CSE 331
Software Design & Implementation

Spring 2022

Section 4 – Rep Exposure, JUnit, and HW4

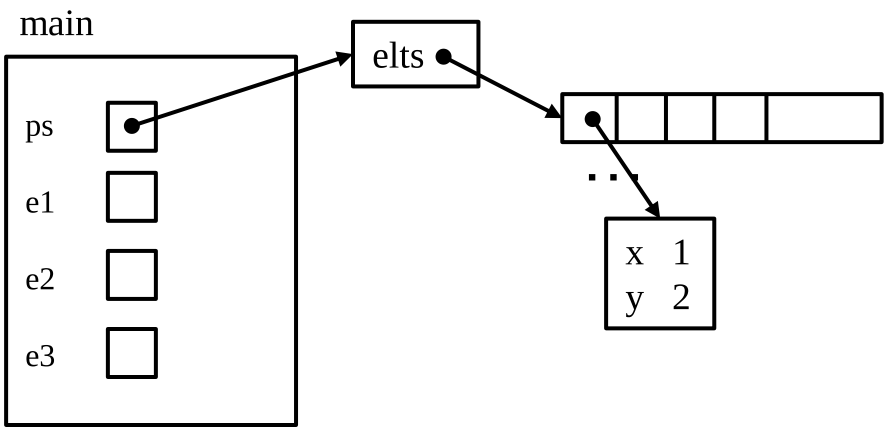
Administrivia

- Done with HW3!
- HW3 due yesterday!
- HW4 due next Wednesday (at 11PM)!
- Any questions?

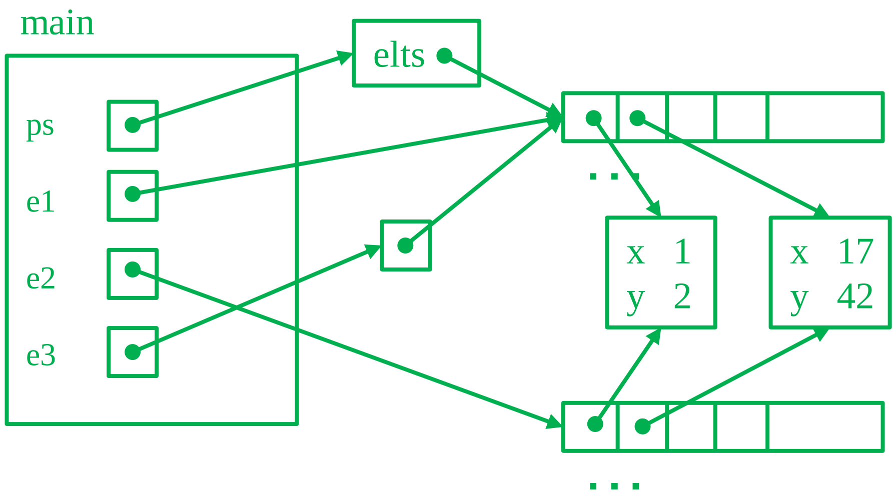
Agenda

- Rep Exposure Exercise
- How to write JUnit Tests
- **`FiniteSet`** and **`SimpleSet`**

Rep Exposure Exercise



Rep Exposure Exercise (Solution)



Testing: A quick introduction

- In past assignments, you have run the test suite.
- But now you must start writing your own tests!

JUnit

- Industry-standard Java toolkit for unit testing
  - We're using JUnit **4.12**
  - Check out the javadocs

- A unit test is a test for one "component" by itself
  - "Component" typically a class or a method

- Each unit test written as a method
  - We'll see the particulars in a moment…

- Closely related unit tests should be grouped into a class
  - For example, all unit tests for the same ADT implementation

Writing tests with JUnit

A method annotated with **`@Test`** is flagged as a JUnit test

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

/** Unit tests for my Foo ADT implementation */
public class FooTests {
  @Test
  public void testBar() {
    ... /* use JUnit assertions in here */
  }
}
```

Using JUnit assertions

- JUnit assertions establish success or failure of the test method
  - *Note*: JUnit assertions are *different* from Java's **`assert`** statement
- Use to check that an actual result matches the expected value
  - Example: **`assertEquals(42, meaningOfLife());`**
  - Example: **`assertTrue(list.isEmpty());`**
- A test method stops immediately after the first assertion failure
  - If no assertion fails, then the test method passes
  - Other test methods still run either way
- JUnit results show details of any test failures

Common JUnit assertions

JUnit's [documentation] has a full list, but these are the most common assertions.

Assertion	**Failure condition**
`assertTrue(`*`test`*`)`	*`test`* `== false`
`assertFalse(`*`test`*`)`	*`test`* `== true`
`assertEquals(`*`expected, actual`*`)`	*`expected`* and *`actual`* are not equal
`assertSame(`*`expected, actual`*`)`	*`expected`* `!=` *`actual`*
`assertNotSame(`*`expected, actual`*`)`	*`expected`* `==` *`actual`*
`assertNull(`*`value`*`)`	*`value`* `!= null`
`assertNotNull(`*`value`*`)`	*`value`* `== null`

Any JUnit assertion can also take a string to show in case of failure, *e.g.*, **`assertEquals("helpful message", expected, actual)`**.

Always* use >= 1 JUnit Assertion

- If you don’t use any JUnit assertions, you are only checking that no exception/error occurs
- That’s a pretty weak notion of passing a test; rarely the best test you could write
- Having more than one JUnit assertion in a test may make sense, but one is the most common scenario

* Special case coming in a couple slides ☺️

JUnit assertions vs Java's assert

- Use JUnit assertions **only in JUnit test code**
  - JUnit assertions have names like `assertEquals`, `assertNotNull`, `assertTrue`
  - Part of JUnit framework used to report test results
    - Accessed via `import org.junit`….
  - **Don't** use in ordinary Java code (***never*** `import org.junit`…. in non-JUnit code)

- Use Java's `assert` statement in ordinary Java code
  - Use liberally to annotate/check "must be true" / "must not happen" / etc. conditions
  - Use in `checkRep()` to detect failure if problem(s) found
  - **Do not** use in JUnit tests to check test result – does not interact properly with JUnit framework to report results

Checking for a thrown exception

- Should test that your code throws exceptions as specified
- This kind of test method fails if its body does *not* throw an exception of the named class
  - May not need any JUnit assertions inside the test method unlike our previous guideline

```
@Test(expected=IndexOutOfBoundsException.class)
public void testGetEmptyList() {
  List<String> list = new ArrayList<String>();
  list.get(0);
}
```

- **Do not** use **`assertThrows()`** (that comes in JUnit 4.13, and we are using JUnit 4.12)

Test ordering, setup, clean-up

JUnit does not promise to run tests in any particular order.

However, JUnit can run helper methods for common setup/cleanup

- Run before/after ***each*** test method in the class:

```
@Before
public void m() { ... }
@After
public void m() { ... }
```

- Run once before/after running ***all*** test methods in the class:

```
@BeforeClass
public static void m() { ... }
@AfterClass
public static void m() { ... }
```

JUnit Tests Example

- Let’s look at some example JUnit tests…

Tips for effective testing

- Use constants instead of hard-coded values
  - Makes easier to change later on
- Take advantage of assertion messages
- Give a descriptive name to each unit test (method)
  - Verbose but clear is better than short and inscrutable
  - Don’t go overboard, though :-)
- Write tests with a simple structure
  - Isolate bugs one at a time with successive assertions
  - Helps avoid bugs in your tests too!
- Aim for thorough test coverage
  - Big/small inputs, common/edge cases, exceptions, ...

Test Design Worksheet

- Work in small groups
- Give logic of the tests, not actual code
- Only test the operations provided on the worksheet
- More details in lecture if additional information/review needed

HW4 Background: Floats

- Floats vs. Doubles
  - Both represent floating point numbers, but doubles are twice the size (think **`int`** vs **`long`**)
  - But we will be using floats
- Special cases:
  - **`Float.POSITIVE_INFINITY`** and **`Float.NEGATIVE_INFINITY`**
  - **`Float.NaN`** – means not a number
- Operations where either one of the operands is **`NaN`**
  - **<u>All operations</u>** will return **`NaN`**
  - e.g. **`NaN * 1.23456f = NaN`**
- Including **==**
  - **`Float.NaN == Float.NaN -> false`**
  - Use **`Float.isNaN()`** or **`Float.isFinite()`** instead

Finite Sets

- In HW4, we will be working in the **`FiniteSet`** class, which represents a set of points along a number line, where each point is a **`float`**.

- Let's say we choose to represent this as an array of floats, i.e. **`float[]`**
- We need to make some choices:
  - Should we allow duplicates? Why or why not?
  - Should we sort our array? Why or why not?

- We will not allow duplicates and keep the array sorted.
- We will also store a **`Float.NEGATIVE_INFINITY`** as the first element in the array and a **`Float.POSTIVE_INFINITY`** as the last element…
  - This will make reasoning about it easier. For instance, we can guarantee that there is an index **`i`** such that **`D[i] < x < D[i+1]`**

`FiniteSet` Field

```
private final float[] vals;
```

The set `{ -5.3, 1.48, 7.1234, 463.8 }` will be represented as:

```
[Float.NEGATIVE_INFINITY, -5.3, 1.48, 7.1234, 463.8, Float.POSITIVE_INFINITY]
```

What is our representation invariant and abstraction function?

```
// Points are stored in an array, in sorted order, with an
// extra -infinity at the front and +infinity at the end
// to simplify union etc.
//
// RI: -infinity = vals[0] < vals[1] < ... <
//                             vals[vals.length-1] = +infinity
// AF(this) = { vals[1], vals[2], ..., vals[vals.length-2] }
```

`FiniteSet` Methods

Some common set operations:

- Finding the **union** (∪) of set A and set B. This is a **new** set of points that are **either** in A, B, or **both** A and B:
  - **`union([-inf, 1, 4, 5, 7, inf], [-inf, 1, 6, 7, 11, inf]) = [-inf, 1, 4, 5, 6, 7, 11, inf] => { 1, 4, 5, 6, 7, 11 }`**

- Finding the **intersection** (∩) of set A and set B. This is a **new** set of points that are in **both** A and B:
  - **`intersection([-inf, 1, 4, 5, 7, inf], [-inf, 1, 6, 7, 11, inf]) = [-inf, 1, 7, inf] => { 1, 7 }`**

- Finding the **difference** (\) of set A and set B. This is a **new** set of points that are **in** A but **not** B:
  - **`difference([-inf, 1, 4, 5, 7, inf], [-inf, 1, 6, 7, 11, inf]) = [-inf, 4, 5, inf] => { 4, 5 }`**

`SimpleSet`

For much of the assignment, you will be working in **`SimpleSet.java`**

- A SimpleSet is defined as either a finite set of points **or** the complement of a finite set of points (meaning everything but).
  - e.g. given the set of points **`{ 1, 7, 9 }`**:
    - we can have a simple set that contains **`1`, `7`,** and **`9` or**
    - one that contains all real numbers **except `1`, `7`,** and **`9`**

```
/**
 * Represents an immutable set of points on the real line that is easy to
 * describe, either because it is a finite set, e.g., {p1, p2, ..., pN},
 * or because it excludes only a finite set, e.g., R \ {p1, p2, ..., pN}.
 * As with FiniteSet, each point is represented by a Java float with a
 * non-infinite, non-NaN value.
 */
public class SimpleSet {
```

`FiniteSet` starter code

Let’s now skim the starter code…