



Garbage Collection

CSCI 201

Principles of Software Development

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Outline

- Garbage Collection

Garbage Collection



- Java doesn't require much memory management
 - › C++ has `malloc`, `free`, `delete`
- Since Java does not have these key words, another mechanism was needed to clean up memory after it was used
 - › When a memory location is no longer referenced, the **Garbage Collector** will come around and delete that reference in memory
- Garbage collection looks at memory and identifies which locations are still referenced by variables and which are not
 - › An memory location is a candidate for garbage collection when it no longer is referenced by *any* part of your program



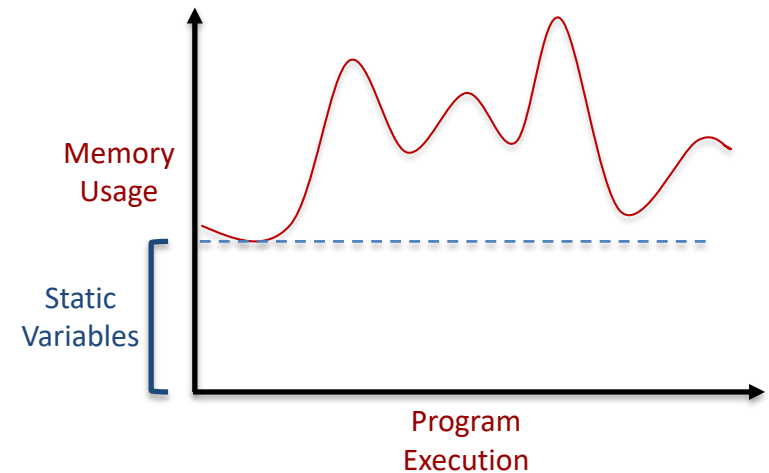
Garbage Collection Example



- When are the memory locations pointed to by each of the following variables candidates for garbage collection?

```
1 public class Garbage {
2     private ArrayList num;
3     private static String val;
4     public Garbage(ArrayList num) {
5         this.num = num;
6         val = "hello";
7     }
8     public static void meth() {
9         Garbage g = new Garbage(new ArrayList());
10        g.num = new ArrayList();
11        Garbage.val = "hi";
12    }
13    public static void main(String [] args) {
14        Integer number = new Integer(3);
15        for (int i=0; i < number; i++) {
16            System.out.print(i);
17        }
18        meth();
19        System.out.println(number);
20    }
21 }
```

Typical Memory Usage of Variables during Program Execution



Garbage Collection Steps



- Step 1 – Marking

- › The garbage collector determines which pieces of memory are in use and which are not

Marking

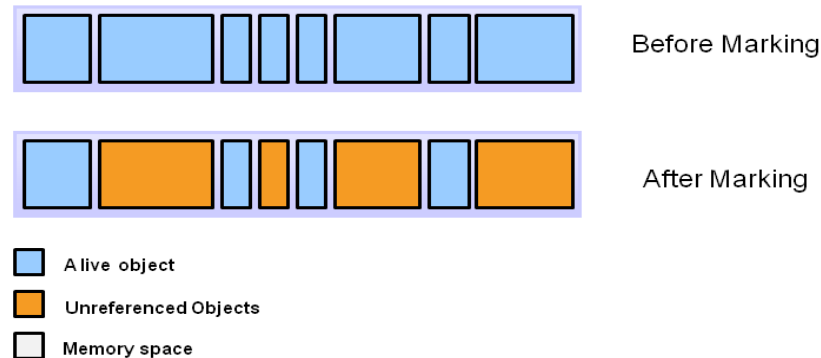


Image Source: <http://www.oracle.com/webfolder/technetwork/tutorials/obe/java/gc01/index.html>

Garbage Collection Steps



- Step 2 – Normal Deletion
 - › Garbage collector removes unreferenced objects leaving referenced objects and pointers to free space

Normal Deletion

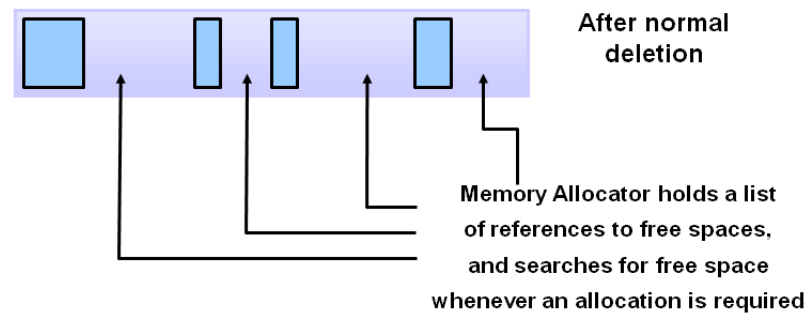


Image Source: <http://www.oracle.com/webfolder/technetwork/tutorials/obe/java/gc01/index.html>

Garbage Collection Steps



- Step 2a – Deletion with Compacting
 - › Garbage collector deletes unreferenced objects and compacts the remaining referenced objects

Deletion with Compacting

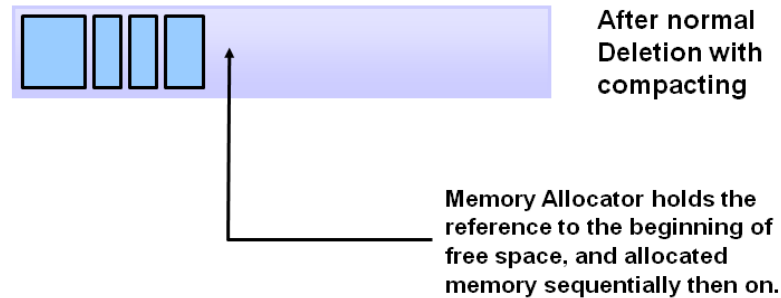


Image Source: <http://www.oracle.com/webfolder/technetwork/tutorials/obe/java/gc01/index.html>

Invoking Garbage Collection



- Programmers are not able to explicitly invoke the garbage collector
- We can make a suggestion to the JVM to run the garbage collector with

```
System.gc ( ) ;
```

- › This does not mean that the garbage collector will be run immediately though
- More garbage collection information can be found at <http://www.oracle.com/webfolder/technetwork/tutorials/obe/java/gc01/index.html>

