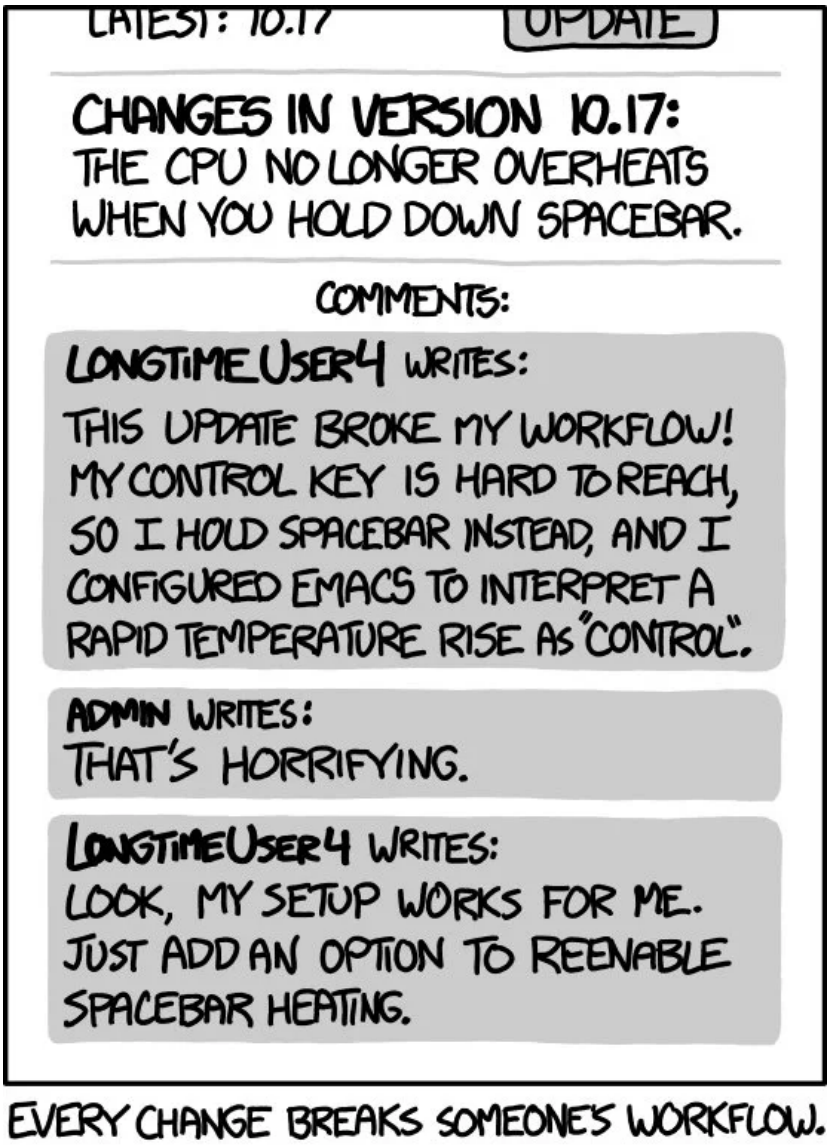
Assignment 3 - Mutation testing

Group 13B
22-01-2022



Authors

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Comic via xkcd.com

Identified and resolved classes

ContractId's internal builder (75% mutation coverage) final build method was mutated to return null which was never checked. This has been fixed and the class has 100% mutation coverage.
https://gitlab.ewi.tudelft.nl/cse2115/2021-2022/sem-group-13b/sem-repo-13b/-/merge_requests/94

hiring.services.communication/MicroserviceCommunicationHelper.java originally had 0% mutation coverage. This was fixed and improved to 100% mutation coverage.
https://gitlab.ewi.tudelft.nl/cse2115/2021-2022/sem-group-13b/sem-repo-13b/-/merge_requests/95

nl.tudelft.sem.tams.ta.models/HourRequestModel.java originally had 0% mutation coverage. This was fixed and improved to 100% mutation coverage.
https://gitlab.ewi.tudelft.nl/cse2115/2021-2022/sem-group-13b/sem-repo-13b/-/merge_requests/93

nl.tudelft.sem.tams.hiring.models/RetrieveTeachingAssistantApplicationStatusModel.java originally had 0% mutation coverage. This was due to a specific method (the only method in this class) not being tested on itself at all. An extra test was added to ensure this method works correctly and this class now has 100% mutation coverage.
https://gitlab.ewi.tudelft.nl/cse2115/2021-2022/sem-group-13b/sem-repo-13b/-/merge_requests/98

nl.tudelft.sem.tams.hiring.models/PendingTeachingAssistantApplicationResponseModel.java originally had 89% mutation coverage as there was a return statement that could return 0.0 unchecked. This has been covered and currently the class has 100% mutation coverage.
https://gitlab.ewi.tudelft.nl/cse2115/2021-2022/sem-group-13b/sem-repo-13b/-/merge_requests/98

PITest reports

Before

nl/tudelft/sem/tams/ta/entities/compositekeys/ContractId.java

Name	Line Coverage		Mutation Coverage	
ContractId.java	100%	12/12	75%	3/4

nl/tudelft/sem/tams/ta/services/communication/MicroserviceCommunicationHelper.java

Name	Line Coverage		Mutation Coverage	
ConnectedCourseInformationService.java	100%	19/19	90%	9/10
MicroserviceCommunicationHelper.java	21%	3/14	0%	0/7

nl/tudelft/sem/tams/ta/models/HourRequestModel.java

Name	Line Coverage		Mutation Coverage	
ContractResponseModel.java	100%	19/19	100%	1/1
HourRequestModel.java	0%	0/13	0%	0/4
HourResponseModel.java	100%	18/18	100%	1/1

nl/tudelft/sem/tams/hiring/models

Name	Line Coverage		Mutation Coverage	
PendingTeachingAssistantApplicationResponseModel.java	96%	23/24	89%	8/9
RetrieveTeachingAssistantApplicationStatusModel.java	86%	12/14	0%	0/1
TeachingAssistantApplicationAcceptRequestModel.java	100%	19/19	100%	6/6

After

nl/tudelft/sem/tams/ta/entities/compositekeys/ContractId.java

Name	Line Coverage		Mutation Coverage	
ContractId.java	100%	14/14	100%	4/4

nl/tudelft/sem/tams/ta/services/communication/MicroserviceCommunicationHelper.java

Name	Line Coverage		Mutation Coverage	
ConnectedContractInformationService.java	100%	12/12	100%	4/4
ConnectedCourseInformationService.java	100%	19/19	90%	9/10
MicroserviceCommunicationHelper.java	100%	14/14	100%	7/7

nl/tudelft/sem/tams/ta/models/HourRequestModel.java

Name	Line Coverage		Mutation Coverage	
ContractResponseModel.java	100%	19/19	100%	1/1
HourRequestModel.java	85%	11/13	100%	4/4
HourResponseModel.java	100%	18/18	100%	1/1

nl/tudelft/sem/tams/hiring/models

Name	Line Coverage		Mutation Coverage	
PendingTeachingAssistantApplicationResponseModel.java	96%	23/24	100%	9/9
RetrieveTeachingAssistantApplicationStatusModel.java	93%	13/14	100%	1/1
TeachingAssistantApplicationAcceptRequestModel.java	100%	19/19	100%	6/6

Equivalent mutants

A mutant that is alive can either be killed by improving the test data or cannot be killed at all. In the second situation the type of mutant is identical to the original program, called an equivalent mutant. The mutation score is determined by the percentage of mutants that are killed with taking into account the equivalent mutants, we have to find these as well.

Package nl.tudelft.sem.tams.authentication.controllers

UsersController

Mutation Coverage = 67%
Out of the 3 mutants, 2 get killed
Survived mutant: replaced return value in line 78 with null.
Untestable as Spring implicitly returns 200 OK, making this an equivalent mutant.

Package nl.tudelft.sem.tams.hiring.controllers

ApplicantHiringController

Mutation Coverage = 80%
Out of the 5 mutants, 4 get killed
Survived mutant: replaced return value in line 88 with null.
Untestable as Spring implicitly returns 200 OK, making this an equivalent mutant.

LecturerHiringController

Mutation Coverage = 92%
Out of the 13 mutants, 12 get killed
Survived mutant: replaced return value in line 88 with null.
Untestable as Spring implicitly returns 200 OK, making this an equivalent mutant.

Package nl.tudelft.sem.tams.hiring.providers.implementations

CurrentTimeProvider

Mutation Coverage = 0%
Out of the 1 mutant, 0 get killed
Survived mutant: replaced return value in line 22 with null
Untestable as it was designed to move untestable logic out of other classes, making this an equivalent mutant.

Package nl.tudelft.sem.tams.ta.controllers

ContractController

Mutation Coverage = 95%
Out of the 20 mutants, 19 get killed
Survived mutant: replaced return value in line 114 with null.
Untestable as Spring implicitly returns 200 OK, making this an equivalent mutant.

Package nl.tudelft.sem.tams.ta.services.communication

ConnectedCourseInformationService

Mutation Coverage = 90%
Out of the 10 mutants, 9 get killed
Survived mutant: replaced boolean return with true.
This code is unreachable, since the line will never be called when the body contains false - false is only returned together with a 404 status code, making this an equivalent mutant.

Package nl.tudelft.sem.tams.hiring.models

PendingTeachingAssistantApplicationResponseModel

Survived mutant: replaced double return with 0.0d.
Untestable as it does not change the functionality of the equals method, making this an equivalent mutant.

Package nl.tudelft.sem.tams…

AuthFilter

The AuthFilter contains untestable mutants related to printing to the standard output.

TokenVerifier

TokenVerifiercontains an unreachable line that was left for readability - if the token has expired, an exception is thrown by the JWT library, making this an equivalent mutant.

H2Config

The database configuration contains a username and a password, which do not affect our in-memory database, making this an equivalent mutant.

Reflection

This assignment helped the team improve tests. We also discovered new ways to test some previously untestable code. This significantly improved our code quality and increased the test coverage of our product to 98.25%.

Noteworthy is the resolution of PendingTeachingAssistantApplicationResponseModel. Depending on who runs the pitest module this class either has 89% mutation coverage, due to an equivalent mutant or 100% mutation coverage. Pitest has been non consistent throughout this assignment, even going as far as giving classes which were 100% covered on one machine to be not covered at all on the other.

Currently there are still some mutants left alive in our code. Luckily those mutants are not of a matter to our system, either being an equivalent mutant or an untestable one, untestable such as the TimeProvider class which themselves remove untestable code from other classes. This forced us to pick classes that had more than 70% mutation coverage such as contractId and a hiring-microservice response model.

Individual contributions

- Ali - Did not participate in the assignment, last active on 15/01/2022
- Julie - Documented equivalent mutants (#89)
- Martin - Tests for ContractIdBuilder, made MicroserviceCommunicationHelper testable, general assignment coordination (#87, #88)
- Mattheo - Tests for models in the Hiring microservice (#90)
- Maurits - Tests for HourRequestModel, general assignment coordination (#86)
- Winstijn - Tests for MicroserviceCommunicationHelper (#88), took over Ali’s part