# COMP2005 Assessment 2: Report

## Assessment Materials

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| D2 GitHub Repository: | <https://github.com/Plymouth-University/comp2005-assessment2-corey-richardson> |
| D3 YouTube Link: |  |

## Introduction

## Unit and Integration Testing for Part A

Each layer of the application was tests according to its role in the application architecture. Classes and service methods were tested using Unit Tests to verify their behaviour in isolation from the API returns. Services were tested using mocked dependencies and returns to ensure that the implementations matched expected business logic. Controllers were tested using Integration Tests to verify the API’s behaviour.

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| **Test File** | **Layer Tested** | **Test Types** |
| AdmissionControllerTest.java | Controller | Integration Tests |
| AdmissionServiceTest.java | Service | Unit Tests |
| AdmissionTest.java | Class | Unit Tests |
| AllocationTest.java | Class | Unit Tests |
| ApiHelperTest.java | Service | Unit Tests |
| Comp2005ApiApplicationTests.java | Application Context | Smoke Test |
| EmployeeTest.java | Class | Unit Tests |
| PatientControllerTest.java | Controller | Integration Tests |
| PatientServiceTest.java | Service | Unit Tests |
| PatientTest.java | Class | Unit Tests |

The following tables list each test case and explain their purpose in testing the application.

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| **AdmissionControllerTest.java** | | |
| **Layer Tested** | Controller | |
| **Test Types** | Integration Tests | |
| returnsExpectedMonth | | Checks that the controller returns the expected month string when admissions exist and are returned by the Service layer. |
| returnsEmptyWhenNoAdmissions | | Ensures that the controller returns a fallback message that is passed by the Service layer if no admissions exist. |
| handlesErrorsGracefully | | Checks that the controller returns a fallback message that is passed by the Service layer if it encounters an error or exception. |

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| **AdmissionServiceTest.java** | | |
| **Layer Tested** | Service | |
| **Test Types** | Unit Tests | |
| **MonthWithMostAdmissionsTests** | | |
| returnsExpectedMonth | | Checks that the service method returns the correct datestring/month when admissions are successfully fetched, in form ‘YYYY-MM’. |
| returnsEmptyWhenNoAdmissions | | Checks the service returns a fallback message if it fetches no admissions; loudly fails. |
| handlesErrorsGracefully | | Checks that the service returns an expected fallback message if the API fails to fetch any admissions. |

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| **AdmissionTest.java** | | |
| **Layer Tested** | Class | |
| **Test Types** | Unit Tests | |
| testParameterlessNotNull | | Tests that the parameterless constructor creates an object. |
| testConstructedNotNull | | Tests that the constructor with parameters creates an object. |
| testSetAndGetId | | Tests for GETTER and SETTER methods. |
| testSetAndGetPatientId | |
| testSetAndGetAdmissionDate | |
| testSetAndGetDischargeDate | |
| constructedAdmissionTest | | Test that the constructor with parameters creates an object and assigns expected values to the attributes. |

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| **AllocationTest.java** | | |
| **Layer Tested** | Class | |
| **Test Types** | Unit Tests | |
| testParameterlessNotNull | | Tests that the parameterless constructor creates an object. |
| testConstructedNotNull | | Tests that the constructor with parameters creates an object. |
| testSetAndGetId | | Tests for GETTER and SETTER methods. |
| testSetAndGetAdmissionId | |
| testSetAndGetEmployeeId | |
| testSetAndGetStartTime | |
| testSetAndGetEndTime | |
| constructedAllocationTest | | Test that the constructor with parameters creates an object and assigns expected values to the attributes. |

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| **ApiHelperTest.java** | | |
| **Layer Tested** | Service | |
| **Test Types** | Unit Tests | |
| **HandleRequestTests** | | |
| propagateExceptionWhenNot404Error | | Checks that if the API call results in a HTTP error other than 404 NOT FOUND, the exception is propagated and the application fails loudly. |
| **AdmissionTests** | | |
| getAllAdmissions\_returnsAdmissions | | Checks that the method returns a list of Admission objects when the API responds with data. |
| getAdmissionById\_returnsAdmission | | Checks that the method returns a single Admission object when the ID exists. |
| getAdmissionById\_handles404 | | Checks that the method returns null rather than throws an exception when an object is not found; 404 NOT FOUND. |
| **AllocationTests** | | |
| getAllAllocations\_returnsAllocations | | Checks that the method returns a list of Allocation objects when the API responds with data. |
| getAllocationById\_returnsAllocation | | Checks that the method returns a single Allocation object when the ID exists. |
| getAllocationById\_handles404 | | Checks that the method returns null rather than throws an exception when an object is not found; 404 NOT FOUND. |
| **EmployeeTests** | | |
| getAllEmployees\_returnsEmployees | | Checks that the method returns a list of Employee objects when the API responds with data. |
| getEmployeeById\_returnsEmployee | | Checks that the method returns a single Employee object when the ID exists. |
| getAllocationById\_handles404 | | Checks that the method returns null rather than throws an exception when an object is not found; 404 NOT FOUND. |
| **PatientTests** | | |
| getAllPatients\_returnsPatients | | Checks that the method returns a list of Patient objects when the API responds with data. |
| getPatientById\_returnsPatient | | Checks that the method returns a single Patient object when the ID exists. |
| getPatientById\_handles404 | | Checks that the method returns null rather than throws an exception when an object is not found; 404 NOT FOUND. |

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| **Comp2005ApiApplication.java** | | |
| **Layer Tested** | Application Context | |
| **Test Types** | Smoke Test | |
| contextLoads | | Ensures that the Spring Boot application context starts up correctly. |
| **EmployeeTest.java** | | |
| **Layer Tested** | Class | |
| **Test Types** | Unit Tests | |
| testParameterlessNotNull | | Tests that the parameterless constructor creates an object. |
| testConstructedNotNull | | Tests that the constructor with parameters creates an object. |
| testSetAndGetId | | Tests for GETTER and SETTER methods. |
| testSetAndGetFirstName | |
| testSetAndGetLastName | |
| constructedEmployeeTest | | Test that the constructor with parameters creates an object and assigns expected values to the attributes. |

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| **PatientControllerTest.java** | | |
| **Layer Tested** | Controller | |
| **Test Types** | Integration Tests | |
| **NeverAdmittedTests** | | |
| returnsExpectedPatients | | Checks that when the service returns a list of patients, the controller successfully propagates this list. |
| returnsEmptyListWhenNoPatients | | Checks that if the services returns an empty list, the controller layer does so too to ensure no null unexpected behaviour. |
| handleServiceFailure | | Simulates a service failure and ensures that the controller layer handles it gracefully by returning an empty list rather than an exception. |
| **ReadmittedWithinSevenDaysTests** | | |
| returnsExpected | | Checks that when the service returns a list of patients, the controller successfully propagates this list. |
| returnsEmptyListWhenNoPatients | | Checks that if the services returns an empty list, the controller layer does so too to ensure no null unexpected behaviour. |
| handleServiceFailure | | Simulates a service failure and ensures that the controller layer handles it gracefully by returning an empty list rather than an exception. |
| **MultipleStaffTests** | | |
| returnsExpected | | Checks that when the service returns a list of patients, the controller successfully propagates this list. |
| returnsExpectedDifferentAdmissions | | Checks that if a patient has multiple admissions with different Employees allocated the method still returns the expected response. |
| returnsEmptyWhenNoMultiples | | Checks that if the services returns an empty list, the controller layer does so too to ensure no null unexpected behaviour. |
| handleServiceFailure | | Simulates a service failure and ensures that the controller layer handles it gracefully by returning an empty list rather than an exception. |

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| **PatientServiceTest.java** | | |
| **Layer Tested** | Service | |
| **Test Types** | Unit Tests | |
| **NeverAdmittedTests** | | |
| returnsExpected | | Checks that the service method returns the expected patients from a list of mocked patients and admissions. |
| testBoundaryBehaviour | | Tests that the actual behaviour matches the expected behaviour at the boundary value of 7 days. Admissions of lengths 6:23:59:59, 7:00:00:00 and 7:00:00:01 are checked - only the patient information related to the first two admission lengths should be returned by the service method. This tests an edge case. |
| returnsAllWhenNoAdmissions | | Checks that the service method returns the expected (all given) patients from a list of mocked patients and an empty list of admissions. |
| returnsEmptyWhenNoPatients | | Checks the service returns a fallback  message if it fetches no admissions; loudly  fails. |
| handlesErrorsGracefully | | Checks that the service returns an expected  fallback message if the API fails to fetch any  admissions. |
| **ReadmittedWithinSevenDaysTests** | | |
| returnsExpected | | Checks that the service method returns the expected patients from a list of mocked patients and admissions. |
| returnsEmptyWhenNoPatients | | Checks the service returns a fallback  message if it fetches no admissions; loudly  fails. |
| handlesErrorsGracefully | | Checks that the service returns an expected  fallback message if the API fails to fetch any  admissions. |
| **MultipleStaffTests** | | |
| returnsExpected | | Checks that the service method returns the expected patients from a list of mocked patients, allocations and admissions. |
| returnsExpectedDifferentAdmissions | | Checks that the service method returns the expected patients from a list of mocked patients, allocations and admissions. In this test, it tests the case where multiple employees are allocated across two separate admissions, whereas the first test only checks a single admission. |
| returnsEmptyWhenNoMultiples | | Checks the service returns a fallback  message if it fetches no admissions; loudly  fails. |
| handlesErrorsGracefully | | Checks that the service returns an expected  fallback message if the API fails to fetch any  admissions. |
| **PatientTest.java** | | |
| **Layer Tested** | Class | |
| **Test Types** | Unit Tests | |
| testParameterlessNotNull | | Tests that the parameterless constructor creates an object. |
| testConstructedNotNull | | Tests that the constructor with parameters creates an object. |
| testSetAndGetId | | Tests for GETTER and SETTER methods. |
| testSetAndGetFirstName | |
| testSetAndGetLastName | |
| testSetAndGetNhsNumber | |
| constructedPatientTest | | Test that the constructor with parameters creates an object and assigns expected values to the attributes. |

Tests were implemented using the Junit framework. Test classes often contained ‘@Nested’ sub-classes, each focusing on a different portion of a service, to ensure that the test suites remained readable. ‘@BeforeEach’ decorators were used to control test set-up and configurations, and ‘@Test’ is used to decorate test methods. JUnit uses these decorations to manage the discovery, lifecycles and execution of the tests.

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| Figure 1: Example of a Test Class, Sub-class and Method, ApiHelperTest::HandleRequestTests::propagateExceptionWhenNot404Error() |

Mock objects were used to isolate units of code using a top-down manner to emulate the behaviour of dependent methods and API calls. By replacing dependencies with mocks, tests can concentrate on the logic of the method they are designed to tests, rather than external factors.

The ‘Mockito’ library was largely used to create mock instances of service class methods, which were subsequently injected into the controller layer using ‘@Mock’ and ‘@InjectMock’ decorators. Method returns were controlled using ‘when(<method>).thenReturn(<data>)’ logic to ensure consistency in the behaviour of dependencies during test runs.

I ran my tests using IntelliJ IDEA Community Edition (2024.2.2). To do this, open the   
**‘part-a-web-service-api’** Spring Boot project and navigate to the **‘src/test/java’** directory in the **Project** explorer window. To run all tests right click on the **‘com.example.comp2005\_api’** package or to run individual test classes right click on the respective file (for example ‘**ApiHelperTest.java’** and select the option for **‘Run Tests in com.example.comp2005\_api’** or **‘Run ApiHelperTest’** (example).

Any selected tests will run, and the test results will be displayed in the terminal section of the IDE.

Tests can also be run from the terminal section using the command **‘./gradlew clean test’**.

### Use of the Test Driven Development Approach

To assist with the implementation of F2, F3 and F4 for Part A of the task, I used a Test Driven Development (TDD) approach, where I wrote failing tests for each method before implementing the methods. The TDD workflow consists of 3 stages:

* Red: Write a failing test.
* Green: Write code to make the test pass.
* Refactor: Refactor and tidy the code, without changing its behaviour.

This approach helped me to ensure that the behaviour of methods and return values matched the expected behaviour. This approach shifts the focus from writing code that “works” to writing code the “works correctly”.

The use of this approach is evidenced by commits `11a2b7e`, `b8812a0` and `8cc565b`.

## Metrics and Code Coverage

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| Figure 2: Code Coverage Metrics from IntelliJ IDE |
| **Test Report: part-a-web-service-api/htmlReport/index.html** |

A large proportion of the application has been covered by the unit and integration tests. This should result in better-tested and more robust code, reducing the number of bugs likely to be found in a non-development environment. There are some minor gaps in coverage, primarily to do with the ‘Comp2005ApiApplication.java’ file, which only contains the main function which acts as an entry point to the application; even then, this is covered by a ‘contextLoad’ test which confirms that the application successfully begins. There is also a gap in coverage on the two service files, relating to catching exceptions and date parsing errors: branch coverage.

## Usability Testing for Part B

## System Testing

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| Figure 3: curl Requests to the API Endpoints |

## Tools and Practices

### GitHub Actions, CI/CD

I set up a GitHub Actions workflow to automatically run the full test suite on every push to the main branch of the GitHub repository.

This workflow is defined in **.github\workflows\run-tests.yaml**.

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| Figure 4: GitHub Actions Workflow |

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The workflow ensures that it is testing the latest pushed code before setting up a Java 17 environment and ensuring that the Gradle Wrapper file is executable. It then runs the test suite and reports the results on the Actions section of the GitHub repository; test failures are also notified by email.

The automated workflow ensures that tests are executed regularly on changes in an independent and consistent environment, identifying integration, build and regression errors early in the change process.

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| Figure 5: GitHub Actions Page  <https://github.com/Plymouth-University/comp2005-assessment2-corey-richardson/actions> |

To test the workflow I had set up, I used the ‘GitHub Local Actions’ extension for VS Code to run the workflow locally before pushing new code. This extension utilises the Docker Engine to create containerised environments like those used by the GitHub action runners, and ‘nektons/act’ to locally run the workflow.

This local testing helped me to reduce the development time for the CI/CD pipeline and ensured that the workflow would work as intended before integrating it into the main GitHub repository.

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| Figure 6: GitHub Local Actions Workflow |

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| GitHub Local Actions for VS Code (Sanjula Ganepola) | <https://marketplace.visualstudio.com/items?itemName=SanjulaGanepola.github-local-actions> |

## Evaluation