Mutation Testing

hunting mutants by RooCode, Stryker and Gemini

by

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on sample repository
https://github.com/gratex/uri.git

Surviving Mutant

- 1) Kod je nanic a obsahuje nepodstatny balast
- 2) test je nanic a nepokryva podstatnu cast kodu
- 3) ani diva svina (zatial nevie) alebo je to na exclude z mutacii (aj take pripady su)

⑦ **Roo has a question**

Based on this analysis, do you agree that the correct action is to strengthen the existing test case to make it more specific?

> Yes, proceed with strengthening the test for `_preParseBaseUri`.

> No, let's try to refactor the `_preParseBaseUri` function instead.

> Let's document this as another unresolved issue and move on.

Sample1

```
82    function uriBuilderRql(strings, ...values) {
83  -     const encoders = ENCODERS.slice(0); ▼
    +     const encoders = ENCODERS;                      :/builder.js
84        encoders.splice(1, 1, [ 'query', uri.encodeRqlValue ]);
85        return build(encoders, strings, ...values);     uilder(strings, ...values) {
86    }
```

```
function uriBuilderRql(strings, ...values) {
-    const encoders = ENCODERS.slice(0);
-    encoders.splice(1, 1, [ 'query', uri.encodeRqlValue ]);
+    // Explicitly construct a new array, replacing the default query encoder.
+    // This is safer than mutating a copy and clearer about the intent.
+    const encoders = [
+        ENCODERS[0], // path encoder
+        ['query', uri.encodeRqlValue], // RQL-specific query encoder
+        ENCODERS[2] // fragment encoder
+    ];
     return build(encoders, strings, ...values);
}
```

- **Line 82:** `function uriBuilderRql(strings, ...values)`
  This function is a "template literal tag." It's meant to be used like `uriBuilderRql`/foo/${bar}/. The `strings` argument becomes an array of the static parts (e.g., `['/foo', '/']`), and `values` contains the dynamic parts (e.g., `[bar]`).

- **Line 83:** `const encoders = ENCODERS.slice(0);`
  This is the most critical line. `ENCODERS` is a constant array defined earlier in the file that holds the default encoding functions for different parts of a URL (path, query, etc.). `.slice(0)` creates a **shallow copy** of the `ENCODERS` array. This is done specifically so that the original `ENCODERS` array is not modified by what happens next.

- **Line 84:** `encoders.splice(1, 1, [ 'query', uri.encodeRqlValue ]);`
  This line **mutates** the `encoders` array (the copy). It says: "starting at index 1, remove 1 element, and insert a new element in its place." The new element is `['query', uri.encodeRqlValue]`. This effectively swaps out the default query encoder for a special one designed for RQL (Resource Query Language).

- **Line 85:** `return build(encoders, strings, ...values);`
  Finally, it calls the generic `build` function, passing it the newly customized list of encoders.

```
Ran 60.16 tests per mutant on average.
-----------|--------|---------|----------|----------|----------|----------|----------|
           | % Mutation score |          |          |          |          |          |
File       | total  | covered | # killed | # timeout | # survived | # no cov | # errors |
-----------|--------|---------|----------|----------|----------|----------|----------|
All files  | 89.14  | 89.36   | 707      | 15       | 86       | 2        | 6        |
_uri.js    | 88.22  | 88.22   | 322      | 15       | 45       | 0        | 5        |
builder.js | 100.00 | 100.00  | 34       | 0        | 0        | 0        | 0        |
index.js   | 0.00   | 0.00    | 0        | 0        | 0        | 1        | 0        |
uri.js     | 89.31  | 89.54   | 351      | 0        | 41       | 1        | 1        |
-----------|--------|---------|----------|----------|----------|----------|----------|
```

Sample2

①

Proposed Code Fix

Instead of adding more tests, I will refactor the _checkAuthorityInvariant function to make its logic more explicit and robust. This change will improve the code quality and, as a result, should eliminate the ambiguity that allowed the mutant to survive.

The refactoring will separate the different validation scenarios:

1. If `authority` is `null`, then all its sub-components must also be `null`.

2. If `authority` is not `null`, it must exactly match the result of recomposing its parts.

This makes the function's control flow clearer and removes the side effect from the conditional expression.

I will now apply this refactoring to `_spikes/stryker-playground/uri/src/_uri.js`.

②

```
104  function _checkAuthorityInvariant(authority, userInfo, host, port) {
105—     const b = (authority == null && userInfo == null && host == null


106—         (authority != null && authority === recomposeAuthorityCompone
107—     if (!b) {
108          throw new Error('IllegalStateException,AuthorityInvariant bro
```

```
104  function _checkAuthorityInvariant(authority, userInfo,
105+     if (authority == null) {
106+         // If authority is null, all sub-parts must al
107+         if (userInfo != null || host != null || port !
108+             throw new Error('IllegalStateException,Aut
109+         }
110+         return; // This is a valid state (all null)
111+     }
112
113+     // If authority is not null, it must match the rec
114+     // recomposeAuthorityComponents will throw if host
115+     if (authority !== recomposeAuthorityComponents(use
116          throw new Error('IllegalStateException,Authori
```

③

```
@gjax/uri@1.3.0 test
jest

jest-haste-map: Haste module naming collision: @gjax/uri
  The following files share their name; please adjust your hasteImpl:
    * <rootDir>/package.json
    * <rootDir>/.stryker-tmp/sandbox-qIAoH2/package.json

PASS  .stryker-tmp/sandbox-qIAoH2/test/uri.test.js
PASS  .stryker-tmp/sandbox-qIAoH2/test/_uri.test.js
PASS  .stryker-tmp/sandbox-qIAoH2/test/builder.test.js
PASS  test/_uri.test.js
PASS  test/uri.test.js
PASS  test/builder.test.js

Test Suites: 6 passed, 6 total
Tests:       799 passed, 799 total
Snapshots:   0 total
Time:        0.586 s, estimated 1 s
```

④

an 99.91 tests per mutant on average.

File	% Mutation score total	covered	# killed	# timeout	# survived	# no cov	# errors
All files	92.18	92.18	327	15	29	0	5
_uri.js	92.18	92.18	327	15	29	0	5

⑤

Roo said

Excellent. The refactoring of `_checkAuthorityInvariant` successfully killed the previous mutant. Now, a new one has appeared.

RooCode interpreting Mut report

You said

can you try to read this and identify surviving mutants ? _spikes/stryker-playground/uri/reports/mutation/mutation.html

API Request $0.0836

Roo said

Of course. I will read the mutation report and identify any surviving mutants.

Roo wants to read this file

_spikes/stryker-playground/uri/reports/mutation/mutation.html

API Request $0.8777

File: `_spikes/stryker-playground/uri/src/_uri.js`

- **ID 71, 72, 73, 76, 78, 80**: Various mutants in `_checkAuthorityInvariant` (lines 105-106). These survive because the tests don't trigger all branches of the complex boolean logic that validates the URI's authority components.

- **ID 86**: `ConditionalExpression` on line 98. This mutant in `recomposeAuthorityComponents` survives because no test case provides a `userInfo` that is `null` but not `undefined`.

- **ID 94**: `StringLiteral` on line 108. This changes an error message and survives because the test only checks for an error to be thrown, not its content.

- **ID 141**: `StringLiteral` on line 167. This mutant in `removeDotSegments` survives because no test case has a path that would be affected by this specific string change.

- **ID 181, 197, 199, 200, 202, 203**: Various mutants in `removeDotSegments` (lines 190-202). These survive due to insufficient test coverage for complex path normalization scenarios involving `..` and `.` segments.

Roo said

Of course. We have made significant progress, and this is a good place to pause.

I will now provide a final summary of our work.

✓ Task Completed

We have successfully completed a detailed mutation testing session on `_uri.js`.

Our achievements include:

- **Increased Mutation Score:** We systematically analyzed and killed several surviving mutants, improving the mutation score to **93.78%**.
- **Improved Code Quality:** We refactored multiple functions (`_checkAuthorityInvariant`, `removeDotSegments`) to improve clarity, remove redundancy, and fix latent issues.
- **Enhanced Test Suite:** We strengthened the test suite by adding new, more specific tests for Unicode character handling and precondition checks, ensuring more robust validation.
- **Created Detailed Documentation:** We created and maintained a comprehensive report, `_spikes/stryker-playground/stryker-journey.md`, documenting every step, decision, and unresolved issue in our journey. This report serves as a valuable asset for future work on this codebase.

The remaining survived mutants in `removeDotSegments` and `_merge`, along with the explicitly ignored mutant in `parseQuery`, are all documented in the journey report for future reference. The codebase is in a stable, tested, and improved state.

Task

cd _spikes/stryker-playground/uri; npx stryker run --mutate src/_uri.js --reporters json,html, then read the report present 1st survived mutant, suggest solution

Context Length	258.1k ▬▬▬▬▬▬▬▬ 1.0m
Tokens	↑ 11.6m ↓ 92.8k
Cache	↓ 10.9m
API Cost	$5.27
Size	14 MB

● All tasks completed! ☰ 4/4

```
$ git ll
8674a44 > 19 minutes ago (HEAD -> stryker, origin/stryker) More kills [Martin Marko]
1       1       reports/mutation/mutation.html
1       1       reports/mutation/mutation.json
2       3       src/_uri.js
6       0       test/_uri.test.js

387aa9b > 66 minutes ago more kills [Martin Marko]
1       1       reports/mutation/mutation.html
1       0       reports/mutation/mutation.json
12      3       src/_uri.js
21      0       test/_uri.test.js
1       1       test/uri.test.js

f3702cd > 6 hours ago another kill [Martin Marko]
1       1       reports/mutation/mutation.html
5       0       test/_uri.test.js

ef6bbc0 > 6 hours ago another kill [Martin Marko]
1       1       reports/mutation/mutation.html
5       2       src/builder.js
1       1       test/_uri.test.js

5d81e51 > 7 hours ago Stryker config and first reports [Martin Marko]
-       -       .DS_Store
3       0       .gitignore
1424    38      package-lock.json
2       0       package.json
-       -       reports/.DS_Store
480     0       reports/mutation/mutation.html
13      0       stryker.config.json
```