Compile to JVM

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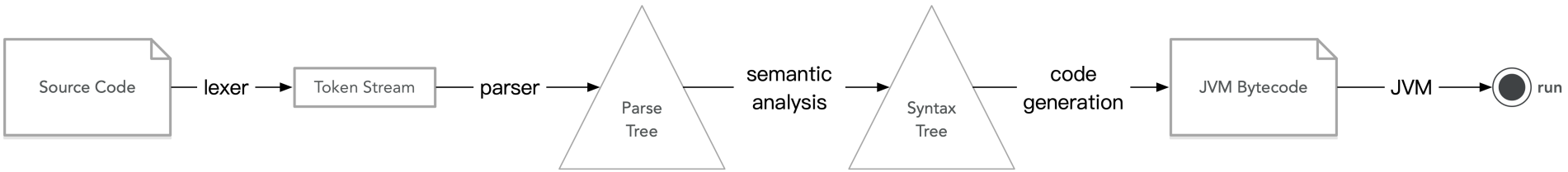
June 10, 2019

Language Specification

Example

```
1  namespace Test {
2      struct MyStruct {
3          int a = f();
4      }
5
6      double d = 4;
7
8      def void main(String[] args) {
9          print("Hello world!\n");
10     }
11
12     def int f() {
13         return 3;
14     }
15 }
```

Compiler Architecture



Platform & Dependency

- Java 8
- Gradle
- COMMONS-CLI: parse the command line
- ANTLR 4: lexical/syntactic analysis
- ASM: help to generate Java bytecode

Lexical Analysis

With the help of ANTLR, lexical analysis can be easy:

Lexical Rules Example

```
1 WHITE_SPACE: [ \t\r\n]+ -> skip;
2 LINE_COMMENT: '//' r\n]* -> skip;
3 CHAR_LITERAL: '\'' [a-zA-Z\\] '\'';
```

Syntactic Analysis

By ANTLR, we can write the following parsing rules. All the rules are placed in a .g4 file.

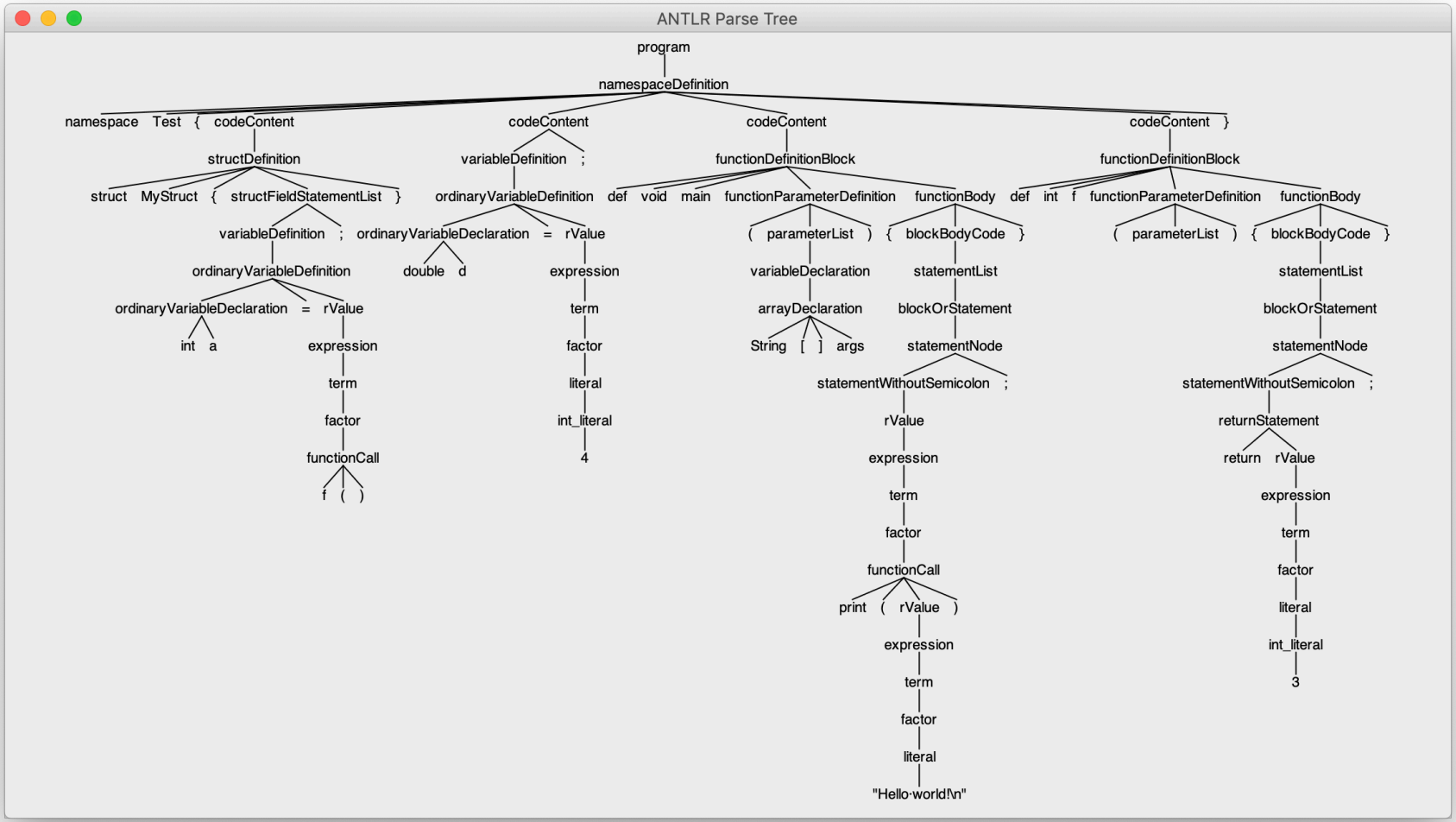
Parsing Rules Example

```
1 namespaceDefinition:
2     NAMESPACE_SYMBOL IDENTIFIER LEFT_CURLY_BRACE codeContent+
          RIGHT_CURLY_BRACE;
```

Note : ANTLR doesn't support left-recursive, we have to solve it manually.

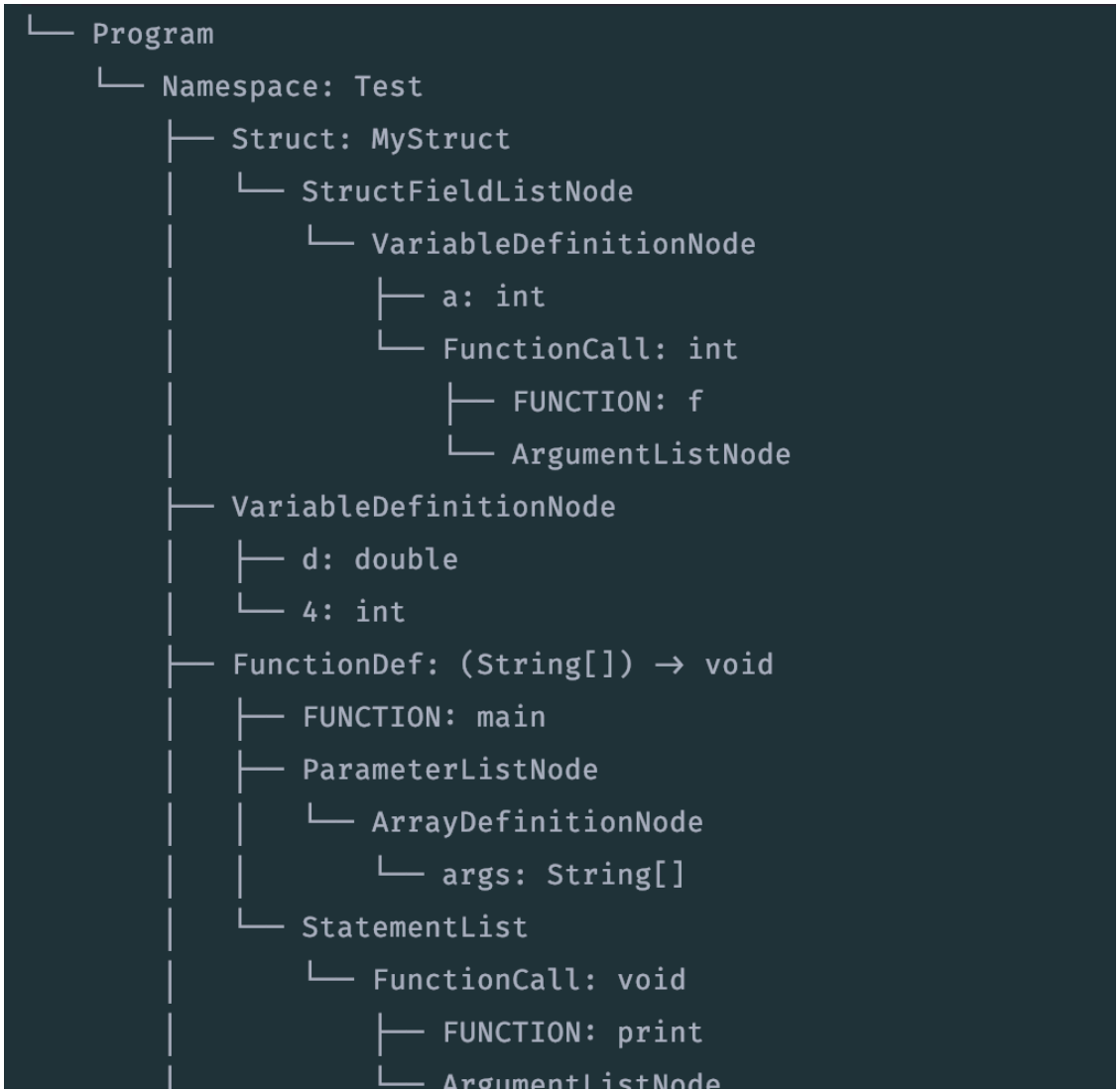
Syntactic Analysis

Result of Syntactic Analysis:



Semantic Analysis

Syntax Tree:



Code Generation

- Map from language to JVM inner structure:

Structure in this language	Corresponding structure in JVM
Namespace	Class
Struct	Inner class
Fields in Struct	Fields in inner class
Variable declared in namespace	Static fields in class
function	Static method in class
other	Same as JVM

Code Generation

- Equivalent code between this language and Java:

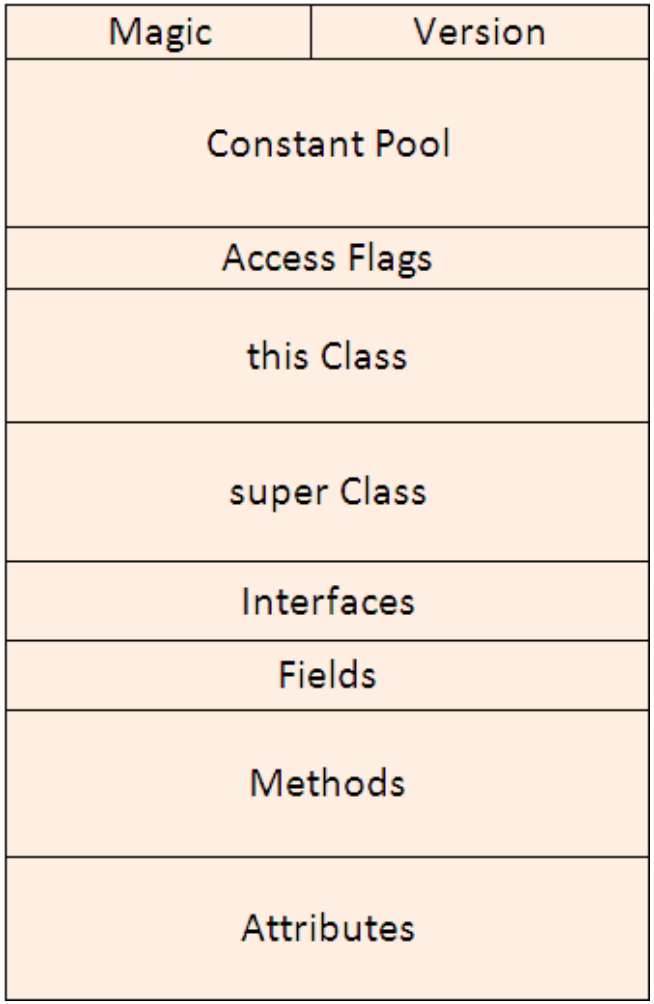
```
namespace Test {
    struct MyStruct {
        int a = f();
    }

    double d = 4;

    def void main(String[] args) {
        print("Hello world!\n");
    }

    def int f() {
        return 3;
    }
}
```



```
public class Test {
    public static class MyStruct {
        public int a = f();
    }

    public static double d = 4;

    public static void main(String[] args) {
        System.out.println("Hello world!\n");
    }

    public static int f() {
        return 3;
    }
}
```

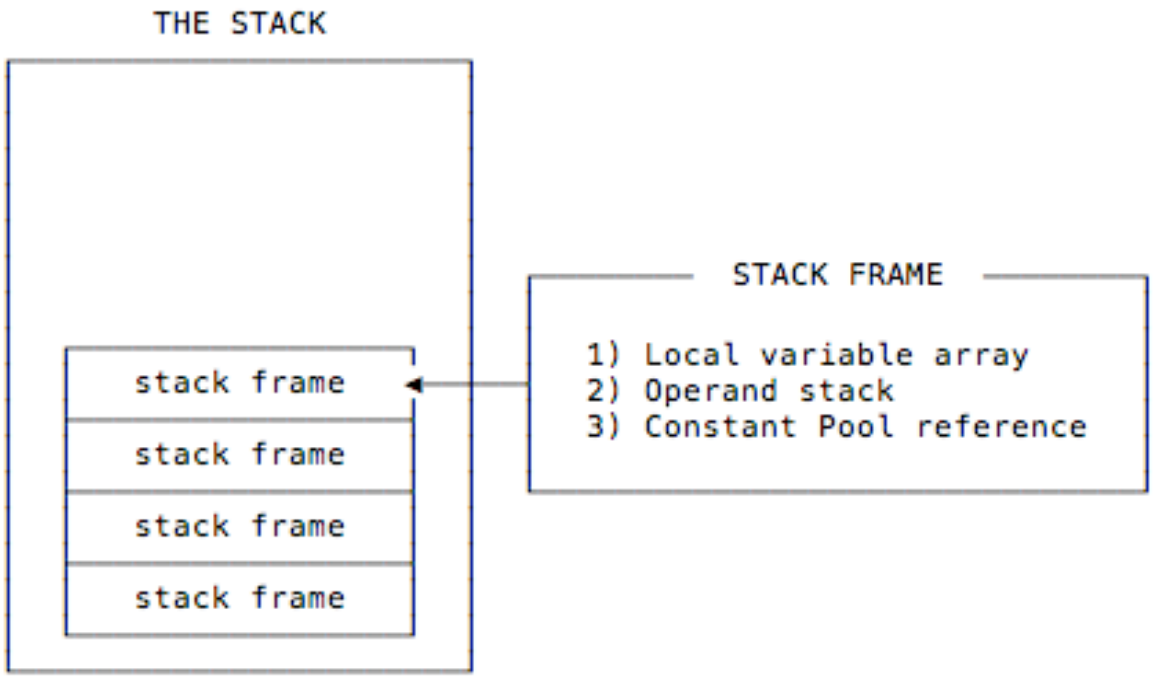
Code Generation

- Format of JVM .class file



Code Generation

- JVM is a stack machine
- JVM assembly language is a kind of P-Code



Code Generation

Pseudocode of for-loop

```
for (initStatements; condition; stepStatements) { }
```

JVM assembly code of for-loop

```
    //do initStatements
loop_label:
    //push condition
    ifeq end_label
    //BlockCode
continue_label:
    //stepStatements
    goto loop_label
end_label:
```

Contributions

- Jiawei Chen
  lexical analysis (part), semantic analysis, code generation (part), test
- Zhetuo Qi
  lexical analysis (part), syntactic analysis, code generation (part)