

# Assignment 3

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## Task 1: Automated Mutation Testing

Class	Mutation score before	Mutation score after	Link to related commit
AppUser in authentication microservice	64%	93%	<a href="https://gitlab.ewi.tudelft.nl/cse2115/2022-2023/SEM26b/-/commit/39bbed124da12a5f963317aebd2ad7929085dc2e">https://gitlab.ewi.tudelft.nl/cse2115/2022-2023/SEM26b/-/commit/39bbed124da12a5f963317aebd2ad7929085dc2e</a>
NetId in contract microservice	0%	100%	<a href="https://gitlab.ewi.tudelft.nl/cse2115/2022-2023/SEM26b/-/commit/d7900d49092dcd1655d32ce3cf4b2a596503dfe3">https://gitlab.ewi.tudelft.nl/cse2115/2022-2023/SEM26b/-/commit/d7900d49092dcd1655d32ce3cf4b2a596503dfe3</a>
MessageController in message microservice	0%	100%	<a href="#">Update tests to improve Pit test coverage report for MessageController.java (!57) · Merge requests · CSE2115 - Software Engineering Methods / 2022-2023 / SEM-26b · GitLab (tudelft.nl)</a>
MessageSenderService in message microservice	67%	100%	<a href="#">Update tests to improve Pit test coverage report for MessageSenderService.java (!63) · Merge requests · CSE2115 - Software Engineering Methods / 2022-2023 / SEM-26b · GitLab (tudelft.nl)</a>

MessageController before:

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## Pit Test Coverage Report

### Package Summary

nl.tudelft.sem.sem26b.message.controllers

Number of Classes	Line Coverage	Mutation Coverage
1	0% <div>0/34</div>	0% <div>0/21</div>

### Breakdown by Class

Name	Line Coverage	Mutation Coverage
<a href="#">MessageController.java</a>	0% <div>0/34</div>	0% <div>0/21</div>

MessageController after:

## Pit Test Coverage Report

### Package Summary

nl.tudelft.sem.sem26b.message.controllers

Number of Classes	Line Coverage	Mutation Coverage
1	100% <div>34/34</div>	100% <div>21/21</div>

### Breakdown by Class

Name	Line Coverage	Mutation Coverage
<a href="#">MessageController.java</a>	100% <div>34/34</div>	100% <div>21/21</div>

MessageSenderService before:

## Pit Test Coverage Report

### Package Summary

nl.tudelft.sem.sem26b.message.domain

Number of Classes	Line Coverage	Mutation Coverage
11	99% 178/179	95% 74/78

### Breakdown by Class

Name	Line Coverage	Mutation Coverage
<a href="#">MailboxService.java</a>	100% 22/22	100% 10/10
<a href="#">Message.java</a>	100% 16/16	100% 1/1
<a href="#">MessagePayload.java</a>	100% 10/10	100% 1/1
<a href="#">MessageRetrieverService.java</a>	100% 22/22	100% 8/8
<a href="#">MessageSenderService.java</a>	100% 18/18	67% 4/6

MessageSenderService after:

## Pit Test Coverage Report

### Package Summary

nl.tudelft.sem.sem26b.message.domain

Number of Classes	Line Coverage	Mutation Coverage
11	99% 178/179	97% 76/78

### Breakdown by Class

Name	Line Coverage	Mutation Coverage
<a href="#">MailboxService.java</a>	100% 22/22	100% 10/10
<a href="#">Message.java</a>	100% 16/16	100% 1/1
<a href="#">MessagePayload.java</a>	100% 10/10	100% 1/1
<a href="#">MessageRetrieverService.java</a>	100% 22/22	100% 8/8
<a href="#">MessageSenderService.java</a>	100% 18/18	100% 6/6

AppUser before:

# Pit Test Coverage Report

## Package Summary

nl.tudelft.sem.template.authentication.domain.user

Number of Classes	Line Coverage	Mutation Coverage
11	87% <div><div></div><div>65/75</div></div>	79% <div><div></div><div>23/29</div></div>

### Breakdown by Class

Name	Line Coverage	Mutation Coverage
<a href="#">AppUser.java</a>	63% <div><div></div><div>17/27</div></div>	64% <div><div></div><div>9/14</div></div>
<a href="#">HashedPassword.java</a>	100% <div><div></div><div>5/5</div></div>	100% <div><div></div><div>1/1</div></div>
<a href="#">HashedPasswordAttributeConverter.java</a>	100% <div><div></div><div>3/3</div></div>	100% <div><div></div><div>2/2</div></div>
<a href="#">NetId.java</a>	100% <div><div></div><div>5/5</div></div>	100% <div><div></div><div>1/1</div></div>
<a href="#">NetIdAttributeConverter.java</a>	100% <div><div></div><div>3/3</div></div>	100% <div><div></div><div>2/2</div></div>
<a href="#">Password.java</a>	100% <div><div></div><div>5/5</div></div>	100% <div><div></div><div>1/1</div></div>
<a href="#">PasswordHashingService.java</a>	100% <div><div></div><div>4/4</div></div>	100% <div><div></div><div>1/1</div></div>
<a href="#">PasswordWasChangedEvent.java</a>	100% <div><div></div><div>4/4</div></div>	100% <div><div></div><div>1/1</div></div>
<a href="#">RegistrationService.java</a>	100% <div><div></div><div>11/11</div></div>	75% <div><div></div><div>3/4</div></div>
<a href="#">UserLoggedInEvent.java</a>	100% <div><div></div><div>4/4</div></div>	100% <div><div></div><div>1/1</div></div>
<a href="#">UserWasCreatedEvent.java</a>	100% <div><div></div><div>4/4</div></div>	100% <div><div></div><div>1/1</div></div>

AppUser after:

# Pit Test Coverage Report

## Package Summary

nl.tudelft.sem.template.authentication.domain.user

Number of Classes	Line Coverage	Mutation Coverage
11	100% <div><div></div><div>78/78</div></div>	93% <div><div></div><div>28/30</div></div>

### Breakdown by Class

Name	Line Coverage	Mutation Coverage
<a href="#">AppUser.java</a>	100% <div><div></div><div>30/30</div></div>	93% <div><div></div><div>14/15</div></div>
<a href="#">HashedPassword.java</a>	100% <div><div></div><div>5/5</div></div>	100% <div><div></div><div>1/1</div></div>
<a href="#">HashedPasswordAttributeConverter.java</a>	100% <div><div></div><div>3/3</div></div>	100% <div><div></div><div>2/2</div></div>
<a href="#">NetId.java</a>	100% <div><div></div><div>5/5</div></div>	100% <div><div></div><div>1/1</div></div>
<a href="#">NetIdAttributeConverter.java</a>	100% <div><div></div><div>3/3</div></div>	100% <div><div></div><div>2/2</div></div>
<a href="#">Password.java</a>	100% <div><div></div><div>5/5</div></div>	100% <div><div></div><div>1/1</div></div>
<a href="#">PasswordHashingService.java</a>	100% <div><div></div><div>4/4</div></div>	100% <div><div></div><div>1/1</div></div>
<a href="#">PasswordWasChangedEvent.java</a>	100% <div><div></div><div>4/4</div></div>	100% <div><div></div><div>1/1</div></div>
<a href="#">RegistrationService.java</a>	100% <div><div></div><div>11/11</div></div>	75% <div><div></div><div>3/4</div></div>
<a href="#">UserLoggedInEvent.java</a>	100% <div><div></div><div>4/4</div></div>	100% <div><div></div><div>1/1</div></div>
<a href="#">UserWasCreatedEvent.java</a>	100% <div><div></div><div>4/4</div></div>	100% <div><div></div><div>1/1</div></div>

NetId before:

## Pit Test Coverage Report

### Package Summary

nl.tudelft.sem.template.contract.models

Number of Classes	Line Coverage	Mutation Coverage
3	67% <div><div></div><div></div><div></div></div> 14/21	75% <div><div></div><div></div><div></div></div> 3/4

### Breakdown by Class

Name	Line Coverage	Mutation Coverage
<a href="#">HashedPassword.java</a>	100% <div><div></div><div></div><div></div></div> 6/6	100% <div><div></div><div></div><div></div></div> 2/2
<a href="#">MessagePayload.java</a>	80% <div><div></div><div></div><div></div></div> 8/10	100% <div><div></div><div></div><div></div></div> 1/1
<a href="#">NetId.java</a>	0% <div><div></div><div></div><div></div></div> 0/5	0% <div><div></div><div></div><div></div></div> 0/1

Report generated by [PIT](#) 1.5.1

NetId after:

## Pit Test Coverage Report

### Package Summary

nl.tudelft.sem.template.contract.models

Number of Classes	Line Coverage	Mutation Coverage
3	86% <div><div></div><div></div><div></div></div> 18/21	100% <div><div></div><div></div><div></div></div> 4/4

### Breakdown by Class

Name	Line Coverage	Mutation Coverage
<a href="#">HashedPassword.java</a>	100% <div><div></div><div></div><div></div></div> 6/6	100% <div><div></div><div></div><div></div></div> 2/2
<a href="#">MessagePayload.java</a>	80% <div><div></div><div></div><div></div></div> 8/10	100% <div><div></div><div></div><div></div></div> 1/1
<a href="#">NetId.java</a>	80% <div><div></div><div></div><div></div></div> 4/5	100% <div><div></div><div></div><div></div></div> 1/1

Report generated by [PIT](#) 1.5.1

## Task 2: Manual Mutation Testing

For Task 2 we decided to test our contract domain, as it is an essential part of our project which contains a lot of business logic. The four critical classes we chose to test within this domain are: ContractController, CandidateController, ValidateCandidateDetailsHandler and IsHrHandler.

### ContractController

ContractController is a critical class because it's the point of entry to many contract-related tasks such as proposing a contract and accepting a contract. Contracts are legally binding, so we felt that this class should be a priority with respect to testing.

During our checks, we realized that our methods in ContractController did not null-check the parameters supplied to the methods. Therefore, we initially created checks for null/empty parameters. Then, we mutated these checks by using AND operators instead of OR operators, meaning the methods would not complain if at least one parameter wasn't null. Finally, we created relevant test cases such that they do not fail on the (improved) methods but fail on the manual mutations (<https://gitlab.ewi.tudelft.nl/cse2115/2022-2023/SEM26b/-/commit/be78c00224a01aaa941aa80981f3641a163a55b7>).

## **CandidateController**

For a contract to be negotiated, the person to be hired must be registered to our application as a candidate first. This important task is handled by CandidateController, therefore it is vital to make sure the createCandidate() method inside this class is executed with valid parameters.

In a similar fashion to our manual mutations for ContractController, we added null-checks for the parameters and mutated them so that they still allow empty parameters as long as not all parameters are empty. We then wrote tests to cover this mutation

(<https://gitlab.ewi.tudelft.nl/cse2115/2022-2023/SEM26b/-/commit/dd6db5747fdb84a7eb1d11b6bedb194cdfb028fc>).

## **ValidateCandidateDetailsHandler**

The ValidateCandidateDetailsHandler is used in our chain of responsibility in order to validate that a new candidate's credentials are between 3 and 50 characters long. It is essential to our application as it provides an important check, and bugs in this link of the chain could cause the rest of the chain to execute or fail when it shouldn't.

Now, our tests make sure that the nickname and the password String does not exceed 50 characters, excluding the null terminator (<https://gitlab.ewi.tudelft.nl/cse2115/2022-2023/SEM26b/-/commit/f06daba231789eaadd13dff8b0f06bc00a6102b2>).

## **IsHrHandler**

The IsHrHandler is used in our chain of responsibility in order to check whether a user has the HR role. It is essential to our application as it a handler that grants permission to critical user actions. When this handler does not work as expected, users can execute actions that they are not supposed to.

The handler checks if the role contains "HR" by calling toString() on the given data map. But when the role Object in the data map is another type than String, that object can return the word "HR" in its toString() method. For example, if the object has the name "HR" in it. We wrote a new part in the handler that checks whether the “role” object in the data map is an Object of type String. We then wrote tests to cover this mutation:

[https://gitlab.ewi.tudelft.nl/cse2115/2022-2023/SEM26b/-/merge\\_requests/65/commits](https://gitlab.ewi.tudelft.nl/cse2115/2022-2023/SEM26b/-/merge_requests/65/commits)