

IT314 - Software engineering

Group - 11

Mutation Testing

Tools Used :

- Stryker: The primary tool used for mutation testing. It inserts small mutants into the JavaScript source code and runs the tests to see if they fail (to kill the mutant) or pass.
- Mocha: The test runner that executes the test suite against every mutant generated by Stryker.
- Chai: The assertion library used within the tests to define expected outcomes.
- c8: Used for code coverage.

Overall Mutation score:

All files		Mutation Score											
File / Directory	I	Mutation Score		Killed	Survived	Timeout	No coverage	Ignored	Runtime errors	Compile errors	Detected	Undetected	Total
		Of total	Of covered										
All files		38.57	52.91	1490	1328	2	1048	742	4	0	1492	2376	4614
controllers		83.86	83.86	582	112	0	0	742	0	0	582	112	1436
J5 middlewares/authMiddleware.js		90.00	90.00	27	3	0	0	0	0	0	27	3	30
models		90.78	90.78	128	13	0	0	0	4	0	128	13	145
routes		100.00	100.00	28	0	0	0	0	0	0	28	0	28
services		11.72	14.10	85	518	0	122	0	0	0	85	640	725
utils		23.97	42.50	502	682	2	917	0	0	0	504	1599	2103
JS server.js		93.88	100.00	138	0	0	9	0	0	0	138	9	147

1) Controllers:

File / Directory	Mutation Score		Killed	Survived	Timeout	No coverage	Ignored	Runtime errors	Compile errors	Detected	Undetected	Total
	Of total	Of covered										
controllers	<div style="width: 83.86%;"> </div> 83.86	<div style="width: 83.86%;"> </div> 83.86	582	112	0	0	742	0	0	582	112	1436
JS authController.js	<div style="width: 72.75%;"> </div> 72.75	<div style="width: 72.75%;"> </div> 72.75	299	112	0	0	0	0	0	299	112	411
JS complaintController.js	<div style="width: 100.00%;"> </div> 100.00	<div style="width: 100.00%;"> </div> 100.00	126	0	0	0	742	0	0	126	0	868
JS notificationController.js	<div style="width: 100.00%;"> </div> 100.00	<div style="width: 100.00%;"> </div> 100.00	73	0	0	0	0	0	0	73	0	73
JS reportController.js	<div style="width: 100.00%;"> </div> 100.00	<div style="width: 100.00%;"> </div> 100.00	84	0	0	0	0	0	0	84	0	84

2) Middleware:

All files / middlewares / authMiddleware.js	1492	1328	1048								
File / Directory	Mutation Score	Killed	Survived	Timeout	No coverage	Ignored	Runtime errors	Compile errors	Detected	Undetected	Total
JS authMiddleware.js	<div style="width: 90.00%;"> </div> 90.00	<div style="width: 90.00%;"> </div> 90.00	27	3	0	0	0	0	27	3	30

3) Models:

All files / models	1492	1328	1048									
File / Directory	Mutation Score	Killed	Survived	Timeout	No coverage	Ignored	Runtime errors	Compile errors	Detected	Undetected	Total	
models	<div style="width: 90.78%;"> </div> 90.78	<div style="width: 90.78%;"> </div> 90.78	128	13	0	0	0	4	0	128	13	145
JS Complaint.js	<div style="width: 82.19%;"> </div> 82.19	<div style="width: 82.19%;"> </div> 82.19	60	13	0	0	0	1	0	60	13	74
JS Notification.js	<div style="width: 100.00%;"> </div> 100.00	<div style="width: 100.00%;"> </div> 100.00	18	0	0	0	0	1	0	18	0	19
JS otpModel.js	<div style="width: 100.00%;"> </div> 100.00	<div style="width: 100.00%;"> </div> 100.00	7	0	0	0	0	1	0	7	0	8
JS userModel.js	<div style="width: 100.00%;"> </div> 100.00	<div style="width: 100.00%;"> </div> 100.00	43	0	0	0	0	1	0	43	0	44

4) Routes:

File / Directory 	Mutation Score		Killed	Survived	Timeout	No coverage	Ignored	Runtime errors	Compile errors	Detected	Undetected	Total
	Of total	Of covered										
routes	<div style="width: 100.00%;"> </div>	<div style="width: 100.00%;"> </div>	28	0	0	0	0	0	0	28	0	28
JS analyticsRoutes.js	<div style="width: 100.00%;"> </div>	<div style="width: 100.00%;"> </div>	1	0	0	0	0	0	0	1	0	1
JS authRoutes.js	<div style="width: 100.00%;"> </div>	<div style="width: 100.00%;"> </div>	8	0	0	0	0	0	0	8	0	8
JS complaintRoutes.js	<div style="width: 100.00%;"> </div>	<div style="width: 100.00%;"> </div>	14	0	0	0	0	0	0	14	0	14
JS notificationRoutes.js	<div style="width: 100.00%;"> </div>	<div style="width: 100.00%;"> </div>	4	0	0	0	0	0	0	4	0	4
JS reportRoutes.js	<div style="width: 100.00%;"> </div>	<div style="width: 100.00%;"> </div>	1	0	0	0	0	0	0	1	0	1

5) Services:

All files / services												
1492			1328				1048					
File / Directory 	Mutation Score		Killed	Survived	Timeout	No coverage	Ignored	Runtime errors	Compile errors	Detected	Undetected	Total
	Of total	Of covered										
services	<div style="width: 11.72%; background-color: #ff0000;"> </div>	<div style="width: 14.10%; background-color: #ff0000;"> </div>	85	518	0	122	0	0	0	85	640	725
JS routingClassifier.js	<div style="width: 5.70%; background-color: #ff0000;"> </div>	<div style="width: 5.88%; background-color: #ff0000;"> </div>	27	432	0	15	0	0	0	27	447	474
JS spamClassifier.js	<div style="width: 23.11%; background-color: #ff0000;"> </div>	<div style="width: 40.28%; background-color: #ff0000;"> </div>	58	86	0	107	0	0	0	58	193	251

Reasons for low mutation score of Routing and Spam classifier services:

Primary reasons are **Keyword Dictionaries** and **Pattern-Based Logic**.

- These files depend on large lists of keywords, like ['hack', 'cheat', 'kill', 'urgent', 'wifi'], to detect certain categories. During mutation testing, Stryker creates a separate mutant for every keyword. To kill each one of these mutants, we would need a dedicated test case that triggers every individual keyword.
(In the code, the dictionary contains a large set of words, but our tests only use a handful of them, that means remaining mutants remain untouched – which sharply reduces the mutation score.)

- Cumulative Scoring: Many of these classifiers don't rely on a single keyword. Instead, they accumulate points (For example, "If score > 5, classify as spam"). If an input triggers several keywords and reaches a score of 10, the test will still pass even if the mutation changes the threshold from > 5 to > 8. This resilience is good for the classifier's reliability, but it makes mutation testing much harder because certain mutations don't meaningfully affect the outcome.

6) Utils:

File / Directory	Mutation Score		Killed	Survived	Timeout	No coverage	Ignored	Runtime errors	Compile errors	Detected	Undetected	Total
	Of total	Of covered										
utils	23.97	42.50	502	682	2	917	0	0	0	504	1599	2103
aiRouting.js	20.63	38.36	405	654	2	912	0	0	0	407	1566	1973
emailService.js	71.67	76.79	43	13	0	4	0	0	0	43	17	60
fileUploadService.js	75.76	76.92	50	15	0	1	0	0	0	50	16	66
generateToken.js	100.00	100.00	4	0	0	0	0	0	0	4	0	4

Reasons for Lower mutation score of aiRouting.js :

- Running a heavy Python ML model during unit tests is slow and flaky. Therefore, our tests use an E2E_MODE flag or mock functions to bypass the actual Python execution. Since the test suite skips the Python execution block entirely (to rely on mocks). So, any mutants injected into the Python-handling logic (which is a major portion of the file) are never executed, so they survive by default.
- Stryker sees that huge amount of mutants are still surviving after running the test suite which results in the significantly low mutation score of aiRouting.js.

File	% Mutation score		# killed	# timeout	# survived	# no cov	# errors
	total	covered					
All files	38.57	52.91	1490	2	1328	1048	4
controllers	83.86	83.86	582	0	112	0	0
authController.js	72.75	72.75	299	0	112	0	0
complaintController.js	100.00	100.00	126	0	0	0	0
notificationController.js	100.00	100.00	73	0	0	0	0
reportController.js	100.00	100.00	84	0	0	0	0
middlewares	90.00	90.00	27	0	3	0	0
authMiddleware.js	90.00	90.00	27	0	3	0	0
models	90.78	90.78	128	0	13	0	4
Complaint.js	82.19	82.19	60	0	13	0	1
Notification.js	100.00	100.00	18	0	0	0	1
otpModel.js	100.00	100.00	7	0	0	0	1
userModel.js	100.00	100.00	43	0	0	0	1
routes	100.00	100.00	28	0	0	0	0
analyticsRoutes.js	100.00	100.00	1	0	0	0	0
authRoutes.js	100.00	100.00	8	0	0	0	0
complaintRoutes.js	100.00	100.00	14	0	0	0	0
notificationRoutes.js	100.00	100.00	4	0	0	0	0
reportRoutes.js	100.00	100.00	1	0	0	0	0
services	11.72	14.10	85	0	518	122	0
routingClassifier.js	5.70	5.88	27	0	432	15	0
spamClassifier.js	23.11	40.28	58	0	86	107	0
utils	23.97	42.50	502	2	682	917	0
aiRouting.js	20.63	38.36	405	2	654	912	0
emailService.js	71.67	76.79	43	0	13	4	0
fileUploadService.js	75.76	76.92	50	0	15	1	0
generateToken.js	100.00	100.00	4	0	0	0	0
server.js	93.88	100.00	138	0	0	9	0

04:38:25 (2404) INFO HtmlReporter Your report can be found at: file:///C:/Users/neel4/IT314_Project/Campus-Complaint-Management-System/reports/mutation/mutation.html