2020-Summer-CSE-5321-002-Software Testing
Prof. John Robb
Homework 5
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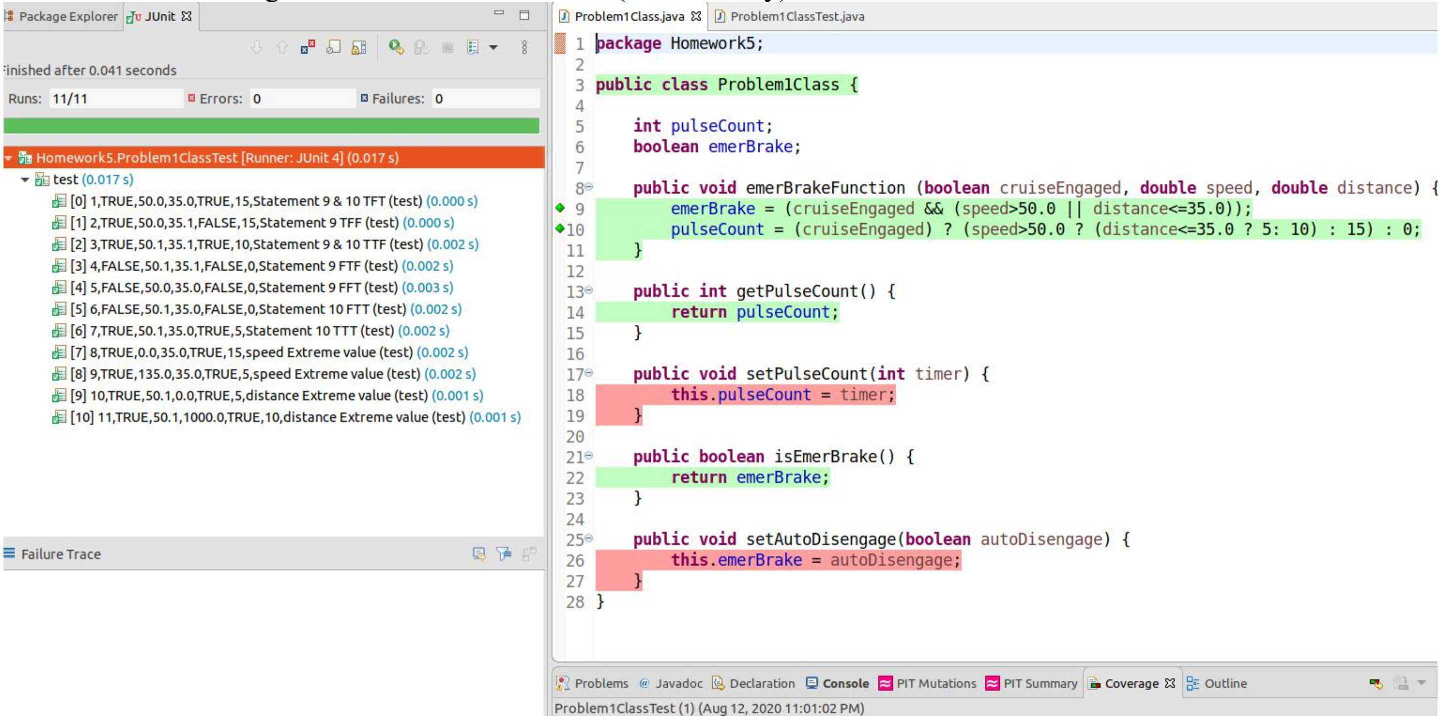
Problem 1:

1. Test case table snapshot

Test Case	Inputs			Expected Outputs		
Number	cruiseEngaged	speed (mph)	distance (ft)	emerBrake	pulseCount	MCDC
1	TRUE	50.0	35.0	TRUE	15	Statement 9 & 10 TFT
2	TRUE	50.0	35.1	FALSE	15	Statement 9 TFF
3	TRUE	50.1	35.1	TRUE	10	Statement 9 & 10 TTF
4	FALSE	50.1	35.1	FALSE	0	Statement 9 FTF
5	FALSE	50.0	35.0	FALSE	0	Statement 9 FFT
6	FALSE	50.1	35.0	FALSE	0	Statement 10 FTT
7	TRUE	50.1	35.0	TRUE	5	Statement 10 TTT
8	TRUE	0.0	35.0	TRUE	15	speed Extreme value
9	TRUE	135.0	35.0	TRUE	5	speed Extreme value
10	TRUE	50.1	0.0	TRUE	5	distance Extreme value
11	TRUE	50.1	1,000.0	TRUE	10	distance Extreme value

2. JUnit pass indicator (green bar expanded)
3. JaCoCo statement green source line annotations (not summary)



Finished after 0.041 seconds

Runs: 11/11 Errors: 0 Failures: 0

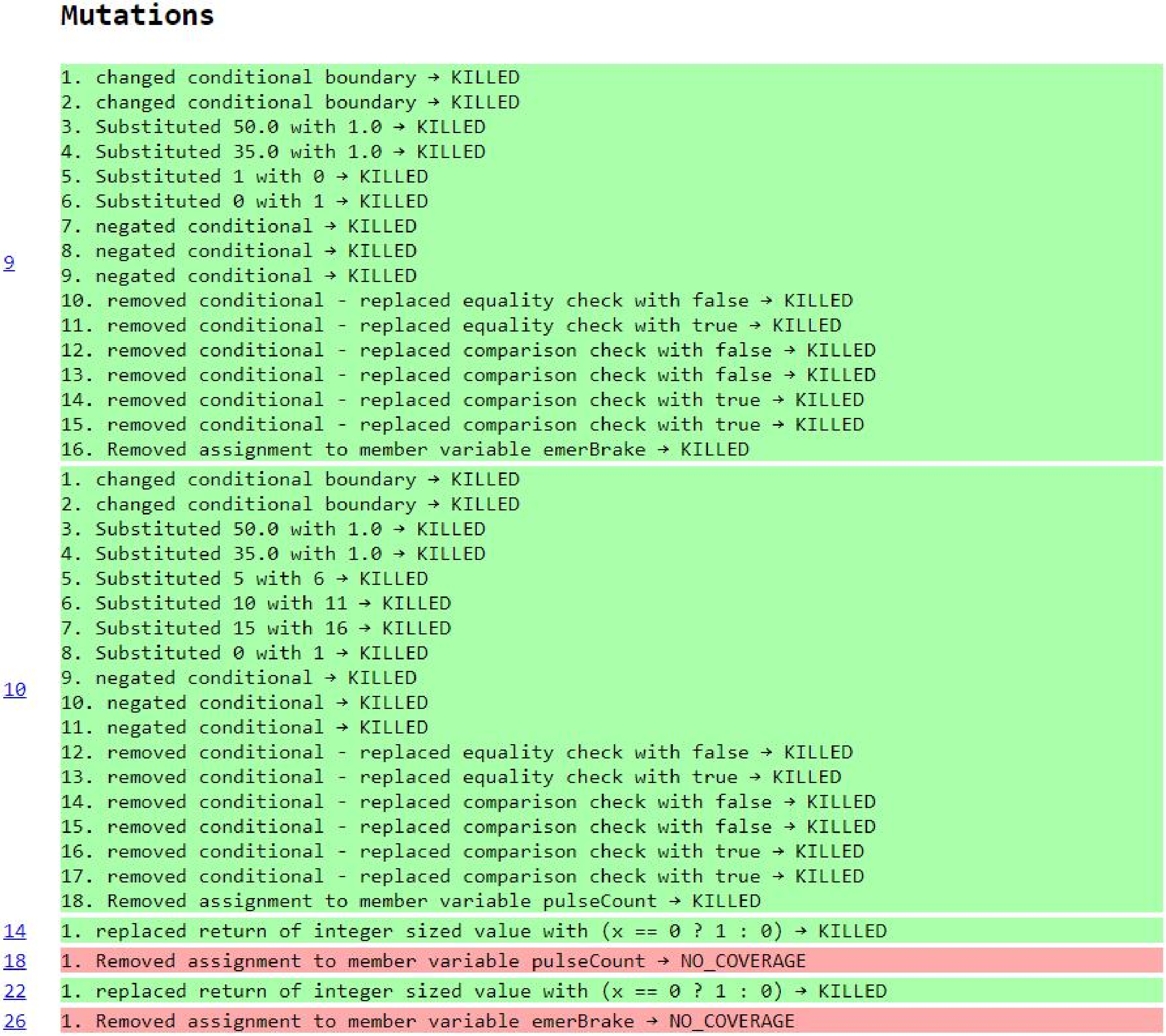
```
Homework5.Problem1ClassTest [Runner: JUnit 4] (0.017 s)
  test (0.017 s)
    [0] 1,TRUE,50.0,35.0,TRUE,15,Statement 9 & 10 TFT (test) (0.000 s)
    [1] 2,TRUE,50.0,35.1,FALSE,15,Statement 9 TFF (test) (0.000 s)
    [2] 3,TRUE,50.1,35.1,TRUE,10,Statement 9 & 10 TTF (test) (0.002 s)
    [3] 4,FALSE,50.1,35.1,FALSE,0,Statement 9 FTF (test) (0.002 s)
    [4] 5,FALSE,50.0,35.0,FALSE,0,Statement 9 FFT (test) (0.003 s)
    [5] 6,FALSE,50.1,35.0,FALSE,0,Statement 10 FTT (test) (0.002 s)
    [6] 7,TRUE,50.1,35.0,TRUE,5,Statement 10 TTT (test) (0.002 s)
    [7] 8,TRUE,0.0,35.0,TRUE,15,speed Extreme value (test) (0.002 s)
    [8] 9,TRUE,135.0,35.0,TRUE,5,speed Extreme value (test) (0.002 s)
    [9] 10,TRUE,50.1,0.0,TRUE,5,distance Extreme value (test) (0.001 s)
    [10] 11,TRUE,50.1,1000.0,TRUE,10,distance Extreme value (test) (0.001 s)
```

```java
 1 package Homework5;
 2 
 3 public class Problem1Class {
 4 
 5     int pulseCount;
 6     boolean emerBrake;
 7 
 8     public void emerBrakeFunction (boolean cruiseEngaged, double speed, double distance) {
 9         emerBrake = (cruiseEngaged && (speed>50.0 || distance<=35.0));
10         pulseCount = (cruiseEngaged) ? (speed>50.0 ? (distance<=35.0 ? 5: 10) : 15) : 0;
11     }
12 
13     public int getPulseCount() {
14         return pulseCount;
15     }
16 
17     public void setPulseCount(int timer) {
18         this.pulseCount = timer;
19     }
20 
21     public boolean isEmerBrake() {
22         return emerBrake;
23     }
24 
25     public void setAutoDisengage(boolean autoDisengage) {
26         this.emerBrake = autoDisengage;
27     }
28 }
```

Problem1ClassTest (1) (Aug 12, 2020 11:01:02 PM)

(Not caring about setters.)

4. PIT coverage annotation for the source method under test (all green lines)



```
Mutations

    1. changed conditional boundary → KILLED
    2. changed conditional boundary → KILLED
    3. Substituted 50.0 with 1.0 → KILLED
    4. Substituted 35.0 with 1.0 → KILLED
    5. Substituted 1 with 0 → KILLED
    6. Substituted 0 with 1 → KILLED
    7. negated conditional → KILLED
    8. negated conditional → KILLED
9   9. negated conditional → KILLED
    10. removed conditional - replaced equality check with false → KILLED
    11. removed conditional - replaced equality check with true → KILLED
    12. removed conditional - replaced comparison check with false → KILLED
    13. removed conditional - replaced comparison check with false → KILLED
    14. removed conditional - replaced comparison check with true → KILLED
    15. removed conditional - replaced comparison check with true → KILLED
    16. Removed assignment to member variable emerBrake → KILLED
    1. changed conditional boundary → KILLED
    2. changed conditional boundary → KILLED
    3. Substituted 50.0 with 1.0 → KILLED
    4. Substituted 35.0 with 1.0 → KILLED
    5. Substituted 5 with 6 → KILLED
    6. Substituted 10 with 11 → KILLED
    7. Substituted 15 with 16 → KILLED
    8. Substituted 0 with 1 → KILLED
    9. negated conditional → KILLED
10  10. negated conditional → KILLED
    11. negated conditional → KILLED
    12. removed conditional - replaced equality check with false → KILLED
    13. removed conditional - replaced equality check with true → KILLED
    14. removed conditional - replaced comparison check with false → KILLED
    15. removed conditional - replaced comparison check with false → KILLED
    16. removed conditional - replaced comparison check with true → KILLED
    17. removed conditional - replaced comparison check with true → KILLED
    18. Removed assignment to member variable pulseCount → KILLED
14  1. replaced return of integer sized value with (x == 0 ? 1 : 0) → KILLED
18  1. Removed assignment to member variable pulseCount → NO_COVERAGE
22  1. replaced return of integer sized value with (x == 0 ? 1 : 0) → KILLED
26  1. Removed assignment to member variable emerBrake → NO_COVERAGE
```

(Not caring about setters.)

5. The time stamp is at the bottom of the JUnit&JaCoco snapshot.

Problem 2:

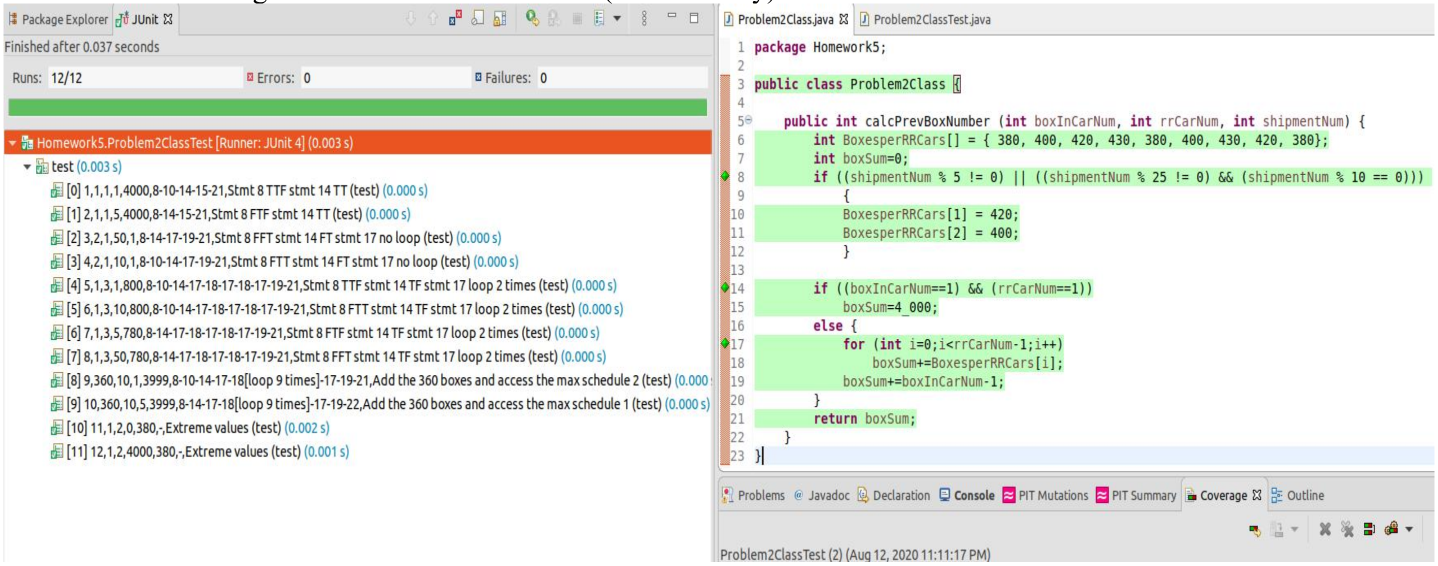
1. Test case table snapshot

	Input			Output		
Test Case Number	Box In Car Number	RailRoad Car number	Shipment Number	Previous Box number (absolute)	Basis Path	Comments
1	1	1	1	4,000	8-10-14-15-21	Stmt 8 TTF stmt 14 TT
2	1	1	5	4,000	8-14-15-21	Stmt 8 FTF stmt 14 TT
3	2	1	50	1	8-14-17-19-21	Stmt 8 FFT stmt 14 FT stmt 17 no loop
4	2	1	10	1	8-10-14-17-19-21	Stmt 8 FTT stmt 14 FT stmt 17 no loop
5	1	3	1	800	8-10-14-17-18-17-18-17-19-21	Stmt 8 TTF stmt 14 TF stmt 17 loop 2 times
6	1	3	10	800	8-10-14-17-18-17-18-17-19-21	Stmt 8 FTT stmt 14 TF stmt 17 loop 2 times
7	1	3	5	780	8-14-17-18-17-18-17-19-21	Stmt 8 FTF stmt 14 TF stmt 17 loop 2 times
8	1	3	50	780	8-14-17-18-17-18-17-19-21	Stmt 8 FFT stmt 14 TF stmt 17 loop 2 times
9	360	10	1	3,999	8-10-14-17-18(loop 9 times)-17-19-21	Add the 360 boxes and access the max schedule 2
10	360	10	5	3,999	8-14-17-18(loop 9 times)-17-19-22	Add the 360 boxes and access the max schedule 1
11	1	2	0	380	-	Extreme values
12	1	2	4000	380	-	Extreme values

Statement 8 has the logical expression: (shipmentNum%5!=0) || ((shipmentNum%25!= 0) && (shipmentNum%10==0))
Which can be considered as “a + bc”, which has the MCDC solution: TTF, FTF, FFT, FTT
TTF - shipmentNum%5 is non-zero, %25 is non-zero, %10 is non-zero, thus, shipmentNum can be 1.
FTF - shipmentNum%5 is zero, %25 is non-zero, %10 is non-zero, thus, shipmentNum can be 5.
FFT- shipmentNum%5 is zero, %25 is zero, %10 is zero, thus, shipmentNum can be 50.
FTT - shipmentNum%5 is zero, %25 is non-zero, %10 is zero, thus, shipmentNum can be 10.

Statement 14 has the logical expression: (boxInCarNum==1) && (rrCarNum==1), which has the MCDC: FT, TF, TT

2. JUnit pass indicator (green bar expanded)
3. JaCoCo statement green source line annotations (not summary)



```
Finished after 0.037 seconds
Runs: 12/12    Errors: 0    Failures: 0

Homework5.Problem2ClassTest [Runner: JUnit 4] (0.003 s)
  test (0.003 s)
    [0] 1,1,1,1,4000,8-10-14-15-21,Stmt 8 TTF stmt 14 TT (test) (0.000 s)
    [1] 2,1,1,5,4000,8-14-15-21,Stmt 8 FTF stmt 14 TT (test) (0.000 s)
    [2] 3,2,1,50,1,8-14-17-19-21,Stmt 8 FFT stmt 14 FT stmt 17 no loop (test) (0.000 s)
    [3] 4,2,1,10,1,8-10-14-17-19-21,Stmt 8 FTT stmt 14 FT stmt 17 no loop (test) (0.000 s)
    [4] 5,1,3,1,800,8-10-14-17-18-17-18-17-19-21,Stmt 8 TTF stmt 14 TF stmt 17 loop 2 times (test) (0.000 s)
    [5] 6,1,3,10,800,8-10-14-17-18-17-18-17-19-21,Stmt 8 FTT stmt 14 TF stmt 17 loop 2 times (test) (0.000 s)
    [6] 7,1,3,5,780,8-14-17-18-17-18-17-19-21,Stmt 8 FTF stmt 14 TF stmt 17 loop 2 times (test) (0.000 s)
    [7] 8,1,3,50,780,8-14-17-18-17-18-17-19-21,Stmt 8 FFT stmt 14 TF stmt 17 loop 2 times (test) (0.000 s)
    [8] 9,360,10,1,3999,8-10-14-17-18[loop 9 times]-17-19-21,Add the 360 boxes and access the max schedule 2 (test) (0.000
    [9] 10,360,10,5,3999,8-14-17-18[loop 9 times]-17-19-22,Add the 360 boxes and access the max schedule 1 (test) (0.000 s)
    [10] 11,1,2,0,380,-,Extreme values (test) (0.002 s)
    [11] 12,1,2,4000,380,-,Extreme values (test) (0.001 s)
```

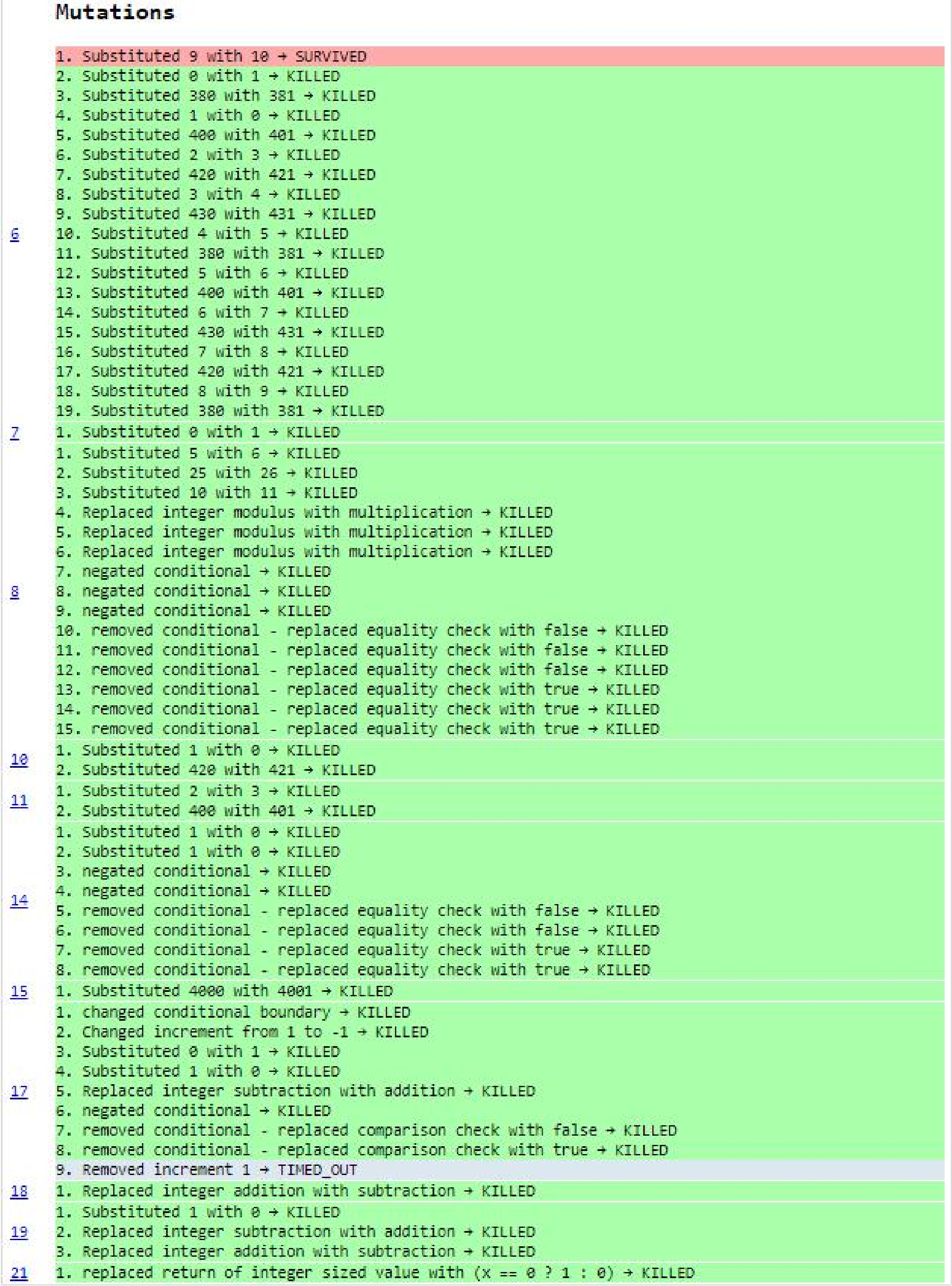
```
1  package Homework5;
2
3  public class Problem2Class {
4
5      public int calcPrevBoxNumber (int boxInCarNum, int rrCarNum, int shipmentNum) {
6          int BoxesperRRCars[] = { 380, 400, 420, 430, 380, 400, 430, 420, 380};
7          int boxSum=0;
8          if ((shipmentNum % 5 != 0) || ((shipmentNum % 25 != 0) && (shipmentNum % 10 == 0)))
9              {
10             BoxesperRRCars[1] = 420;
11             BoxesperRRCars[2] = 400;
12             }
13
14         if ((boxInCarNum==1) && (rrCarNum==1))
15             boxSum=4_000;
16         else {
17             for (int i=0;i<rrCarNum-1;i++)
18                 boxSum+=BoxesperRRCars[i];
19             boxSum+=boxInCarNum-1;
20         }
21         return boxSum;
22     }
23 }
```

```
Problem2ClassTest (2) (Aug 12, 2020 11:11:17 PM)
```

The incorrect part of the code is provided by the Professor.

```
5   public int calcPrevBoxNumber (int boxInCarNum, int rrCarNum, int shipmentNum) {
6   int BoxesperRRCars[] = { 380, 400, 420, 430, 380, 400, 430, 420, 380};
7   int boxSum=0;
8   if ((shipmentNum % 5 != 0) || ((shipmentNum % 25 != 0) && (shipmentNum % 10 == 0)))
9       {
10      BoxesperRRCars[1] = 420;
11      BoxesperRRCars[2] = 400;
12      }
```

4. PIT coverage annotation for the source method under test (all green lines)



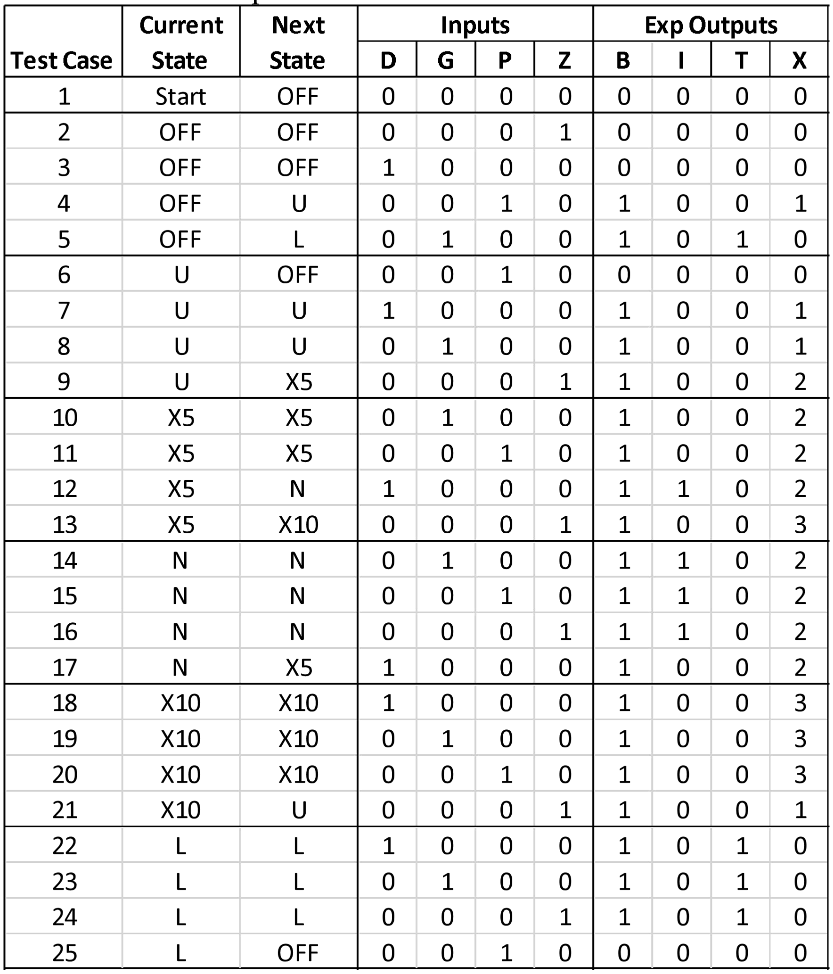
```
     Mutations

     1. Substituted 9 with 10 → SURVIVED
     2. Substituted 0 with 1 → KILLED
     3. Substituted 380 with 381 → KILLED
     4. Substituted 1 with 0 → KILLED
     5. Substituted 400 with 401 → KILLED
     6. Substituted 2 with 3 → KILLED
     7. Substituted 420 with 421 → KILLED
     8. Substituted 3 with 4 → KILLED
     9. Substituted 430 with 431 → KILLED
6    10. Substituted 4 with 5 → KILLED
     11. Substituted 380 with 381 → KILLED
     12. Substituted 5 with 6 → KILLED
     13. Substituted 400 with 401 → KILLED
     14. Substituted 6 with 7 → KILLED
     15. Substituted 430 with 431 → KILLED
     16. Substituted 7 with 8 → KILLED
     17. Substituted 420 with 421 → KILLED
     18. Substituted 8 with 9 → KILLED
     19. Substituted 380 with 381 → KILLED
7    1. Substituted 0 with 1 → KILLED
     1. Substituted 5 with 6 → KILLED
     2. Substituted 25 with 26 → KILLED
     3. Substituted 10 with 11 → KILLED
     4. Replaced integer modulus with multiplication → KILLED
     5. Replaced integer modulus with multiplication → KILLED
     6. Replaced integer modulus with multiplication → KILLED
     7. negated conditional → KILLED
8    8. negated conditional → KILLED
     9. negated conditional → KILLED
     10. removed conditional - replaced equality check with false → KILLED
     11. removed conditional - replaced equality check with false → KILLED
     12. removed conditional - replaced equality check with false → KILLED
     13. removed conditional - replaced equality check with true → KILLED
     14. removed conditional - replaced equality check with true → KILLED
     15. removed conditional - replaced equality check with true → KILLED
10   1. Substituted 1 with 0 → KILLED
     2. Substituted 420 with 421 → KILLED
11   1. Substituted 2 with 3 → KILLED
     2. Substituted 400 with 401 → KILLED
     1. Substituted 1 with 0 → KILLED
     2. Substituted 1 with 0 → KILLED
     3. negated conditional → KILLED
14   4. negated conditional → KILLED
     5. removed conditional - replaced equality check with false → KILLED
     6. removed conditional - replaced equality check with false → KILLED
     7. removed conditional - replaced equality check with true → KILLED
     8. removed conditional - replaced equality check with true → KILLED
15   1. Substituted 4000 with 4001 → KILLED
     1. changed conditional boundary → KILLED
     2. Changed increment from 1 to -1 → KILLED
     3. Substituted 0 with 1 → KILLED
     4. Substituted 1 with 0 → KILLED
17   5. Replaced integer subtraction with addition → KILLED
     6. negated conditional → KILLED
     7. removed conditional - replaced comparison check with false → KILLED
     8. removed conditional - replaced comparison check with true → KILLED
     9. Removed increment 1 → TIMED_OUT
18   1. Replaced integer addition with subtraction → KILLED
     1. Substituted 1 with 0 → KILLED
19   2. Replaced integer subtraction with addition → KILLED
     3. Replaced integer addition with subtraction → KILLED
21   1. replaced return of integer sized value with (x == 0 ? 1 : 0) → KILLED
```

The exception acceptable: Statement 6 - one case of "Substituted 9 with 10 → SURVIVED"

5. The time stamp is at the bottom of the JUnit&JaCoco snapshot.

Problem 3:

1. Test case table snapshot



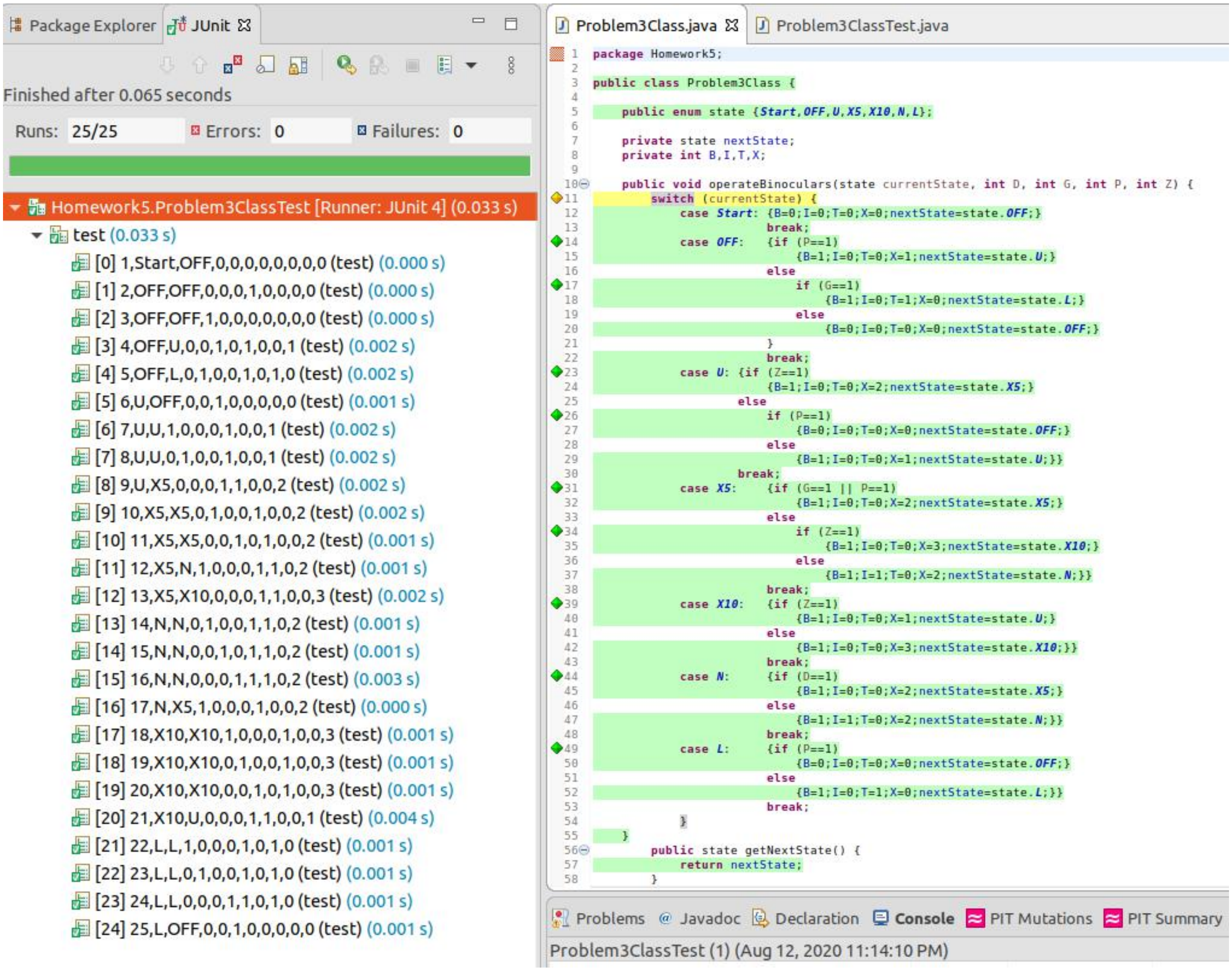
Test Case	Current State	Next State	Inputs				Exp Outputs			
			D	G	P	Z	B	I	T	X
1	Start	OFF	0	0	0	0	0	0	0	0
2	OFF	OFF	0	0	0	1	0	0	0	0
3	OFF	OFF	1	0	0	0	0	0	0	0
4	OFF	U	0	0	1	0	1	0	0	1
5	OFF	L	0	1	0	0	1	0	1	0
6	U	OFF	0	0	1	0	0	0	0	0
7	U	U	1	0	0	0	1	0	0	1
8	U	U	0	1	0	0	1	0	0	1
9	U	X5	0	0	0	1	1	0	0	2
10	X5	X5	0	1	0	0	1	0	0	2
11	X5	X5	0	0	1	0	1	0	0	2
12	X5	N	1	0	0	0	1	1	0	2
13	X5	X10	0	0	0	1	1	0	0	3
14	N	N	0	1	0	0	1	1	0	2
15	N	N	0	0	1	0	1	1	0	2
16	N	N	0	0	0	1	1	1	0	2
17	N	X5	1	0	0	0	1	0	0	2
18	X10	X10	1	0	0	0	1	0	0	3
19	X10	X10	0	1	0	0	1	0	0	3
20	X10	X10	0	0	1	0	1	0	0	3
21	X10	U	0	0	0	1	1	0	0	1
22	L	L	1	0	0	0	1	0	1	0
23	L	L	0	1	0	0	1	0	1	0
24	L	L	0	0	0	1	1	0	1	0
25	L	OFF	0	0	1	0	0	0	0	0

2. Code modifications

There are several lines I have changed from the original file:
line 22, change “X=3” to “X=2”
line 25, change “nextState=state.L” to “nextState=state.OFF”
line 27, change “X=2” to “X=1”
line 28, change “if (G==1 || B==1)” to “if (G==1 || P==1)”
line 29, change “nextState=state.U” to “nextState=state.X5”
line 34, change “B=1;T=1;T=0;X=2;” to “B=1;I=1;T=0;X=2;”
line 35, change “if (P==1)” to “if (Z==1)”
line 36, change “B=1;T=0;T=0;X=1;nextState=state.OFF;” to “B=1;I=0;T=0;X=1;nextState=state.U;”
line 38, change “B=1;T=0;T=0;X=3;” to “B=1;I=0;T=0;X=3;”
line 42, change “B=1;T=1;T=0;X=2;” to “B=1;I=1;T=0;X=2;
line 46, change “B=1;I=0;I=1;X=0;” to “B=1;I=0;T=1;X=0;”

And also, in each case, I added “break;” at the end.

3. JUnit pass indicator (green bar expanded)
4. JaCoCo statement green source line annotations (not summary)
5. The time stamp is at the bottom of the JUnit&JaCoco snapshot.



Finished after 0.065 seconds

Runs: 25/25 Errors: 0 Failures: 0

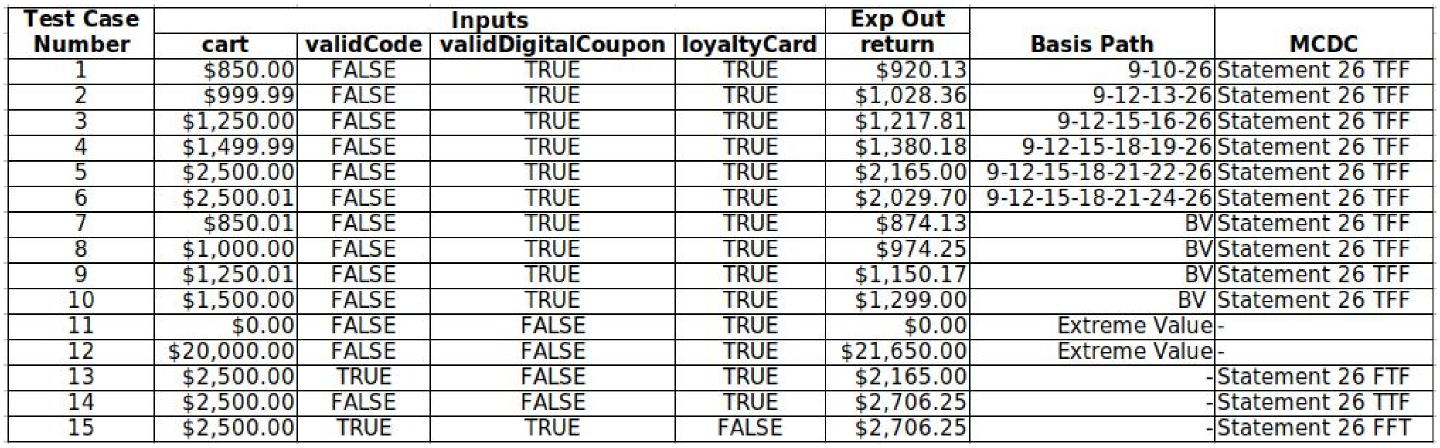
```
Homework5.Problem3ClassTest [Runner: JUnit 4] (0.033 s)
  test (0.033 s)
    [0] 1,Start,OFF,0,0,0,0,0,0,0,0 (test) (0.000 s)
    [1] 2,OFF,OFF,0,0,0,1,0,0,0,0 (test) (0.000 s)
    [2] 3,OFF,OFF,1,0,0,0,0,0,0,0 (test) (0.000 s)
    [3] 4,OFF,U,0,0,1,0,1,0,0,1 (test) (0.002 s)
    [4] 5,OFF,L,0,1,0,0,1,0,1,0 (test) (0.002 s)
    [5] 6,U,OFF,0,0,1,0,0,0,0,0 (test) (0.001 s)
    [6] 7,U,U,1,0,0,0,1,0,0,1 (test) (0.002 s)
    [7] 8,U,U,0,1,0,0,1,0,0,1 (test) (0.002 s)
    [8] 9,U,X5,0,0,0,1,1,0,0,2 (test) (0.002 s)
    [9] 10,X5,X5,0,1,0,0,1,0,0,2 (test) (0.002 s)
    [10] 11,X5,X5,0,0,1,0,1,0,0,2 (test) (0.001 s)
    [11] 12,X5,N,1,0,0,0,1,1,0,2 (test) (0.001 s)
    [12] 13,X5,X10,0,0,0,1,1,0,0,3 (test) (0.002 s)
    [13] 14,N,N,0,1,0,0,1,1,0,2 (test) (0.001 s)
    [14] 15,N,N,0,0,1,0,1,1,0,2 (test) (0.001 s)
    [15] 16,N,N,0,0,0,1,1,1,0,2 (test) (0.003 s)
    [16] 17,N,X5,1,0,0,0,1,0,0,2 (test) (0.000 s)
    [17] 18,X10,X10,1,0,0,0,1,0,0,3 (test) (0.001 s)
    [18] 19,X10,X10,0,1,0,0,1,0,0,3 (test) (0.001 s)
    [19] 20,X10,X10,0,0,1,0,1,0,0,3 (test) (0.001 s)
    [20] 21,X10,U,0,0,0,1,1,0,0,1 (test) (0.004 s)
    [21] 22,L,L,1,0,0,0,1,0,1,0 (test) (0.001 s)
    [22] 23,L,L,0,1,0,0,1,0,1,0 (test) (0.001 s)
    [23] 24,L,L,0,0,0,1,1,0,1,0 (test) (0.001 s)
    [24] 25,L,OFF,0,0,1,0,0,0,0,0 (test) (0.001 s)
```

```java
package Homework5;

public class Problem3Class {

    public enum state {Start,OFF,U,X5,X10,N,L};

    private state nextState;
    private int B,I,T,X;

    public void operateBinoculars(state currentState, int D, int G, int P, int Z) {
        switch (currentState) {
            case Start: {B=0;I=0;T=0;X=0;nextState=state.OFF;}
                        break;
            case OFF:   {if (P==1)
                            {B=1;I=0;T=0;X=1;nextState=state.U;}
                        else
                            if (G==1)
                                {B=1;I=0;T=1;X=0;nextState=state.L;}
                            else
                                {B=0;I=0;T=0;X=0;nextState=state.OFF;}
                        }
                        break;
            case U: {if (Z==1)
                        {B=1;I=0;T=0;X=2;nextState=state.X5;}
                    else
                        if (P==1)
                            {B=0;I=0;T=0;X=0;nextState=state.OFF;}
                        else
                            {B=1;I=0;T=0;X=1;nextState=state.U;}}
                    break;
            case X5:    {if (G==1 || P==1)
                            {B=1;I=0;T=0;X=2;nextState=state.X5;}
                        else
                            if (Z==1)
                                {B=1;I=0;T=0;X=3;nextState=state.X10;}
                            else
                                {B=1;I=1;T=0;X=2;nextState=state.N;}}
                        break;
            case X10:   {if (Z==1)
                            {B=1;I=0;T=0;X=1;nextState=state.U;}
                        else
                            {B=1;I=0;T=0;X=3;nextState=state.X10;}}
                        break;
            case N:     {if (D==1)
                            {B=1;I=0;T=0;X=2;nextState=state.X5;}
                        else
                            {B=1;I=1;T=0;X=2;nextState=state.N;}}
                        break;
            case L:     {if (P==1)
                            {B=0;I=0;T=0;X=0;nextState=state.OFF;}
                        else
                            {B=1;I=0;T=1;X=0;nextState=state.L;}}
                        break;
            }
    }
        public state getNextState() {
            return nextState;
        }
```

Problem3ClassTest (1) (Aug 12, 2020 11:14:10 PM)

Problem 4:

1. Test case table snapshot

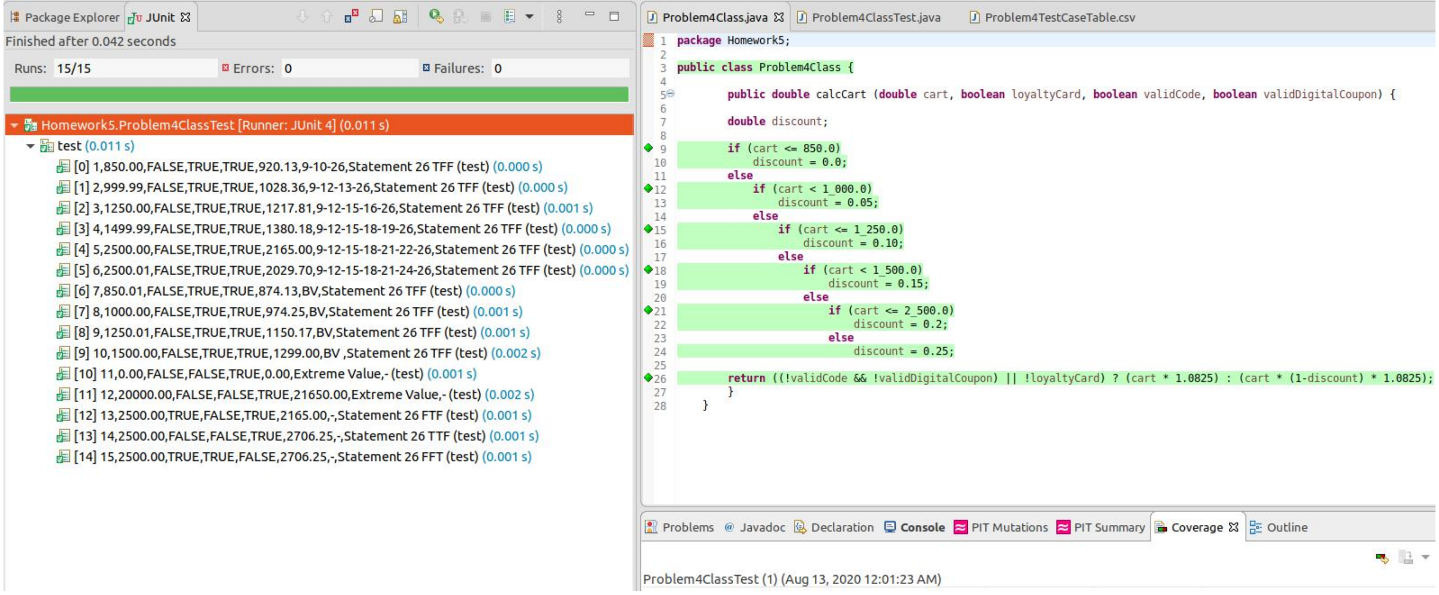


Test Case Number	Inputs				Exp Out		
	cart	validCode	validDigitalCoupon	loyaltyCard	return	Basis Path	MCDC
1	$850.00	FALSE	TRUE	TRUE	$920.13	9-10-26	Statement 26 TFF
2	$999.99	FALSE	TRUE	TRUE	$1,028.36	9-12-13-26	Statement 26 TFF
3	$1,250.00	FALSE	TRUE	TRUE	$1,217.81	9-12-15-16-26	Statement 26 TFF
4	$1,499.99	FALSE	TRUE	TRUE	$1,380.18	9-12-15-18-19-26	Statement 26 TFF
5	$2,500.00	FALSE	TRUE	TRUE	$2,165.00	9-12-15-18-21-22-26	Statement 26 TFF
6	$2,500.01	FALSE	TRUE	TRUE	$2,029.70	9-12-15-18-21-24-26	Statement 26 TFF
7	$850.01	FALSE	TRUE	TRUE	$874.13	BV	Statement 26 TFF
8	$1,000.00	FALSE	TRUE	TRUE	$974.25	BV	Statement 26 TFF
9	$1,250.01	FALSE	TRUE	TRUE	$1,150.17	BV	Statement 26 TFF
10	$1,500.00	FALSE	TRUE	TRUE	$1,299.00	BV	Statement 26 TFF
11	$0.00	FALSE	FALSE	TRUE	$0.00	Extreme Value	-
12	$20,000.00	FALSE	FALSE	TRUE	$21,650.00	Extreme Value	-
13	$2,500.00	TRUE	FALSE	TRUE	$2,165.00	-	Statement 26 FTF
14	$2,500.00	FALSE	FALSE	TRUE	$2,706.25	-	Statement 26 TTF
15	$2,500.00	TRUE	TRUE	FALSE	$2,706.25	-	Statement 26 FFT

Statement 26 has the logical expression: (!validCode && !validDigitalCoupon) || !loyaltyCard)
withe the formation of "ab + c", thus has the masking MCDC solution: TFF, FTF, TTF, FFT.

Notice, a is T, validCode is F; b is T, validDigitalCoupon is F; c is T, loyaltyCard is F; vice versa.

2. JUnit pass indicator (green bar expanded)
3. JaCoCo statement green source line annotations (not summary)

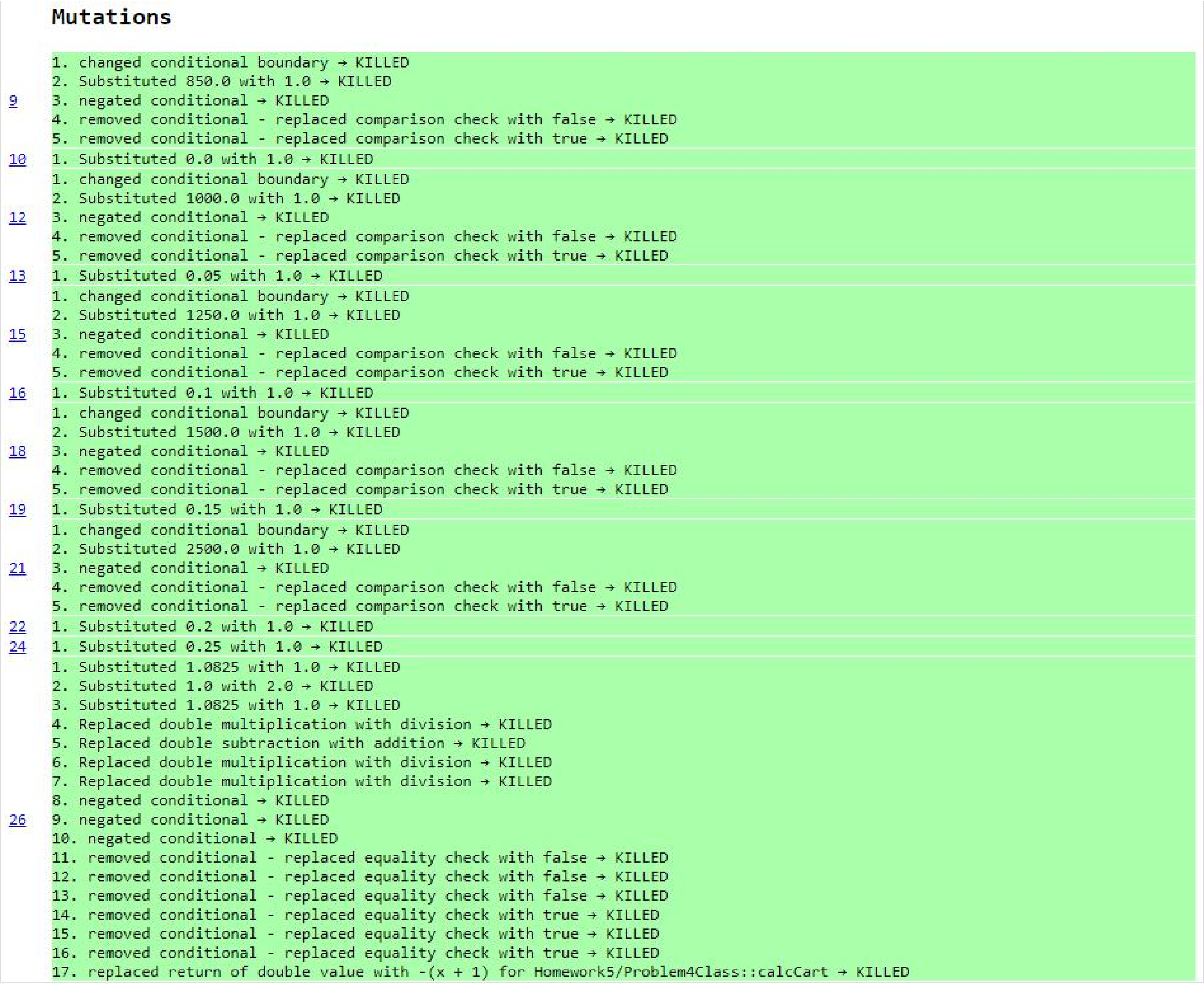


```
Finished after 0.042 seconds

Runs: 15/15     Errors: 0     Failures: 0

Homework5.Problem4ClassTest [Runner: JUnit 4] (0.011 s)
  test (0.011 s)
    [0] 1,850.00,FALSE,TRUE,TRUE,920.13,9-10-26,Statement 26 TFF (test) (0.000 s)
    [1] 2,999.99,FALSE,TRUE,TRUE,1028.36,9-12-13-26,Statement 26 TFF (test) (0.000 s)
    [2] 3,1250.00,FALSE,TRUE,TRUE,1217.81,9-12-15-16-26,Statement 26 TFF (test) (0.001 s)
    [3] 4,1499.99,FALSE,TRUE,TRUE,1380.18,9-12-15-18-19-26,Statement 26 TFF (test) (0.000 s)
    [4] 5,2500.00,FALSE,TRUE,TRUE,2165.00,9-12-15-18-21-22-26,Statement 26 TFF (test) (0.000 s)
    [5] 6,2500.01,FALSE,TRUE,TRUE,2029.70,9-12-15-18-21-24-26,Statement 26 TFF (test) (0.000 s)
    [6] 7,850.01,FALSE,TRUE,TRUE,874.13,BV,Statement 26 TFF (test) (0.000 s)
    [7] 8,1000.00,FALSE,TRUE,TRUE,974.25,BV,Statement 26 TFF (test) (0.001 s)
    [8] 9,1250.01,FALSE,TRUE,TRUE,1150.17,BV,Statement 26 TFF (test) (0.001 s)
    [9] 10,1500.00,FALSE,TRUE,TRUE,1299.00,BV ,Statement 26 TFF (test) (0.002 s)
    [10] 11,0.00,FALSE,FALSE,TRUE,0.00,Extreme Value,- (test) (0.001 s)
    [11] 12,20000.00,FALSE,FALSE,TRUE,21650.00,Extreme Value,- (test) (0.002 s)
    [12] 13,2500.00,TRUE,FALSE,TRUE,2165.00,-,Statement 26 FTF (test) (0.001 s)
    [13] 14,2500.00,FALSE,FALSE,TRUE,2706.25,-,Statement 26 TTF (test) (0.001 s)
    [14] 15,2500.00,TRUE,TRUE,FALSE,2706.25,-,Statement 26 FFT (test) (0.001 s)
```

```
 1  package Homework5;
 2
 3  public class Problem4Class {
 4
 5          public double calcCart (double cart, boolean loyaltyCard, boolean validCode, boolean validDigitalCoupon) {
 6
 7          double discount;
 8
 9          if (cart <= 850.0)
10              discount = 0.0;
11          else
12              if (cart < 1_000.0)
13                  discount = 0.05;
14              else
15                  if (cart <= 1_250.0)
16                      discount = 0.10;
17                  else
18                      if (cart < 1_500.0)
19                          discount = 0.15;
20                      else
21                          if (cart <= 2_500.0)
22                              discount = 0.2;
23                          else
24                              discount = 0.25;
25
26          return ((!validCode && !validDigitalCoupon) || !loyaltyCard) ? (cart * 1.0825) : (cart * (1-discount) * 1.0825);
27          }
28      }
```

Problem4ClassTest (1) (Aug 13, 2020 12:01:23 AM)

4. PIT coverage annotation for the source method under test (all green lines)

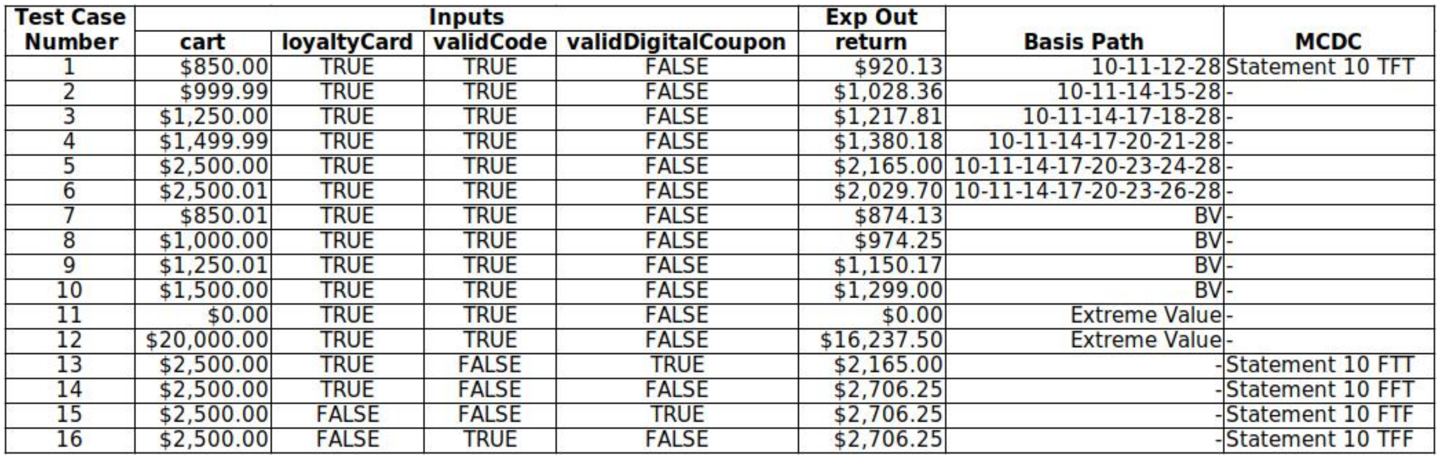


```
    Mutations

    1. changed conditional boundary → KILLED
    2. Substituted 850.0 with 1.0 → KILLED
9   3. negated conditional → KILLED
    4. removed conditional - replaced comparison check with false → KILLED
    5. removed conditional - replaced comparison check with true → KILLED
10  1. Substituted 0.0 with 1.0 → KILLED
    1. changed conditional boundary → KILLED
    2. Substituted 1000.0 with 1.0 → KILLED
12  3. negated conditional → KILLED
    4. removed conditional - replaced comparison check with false → KILLED
    5. removed conditional - replaced comparison check with true → KILLED
13  1. Substituted 0.05 with 1.0 → KILLED
    1. changed conditional boundary → KILLED
    2. Substituted 1250.0 with 1.0 → KILLED
15  3. negated conditional → KILLED
    4. removed conditional - replaced comparison check with false → KILLED
    5. removed conditional - replaced comparison check with true → KILLED
16  1. Substituted 0.1 with 1.0 → KILLED
    1. changed conditional boundary → KILLED
    2. Substituted 1500.0 with 1.0 → KILLED
18  3. negated conditional → KILLED
    4. removed conditional - replaced comparison check with false → KILLED
    5. removed conditional - replaced comparison check with true → KILLED
19  1. Substituted 0.15 with 1.0 → KILLED
    1. changed conditional boundary → KILLED
    2. Substituted 2500.0 with 1.0 → KILLED
21  3. negated conditional → KILLED
    4. removed conditional - replaced comparison check with false → KILLED
    5. removed conditional - replaced comparison check with true → KILLED
22  1. Substituted 0.2 with 1.0 → KILLED
24  1. Substituted 0.25 with 1.0 → KILLED
    1. Substituted 1.0825 with 1.0 → KILLED
    2. Substituted 1.0 with 2.0 → KILLED
    3. Substituted 1.0825 with 1.0 → KILLED
    4. Replaced double multiplication with division → KILLED
    5. Replaced double subtraction with addition → KILLED
    6. Replaced double multiplication with division → KILLED
    7. Replaced double multiplication with division → KILLED
    8. negated conditional → KILLED
26  9. negated conditional → KILLED
    10. negated conditional → KILLED
    11. removed conditional - replaced equality check with false → KILLED
    12. removed conditional - replaced equality check with false → KILLED
    13. removed conditional - replaced equality check with false → KILLED
    14. removed conditional - replaced equality check with true → KILLED
    15. removed conditional - replaced equality check with true → KILLED
    16. removed conditional - replaced equality check with true → KILLED
    17. replaced return of double value with -(x + 1) for Homework5/Problem4Class::calcCart → KILLED
```

5. The time stamp is at the bottom of the JUnit&JaCoco snapshot.

Problem 5:

1. Test case table snapshot

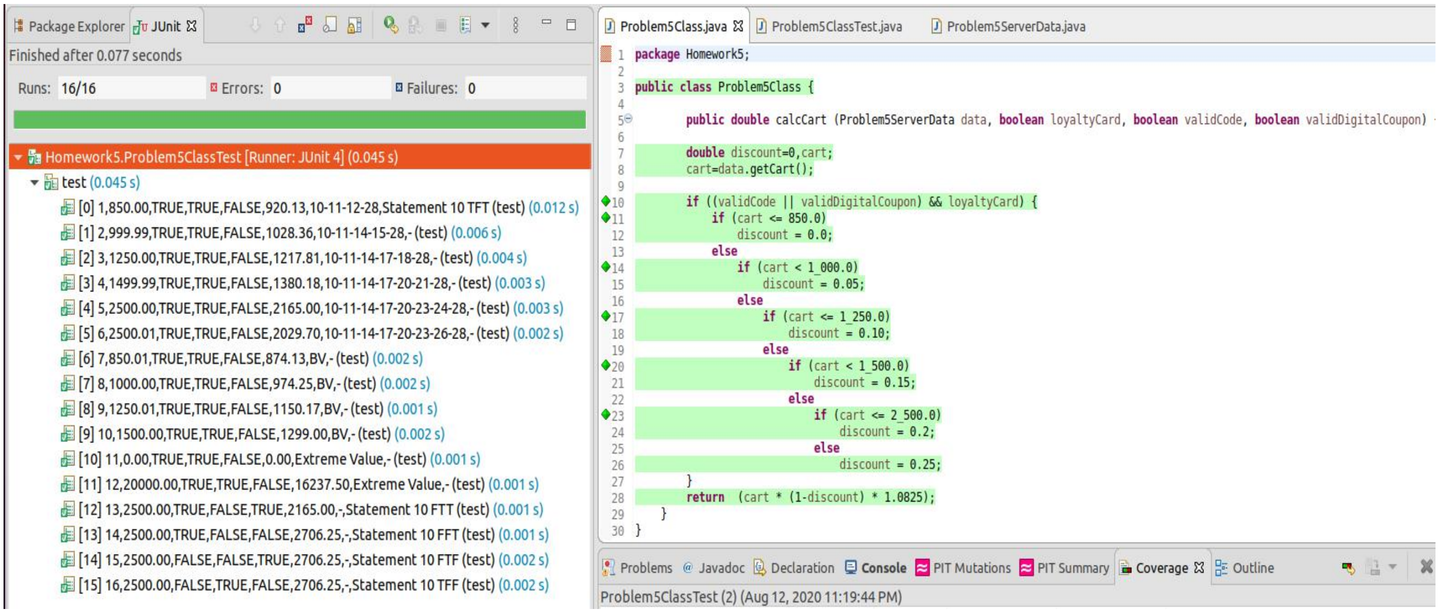


Test Case Number	Inputs				Exp Out	Basis Path	MCDC
	cart	loyaltyCard	validCode	validDigitalCoupon	return		
1	$850.00	TRUE	TRUE	FALSE	$920.13	10-11-12-28	Statement 10 TFT
2	$999.99	TRUE	TRUE	FALSE	$1,028.36	10-11-14-15-28	-
3	$1,250.00	TRUE	TRUE	FALSE	$1,217.81	10-11-14-17-18-28	-
4	$1,499.99	TRUE	TRUE	FALSE	$1,380.18	10-11-14-17-20-21-28	-
5	$2,500.00	TRUE	TRUE	FALSE	$2,165.00	10-11-14-17-20-23-24-28	-
6	$2,500.01	TRUE	TRUE	FALSE	$2,029.70	10-11-14-17-20-23-26-28	-
7	$850.01	TRUE	TRUE	FALSE	$874.13	BV	-
8	$1,000.00	TRUE	TRUE	FALSE	$974.25	BV	-
9	$1,250.01	TRUE	TRUE	FALSE	$1,150.17	BV	-
10	$1,500.00	TRUE	TRUE	FALSE	$1,299.00	BV	-
11	$0.00	TRUE	TRUE	FALSE	$0.00	Extreme Value	-
12	$20,000.00	TRUE	TRUE	FALSE	$16,237.50	Extreme Value	-
13	$2,500.00	TRUE	FALSE	TRUE	$2,165.00	-	Statement 10 FTT
14	$2,500.00	TRUE	FALSE	FALSE	$2,706.25	-	Statement 10 FFT
15	$2,500.00	FALSE	FALSE	TRUE	$2,706.25	-	Statement 10 FTF
16	$2,500.00	FALSE	TRUE	FALSE	$2,706.25	-	Statement 10 TFF

Statement 10 has the logical expression: ((validCode || validDigitalCoupon) && loyaltyCard)
withe the formation of "(a+b)c = ac + ab", thus has the MCDC solution: TFT, FTT, FFT, FTF, TFF.

Notice, in the test case table, the order of validCode, validDigitalCoupon and loyaltyCard is not exact as "a,b,c".

2. JUnit pass indicator (green bar expanded)
3. JaCoCo statement green source line annotations (not summary)



Finished after 0.077 seconds

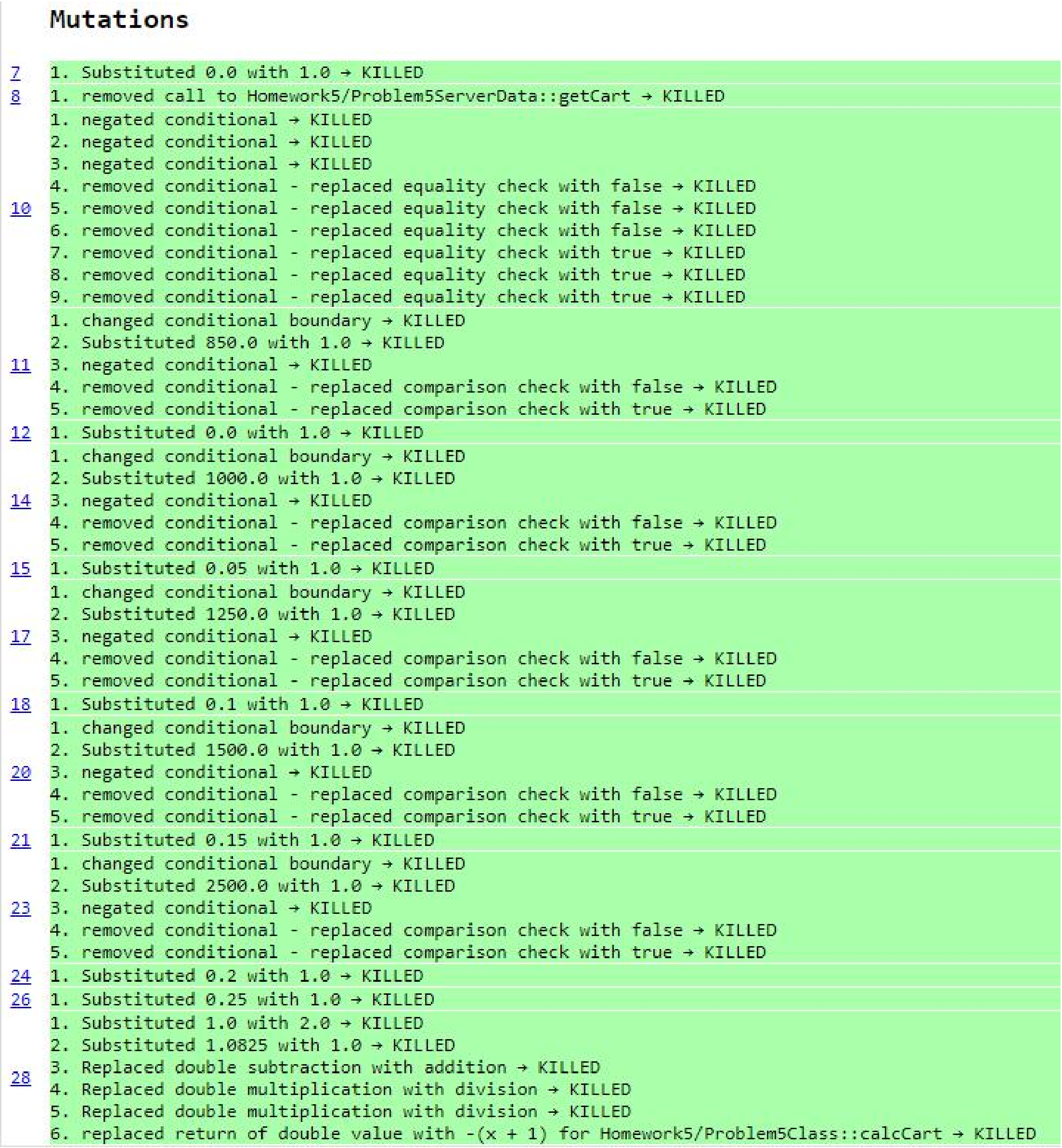
Runs: 16/16 ☒ Errors: 0 ☒ Failures: 0

```
Homework5.Problem5ClassTest [Runner: JUnit 4] (0.045 s)
  test (0.045 s)
    [0] 1,850.00,TRUE,TRUE,FALSE,920.13,10-11-12-28,Statement 10 TFT (test) (0.012 s)
    [1] 2,999.99,TRUE,TRUE,FALSE,1028.36,10-11-14-15-28,- (test) (0.006 s)
    [2] 3,1250.00,TRUE,TRUE,FALSE,1217.81,10-11-14-17-18-28,- (test) (0.004 s)
    [3] 4,1499.99,TRUE,TRUE,FALSE,1380.18,10-11-14-17-20-21-28,- (test) (0.003 s)
    [4] 5,2500.00,TRUE,TRUE,FALSE,2165.00,10-11-14-17-20-23-24-28,- (test) (0.003 s)
    [5] 6,2500.01,TRUE,TRUE,FALSE,2029.70,10-11-14-17-20-23-26-28,- (test) (0.002 s)
    [6] 7,850.01,TRUE,TRUE,FALSE,874.13,BV,- (test) (0.002 s)
    [7] 8,1000.00,TRUE,TRUE,FALSE,974.25,BV,- (test) (0.002 s)
    [8] 9,1250.01,TRUE,TRUE,FALSE,1150.17,BV,- (test) (0.001 s)
    [9] 10,1500.00,TRUE,TRUE,FALSE,1299.00,BV,- (test) (0.002 s)
    [10] 11,0.00,TRUE,TRUE,FALSE,0.00,Extreme Value,- (test) (0.001 s)
    [11] 12,20000.00,TRUE,TRUE,FALSE,16237.50,Extreme Value,- (test) (0.001 s)
    [12] 13,2500.00,TRUE,FALSE,TRUE,2165.00,-,Statement 10 FTT (test) (0.001 s)
    [13] 14,2500.00,TRUE,FALSE,FALSE,2706.25,-,Statement 10 FFT (test) (0.001 s)
    [14] 15,2500.00,FALSE,FALSE,TRUE,2706.25,-,Statement 10 FTF (test) (0.002 s)
    [15] 16,2500.00,FALSE,TRUE,FALSE,2706.25,-,Statement 10 TFF (test) (0.002 s)
```

```java
 1 package Homework5;
 2 
 3 public class Problem5Class {
 4 
 5         public double calcCart (Problem5ServerData data, boolean loyaltyCard, boolean validCode, boolean validDigitalCoupon)
 6 
 7         double discount=0,cart;
 8         cart=data.getCart();
 9 
10         if ((validCode || validDigitalCoupon) && loyaltyCard) {
11             if (cart <= 850.0)
12                 discount = 0.0;
13             else
14                 if (cart < 1_000.0)
15                     discount = 0.05;
16                 else
17                     if (cart <= 1_250.0)
18                         discount = 0.10;
19                     else
20                         if (cart < 1_500.0)
21                             discount = 0.15;
22                         else
23                             if (cart <= 2_500.0)
24                                 discount = 0.2;
25                             else
26                                 discount = 0.25;
27         }
28         return  (cart * (1-discount) * 1.0825);
29     }
30 }
```

Problem5ClassTest (2) (Aug 12, 2020 11:19:44 PM)

4. PIT coverage annotation for the source method under test (all green lines)



```
    Mutations

7   1. Substituted 0.0 with 1.0 → KILLED
8   1. removed call to Homework5/Problem5ServerData::getCart → KILLED
    1. negated conditional → KILLED
    2. negated conditional → KILLED
    3. negated conditional → KILLED
    4. removed conditional - replaced equality check with false → KILLED
10  5. removed conditional - replaced equality check with false → KILLED
    6. removed conditional - replaced equality check with false → KILLED
    7. removed conditional - replaced equality check with true → KILLED
    8. removed conditional - replaced equality check with true → KILLED
    9. removed conditional - replaced equality check with true → KILLED
    1. changed conditional boundary → KILLED
    2. Substituted 850.0 with 1.0 → KILLED
11  3. negated conditional → KILLED
    4. removed conditional - replaced comparison check with false → KILLED
    5. removed conditional - replaced comparison check with true → KILLED
12  1. Substituted 0.0 with 1.0 → KILLED
    1. changed conditional boundary → KILLED
    2. Substituted 1000.0 with 1.0 → KILLED
14  3. negated conditional → KILLED
    4. removed conditional - replaced comparison check with false → KILLED
    5. removed conditional - replaced comparison check with true → KILLED
15  1. Substituted 0.05 with 1.0 → KILLED
    1. changed conditional boundary → KILLED
    2. Substituted 1250.0 with 1.0 → KILLED
17  3. negated conditional → KILLED
    4. removed conditional - replaced comparison check with false → KILLED
    5. removed conditional - replaced comparison check with true → KILLED
18  1. Substituted 0.1 with 1.0 → KILLED
    1. changed conditional boundary → KILLED
    2. Substituted 1500.0 with 1.0 → KILLED
20  3. negated conditional → KILLED
    4. removed conditional - replaced comparison check with false → KILLED
    5. removed conditional - replaced comparison check with true → KILLED
21  1. Substituted 0.15 with 1.0 → KILLED
    1. changed conditional boundary → KILLED
    2. Substituted 2500.0 with 1.0 → KILLED
23  3. negated conditional → KILLED
    4. removed conditional - replaced comparison check with false → KILLED
    5. removed conditional - replaced comparison check with true → KILLED
24  1. Substituted 0.2 with 1.0 → KILLED
26  1. Substituted 0.25 with 1.0 → KILLED
    1. Substituted 1.0 with 2.0 → KILLED
    2. Substituted 1.0825 with 1.0 → KILLED
    3. Replaced double subtraction with addition → KILLED
28  4. Replaced double multiplication with division → KILLED
    5. Replaced double multiplication with division → KILLED
    6. replaced return of double value with -(x + 1) for Homework5/Problem5Class::calcCart → KILLED
```

5. The time stamp is at the bottom of the JUnit&JaCoco snapshot.