

Group-Project-8-OP29-SEM57-Assignment-3

Timen Zandbergen
Merdan Durmuş
Luca Becheanu
Can Parlar
Alexandru Bobe
Matthijs de Goede

Task 1: Mutation Testing

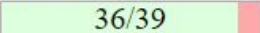
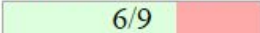
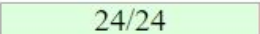
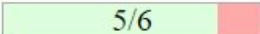
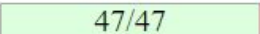
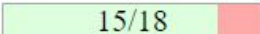
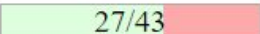
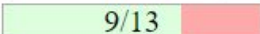
1. Select a mutation testing tool. We recommend Pitest (<https://pitest.org>), which has an IntelliJ plugin and generates readable HTML reports.

We used Pitest to check for the mutation scores.

2. Run the mutation testing tool against your test suites and identify four classes with a mutation score lower than 70%.

We have identified following four classes with a mutation score lower than 70%:

2.1. Calendar Microservice - Teacher Retrieval Controller

Name	Line Coverage	Mutation Coverage
AbsenceController.java	92%  36/39	67%  6/9
SchedulingController.java	100%  24/24	83%  5/6
StudentRetrievalController.java	100%  47/47	83%  15/18
TeacherRetrievalController.java	63%  27/43	69%  9/13

Mutations

```
74 1. negated conditional -> KILLED
75 1. replaced return value with null for nl/tudelft/sem/calendar/controllers/TeacherRetrievalController::getMyPersonalScheduleTeacher -> KILLED
85 1. removed call to nl/tudelft/sem/calendar/entities/Lecture::setSelectedForOnCampus -> NO_COVERAGE
86 1. removed call to nl/tudelft/sem/calendar/entities/Lecture::setRoomName -> NO_COVERAGE
90 1. replaced return value with null for nl/tudelft/sem/calendar/controllers/TeacherRetrievalController::getMyPersonalScheduleTeacher -> KILLED
112 1. negated conditional -> KILLED
113 1. replaced return value with null for nl/tudelft/sem/calendar/controllers/TeacherRetrievalController::getMyPersonalScheduleForDayTeacher -> KILLED
125 1. removed call to nl/tudelft/sem/calendar/entities/Lecture::setSelectedForOnCampus -> NO_COVERAGE
126 1. removed call to nl/tudelft/sem/calendar/entities/Lecture::setRoomName -> NO_COVERAGE
130 1. replaced return value with null for nl/tudelft/sem/calendar/controllers/TeacherRetrievalController::getMyPersonalScheduleForDayTeacher -> KILLED
151 1. negated conditional -> KILLED
152 1. replaced return value with null for nl/tudelft/sem/calendar/controllers/TeacherRetrievalController::getMyPersonalScheduleForCourseTeacher -> KILLED
158 1. replaced return value with null for nl/tudelft/sem/calendar/controllers/TeacherRetrievalController::getMyPersonalScheduleForCourseTeacher -> KILLED
```

2.2. Course Management Microservice - Enrollment Controller

Name	Line Coverage	Mutation Coverage
CourseController.java	97% <div><div></div></div> 31/32	59% <div><div></div></div> 10/17
CourseRetrievalController.java	59% <div><div></div></div> 10/17	50% <div><div></div></div> 4/8
EnrollmentController.java	86% <div><div></div></div> 6/7	50% <div><div></div></div> 3/6
LectureController.java	100% <div><div></div></div> 15/15	83% <div><div></div></div> 5/6
LecturePlannerController.java	100% <div><div></div></div> 16/16	63% <div><div></div></div> 5/8
LectureRetrievalController.java	85% <div><div></div></div> 11/13	50% <div><div></div></div> 2/4

Mutations

```
35 1. replaced return value with null for nl/tudelft/sem/courses/controller/EnrollmentController::getAllEnrollments → KILLED
48 1. replaced return value with null for nl/tudelft/sem/courses/controller/EnrollmentController::getEnrollmentsByCourse → KILLED
49 1. replaced boolean return with false for nl/tudelft/sem/courses/controller/EnrollmentController::lambda$getAllEnrollmentsByCourse$0 → NO_COVERAGE
2. replaced boolean return with true for nl/tudelft/sem/courses/controller/EnrollmentController::lambda$getAllEnrollmentsByCourse$0 → NO_COVERAGE
59 1. replaced return value with null for nl/tudelft/sem/courses/controller/EnrollmentController::bareFromEnrollment → KILLED
2. replaced return value with null for nl/tudelft/sem/courses/controller/EnrollmentController::lambda$bareFromEnrollment$1 → NO_COVERAGE
```

2.3. Course Management Service - Lecture Retrieval Controller

35	1. replaced return value with null for nl/tudelft/sem/courses/controller/LectureRetrievalController::lambda\$getAllLectures\$0 → NO_COVERAGE
39	1. replaced return value with null for nl/tudelft/sem/courses/controller/LectureRetrievalController::getAllLectures → KILLED
55	1. replaced return value with null for nl/tudelft/sem/courses/controller/LectureRetrievalController::lambda\$getAllLecturesAfterDate\$1 → SURVIVED
58	1. replaced return value with null for nl/tudelft/sem/courses/controller/LectureRetrievalController::getLecturesAfterDate → KILLED

2.4. Identity Microservice - JwtUtil

Name	Line Coverage	Mutation Coverage
JwtUtil.java	80% <div><div></div></div> 16/20	50% <div><div></div></div> 7/14

Mutations

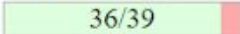
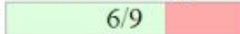
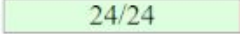


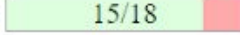
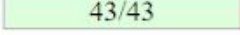
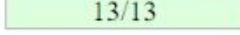
```
37 1. replaced return value with "" for nl/tudelft/sem/identity/util/JwtUtil::getSecret → KILLED
47 1. replaced return value with "" for nl/tudelft/sem/identity/util/JwtUtil::extractNetid → KILLED
57 1. replaced return value with null for nl/tudelft/sem/identity/util/JwtUtil::extractExpiration → NO_COVERAGE
62 1. replaced return value with null for nl/tudelft/sem/identity/util/JwtUtil::extractClaim → KILLED
66 1. replaced return value with null for nl/tudelft/sem/identity/util/JwtUtil::extractAllClaims → KILLED
76 1. replaced Boolean return with False for nl/tudelft/sem/identity/util/JwtUtil::isTokenExpired → NO_COVERAGE
2. replaced Boolean return with True for nl/tudelft/sem/identity/util/JwtUtil::isTokenExpired → NO_COVERAGE
89 1. replaced return value with "" for nl/tudelft/sem/identity/util/JwtUtil::generateToken → KILLED
100 1. replaced return value with "" for nl/tudelft/sem/identity/util/JwtUtil::createToken → KILLED
101 1. Replaced long addition with subtraction → KILLED
115 1. replaced Boolean return with False for nl/tudelft/sem/identity/util/JwtUtil::validateToken → NO_COVERAGE
2. replaced Boolean return with True for nl/tudelft/sem/identity/util/JwtUtil::validateToken → NO_COVERAGE
3. negated conditional → NO_COVERAGE
4. negated conditional → NO_COVERAGE
```

- For each of the classes (and their test suites) identified in point (2), add new test cases (or modify existing ones) to improve the mutation score by at least 20%.

3.1. Calendar Microservice - Teacher Retrieval Controller

After implementing more test coverage and mutations for the Teacher Retrieval Controller the mutation score improved from 69% to 100%. To kill the mutants, we had to first improve the mocks, to assess that the `setForPresenceOnCampus` has been set to true and that the `roomName` was changed from null to the name of the room. We changed 2 tests from this test suite and we achieved both 100% line coverage and 100% mutation coverage.

([Merge Request Link](#))

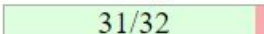
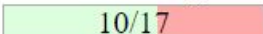
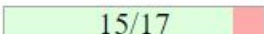
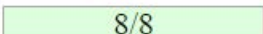
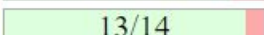
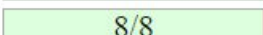
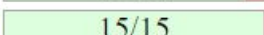
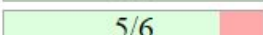
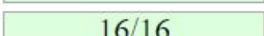
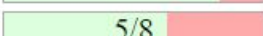
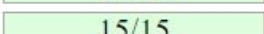
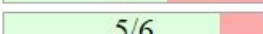
Name	Line Coverage	Mutation Coverage
AbsenceController.java	92% 	67% 
SchedulingController.java	100% 	83% 
StudentRetrievalController.java	100% 	83% 
TeacherRetrievalController.java	100% 	100% 

Mutations	
74	1. negated conditional → KILLED
75	1. replaced return value with null for nl/tudelft/sem/calendar/controllers/TeacherRetrievalController::getMyPersonalScheduleTeacher → KILLED
85	1. removed call to nl/tudelft/sem/calendar/entities/Lecture::setSelectedForOnCampus → KILLED
86	1. removed call to nl/tudelft/sem/calendar/entities/Lecture::setRoomName → KILLED
98	1. replaced return value with null for nl/tudelft/sem/calendar/controllers/TeacherRetrievalController::getMyPersonalScheduleTeacher → KILLED
112	1. negated conditional → KILLED
113	1. replaced return value with null for nl/tudelft/sem/calendar/controllers/TeacherRetrievalController::getMyPersonalScheduleForDayTeacher → KILLED
125	1. removed call to nl/tudelft/sem/calendar/entities/Lecture::setSelectedForOnCampus → KILLED
126	1. removed call to nl/tudelft/sem/calendar/entities/Lecture::setRoomName → KILLED
130	1. replaced return value with null for nl/tudelft/sem/calendar/controllers/TeacherRetrievalController::getMyPersonalScheduleForDayTeacher → KILLED
151	1. negated conditional → KILLED
152	1. replaced return value with null for nl/tudelft/sem/calendar/controllers/TeacherRetrievalController::getMyPersonalScheduleForCourseTeacher → KILLED
158	1. replaced return value with null for nl/tudelft/sem/calendar/controllers/TeacherRetrievalController::getMyPersonalScheduleForCourseTeacher → KILLED

3.2. Course Management Microservice - Enrollment Controller

After implementing more test coverage and mutations for the Enrollment Controller the mutation score improved from 50% to 100%. While Testing this class we have realized that the test is only testing null comparisons and just working because asserts are checking for nulls. To fix this we have improved the mocks in the test file, added null checks to the original code, and another one inside the lambda function. We fixed one test and added 3 others to explicitly check null, random input and false input.

([Merge Request Link](#))

Name	Line Coverage	Mutation Coverage
CourseController.java	97% 	59% 
CourseRetrievalController.java	88% 	100% 
EnrollmentController.java	93% 	100% 
LectureController.java	100% 	83% 
LecturePlannerController.java	100% 	63% 
LectureRetrievalController.java	100% 	83% 

Mutations

```
38 1. replaced return value with null for nl/tudelft/sem/courses/controller/EnrollmentController::getAllEnrollments → KILLED
51 1. negated conditional → KILLED
52 1. replaced return value with null for nl/tudelft/sem/courses/controller/EnrollmentController::getEnrollmentsByCourse → KILLED
55 1. replaced return value with null for nl/tudelft/sem/courses/controller/EnrollmentController::getEnrollmentsByCourse → KILLED
57 1. replaced boolean return with false for nl/tudelft/sem/courses/controller/EnrollmentController::lambda$getEnrollmentsByCourse$0 → KILLED
2. replaced boolean return with true for nl/tudelft/sem/courses/controller/EnrollmentController::lambda$getEnrollmentsByCourse$0 → KILLED
70 1. replaced return value with null for nl/tudelft/sem/courses/controller/EnrollmentController::bareFromEnrollment → KILLED
2. replaced return value with null for nl/tudelft/sem/courses/controller/EnrollmentController::lambda$bareFromEnrollment$1 → KILLED
```

3.3. Course Management Service - Lecture Retrieval Controller

After implementing more tests to improve coverage and cover/kill mutations for the Lecture Retrieval Controller the mutation score improved from 50% to 83%. By refactoring the code we were able to ensure that for mutations made by the lambda function for the getAllLectures method all mutants were covered and killed. This was unfortunately not possible for the getLectureAfterDate method. So we could not kill the final mutant.

([Merge Request Link](#))

Mutations

```
39 1. replaced return value with null for nl/tudelft/sem/courses/controller/LectureRetrievalController::lambda$getAllLectures$0 → KILLED
43 1. replaced return value with null for nl/tudelft/sem/courses/controller/LectureRetrievalController::getAllLectures → KILLED
57 1. negated conditional → KILLED
58 1. replaced return value with null for nl/tudelft/sem/courses/controller/LectureRetrievalController::getLecturesAfterDate → KILLED
62 1. replaced return value with null for nl/tudelft/sem/courses/controller/LectureRetrievalController::lambda$getLecturesAfterDate$1 → SURVIVED
65 1. replaced return value with null for nl/tudelft/sem/courses/controller/LectureRetrievalController::getLecturesAfterDate → KILLED
```

3.4. Identity Microservice - JwtUtil

After implementing tests to cover the cases that weren't transitively covered by tests for other classes for the JwtUtil, the mutation score improved from 50% to 93%. We could not kill the final mutant due to how Spring JWT handles expired tokens.

([Merge Request Link](#))

Name	Line Coverage	Mutation Coverage
JwtUtil.java	100% <div>20/20</div>	93% <div>13/14</div>

Mutations

```
37 1. replaced return value with "" for nl/tudelft/sem/identity/util/JwtUtil::getSecret → KILLED
47 1. replaced return value with "" for nl/tudelft/sem/identity/util/JwtUtil::extractNetid → KILLED
57 1. replaced return value with null for nl/tudelft/sem/identity/util/JwtUtil::extractExpiration → KILLED
62 1. replaced return value with null for nl/tudelft/sem/identity/util/JwtUtil::extractClaim → KILLED
66 1. replaced return value with null for nl/tudelft/sem/identity/util/JwtUtil::extractAllClaims → KILLED
76 1. replaced Boolean return with False for nl/tudelft/sem/identity/util/JwtUtil::isTokenExpired → SURVIVED
2. replaced Boolean return with True for nl/tudelft/sem/identity/util/JwtUtil::isTokenExpired → KILLED
89 1. replaced return value with "" for nl/tudelft/sem/identity/util/JwtUtil::generateToken → KILLED
100 1. replaced return value with "" for nl/tudelft/sem/identity/util/JwtUtil::createToken → KILLED
101 1. Replaced long addition with subtraction → KILLED
2. replaced Boolean return with False for nl/tudelft/sem/identity/util/JwtUtil::validateToken → KILLED
115 2. replaced Boolean return with True for nl/tudelft/sem/identity/util/JwtUtil::validateToken → KILLED
3. negated conditional → KILLED
4. negated conditional → KILLED
```