Assess Yourself

Write the `Character createCharacter(String name)` method, that throws an `InvalidNameException` if the name provided is *not* a Game of Thrones character name.

```
private static final String[] VALID_NAMES =
    {"Jon Snow", "Arya Stark", "Danaerys Targaryen", ...}

public Actor createActor(String name)
        throws InvalidNameException {

    for (String s : VALID_NAMES) {
        if (s.equals(name)) {
            return new Character(name);
        }
    }

    throw new InvalidNameException(name);
}
```

SWEN20003
Object Oriented Software Development

Software Testing and Design

Semester 1, 2019

The Road So Far

- Java Foundations
- Classes and Objects
- Abstraction
- Advanced OOP
  - Generic Classes
  - Generic Programming
  - Exception Handling
  - Design Patterns
- Software Development Tools

Lecture Objectives

After this lecture you will be able to:

- **Write better** code
- **Design better** software
- **Test** your software for bugs

Documentation

Boring Stuff (Code Formatting)

While writing code is largely subjective, there are plenty of **conventions** that most programmers share:

- Use consistent layout (indentation, white space)
- Avoid long lines (80 characters is "historic")
- Beware of tabs
- Lay out comments and code neatly
- Sensible naming of variables, method and classes
- Divide long files into sections with clear purposes
- Avoid copy and pasting/duplicating code
- Use a comment to explain each section

Boring Stuff (Comment Style)

While writing comments is largely subjective, there are plenty of **conventions** that most programmers share:

- Intended primarily for **yourself**, and developers writing code **with** you
- Code should be written to be **self-documenting**; readable without extra documentation
- Comments "tell the story" of the code
- If your code were removed, comments should be sufficient to "piece together" the algorithm
- Comments should be attached to *blocks* of code, which loosely correspond to *steps* in completing your algorithm

Boring Stuff (Comment Placement)

Bad Comment Placement

```
<line of code>
// This is a comment below my code
```

Terrible Comment Placement

```
<line of code> // This is an inline comment
```

Great Comment Placement

```
// This is a comment above my code
<line of code>
```

Comments appearing **before** code are like a "prologue" for your code; they introduce the *idea* of the code before you actually try to digest it.

Boring Stuff (Javadoc)

```
javadoc.equals(comments); // false
```

- Javadoc is a special kind of comment that can be **compiled to HTML**
- Intended primarily for developers **using** your program (exactly like Slick documentation)
- Used to document packages, classes, methods, and attributes (among others)
- Should document how to **use** and **interact** with your classes and their methods
- Various @ tags (like `@param` and `@return`) for generating specific documentation

Project Expectations (Javadoc)

You **must** include Javadoc documentation in your project 2 submission:

- **All** public classes, attributes, and methods
- Yes, this includes getters, setters, and constructors (hint, some things can be auto-generated)
- You **do not** need to use any fancy `@` tags, just provide `@param` and `@return` when appropriate
- No, we're not generating the HTML of your Javadoc

x

Software Design

Poor Design Symptoms

Think about how the following slide can be applied to your current/expected implementation of Project 2.

Imagine how difficult it would be for you to **change**/**fix**/**update** your solution if you identified a problem, or if the specification changed.

Poor Design Symptoms

Rigidity	Hard to modify the system because changes in one class/method cascade to many others
Fragility	Changing one part of the system causes unrelated parts to break
Immobility	Cannot decompose the system into reusable modules
Viscosity	Writing "hacks" when adding code in order to preserve the design
Complexity	Lots of clever code that isn't necessary right now; premature optimisation is bad
Repetition	Code looks like it was written by Cut and Paste
Opacity	Lots of convoluted logic, design is hard to follow

GRASP

In SWEN30006 you'll learn about

- G General
- R Responsibility
- A Assignment
- S Software
- P Patterns/Principles

Keyword

GRASP: A series of guidelines for assigning responsibility to classes in an object-oriented design; how to break a problem down into modules with clear purpose.

GRASP Basics

Keyword

Cohesion: Classes are designed to solve clear, focused problems. The class' methods/attributes are related to, and work towards, this objective. Designs should have **maximum** cohesion.

Keyword

Coupling: The degree of interaction between classes; invoking another class' methods or accessing/modifying its variables. Designs should have **minimum** coupling.

GRASP Basics

Keyword

Open-Closed Principle: Classes should be **open** to extension, but **closed** to modification.

In practice, this means if we need to *change* or *add* functionality to a class, we should not modify the original, but instead use **inheritance**.

GRASP Basics

Keyword

Abstraction: Solving problems by creating *abstract data types* to represent problem components; achieved in OOP through *classes*, which represent data and actions.

Keyword

Encapsulation: The details of a class should be kept *hidden* or *private*, and the user's ability to access the hidden details is *restricted* or *controlled*. Also known as **data** or **information hiding**.

GRASP Basics

Keyword

Polymorphism: The ability to use an object or method in many different ways; achieved in Java through *ad hoc* (overloading), *subtype* (overriding, substitution), and *parametric* (generics) polymorphism.

Keyword

Delegation: Keeping classes *focused* by passing work to other classes. Computations should be performed in the class with the *greatest amount of relevant information*.

Software Testing

Bug Fixing

How do you normally find/fix a bug?

- Print statements

```
System.out.println("Why does my code not reach here?");
```

- Google

```
How to fix my Java code
```

- Forums (Stackoverflow, etc.)

```
Someone please help my code is broken
```

Bug Fixing

Java offers a structured method for **testing**, very important for COMP30022:

Keyword

Unit: A small, well-defined component of a software system with one, or a small number, of responsibilities.

Keyword

Unit Test: Verifying the operation of a *unit* by testing a single *use case* (input/output), intending for it to **fail**.

Keyword

Unit Testing: Identifying bugs in software by subjecting every *unit* to a suite of *tests*.

Assess Yourself

What **use cases** can you think of for the following code?

```
public boolean makeMove(Player player, Move move) {

    int row = move.row;
    int col = move.col;

    if (row < 0 || row >= SIZE || col < 0 || col >= SIZE ||
            !board[row][col].equals(EMPTY)) {
        return false;
    }

    board[row][col] = player.getCharacter();

    return true;

}
```

Assess Yourself

Use Cases:

- Valid input
- Invalid input

Great... But that's not helpful

Assess Yourself

Use Cases:

- Valid input
  - Does a move with row and column on the board...
    - ★ Mutate the board if it is empty?
    - ★ Mutate the right position on the board?
    - ★ Does the right character get used?
    - ★ Does the method return true in this case?
- Invalid input
  - Does a move that is not on the board do nothing?
  - Does a move do nothing if the position is full?
  - Does the method return false in these cases?

Another Look

```
public boolean makeMove(Player player, Move move) {

    int row = move.row;
    int col = move.col;

    if (row < 0 || row >= SIZE || col < 0 || col >= SIZE ||
            !board[row][col].equals(EMPTY)) {
        return false;
    }

    board[row][col] = player.getCharacter();

    return true;
}
```

How could we *better abstract* this code to make testing easier?

Creating Units

What are the fundamental *units* of this method?

```
public boolean makeMove(Player player, Move move) {

    int row = move.row;
    int col = move.col;

    if (row < 0 || row >= SIZE || col < 0 || col >= SIZE ||
            !board[row][col].equals(EMPTY)) {
        return false;
    }

    board[row][col] = player.getCharacter();

    return true;
}
```

Creating Units

```
public boolean cellIsEmpty(Move move) {
    return board[move.row][move.col].equals(EMPTY);
}
```

```
public boolean onBoard(Move move) {
    return move.row >= 0 && move.row < SIZE &&
            move.col >= 0 && move.col < SIZE;
}
```

```
public boolean isValidMove(Move move) {
    if (onBoard(move) && cellIsEmpty(move)) {
        return true;
    }
    return false;
}
```

```
public void makeMove(Player player, Move move) {
    board[move.row][move.col] = player.getCharacter();
}
```

Unit Testing With Java

Much better! What now?

Keyword

Manual Testing: Testing code manually, in an ad-hoc manner. Generally difficult to reach all edge cases, and not scalable for large projects.

Keyword

Automated Testing: Testing code with automated, purpose built software. Generally faster, more reliable, and less reliant on humans.

JUnit Automated Testing

Keyword

assert: A true or false statement that indicates the success or failure of a test case.

Keyword

TestCase class: A class dedicated to testing a single unit.

Keyword

TestRunner class: A class dedicated to *executing* the tests on a unit.

TestCase Class

```
import static org.junit.Assert.*;
import org.junit.Test;

public class BoardTest {
    @Test
    public void testBoard() {
        Board board = new Board();
        assertEquals(board.cellIsEmpty(0, 0), true);
    }

    @Test
    public void testValidMove() {
        Board board = new Board();
        Move move = new Move(0, 0);
        assertEquals(board.isValidMove(move), true);
    }
}
```

TestCase Class

```
@Test
public void testMakeMove() {
    Board board = new Board();
    Player player = new HumanPlayer("R");
    Move move = new Move(0, 0);
    board.makeMove(player, move);
    assertEquals(board.getBoard()[move.row][move.col], "r");
}
```

TestRunner Class

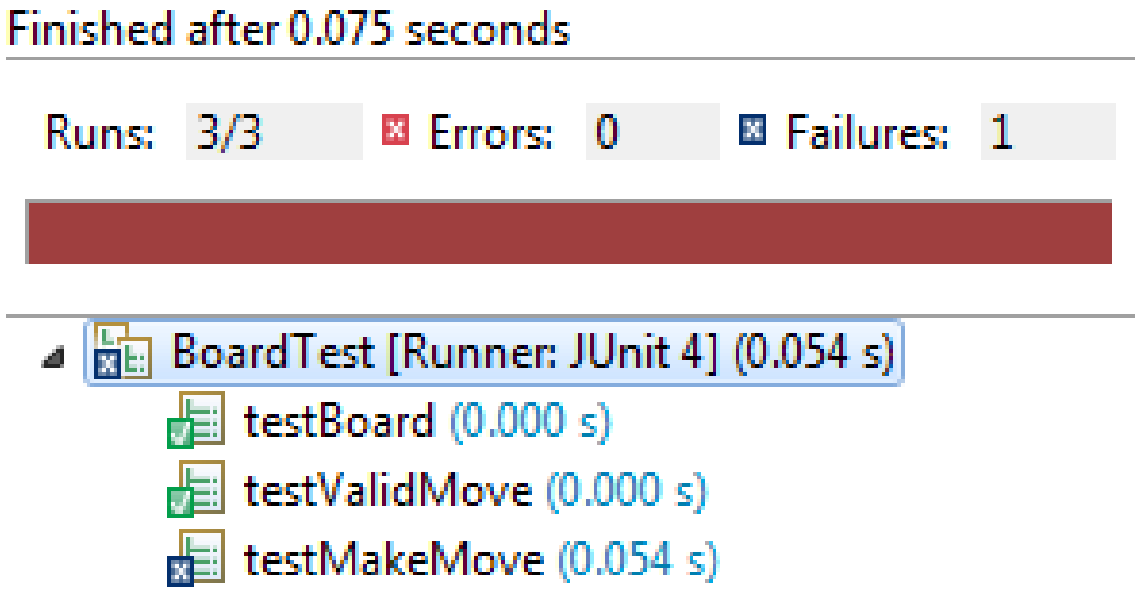
```
import org.junit.runner.JUnitCore;
import org.junit.runner.Result;
import org.junit.runner.notification.Failure;

public class TestRunner {
    public static void main(String[] args) {
        Result result = JUnitCore.runClasses(BoardTest.class);

        for (Failure failure : result.getFailures()) {
            System.out.println(failure.toString());
        }

        System.out.println(result.wasSuccessful());
    }
}
```

TestRunner Class




```
testMakeMove(BoardTest): expected:<[r]> but was:<[R]>
false
```

JUnit Automated Testing

Woops, there was a bug *in my test*

```
@Test
public void testMakeMove() {
    Board board = new Board();
    Player player = new HumanPlayer("R");
    Move move = new Move(0, 0);
    board.makeMove(player, move);
    assertEquals("R", board.getBoard()[move.row][move.col]);
}
```

Automated testing is as useful for testing your *test suite* as it is for testing your *program*.

Assess Yourself

Write a unit test to verify that when a move is made **off the board**, the `isValidMove` method returns false.

There are actually (at least) **four** test cases for this, but here's one:

```
@Test
public void testValidMove2() {
    Board board = new Board();
    Move move = new Move(-1, 0);
    assertEquals(false, board.isValidMove(move));
}
```

JUnit Advantages

Large teams and open source development **(should) always** use automated testing:

- Easy to set up
- Scalable
- Repeatable
- Not human intensive
- Incredibly powerful
- **Finds bugs**

We don't expect you to use it, but getting used to automated testing makes you more useful in a team.

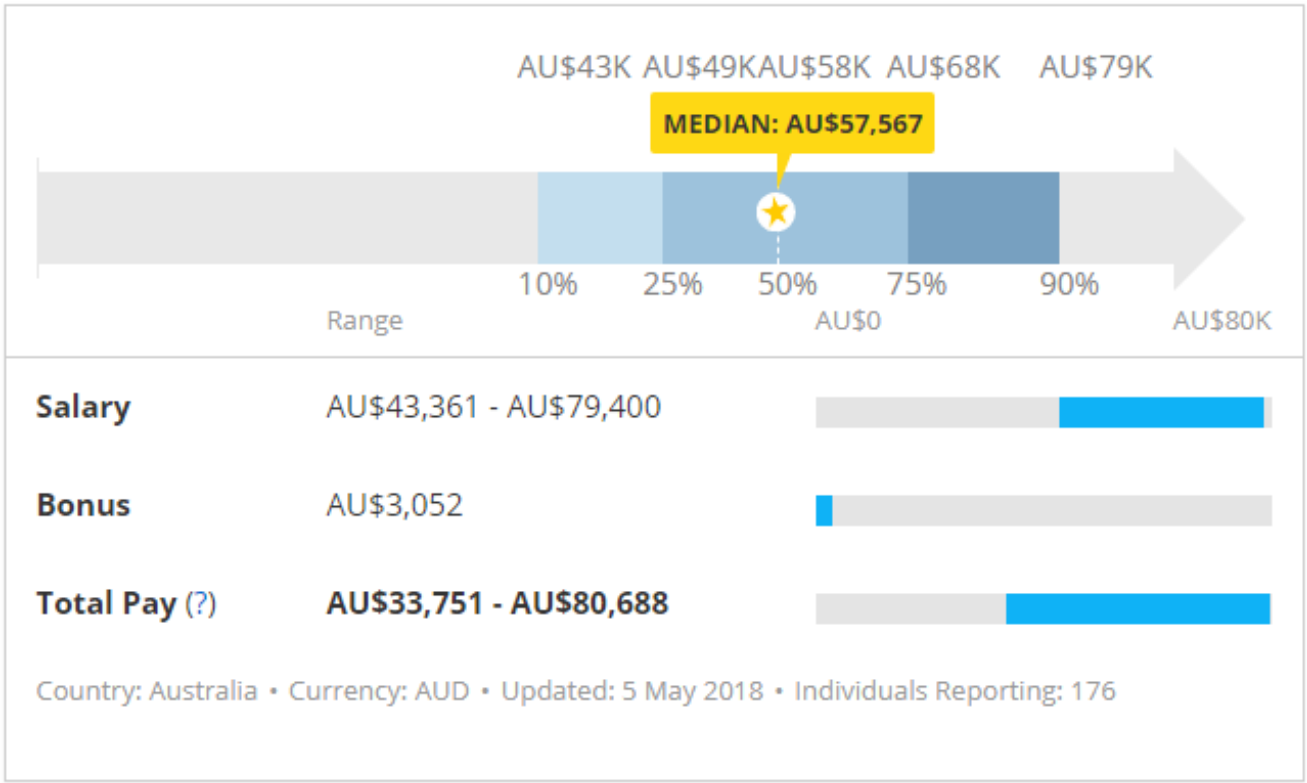
Here's an example.

Assess Yourself

What units, use cases, and unit tests *could* you write for Project 2B?

Again, we don't expect you to do this.

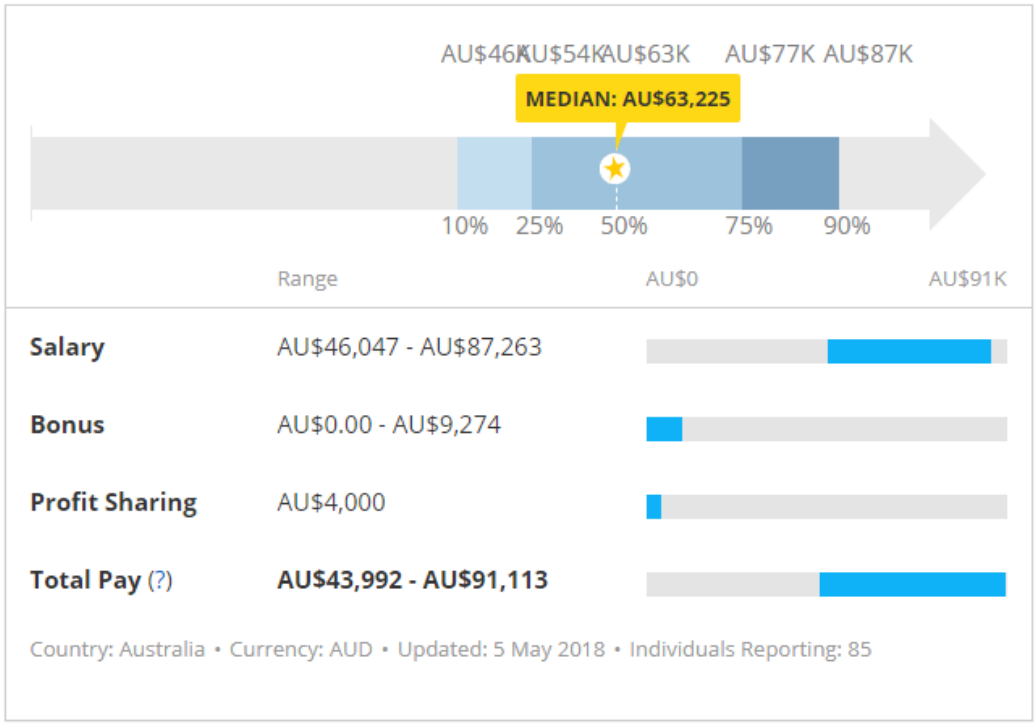
Software Testing and QA Jobs



Keyword

Software Tester: Conducts tests on software, primarily to find and eliminate bugs.

Software Testing and QA Jobs



Keyword

Software Quality Assurance: Actively works to improve the development process/lifecycle. Directs software testers to conduct tests, primarily to prevent bugs.

Metrics

Documentation
This will be assessed in the project, but not the exam.

Software Design
You will need to be able to define the *keywords* defined in this lecture. You will need to know *definitions* for the exam, but you will not be assessed on software design principles by writing code.

Software Testing
You will need to be able to define the keywords as well as implement a *unit test* for the exam. You will **not** be asked to write a `TestRunner` class, only one or two standalone test cases.