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Autoboxing in Java

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Introduction

- Since Java 1.5 there exists boxing and unboxing operations. These consist in converting primitive types into their corresponding wrapper(reference) type and the other way around. Although this is done automaticaly it is very costly.

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Goals

- Detecting boxing and unboxing operations in Java for all primitive types and their respective reference types.

Solution

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Code Instrumentation

- First we added a TreeMap to count the number of boxing/unboxing operations done ordered by the following keys:

  Method Name->Type->Action->Count

Action={Boxing,Unboxing}

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Code Instrumentation

- Then we injected a function(*insertData*), to increment the count in the TreeMap;

- Also we injected another function(*printData*) to print the results.

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Algorithm used

1. Search for where boxing and unboxing operations where done in the code;
2. Added a call after the operation to function insertData;
3. Added a call after the main method to the function printData.

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Dificulties

- Parametrization(Javassist);
- Stack overflow;

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Extensions added

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Motivation

- Autoboxing operations are relatively slower than simply calling a new <Object>() method;
- Autoboxing caches reference objects and uses these cached objects instead of always instantiating a new Object;
- Calling new <Object>() is a little bit faster than autoboxing (although it uses more memory.

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Solution

- To improve execution times in programs we replace Autoboxing operations for the call to the respective new method of each reference type.

Results

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Old output format

```
C:\Users\gonca\Downloads\g13>java -cp BoxingProfiler.jar ist.meic.pa.BoxingProfiler SumIntegers
Sum: 124750
Time: 7
SumIntegers.main(java.lang.String[]) boxed 2 java.lang.Integer
SumIntegers.main(java.lang.String[]) boxed 1 java.lang.Long
SumIntegers.printSum(java.lang.Long) unboxed 1 java.lang.Long
SumIntegers.sumOfIntegerUptoN(java.lang.Integer) unboxed 501 java.lang.Integer
SumIntegers.sumOfIntegerUptoN(java.lang.Integer) boxed 501 java.lang.Long
SumIntegers.sumOfIntegerUptoN(java.lang.Integer) unboxed 501 java.lang.Long
```

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New output format

```
C:\Users\gonca\Downloads\g13>java -cp BoxingProfiler.jar ist.meic.pa.BoxingProfilerExtended SumIntegers
Sum: 124750
Time: 5
SumIntegers.printSum(java.lang.Long) unboxed 1 java.lang.Long
SumIntegers.sumOfIntegerUptoN(java.lang.Integer) unboxed 501 java.lang.Integer
SumIntegers.sumOfIntegerUptoN(java.lang.Integer) unboxed 501 java.lang.Long
Replaced boxing operation in SumIntegers.main(java.lang.String[]) 2 times for type: java.lang.Integer
Replaced boxing operation in SumIntegers.main(java.lang.String[]) 1 times for type: java.lang.Long
Replaced boxing operation in SumIntegers.sumOfIntegerUptoN(java.lang.Integer) 2 times for type: java.lang.Long
```

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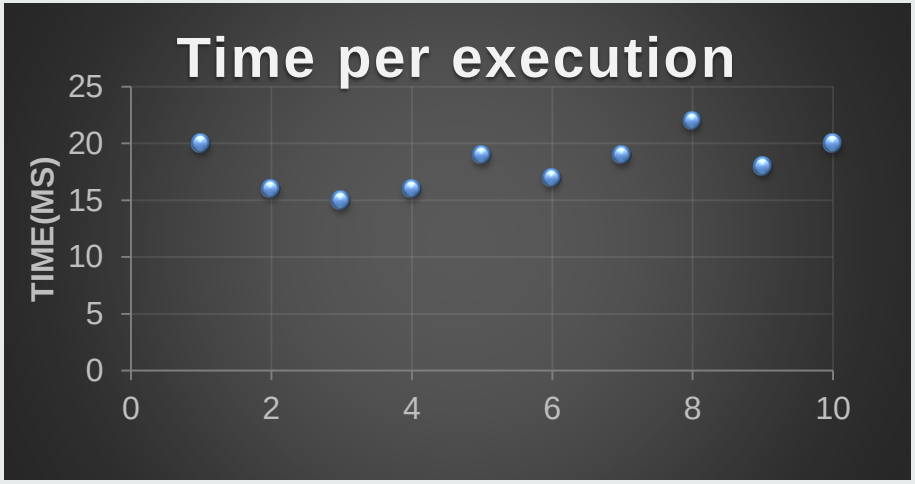
Test Program

```
public class SumIntegers {
    private static long sumOfIntegerUptoN(Integer n) {
        Long sum = 0L;
        for (int i = 0; i < n; i++) {
            sum += i;
        }
        return sum;
    }
    private static long printSum(Long n) {
        System.out.println("Sum: " + n);
        return n;
    }
    public static void main(String[] args) {
        long start = System.currentTimeMillis();
        printSum(sumOfIntegerUptoN(10000));
        Integer i=1;
        long end = System.currentTimeMillis();
        System.out.println("Time: " + (end - start));
    }
}
```

BoxingProfiler(original)

- The average execution time of the program is 18.2ms with 22ms being the highest execution time and 15ms being the smallest.



BoxingProfilerExtended

- The average execution time of the program is 14ms with 16ms being the highest execution time and 12ms being the smallest.