**Software Testing**

**Project Report**

Session: Spring 2021

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## Project Description

### Environment Setup

1. Download maven from here: <https://maven.apache.org/download.cgi>
2. Download and install the mysql workbench from here: <https://dev.mysql.com/downloads/installer/>
3. Download jdk1.8+
4. In the .\timesheet-master\build.bat, set the JAVA\_HOME to jdk path and similarly set MAVEN\_HOME to the maven path.
5. In the .\timesheet-master\run.bat, set the JAVA\_HOME and set CATALINA\_HOME to absolute path appended by ".\PaySystem\apache-tomcat-7.0.108-windows-x64\apache-tomcat-7.0.108".
6. Open Command prompt, navigate to project repository i.e .\Paysystem\timesheet-master\ and execute build.bat.
7. This will build the project.
8. Open mysql workbench and enter following two queries:
   1. drop database paysystem;
   2. create database paysystem;
9. When the database is created for first time, only execute the create query.
10. Execute run.bat.

### Description

The project is a lighter version of a pay system for managing the expenses of the employees.

* Adding the new employees in the database.
* Adding the time worked for a specific employee.
* Configuring the database settings.
* Managing the groups in the company.
* Generate the ADP reports of the employees.

### Application Running

After the local server is running, go to <http://localhost:8090/> or you can just go to the application <http://localhost:8090/PaySystem>



Enter the company name, and then click next.

Then you will be redirected to add information about the database. To avoid confusion, database username and database password are kept same.



You will be redirected to add username and password for the user purpose. These are also kept same.



You will be redirected to the login page.



After clicking login, Login using the username you set earlier.



After login you will be directed to the dashboard. Below is the full dashboard.



In the manage account section, you can add the wage.



In the manage employee section, you can add/delete the employees.



In the manage settings section, you can change the settings.



In the hour management section, you can add/delete/edit the hour types.



In the group management section, you can add/delete/edit the groups.



In the report section, you can generate the reports.



For the report generation, you can add the data for the employee.



After clicking the finalize data, a csv file is downloaded.

## White-Box Testing

### **Function 1**:

Encodes a byte array into Base64 format.

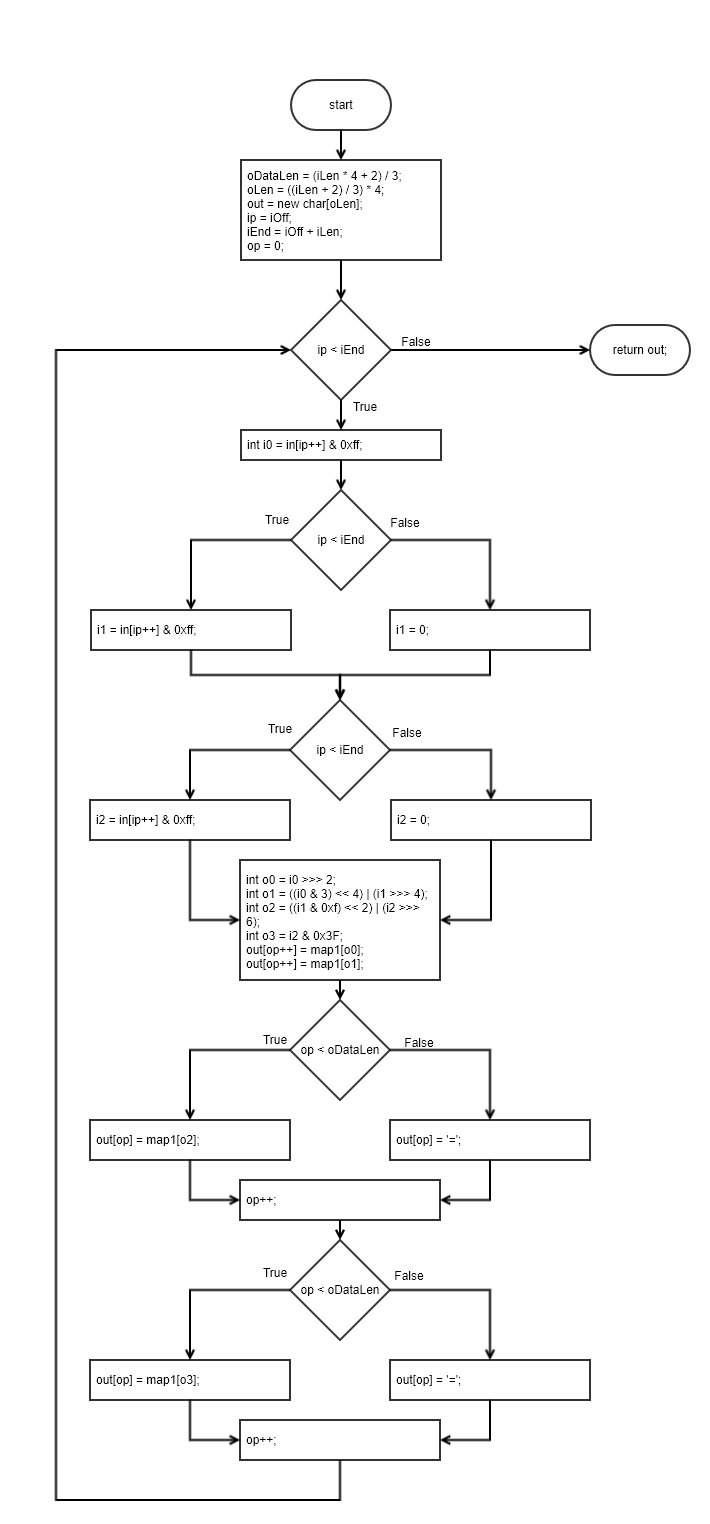
Note: map[] table is populated in another constructor function.

**Source Code:**

timesheet-master\src\main\java\timeSheet\util\properties\Base64Coder.java



**CFG:**

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**Statement Coverage:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | In[] = {‘A’, ‘B’, ‘C’};  iOff = 0;  iLen = 3; | QUJD | Covers all statements |

**Branch Coverage:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | In[] = {‘A’, ‘B’, ‘C’};  iOff = 0;  iLen = 3; | QUJD | Covers 66TF, 68T, 69T, 76T, 78T |
| **2** | In[] = {‘A’, ‘B’, ‘C’};  iOff = 0;  iLen = 1; | QQ== | Covers 66TF, 68F, 69F, 76F, 78F |

**Condition Coverage with Short Circuit Evaluation:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | In[] = {‘A’, ‘B’, ‘C’};  iOff = 0;  iLen = 3; | QUJD | Covers 66TF, 68T, 69T, 76T, 78T |
| **2** | In[] = {‘A’, ‘B’, ‘C’};  iOff = 0;  iLen = 1; | QQ== | Covers 66TF, 68F, 69F, 76F, 78F |

**Boundary Interior:**

Possible logical paths

* 68T, 69T, 76T, 78T
* 68T, 69F, 76T, 78F
* 68F, 69F, 76F, 78F

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | In[] = {‘A’, ‘B’, ‘C’};  iOff = 0;  iLen = 3; | QUJD | Covers 68T, 69T, 76T, 78T |
| **2** | In[] = {‘A’, ‘B’, ‘C’};  iOff = 0;  iLen = 1; | QQ== | Covers 68F, 69F, 76F, 78F |
| **3** | In[] = {‘A’, ‘B’, ‘C’};  iOff = 0;  iLen = 2; | QUI= | Covers 68T, 69F, 76T, 78F |

**Loop Boundary:**

Consider N for loop boundary as 5

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | In[] = {‘A’, ‘B’, ‘C’};  iOff = 0;  iLen = 0; | Empty string | Covers 66F |
| **2** | In[] = {‘A’, ‘B’, ‘C’};  iOff = 0;  iLen = 3; | QUJD | Covers 66T once |
| **3** | In[] = {‘A’, ‘B’, ‘C’, ‘D’};  iOff = 0;  iLen = 4; | QUJDRA== | Covers 66T at N-1 |
| **4** | In[] = {‘A’, ‘B’, ‘C’, ‘D’, ‘E’};  iOff = 0;  iLen = 5; | QUJDREU= | Covers 66T at N |
| **54** | In[] = {‘A’, ‘B’, ‘C’, ‘D’, ‘E’, ‘F’};  iOff = 0;  iLen = 6; | QUJDREVG | Covers 66T at N+1 |

**Basis Path:**

Path 1: 66F

Path 2: 66T, 68T, 69T, 76T, 78T

Path 3: 66T, 68T, 69F, 76T, 78F

Path 4: 66T, 68F, 69F, 76F, 78F

Note that no logical path is possible to cause 69T while 68F. Same is case with 76F and 78T. Similarly, conditions in 76 and 78 also depend upon same factor as 68, 69 so it is not possible for 68T but 76F and vice versa.

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | In[] = {‘A’, ‘B’, ‘C’};  iOff = 0;  iLen = 3; | QUJD | Covers Path2 |
| **2** | In[] = {‘A’, ‘B’, ‘C’};  iOff = 0;  iLen = 1; | QQ== | Covers Path4 |
| **3** | In[] = {‘A’, ‘B’, ‘C’};  iOff = 0;  iLen = 0; | Empty String | Covers Path1 |
| **4** | In[] = {‘A’, ‘B’, ‘C’};  iOff = 0;  iLen = 2; | QUI= | Covers Path3 |

**Data Flow Testing:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable #** | **Variable Name** | **Definitions** | **Uses** |
| 1 | iLen | 59 | 60, 61, 64 |
| 2 | oLen | 61 | 62 |
| 3 | op | 65, 74, 75, 77, 79 | 74, 75, 76, 77, 78, 79 |

|  |  |  |
| --- | --- | --- |
| **Variable #** | **Variable Name** | **DU pairs** |
| 1 | iLen | <59, 60>, <59, 61>, <59, 64> |
| 2 | oLen | <61, 62> |
| 3 | op | <65,74>, <74,75>, <75,76>, <75,77>, <77,78>, <77,79>, <79,74> |

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | In[] = {‘A’, ‘B’, ‘C’, ‘D’, ‘E’, ‘F’};  iOff = 0;  iLen = 6; | QUJDREVG | iLen = Covers <59, 60>, <59, 61>, <59, 64>  oLen = Covers <61, 62>  op = Covers <65,74>, <74,75>, <75,76>, <75,77>, <77,78>, <77,79>, <79,74> |

### **Function 2:**

**Source Code:**

https://github.com/openjdk/jdk/tree/master/src/java.base/share/classes/java/time/Duration.java

**CFG:**

Diagram

Description automatically generated

**Statement Coverage:**

Line 414 exception case is not covered under sir’s guidance.

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | text = “PT6H” | “6 hours” | Covers statements from 391 to 395, 398 to 412 |
| **2** | text = “G3D” | “Exception” | Covers statement 419 |
| **3** | text = “-P2D” | “-2 days” | Covers statement 396 |

**Branch Coverage:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | text = “PT6H” | “6 hours” | Covers B393T, B395F, B404T |
| **2** | text = “G3D” | Exception | Covers B393F |
| **3** | text= “-PT6H3M” | “-6 Hours and -3 minutes” | Covers B393T, B395T |
| **4** | text= “PTDHM” | Exception | Covers B404F |

**Condition Coverage with Short Circuit Evaluation:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | text = “PT6H” | “6 hours” | Covers C393T, C395F,  C404-1T |
| **2** | text = “G3D” | Exception | Covers C393F |
| **3** | text= “PT-6D6H” | “-6 Days and 6 Hours” | Covers C393T, C395T, C404-1F, C404-2T |
| **4** | text= “PT-6D-6H6M” | “-6 Days and -6 Hours and 6 minutes” | Covers C393T, C395T, C404-1F, C404-2F, C404-3T |
| **5** | text= “PT-6D-6H-6M6S” | “-6 Days and -6 Hours and -6 minutes and 6 seconds” | Covers C393T, C395T, C404-1F, C404-2F, C404-3F, C404-4T |
| **6** | text= “PT-6D-6H-6M-6S” | Exception | Covers C393T, C395T, C404-1F, C404-2F, C404-3F, C404-4F |

**Boundary Interior:**

Boundary Interior Technique cannot be applied to this function because it does not contain any loop.

**Loop Boundary:**

Loop Boundary Technique cannot be applied to this function because it does not contain any loop.

**Basis Path:**

No. of Basis Paths = No. of decision points + 1

No. of Basis Paths = 3 + 1 = 4

Path 1: ABCDEFG

Path 2: ABH

Path 3: ABCEFG

Path 4: ABCEFH

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | text = “PT-6H3M” | “6 Hours and -3 minutes” | Covers path ABCDEFG |
| **2** | text = “G3D” | “Exception” | Covers path ABH |
| **3** | text = “PT6H” | “6 hours” | Covers ABCEFG |
| **4** | text= “PTDHM” | Exception | Covers ABCEFH |

**Data Flow Testing:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable #** | **Variable Name** | **Definitions** | **Uses** |
| 1 | matcher | 392 | 393, 395, 396, 398, 399, 400, 401, 402 |
| 2 | dayStart | 398 | 404, 405 |
| 3 | hourStart | 399 | 404, 406 |

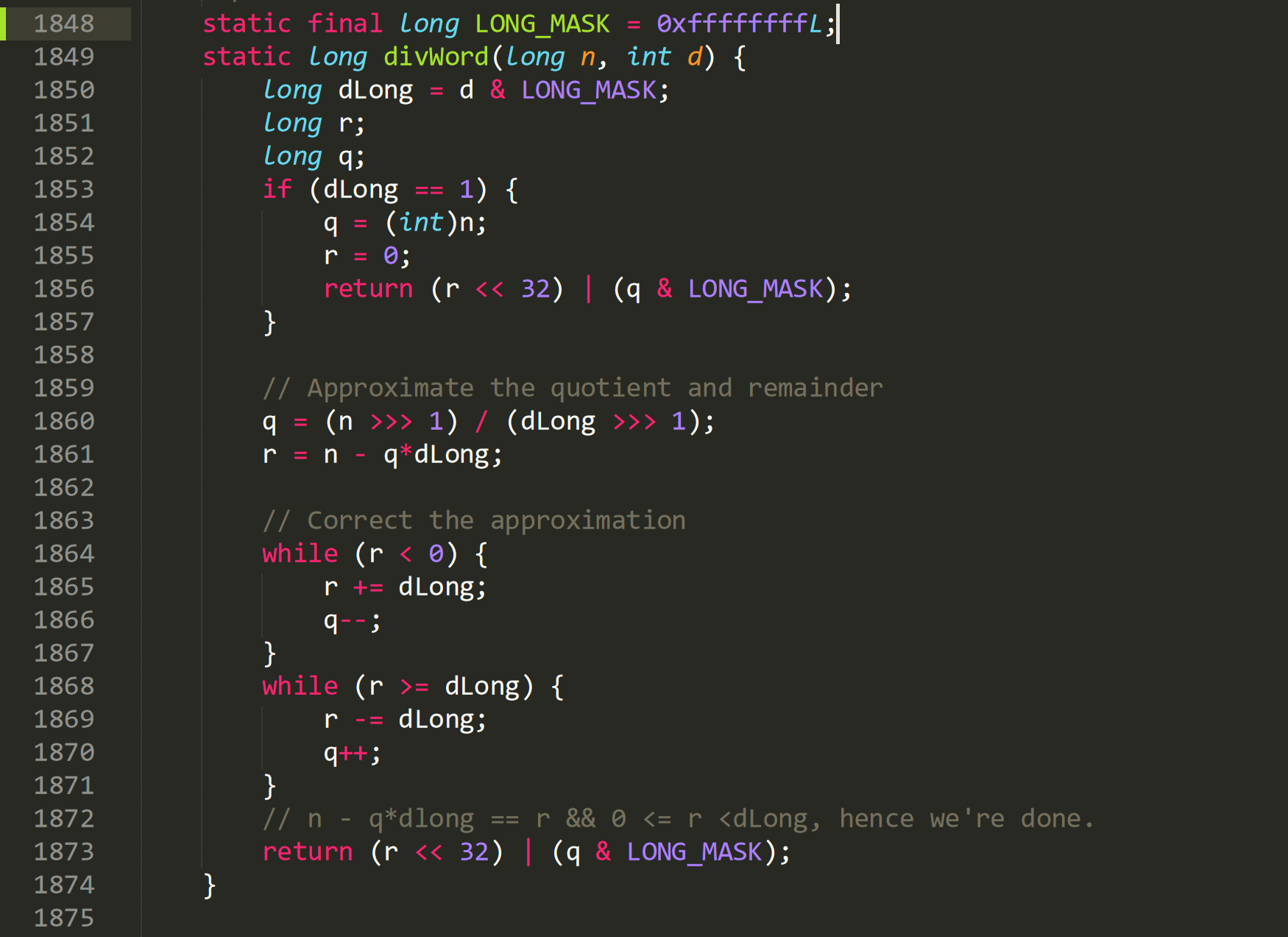
|  |  |  |
| --- | --- | --- |
| **Variable #** | **Variable Name** | **DU pairs** |
| 1 | Matcher | <392, 393> <392, 395> <392, 396>  <392, 398> <392, 399> <392, 400> <392, 401> <392, 402> |
| 2 | dayStart | <398, 404> <398,405> |
| 3 | hourStart | <399, 404> <399,406> |

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | text  =“-PT2D6H4M20.345S” | “-2 days and -6 Hours and -4 minutes and -20.345 seconds” | For matcher : Covers  <392, 393>  <392, 395>  <392, 396>  <392, 398>  <392, 399>  <392, 400>  <392, 401>  <392, 402>  For dayStart: Covers  <398, 404> <398, 405>  For hourStar: Covers  <398, 404> <398, 406> |

### **Function 3:**

**Source Code:**

https://github.com/openjdk/jdk/tree/master/src/java.base/share/classes/java/math/ MutableBigInteger.java

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**CFG:**

Diagram

Description automatically generated

**Statement Coverage:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | n = 16  d = 1 | 16 | Covers Statement 1850-1857 |
| **2** | n = 10  d = 3 | 4294967299 | Covers Statement 1850,1851,1852, 1860-1868, 1873 |
| **3** | - | - | Statement 1869- 1870 I think this is a dead code, I could not find any such case in which the condition at 1868 becomes True |

**Branch Coverage:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | n = 16  d = 1 | 16 | Covers B1853T |
| **2** | n = 10  d = 3 | 4294967299 | Covers B1853F , B1864TF, B1864F |
| **3** | - | - | Statement 1869- 1870 I think this is a dead code, I could not find any such case in which the condition at 1868 becomes True |

**Condition Coverage with Short Circuit Evaluation:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | n = 16  d = 1 | 16 | Covers C1853T |
| **2** | n = 10  d = 3 | 4294967299 | Covers C1853F , C1864TF, C1864F |
| **3** | - | - | Statement 1869- 1870 I think this is a dead code, I could not find any such case in which the condition at 1868 becomes True |

**Boundary Interior:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | n = 10  d = 3 | 4294967299 | Covers loop starting at Line 1864. This while loop has only one path. |
| **2** | - | - | Statement 1869- 1870 I think this is a dead code, I could not find any such case in which the condition at 1868 becomes True. |

**Loop Boundary:**

I think Loop at line 1868 is a dead code, I could not find any such case in which the condition at 1868 becomes True.

**Test cases are only for the loop at line 1864.**

I choose loop upper bound = 5

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | n =10  d = 5 | 2 | Loop at line 1864 is skipped entirely. |
| **2** | n =5  d = 3 | 8589934593 | Loop at line 1864 is run only once |
| **3** | n = 14  d = 6 | 8589934596 | Loop at line 1864 is run 3 times. |
| **4** | n =20  d =3 | 8589934598 | Loop at line 1864 is run 4 times |
| **5** | n = 28  d = 3 | 4294967305 | Loop at line 1864 is run 5 times. |
| **6** | n = 32  d = 3 | 8589934602 | Loop at line 1864 is run 6 times. |

**Basis Path:**

No. of Basis Paths = No. of decision points + 1

No. of Basis Paths = 3 + 1 = 4

Path 1: ABD

Path 2: ABCEFGHI

Path 3: ABCEFGI

Path 4: ABCEGI

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | n = 16  d = 1 | 16 | Covers path ABD |
| **2** | - | - | Path ABCEFGHI cannot be covered since the condition in the G block is never True so H block cannot be executed. |
| **3** | n =5  d = 3 | 8589934593 | Covers path ABCEFGI |
| **4** | n = 10  d = 2 | 5 | Covers path ABCEGI |

**Data Flow Testing:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable #** | **Variable Name** | **Definitions** | **Uses** |
| 1 | dLong | 1850 | 1853, 1860, 1861, 1865, 1868, 1869 |
| 2 | N | 1849 | 1854, 1860, 1861 |
| 3 | q | 1854, 1860, 1866, 1870 | 1856, 1861, 1866, 1870, 1873 |

|  |  |  |
| --- | --- | --- |
| **Variable #** | **Variable Name** | **DU pairs** |
| 1 | dLong | <1850,1853> <1850,1860> <1850,1861> <1850,1865>  <1850,1868> <1850,1869> |
| 2 | n | <1849,1854> <1849,1860> <1850,1861> |
| 3 | q | <1854, 1856> <1860, 1861>  <1860, 1866> <1860, 1870>  <1860, 1873>  <1866, 1866> <1866, 1870>  <1866, 1873>  <1870, 1870> <1870, 1873> |

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | n = 28  d = 3 | 4294967305 | For dLong covers:  <1850,1853> <1850,1860> <1850,1861> <1850,1865>  <1850,1868>  For n covers:  <1849,1860> <1850,1861>  For q covers:  <1860, 1861>  <1860,1866>  <1866, 1866> <1866, 1873> |
| **2** | n = 10  d = 1 | 10 | For dLong covers:  <1850,1853> For n covers:  <1849,1854>  For q covers:  <1854,1856> |
| **3** | n = 10  d = 2 | 5 | For dLong covers:  <1850,1853>  <1850,1860>  <1850,1861> For n covers:  <1849,1860>  <1849,1861>  For q covers:  <1860, 1873> |
| **-** | - | - | For q these DU pairs cannot be covered: <1870, 1870>  <1870, 1873>  <1866, 1870>  <1866, 1873> |

### **Function 4:**

Decodes a byte array from Base64 format.

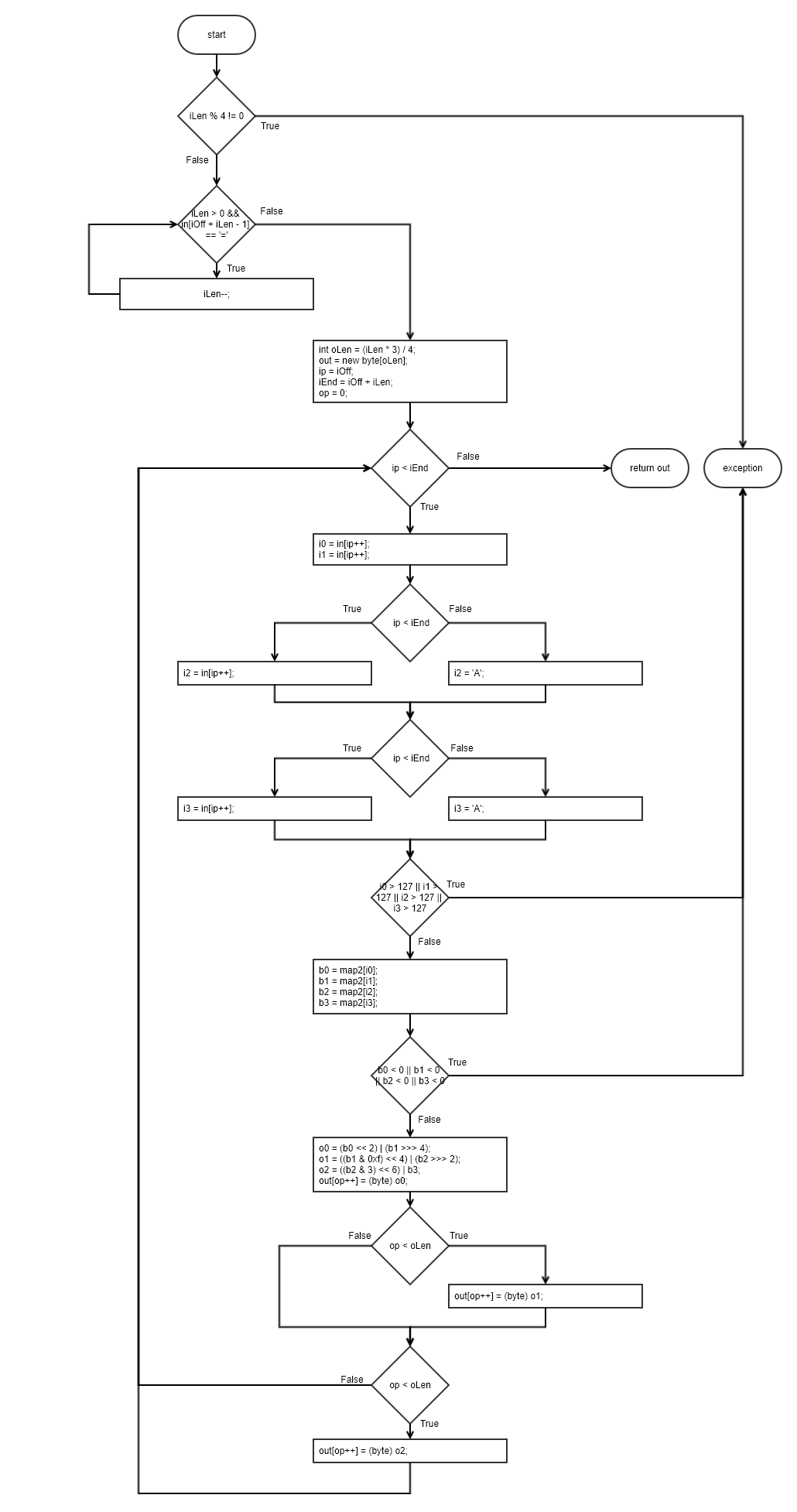
Note: map2[] table is populated in another constructor function.

**Source Code:**

timesheet-master\src\main\java\timeSheet\util\properties\Base64Coder.java



**CFG:**



**Statement Coverage:**

Exception cases are not covered under sir’s guidance.

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | In[] = ‘QUJD’  iOff = 0  iLen = 4 | ‘ABC’ | No padding |
| **2** | In[] = ‘QQ==’  iOff = 0  iLen = 4 | ‘A’ | Padded with == |

**Branch Coverage:**

Exception cases are not covered under sir’s guidance.

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | In[] = ‘QUJD’  iOff = 0  iLen = 4 | ‘ABC’ | 109F, 115TF, 118T, 119T, 132T, 133T |
| **2** | In[] = ‘QQ==’  iOff = 0  iLen = 4 | ‘A’ | 109TF, 115TF, 118F, 119F, 132F, 133F |

**Condition Coverage with Short Circuit Evaluation:**

Exception cases are not covered under sir’s guidance.

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | In[] = ‘QUJD’  iOff = 0  iLen = 0 | Empty String | 109aF, 115F |
| **2** | In[] = ‘QUJD’  iOff = 0  iLen = 4 | ‘ABC’ | 109aT, 109bF, 115TF, 118T, 119T, 132T, 133T |
| **3** | In[] = ‘QQ==’  iOff = 0  iLen = 4 | ‘A’ | 109aT, 109bTF, 115TF, 118F, 119F, 132F, 133F |

**Boundary Interior:**

Exception cases are not covered under sir’s guidance.

Possible logical paths:

* A: 118T->119T-> 132T-> 133T
* B: 118T-> 119F-> 132T->133F
* C: 118F-> 119F-> 132T-> 133F

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | In[] = ‘QUJD’  iOff = 0  iLen = 4 | ‘ABC’ | Covers Path A |
| **2** | In[] = ‘QQ==’  iOff = 0  iLen = 4 | ‘A’ | Covers Path B |
| **3** | In[] = ‘QUI=’  iOff = 0  iLen = 4 | ‘AB’ | Covers Path C |

**Loop Boundary:**

Consider N=12 for loop. (Note that for valid input N-1 must be 8 and N+1 must be 16)

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | In[] = ‘QUJD’  iOff = 0  iLen = 0 | Empty String | Covers 115F |
| **2** | In[] = ‘QUJD’  iOff = 0  iLen = 4 | ‘ABC’ | Covers 115F once |
| **3** | In[] = ‘QUJDREU=’  iOff = 0  iLen = 8 | ‘ABCDE’ | Covers 115T for N-1 |
| **4** | In[] = ‘QUJDREVGRw==’  iOff = 0  iLen = 12 | ‘ABCDEFG’ | Covers 115T for N |
| **5** | In[] = ‘QUJDREVGR0hJSg==’  iOff = 0  iLen = 16 | ‘ABCDEFGHIJ’ | Covers 115T for N+1 |

**Basis Path:**

Path 1: 109F, 115F

Path 2: 109F, 115T, 118T, 119T, 132T, 133T

Path 3: 109T, 115F

Path 4: 109T, 115T, 118T, 119F, 132T, 133F

Path 5: 109T, 115T, 118F, 119F, 132F, 133F

Note that no logical path is possible to cause 119T while 118F. Same is case with 132F and 133T. Similarly, conditions in 132 and 133 also depend upon same factor as 118, 119 so it is not possible for 118T but 132F and vice versa. Furthermore, condition 109 also shares data dependency with 118, 119, 132, 133.

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | In[] = ‘QUJD’  iOff = 0  iLen = 0 | Empty String | Covers Path1 |
| **2** | In[] = ‘QUJD’  iOff = 0  iLen = 4 | ‘ABC’ | Covers Path2 |
| **3** | In[] = ‘QQ==’  iOff = 2  iLen = 4 | Empty String | Covers Path3 |
| **4** | In[] = ‘QQ==’  iOff = 0  iLen = 4 | ‘A’ | Covers Path5 |
| **5** | In[] = ‘QUI=’  iOff = 0  iLen = 4 | ‘AB’ | Covers Path4 |

**Data Flow Testing:**

Exceptions cases not considered under sir’s guidance

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable #** | **Variable Name** | **Definitions** | **Uses** |
| 1 | iLen | 106, 109 | 109, 110, 113 |
| 2 | oLen | 110 | 111, 132, 133 |
| 3 | Op | 114, 131, 132, 133 | 131, 132, 133 |

|  |  |  |
| --- | --- | --- |
| **Variable #** | **Variable Name** | **DU pairs** |
| 1 | iLen | <106, 109>, <109, 109>, <106, 113>, <109, 113>, <106, 110>, <109, 110> |
| 2 | oLen | <110, 111>, <110, 132>, <110, 133> |
| 3 | Op | <114, 131>, <131, 132>, <131, 133>, <132, 133> |

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | In[] = ‘QUJD’  iOff = 0  iLen = 4 | ‘ABC’ | iLen = Covers <106, 109>, <106, 110>, <106, 113>  oLen = Covers <110, 111>, <110, 132>, <110, 133>  op = Covers <114, 131>, <131, 132>, <132, 133> |
| **2** | In[] = ‘QQ==’  iOff = 0  iLen = 4 | ‘A’ | iLen = Covers <106, 109>, <106, 110>, <106, 113>  oLen = Covers <110, 111>, <110, 132>, <110, 133>  op = Covers <114, 131>, <131, 132>, <131, 133> |

### **Function 5:**

**Source Code:**

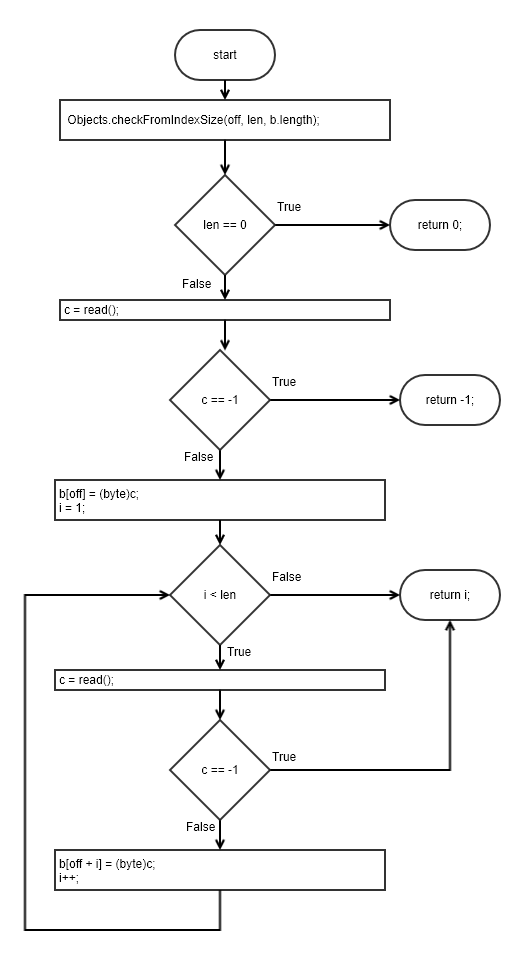
https://github.com/openjdk/jdk/blob/master/src/java.base/share/classes/java/io/InputStream.

Java

checkFromIndexSize and read are external APIs. checkFromIndexSize can be implemented as dummy stub while read is implemented as needed by each test case.



**CFG:**



**Statement Coverage:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | b[] = Empty Array  off = 0  len = 3 | 3,  b[] =‘ABC’ | External module API read() returns ‘A’, ‘B’, ‘C’ in consecutive calls. |
| **2** | b[] = Empty Array  off = 0  len = 0 | 0,  b[] = Empty Array | External module API read() is never called |
| **3** | b[] = Empty Array  off = 0  len = 3 | -1,  b[] = Empty Array | External module API read() returns -1 to notify an error at first call. |
| **4** | b[] = Empty Array  off = 0  len = 3 | 1,  b[] = ‘A’ | External module API read() returns ‘A’, -1 in consecutive calls. |

**Branch Coverage:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | b[] = Empty Array  off = 0  len = 3 | 3,  b[] =‘ABC’ | External module API read() returns ‘A’, ‘B’, ‘C’ in consecutive calls.  280F, 285F, 292TF, 294F |
| **2** | b[] = Empty Array  off = 0  len = 0 | 0,  b[] = Empty Array | External module API read() is never called.  280T |
| **3** | b[] = Empty Array  off = 0  len = 3 | -1,  b[] = Empty Array | External module API read() returns -1 to notify an error at first call.  280F, 285T |
| **4** | b[] = Empty Array  off = 0  len = 3 | 1,  b[] = ‘A’ | External module API read() returns ‘A’, -1 in consecutive calls.  280F, 285F, 292T, 294T |

**Condition Coverage with Short Circuit Evaluation:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | b[] = Empty Array  off = 0  len = 3 | 3,  b[] =‘ABC’ | External module API read() returns ‘A’, ‘B’, ‘C’ in consecutive calls.  280F, 285F, 292TF, 294F |
| **2** | b[] = Empty Array  off = 0  len = 0 | 0,  b[] = Empty Array | External module API read() is never called.  280T |
| **3** | b[] = Empty Array  off = 0  len = 3 | -1,  b[] = Empty Array | External module API read() returns -1 to notify an error at first call.  280F, 285T |
| **4** | b[] = Empty Array  off = 0  len = 3 | 1,  b[] = ‘A’ | External module API read() returns ‘A’, -1 in consecutive calls.  280F, 285F, 292T, 294T |

**Boundary Interior:**

Possible logical paths (depends upon successful or unsuccessful read, returned from stub function. Input does not effectively dictate the decision):

* 294T
* 294F

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | b[] = Empty Array  off = 0  len = 3 | 3,  b[] =‘ABC’ | External module API read() returns ‘A’, ‘B’, ‘C’ in consecutive calls.  294F |
| **2** | b[] = Empty Array  off = 0  len = 3 | 1,  b[] =‘A’ | External module API read() returns ‘A’, ‘-1’ in consecutive calls.  294T |

**Loop Boundary:**

Consider N=4 for loop boundary

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | b[] = Empty Array  off = 0  len = 1 | 1,  b[] =‘A’ | External module API read() returns ‘A’ in consecutive calls.  Covers 292F |
| **2** | b[] = Empty Array  off = 0  len = 2 | 2,  b[] =‘AB’ | External module API read() returns ‘A’, ‘B’ in consecutive calls.  Covers 292T once |
| **3** | b[] = Empty Array  off = 0  len = 4 | 4,  b[] =‘ABCD’ | External module API read() returns ‘A’, ‘B’, ‘C’, ‘D’ in consecutive calls.  Covers 292T N-1 times |
| **4** | b[] = Empty Array  off = 0  len = 2 | 4,  b[] =‘ABCDE’ | External module API read() returns ‘A’, ‘B’, ‘C’, ‘D’, ‘E’ in consecutive calls.  Covers 292T N times |
| **5** | b[] = Empty Array  off = 0  len = 2 | 4,  b[] =‘ABCDEF’ | External module API read() returns ‘A’, ‘B’, ‘C’, ‘D’, ‘E’, ‘F’ in consecutive calls.  Covers 292T N+1 times |

**Basis Path:**

Path 1: 280T

Path 2: 280F, 285T

Path 3: 280F, 285F, 292F

Path 4: 280F, 285F, 292TF, 294F

Path 5: 280F, 285F, 292T, 294T

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | b[] = Empty Array  off = 0  len = 3 | 3,  b[] =‘ABC’ | External module API read() returns ‘A’, ‘B’, ‘C’ in consecutive calls.  **Covers Path4** |
| **2** | b[] = Empty Array  off = 0  len = 0 | 0,  b[] = Empty Array | External module API read() is never called.  **Covers Path1** |
| **3** | b[] = Empty Array  off = 0  len = 3 | -1,  b[] = Empty Array | External module API read() returns -1 to notify an error at first call.  **Covers Path2** |
| **4** | b[] = Empty Array  off = 0  len = 3 | 1,  b[] = ‘A’ | External module API read() returns ‘A’, -1 in consecutive calls.  **Covers Path5** |
| **5** | b[] = Empty Array  off = 0  len = 1 | 1,  b[] = ‘A’ | External module API read() returns ‘A’ in consecutive calls.  **Covers Path3** |

**Data Flow Testing:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable #** | **Variable Name** | **Definitions** | **Uses** |
| 1 | i | 290, 292 | 292, 297 |
| 2 | c | 284, 293 | 285, 288, 294, 297 |
| 3 | len | 278 | 279, 292 |

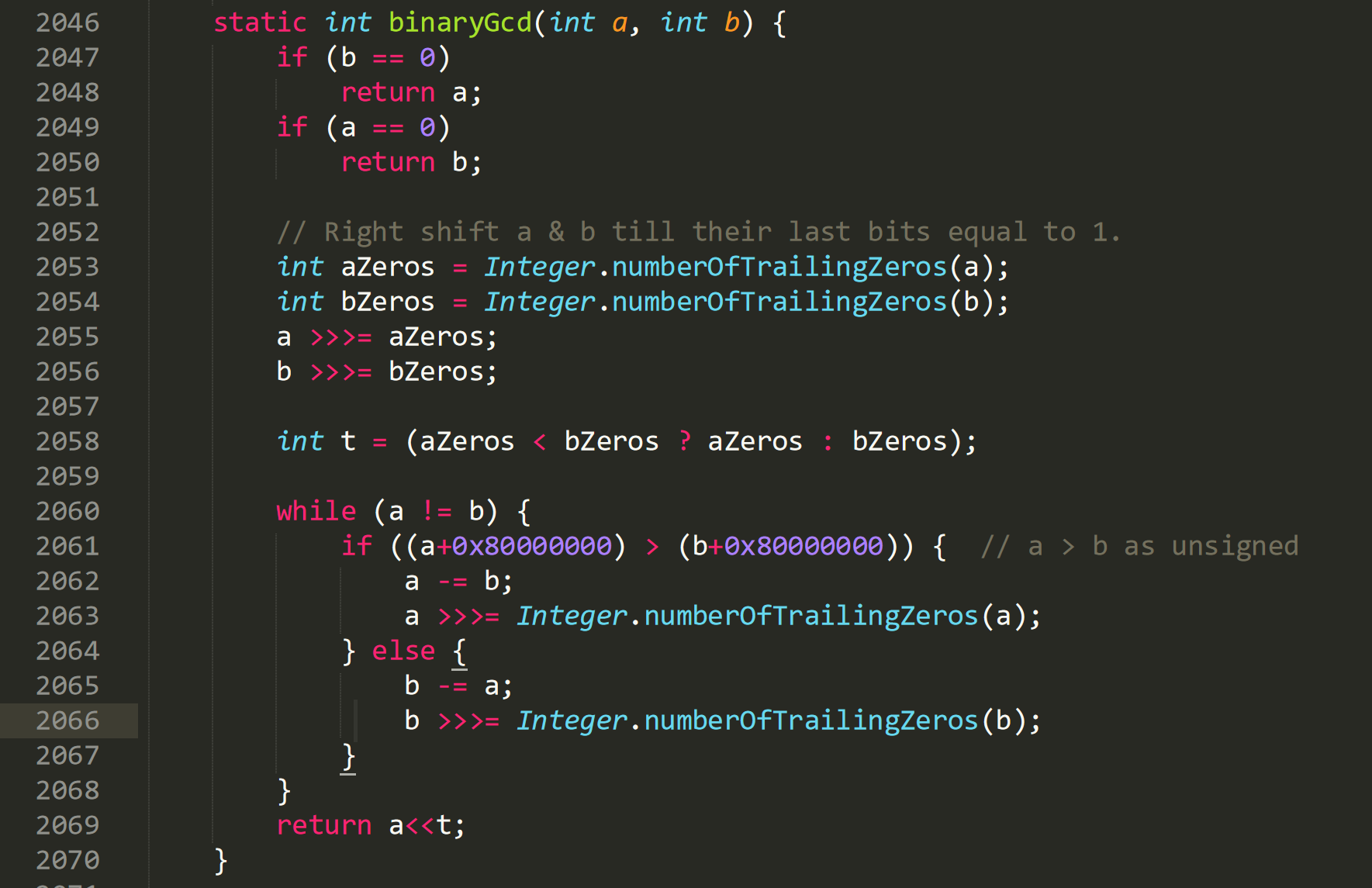
|  |  |  |
| --- | --- | --- |
| **Variable #** | **Variable Name** | **DU pairs** |
| 1 | i | <290,292>, <290,297>, <292, 292>, <292,297> |
| 2 | c | <284,285>, <284,288>, <293,294>, <293,297> |
| 3 | len | <278, 279>, <278,292> |

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | b[] = Empty Array  off = 0  len = 3 | 3,  b[] =‘ABC’ | i = Covers <290,292>, <290,297>, <292, 292>, <292,297>  c = Covers <284,285>, <284,288>, <293,294>, <293,297>  len = Covers <278, 279>, <278,292> |

### **Function 6:**

**Source Code:**

https://github.com/openjdk/jdk/tree/master/src/java.base/share/classes/java/math/ MutableBigInteger.java

****

**CFG:**

Diagram

Description automatically generated.

**Statement Coverage:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | a = 15 b = 0 | 15 | Covers statement 2047-2048 |
| **2** | a = 0  b =15 | 15 | Covers statement 2049-2050 |
| **3** | a = 98  b =56 | 14 | Covers statement 2047,2049, 2051-2069 |

**Branch Coverage:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | a = 15 b = 0 | 15 | Covers B2047T |
| **2** | a = 0  b =15 | 15 | Covers B2049T, B2047F |
| **3** | a = 98  b =56 | 14 | Covers B2047F, B2049F, B2060TF, B2061T |
| **4** | a = 56  b =98 | 14 | Covers B2047F, B2049F, B2060TF, B2061F |

**Condition Coverage with Short Circuit Evaluation:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | a = 15 b = 0 | 15 | Covers C2047T |
| **2** | a = 0  b =15 | 15 | Covers C2049T, C2047F |
| **3** | a = 98  b =56 | 14 | Covers C2047F, C2049F, C2060TF, C2061T |
| **4** | a = 56  b =98 | 14 | Covers C2047F, C2049F, C2060TF, C2061F |

**Boundary Interior:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | a = 98  b =56 | 14 | Covers boundary interior path  DEG |
| **2** | a = 56  b =98 | 14 | Covers boundary interior path  DEF |

**Loop Boundary:**

I choose loop upper bound = 5

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | a = 12  b = 12 | 12 | Loop is skipped entirely. |
| **2** | a = 4  b = 2 | 2 | Loop is run only once |
| **3** | a = 6  b = 2 | 2 | Loop is run twice. |
| **4** | a = 10  b = 2 | 2 | Loop is run 4 times |
| **5** | a = 12  b = 2 | 2 | Loop is run 5 times. |
| **6** | a = 14  b = 2 | 2 | Loop is run 6 times. |

**Basis Path:**

No. of Basis Paths = No. of decision points + 1

No. of Basis Paths = 4 + 1 = 5

Path 1: AI

Path 2: ABJ

Path 3: ABCDH

Path 4: ABCDEFH

Path 5: ABCDEGH

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | a = 15 b = 0 | 15 | Covers basis path AI |
| **2** | a = 0  b =15 | 15 | Covers basis path ABJ |
| **3** | a = 12  b = 12 | 12 | Covers basis path ABCDH |
| **4** | a = 2  b = 4 | 2 | Covers basis path ABCDEFH |
| **5** | a = 4  b = 2 | 2 | Covers basis path ABCDEFH |

**Data Flow Testing:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable #** | **Variable Name** | **Definitions** | **Uses** |
| 1 | A | 2046, 2055, 2062, 2063 | 2048, 2049, 2053, 2055, 2060, 2061, 2062, 2063, 2065, 2069 |
| 2 | b | 2046, 2056, 2065, 2066 | 2047, 2050, 2054, 2056, 2060, 2061, 2062, 2065, 2066 |
| 3 | aZeros | 2053 | 2055, 2058 |

|  |  |  |
| --- | --- | --- |
| **Variable #** | **Variable Name** | **DU pairs** |
| 1 | a | <2046, 2048> <2046, 2049>  <2046, 2053> <2046, 2055>  <2055, 2060> <2055, 2061>  <2055, 2062> <2055, 2065>  <2055, 2069>  <2062, 2063>  <2063, 2060> <2063, 2061>  <2063, 2062> <2063, 2069> |
| 2 | b | <2046, 2047> <2046, 2050>  <2046, 2054> <2046, 2056>  <2056, 2060> <2056, 2061> <2056, 2062> <2056, 2065>  <2065, 2066>  <2066, 2060> <2066, 2061> <2066, 2062> |
| 3 | aZeros | <2053, 2055> <2053, 2058> |

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | a = 15 b = 0 | 15 | For a covers  <2046, 2048>  For b covers  <2046, 2047> |
| **2** | a = 0  b =15 | 15 | For a covers  <2046, 2049>  For b covers  <2046, 2047>  <2046, 2050> |
| **3** | a = 12  b = 12 | 12 | For a covers:  <2046, 2049>  <2046, 2055>  <2055, 2060>  <2055, 2069>  For b covers:  <2046, 2047>  <2046, 2056>  <2056, 2060>  For aZeros covers:  <2053, 2055>  <2053, 2058> |
| **4** | a = 98  b =56 | 14 | For a covers  <2046, 2049>  <2046, 2053>  <2046, 2055>  <2055, 2060>  <2055, 2061>  <2055, 2062>  <2062, 2063>  <2063, 2060>  <2063, 2061>  <2063, 2062>  <2063, 2069>  For b covers  <2046, 2047>  <2046, 2054>  <2046, 2056>  <2056, 2060>  <2056, 2061> <2056, 2062>  For aZeros covers:  <2053, 2055>  <2053, 2058> |
| **5** | a = 56  b =98 | 14 | For a covers  <2046, 2049>  <2046, 2053>  <2046, 2055>  <2055, 2060>  <2055, 2061>  <2055, 2065>  <2055, 2069>  For b covers  <2046, 2047>  <2046, 2054>  <2046, 2056>  <2056, 2060>  <2056, 2061>  <2056, 2065>  <2065, 2066>  <2066, 2060>  <2066, 2061> <2066, 2062>  For aZeros covers:  <2053, 2055>  <2053, 2058> |

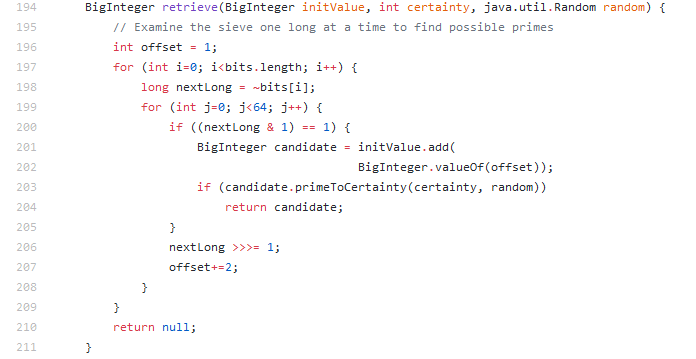
### **Function 7:**

(This function we tried to write for 4th member but from submission 2, we discontinued doing his part)

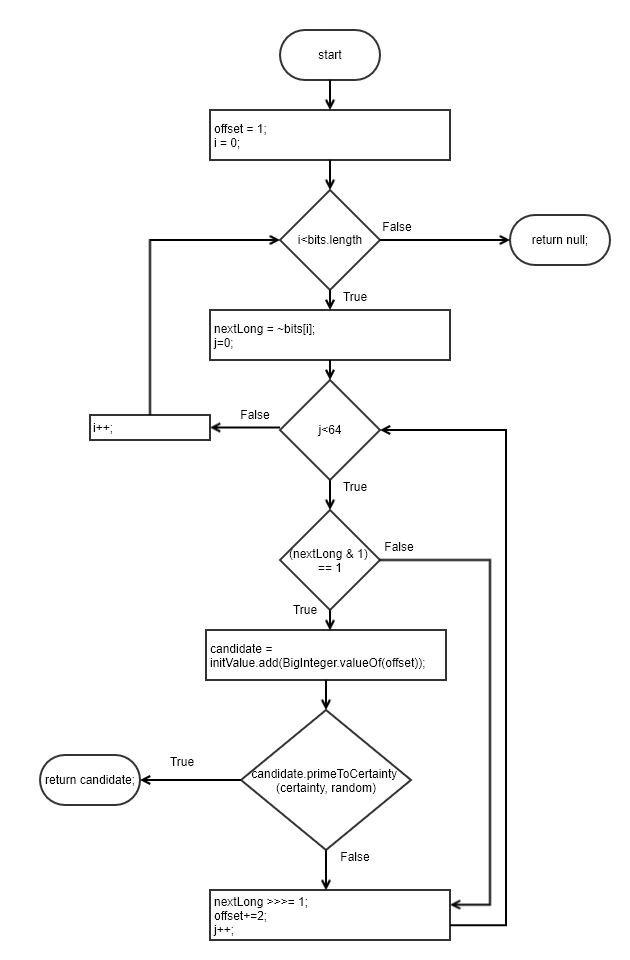
**Source Code:**

<https://github.com/openjdk/jdk/blob/master/src/java.base/share/classes/java/math/BitSieve.java>

bits are sieve bits where each bit represents a candidate odd integer. primeToCertainty is an external function which returns true if it is a prime with given probability.



**CFG:**



**Statement Coverage:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | initValue = 0;  certainity = 100;  random = 10  bits[] = b’11111010’ | 257 | Stub primeToCertainty shall return ‘False, True’ in consecutive calls. |
| **2** | initValue = 0;  certainity = 100;  random = 10  bits[] = b’11111111’ | Null | Stub primeToCertainty shall never be called. |

**Branch Coverage:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | initValue = 0;  certainity = 100;  random = 10  bits[] = b’11111010’ | 257 | Stub primeToCertainty shall return ‘False, True’ in consecutive calls.  197T, 199TF, 200TF, 203TF |
| **2** | initValue = 0;  certainity = 100;  random = 10  bits[] = b’11111111’ | Null | Stub primeToCertainty shall never be called.  197TF, 199TF, 200F |

**Condition Coverage with Short Circuit Evaluation:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | initValue = 0;  certainity = 100;  random = 10  bits[] = b’11111010’ | 257 | Stub primeToCertainty shall return ‘False, True’ in consecutive calls.  197T, 199TF, 200TF, 203TF |
| **2** | initValue = 0;  certainity = 100;  random = 10  bits[] = b’11111111’ | Null | Stub primeToCertainty shall never be called.  197TF, 199TF, 200F |

**Boundary Interior:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** |  |  |  |
| **2** |  |  |  |

**Loop Boundary:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** |  |  |  |
| **2** |  |  |  |

**Basis Path:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** |  |  |  |
| **2** |  |  |  |

**Data Flow Testing:**

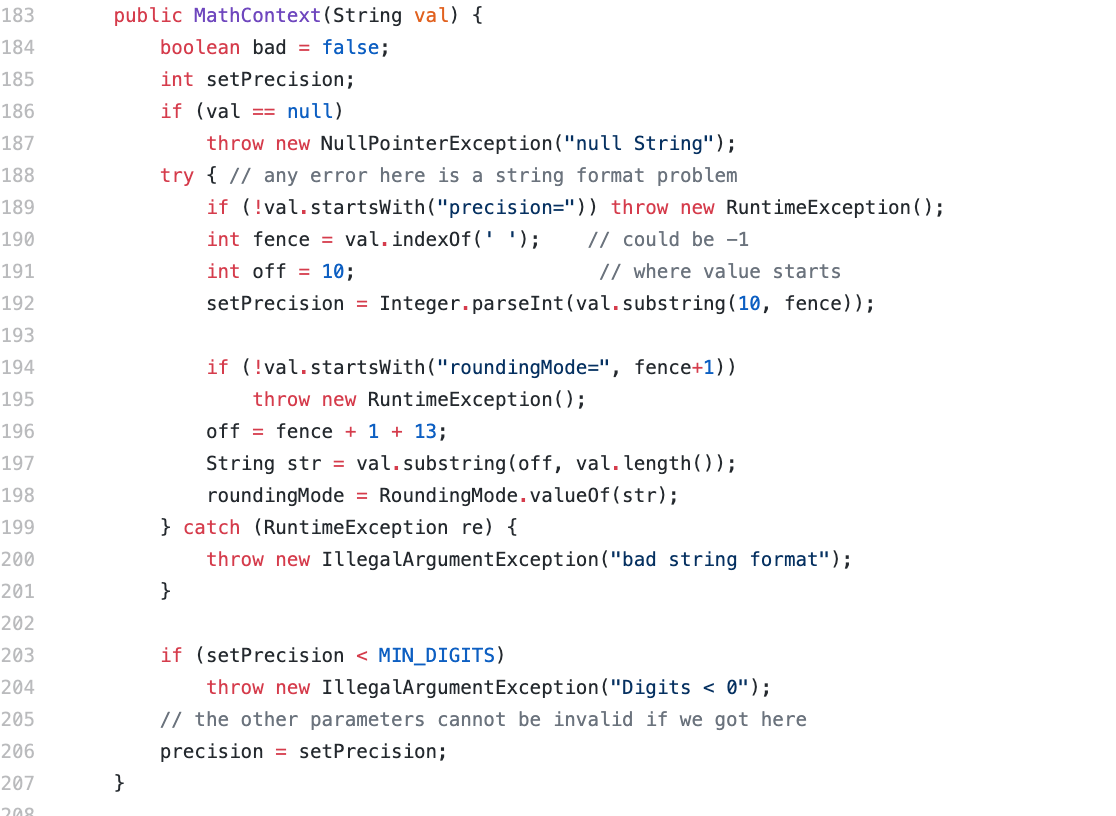
|  |  |  |  |
| --- | --- | --- | --- |
| **Variable #** | **Variable Name** | **Definitions** | **Uses** |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |

|  |  |  |
| --- | --- | --- |
| **Variable #** | **Variable Name** | **DU pairs** |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |

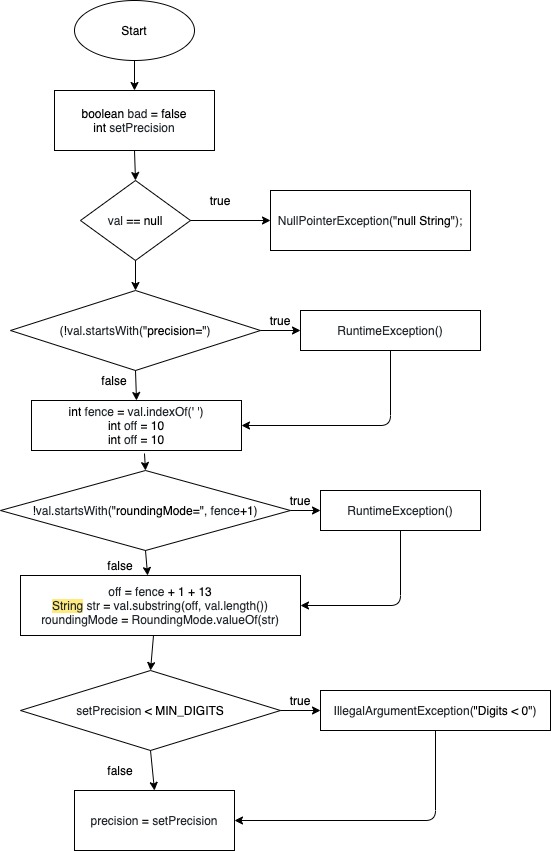
|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** |  |  |  |
| **2** |  |  |  |

### **Function 8:**

**Source Code:**

****

**CFG:**

****

**Statement Coverage:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test**  **case#** | **Input** | **Expected**  **Output** | **Comments/Remarks** |
| **1** | null | exception | Covered 184, 185, 186, 187 |
| **2** | ‘ThisString’ | exception | Covered 184, 185, 186, 188, 189 |
| **3** | ‘precision=12  12’ | exception | Covered 184, 185, 186, 188, 190, 191, 192, 194, 195 |
| **4** | roundingMode =12 12’ | exception | Covered 184, 185, 186, 188, 189 |

**Branch Coverage:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test**  **case#** | **Input** | **Expected**  **Output** | **Comments/Remarks** |
| **1** | (null) | exception | Covered B186(True) |
| **2** | ‘ThisString’ | exception | Covered B186(False), B189(True) |
| **3** | ‘precision=12  12’ | exception | Covered B186(False), B189(False), B194(True) |
| **4** | ‘roundingMode =12 12’ | Exception | Covered B186(False), B189(True) |

**Condition Coverage with Short Circuit Evaluation:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test**  **case#** | **Input** | **Expected**  **Output** | **Comments/Remarks** |
| **1** | (null) | exception | Covered C186(True) |

|  |  |  |  |
| --- | --- | --- | --- |
| **2** | ‘ThisString’ | exception | Covered C186(False), C189(True) |
| **3** | ‘precision=12  12’ | exception | Covered C186(False), C189(False),  C194(True) |
| **4** | ‘roundingMode =12 12’ | exception | Covered C186(False), C189(True) |

**Boundary Interior:**

No Loop in the program.

**Loop Boundary:**

No Loop in the program.

**Basis Path:**

**Path 1:**

183, 184, 185, 186, 203, 206

**Path 2:**

183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 196, 197, 198, 203, 206

**Path 3:**

183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 194, 195, 196, 197, 198, 199, 200, 203, 206

**Path 4:**

183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 194, 195, 196, 197, 198, 199, 200, 203, 204, 206

**Path 5:**

183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 194, 195, 196, 197, 198, 199, 200, 203, 204, 206

**Data Flow Testing:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable #** | **Variable Name** | **Definitions** | **Uses** |
| 1 | Val | 183 | 186,189,190,192,197 |
| 2 | setPrecision | 185,192 | 203,206 |
| 3 | Fence | 190 | 192,194 |

|  |  |  |
| --- | --- | --- |
| **Variable #** | **Variable Name** | **DU pairs** |
| 1 | Val | <183,186>,<183,189>,<183,190>,<183,192>,<183,197> |
| 2 | setPrecision | <192,203>,<192,206> |
| 3 | Fence | <190,192>,<190,194> |

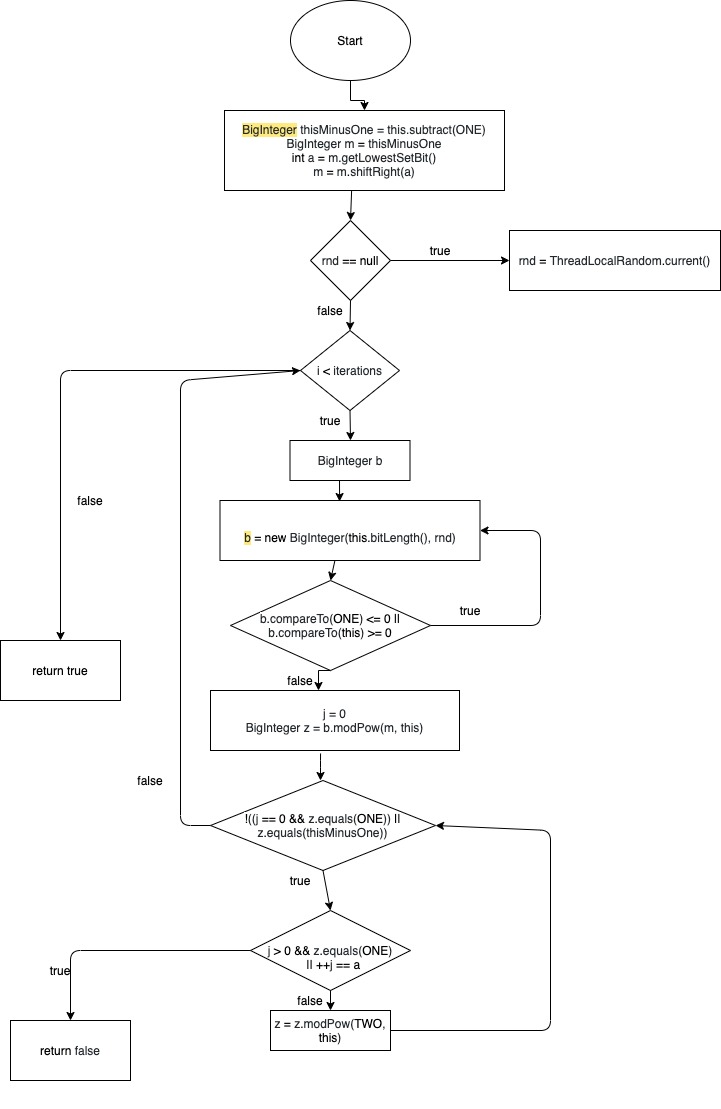
|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | ‘abcdef’ | exception | because it does not contains ‘precision=’ at start |
| **2** | ‘precision=12  12’ | exception | It returns exception because when next if executes it’ll not find ‘roundingMode=’ at start |

### **Function 9**

**Source Code:**

****

**CFG:**

****

**Statement Coverage:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test**  **case#** | **Input** | **Expected**  **Output** | **Comments/Remarks** |
| **1** | (4, null) | true | covers 1103,1104,1105,,1106,1109,1110,1111,1112,1113,1114-1128 |
| **2** | (0,4) | true | covers 1103,1104,1105,,1106,1109,1112,1127 |
| **3** | (null,null) | true | covers 1103-1111,1112 |
| **4** | (7,9) | false | Covered 1103-1111,1112-1123 |

**Branch Coverage:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test**  **case#** | **Input** | **Expected**  **Output** | **Comments/Remarks** |
| **1** | (4, null) | true | covers B1109(T),  B1112(T), B1117(T),  B1121(T) |
| **2** | (0, 4) | true | covers B1109(F),  B1112(F) |
| **3** | (null, null) | no output |  |
| **4** | (7,9) | false | covers B1109(T)  B1112(T), B1117(T),  B1121(T), B1122(T) |

**Condition Coverage with Short Circuit Evaluation:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test**  **case#** | **Input** | **Expected**  **Output** | **Comments/Remarks** |
| **1** | (4, null) | true | covers C1109(T),  C1112(T), C1117(T),  C1121(T) |
| **2** | (0, 4) | true | covers C1109(F),  C1112(F) |
| **3** | (null, null) | no output | covers C1109(T),  C1112(Crash) |
| **4** | (7,9) | false | covers C1109(T),  C1112(T), C1117(T),  C1121(T), C1122(T) |

**Boundary Interior:**

Below we are taking line numbers to execute boundary interior.

1112 -> 1114

1112 -> 1114 -> 1115

1112 -> 1114 -> 1116 -> 1117

1112 -> 1114 -> 1116 -> 1117 -> 1116

1112 -> 1114 -> 1116 -> 1117 -> 1116 -> 1119

1112 -> 1114 -> 1116 -> 1117 -> 1116 -> 1119 -> 1120

1112 -> 1114 -> 1116 -> 1117 -> 1116 -> 1119 -> 1120 -> 1121

1112 -> 1114 -> 1116 -> 1117 -> 1116 -> 1119 -> 1120 -> 1121 -> 1122

1112 -> 1114 -> 1116 -> 1117 -> 1116 -> 1119 -> 1120 -> 1121 -> 1122 -> 1123

1112 -> 1114 -> 1116 -> 1117 -> 1116 -> 1119 -> 1120 -> 1121 -> 1122 -> 1124

1112 -> 1114 -> 1116 -> 1117 -> 1116 -> 1119 -> 1120 -> 1121 -> 1122 -> 1124 -> 1121

1112 -> 1114 -> 1116 -> 1117 -> 1116 -> 1119 -> 1120 -> 1121 -> 1122 -> 1124 -> 1121 -> 1127

**Loop Boundary:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | (0,2) | True | Covers 1109T  When the loop will not execute |
| **2** | (1,2) | True | Covers 1112T once |
| **3** | (5,2) | False | Covers 1112T  more than one passes |

**Basis Path:**

**Path 1:**

1101, 1103, 1104, 1105, 1106, 1127

**Path 2:**

1101, 1103, 1104, 1105, 1106, 1109, 1110, 1127

**Path 3:**

1101, 1103, 1104, 1105, 1106, 1109, 1110, 1112, 1113, 1114, 1115, 1116, 1117, 1119, 1120, 1127

**Path 4:**

1101, 1103, 1104, 1105, 1106, 1109, 1110, 1112, 1113, 1114, 1115, 1116, 1117, 1119, 1120, 1121, 1122, 1123, 1124, 1127

**Data Flow Testing:**

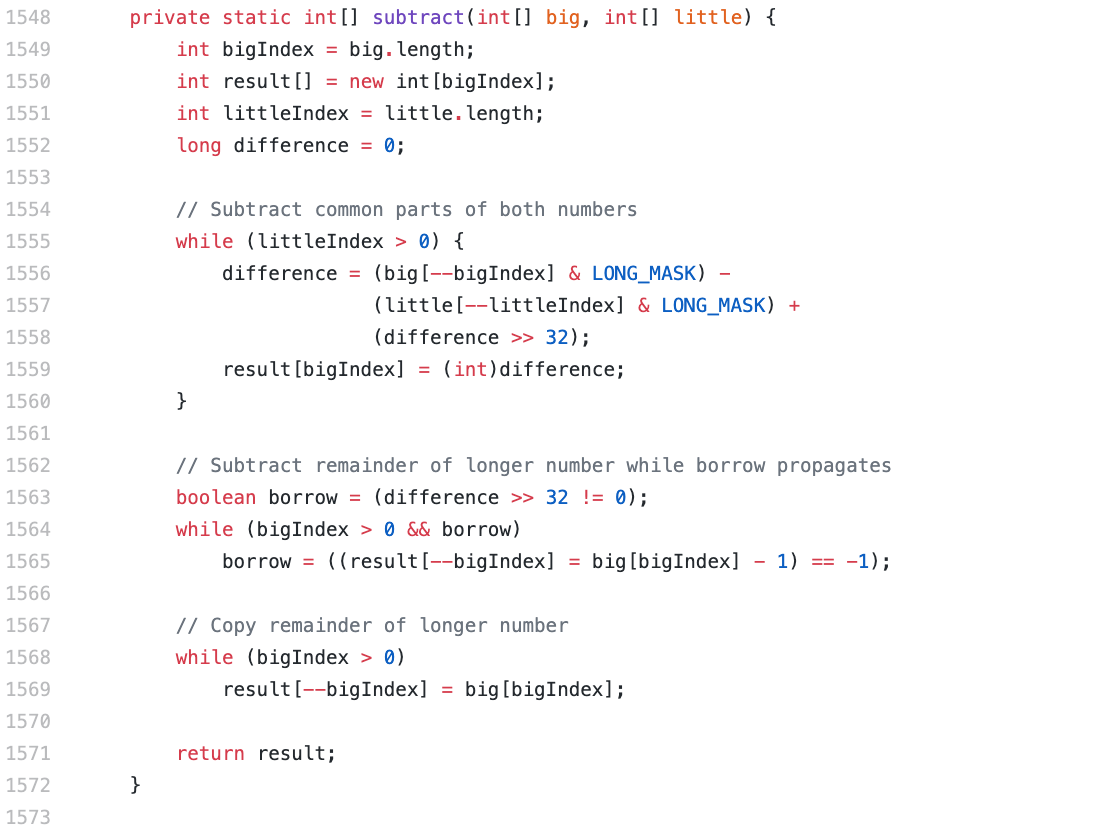
|  |  |  |  |
| --- | --- | --- | --- |
| **Variable #** | **Variable Name** | **Definitions** | **Uses** |
| 1 | iterations | 1101 | 1112 |
| 2 | Rnd | 1101,1110 | 1109,1116 |
| 3 | A | 1105 | 1106 |

|  |  |  |
| --- | --- | --- |
| **Variable #** | **Variable Name** | **DU pairs** |
| 1 | iterations | <1101,1112> |
| 2 | Rnd | <1101,1109>,<1110,1116> |
| 3 | A | <1105,1106> |

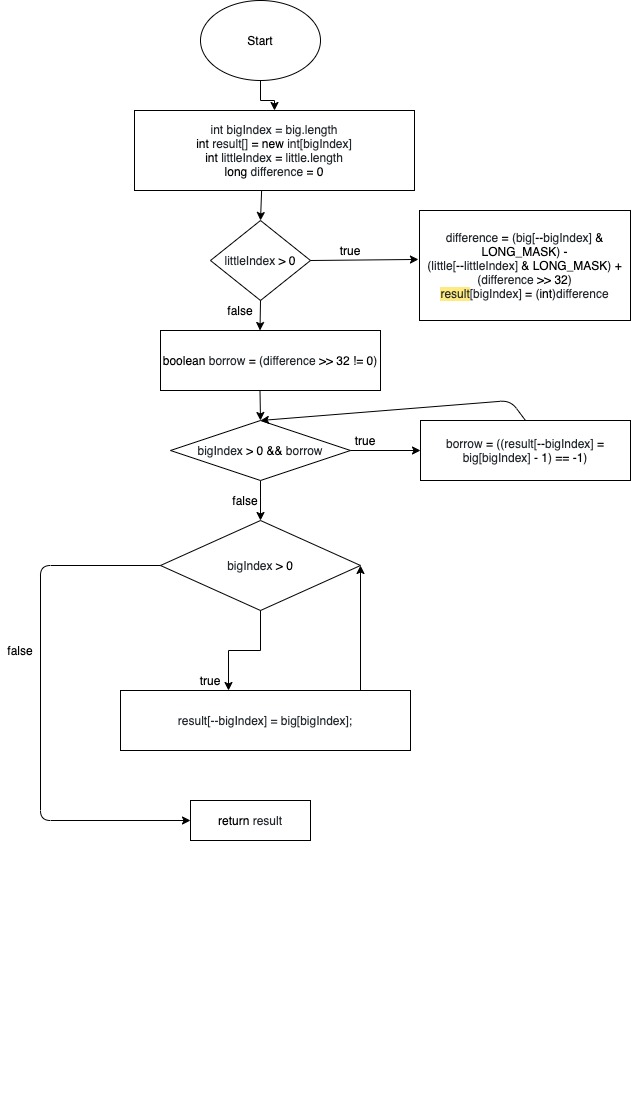
|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | (4, null) | true | It returns true second null value is handled in function |
| **2** | (7,9) | false | It returns the result false due to its values |

### **Function 10:**

**Source Code:**

****

**CFG:**

****

**Statement Coverage:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test**  **case#** | **Input** | **Expected**  **Output** | **Comments/Remarks** |
| **1** | x = {10,20}  y = {30,40} | [-21,20] | covers 1549, 1550, 1551, 1552, 1553, 1555,  1563,1564, 1565, 1568 |
| **2** | x={10,20}  y = {} | [10,20] | covers 1549, 1550, 1551, 1552, 1553, 1555,  1563,1564, 1565, 1568,  1569 |
| **3** | x = {}  y = {30, 40} | [30, 40] | 2nd empty array case is not handled |

**Branch Coverage:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test**  **case#** | **Input** | **Expected**  **Output** | **Comments/Remarks** |
| **1** | x = {10, 20}  y = {30, 40} | [-21,20] | covers B1555T,  B1564T, B1568T |
| **2** | x = {10,20}  y = {} | [10,20] | covers B1555F, B1564T, B1568T |
| **3** | x = {}  y = {30, 40} | [30, 40] | covers B1555F, B1564F, B1568F |

**Condition Coverage with Short Circuit Evaluation:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test**  **case#** | **Input** | **Expected**  **Output** | **Comments/Remarks** |
| **1** | x = {10,20};  y = {30,40} | [-21,20] | covers C1555T,  C1564T, C1568T |
| **2** | x={10,20}  y = {} | [10,20] | covers C1555F,  C1564T, C1568T |
| **3** | x ={}  y = {30, 40} | [30, 40] | covers C1555F, C1564F, C1568F |

**Boundary Interior:**

**Loop 1:**

1555 -> 1556

1555 -> 1556 -> 1557

1555 -> 1556 -> 1557 -> 1558

1555 -> 1556 -> 1557 -> 1558 -> 1559

1555 -> 1556 -> 1557 -> 1558 -> 1559 -> 1555

**Loop 2:**

1564 -> 1565

1564 -> 1565 - 1564

**Loop 3:**

1568 -> 1569

1568 -> 1569 -> 1568

**Loop Boundary:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Test case#** | **Input** | **Expected Output** | **Comments/Remarks** |
| **1** | ([0,2], []) | [0,2] | Covers:  Loop 1:  1555T  Loop 2:  1564T  Loop 3:  1568T  When the loop will not execute |
| **2** | ([5],[2]) | [2,4] | loop 1:  1555T  loop 2:  1564T  loop 3:  1568T  Only one iteration |
| **3** | ([10,20], [30,40]) | [-21,20] | loop 1:  littleIndex > 0 True  loop 2:  bigIndex > 0 True  loop 3:  bigIndex > 0 True  more than one passes |

**Basis Path:**

**Path 1:**

1548, 1549, 1550, 1551, 1552, 1555, 1556, 1557, 1558, 1559, 1563, 1571

**Path 2:**

1548, 1549, 1550, 1551, 1552, 1555, 1556, 1557, 1558, 1559, 1563, 1564, 1565, 1571

**Path 3:**

1548, 1549, 1550, 1551, 1552, 1555, 1556, 1557, 1558, 1559, 1563, 1564, 1565, 1568, 1569, 1571

**Path 4:**

1548, 1549, 1550, 1551, 1552, 1555, 1556, 1557, 1558, 1559, 1563, 1568, 1569, 1571

**Data Flow Testing:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variable #** | **Variable Name** | **Definitions** | **Uses** |
| 1 | big | 1548 | 1549, 1556, 1565, 1569 |
| 2 | little | 1548 | 1551,1556 |
| 3 | borrow | 1563,1565 | 1564 |

|  |  |  |
| --- | --- | --- |
| **Variable #** | **Variable Name** | **DU pairs** |
| 1 | big | <1548,1549>,<1548,1549><1548,1556><1565,1569> |
| 2 | little | <1548,1551>,<1548,1556> |
| 3 | borrow | <1563,1564> |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Test case#** | **Input** | **Output** | **Expected Output** | **Pass/Fail** | **Comments/Remarks** |
| **1** | x = {10, 20}  y = {30, 40} | [-21,20] | [-21,20] | Pass | It returns true second null value is handled in function |
| **2** | x={10,20}  y = {} | [10,20] | [10,20] | Pass | It returns the result false due to its values |

## Project Contribution

|  |  |  |  |
| --- | --- | --- | --- |
| **Member** | **Submission 1** | **Submission 2** | **Submission 3** |
| **Danish** | Setup and Run the web application, resolved all errors to run the project successfully | Chose func 1, 4, 5, 7  Wrote test cases for these functions | Wrote test cases for these func 1, 4 , 5 |
| **Abu Bakar** | Documented the environment setup and prepared report for submission 1. | Chose func 2, 3, 6  Wrote test cases for these functions | Wrote test cases for these func 2, 3 , 6 |
| **Awais** | Was not part of the group at that time. | Chose func 8, 9, 10  Wrote test cases for these functions  Submitted late, and individually. | Wrote test cases for these func 8, 9, 10 |
| **Musa** | No contribution | No contribution | No contribution |

**Note:**

In the 2nd submission, we thought we would split function on behalf of the 4th member, but since we all have other assignments and office work too. So, we are not doing anything on behalf of 4th member.

In the 2nd submission, Danish wrote test cases for an additional function 7.   
Abu Bakar and Awais could not do so because of time constraint.