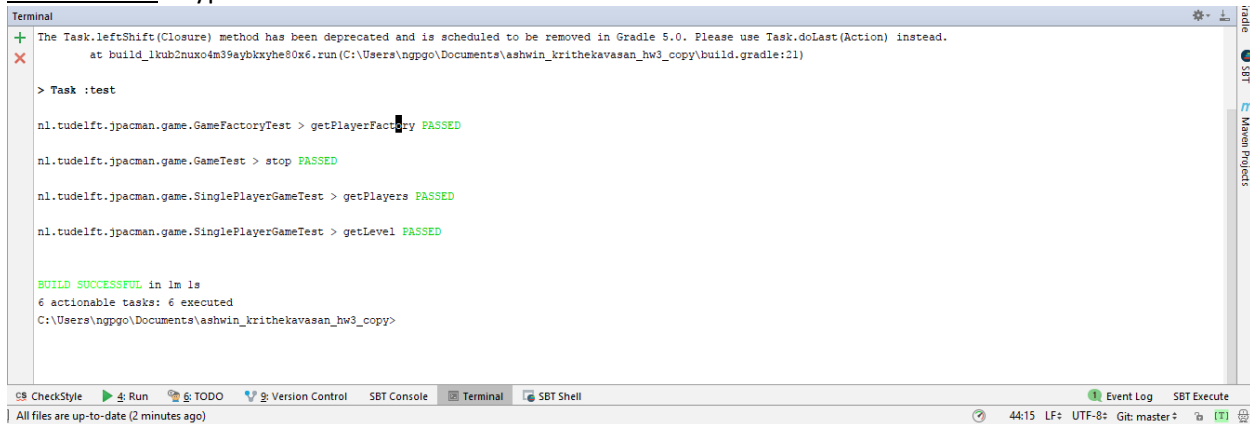The main program to launch application is in **src/main/java/nl.tudelft.jpacman/Launcher.java**

Gradle and SBT builds: Both Gradle and SBT builds have been included in the project

Application Run Using Gradle:

Gradle Build - Type " **Gradle build** " to build Gradle.

```
Terminal
+  The Task.leftShift(Closure) method has been deprecated and is scheduled to be removed in Gradle 5.0. Please use Task.doLast(Action) instead.
x         at build_1kub2nuxo4m39aybkxyhe80x6.run(C:\Users\ngpgo\Documents\ashwin_krithekavasan_hw3_copy\build.gradle:21)

   > Task :test

   nl.tudelft.jpacman.game.GameFactoryTest > getPlayerFactory PASSED

   nl.tudelft.jpacman.game.GameTest > stop PASSED

   nl.tudelft.jpacman.game.SinglePlayerGameTest > getPlayers PASSED

   nl.tudelft.jpacman.game.SinglePlayerGameTest > getLevel PASSED


   BUILD SUCCESSFUL in 1m 1s
   6 actionable tasks: 6 executed
   C:\Users\ngpgo\Documents\ashwin_krithekavasan_hw3_copy>
```
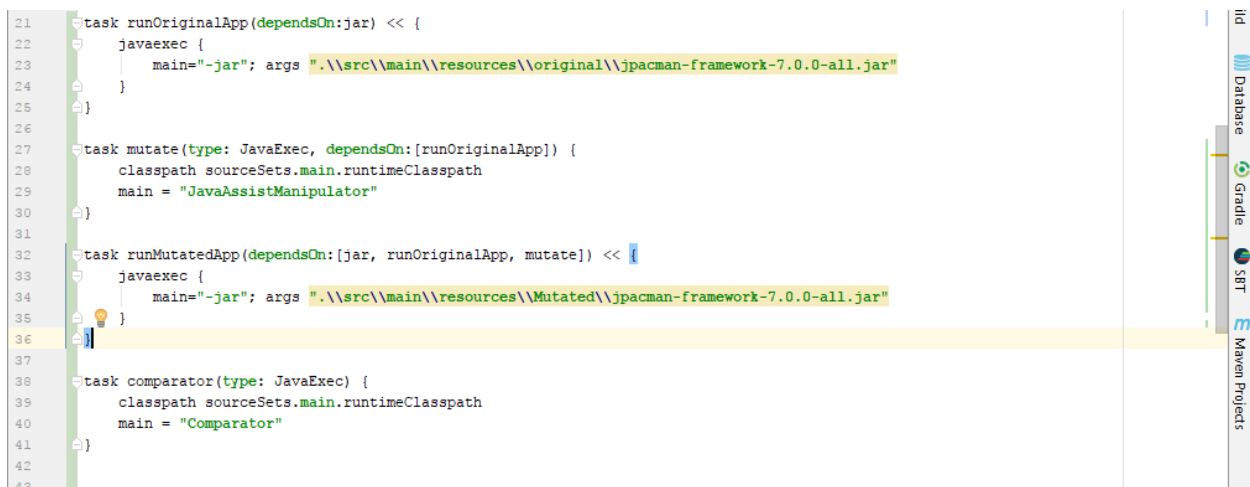
CheckStyle   4: Run   6: TODO   9: Version Control   SBT Console   Terminal   SBT Shell   Event Log   SBT Execute
All files are up-to-date (2 minutes ago)   44:15 LF÷ UTF-8÷ Git: master÷

Gradle Tasks:
Run OriginalApp task – Runs the original application.
Run Mutate task- Mutates the original class files (also the task depends on Run Original jar task).
Run MutatedApp task - Runs the mutated jar files
Comparator task - which invokes the comparator class and displays the error line which causes the application and therefore build to fail.

```
21  task runOriginalApp(dependsOn:jar) << {
22      javaexec {
23          main="-jar"; args ".\\src\\main\\resources\\original\\jpacman-framework-7.0.0-all.jar"
24      }
25  }
26
27  task mutate(type: JavaExec, dependsOn:[runOriginalApp]) {
28      classpath sourceSets.main.runtimeClasspath
29      main = "JavaAssistManipulator"
30  }
31
32  task runMutatedApp(dependsOn:[jar, runOriginalApp, mutate]) << {
33      javaexec {
34          main="-jar"; args ".\\src\\main\\resources\\Mutated\\jpacman-framework-7.0.0-all.jar"
35      }
36  }
37
38  task comparator(type: JavaExec) {
39      classpath sourceSets.main.runtimeClasspath
40      main = "Comparator"
41  }
42
43
```

Gradle Run: To run the original jar file and mutated jar file type in

> "gradle runMutatedApp --continue comparator"

```
C:\Users\ngpgo\Documents\ashwin_krithekavasan_hw3_copy>gradle runMutatedApp --continue comparator

> Configure project :
The Task.leftShift(Closure) method has been deprecated and is scheduled to be removed in Gradle 5.0. Please use Task.doLast(Action) instead.
        at build_1kub2nuxo4m39aybkxyhe80x6.run(C:\Users\ngpgo\Documents\ashwin_krithekavasan_hw3_copy\build.gradle:21)
<=======------> 50% EXECUTING [1m 37s]
> :runOriginalApp
```

```
CheckStyle    4: Run    6: TODO    9: Version Control    SBT Console    Terminal    SBT Shell    Event Log    SBT Execute
All files are up-to-date (12 minutes ago)                                              30:36  LF  UTF-8  Git: master
```

This will execute the run original app task, run mutated app task and generate logging text for both the runs.

Also, it will run a comparator task to compare both the text files generated by running original jar and mutated jar.

```
> Task :runMutatedApp
Exception in thread "main" nl.tudelft.jpacman.PacmanConfigurationException: Input text cannot be null.
        at nl.tudelft.jpacman.level.MapParser.checkMapFormat(MapParser.java:208)
        at nl.tudelft.jpacman.level.MapParser.parseMap(MapParser.java:182)
        at nl.tudelft.jpacman.level.MapParser.parseMap(MapParser.java:254)
        at nl.tudelft.jpacman.level.MapParser.parseMap(MapParser.java:274)
        at nl.tudelft.jpacman.Launcher.makeLevel(Launcher.java:96)
        at nl.tudelft.jpacman.Launcher.makeGame(Launcher.java:82)
        at nl.tudelft.jpacman.Launcher.launch(Launcher.java:191)
        at nl.tudelft.jpacman.Launcher.main(Launcher.java:226)
```

```
> Task :comparator
Two files have different content. They differ at line 2
File1 has Line Number: 28 TypeofStatement: Assign Parameters: SpriteStore.SpriteStore().spriteMap: :[],
File2 has Line Number: 24 TypeofStatement: Assign Parameters: PlayerFactory.PlayerFactory().sprites: :nl.tudelft.jpacman.sprite.PacManSprites@63947c6b, PlayerFactory.PlayerFactory().
spriteStore: :nl.tudelft.jpacman.sprite.PacManSprites@63947c6b,  at line 2


FAILURE: Build failed with an exception.
```

```
Terminal

FAILURE: Build failed with an exception.

* Where:
Build file 'C:\Users\ngpgo\Documents\ashwin_krithekavasan_hw3_copy\build.gradle' line: 33

* What went wrong:
Execution failed for task ':runMutatedApp'.
> Process 'command 'C:\Program Files\Java\jdk1.8.0_144\bin\java.exe'' finished with non-zero exit value 1

* Try:
Run with --stacktrace option to get the stack trace. Run with --info or --debug option to get more log output.

* Get more help at https://help.gradle.org

BUILD FAILED in 2m 32s
7 actionable tasks: 6 executed, 1 up-to-date
```

```
CheckStyle    4: Run    6: TODO    9: Version Control    SBT Console    Terminal    SBT Shell    Event Log    SBT Execute
All files are up-to-date (16 minutes ago)                                              23:41  LF  UTF-8  Git: master
```

The build fails because the of difference in mutated class file and original class file (Screenshot attached below).We can see that the operator is changed from == to != which causes application to throw exception, however the trace of the application is captured till it throws the application

```
> Task :runMutatedApp
Exception in thread "main" nl.tudelft.jpacman.PacmanConfigurationException: Input text cannot be null.
        at nl.tudelft.jpacman.level.MapParser.checkMapFormat(MapParser.java:208)
        at nl.tudelft.jpacman.level.MapParser.parseMap(MapParser.java:182)
        at nl.tudelft.jpacman.level.MapParser.parseMap(MapParser.java:254)
        at nl.tudelft.jpacman.level.MapParser.parseMap(MapParser.java:274)
        at nl.tudelft.jpacman.Launcher.makeLevel(Launcher.java:96)
        at nl.tudelft.jpacman.Launcher.makeGame(Launcher.java:82)
        at nl.tudelft.jpacman.Launcher.launch(Launcher.java:191)
        at nl.tudelft.jpacman.Launcher.main(Launcher.java:226)
```

Original class File:

Mutated class file:

Mutations Implemented: (the mutations are implemented on all the class files).

1. Encapsulation – AMC
2. Polymorphism - IPC – Explicit call of a parent's constructor deletion:
3. Arithmetic Operator Mutation
4. Relational Operator Mutation
5. Logical Operator Mutation
6. Conditional Operator Mutation
7. Shift Operator Mutation
8. Assignment Operator Mutation

Java Assist: *\src\main\java\JavaAssistManipulator.java
This program creates the mutated class files using parsed programs and implements mutations.
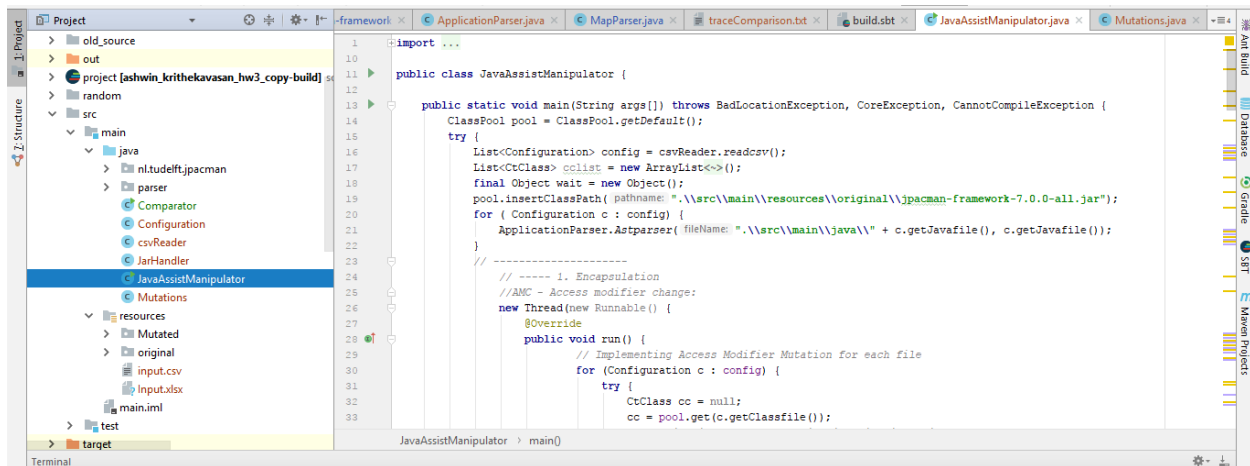
Parser logic is in the path : *\src\main\java\parser\ApplicationParser.java

Comparator: *\src\main\java\Comparator.java

This program compares the logging text generated by running mutated application and original application
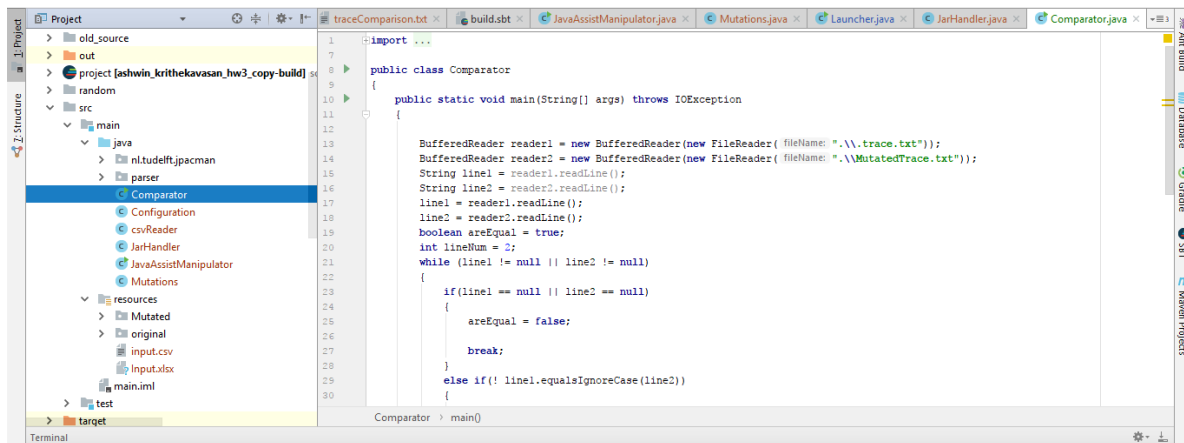
Text Files:

*\.trace.txt – Generated by running the original application

*\MutatedTrace.txt – Generated by running the Mutated application

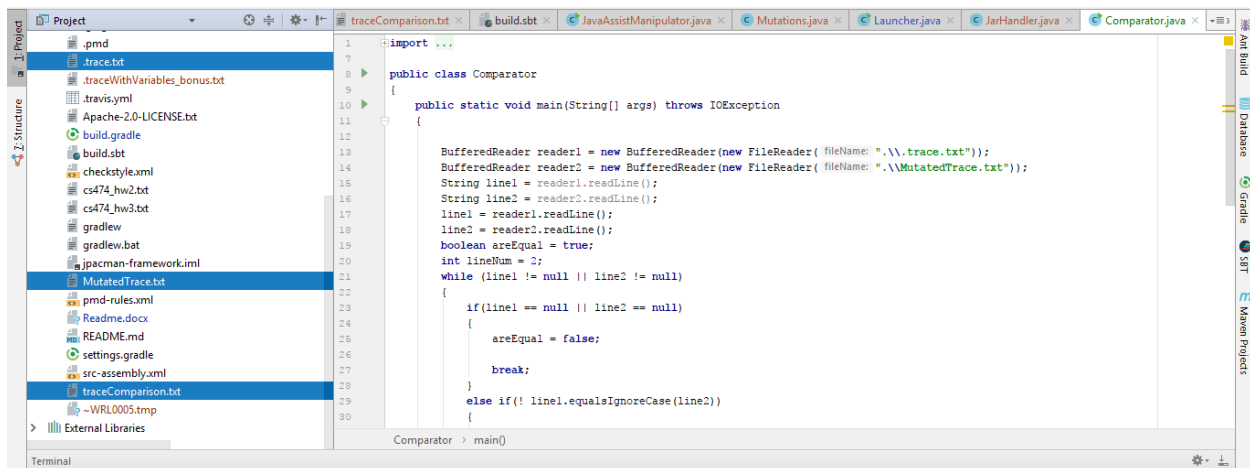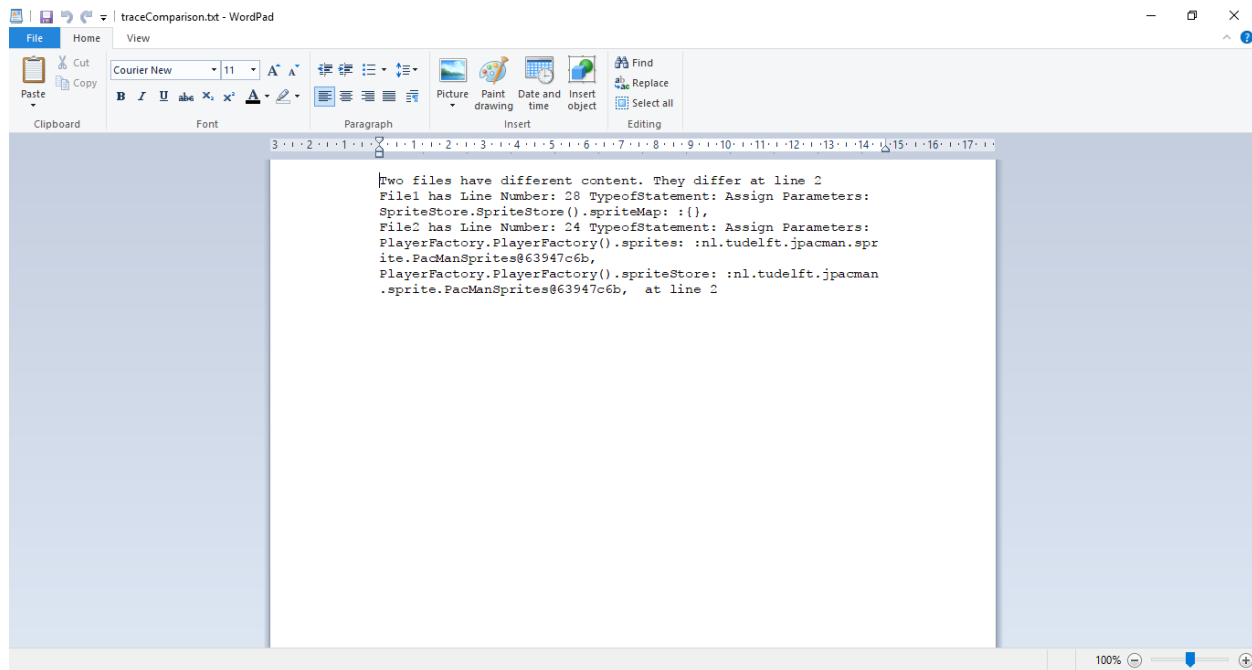*\traceComparison.txt – Generated by running the comparison module.

File last written on13/11/17 18:15:19
Line Number: 28 TypeofStatement: Assign Parameters:
SpriteStore.SpriteStore().spriteMap: :{},
Line Number: 24 TypeofStatement: Assign Parameters:
PlayerFactory.PlayerFactory().sprites: :nl.tudelft.jpacman.spr
ite.PacManSprites@4d7e1886,
PlayerFactory.PlayerFactory().spriteStore: :nl.tudelft.jpacman
.sprite.PacManSprites@4d7e1886,
Line Number: 25 TypeofStatement: Assign Parameters:
GameFactory.GameFactory().playerFactory: :nl.tudelft.jpacman.l
evel.PlayerFactory@3cd1a2f1,
GameFactory.GameFactory().playerFactory: :nl.tudelft.jpacman.l
evel.PlayerFactory@3cd1a2f1,
Line Number: 23 TypeofStatement: Assign Parameters:
GhostFactory.GhostFactory().sprites: :nl.tudelft.jpacman.sprit
e.PacManSprites@4d7e1886,
GhostFactory.GhostFactory().spriteStore: :nl.tudelft.jpacman.s
prite.PacManSprites@4d7e1886,
Line Number: 59 TypeofStatement: Assign Parameters:
LevelFactory.LevelFactory().sprites: :nl.tudelft.jpacman.sprit
e.PacManSprites@4d7e1886,
LevelFactory.LevelFactory().spriteStore: :nl.tudelft.jpacman.s
prite.PacManSprites@4d7e1886,
Line Number: 60 TypeofStatement: Assign Parameters:
LevelFactory.LevelFactory().ghostIndex: :-1,
Line Number: 61 TypeofStatement: Assign Parameters:
LevelFactory.LevelFactory().ghostFact: :nl.tudelft.jpacman.npc
.ghost.GhostFactory@2ff4acd0,
LevelFactory.LevelFactory().ghostFactory: :nl.tudelft.jpacman.
npc.ghost.GhostFactory@2ff4acd0,
Line Number: 27 TypeofStatement: Assign Parameters:

File last written on13/11/17 18:17:34
Line Number: 24 TypeofStatement: Assign Parameters:
PlayerFactory.PlayerFactory().sprites: :nl.tudelft.jpacman.spr
ite.PacManSprites@63947c6b,
PlayerFactory.PlayerFactory().spriteStore: :nl.tudelft.jpacman
.sprite.PacManSprites@63947c6b,
Line Number: 25 TypeofStatement: Assign Parameters:
GameFactory.GameFactory().playerFactory: :nl.tudelft.jpacman.l
evel.PlayerFactory@6ff3c5b5,
GameFactory.GameFactory().playerFactory: :nl.tudelft.jpacman.l
evel.PlayerFactory@6ff3c5b5,
Line Number: 23 TypeofStatement: Assign Parameters:
GhostFactory.GhostFactory().sprites: :nl.tudelft.jpacman.sprit
e.PacManSprites@63947c6b,
GhostFactory.GhostFactory().spriteStore: :nl.tudelft.jpacman.s
prite.PacManSprites@63947c6b,
Line Number: 59 TypeofStatement: Assign Parameters:
LevelFactory.LevelFactory().sprites: :nl.tudelft.jpacman.sprit
e.PacManSprites@63947c6b,
LevelFactory.LevelFactory().spriteStore: :nl.tudelft.jpacman.s
prite.PacManSprites@63947c6b,
Line Number: 60 TypeofStatement: Assign Parameters:
LevelFactory.LevelFactory().ghostIndex: :-1,
Line Number: 61 TypeofStatement: Assign Parameters:
LevelFactory.LevelFactory().ghostFact: :nl.tudelft.jpacman.npc
.ghost.GhostFactory@28a418fc,
LevelFactory.LevelFactory().ghostFactory: :nl.tudelft.jpacman.
npc.ghost.GhostFactory@28a418fc,
Line Number: 27 TypeofStatement: Assign Parameters:
BoardFactory.BoardFactory().sprites: :nl.tudelft.jpacman.sprit
e.PacManSprites@63947c6b

SBT Build and Run:

Type the following command in terminal

> java -jar .\src\main\resources\original\jpacman-framework-7.0.0-all.jar

to run original pacman application. The trace for the original application run is created with a latest time stamp.

C:\Users\ngpgo\Documents\ashwin_krithekavasan_hw3_copy>java -jar .\src\main\resources\original\jpacman-framework-7.0.0-all.jar
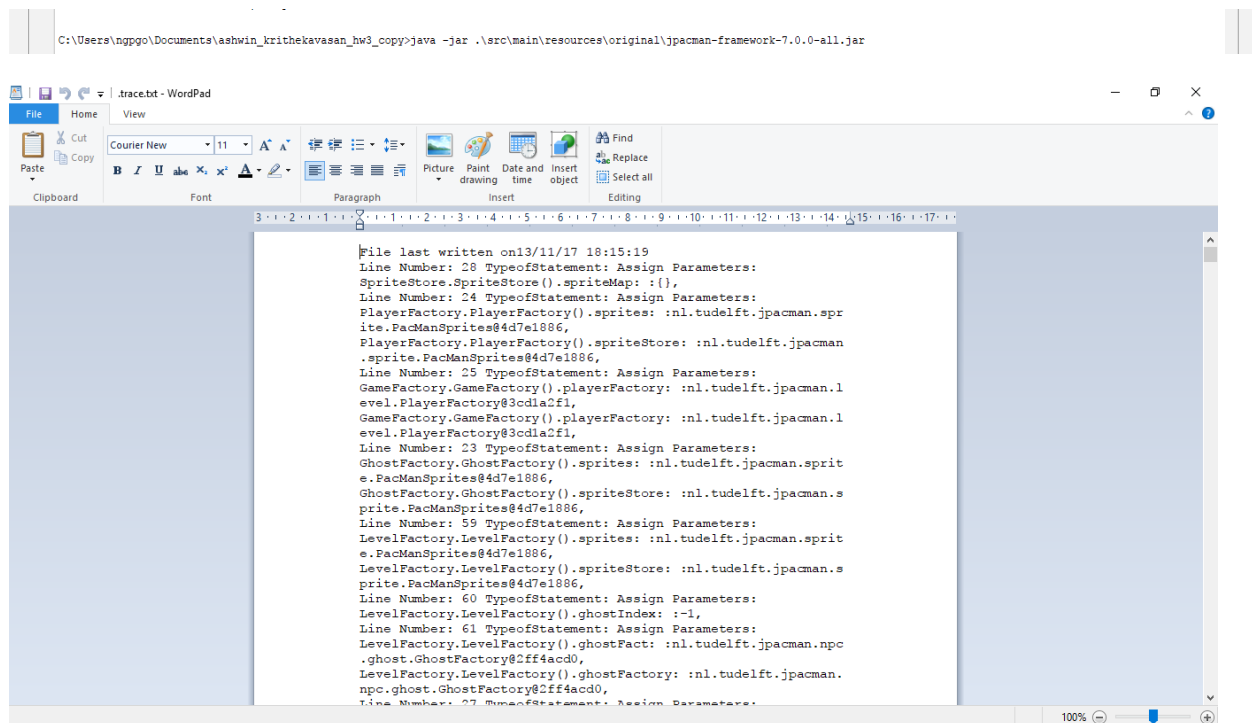
Type the following command

<div style="text-align:center">sbt "runMain JavaAssistManipulator"</div>

It will take original class files from the jar and implement mutations.

```
C:\Users\ngpgo\Documents\ashwin_krithekavasan_hw3_copy>sbt "runMain JavaAssistManipulator
"C:\Users\ngpgo\.sbt\preloaded\org.scala-sbt.sbt\1.0.1"\jars\sbt.jar"
Java HotSpot(TM) 64-Bit Server VM warning: ignoring option MaxPermSize=256m; support was removed in 8.0
[info] Loading global plugins from C:\Users\ngpgo\.sbt\0.13\plugins
[info] Loading project definition from C:\Users\ngpgo\Documents\ashwin_krithekavasan_hw3_copy\project
[info] Set current project to jpacman-framework (in build file:/C:/Users/ngpgo/Documents/ashwin_krithekavasan_hw3_copy/)
[info] Compiling 93 Java sources to C:\Users\ngpgo\Documents\ashwin_krithekavasan_hw3_copy\target\classes...
```

CheckStyle   4: Run   6: TODO   9: Version Control   SBT Console   Terminal   SBT Shell   Event Log   SBT Execute
All files are up-to-date (today 18:04)   11:1   CRLF   UTF-8   Git: master   (T)

Type the following command

<div style="text-align:center">java -jar .\src\main\resources\Mutated\jpacman-framework-7.0.0-all.jar</div>

The mutated class are written in this jar file and the mutated application is run. It will call an exception because of the mutation. It will also create the mutated text with the latest time stamp.

```
Terminal
+
X
C:\Users\ngpgo\Documents\ashwin_krithekavasan_hw3_copy>java -jar .\src\main\resources\Mutated\jpacman-framework-7.0.0-all.jar
Exception in thread "main" nl.tudelft.jpacman.PacmanConfigurationException: Input text cannot be null.
        at nl.tudelft.jpacman.level.MapParser.checkMapFormat(MapParser.java:208)
        at nl.tudelft.jpacman.level.MapParser.parseMap(MapParser.java:182)
        at nl.tudelft.jpacman.level.MapParser.parseMap(MapParser.java:254)
        at nl.tudelft.jpacman.level.MapParser.parseMap(MapParser.java:274)
        at nl.tudelft.jpacman.Launcher.makeLevel(Launcher.java:96)
        at nl.tudelft.jpacman.Launcher.makeGame(Launcher.java:82)
        at nl.tudelft.jpacman.Launcher.launch(Launcher.java:191)
        at nl.tudelft.jpacman.Launcher.main(Launcher.java:226)

C:\Users\ngpgo\Documents\ashwin_krithekavasan_hw3_copy>
```

CheckStyle   4: Run   6: TODO   9: Version Control   SBT Console   Terminal   SBT Shell   Event Log   SBT Execute
All files are up-to-date (today 18:04)   11:1   CRLF   UTF-8   Git: master   (T)

MutatedTrace.txt - WordPad — File Home View

```
File last written on13/11/17 18:17:34
Line Number: 24 TypeofStatement: Assign Parameters:
PlayerFactory.PlayerFactory().sprites: :nl.tudelft.jpacman.spr
ite.PacManSprites@63947c6b,
PlayerFactory.PlayerFactory().spriteStore: :nl.tudelft.jpacman
.sprite.PacManSprites@63947c6b,
Line Number: 25 TypeofStatement: Assign Parameters:
GameFactory.GameFactory().playerFactory: :nl.tudelft.jpacman.l
evel.PlayerFactory@6ff3c5b5,
GameFactory.GameFactory().playerFactory: :nl.tudelft.jpacman.l
evel.PlayerFactory@6ff3c5b5,
Line Number: 23 TypeofStatement: Assign Parameters:
GhostFactory.GhostFactory().sprites: :nl.tudelft.jpacman.sprit
e.PacManSprites@63947c6b,
GhostFactory.GhostFactory().spriteStore: :nl.tudelft.jpacman.s
prite.PacManSprites@63947c6b,
Line Number: 59 TypeofStatement: Assign Parameters:
LevelFactory.LevelFactory().sprites: :nl.tudelft.jpacman.sprit
e.PacManSprites@63947c6b,
LevelFactory.LevelFactory().spriteStore: :nl.tudelft.jpacman.s
prite.PacManSprites@63947c6b,
Line Number: 60 TypeofStatement: Assign Parameters:
LevelFactory.LevelFactory().ghostIndex: :-1,
Line Number: 61 TypeofStatement: Assign Parameters:
LevelFactory.LevelFactory().ghostFact: :nl.tudelft.jpacman.npc
.ghost.GhostFactory@28a418fc,
LevelFactory.LevelFactory().ghostFactory: :nl.tudelft.jpacman.
npc.ghost.GhostFactory@28a418fc,
Line Number: 27 TypeofStatement: Assign Parameters:
BoardFactory.BoardFactory().sprites: :nl.tudelft.jpacman.sprit
e PacManSprites@63947c6b
```
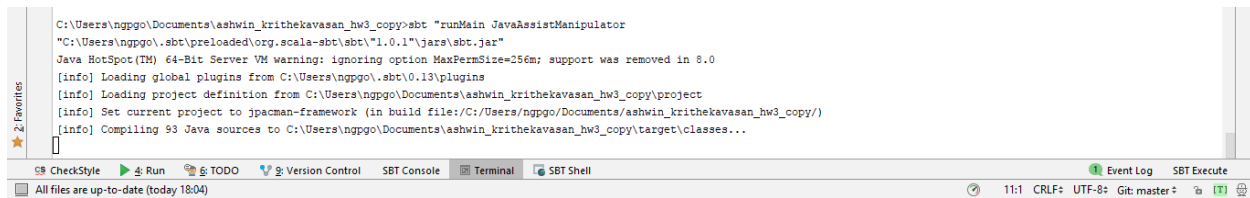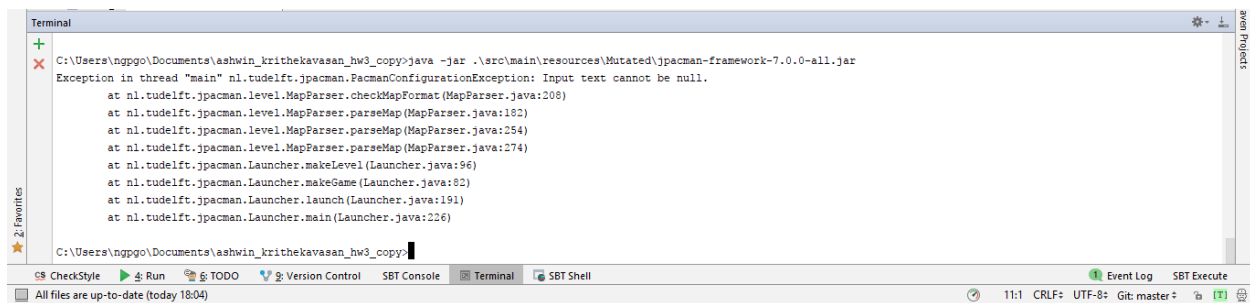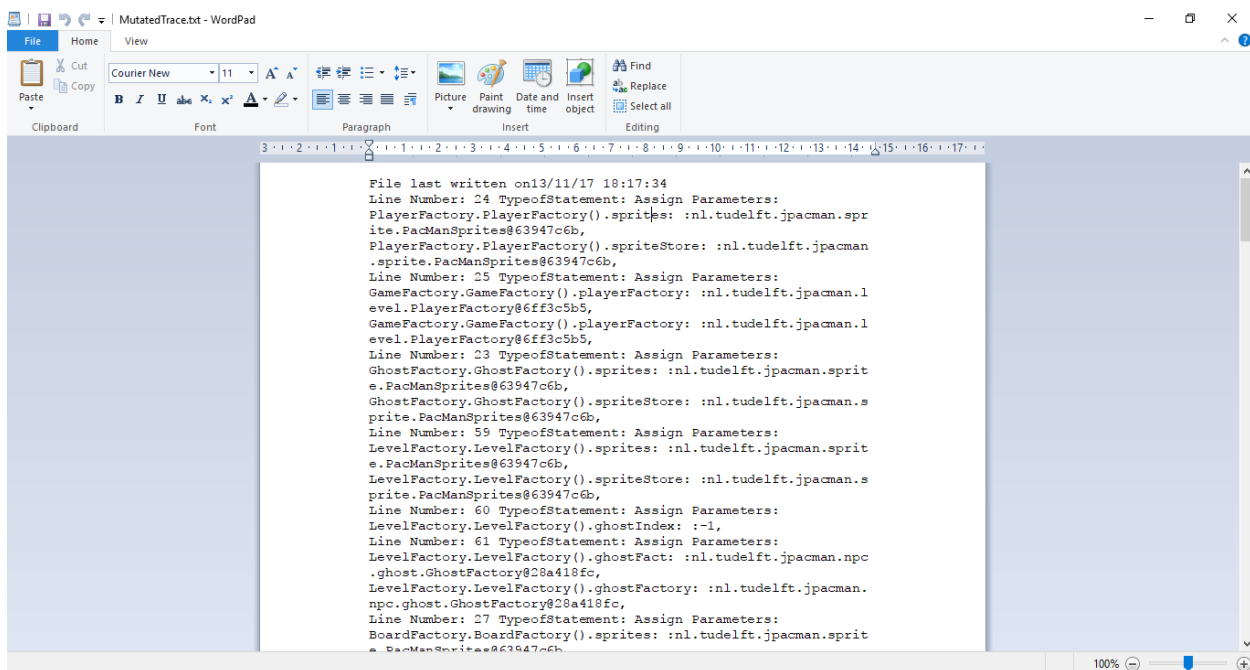
100%

The mutated text file is generated up to the point mutated application throws exception.

Type the following command "

It will compare the mutated text file and text file generated from the original application.