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02: jvisualvm to detect memory leak – a quick tutorial style Java demo

Posted on March 16, 2016 by Arulkumaran Kumaraswamipillai

This is a companion post to 8 Java Memory Management Interview Q&A demonstrating a memory leak scenario step by step with jvisualvm, which is a free profiling tool that gets shipped with JDK.

Step 1: Code that causes memory leak

Here is a sample code that causes memory leak. It is shown with a never ending while loop for the demo purpose, but in a real production application this could be a logic within a method that gets accessed very frequently.

```

import java.util.HashMap;
import java.util.Map;
import java.util.concurrent.TimeUnit;

```

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```
public class MemoryLeakDemo {
    public static void main(String[] args) throw
        Map<Key, String> map = new HashMap<Key,
        int counter = 0;
        while (true) {
            // creates duplicate objects due to
            map.put(new Key("dummyKey"), "value"
            counter++;
            if (counter % 1000 == 0) {
                System.out.println("map size: "
                TimeUnit.SECONDS.sleep(2);
            }
        }
    }

    // inner class key without hashcode() or equ
    static class Key {
        private String key;

        public Key(String key) {
            this.key = key;
        }
    }
}


```

In the above code the “Key” class that is used for storing values into a map is not properly implemented by overriding equals() & hashCode(), hence it will be using Object class’s implementation which uses the memory location of each new object created.

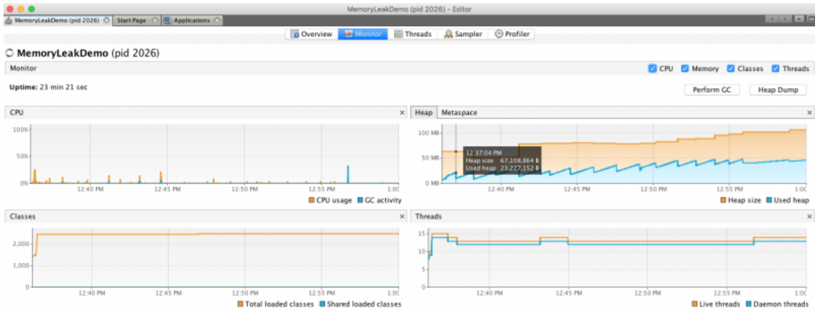
Step 2: Start jvisualvm

```

$ jvisualvm

```

Step 3: Run the code & monitor jvisualvm



Monitoring the heap – when started running the application

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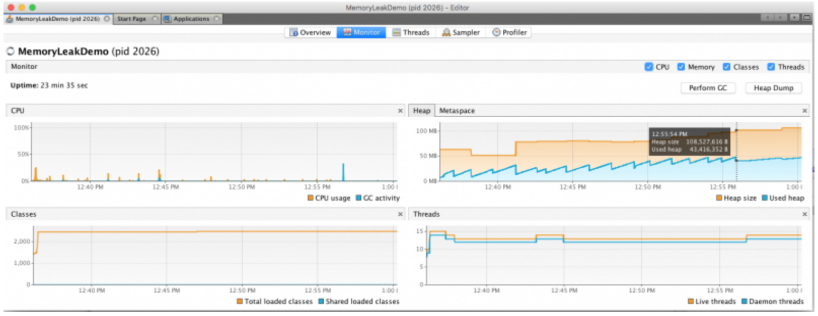
After 35 minutes:



Uptime: 23 min 35 sec

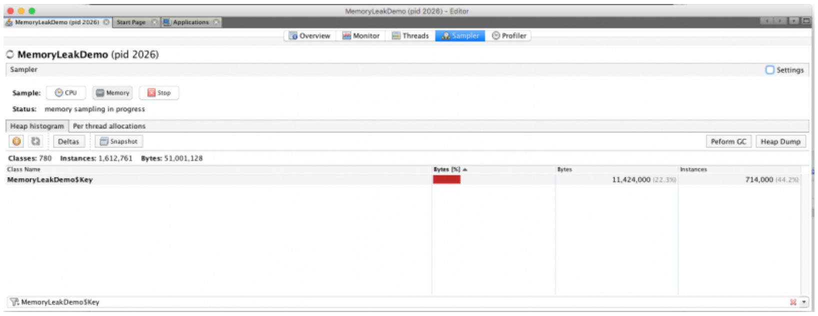
12:55:54 PM
Heap size 108,527,616 B
Used heap 43,416,352 B

Monitoring the JVM heap after 35 minutes

As, you can see the JVM heap memory usage is keep going up, The "saw tooth" like diagram shown above indicates memory leak. The memory used has gone up from 23MB to 43MB within 35 minutes.

Step 4: Uncontrolled creation of the instances of Key class is the culprit

As you can see 714K instances created at this point.



Sample: CPU Memory Stop

Status: memory sampling in progress

Classes: 780 Instances: 1,612,761 Bytes: 51,001,128

Class Name	Bytes [%] ▲	Bytes	Instances
MemoryLeakDemo$Key	🟥	11,424,000 (22.3%)	714,000 (44.2%)

MemoryLeakDemo$Key

Sampling the JVM heap

Step 5: How to fix the code?

Implement the hashCode() & equals() method to the "Key" class and run the code and profile with jvisualvm.

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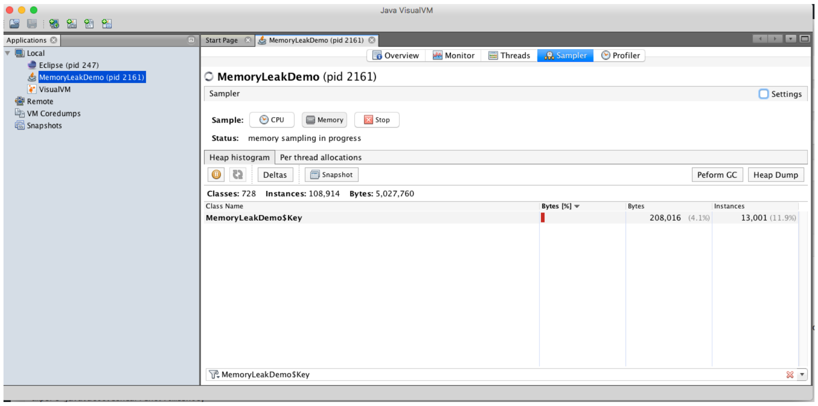
```java

import java.util.HashMap;
import java.util.Map;
import java.util.Objects;
import java.util.concurrent.TimeUnit;

public class MemoryLeakDemo {
    public static void main(String[] args) throw
        Map<Key, String> map = new HashMap<Key,
        int counter = 0;
        while (true) {
            // creates duplicate objects due to
            map.put(new Key("dummyKey"), "value"
            counter++;
            if (counter % 1000 == 0) {
                System.out.println("map size: "
                TimeUnit.SECONDS.sleep(2);
            }
        }
    }

    // inner class key without hashcode() or equ
    static class Key {
        private String key;

        public Key(String key) {
            this.key = key;
        }

        @Override
        public int hashCode() {
            return Objects.hash(key); // Java 8
        }

        @Override
        public boolean equals(Object obj) {
            if (obj == null) {
                return false;
            }
            if (getClass() != obj.getClass()) {
                return false;
            }

            Key other = (Key) obj;

            return Objects.equals(this.key, othe
        }
    }
}


```

Step 6: jvisualvm sampling after fixing the code

Even though the instances count shows 13,000 instances, it was because the GC has not been kicked in yet. Click on the “Perform GC” button a few times and you will see the count go down to 1.



Sample:

Status: memory sampling in progress

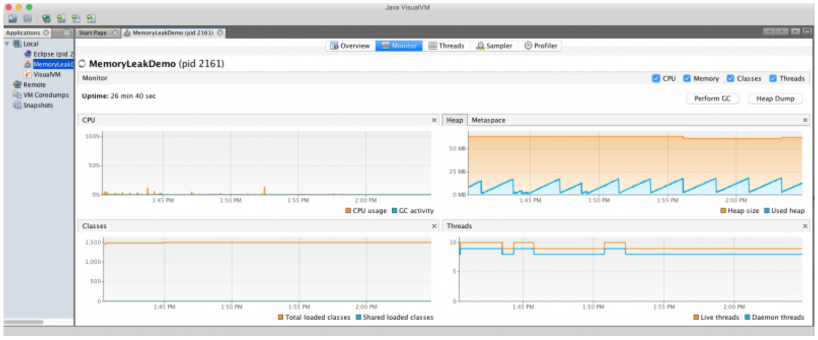
Classes: 728 **Instances:** 108,914 **Bytes:** 5,027,760

Class Name	Bytes [%]	Bytes	Instances
MemoryLeakDemo$Key		208,016 (4.1%)	13,001 (11.9%)

MemoryLeakDemo$Key

JVM heap sampling

Step 7: jvisualvm heap memory monitoring after fixing the code



Uptime: 26 min 40 sec

Heap Memory Monitoring

As you can see, the memory usage is fully under control without any leaks. The key objects created in the while loop periodically gets garbage collected.

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