Cloneable`, `Object.clone()` throws `CloneNotSupportedException`.
- A class should implement `Cloneable` and override `clone()` to create a deep/shallow copy of the object.

```

class Date implements Cloneable {
    private int day, month, year;
    // ...
    // shallow copy
    public Object clone() throws CloneNotSupportedException {
        Date temp = (Date)super.clone();
        return temp;
    }
}

```

```

class Person implements Cloneable {
    private String name;
    private int weight;
    private Date birth;
    // ...
    // deep copy
    public Object clone() throws CloneNotSupportedException {
        Person temp = (Person)super.clone(); // shallow copy
        temp.birth = (Date)this.birth.clone(); // + copy reference types
explicitly
        return temp;
    }
}

```

```

class Program {
    public static void main(String[] args) throws CloneNotSupportedException
    {
        Date d1 = new Date(28, 9, 1983);
        System.out.println("d1 = " + d1.toString());
        Date d2 = (Date)d1.clone();
        System.out.println("d2 = " + d2.toString());
        Person p1 = new Person("Nilesh", 70, d1);
        System.out.println("p1 = " + p1.toString());
        Person p2 = (Person)p1.clone();
        System.out.println("p2 = " + p2.toString());
    }
}

```

Java Strings

- java.lang.Character is wrapper class that represents char. In Java, each char is 2 bytes because it follows unicode encoding.
- String is sequence of characters.
 1. java.lang.String: "Immutable" character sequence
 2. java.lang.StringBuffer: Mutable character sequence (Thread-safe)
 3. java.lang.StringBuilder: Mutable character sequence (Not Thread-safe)
- String helpers
 1. java.util.StringTokenizer: Helper class to split strings

String objects

- java.lang.String is class and strings in java are objects.
- String constants/literals are stored in string pool.

```
String str1 = "Sunbeam";
```

- String objects created using "new" operator are allocated on heap.

```
String str2 = new String("Nilesh");
```

- In java, String is immutable. If try to modify, it creates a new String object on heap.

String literals

- Since strings are immutable, string constants are not allocated multiple times.
- String constants/literals are stored in string pool. Multiple references may refer the same object in the pool.
- String pool is also called as String literal pool or String constant pool.
- From Java 7, String pool is in the heap space (of JVM).
- The string literal objects are created during class loading.

String objects vs String literals

- Example 01:

```
String s1 = "Sunbeam";  
String s2 = "Sunbeam";  
System.out.println(s1 == s2);      // ???  
System.out.println(s1.equals(s2));  // ???
```

- Example 02:

```
String s1 = new String("Sunbeam");  
String s2 = new String("Sunbeam");  
System.out.println(s1 == s2);      // ???  
System.out.println(s1.equals(s2));  // ???
```

- Example 03:

```
String s1 = "Sunbeam";  
String s2 = new String("Sunbeam");  
System.out.println(s1 == s2);      // ???  
System.out.println(s1.equals(s2));  // ???
```

- Example 04:

```
String s1 = "Sunbeam";  
String s2 = "Sun" + "beam";
```

```
System.out.println(s1 == s2);      // ???  
System.out.println(s1.equals(s2)); // ???
```

- Example 05:

```
String s1 = "Sunbeam";  
String s2 = "Sun";  
String s3 = s2 + "beam";  
System.out.println(s1 == s3);      // ???  
System.out.println(s1.equals(s3)); // ???
```

- Example 06:

```
String s1 = "Sunbeam";  
String s2 = new String("Sunbeam").intern();  
System.out.println(s1 == s2);      // ???  
System.out.println(s1.equals(s2)); // ???
```

- Example 07:

```
String s1 = "Sunbeam";  
String s2 = "SunBeam";  
System.out.println(s1 == s2);      // ???  
System.out.println(s1.equals(s2)); // ???  
System.out.println(s1.equalsIgnoreCase(s2)); // ???  
System.out.println(s1.compareTo(s2)); // ???  
System.out.println(s1.compareToIgnoreCase(s2)); // ???
```

String operations

- int length()
- char charAt(int index)
- int compareTo(String anotherString)
- boolean equals(String anotherString)
- boolean equalsIgnoreCase(String anotherString)
- boolean matches(String regex)
- boolean isEmpty()
- boolean startsWith(String prefix)
- boolean endsWith(String suffix)
- int indexOf(int ch)
- int indexOf(String str)
- String concat(String str)
- String substring(int beginIndex)
- String substring(int beginIndex, int endIndex)

- `String[] split(String regex)`
- `String toLowerCase()`
- `String toUpperCase()`
- `String trim()`
- `byte[] getBytes()`
- `char[] toCharArray()`
- `String intern()`
- `static String valueOf(Object obj)`
- `static String format(String format, Object... args)`

StringBuffer vs StringBuilder

- `StringBuffer` and `StringBuilder` are final classes declared in `java.lang` package.
- It is used to create mutable string instances.
- `equals()` and `hashCode()` methods are not overridden inside them.
- Can create instances of these classes using the `new` operator only. Objects are created on heap.
- `StringBuffer` capacity grows if the size of the internal char array is less (than string to be stored).
 - The default capacity is 16.

```
int max = (minimumCapacity > value.length? value.length * 2 + 2 :
value.length);
minimumCapacity = (minimumCapacity < max? max : minimumCapacity);
char[] nb = new char[minimumCapacity];
```

- `StringBuffer` implementation is thread-safe while `StringBuilder` is not thread-safe.
- `StringBuilder` was introduced in Java 5.0 for better performance in single-threaded applications.

Examples

- Example 01:

```
StringBuffer s1 = new StringBuffer("Sunbeam");
StringBuffer s2 = new StringBuffer("Sunbeam");
System.out.println(s1 == s2);           // false
System.out.println(s1.equals(s2));      // false
```

- Example 02:

```
StringBuffer s1 = new StringBuffer("Sunbeam");
String s2 = new String("Sunbeam");
System.out.println(s1 == s2);           // false
System.out.println(s1.equals(s2));      // false
```

- Example 03:

```
String s1 = new String("Sunbeam");
StringBuffer s2 = new StringBuffer("Sunbeam");
System.out.println(s1.equals(s2)); // false -- String compared with
StringBuffer
System.out.println(s1.equals(s2.toString())); // true -- String compared
with String
```

- Example 04:

```
StringBuffer s1 = new StringBuffer("Sunbeam");
StringBuffer s2 = s1.reverse();
System.out.println(s1 == s2); // true
System.out.println(s1.equals(s2)); // true
```

- Example 05:

```
StringBuilder s1 = new StringBuilder("Sunbeam");
StringBuilder s2 = new StringBuilder("Sunbeam");
System.out.println(s1 == s2); // false
System.out.println(s1.equals(s2)); // false -- calls Object.equals()
```

- Example 06:

```
StringBuffer s = new StringBuffer();
System.out.println("Capacity: " + s.capacity() + ", Length: " + s.length());
// 16, 0
s.append("1234567890");
System.out.println("Capacity: " + s.capacity() + ", Length: " + s.length());
// 16, 10
s.append("ABCDEFGHIJKLMNPOQRSTUVWXYZ");
System.out.println("Capacity: " + s.capacity() + ", Length: " + s.length());
// 34, 32
```

StringTokenizer

- Used to break a string into multiple tokens - like split() method.
- Methods of java.util.StringTokenizer
 - int countTokens()
 - boolean hasMoreTokens()
 - String nextToken()
 - String nextToken(String delim)
- Example:


```
String str = "My name is Bond, James Bond.";
String delim = " ,.";
StringTokenizer tokenizer = new StringTokenizer(str, delim);
while(tokenizer.hasMoreTokens()) {
    String token = tokenizer.nextToken();
    System.out.println(token);
}
```

Resource Management

- System resources should be released immediately after the use.
- Few system resources are Memory, File, IO Devices, Socket/Connection, etc.
- The Garbage collector automatically releases memory if objects are no more used (unreferenced).
- The GC collector doesn't release memory/resources immediately; rather it is executed only memory is full upto a threshold.
- The standard way to release the resources immediately after their use is java.io.Closeable interface. It has only one method.
 - void close() throws IOException;
- Programmer should call close() explicitly on resource object after its use.
 - e.g. FileInputStream, FileOutputStream, etc.
- Java 7 introduced an interface java.lang.AutoCloseable as super interface of Closeable. It has only one method.
 - void close() throws Exception;
- Since it is super-interface of Closeable, all classes implementing Closeable now also inherit from AutoCloseable.
- If a class is inherited from AutoCloseable, then it can be closed using try-with-resource syntax.

```
class MyResource implements AutoCloseable {
    // ...
    public void close() {
        // cleanup code
    }
}

class Program {
    public static void main(String[] args) {
        try(MyResource res = new MyResource()) {
            // ...
        } // res.close() called automatically
    }
}
```

- The Scanner class is also AutoCloseable.

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

```
        try(Scanner sc = new Scanner(System.in)) {  
            // ...  
        } // sc.close() is auto-closed  
    }  
}
```