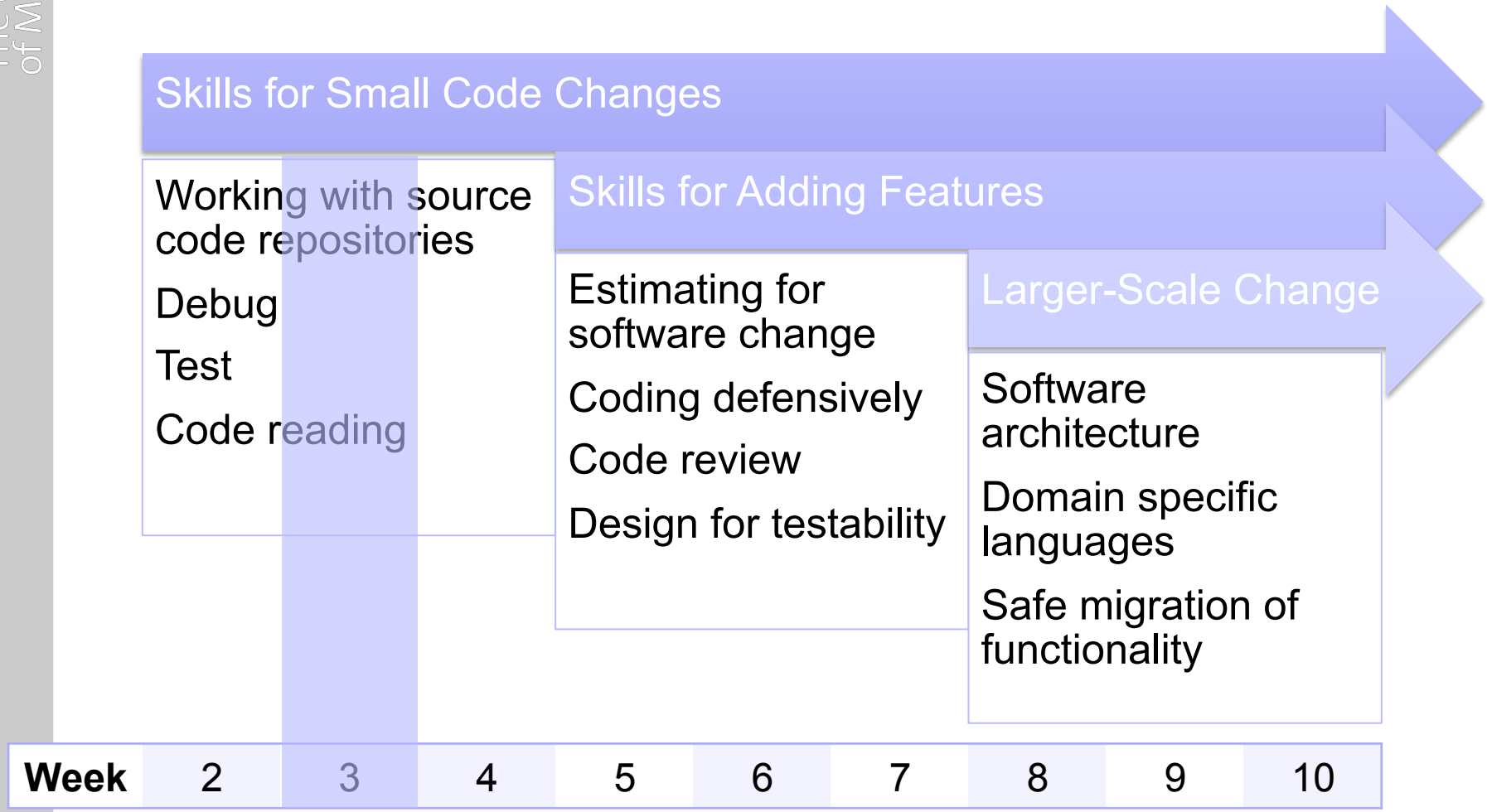
Code comprehension

COMP23420: Software Engineering

Week 3

Markel Vigo

Course Unit Roadmap (Weeks 2-10)



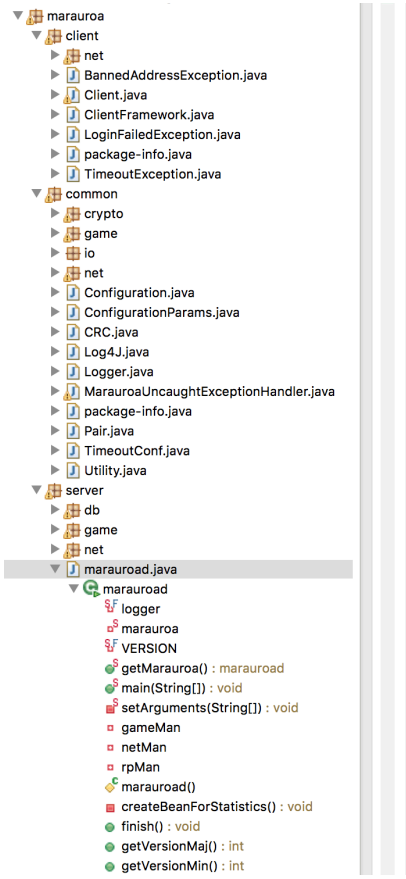
Link to the Coursework/Exam

- We will learn how to understand a unfamiliar domain and codebase
- We will put in practice reading strategies
- We will use the search functionalities provided by the environment to find the location of a specific piece of code and bugs
- We will learn how to read unit tests to understand the codebase
- We will learn how to write unit tests to understand the codebase

Outline

1. Motivation 5’
2. Learning unfamiliar codebases 25’
3. Unit testing overview 25’
4. Break 10’
5. Unit test reading 15’
6. Unit test writing 30’

Motivation




```
        Hash.random(4);
    }
}.start();


try {
    netMan = new marauroa.server.net.nio.NIONetworkServerManager();
    netMan.start();
} catch (Exception e) {
    logger.error("Marauroa can't create NetworkServerManager.\n" + "Reasons:\n"
            + "- You are already running a copy of Marauroa on the same TCP port\n"
            + "- You haven't specified a valid configuration file\n"
            + "- You haven't create database\n"
            + "- You have invalid username and password to connect to database\n", e);
    return false;
}

try {
    rpMan = new RPServerManager(netMan);
    rpMan.start();
} catch (Exception e) {
    logger.error(
                    "Marauroa can't create RPServerManager.\n"
                            + "Reasons:\n"
                            + "- You haven't specified a valid configuration file\n"
                            + "- You haven't correctly filled the values related to game configuration.
                            + "- There may be an error in the Game startup method.\n", e);
    return false;
}

try {
    if (Configuration.getConfiguration().get("n") == null) {
        throw new Exception("Missing RSA key pair in server.ini; run marauroa.tools.GenerateKeys");
    }
    RSAKey key = new RSAKey(new BigInteger(Configuration.getConfiguration().get("n")),
            new BigInteger(Configuration.getConfiguration().get("d")), new BigInteger(
                    Configuration.getConfiguration().get("e")));

    gameMan = new GameServerManager(key, netMan, rpMan);
    gameMan.start();
} catch (Exception e) {
    logger.error(
                    "Marauroa can't create GameServerManager.\n"
                            + "Reasons:\n"
                            + "- You haven't specified a valid configuration file\n"
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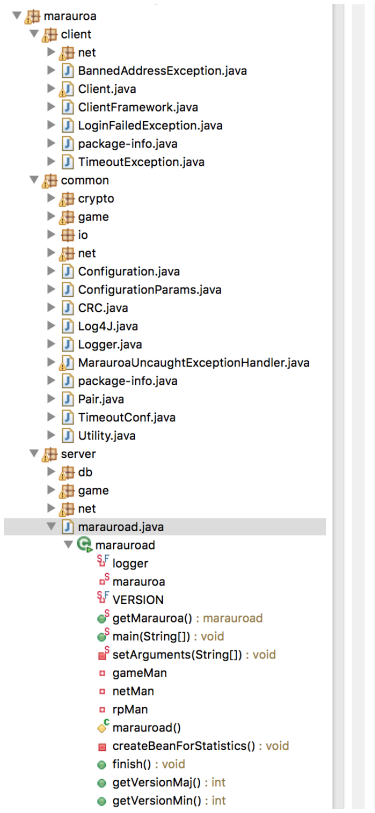
                    e);
    return false;
}
```

Motivation

- **What** activity takes up most of a maintenance programmer's time?
- **Where** can we get information about a software system from?
- **When** we need to get information about a software system?

Learning unfamiliar codebases

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```

Code reading

- Goal: build a mental model of the codebase by acquiring
  - Application domain knowledge
  - General programming knowledge
- Use systematic reading strategies
  - Top-down
  - Bottom-up
- Tip: assume previous coders were sensible and honest

Comprehending Marauroa

- What do we know about the domain?
  - **Marauroa** is a game engine
  - It's used to develop MMORPGs
  - Massive Multiplayer Online Role-Playing Videogame

Comprehending Marauroa: get an overview

- **Top-down** reading strategies **at the outset**:
  - Take advantage of the hierarchical structure of the codebase
  - Ignore unimportant and distracting details
  - Expand the tree and read the names of packages
- What hypotheses can we formulate by doing *just* this:?
  - There are three main packages named `client`, `server` and `common` → client/server architecture
  - There is some sort of network communication and there is some messaging (probably between the client and the server)
  - There is a database

Comprehending Marauroa: find key classes

- Follow the gradual expansion of the hierarchy and read class names
  - At higher levels of the hierarchy
  - With meaningful names
- Identify the classes that play a central role
  - By opening and skimming over these classes
  - Check the `import` clause to see their dependencies
- Check for instance `marauroad.java` within the `server` package

Comprehending Marauroa: reading classes

- Classes can also be read gradually using a top-down strategy
  - Look at the icons provided by the environment
  - Skim the comments – use Javadoc
  - Skim the attributes and methods
- Don't need to understand every word to understand overall meaning
- Which hypotheses can we establish about `marauroad.java` class?
  - It's a daemon running on the server side
  - It's a thread that throws 4 threads
  - It follows a singleton pattern

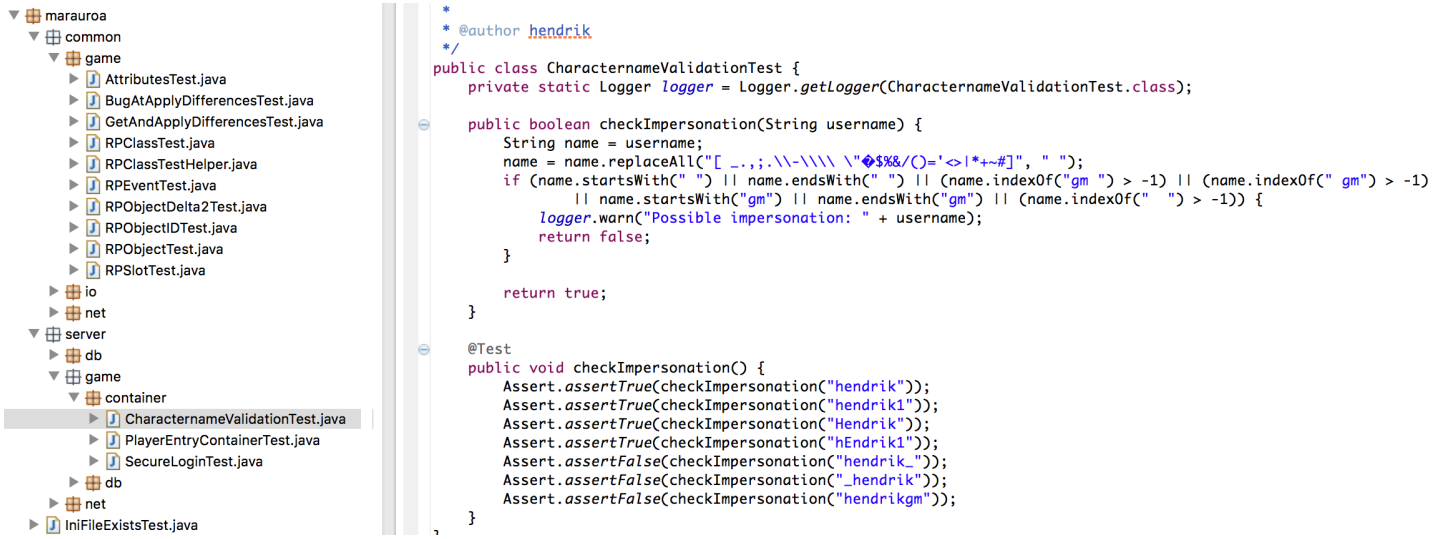
Use the search functionalities of the IDE

- Find the classes of the threads thrown by `marauroad.java`
- Global search: the IDE offers different options
  1. You can navigate the hierarchy. The path pops-up when hovering the class.
  2. Use the search functionality of the menu
  3. Use the mouse by
     i. Select the text
     ii. Right key mouse click
     iii. Select references/declarations
     iv. Select the scope
     v. Select the class from the results

Learning unfamiliar codebases

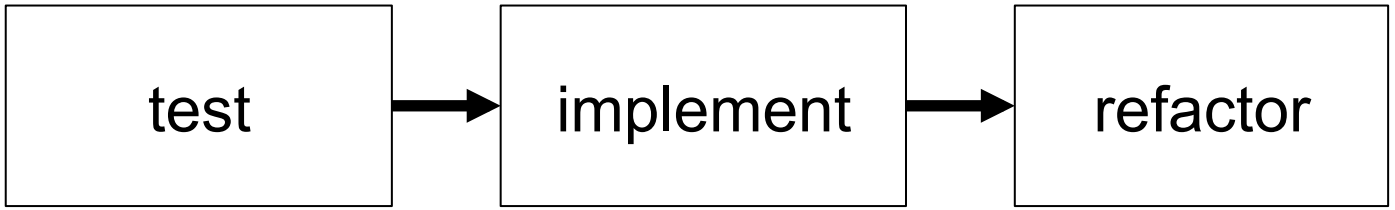
- Acquire knowledge gradually through the top-down reading strategy
- Packages and classes are hierarchical
- Location is indicator of relevance
- Extract meaning from names
- Open files and skim
- Use different sources
- Don’t read everything
- Trust the previous developer

Unit testing overview



Unit testing: what, why & when?

- Replicating problems is key to bug fixing
- What about the debugger and `System.out.println`?
- **Marauroa** is a game engine
  - We need to build a videogame to try it's functionalities!
  - Even if we build a toy game it could take ages to replicate bug
- Unit testing is an elegant and maintainable way of executing pieces of code
- Test-driven development lifecycle:



Unit testing: terminology

- Terminology
  - Test fixture
  - Code under test
  - Unit test
  - Test coverage
  - Integration test
- Organisation
  - Where deploy tests?
  - Which part of the code to test?

JUnit annotations

`@Test` indicates the method as a test method

`@Before` to execute a method before a test

`@BeforeClass` to execute a method before all tests

`@After` to execute a method after a test

`@AfterClass` to execute a method before all test

JUnit statements

`assertTrue(String message, boolean condition)`
Checks that the boolean condition is true.

`assertFalse(String message, boolean condition)`
Checks that the boolean condition is false.

`assertEquals(String message, expected, actual)`
Tests that two values are the same.

`assertNull(String message, object)`
Checks that the object is null.

`assertNotNull(String message, object)`
Checks that the object is not null.

Let's try it ourselves

- Create a new project with two packages
- Code under test contains a class with two methods
  1. Sums two integers
  2. Links two strings
- Another package contains a class with tests to check all is working properly

What do you need to use:

`@Before` to execute a method before a test

`@Test` indicates the method as a test method

`assertEquals(String message, expected, actual)` tests that two values are the same

One Possible Solution

- Code under test

```
package source;

public class CodeUnderTest {

    public int addInteger (int a, int b){
        return a+b;
    }

    public String linkStrings (String a, String b){
        return a+b;
    }

}
```

- Unit test code

```
package tests;

import static org.junit.Assert.*;

import org.junit.Before;
import org.junit.Test;
import source.CodeUnderTest;

public class TestsforCodeUnderTest {
    private CodeUnderTest cut;

    @Before
    public void buildFixture(){
        cut=new CodeUnderTest();
    }
    @Test
    public void sumTest() {
        assertEquals("I'm expecting 18",18, cut.addInteger(7, 11));
    }

    @Test
    public void linkTest() {
        assertEquals("I'm expecting 711","711", cut.linkStrings("7","11"));
    }
}
```

Break: 10 minutes

Unit test reading & writing

Unit testing: terminology

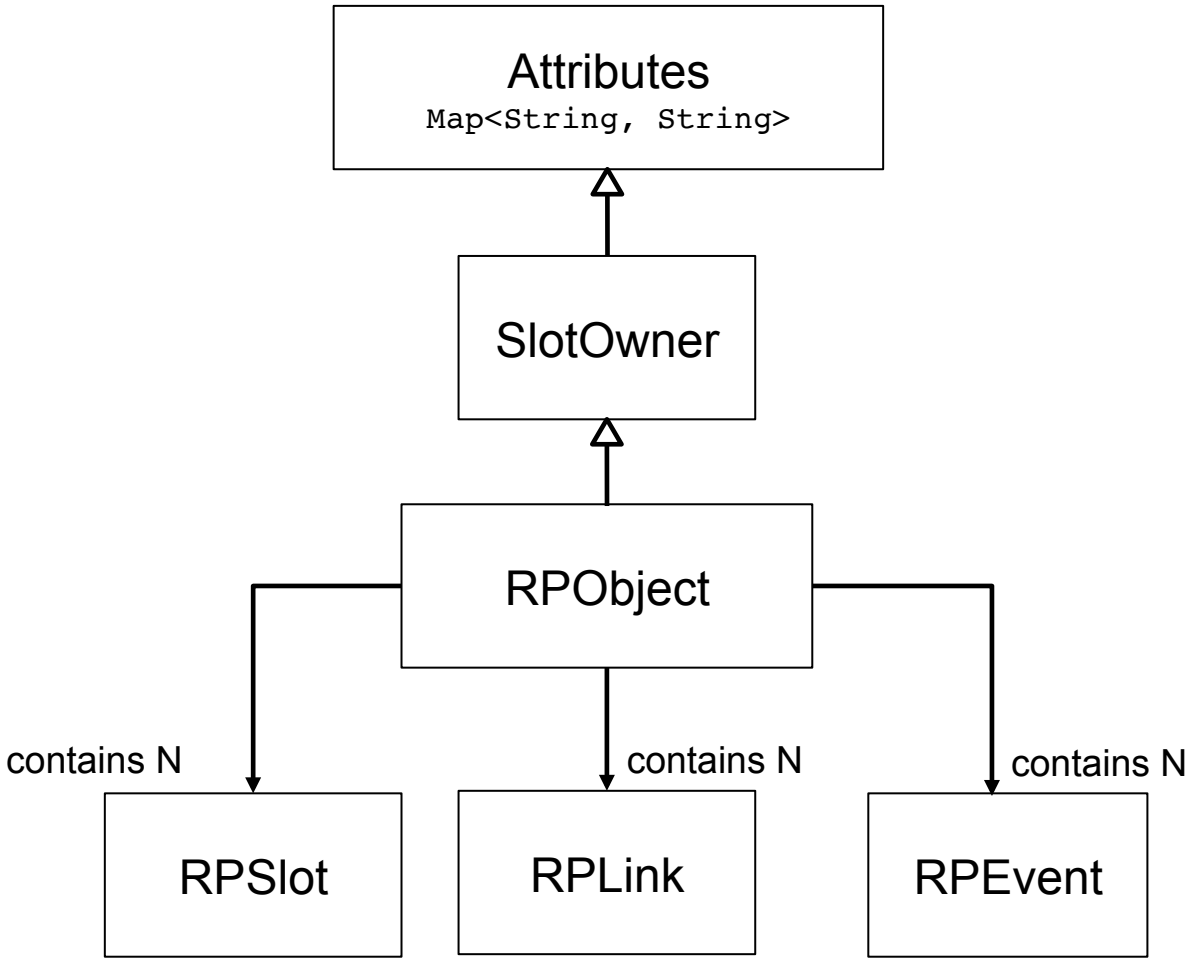
- Terminology
  - Test fixture
  - Code/system under test
  - Unit test
  - Test coverage
  - Integration test
- Organisation
  - Where deploy tests?
  - Which part of the code to test?

What can we learn from unit test reading?

- Unit test indicate traces of
  - Critical and key pieces of code
  - Tricky parts of the code
  - Sensitive excerpts
  - Bugs that were repaired in the past
- **Marauroa** has a dedicated package with tests
- Check `marauroa.common.RPObjectTest.java`
- What can we learn about the class being tested?
  - Star reading the method under the `@Before` clause
  - How is it structured and which are its dependencies?
  - Which is the main data structure?

What can we learn from unit test reading?

- How is it structured and which are its dependencies



Testing worlds, zones and objects

- There is one **world** which can contain N **zones** and zones contain **objects**
- Find the classes in **Marauroa**

  Object: `marauroa.common.game.RPObject`

  Zone: `marauroa.server.game.rp.MarauroaRPZone`

  World: `marauroa.server.game.rp.RPWorld`
- Let's test whether
  1. There is only one instance of **World**
  2. If **Zones** are actually added to **Worlds**
  3. If **Objects** are actually added to **Zones**
  4. If **Objects** are destroyed when removed from **Zones**

Testing worlds, zones and objects

1. Test there is only one instance of **World**
   i. Get two instances of **World**
   ii. Use a JUnit a statement to compare the two instances
2. Test if **Zones** are actually added to **Worlds**
   i. Get an instance of the world
   ii. Create a new **Zone**
   iii. Add the new **Zone** to the **World**
   iv. Use a method from the **World** class to check if our **Zone** belongs to the **World**
   v. Use a JUnit a statement to check the above

Testing worlds, zones and objects

3. Test **Objects** are actually added to **Zones**
   i. Create a **Zone** and create and **Object**
   ii. Set an identifier to the **Object**
   iii. Add the object to **Zone**
   iv. Use a method from the **Zone** class to check if our **Object** belongs to the **Zone**.
   v. Use a JUnit a statement to check the above
4. Test **Objects** are destroyed once they are removed
   i. Same as above until step v.
   ii. Remove object from zone
   iii. Use a method from the **Zone** class to check if our **Object** belongs to the **Zone**. Use JUnit.

Next Week

- In the team study sessions will keep fixing bugs and using. Commit modifications.

- In the workshop we will learn to
  - Do code reviews
  - Use Git workflows