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Eclipse, OSGi, and the Java Model

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Programming Languages/Software Engineering: Eclipse, OSGi, and the Java Model

Project 0, Part 2

Questions a and b

```
class Test {
 public static void main(String[] a) {
  int x = 5;
  int y = x + 6;
  System.out.println(y);
 }
}
```

< Application, LTest, main([Ljava/lang/String;)V >
4 v5 = binaryop(add) v3:#5, v4:#6 (line 4)

a. What is this instruction doing?
b. In the original source, computation occurs on both lines 3 and 4. Why in the IR is there only an instruction for line 4?

My solution to questions c and d

Add (static) fields to hold counts

```java
public class Main {

    /**
     * Total number of instructions seen.
     */
    private static int totalInstructions;

    /**
     * Total number of instructions in all methods that are branching statements.
     */
    private static int totalBranchingInstructions;
```

To the end of main(), add output statements

```
public static void main(String[] args) throws Exception {
	// …
	// output the total number of instructions (part c).
	System.out.println("Total instructions: " + totalInstructions);

	// output the total number of instructions (part d).
	System.out.println("Total branching instructions: " + totalBranchingInstructions);
}
```

Modify checkInstruction() to count *all* instructions seen

```
private static void checkInstruction(SSAInstruction instruction) {
        // increment the instruction count.
        ++totalInstructions;
```

Modify checkInstruction() to count *branching* instructions seen

```
private static void checkInstruction(SSAInstruction instruction) {
	// increment the instruction count.
	++totalInstructions;

	// if it's a branching instruction.
	if (instruction instanceof SSAGotoInstruction ||
		instruction instanceof SSAConditionalBranchInstruction ||
		instruction instanceof SSASwitchInstruction) {
		// output it to see what it looks like.
		System.out.println("Found branching instruction of type " +
			instruction.getClass().getName() + ": " + instruction);

		// increment the branching count.
		++totalBranchingInstructions;
	}
}
```

Import the new instruction types

```
import com.ibm.wala.ssa.SSAConditionalBranchInstruction;
import com.ibm.wala.ssa.SSAGotoInstruction;
import com.ibm.wala.ssa.SSASwitchInstruction;
// ...
class Main {
	// ....
}
```

Output Snippet

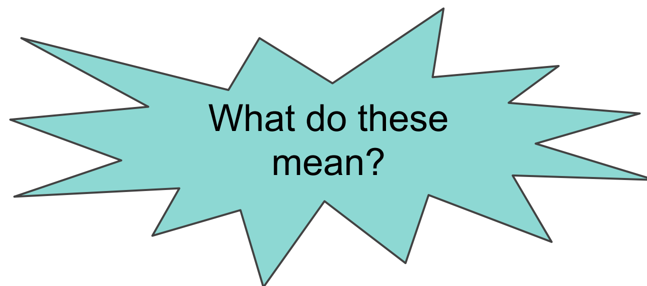
Processing instructions for application method: < Application, LJLex/CLexGen, packCode([C[C[CII)[C >

Found branching instruction of type com.ibm.wala.ssa.**SSAConditionalBranchInstruction**:
    conditional branch(ne, to iindex=63) 9,53

Found branching instruction of type com.ibm.wala.ssa.**SSASwitchInstruction**:
    switch 6 [0->102,1->107,2->112,3->122,4->127,5->132,6->117]

Found branching instruction of type com.ibm.wala.ssa.**SSAGotoInstruction**:
    goto (from iindex= 106 to iindex = 142)

...
Total instructions: **6535**
Total branching instructions: **1089**



A little bit about the Eclipse's Plugin Architecture

- The Eclipse architecture is an interesting case study in itself.
- Follows the conventions of the OSGi component architecture.
- Very dynamic!
  - Plugins are loaded at boot time.
  - Heavy use of *reflection* (actually an interesting research field for static analysis).
- Basically, *everything* is a plugin, even Eclipse core functionality.
  - They are “core” plugins.
  - Eclipse without any plugins is a mere shell.

Eclipse Plugin Extension Points and Extensions

- Plugins are configured through metadata:
  - plugin.xml
    - Extensions, extension points, etc.
  - MANIFEST.mf
    - Runtime stuff (classpath, i.e., where to find libraries), dependencies, version ranges.
- Plugins can have *extension points* and can *extend* other plugins.
- An extension point allows other plugins to extend functionality provided by the plugin.
  - For example, add a menu item to a context menu (right-click).
- A plugin extends the functionality of another plugin by *extending* its extension point.
- Many plugins are both *extensions* of other plugins and also have *extension points*.

Analysis and Transformation in Eclipse

Python?

- WALA is an extensive library of static analysis algorithm implementations.
  - We'll learn about these algorithms throughout the semester.
  - WALA can analyze a variety of software:
    - Android.
    - Javascript.
    - Etc.
  - WALA doesn't have great *transformation* capabilities.
    - It's mainly for analysis.
    - There is another project called Soot that is more ept at *bytecode* transforma
      WALA. We won't Soot in this course, though.
      - WALA used to be a little bit easier to work with within Eclipse since it originally has an OSGi-type architecture.
      - Probably something to do with both originating from IBM.
      - Since a major transition, my understanding is that OSGi metadata was removed.
- Eclipse supports source-to-source transformation on ASTs.

Scalpel?

PyDev?

Analysis and Transformation in Eclipse

- We’ve mainly looked at ASTs, but Eclipse really has *two* models for any given programming language.
- For Java, this is called the *Java Model*.
- It’s a domain model for everything up to Workspaces and Projects down to fields and methods.
- For example, an IProject is an interface representing *any* project in a workspace.
  - An IJavaProject is specific for Java.
- The JavaCore.create() is useful for obtaining IJavaElements (objects in the Java Model) without the UI (e.g., right-clicking on an object).
- The Java Model doesn’t allow transformations at the source level.
- However, there are useful analyses that can be generated, e.g., search engines, type hierarchies, and call graphs (more later on these).

JDT View

- The AST View plugin in Eclipse is useful for visualizing an AST.
- Likewise, the JDT View plugin is useful for visualizing the Java Model.
- These two models work hand-in-hand.
    - For example, you can build an AST node (instance of an CompilationUnit) from a file in the Java Model (instance of an ICompilationUnit).

Assignment 1: This week’s homework

Part 1: Use the Visitor Pattern for Project 0, Part 2

- Checking the types of each instruction can be cumbersome.
  - How do you know which types are available?
- Instructions in WALA support the visitor pattern!
  - But not as fully as we saw last week.
- Use [com.ibm.wala.ssa.IR.visitNormalInstructions(Visitor)]() in the main() method!
  - We don't need an array of all instructions (except to get the count of *all* instructions):
    ```
    // the instructions in the IR.
    SSAInstruction[] instructions = ir.getInstructions();
    ```
  - Instead, give the IR a *visitor* (for the *branching* instruction count).
- Subclass [com.ibm.wala.ssa.SSAInstruction.Visitor]().
  - "Default" implementations of all methods do nothing.
  - Only override the `visit()` methods for types you are interested in.
  - Add your own functionality.

Assignment1, Part 2: Learn how to work with ASTs

- Goals:
  - Appreciate the difference between ASTs and the instruction IR.
    - WALA generates instruction IR, Eclipse generates AST IR.
  - Learn how to build Eclipse plugins.
  - Learn how to discover, build, and analyze open-source projects.
  - Run your plugin on a project you found.
  - Collect various statistical data
- Sample output and resources available