

IT314 - Software Engineering

Mutation Testing



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1. Introduction

Mutation testing is an advanced software testing technique used to **measure the effectiveness of unit test cases**. Instead of checking whether the code simply runs, mutation testing checks whether the tests can **detect small bugs intentionally introduced into the source code**.

These small injected changes are called **mutants**.

2. What is Mutation Testing?

Mutation Testing works by:

1. **Modifying the source code slightly** (creating *mutants*)
 - Replace > with >=
 - Replace + with -
 - Remove a condition
 - Invert a boolean
2. Running all test cases against these modified versions
3. Checking whether the tests **fail** when behavior changes

Goal

If the tests detect the change → **Mutant is Killed**

If the tests do NOT detect the change → **Mutant Survived** (weak test)

3. Stryker (Mutation Testing Tool)

- Generates mutants (code changes) automatically
- Runs the existing Jest tests against each mutant
- Produces HTML dashboards
- Highlights weak areas in the code

4. Setup

Installed Stryker:

```
npm install --save-dev @stryker-mutator/core @stryker-mutator/jest-runner
```

- Created *stryker.conf.json*

Ran:



```
npm run test:mutation
```

Stryker generated:

- **mutation.html**
- **dashboard report**
- **mutation score**

Game Controllers

Before:







95								54					
File / Directory	Mutation Score		Killed	Survived	Timeout	No coverage	Ignored	Runtime errors	Compile errors	Detected	Undetected	Total	
	Of total	Of covered											
 All files	<div><div></div></div> 63.76	<div><div></div></div> 63.76	95	54	0	0	0	0	0	95	54	149	
 getGames.ts	<div><div></div></div> 63.76	<div><div></div></div> 63.76	95	54	0	0	0	0	0	95	54	149	

After:

530												37
File / Directory	Mutation Score		Killed	Survived	Timeout	No coverage	Ignored	Runtime errors	Compile errors	Detected	Undetected	Total
	Of total	Of covered										
All files	<div><div></div></div> 93.47	<div><div></div></div> 93.47	309	37	221	0	0	0	0	530	37	567
TS getGames.ts	<div><div></div></div> 81.94	<div><div></div></div> 81.94	99	28	28	0	0	0	0	127	28	155
TS hostGame.ts	<div><div></div></div> 95.27	<div><div></div></div> 95.27	68	7	73	0	0	0	0	141	7	148
TS joinRequestController.ts	<div><div></div></div> 99.42	<div><div></div></div> 99.42	104	1	67	0	0	0	0	171	1	172
TS postGame.ts	<div><div></div></div> 98.91	<div><div></div></div> 98.91	38	1	53	0	0	0	0	91	1	92







Game Middleware

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File / Directory 	Mutation Score		Killed	Survived	Timeout	No coverage	Ignored	Runtime errors	Compile errors	Detected	Undetected	Total
	Of total	Of covered										
 All files	 100.00	 100.00	7	0	0	0	0	1	0	7	0	8
TS gameMiddleware.ts	 100.00	 100.00	7	0	0	0	0	1	0	7	0	8

Calendar Link







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File / Directory 	Mutation Score		Killed	Survived	Timeout	No coverage	Ignored	Runtime errors	Compile errors	Detected	Undetected	Total
	Of total	Of covered										
 All files	 100.00	 100.00	12	0	0	0	0	0	0	12	0	12
TS getCalendarLink.ts	 100.00	 100.00	12	0	0	0	0	0	0	12	0	12

Coach Controllers

524

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File / Directory 	Mutation Score		Killed	Survived	Timeout	No coverage	Ignored	Runtime errors	Compile errors	Detected	Undetected	Total
	Of total	Of covered										
 All files	 96.86	 98.13	10	10	514	7	0	0	0	524	17	541
TS coachController.ts	 96.86	 98.13	10	10	514	7	0	0	0	524	17	541











Admin Controllers:

Before:

369

57

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File / Directory 	Mutation Score		Killed	Survived	Timeout	No coverage	Ignored	Runtime errors	Compile errors	Detected	Undetected	Total
	Of total	Of covered										
 All files	 81.28	 86.62	210	57	159	28	0	0	0	369	85	454
TS adminAuthController.ts	 89.36	 89.36	42	5	0	0	0	0	0	42	5	47
TS adminManagementController.ts	 84.21	 85.50	70	19	42	2	0	0	0	112	21	133
TS ticketController.ts	 78.47	 86.69	98	33	117	26	0	0	0	215	59	274

After:

383											61	10
File / Directory	Mutation Score		Killed	Survived	Timeout	No coverage	Ignored	Runtime errors	Compile errors	Detected	Undetected	Total
	Of total	Of covered										
All files	84.36	86.26	291	61	92	10	0	0	0	383	71	454
TS adminAuthController.ts	93.62	93.62	34	3	10	0	0	0	0	44	3	47
TS adminManagementController.ts	85.71	85.71	90	19	24	0	0	0	0	114	19	133
TS ticketController.ts	82.12	85.23	167	39	58	10	0	0	0	225	49	274

Google Auth :

Ran 5.54 tests per mutant on average.							
File	% Mutation score		# killed	# timeout	# survived	# no cov	# errors
	total	covered					
All files	84.15	84.15	62	7	13	0	0
googleAuth.ts	84.15	84.15	62	7	13	0	0

Payment :

Ran 6.00 tests per mutant on average.							
File	% Mutation score		# killed	# timeout	# survived	# no cov	# errors
	total	covered					
All files	83.00	83.00	58	25	17	0	0
directBooking.ts	83.00	83.00	58	25	17	0	0

Ran 6.46 tests per mutant on average.							
File	% Mutation score		# killed	# timeout	# survived	# no cov	# errors
	total	covered					
All files	83.78	85.52	85	39	21	3	0
retryPayment.ts	83.78	85.52	85	39	21	3	0

Ran 4.64 tests per mutant on average.							
File	% Mutation score		# killed	# timeout	# survived	# no cov	# errors
	total	covered					
All files	76.60	78.26	56	16	20	2	0
gameBooking.ts	76.60	78.26	56	16	20	2	0

Ran 5.00 tests per mutant on average.							
File	% Mutation score		# killed	# timeout	# survived	# no cov	# errors
	total	covered					
All files	83.72	87.80	36	0	5	2	0
verifyPayment.ts	83.72	87.80	36	0	5	2	0

Ran 2.86 tests per mutant on average.

File	% Mutation score		# killed	# timeout	# survived	# no cov	# errors
	total	covered					
All files	85.94	85.94	55	0	9	0	0
getMyVenueBooking.ts	85.94	85.94	55	0	9	0	0

Ran 10.61 tests per mutant on average.

File	% Mutation score		# killed	# timeout	# survived	# no cov	# errors
	total	covered					
All files	88.89	88.89	56	24	10	0	0
stripeWebhook.ts	88.89	88.89	56	24	10	0	0

Venue and SubVenue Controllers:

File	% Mutation score		# killed	# timeout	# survived	# no cov	# errors
	total	covered					
All files	83.12	86.14	261	0	42	11	0
venueController.ts	83.12	86.14	261	0	42	11	0

TimeSlotcontroller:

Ran 0.79 tests per mutant on average.

File	% Mutation score		# killed	# timeout	# survived	# no cov	# errors
	total	covered					
All files	80.00	80.00	18	2	5	0	0
timeslotController.ts	80.00	80.00	18	2	5	0	0

04:36:27 (93039) INFO HtmlReporter Your report can be found at: file:///mnt/c/SE_project/SportSphere/reports/