

软件测试上机报告



第四次上机作业

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一、实验要求

1. **Install MuJava.** The instruction of how to install and use MuJava can be seen in <https://cs.gmu.edu/~offutt/mujava/>.
 2. Two small programs are given for your task. BubbleSort.java is an implementation of bubble sort algorithm and BackPack.java is a solution of 01 backpack problem. Try to **generate** Mutants of 2 given programs with MuJava.
 3. **Write testing sets for 2 programs with Junit**, and run mutants on the test sets with MuJava.
- Requirements for the experiment:
1. Finish the tasks above individually.
 2. Check in your java code to github or gitee.
 3. Post your experiment report to “智慧树”, the following information should be included in your report:
 - a) The brief description that you install MuJava
 - b) Steps for generating Mutants
 - c) Steps for making test sets and running mutants.
 - d) Your mutants result (The number of live mutants, killed mutants, etc.)

二、源代码

TestBackPack.java:

```
import org.junit.Test;
import static org.junit.Assert.*;

public class TestBackPack {
    private BackPack backpack;
    @Test
    public void testSolution() {
        int result[][] = new int[][]{
            {0,0,0,0,0,0,0,0,0,0},
            {0,0,0,4,4,4,4,4,4,4},
            {0,0,0,4,5,5,5,9,9,9},
            {0,0,0,4,5,6,6,9,10,11}
        };
        int m = 10;
        int n = 3;

        int w[] = {3, 4, 5};
        int p[] = {4, 5, 6};
        assertEquals(result, backpack.BackPack_Solution(m, n, w, p));
    }
}
```

TestBubbleSort.java:

```
import static org.junit.Assert.*;
import java.util.Arrays;
import org.junit.Test;

public class TestBubbleSort {

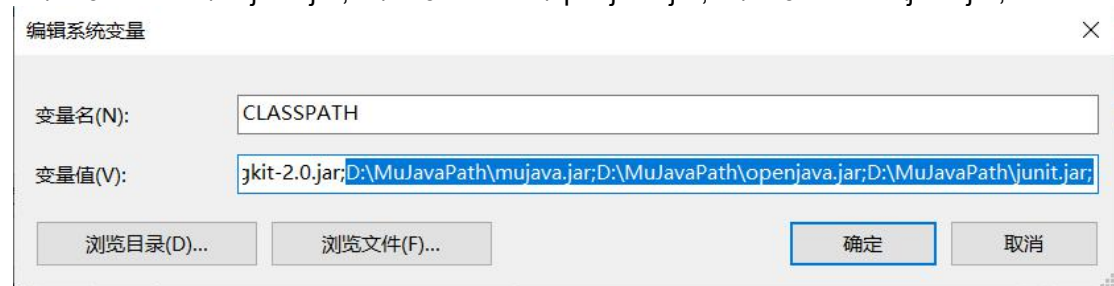
    @Test
    public void test1() {
        int a[] = new int[]{1,8,2,2,5};
        int a1[] = new int[]{1,2,2,5,8};
        assertEquals(Arrays.toString(a1),
            Arrays.toString(BubbleSort.BubbleSort(a)));
    }
}
```

```
}  
}
```

三、运行结果

Add environment variables, add the following in CLASSPATH:

D:\MuJavaPath\mujava.jar;D:\MuJavaPath\openjava.jar;D:\MuJavaPath\junit.jar;



Download mujava.config file from github:

<https://github.com/jeffoffutt/muJava>

bin	Add the option for customized timeout	5 years ago
src	Added code to generate AOIU mutants for logical expressions.	4 years ago
.gitignore	Added code to generate AOIU mutants for logical expressions.	4 years ago
LICENSE	Initial commit	5 years ago
README.md	Update README.md	5 years ago
commons-io-2.4.jar	Initial commit	5 years ago
mujava.config	Initial commit	5 years ago
mujavaCLI.config	Initial commit	5 years ago
openjava.jar	Take out aor_flag, fix a fault in OpenJava	4 years ago

The mujava.config file is placed in the \MuJavaHome folder. Change the content to the current path:


 mujava.config - 记事本

文件(F) 编辑(E) 格式(O) 查看(V) 帮助(H)

```
MuJava_HOME=D:\MuJavaHome  
config_mode=true
```

Next, create a command file: Create two txt files in D: \MuJavaHome. The contents of txt are:


GenMutants.cmd: java mujava.gui.GenMutantsMain

 GenMutants - 记事本

文件(F) 编辑(E) 格式(O) 查看(V) 帮助(H)

```
java mujava.gui.GenMutantsMain
```

RunTest.cmd: java mujava.gui.RunTestMain >TestResult.txt

 RunTest - 记事本

文件(F) 编辑(E) 格式(O) 查看(V) 帮助(H)

```
java mujava.gui.RunTestMain >TestResult.txt
```

Save as cmd suffix, easy to run mujava program:


 GenMutants	2020/4/4 12:29	Windows 命令脚本
 RunTest	2020/4/4 12:30	Windows 命令脚本

Put two Java files in the D:\MuJavaHome\src folder:

▼ ↑		D:\MuJavaHome\src	▼ ↻	搜索"src"
面	★	名称	修改日期	类型
或	★	 Backpack	2019/4/15 16:52	IntelliJ IDEA
当	★	 BubbleSort	2019/4/17 16:43	IntelliJ IDEA

Enter the following command to compile the two files:

javac -encoding UTF-8 Backpack.java BubbleSort.java




 C:\Windows\System32\cmd.exe

```
Microsoft Windows [版本 10.0.17763.1098]
(c) 2018 Microsoft Corporation。保留所有权利。

D:\MuJavaHome\src>javac -encoding UTF-8 Backpack.java BubbleSort.java

D:\MuJavaHome\src>
```

Put the two newly generated class files in the D:\MuJavaHome\classes path:

▼ ↑		D:\MuJavaHome\classes	▼ ↻	搜索"classes"
桌面	★	名称	修改日期	类型
下载	★	 BubbleSort.class	2020/4/4 12:44	CLASS 文件
文档	★	 Backpack.class	2020/4/4 12:44	CLASS 文件

At this point, the following problems occur when running the GenMutants.cmd script:

```
D:\MuJavaHome>java mujava.gui.GenMutantsMain
The main method starts
WARNING: An illegal reflective access operation has occurred
WARNING: Illegal reflective access by mujava.MutationSystem (file:/D:/MuJavaPath/mujava.jar) to method java.net.URLClassLoader.addURL(java.net.URL)
WARNING: Please consider reporting this to the maintainers of mujava.MutationSystem
WARNING: Use --illegal-access=warn to enable warnings of further illegal reflective access operations
WARNING: All illegal access operations will be denied in a future release
Exception in thread "main" java.lang.IllegalArgumentException: object is not an instance of declaring class
    at java.base/jdk.internal.reflect.NativeMethodAccessorImpl.invoke0(Native Method)
    at java.base/jdk.internal.reflect.NativeMethodAccessorImpl.invoke(NativeMethodAccessorImpl.java:62)
    at java.base/jdk.internal.reflect.DelegatingMethodAccessorImpl.invoke(DelegatingMethodAccessorImpl.java:43)
    at java.base/java.lang.reflect.Method.invoke(Method.java:567)
    at mujava.MutationSystem.addURL(MutationSystem.java:548)
    at mujava.MutationSystem.recordInheritanceRelation(MutationSystem.java:480)
    at mujava.gui.GenMutantsMain.main(GenMutantsMain.java:57)

D:\MuJavaHome>java -version
java version "13.0.2" 2020-01-14
Java(TM) SE Runtime Environment (build 13.0.2+8)
Java HotSpot(TM) 64-Bit Server VM (build 13.0.2+8, mixed mode, sharing)
```

Looking for a way to check the Java jdk version of your computer is 13.0.2, which is too high. So uninstall the current Java version and download jdk1.8, as follows:

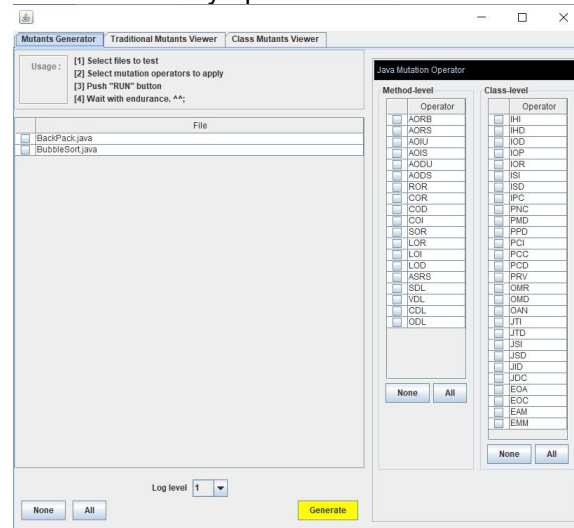
```
C:\Users\Tao Boan>java -version
java version "1.8.0_221"
Java(TM) SE Runtime Environment (build 1.8.0_221-b11)
Java HotSpot(TM) 64-Bit Server VM (build 25.221-b11, mixed mode)
```

Then run the GenMutants.cmd script:

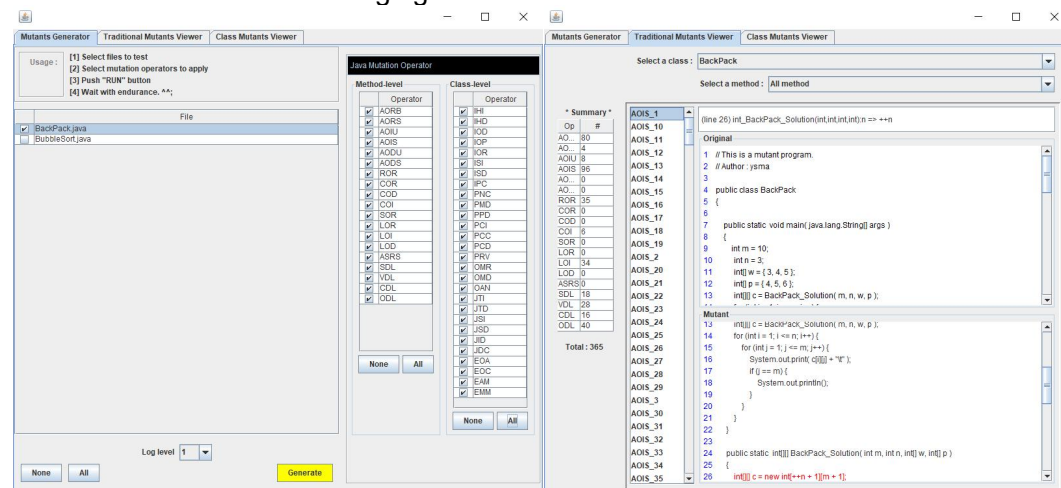
```
D:\MuJavaHome>GenMutants.cmd

D:\MuJavaHome>java mujava.gui.GenMutantsMain
The main method starts
[ERROR] for class Backpack => Backpack has been compiled by a more recent version of the Java Runtime (class file version 57.0), this version of the Java Runtime only recognizes class file versions up to 52.0
[ERROR] for class BubbleSort => BubbleSort has been compiled by a more recent version of the Java Runtime (class file version 57.0), this version of the Java Runtime only recognizes class file versions up to 52.0
```

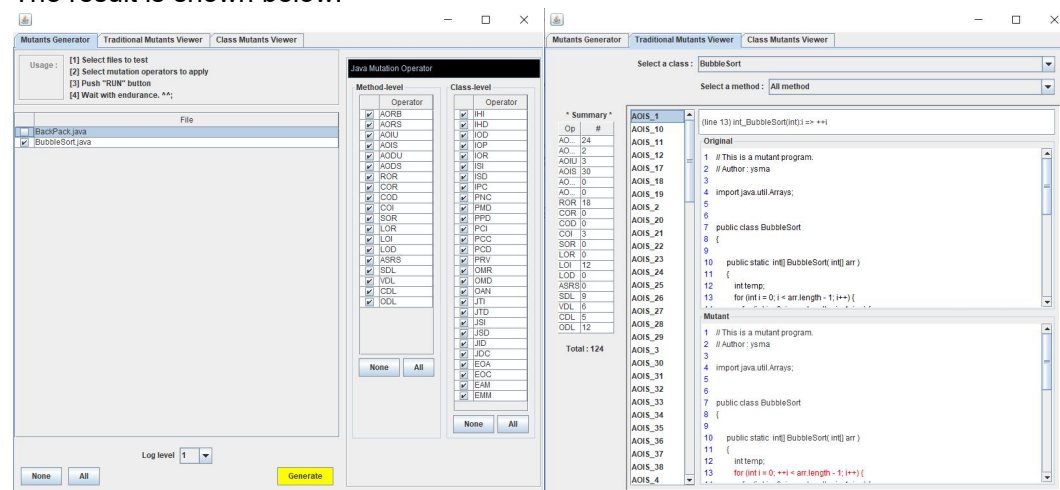
And successfully opened MuJava:



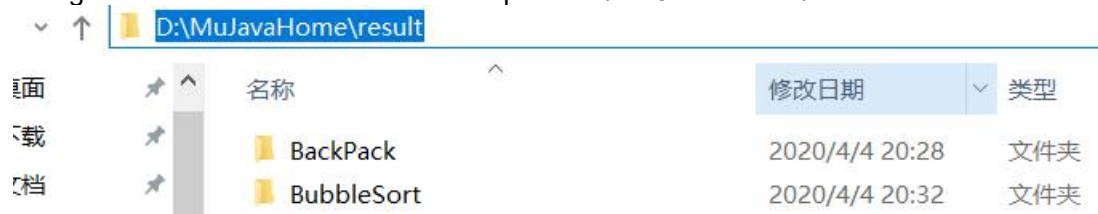
Select BackPack.java, select all mutation operators on the right, and click Generate. The result is shown in the following figure:



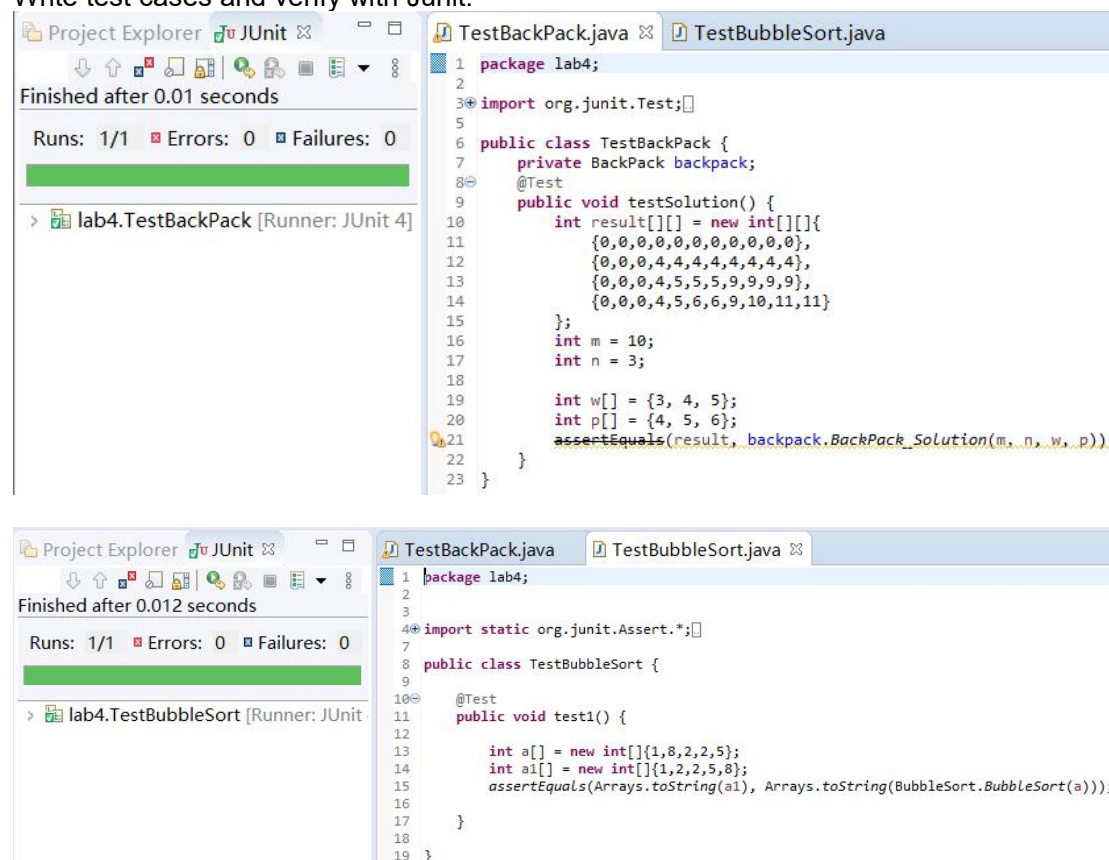
Select BubbleSort.java, select all mutation operators on the right, and click Generate. The result is shown below:



The generated results are stored in the path D: \ MuJavaHome \ result:



Write test cases and verify with Junit:



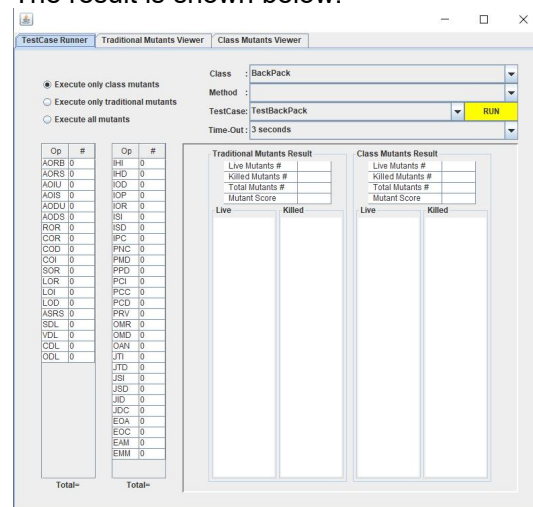
Put the two test files and the class file compiled by Eclipse into the D: \ MuJavaHome \ testset folder:

面	名称	修改日期	类型	大小
载	TestBackPack.class	2020/4/4 21:04	CLASS 文件	2 KB
当	TestBackPack	2020/4/4 21:04	IntelliJ IDEA	1 KB
片	TestBubbleSort.class	2020/4/4 21:04	CLASS 文件	2 KB
JavaHome	TestBubbleSort	2020/4/4 21:04	IntelliJ IDEA	1 KB

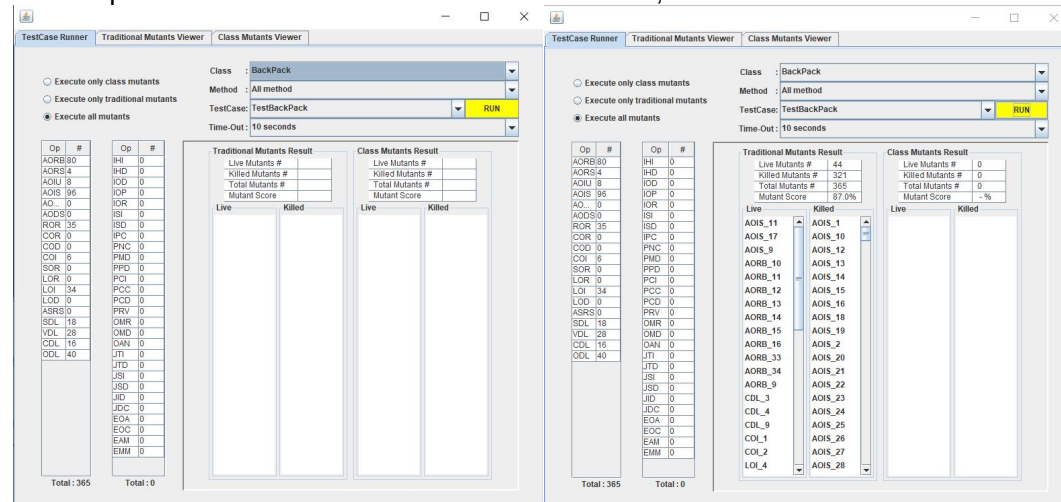
At this point, run the RunTest.cmd script:

```
D:\MuJavaHome>RunTest.cmd
D:\MuJavaHome>java mujava.gui.RunTestMain 1>TestResult.txt
```

The result is shown below:



Set the parameters of Backpack and TestBackPack, click Run:



Live Mutants	Killed Mutants	Total Mutants	Mutant Score
44	321	365	87.0%

TestCase Runner

Traditional Mutants Viewer

Class Mutants Viewer

☐ Execute only class mutants
☐ Execute only traditional mutants
☒ Execute all mutants

Class: Bubble Sort

Method: All method

TestCase: TestBubbleSort

Time-Out: 3 seconds

RUN

Op	#	Op	#
AORB24	0	IRI	0
AORB2	0	IHD	0
AORI	3	IOD	0
AORS	30	IOF	0
AO_10	0	IOR	0
AODS0	0	ISI	0
ISD	0	ISD	0
ROR	18	IPC	0
COR	0	INC	0
COI	0	PNC	0
COI_3	0	PNF	0
SOR	0	PPD	0
LOR	0	PCI	0
LOI	12	PCG	0
LOD	0	PCD	0
ASRS0	0	PRV	0
SOL	9	OMR	0
VDL	6	OMD	0
ODL	5	OAN	0
ODL	12	JTI	0
		JTO	0
		JSI	0
		JSD	0
		JID	0
		JDC	0
		EOA	0
		EOC	0
		EMM	0
		EMM	0

Total: 124

Traditional Mutants Result

Class Mutants Result

Live Mutants #

Killed Mutants #

Total Mutants #

Mutant Score

Live

Killed

Live Mutants #

Killed Mutants #

Total Mutants #

Mutant Score

Live

Killed

TestCase Runner

Traditional Mutants Viewer

Class Mutants Viewer

☐ Execute only class mutants
☐ Execute only traditional mutants
☒ Execute all mutants

Class: BubbleSort

Method: All method

TestCase: TestBubbleSort

Time-Out: 10 seconds

RUN

Op	#	Op	#
AORB24	0	IRI	0
AORB2	0	IHD	0
AORI	3	IOD	0
AORS	30	IOF	0
AO_10	0	IOR	0
AODS0	0	ISI	0
ISD	0	ISD	0
ROR	18	IPC	0
COR	0	INC	0
COI	0	PNC	0
COI_3	0	PNF	0
SOR	0	PPD	0
LOR	0	PCI	0
LOI	12	PCG	0
LOD	0	PCD	0
ASRS0	0	PRV	0
SOL	9	OMR	0
VDL	6	OMD	0
ODL	5	OAN	0
ODL	12	JTI	0
		JTO	0
		JSI	0
		JSD	0
		JID	0
		JDC	0
		EOA	0
		EOC	0
		EMM	0
		EMM	0

Total: 124

Traditional Mutants Result

Class Mutants Result

Live Mutants #

Killed Mutants #

Total Mutants #

Mutant Score

Live

Killed

Live Mutants #

Killed Mutants #

Total Mutants #

Mutant Score

Live

Killed

Live Mutants	Killed Mutants	Total Mutants	Mutant Score
15	109	124	87.0%