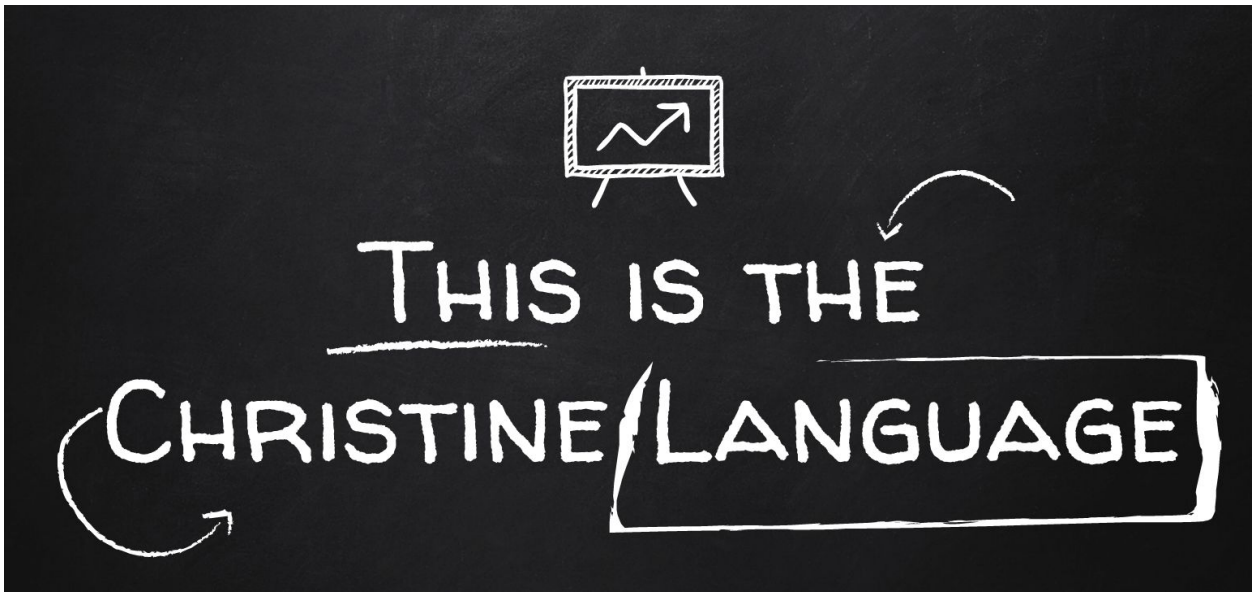
CS 153 - Compiler Design

The Christine Language

Final Report



Introduction

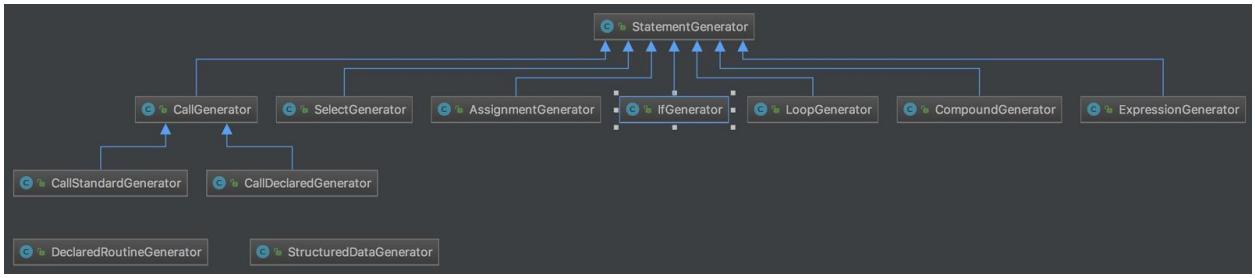
The Christine language was inspired by the verbose recipe language called Chef. Christine requires expressions and declarations to be similar to everyday statements. Through our compiler written in Java, Christine is compiled into Jasmin assembly language. The compiler consists of five packages (frontend, intermediate, backend, util, and message). However, the majority of the work occurs in the frontend package, for type and variable names are declared in the first pass through the program code, while code generation happens during the second pass.

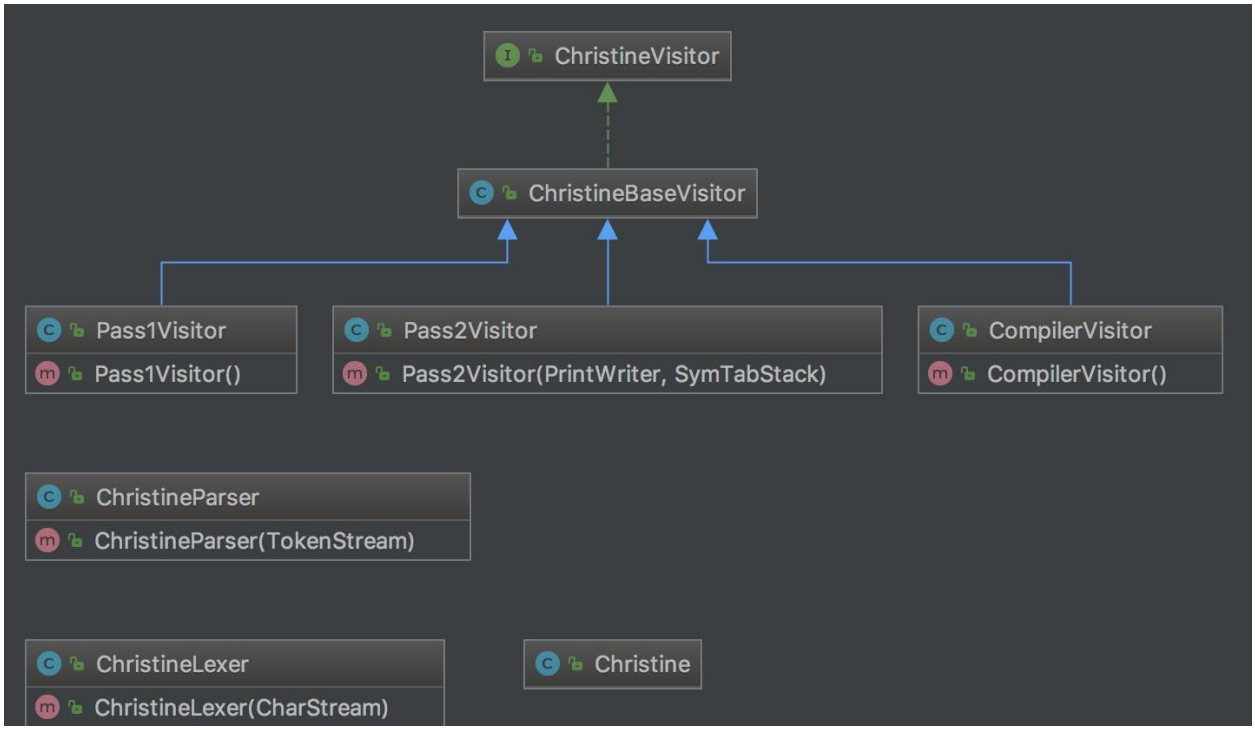
We have to major two major java files that generate the Jasmin assembly code for our program, Pass1Visiter.java and Pass2Visitor.java. Pass1Visitor pushes the global and local variables, method, and array into the Cross Reference table. A very critical role of Pass1Visitor is to push variables and method declaration information into the Symbol table stack and to generate the global variables and program headers in jasmin. Pass2Visitor

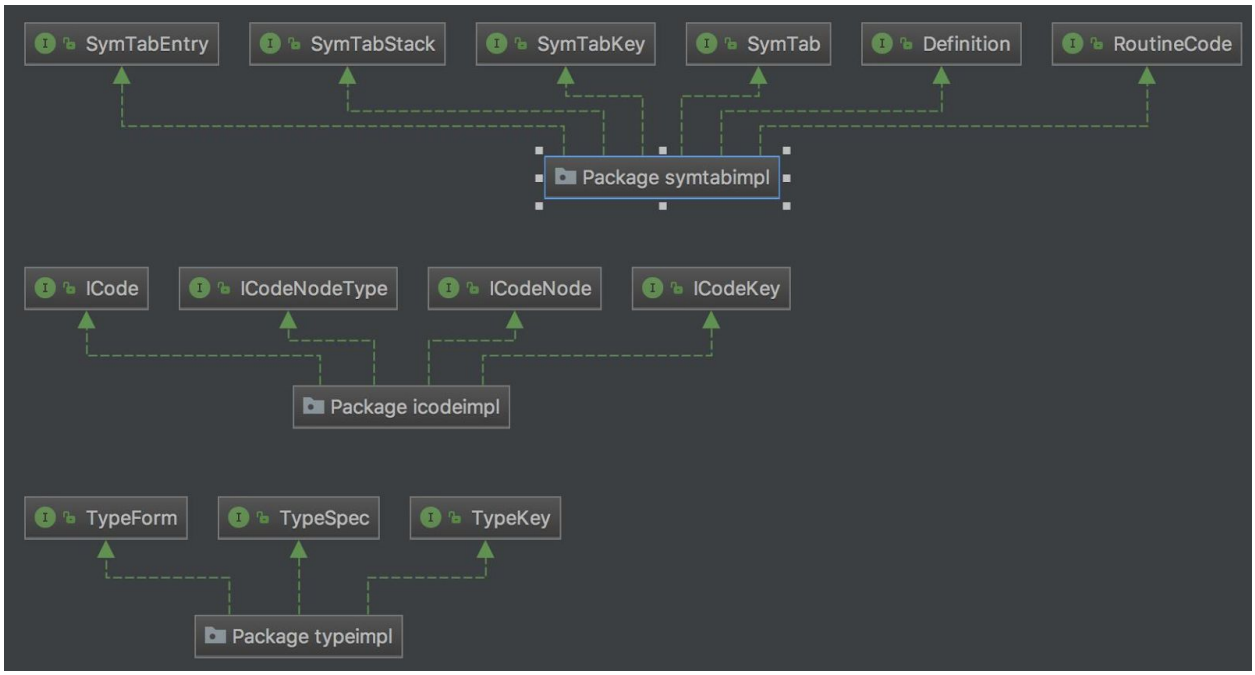
generate the jasmin codes for variable operations, expressions, method operations, and logical statements, control statements, and arrays.

UML Diagrams

Compiler Generators:



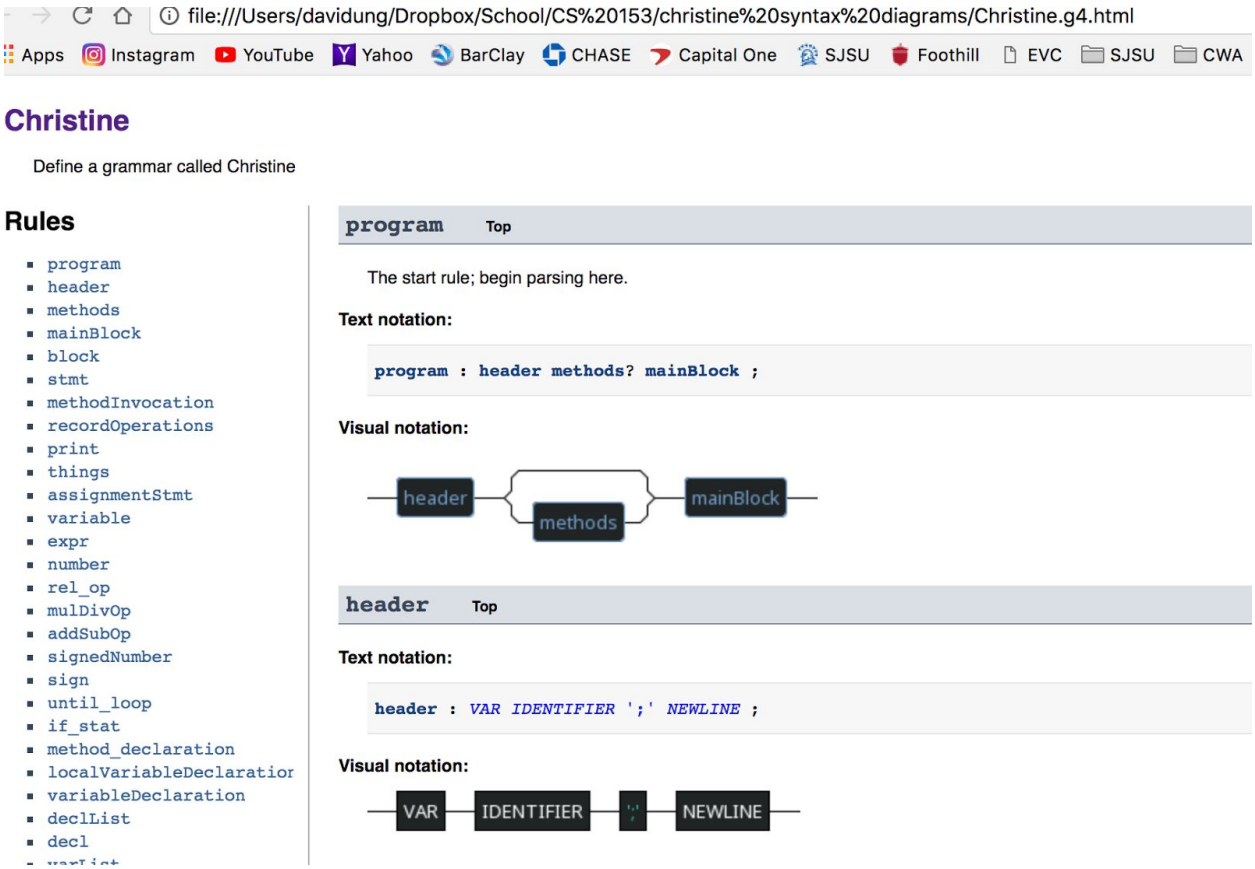



SymTabEntry
SymTabStack
SymTabKey
SymTab
Definition
RoutineCode
Package symtabimpl
ICode
ICodeNodeType
ICodeNode
ICodeKey
Package icodeimpl
TypeForm
TypeSpec
TypeKey
Package typeimpl

Grammar

The grammar syntax diagrams are included in the "**syntax_diagrams**" folder of the zip file this document was extracted from. Opening the "**Christine.g4.html**" file from that folder will show all of the syntax diagrams that represent the Christine language grammar.

Below is an example of what you see when you open "**Christine.g4.html**" in Zip Folder



Code templates (christine -> jasmin code generation)

Variable declaration and assignment

Christine

```
christine eats i as integer;
```

```
   christine eats j as real;
   christine sticks 1 into i;
   christine sticks 1.99 into j;
```

Jasmin

```
; i as integer
.field private static i I
; j as real
.field private static j F
; christine sticks1intoi;
ldc       1
putstatic         test1/i I
; christine sticks1.99intoj;
ldc       1.99
putstatic         test1/j F
```

Conditional control statements

Christine

```
christine needs a moment to decide if (i greater than 60)
{
        christine says {"I'm a horrible language!\n"};
}
```

```
else if (i greater than 50)
{
        christine says {"I am very confused!\n"};
}
else
{
        christine says {"I'm a great language!\n"};
}
```

Jasmin

```
; christine needs a moment to decideif(igreater than15) { christine says{"I'm a horrible language!\n"}; } else if(igreater than14) { christine says{"I am very confused!\n"}; } else { christine says{"I'm a great language!\n"}; }
getstatic       test3/i I
ldc     15
if_icmpgt LBL6
iconst_1
goto LBL7
LBL6:
; visitRelExpr
iconst_0
LBL7:
```

```
; visitRelExpr
ifne LBL5
; christine says{"I'm a horrible language!\n"};
getstatic java/lang/System/out Ljava/io/PrintStream;
ldc "I'm a horrible language!\n"
invokevirtual java/io/PrintStream/print(Ljava/lang/String;)V
goto LBL4
LBL5:
getstatic       test3/i I
ldc     14
if_icmpgt LBL9
iconst_1
goto LBL10
LBL9:
; visitRelExpr
iconst_0
LBL10:
; visitRelExpr
ifne LBL8
; christine says{"I am very confused!\n"};
getstatic java/lang/System/out Ljava/io/PrintStream;
```

```
ldc "I am very confused!\n"
invokevirtual java/io/PrintStream/print(Ljava/lang/String;)V
goto LBL4
LBL8:
; christine says{"I'm a great language!\n"};
getstatic java/lang/System/out Ljava/io/PrintStream;
ldc "I'm a great language!\n"
invokevirtual java/io/PrintStream/print(Ljava/lang/String;)V
LBL4:
LBL11:
```

Loops

Christine

```
christine repeats herself until (i greater than or equal to 55)
{
    christine sticks (christine puts i and 1 together) into i;
    christine says {"i is now equal to ", i, "\n"};
}
```

Jasmin

```
; christine repeats herself until(igreater than or equal to15) { christine sticks(christine putsiand1together)intoi; christine says{"i is now equal to ",i,"\n"}; }
```

```
LBL0:
; visitUntil_loop
getstatic       test3/i I
ldc     15
if_icmpge LBL2
iconst_1
goto LBL3
LBL2:
; visitRelExpr
iconst_0
LBL3:
; visitRelExpr
ifeq LBL1
; christine sticks(christine putsiand1together)intoi;
getstatic       test3/i I
ldc     1
iadd
putstatic       test3/i I
; christine says{"i is now equal to ",i,"\n"};
getstatic java/lang/System/out Ljava/io/PrintStream;
ldc "i is now equal to "
```

```
invokevirtual java/io/PrintStream/print(Ljava/lang/String;)V
getstatic java/lang/System/out Ljava/io/PrintStream;
new       java/lang/StringBuilder
dup
ldc ""
invokenonvirtual java/lang/StringBuilder/<init>(Ljava/lang/String;)V
getstatic     test3/i I
invokevirtual java/lang/StringBuilder/append(I)Ljava/lang/StringBuilder;
invokevirtual java/lang/StringBuilder/toString()Ljava/lang/String;
invokevirtual java/io/PrintStream/println(Ljava/lang/String;)V
goto LBL0
LBL1:
; visitUntil_loop
```

Function declaration and invocation

Christine

christine is breaking a program named fibonacci;

christine is creating a method that returns integer called getFib (christine eats n as integer)
{

    christine eats i as integer;

    christine eats j as integer;

    christine eats k as integer;

```
    christine eats t as integer;
    christine sticks 0 into i;
    christine sticks 1 into j;
    christine sticks 1 into k;
    christine repeats herself until (k equal to n)
    {
        christine sticks (christine puts i and j together) into t;
        christine says {j, " "};
        christine sticks j into i;
        christine sticks t into j;
        christine sticks (christine puts 1 and k together) into k;
    }
    christine says { j, "\n"};
    christine is returning j;
}
christine is doing her main thing {
    christine eats fib as integer;
    # Get a sequence of 5 numbers
    christine says {"christine is calling getFib with a value of 5\n"}
    christine sticks (christine casually strolls to getFib with 5;) into fib;
    christine says {"result of getFib for 5 is ", fib, "\n"};
```

```
    # Get a sequence of 15 numbers
    christine says {"christine is calling getFib with a value of 15\n"}
    christine sticks (christine casually strolls to getFib with 15;) into fib;
    christine says {"result of getFib for 15 is ", fib, "\n"};
}
```

Jasmin

```
; n as integer
.field private static n I
; i as integer
.field private static i I
; j as integer
.field private static j I
; k as integer
.field private static k I
; t as integer
.field private static t I
; fib as integer
.field private static fib I
;visiting void method declaration
.method public static getFib(I)I
iload 0
```

```
putstatic fibonacci/n I

;visiting method statements

; christine eatsi as integer;

; christine eatsj as integer;

; christine eatsk as integer;

; christine eatst as integer;

; christine sticks0intoi;

ldc	0

putstatic	fibonacci/i I

; christine sticks1intoj;

ldc	1

putstatic	fibonacci/j I

; christine sticks1intok;

ldc	1

putstatic	fibonacci/k I

; christine repeats herself until(kequal ton) { christine sticks(christine
putsiandjtogether)intot; christine says{j," "}; christine sticksjintoi; christine stickstintoj;
christine sticks(christine puts1andktogether)intok; }

LBL0:

; visitUntil_loop

getstatic	fibonacci/k I

getstatic	fibonacci/n I
```

```
if_icmpeq LBL2

iconst_1

goto LBL3

LBL2:

; visitRelExpr

iconst_0

LBL3:

; visitRelExpr

ifeq LBL1

; christine sticks(christine putsiandjtogether)intot;

getstatic       fibonacci/i I

getstatic       fibonacci/j I

iadd

putstatic       fibonacci/t I

; christine says{j," "};

getstatic java/lang/System/out Ljava/io/PrintStream;

new     java/lang/StringBuilder

dup

ldc ""

invokenonvirtual java/lang/StringBuilder/<init>(Ljava/lang/String;)V

getstatic    fibonacci/j I
```

```
invokevirtual java/lang/StringBuilder/append(I)Ljava/lang/StringBuilder;

invokevirtual java/lang/StringBuilder/toString()Ljava/lang/String;

invokevirtual java/io/PrintStream/print(Ljava/lang/String;)V

getstatic java/lang/System/out Ljava/io/PrintStream;

ldc " "

invokevirtual java/io/PrintStream/print(Ljava/lang/String;)V

; christine sticksjintoi;

getstatic       fibonacci/j I

putstatic       fibonacci/i I

; christine stickstintoj;

getstatic       fibonacci/t I

putstatic       fibonacci/j I

; christine sticks(christine puts1andktogether)intok;

ldc     1

getstatic       fibonacci/k I

iadd

putstatic       fibonacci/k I

goto LBL0

LBL1:

; visitUntil_loop

; christine says{j,"\n"};
```

```
getstatic java/lang/System/out Ljava/io/PrintStream;
new       java/lang/StringBuilder
dup
ldc ""
invokenonvirtual java/lang/StringBuilder/<init>(Ljava/lang/String;)V
getstatic     fibonacci/j I
invokevirtual java/lang/StringBuilder/append(I)Ljava/lang/StringBuilder;
invokevirtual java/lang/StringBuilder/toString()Ljava/lang/String;
invokevirtual java/io/PrintStream/print(Ljava/lang/String;)V
getstatic java/lang/System/out Ljava/io/PrintStream;
ldc "\n"
invokevirtual java/io/PrintStream/print(Ljava/lang/String;)V
getstatic                   fibonacci/j I
ireturn
.limit locals 16
.limit stack 16
.end method
.method public <init>()V
aload_0
invokenonvirtual    java/lang/Object/<init>()V
return
```

```
.limit locals 1

.limit stack 1

.end method

.method public static main([Ljava/lang/String;)V

new RunTimer

dup

invokenonvirtual RunTimer/<init>()V

putstatic       fibonacci/_runTimer LRunTimer;

new PascalTextIn

dup

invokenonvirtual PascalTextIn/<init>()V

putstatic       fibonacci/_standardIn LPascalTextIn;

; christine eatsfib as integer;

; christine says{"christine is calling getFib with a value of 5\n"}

getstatic java/lang/System/out Ljava/io/PrintStream;

ldc "christine is calling getFib with a value of 5\n"

invokevirtual java/io/PrintStream/print(Ljava/lang/String;)V

; christine sticks(christine casually strolls togetFibwith5;)intofib;

sipush 5

invokestatic fibonacci/getFib(I)I
```

```
putstatic        fibonacci/fib I
; christine says{"result of getFib for 5 is ",fib,"\n"};
getstatic java/lang/System/out Ljava/io/PrintStream;
ldc "result of getFib for 5 is "
invokevirtual java/io/PrintStream/print(Ljava/lang/String;)V
getstatic java/lang/System/out Ljava/io/PrintStream;
new      java/lang/StringBuilder
dup
ldc ""
invokenonvirtual java/lang/StringBuilder/<init>(Ljava/lang/String;)V
getstatic     fibonacci/fib I
invokevirtual java/lang/StringBuilder/append(I)Ljava/lang/StringBuilder;
invokevirtual java/lang/StringBuilder/toString()Ljava/lang/String;
invokevirtual java/io/PrintStream/print(Ljava/lang/String;)V
getstatic java/lang/System/out Ljava/io/PrintStream;
ldc "\n"
invokevirtual java/io/PrintStream/print(Ljava/lang/String;)V
; christine says{"christine is calling getFib with a value of 15\n"}
getstatic java/lang/System/out Ljava/io/PrintStream;
ldc "christine is calling getFib with a value of 15\n"
invokevirtual java/io/PrintStream/print(Ljava/lang/String;)V
```

```
; christine sticks(christine casually strolls togetFibwith15;)intofib;
sipush 15
invokestatic fibonacci/getFib(I)I
putstatic        fibonacci/fib I
; christine says{"result of getFib for 15 is ",fib,"\n"};
getstatic java/lang/System/out Ljava/io/PrintStream;
ldc "result of getFib for 15 is "
invokevirtual java/io/PrintStream/print(Ljava/lang/String;)V
getstatic java/lang/System/out Ljava/io/PrintStream;
new      java/lang/StringBuilder
dup
ldc ""
invokenonvirtual java/lang/StringBuilder/<init>(Ljava/lang/String;)V
getstatic     fibonacci/fib I
invokevirtual java/lang/StringBuilder/append(I)Ljava/lang/StringBuilder;
invokevirtual java/lang/StringBuilder/toString()Ljava/lang/String;
invokevirtual java/io/PrintStream/print(Ljava/lang/String;)V
getstatic java/lang/System/out Ljava/io/PrintStream;
ldc "\n"
invokevirtual java/io/PrintStream/print(Ljava/lang/String;)V
```

Array declaration, storage, and element retrieval

Christine

christine needs 3 coffee for integer array coffeearray;

christine needs 10 coffee for real array cafe;

#christine needs 10 coffee for char array book;

Integer array test

christine is putting a coffee bean 5 into spot 1 of the coffee array coffeearray;

christine is retrieving the coffee bean at 1 from the coffee array coffeearray and placing the value into i;

Should be 5

christine says {"i is equal to ", i, "\n"};

Real array test

christine is putting a coffee bean 5.3 into spot 2 of the coffee array cafe;

christine is retrieving the coffee bean at 2 from the coffee array cafe and placing the value into j;

Should be 5.3

christine says {"j is equal to ", j, "\n"};

Jasmin

; christine needs3coffee forintegerarraycoffeearray;

bipush 3

newarray int

putstatic arrays/coffeearray [I

; christine needs10coffee forrealarraycafe;

bipush 10

newarray float

putstatic arrays/cafe [F

; christine is putting a coffee bean5into spot1of the coffee arraycoffeearray;

getstatic arrays/coffeearray [I

dup

ldc 1

ldc 5

iastore

putstatic arrays/coffeearray [I

; christine is retrieving the coffee bean at1from the coffee arraycoffeearrayand placing the value intoi;

getstatic arrays/coffeearray [I

dup

ldc 1

iaload

putstatic arrays/i I

; christine says{"i is equal to ",i,"\n"};

getstatic java/lang/System/out Ljava/io/PrintStream;

```
ldc "i is equal to "
invokevirtual java/io/PrintStream/print(Ljava/lang/String;)V
getstatic java/lang/System/out Ljava/io/PrintStream;
new       java/lang/StringBuilder
dup
ldc ""
invokenonvirtual java/lang/StringBuilder/<init>(Ljava/lang/String;)V
getstatic     arrays/i I
invokevirtual java/lang/StringBuilder/append(I)Ljava/lang/StringBuilder;
invokevirtual java/lang/StringBuilder/toString()Ljava/lang/String;
invokevirtual java/io/PrintStream/print(Ljava/lang/String;)V
getstatic java/lang/System/out Ljava/io/PrintStream;
ldc "\n"
invokevirtual java/io/PrintStream/print(Ljava/lang/String;)V
; christine is putting a coffee bean5.3into spot2of the coffee arraycafe;
getstatic arrays/cafe [F
dup
ldc 2
ldc 5.3
fastore
putstatic arrays/cafe [F
```

; christine is retrieving the coffee bean at2from the coffee arraycafeand placing the value intoj;

getstatic arrays/cafe [F

dup

ldc 2

faload

putstatic arrays/j F

; christine says{"j is equal to ",j,"\n"};

getstatic java/lang/System/out Ljava/io/PrintStream;

ldc "j is equal to "

invokevirtual java/io/PrintStream/print(Ljava/lang/String;)V

getstatic java/lang/System/out Ljava/io/PrintStream;

new java/lang/StringBuilder

dup

ldc ""

invokenonvirtual java/lang/StringBuilder/<init>(Ljava/lang/String;)V

getstatic arrays/j F

invokevirtual java/lang/StringBuilder/append(F)Ljava/lang/StringBuilder;

invokevirtual java/lang/StringBuilder/toString()Ljava/lang/String;

invokevirtual java/io/PrintStream/print(Ljava/lang/String;)V

getstatic java/lang/System/out Ljava/io/PrintStream;

ldc "\n"

invokevirtual java/io/PrintStream/print(Ljava/lang/String;)V

Screenshot

test1.christine

```
j is equal to 1.99
I'm a funky language!
i is now equal to 2
i is now equal to 3
i is now equal to 4
i is now equal to 5
i is now equal to 6
i is now equal to 7
i is now equal to 8
i is now equal to 9
i is now equal to 10
i is now equal to 11
i is now equal to 12
i is now equal to 13
i is now equal to 14
i is now equal to 15
i is now equal to 16
i is now equal to 17
i is now equal to 18
i is now equal to 19
i is now equal to 20
i is now equal to 21
i is now equal to 22
i is now equal to 23
i is now equal to 24
i is now equal to 25
i is now equal to 26
i is now equal to 27
i is now equal to 28
i is now equal to 29
i is now equal to 30
i is now equal to 31
i is now equal to 32
i is now equal to 33
i is now equal to 34
i is now equal to 35
i is now equal to 36
i is now equal to 37
i is now equal to 38
i is now equal to 39
i is now equal to 40
i is now equal to 41
i is now equal to 42
i is now equal to 43
i is now equal to 44
i is now equal to 45
i is now equal to 46
i is now equal to 47
i is now equal to 48
i is now equal to 49
i is now equal to 50
i is now equal to 51
i is now equal to 52
i is now equal to 53
i is now equal to 54
i is now equal to 55
I am very confused!
funky town 2
funky town 3
begin testVoidFunction
k is now equal to 2
k is now equal to 3
k is now equal to 4
k is now equal to 5
x is now equal to 1001
y is now equal to 55
z is now equal to 55
printing testVoidFunction parameter assignment
x is now equal to 20
y is now equal to 35
z is now equal to 310
ending testVoidFunction

                0.01 seconds total execution time.
```

test2.christine

```
Alexs-MacBook-Pro:jasmin-2.4 fox$ java -cp ./ChristineTool.jar:. test2
k should be equal to 3: 3

                0.00 seconds total execution time.
Alexs-MacBook-Pro:jasmin-2.4 fox$
```

test3.christine

```
Alexs-MacBook-Pro:jasmin-2.4 fox$ java -cp ./ChristineTool.jar:. test3
i is now equal to 2
i is now equal to 3
i is now equal to 4
i is now equal to 5

                0.00 seconds total execution time.
Alexs-MacBook-Pro:jasmin-2.4 fox$
```

test4.christine

```
Alexs-MacBook-Pro:jasmin-2.4 fox$ java -cp ./ChristineTool.jar:. test4
j is equal to 1.99
I'm a funky language!
i is equal to 5
j is equal to 5.3

                0.01 seconds total execution time.
Alexs-MacBook-Pro:jasmin-2.4 fox$
```

test5.christine

```
Alexs-MacBook-Pro:jasmin-2.4 fox$ java -cp ./ChristineTool.jar:. test5
hello world
i is equal to: 12
i is equal to: 13
i is equal to: 14
i is equal to: 15
i is equal to: 16
i is equal to: 17
i is equal to: 18
i is equal to: 19
i is equal to: 20
i is equal to: 21
i is equal to: 22
i is equal to: 23
i is equal to: 24
i is equal to: 25
i is equal to: 26
i is equal to: 27
i is equal to: 28
i is equal to: 29
i is equal to: 30
i is equal to: 31
i is equal to: 32
i is equal to: 33
i is equal to: 34
i is equal to: 35
i is equal to: 36
i is equal to: 37
i is equal to: 38
i is equal to: 39
i is equal to: 40
i is equal to: 41
i is equal to: 42
i is equal to: 43
i is equal to: 44
i is equal to: 45
i is equal to: 46
i is equal to: 47
i is equal to: 48
i is equal to: 49
i is equal to: 50
i is equal to: 51
i is equal to: 52
i is equal to: 53
i is equal to: 54
i is equal to: 55

                0.01 seconds total execution time.
Alexs-MacBook-Pro:jasmin-2.4 fox$
```

fibonacci.christine

```
Alexs-MacBook-Pro:jasmin-2.4 fox$ java -jar jasmin.jar fibonacci.j
Generated: fibonacci.class
Alexs-MacBook-Pro:jasmin-2.4 fox$ java -cp ./ChristineTool.jar:. fibonacci
christine is calling getFib with a value of 5
1 1 2 3 5
result of getFib for 5 is 5
christine is calling getFib with a value of 15
1 1 2 3 5 8 13 21 34 55 89 144 233 377 610
result of getFib for 15 is 610

                0.01 seconds total execution time.
Alexs-MacBook-Pro:jasmin-2.4 fox$
```