

## Homework 4: Mutation Based Testing

(a) How many mutants are there?

237 mutants

(b) How many test cases do you need to kill the non-equivalent mutants?

8 test cases

(c) What mutation score were you able to achieve before analyzing for equivalent mutants?

一開始寫 6 個 test case 達到 score 84%，分析之後有 30 個 equivalent mutants，扣掉 equivalent mutants 剩下 207 non-equivalent mutants，此時的 score 是 96.66%

The screenshot shows the TestCase Runner application with the following details:

- Test Case Runner** tab is active.
- Class:** Cal
- Method:** int\_cal(int,int,int,int,int)
- TestCase:** CalTest
- Time-Out:** 3 seconds
- Buttons:** RUN (yellow), 3 s
- Execution Options:**
  - ☐ Execute only class mutants
  - ☐ Execute only traditional mutants
  - ☒ Execute all mutants
- Traditional Mutants Result:**

Op	#
AO...	36
AO...	1
AOIU	12
AOIS	74
AO...	0
AO...	0
ROR	34
COR	4
COD	0
COI	7
SOR	0
LOR	0
LOI	19
LOD	0
ASRS	0
SDL	10
VDL	13
CDL	5
ODL	22
Total : 237	

Op	#
IHI	0
IHD	0
IOD	0
IOP	0
IOR	0
ISI	0
ISD	0
IPC	0
PNC	0
PMD	0
PPD	0
PCI	0
PCC	0
PCD	0
PRV	0
OMR	0
OMD	0
OAN	0
JTI	0
JTD	0
JSI	0
JSD	0
JID	0
JDC	0
EOA	0
EOC	0
EAM	0
EMM	0
Total : 0	
- Class Mutants Result:**

Op	#
AOIS_55	1
ROR_22	1
AOIS_35	1
AOIS_16	1
AOIS_51	1
COR_4	1
AOIS_39	1
AOIS_11	1
ROR_14	1
AOIS_52	1
AOIS_28	1
AOIS_74	1
AOIS_32	1
AOIS_43	1
AOIU_4	1
AOIS_72	1
ROR_4	1
AOIU_5	1
AOIS_73	1
AOIS_71	1
ROR_10	1
AOIS_56	1
AOIS_36	1
Total : 37	

Op	#
IHI	0
IHD	0
IOD	0
IOP	0
IOR	0
ISI	0
ISD	0
IPC	0
PNC	0
PMD	0
PPD	0
PCI	0
PCC	0
PCD	0
PRV	0
OMR	0
OMD	0
OAN	0
JTI	0
JTD	0
JSI	0
JSD	0
JID	0
JDC	0
EOA	0
EOC	0
EAM	0
EMM	0
Total : 0	

(d) How many equivalent mutants are there?

30 mutants, score 87%(with 30 equivalent mutants)

The screenshot shows the 'Traditional Mutants Viewer' tab of the 'TestCase Runner' application. The configuration at the top is: Class: Cal, Method: int\_cal(int,int,int,int,int), TestCase: CalTest, Time-Out: 3 seconds. The execution options are:   
☐ Execute only class mutants   
☐ Execute only traditional mutants   
☒ Execute all mutants   
A 'RUN' button is visible next to the Time-Out field.

On the left, there are two tables of mutants. The first table lists 36 mutants with their operators and counts. The second table lists 19 mutants, all with a count of 0. The total for both tables is 237.

Op	#
AO...	36
AO...	1
AOIU	12
AOIS	74
AO...	0
AO...	0
ROR	34
COR	4
COD	0
COI	7
SOR	0
LOR	0
LOI	19
LOD	0
ASRS	0
SDL	10
VDL	13
CDL	5
ODL	22

Op	#
IHI	0
IHD	0
IOD	0
IOP	0
IOR	0
ISI	0
ISD	0
IPC	0
PNC	0
PMD	0
PPD	0
PCI	0
PCC	0
PCD	0
PRV	0
OMR	0
OMD	0
OAN	0
JTI	0
JTD	0
JSI	0
JSD	0
JID	0
JDC	0
EOA	0
EOC	0
EAM	0
EMM	0

Total : 237      Total : 0

The 'Traditional Mutants Result' section shows:   
Live Mutants #: 30   
Killed Mutants...: 207   
Total Mutants...: 237   
Mutant Score: 87.0%   
Below this are two lists of mutants: 'Live' (containing 30 mutants like AOIS\_11, AOIS\_52, etc.) and 'Killed' (containing 207 mutants like AOIS\_10, AORB\_6, etc.).

The 'Class Mutants Result' section shows:   
Live Mutants #: 0   
Killed Mutants...: 0   
Total Mutants...: 0   
Mutant Score: - %   
Below this are two empty lists labeled 'Live' and 'Killed'.

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

public class CalTest {
    @Test
    public void test1() {
        Assert.assertEquals(0, Cal.cal(2, 29, 2, 29, 2020));
    }

    @Test
    public void test2() {
        Assert.assertEquals(91, Cal.cal(1, 1, 4, 1, 2000));
    }

    @Test
    public void test3() {
        Assert.assertEquals(60, Cal.cal(2, 1, 4, 2, 1800));
    }

    @Test
    public void test4() {
        Assert.assertEquals(92, Cal.cal(3, 5, 6, 5, 2400));
    }

    @Test
    public void test5() {
        Assert.assertEquals(364, Cal.cal(1, 1, 12, 31, 1));
    }

    @Test
    public void test6() {
        Assert.assertEquals(365, Cal.cal(1, 1, 12, 31, 4));
    }

    @Test
    public void test7() {
        Assert.assertEquals(1, Cal.cal(2, 28, 2, 29, 2024));
    }

    @Test
    public void test8() {
        Assert.assertEquals(29, Cal.cal(9, 1, 9, 30, 789));
    }
}
```