
ETSA02-ADM-LAB3

Lab 3

Code Coverage Testing and static code analysis

Version 1.0 approved

Prepared by Markus Borg
Dept. of Computer Science, Lund University

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Revision History

Name	Date	Reason For Changes	Version
Markus Borg	2018-03-21	Initial draft.	0.1
Markus Borg	2018-04-01	First instructions for the RobotTestBed.	0.2
Markus Borg	2018-04-04	Drafted introduction section.	0.3
Markus Borg	2018-04-07	Complete draft, ready for internal review.	0.4
Markus Borg	2018-04-16	Updated after internal review.	0.5
Markus Borg	2018-04-17	Ready for lab.	1.0

1 Introduction

During Lab 3 you will continue working with automated testing of Basic Melee Bot. You will still use the JUnit framework to drive the test automation, but your test design will leave the unit level to instead target robot behavior on the system level. To enable such testing, you will work with the Robocode plug-in RobotTestBed. Furthermore, you will design test cases to verify quality requirements regarding the battle performance of Basic Melee Bot. More specifically, Lab 3 covers:

- Working with the RobotTestBed plugin.
- Designing JUnit test cases for system testing.
- Designing JUnit test cases for testing quality requirements.

2 Before the lab

The source code required for Lab 3 is available on GitHub:
<https://github.com/lunduniversity/introsofteng>

If you have already cloned the repository, pull the latest source code to make sure you work with the latest version. If you prefer downloading the code, instead click the button presented in Figure 2.1 and choose “Download ZIP”. Once downloaded, locate the files you need for Lab 3. The files are in the folder `introsofteng-master/labs/lab3/src`, and its subfolder: ‘test’. Rewatch the video “Lab2_download.avi” on Google Drive (ETSA02 Everyone/Labs) if you need support.

2.1 Install, setup, and run test cases with RobotTestBed and JUnit

Importing the Lab 3 source code and configuring RobotTestBed are not trivial tasks, but most steps are similar to what you did for Lab 1 and Lab 2, e.g., creating a Java project, importing source files, adding external libraries in Eclipse, adding the path to the Eclipse Java project to Robocode, and creating a JUnit run configuration. You might need to revisit instructions from previous labs if you get lost.

Follow the instructions below to install the Robocode testing plugin and setup JUnit for system testing of robots. Figure 2.2 shows an overview of the setup we will use in Lab 3.

1. **Download Robot testing plugin.** Download the latest Robot testing plugin (1.9.3.2) from <https://sourceforge.net/projects/robocode/files/robocode/1.9.3.2/>
2. **Install Robot testing plugin.** Install the Robot testing plugin. The default option is to install the plugin in the existing Robocode folder – this is fine.
3. **Create a new Java project for Lab3 in your Eclipse workplace.** As in Lab 1 and Lab 2, add the `robocode.jar` as an “External JAR” in the Libraries tab, either when creating the project or afterwards in the project properties.
4. **Create a new package called `etsa02_lab3`.** In the “Package Explorer” pane, right click “src” and create a new “Package” called “etsa02_lab3”.
5. **Import the source files required for lab3,** either from the cloned repository or the zip archive. In the “Package Explorer” pane, right click the newly created package and run “Import...”. Click “General” and then choose “File system” and

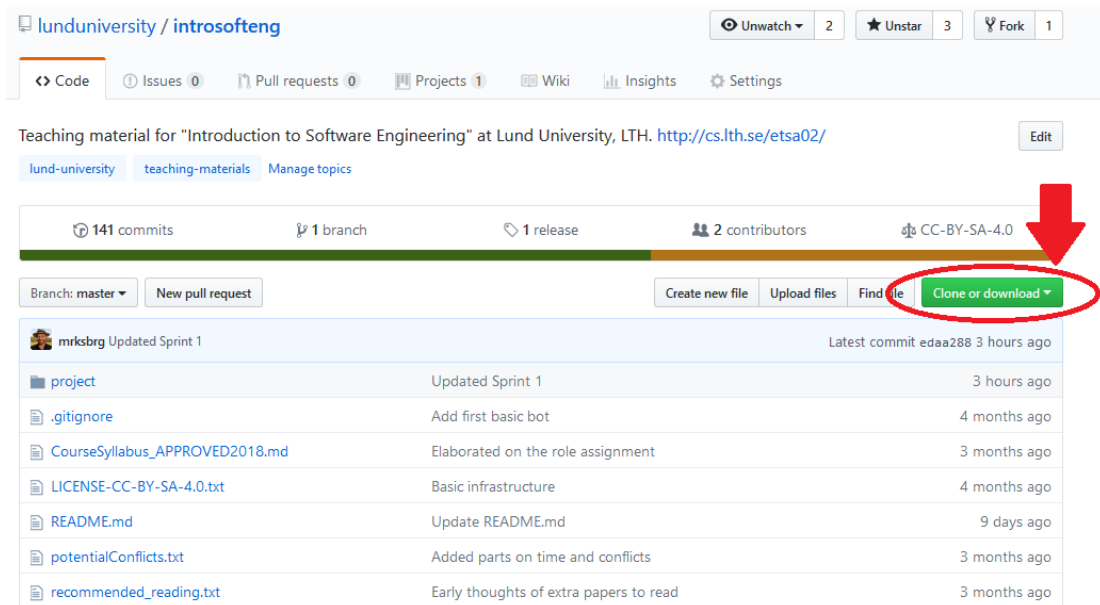


Figure 2.1: introsofteng repository on GitHub. The arrow shows the “Clone or download” button.

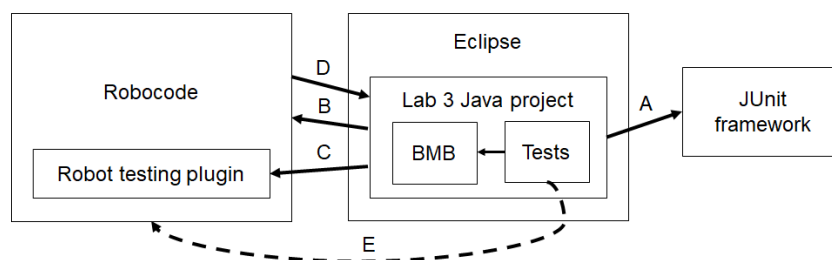


Figure 2.2: The three main elements in the Lab 3 setup, and the key links A-E. To the left, your local Robocode installation with the new Robot testing plugin. The link from Robocode to the Lab 3 Java project (cf. D) is configured in the Robocode options menu. In the middle, your Lab 3 Java project containing BasicMeleeBot (BMB) and its test cases. The references to Robocode (cf. B) and to Robot testing plugin (cf. C) are configured in the “Java build path” in Eclipse. To the right, the JUnit framework. The Lab 3 Java project in Eclipse needs a reference to the JUnit library (cf. A). Finally, the test cases contain a string to explicitly specify which Robocode robot is under test (cf. E) – this should for all test cases be “etsa02_lab3.BasicMeleeBot*”.

select all downloaded files in both the “src” folder and the “src/test” folder. The content in the Package Explorer should resemble Figure 2.3.

6. **Add JUnit as a library.** As in Lab 2, right click the Java project and select “Build Path” and click “Add Libraries...” and select JUnit. Click “Next >” followed by “Finish” to accept the default settings. This step creates the A link in Fig. 2.2.
7. **Add references to robocode libraries.** Add robocode.jar (cf. B in Fig. 2.2) and robocode.testing.jar (cf. C in Fig. 2.2) to the Java build path. If you don’t remember the steps, have a look at:
http://robowiki.net/wiki/Robocode/Eclipse/Create_a_Project
(Same as for Lab 1, but add also robocode.testing.jar this time).
8. **Create a JUnit run configuration.** Right click “BMBSYSTEMTestSuite.java” and choose “Run as...” and create a new JUnit run configuration. Give the configuration a descriptive name, such as “Lab3 system tests”. Do this in the same way as when creating a normal JUnit run configuration (i.e., Lab 2), but you must also add -Drobocode.home=PATH TO ROBOCODE as an argument to the VM (in the second tab, in the second text field).
9. **Add path to BMB from Robocode.** Robocode must find the “etsa02.lab3.BasicMeleeBot*” specified in the test cases (cf. E in Fig. 2.2). To do this, start Robocode and add a path to the new Lab 3 Java project (from the Options menu → Preferences in the “Development Options” tab). This step creates the D link in Fig. 2.2.

2.2 The fundamentals of RobotTestBed

To get an initial understanding of RobotTestBed, study the simple example TestWall-Behavior that follows. The test case verifies that the corresponding robot visits all four corners of the battlefield. RobotTestBed lets you override methods in Robocode’s BattleAdaptor to add JUnit assertions for testing robot behavior. The complete list is available in the Robocode API, but a handful of methods should be enough for Lab 3:

- public void onBattleCompleted(BattleCompletedEvent event)
- public void onRoundStarted(RoundStartedEvent event)
- public void onRoundEnded(RoundEndedEvent event)
- public void onTurnEnded(TurnEndedEvent event)

During the lab, you will work on designing test cases to verify the four primary features of Basic Melee Bot: 1) Spinning radar, 2) Closest enemy targeting, 3) Non-stop anti-gravity movement, and 4) Wall avoidance. You can study the features and requirements of Basic Melee Bot in Section 3.

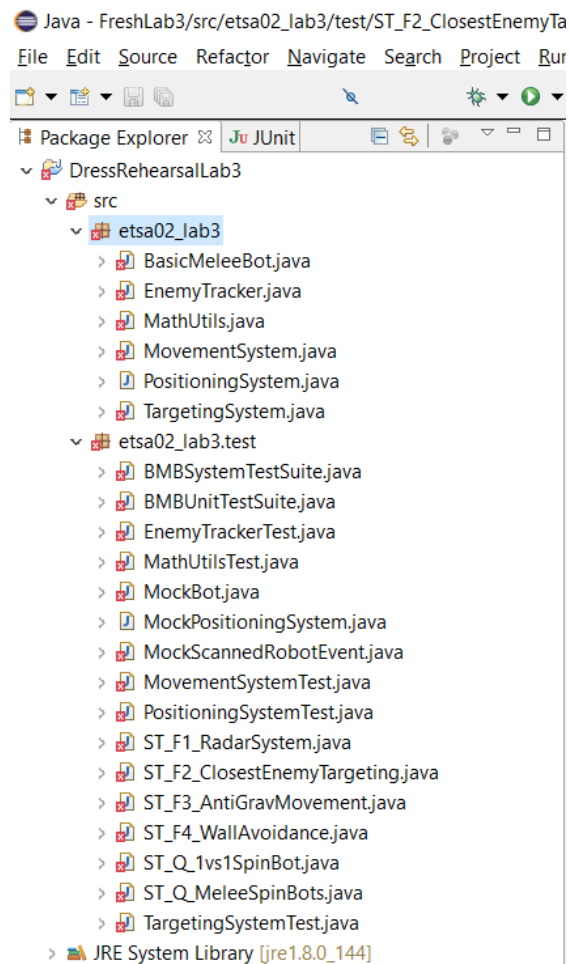


Figure 2.3: The Package Explorer in Eclipse after importing the Lab 3 source code. You should recognize BasicMeleeBot from Lab 2, including its unit tests – now organized in the test suite ‘BMBUnitTestSuite.java’. New for Lab 3 are the system tests (prefix ‘ST’) and the system tests for the quality requirements (prefix ‘Q’).

```

/**
 * Copyright (c) 2001-2018 Mathew A. Nelson and Robocode contributors
 * All rights reserved. This program and the accompanying materials
 * are made available under the terms of the Eclipse Public License v1.0
 * which accompanies this distribution, and is available at
 * http://robocode.sourceforge.net/license/epl-v10.html
 */
package sample;

import static org.junit.Assert.assertTrue;
import robocode.control.events.BattleCompletedEvent;
import robocode.control.events.TurnEndedEvent;
import robocode.control.snapshot.IRobotSnapshot;
import robocode.control.testing.RobotTestBed;

/**
 * Tests that sample.Walls moves to all four corners.
 *
 * @author Philip Johnson (original)
 * @author Pavel Savara (contributor)
 */
public class TestWallBehavior extends RobotTestBed {

    /**
     * True if the robot visited this corner during the test case.
     */
    boolean visitedUpperLeft = false;

    /**
     * True if the robot visited this corner during the test case.
     */
    boolean visitedUpperRight = false;

    /**
     * True if the robot visited this corner during the test case.
     */
    boolean visitedLowerLeft = false;

    /**
     * True if the robot visited this corner during the test case.
     */
    boolean visitedLowerRight = false;

    /**

```



```

    * Specifies that SittingDuck and DaCruzer are to be matched up in this test case.
    *
    * @return The comma-delimited list of robots in this match.
    */
@Override
public String getRobotNames() {
    return "sample.SittingDuck,sample.Walls";
}

/**
 * This test runs for 1 round.
 *
 * @return The number of rounds.
 */
@Override
public int getNumRounds() {
    return 1;
}

/**
 * After each turn, check to see if we're at a corner.
 * If so, set the corresponding flag.
 *
 * @param event Info about the current state of the battle.
 */
@Override
public void onTurnEnded(TurnEndedEvent event) {
    IRobotSnapshot robot = event.getTurnSnapshot().getRobots()[1];
    double xPos = robot.getX();
    double yPos = robot.getY();

    if ((xPos < 40) && (yPos < 40)) {
        visitedUpperLeft = true;
    }
    if ((xPos < 40 && (yPos > (height - 40)))) {
        visitedLowerLeft = true;
    }
    if ((xPos > (width - 40)) && (yPos < 40)) {
        visitedUpperRight = true;
    }
    if ((xPos > (width - 40) && (yPos > (height - 40)))) {
        visitedLowerRight = true;
    }
}

```

```
/**
 * After the battle, check to see that we've visited the corners.
 *
 * @param event Details about the completed battle.
 */
@Override
public void onBattleCompleted(BattleCompletedEvent
event) {
    assertTrue("Check UpperLeft", visitedUpperLeft);
    assertTrue("Check LowerLeft", visitedLowerLeft);
    assertTrue("Check UpperRight", visitedUpperRight);
    assertTrue("Check LowerRight", visitedLowerRight);
}
}
```

3 At the lab

In Lab 3, your task is to design automated test cases that verify features and detailed requirements of Basic Melee Bot. This is far from trivial, as all robot states are not observable when working with RobotTestBed. A considerable challenge in Lab 3, and in the project in general, is to create as good test cases as possible given the constraints imposed by RobotTestBed. For some requirements, you might have to argue that you will have to rely on code reviews for verification. However, in most cases you should be able design test cases that – at least partly – verify the requirements in question. Software testing is a creative activity, and sometimes more demanding than implementing the actual features in source code.

Below you will find the four features of Basic Melee Bot and two quality requirements, listed in the recommended implementation order. All items listed below have a corresponding test case in the test src/test folder. Implement the test cases in the prepared files (ST_FX or ST_Q prefixes) and make sure they all pass in JUnit. We suggest that you complete Lab 3 in the following order:

- Feature 3: Non-stop anti-gravity movement
- Feature 4: Wall avoidance
- Quality requirement: 1-vs-1 battle performance
- Quality requirement: Melee battle performance
- Feature 2: Closest enemy targeting
- Feature 1: Spinning radar

3.1 Feature 3 – Non-stop anti-gravity movement

BMB shall use anti-gravity movement.

3.1.1 Description and Priority

Anti-gravity movement is used to keep a distance to certain points on the battlefield. BMB shall use this movement to stay away from enemy robots. Furthermore, BMB shall never stay at one position.

Business priority: **medium**

Implementation risk: **medium**

3.1.2 Functional Requirements

REQ-F3-1 BMB shall continuously move away from enemy robots.

REQ-F3-2 BMB shall never stay in the same position for more than 25 consecutive turns.

3.2 Feature 4 – Wall avoidance

BMB shall avoid driving into walls.

3.2.1 Description and Priority

Crashing into walls damages robots and forces them into a stop. BMB shall not end up in walls, even when the anti-gravity movement suggests such positions.

Business priority: **medium**

Implementation risk: **medium**

3.2.2 Functional Requirements

REQ-F4-1 When closer than 40 distance units to a wall, BMB shall alter its course to avoid collision.

3.3 Quality Requirements

This section describes quality requirements for Basic Melee Bot. The robot is primarily intended for use in the LU Rumble, but it shall also be competitive in 1-vs-1 battles and melee battles.

3.3.1 1-vs-1 Battle Performance Requirements

When Basic Melee Bot battles against a single enemy robot, it will continuously change its position on the battlefield and stay away from the enemy robot by using its non-stop anti-gravity movement. Basic Melee Bot shall perform well against the Robocode sample robots.

REQ-Q1 Basic Melee Bot shall have at least 75% win rate against SpinBot in battles over 100 rounds on the standard Robocode battlefield size.

3.3.2 Melee Battle Performance Requirements

When Basic Melee Bot battles against multiple enemy robot, it will try to stay away from enemy robots by using its non-stop anti-gravity movement. Basic Melee Bot shall perform well in melee battles against the Robocode sample robots.

REQ-Q2 Basic Melee Bot shall have at least 33% win rate in melee battles against three enemy SpinBots in battles over 100 rounds on the standard Robocode battlefield size.

3.4 Feature 1 – Spinning radar

BMB shall feature a spinning radar.

3.4.1 Description and Priority

The spinning radar is a simple solution to detect enemy robots by continuously scanning the entire battlefield.

Business priority: **high**

Implementation risk: **very low**

3.4.2 Functional Requirements

REQ-F1-1 The radar shall scan the battlefield clockwise as long as BMB is operational and the battle is ongoing.

REQ-F1-2 Detected enemy robots shall be stored in an internal data structure.

3.5 Feature 2 – Closest enemy targeting

BMB shall target and shoot at the closest enemy robot.

3.5.1 Description and Priority

The rationale behind targeting and shooting at the closest enemy is that nearby robots are easier to hit. The solution is simple but useful.

Business priority: **high**

Implementation risk: **low**

3.5.2 Functional Requirements

REQ-F2-1 BMB shall fire at the closest enemy robot as long as the battle is ongoing.

REQ-F2-2 BMB shall use a constant fire power of 1.

4 After the lab

In the project, your group should verify all requirements specified in your Software Requirements Specification. Reflect on the testability of robots developed in Robocode. What is particularly difficult to test with RobotTestBed? Can you specify requirements in a way that supports software testing? Your group might end up in a trade-off between specifying something amazing that cannot be dynamically tested versus specifying something less amazing that can be tested exhaustively. What will you prioritize? And how will you build your arguments around requirements that have been only statically tested, or only partly tested using unit testing?