

HW 4: Mutation Based Testing

Software Testing 2025 fall

2025/12/4

Mutation Based Testing

Introduction

- A software testing technique used to evaluate the quality of test suites.
- Involves making small changes (mutations) to program code and checking if tests detect them.
- Helps measure test effectiveness beyond code coverage.
- Identifies weaknesses in test cases that fail to catch logic changes.

How It Works

- Mutants (modified versions of the original program) are generated by applying mutation operators.
- The test suite is run against each mutant.
- If a test fails, the mutant is killed. If all tests pass, the mutant survives.

Common Mutation Operators

- Replacing arithmetic operators (+ to -)
- Changing logical conditions (> to <)
- Modifying boolean values (true to false)
- Removing method calls

Mutation Score

- Mutation Score = $(\text{Killed Mutants} / \text{Total Mutants}) \times 100\%$
- A low score suggests insufficient tests; a high score indicates better test quality.

Stryker

Stryker - Introduction

- Open source mutation testing framework
- Support language JavaScript
- References
 - <https://stryker-mutator.io/docs/stryker-js/introduction/>

Stryker - Setup

- re-sync your fork and goto directory `hw4` in repo
- you will see these files

```
$ tree
.
├── README.md
├── package-lock.json
├── package.json
├── src
│   └── calculator.js
├── stryker.config.json
└── test
    └── calculator_test.js
```

Stryker - Setup

- npm config (npm init)
- npm i
 - install dependency
- npm run test
 - node --test
- npm run mutate
 - npx stryker run

```
{ } package.json > ...
1   {
2     "name": "hw4",
3     "version": "1.0.0",
4     "description": "software testing hw4",
5     "main": "src/calculator.js",
6     "scripts": {
7       "test": "node --test",
8       "mutate": "npx stryker run"
9     },
10    "license": "MIT",
11    "devDependencies": {
12      "@stryker-mutator/core": "^9.0.1"
13    }
14  }
```

Stryker - Setup

- Stryker config (stryker init)

```
{  
  "$schema": "./node_modules/@stryker-mutator/core/schema/stryker-schema.json",  
  "_comment": "This config was generated using 'stryker init'. Please take a look",  
  "packageManager": "npm",  
  "reporters": [  
    "html",  
    "clear-text",  
    "progress"  
  ],  
  "testRunner": "command",  
  "testRunner_comment": "Take a look at (missing 'homepage' URL in package.json) f",  
  "coverageAnalysis": "off"  
}
```

reports on terminal and html file

Use node default test as testRunner

Stryker - Setup

- npm i

```
$ npm i  
  
added 169 packages, and audited 170 packages in 5s  
  
39 packages are looking for funding  
  run `npm fund` for details  
  
found 0 vulnerabilities
```

Stryker - Setup

- npm run mutate

```
$ npm run mutate
> hw4@1.0.0 mutate
> npx stryker run

20:11:53 (114278) INFO ConfigReader No config file specified. Running with command line arguments.
20:11:53 (114278) INFO ConfigReader Use `stryker init` command to generate your config file.
20:11:53 (114278) INFO ProjectReader Found 1 of 4 file(s) to be mutated.
20:11:53 (114278) INFO Instrumenter Instrumented 1 source file(s) with 106 mutant(s)
20:11:53 (114278) INFO ConcurrencyTokenProvider Creating 15 test runner process(es).
20:11:53 (114278) INFO DryRunExecutor Starting initial test run (command test runner with "perTest" coverage analysis). This may take a while.
20:11:54 (114278) INFO DryRunExecutor Initial test run succeeded. Ran 1 tests in 0 seconds (net 244 ms, overhead 1 ms).
Mutation testing [==] 100% (elapsed: <1m, remaining: n/a) 106/106 Mutants tested (106 survived, 0 timed out)

All tests
  X All tests (covered 0)
```

Stryker - Setup

- npm run mutate
 - list survived

```
[Survived] ConditionalExpression
src/calculator.js:3:27
-       if (month1 < 1 || month1 > 12) {
+       if (month1 < 1 || false) {

[Survived] EqualityOperator
src/calculator.js:3:27
-       if (month1 < 1 || month1 > 12) {
+       if (month1 < 1 || month1 >= 12) {

[Survived] ConditionalExpression
src/calculator.js:3:13
-       if (month1 < 1 || month1 > 12) {
+       if (false || month1 > 12) {
```

Stryker - Setup

- npm run mutate
 - Show average score (killed / totals)

Ran 1.00 tests per mutant on average.

File	% Mutation score		# killed	# timeout	# survived	# no cov	# errors
	total	covered					
All files	0.00	0.00	0	0	106	0	0
calculator.js	0.00	0.00	0	0	106	0	0

Stryker - Setup

- npm run mutate
 - Show average by html (`reports/mutation/mutation.html`)

File / Directory	Mutation Score		Killed	Survived	Timeout	No coverage	Ignored	Runtime errors	Compile errors	Detected	Undetected	Total
	Of total	Of covered										
All files	0.00	0.00	0	106	0	0	0	0	0	0	106	106
calculator.js	0.00	0.00	0	106	0	0	0	0	0	0	106	106

Requirement

1. Please refer to the assignment description on E3 for details
2. Hint
 - a. For lab1 part, You can use configs in hw4 to build Stryker environment, or just try to build by yourself.
 - b. For kill mutants part, You can observe the mutation contents of the survived list to adjust your test code accordingly.