

Sinking Your Teeth Into Bytecode

Jake Wharton

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"How do lambdas work on old versions of Android?"

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"Is there overhead to Kotlin?"

"How does synchronized work?"

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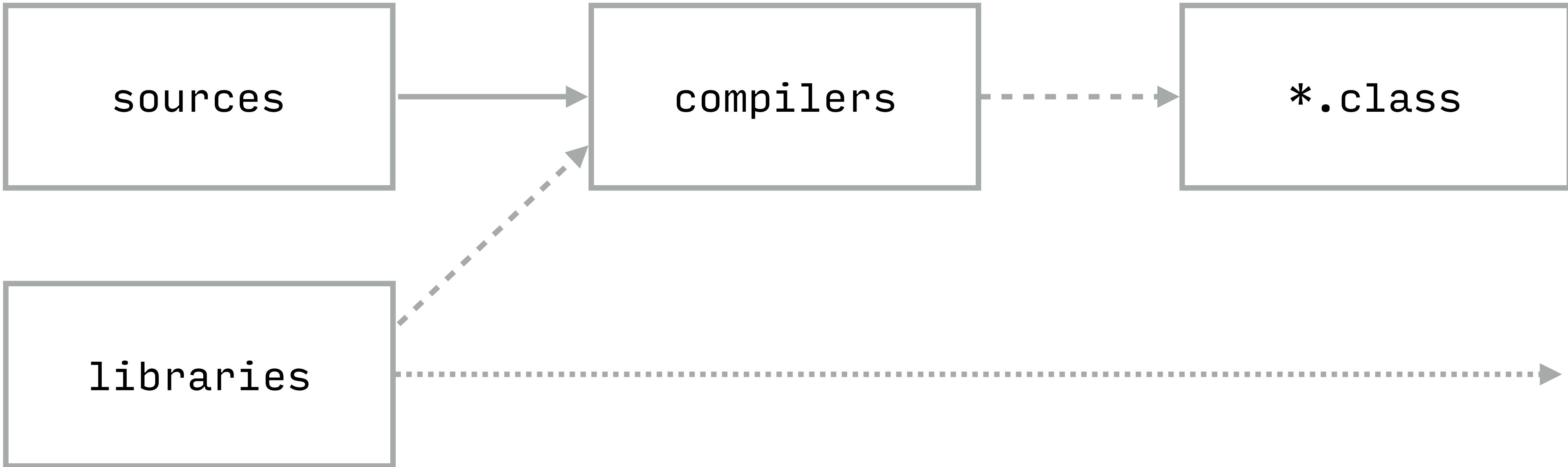
"F*%K YOU PROGUARD"

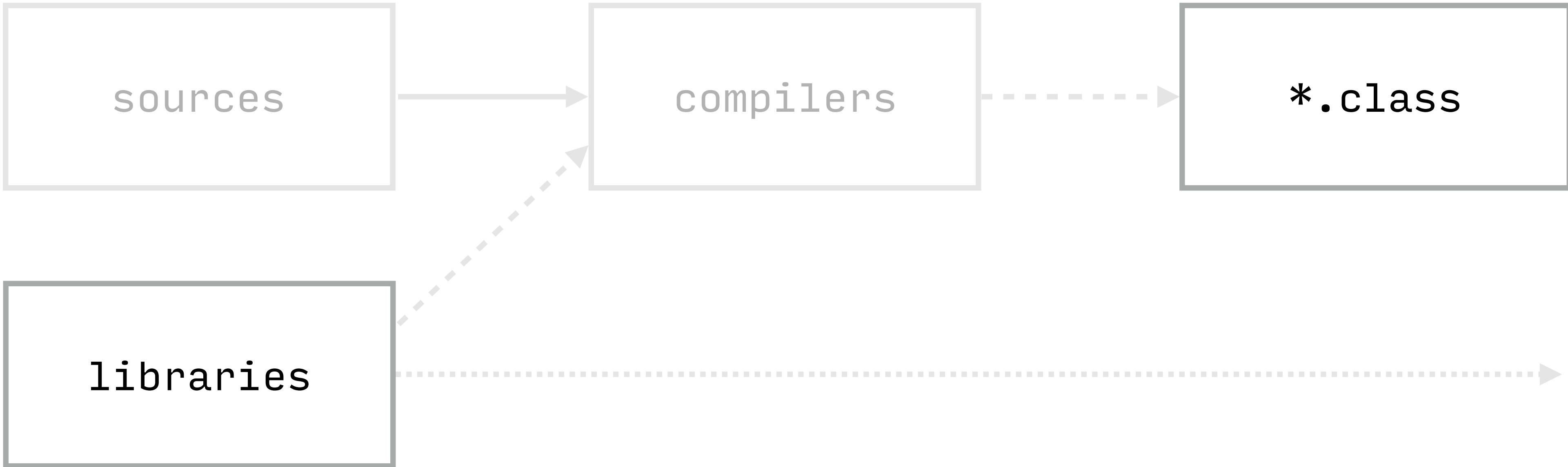
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"Can I cheat at this game?"

"Which loop is faster?"

"How do checked vs. unchecked exceptions work?"





```
$ cat Print.java
```

```
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```

```
public class Print {  
    public static void main(String[] args) {  
        for (int i = 0; i < 10; i++) {  
            System.out.println("Hello");  
        }  
    }  
}
```

```
$ cat Print.java
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```
public class Print {  
    public static void main(String[] args) {  
        for (int i = 0; i < 10; i++) {  
            System.out.println("Hello");  
        }  
    }  
}
```

```
$ javac Print.java
```



```
$ cat Print.java
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```
public class Print {  
    public static void main(String[] args) {  
        for (int i = 0; i < 10; i++) {  
            System.out.println("Hello");  
        }  
    }  
}
```

```
$ javac Print.java
```

```
$ java Print
```

```
public class Print {  
    public static void main(String[] args) {  
        for (int i = 0; i < 10; i++) {  
            System.out.println("Hello");  
        }  
    }  
}
```

```
$ javac Print.java
```

```
$ java Print
```

Hello

Hello

Hello

Hello

Hello

Hello

Hello

Hello

Hello

Hello

```
$ javap Print
```

```
$ javap Print
```

```
Compiled from "Print.java"
```

```
public class Print {
```

```
    public Print();
```

```
    public static void main(java.lang.String[]);
```

```
}
```

```
$ javap -c Print
```

```
$ javap -c Print
```

```
Compiled from "Print.java"
```

```
public class Print {
```

```
    public Print();
```

```
        Code:
```

```
            0: aload_0
```

```
            1: invokespecial #1      // Method java/lang/Object."<init>":()V
```

```
            4: return
```

```
    public static void main(java.lang.String[]);
```

```
        Code:
```

```
            0: iconst_0
```

```
            1: istore_1
```

```
            2: iload_1
```

```
            3: bipush      10
```

```
            5: if_icmpge   22
```

```
            8: getstatic   #2      // Field java/lang/System.out:Ljava/io/PrintStream;
```

```
           11: ldc         #3      // String Hello
```

```
           13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
```

```
           16: iinc        1, 1
```

```
           19: goto        2
```

```
           22: return
```

```
}
```

```
$ javap -v Print
```

\$ javap -v Print

```
Classfile /Users/jw/Desktop/bytecodes/Print.class
  Last modified Oct 18, 2017; size 462 bytes
  MD5 checksum cf33844b3ed95ff736b59ba4b8417a0c
  Compiled from "Print.java"
public class Print
  minor version: 0
  major version: 52
  flags: ACC_PUBLIC, ACC_SUPER
Constant pool:
 #1 = Methodref      #6.#16      // java/lang/Object.<init>:()V
 #2 = Fieldref       #17.#18      // java/lang/System.out:Ljava/io/PrintStream;
 #3 = String         #19          // Hello
 #4 = Methodref      #20.#21      // java/io/PrintStream.println:(Ljava/lang/String;)V
 #5 = Class          #22          // Print
 #6 = Class          #23          // java/lang/Object
 #7 = Utf8           <init>
 #8 = Utf8           ()V
 #9 = Utf8           Code
#10 = Utf8           LineNumberTable
#11 = Utf8           main
#12 = Utf8           ([Ljava/lang/String;)V
#13 = Utf8           StackMapTable
#14 = Utf8           SourceFile
#15 = Utf8           Print.java
#16 = NameAndType    #7:#8        // "<init>:()V
#17 = Class          #24          // java/lang/System
#18 = NameAndType    #25:#26      // out:Ljava/io/PrintStream;
#19 = Utf8           Hello
#20 = Class          #27          // java/io/PrintStream
#21 = NameAndType    #28:#29      // println:(Ljava/lang/String;)V
#22 = Utf8           Print
#23 = Utf8           java/lang/Object
#24 = Utf8           java/lang/System
#25 = Utf8           out
#26 = Utf8           Ljava/io/PrintStream;
#27 = Utf8           java/io/PrintStream
#28 = Utf8           println
#29 = Utf8           (Ljava/lang/String;)V
{
  public Print();
    descriptor: ()V
    flags: ACC_PUBLIC
    Code:
      stack=1, locals=1, args_size=1
      0: aload_0
      1: invokespecial #1      // Method java/lang/Object.<init>:()V
      4: return
    LineNumberTable:
      line 1: 0

  public static void main(java.lang.String[]);
    descriptor: ([Ljava/lang/String;)V
    flags: ACC_PUBLIC, ACC_STATIC
    Code:
      stack=2, locals=2, args_size=1
      0: iconst_0
      1: istore_1
      2: iload_1
      3: bipush      10
      5: if_icmpge    22
      8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
     11: ldc          #3      // String Hello
     13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
     16: iinc         1, 1
     19: goto        2
     22: return
    LineNumberTable:
      line 3: 0
      line 4: 8
      line 3: 16
      line 6: 22
    StackMapTable: number_of_entries = 2
      frame_type = 252 /* append */
      offset_delta = 2
      locals = [ int ]
      frame_type = 250 /* chop */
      offset_delta = 19
}
SourceFile: "Print.java"
```



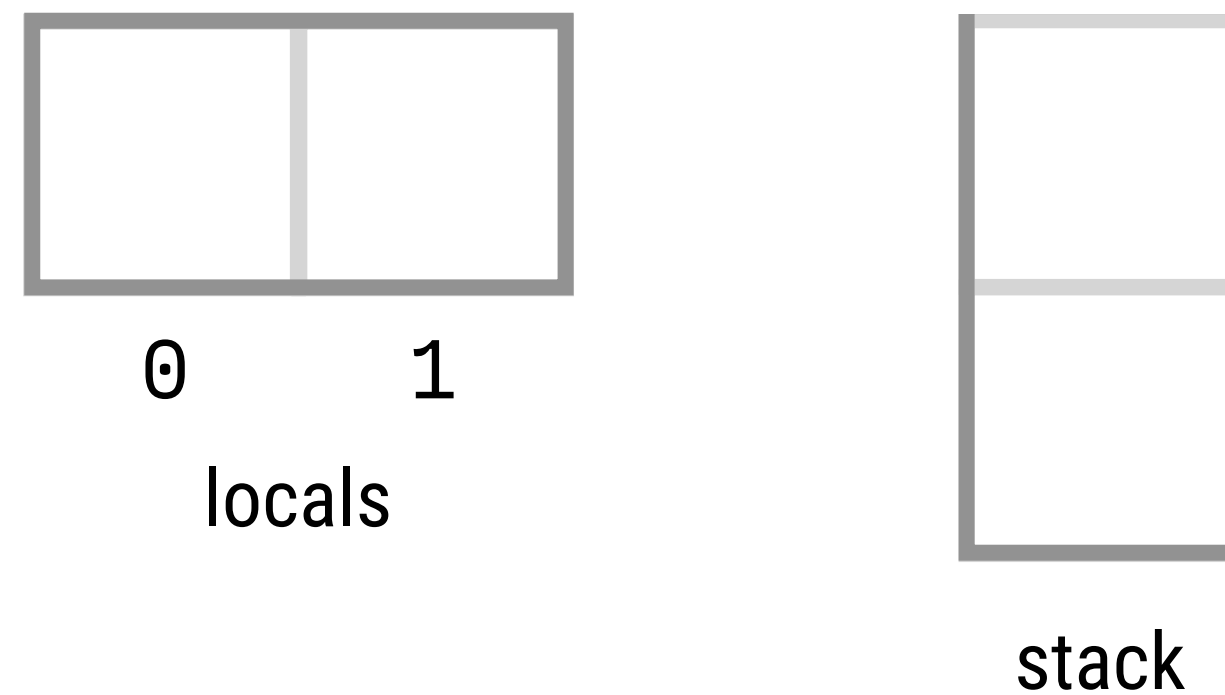
```
public static void main(java.lang.String[]);
  descriptor: ([Ljava/lang/String;)V
  flags: ACC_PUBLIC, ACC_STATIC
  Code:
    stack=2, locals=2, args_size=1
       0: iconst_0
       1: istore_1
       2: iload_1
       3: bipush      10
       5: if_icmpge    22
       8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
      11: ldc          #3      // String Hello
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 LineNumberTable:
    line 3: 0
    line 4: 8
    line 3: 16
    line 6: 22
  StackMapTable: number_of_entries = 2
    <snipped>
```

```
public static void main(java.lang.String[]);
  descriptor: ([Ljava/lang/String;)V
  flags: ACC_PUBLIC, ACC_STATIC
  Code:
    stack=2, locals=2, args_size=1
       0: iconst_0
       1: istore_1
       2: iload_1
       3: bipush      10
       5: if_icmpge     22
       8: getstatic     #2      // Field java/lang/System.out:Ljava/io/PrintStream;
      11: ldc           #3      // String Hello
      13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
      16: iinc          1, 1
      19: goto          2
      22: return
 LineNumberTable:
    line 3: 0
    line 4: 8
    line 3: 16
    line 6: 22
  StackMapTable: number_of_entries = 2
    <snipped>
```

stack=2, locals=2

```
public static void main(java.lang.String[]);
```

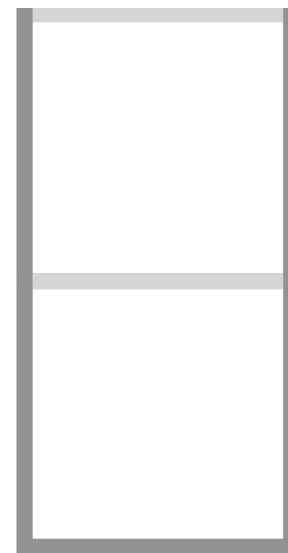
0:	iconst_0		
1:	istore_1		
2:	iload_1		
3:	bipush	10	
5:	if_icmpge	22	
8:	getstatic	#2	// Field java/lang/System.out:Ljava/io/PrintStream;
11:	ldc	#3	// String Hello
13:	invokevirtual	#4	// Method java/io/PrintStream.println:(Ljava/lang/String;)V
16:	iinc	1, 1	
19:	goto	2	
22:	return		



```
public static void main(java.lang.String[]);
  0: iconst_0
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  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
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 19: goto         2
 22: return
```



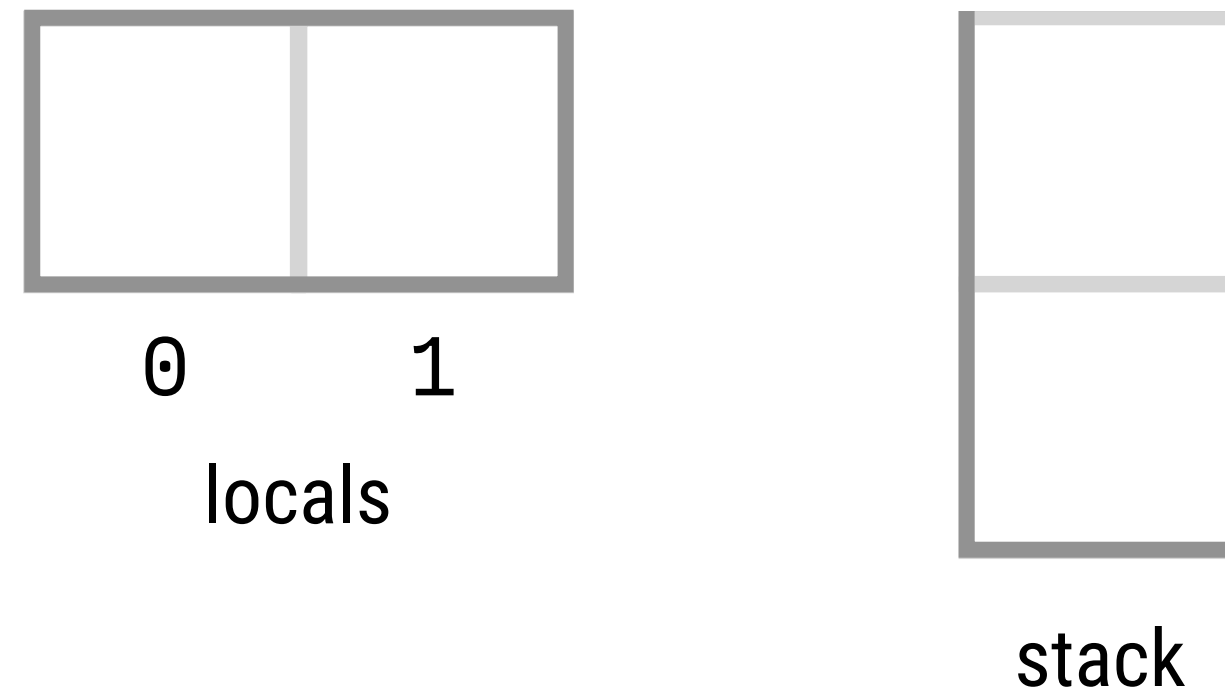
0 1
locals



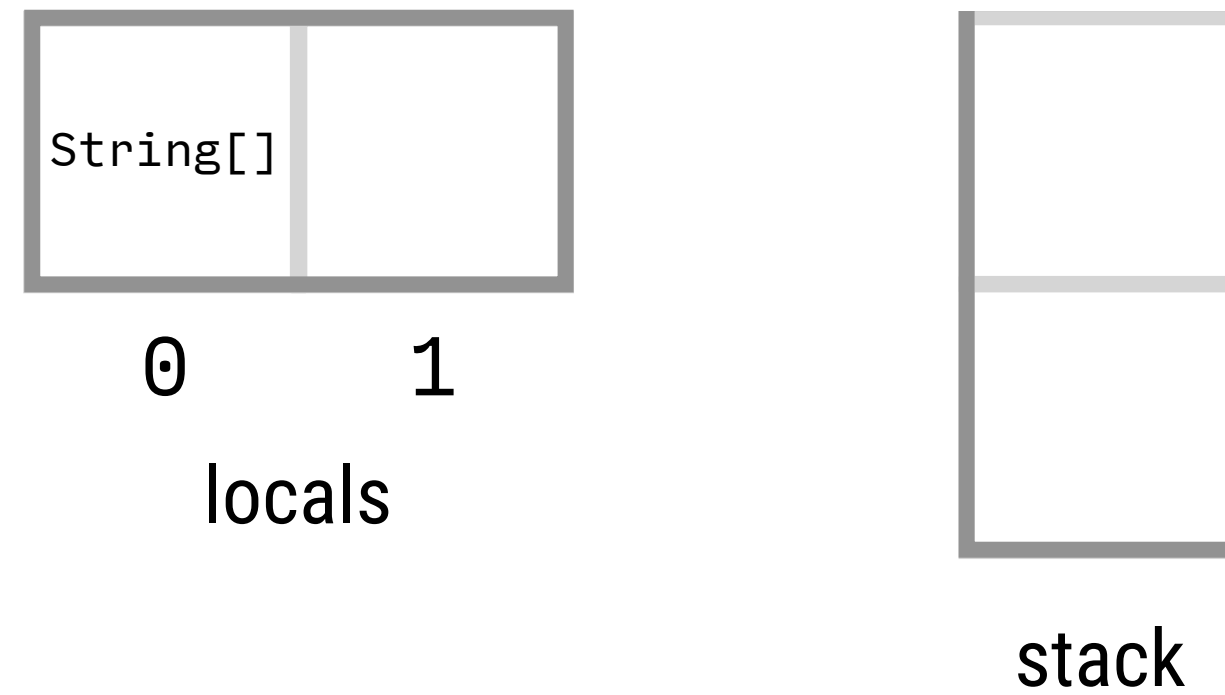
stack

```
public static void main(java.lang.String[]);
```

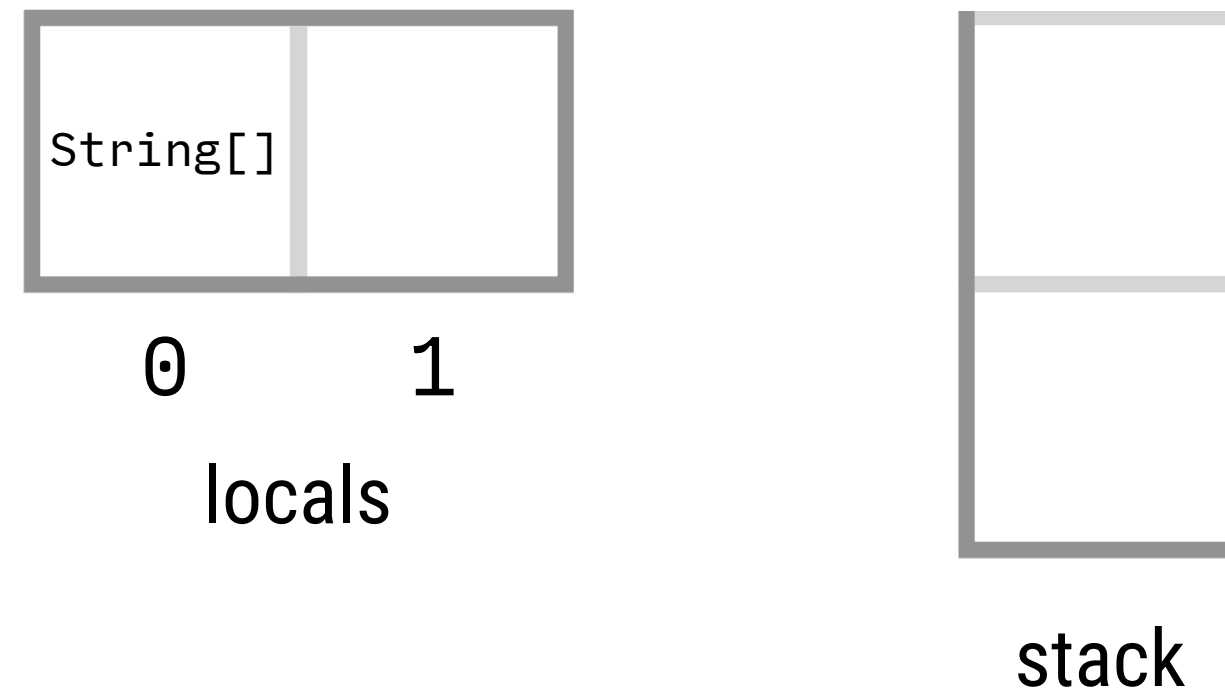
```
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
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 16: iinc          1, 1
 19: goto          2
 22: return
```



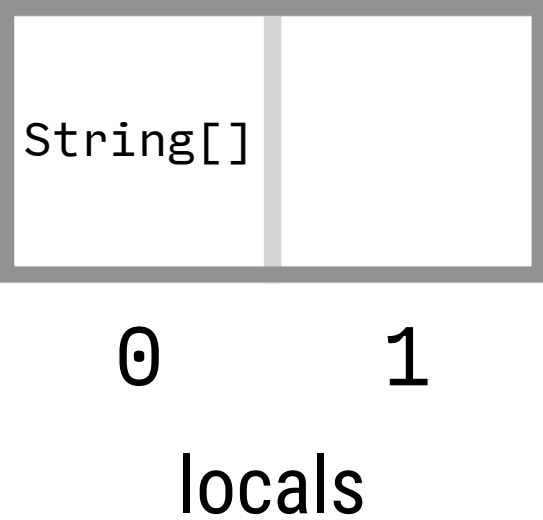
```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
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  2: iload_1
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 16: iinc         1, 1
 19: goto         2
 22: return
```

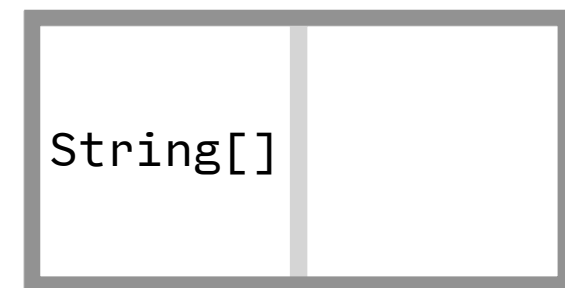


```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```

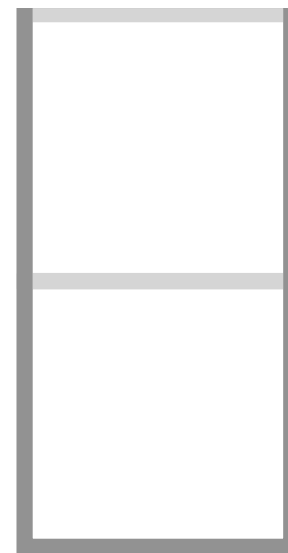



iconst_0

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```



0 1
locals



stack

iconst_0

int constant 0

```
public static void main(java.lang.String[]);
```

```
0: iconst_0
```

```
1: istore_1
```

```
2: iload_1
```

```
3: bipush            10
```

```
5: if_icmpge        22
```

```
8: getstatic       #2
```

```
// Field java/lang/System.out:Ljava/io/PrintStream;
```

```
11: ldc            #3
```

```
// String Hello
```

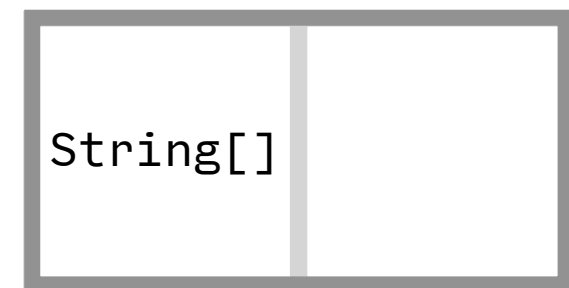
```
13: invokevirtual #4
```

```
// Method java/io/PrintStream.println:(Ljava/lang/String;)V
```

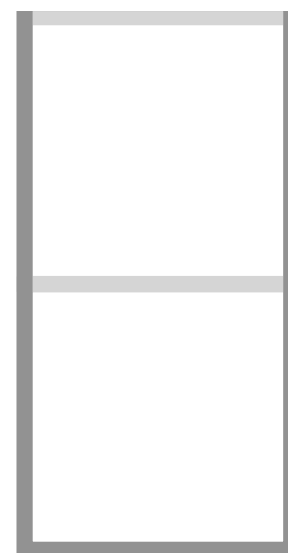
```
16: iinc            1, 1
```

```
19: goto            2
```

```
22: return
```



0 1
locals



stack

iconst_0

```
public static void main(java.lang.String[]);
```

```
0: iconst_0
```

```
1: istore_1
```

```
2: iload_1
```

```
3: bipush            10
```

```
5: if_icmpge        22
```

```
8: getstatic        #2      // Field java/lang/System.out:Ljava/io/PrintStream;
```

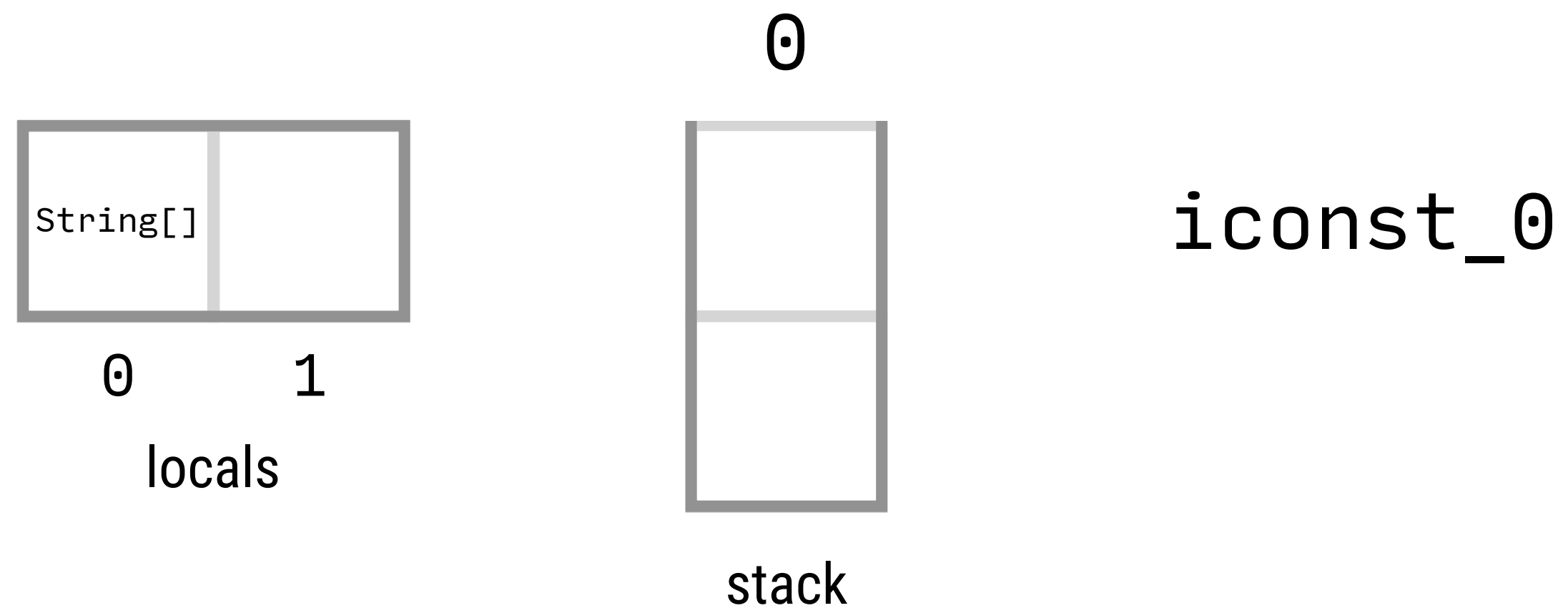
```
11: ldc              #3      // String Hello
```

```
13: invokevirtual    #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
```

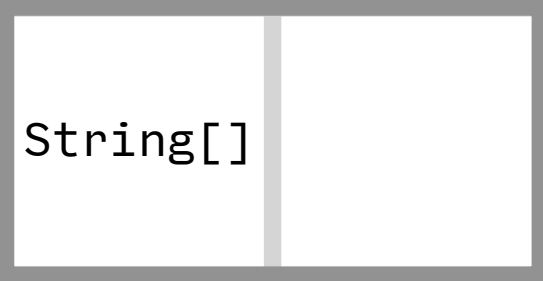
```
16: iinc             1, 1
```

```
19: goto             2
```

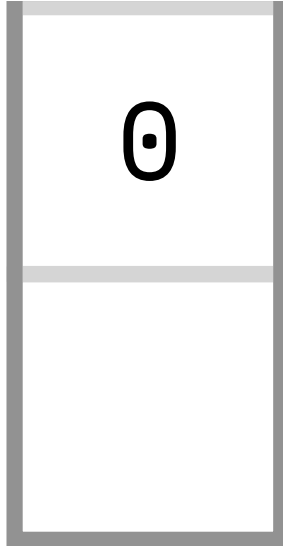
```
22: return
```



```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
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 16: iinc         1, 1
 19: goto         2
 22: return
```



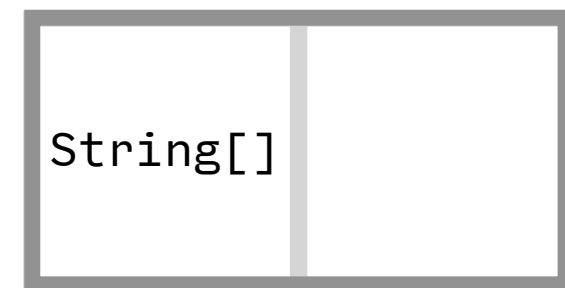
0 1
locals



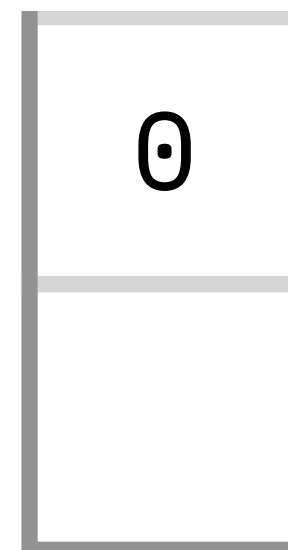
stack

iconst_0

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```



0 1
locals



stack

```
public static void main(java.lang.String[]);
```

```
  0: iconst_0
```

```
  1: istore_1
```

```
  2: iload_1
```

```
  3: bipush      10
```

```
  5: if_icmpge   22
```

```
  8: getstatic   #2    // Field java/lang/System.out:Ljava/io/PrintStream;
```

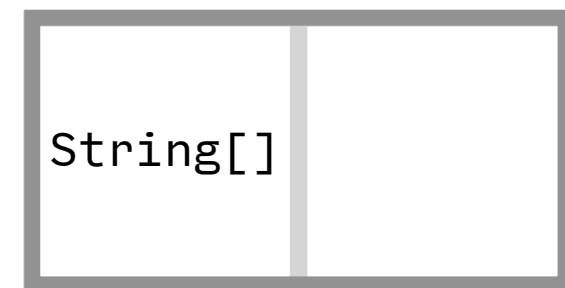
```
 11: ldc         #3    // String Hello
```

```
 13: invokevirtual #4    // Method java/io/PrintStream.println:(Ljava/lang/String;)V
```

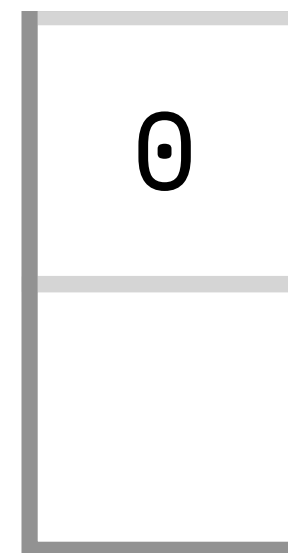
```
 16: iinc        1, 1
```

```
 19: goto        2
```

```
 22: return
```

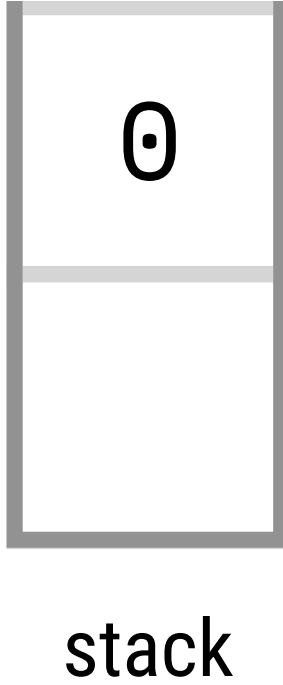
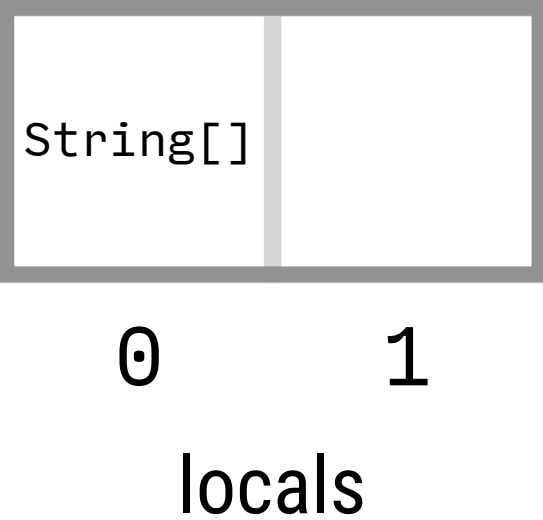


0 1
locals



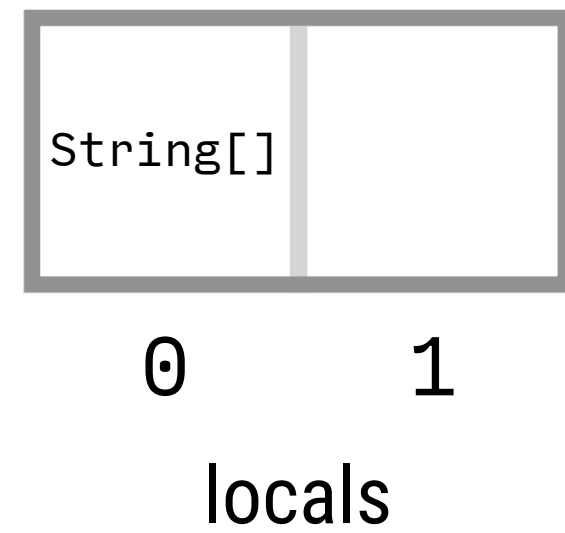
stack

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```



istore_1

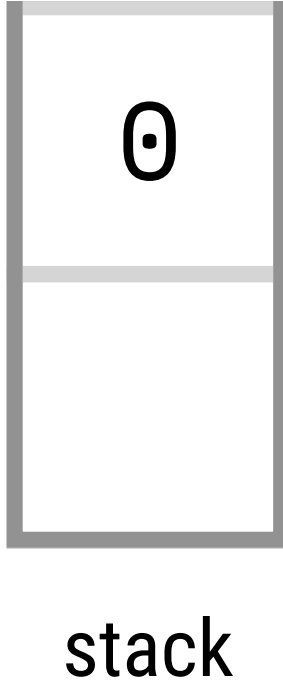
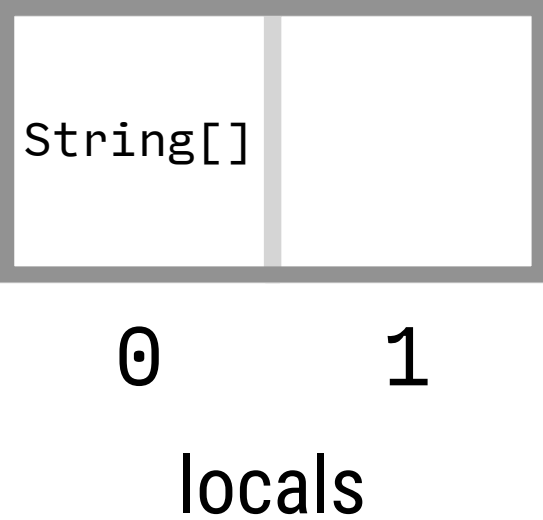
```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```

istore_1

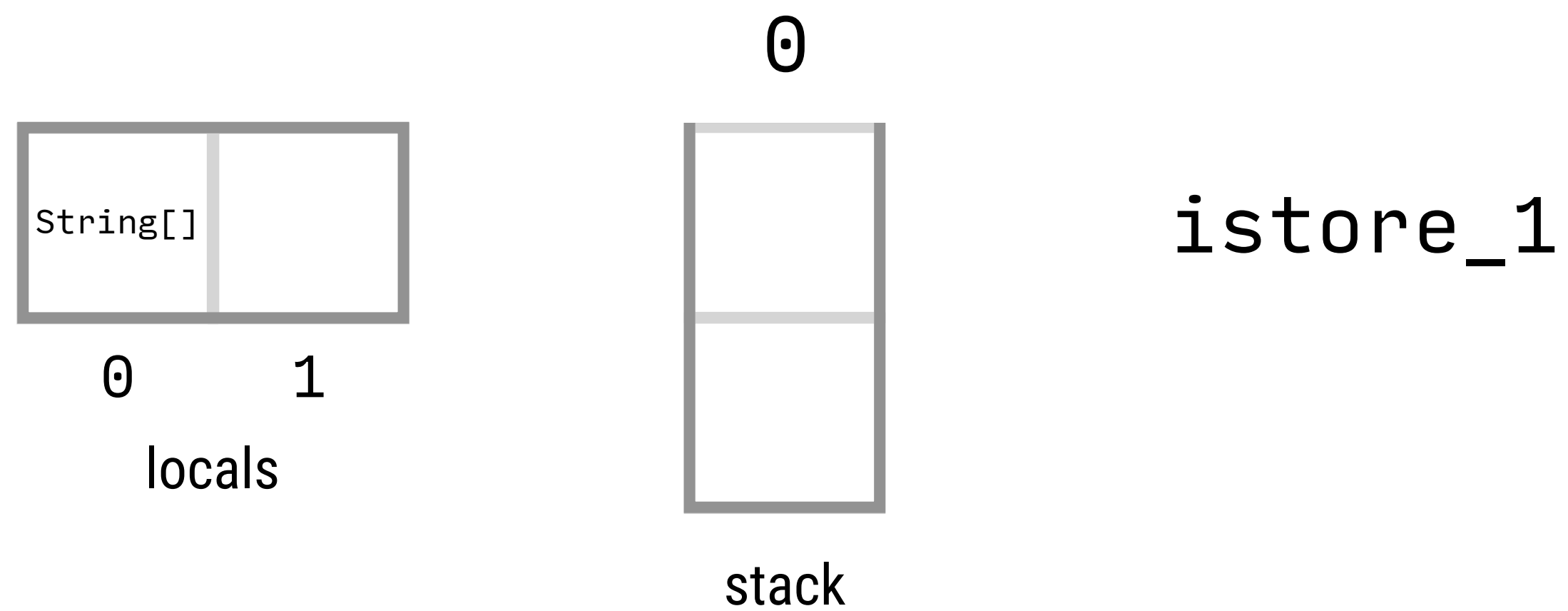
int store into local slot **1**

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
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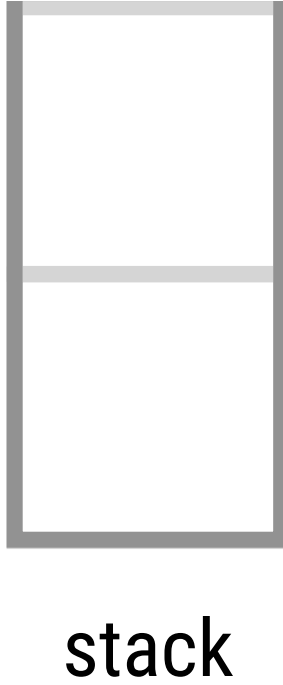
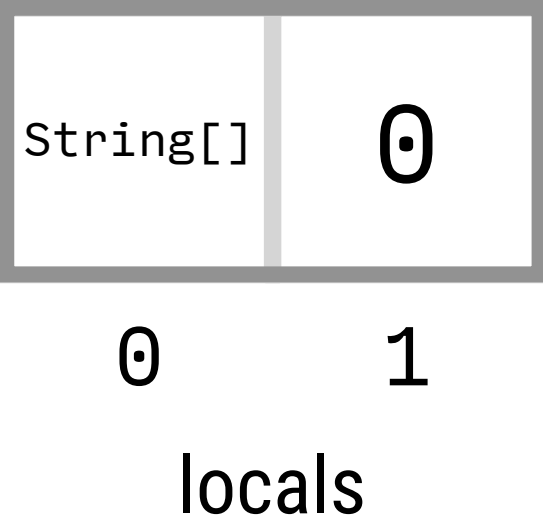


istore_1

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```

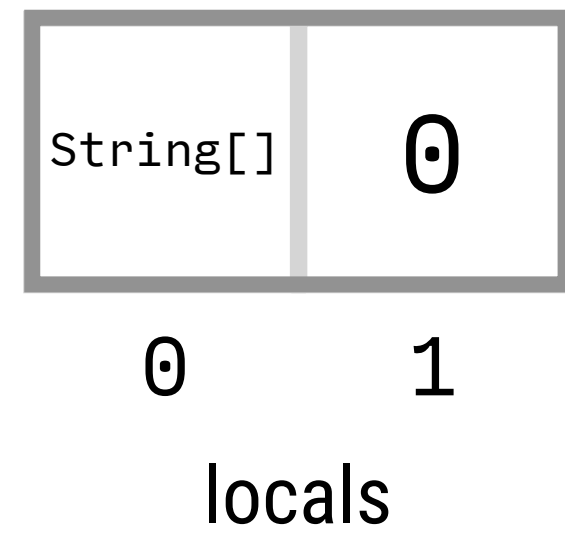


```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```

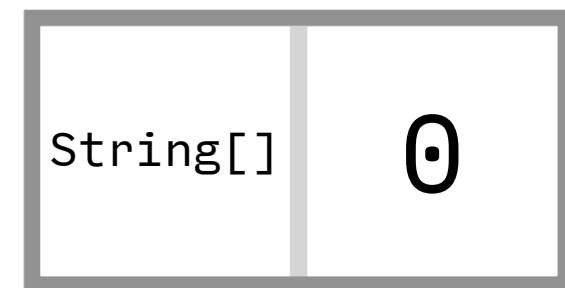


istore_1

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```



```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```

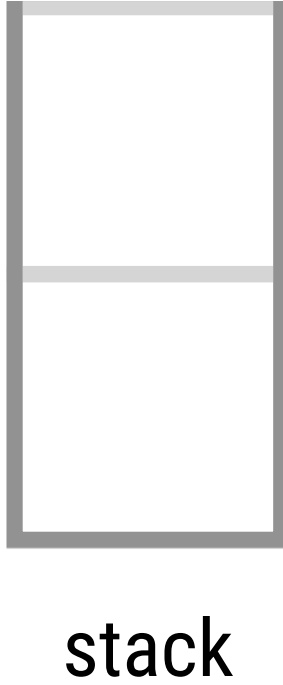
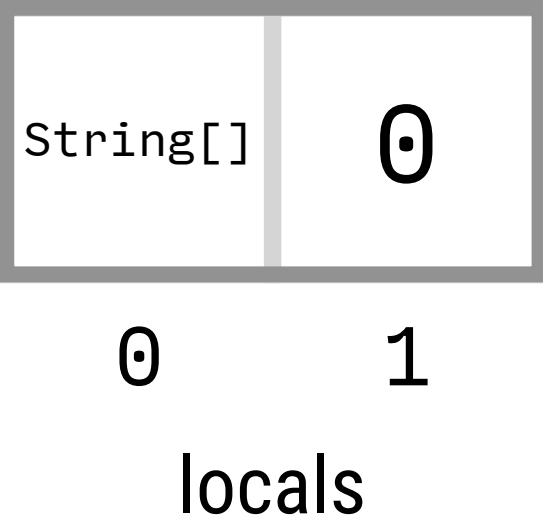


0 1
locals



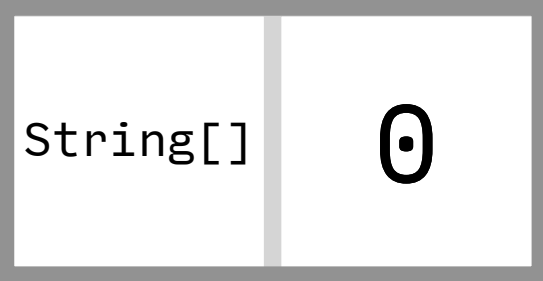
stack

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```

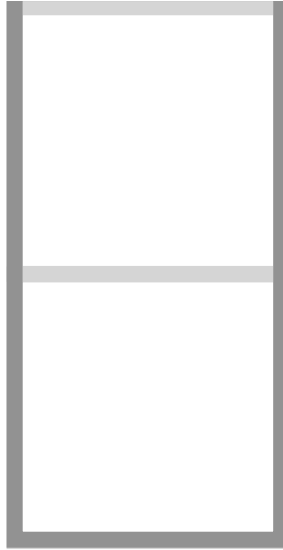


iload_1

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge   22
  8: getstatic   #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc         #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc        1, 1
 19: goto        2
 22: return
```



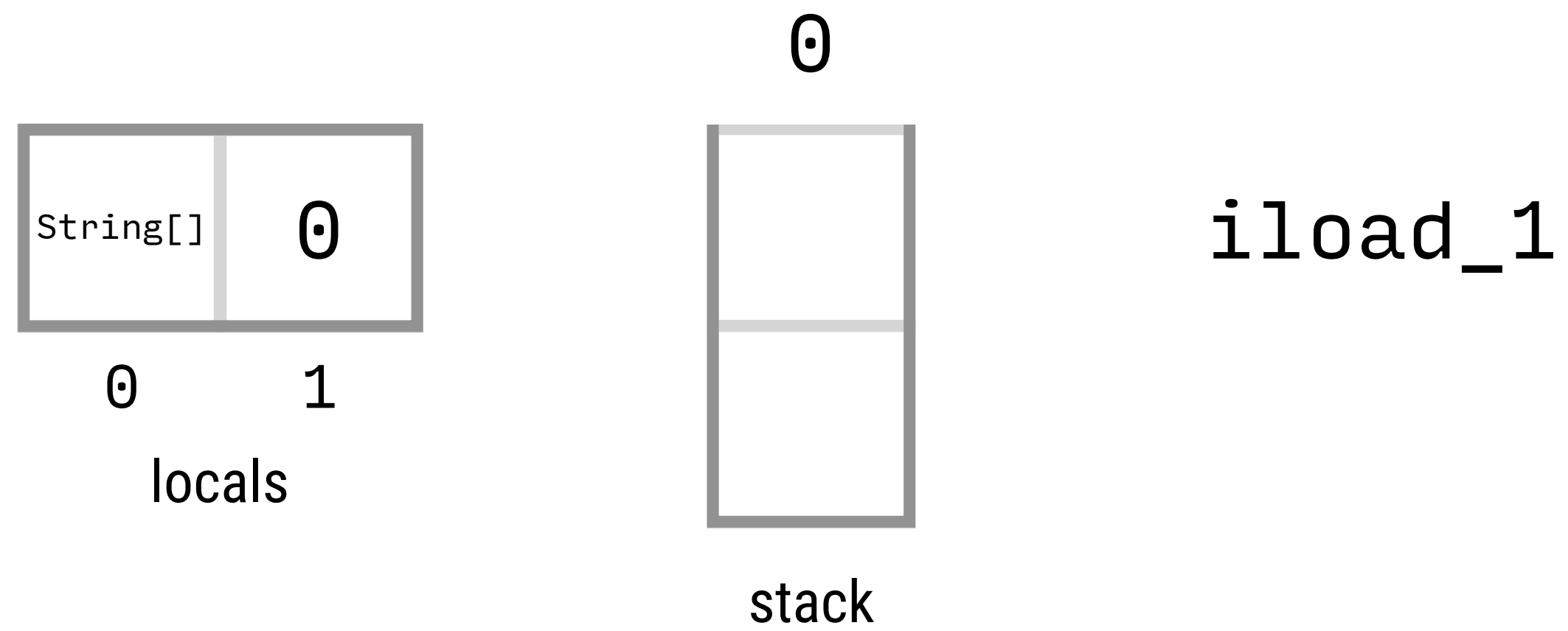
0 1
locals



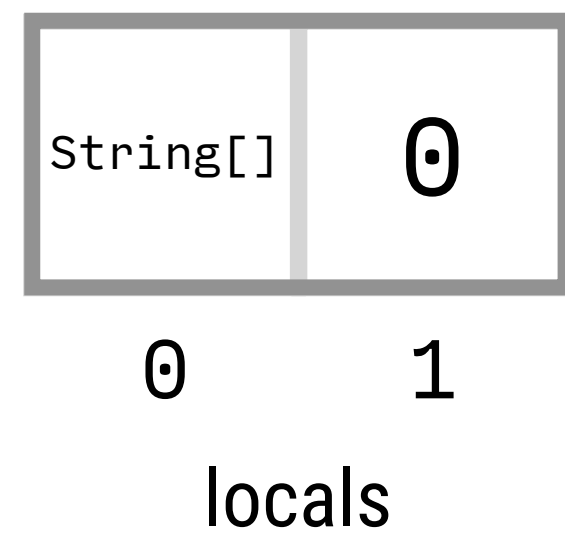
stack

iload_1

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```

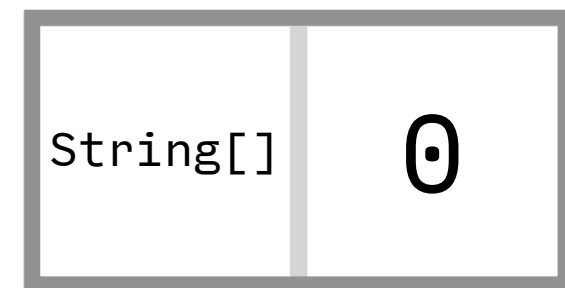



```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge   22
  8: getstatic   #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc         #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc        1, 1
 19: goto        2
 22: return
```

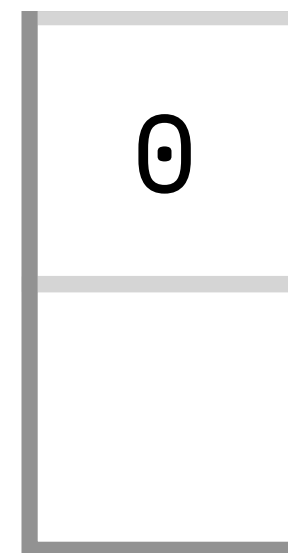


iload_1

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```

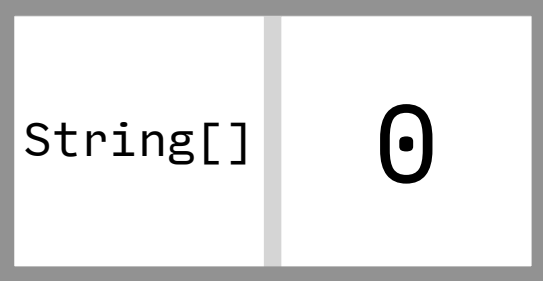


0 1
locals

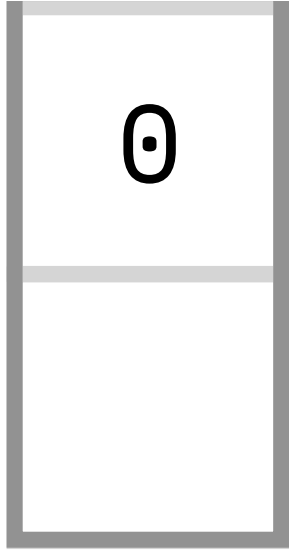


stack

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```

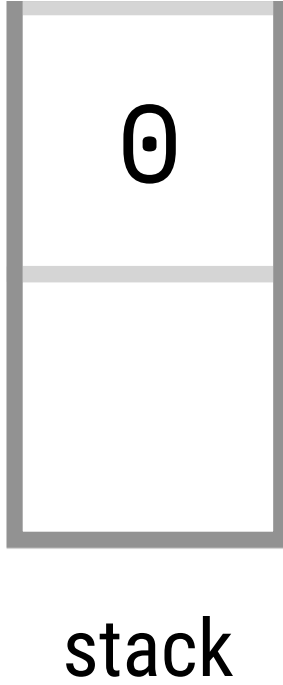
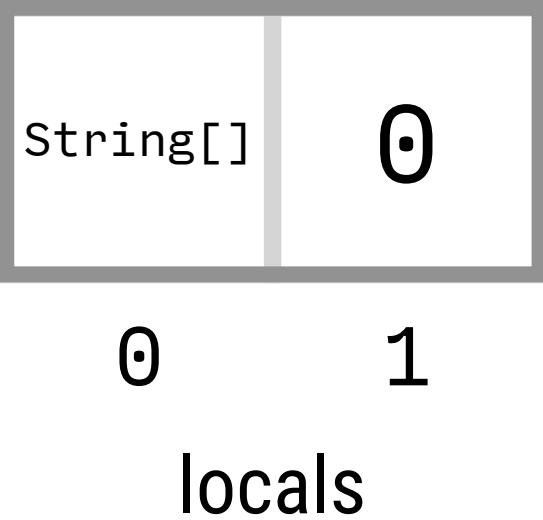


0 1
locals



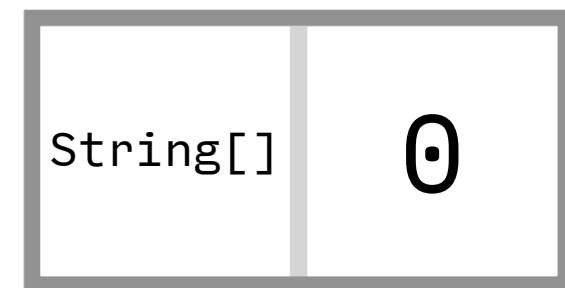
stack

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```

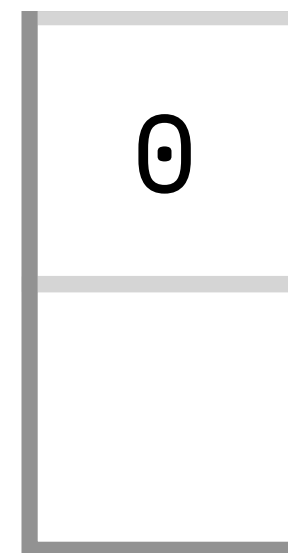


bipush 10

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush          10
  5: if_icmpge        22
  8: getstatic        #2    // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc              #3    // String Hello
 13: invokevirtual    #4    // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc              1, 1
 19: goto             2
 22: return
```



0 1
locals



stack

bipush 10

byte as int push 10

```
public static void main(java.lang.String[]);
```

```
0: iconst_0
```

```
1: istore_1
```

```
2: iload_1
```

```
3: bipush                10
```

```
5: if_icmpge            22
```

```
8: getstatic            #2
```

// Field java/lang/System.out:Ljava/io/PrintStream;

```
11: ldc                   #3
```

// String Hello

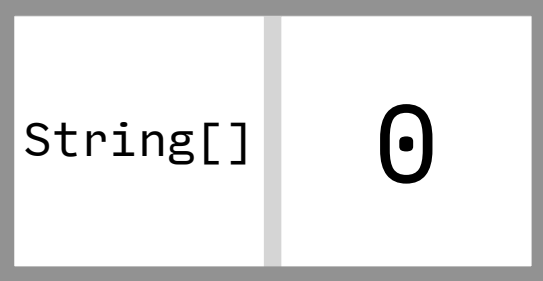
```
13: invokevirtual        #4
```

// Method java/io/PrintStream.println:(Ljava/lang/String;)V

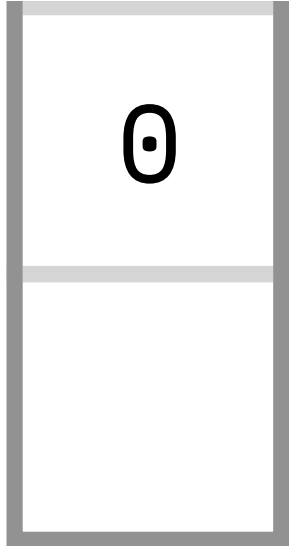
```
16: iinc                  1, 1
```

```
19: goto                  2
```

```
22: return
```



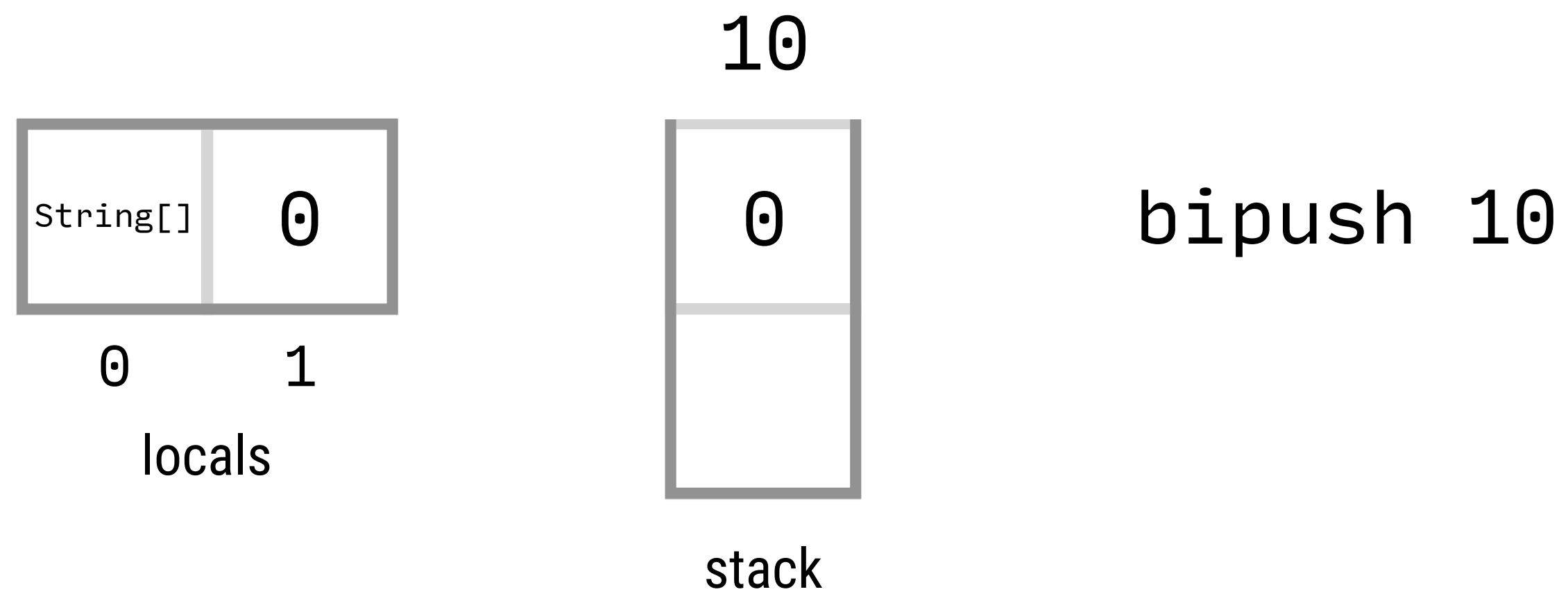
0 1
locals



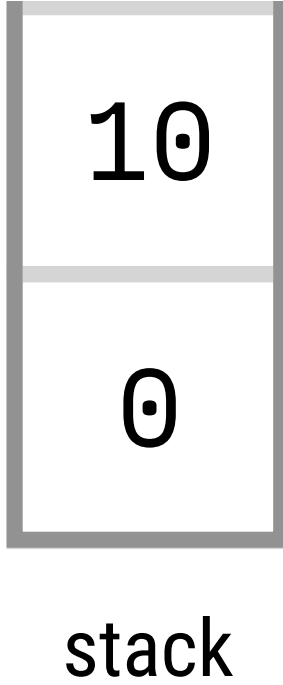
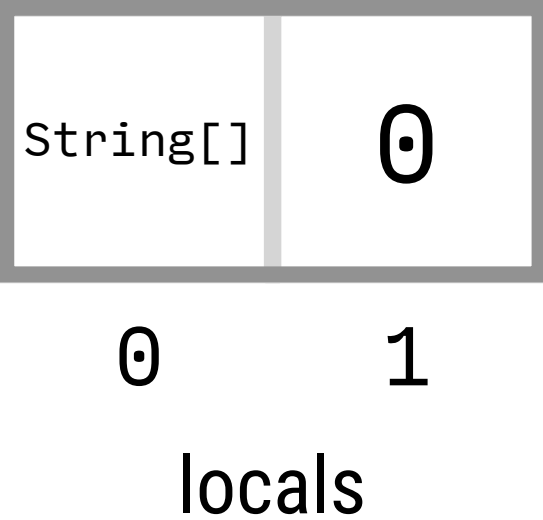
stack

bipush 10

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush          10
  5: if_icmpge        22
  8: getstatic        #2    // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc              #3    // String Hello
 13: invokevirtual    #4    // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc             1, 1
 19: goto            2
 22: return
```

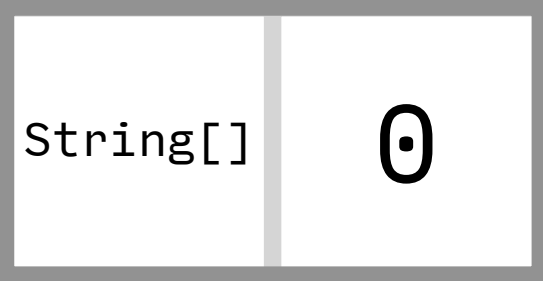


```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush          10
  5: if_icmpge        22
  8: getstatic        #2    // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc              #3    // String Hello
 13: invokevirtual    #4    // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc              1, 1
 19: goto             2
 22: return
```

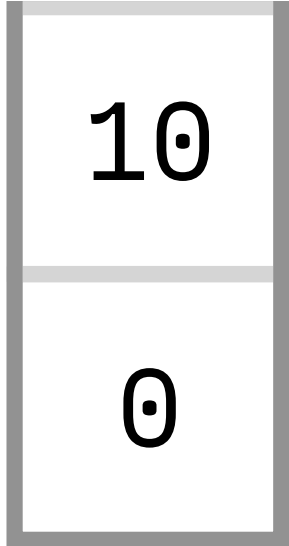



bipush 10

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush          10
  5: if_icmpge        22
  8: getstatic        #2    // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc              #3    // String Hello
 13: invokevirtual    #4    // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc             1, 1
 19: goto            2
 22: return
```

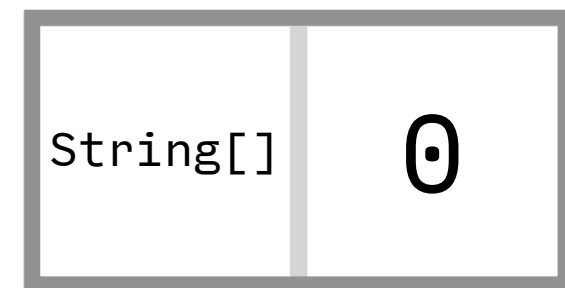


0 1
locals

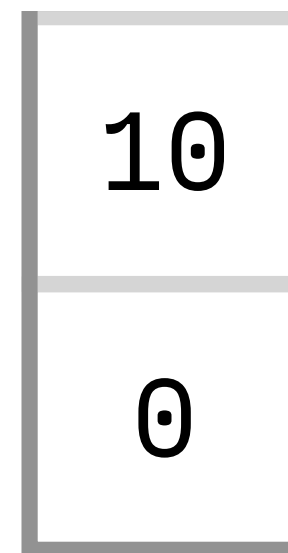


stack

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush          10
  5: if_icmpge        22
  8: getstatic        #2    // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc              #3    // String Hello
 13: invokevirtual    #4    // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc             1, 1
 19: goto             2
 22: return
```

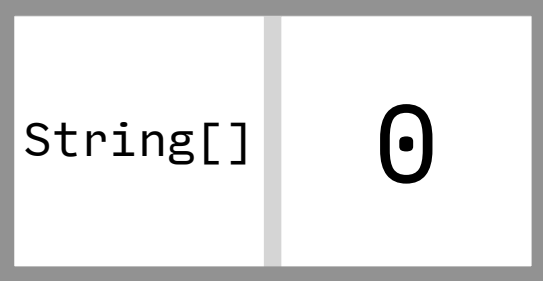


0 1
locals

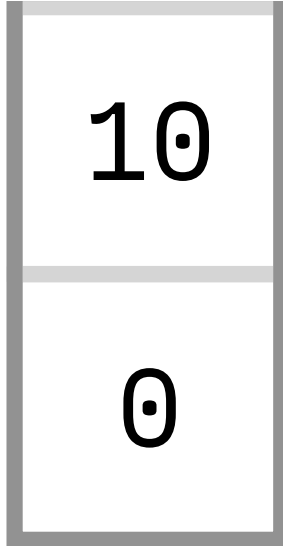


stack

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```



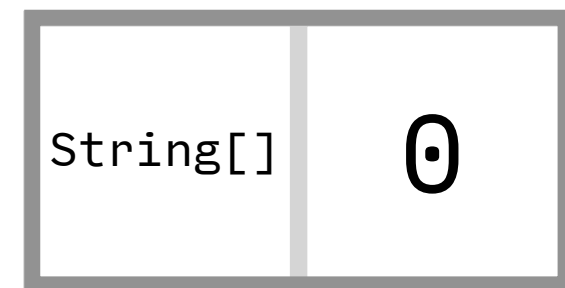
0 1
locals



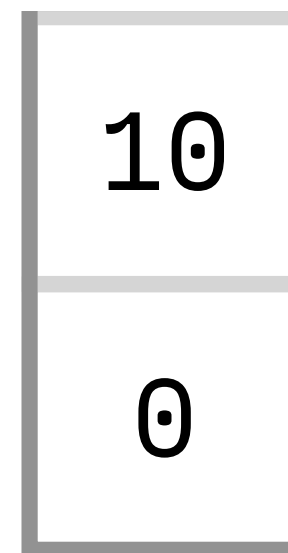
stack

if_icmpge 22

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```



0 1
locals



stack

if_icmpge 22

if int compare greater-than or equal to
then jump to bytecode 22

```
public static void main(java.lang.String[]);
```

```
0: iconst_0
```

```
1: istore_1
```

```
2: iload_1
```

```
3: bipush            10
```

```
5: if_icmpge        22
```

```
8: getstatic        #2
```

// Field java/lang/System.out:Ljava/io/PrintStream;

```
11: ldc              #3
```

// String Hello

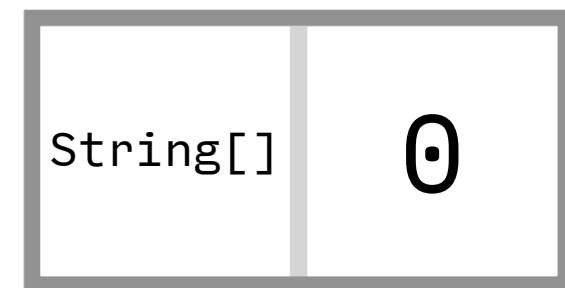
```
13: invokevirtual    #4
```

// Method java/io/PrintStream.println:(Ljava/lang/String;)V

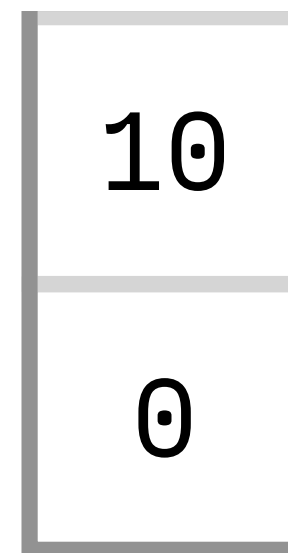
```
16: iinc             1, 1
```

```
19: goto             2
```

```
22: return
```



0 1
locals



stack

if_icmpge 22

if int compare greater-than or equal to
then jump to bytecode 22

```
public static void main(java.lang.String[]);
```

```
0: iconst_0
```

```
1: istore_1
```

```
2: iload_1
```

```
3: bipush            10
```

```
5: if_icmpge        22
```

```
8: getstatic        #2
```

// Field java/lang/System.out:Ljava/io/PrintStream;

```
11: ldc              #3
```

// String Hello

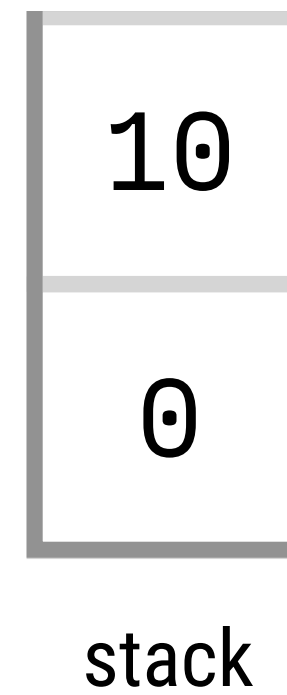
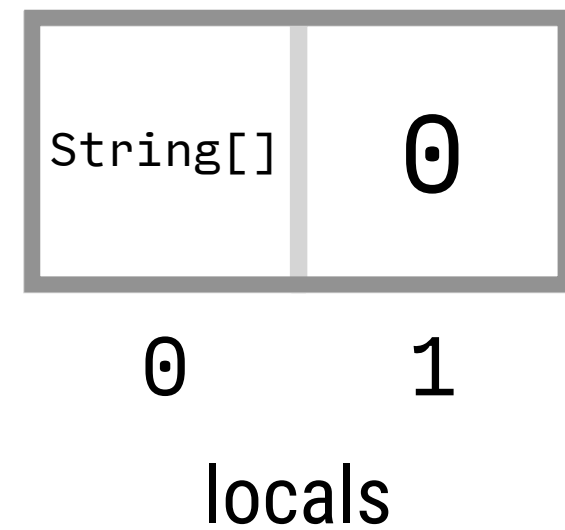
```
13: invokevirtual    #4
```

// Method java/io/PrintStream.println:(Ljava/lang/String;)V

```
16: iinc             1, 1
```

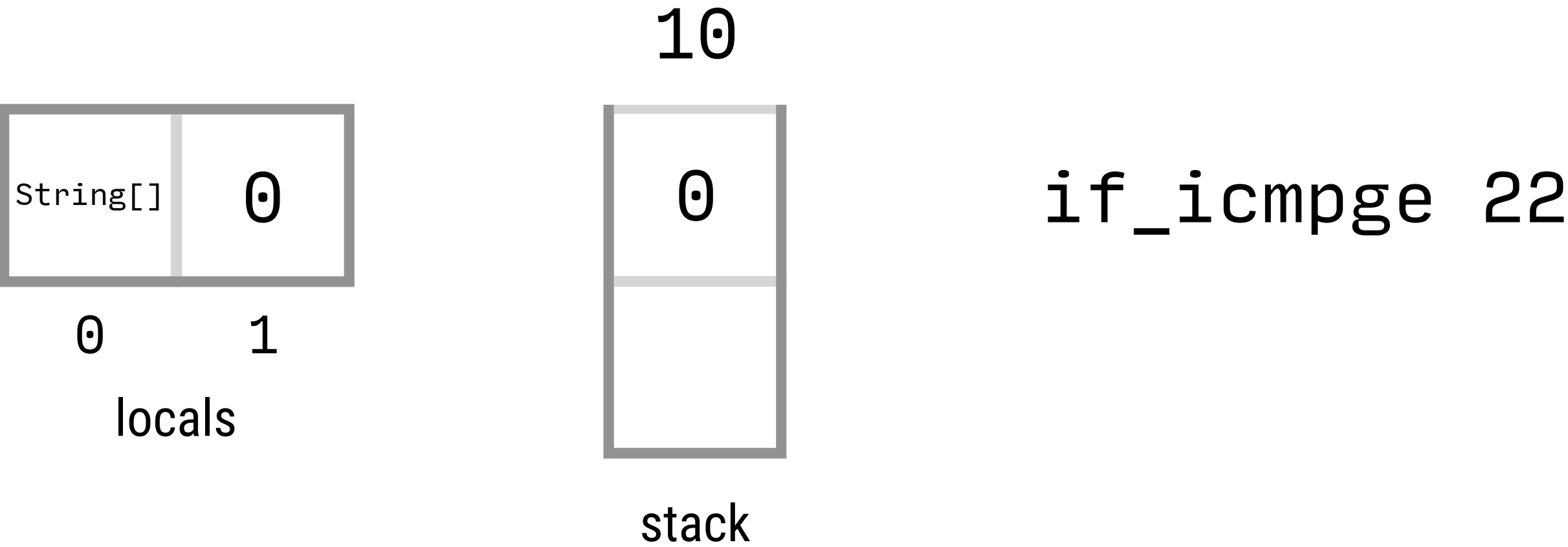
```
19: goto             2
```

```
22: return
```

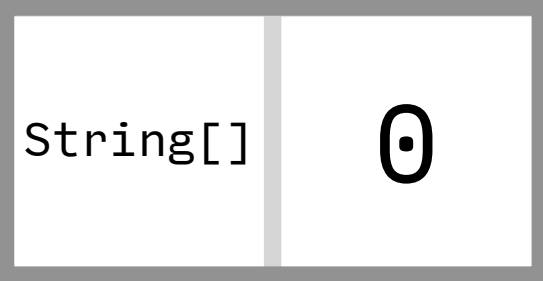


if_icmpge 22

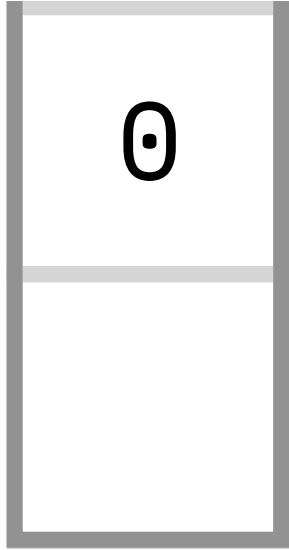
```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```



```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```

0 1
locals

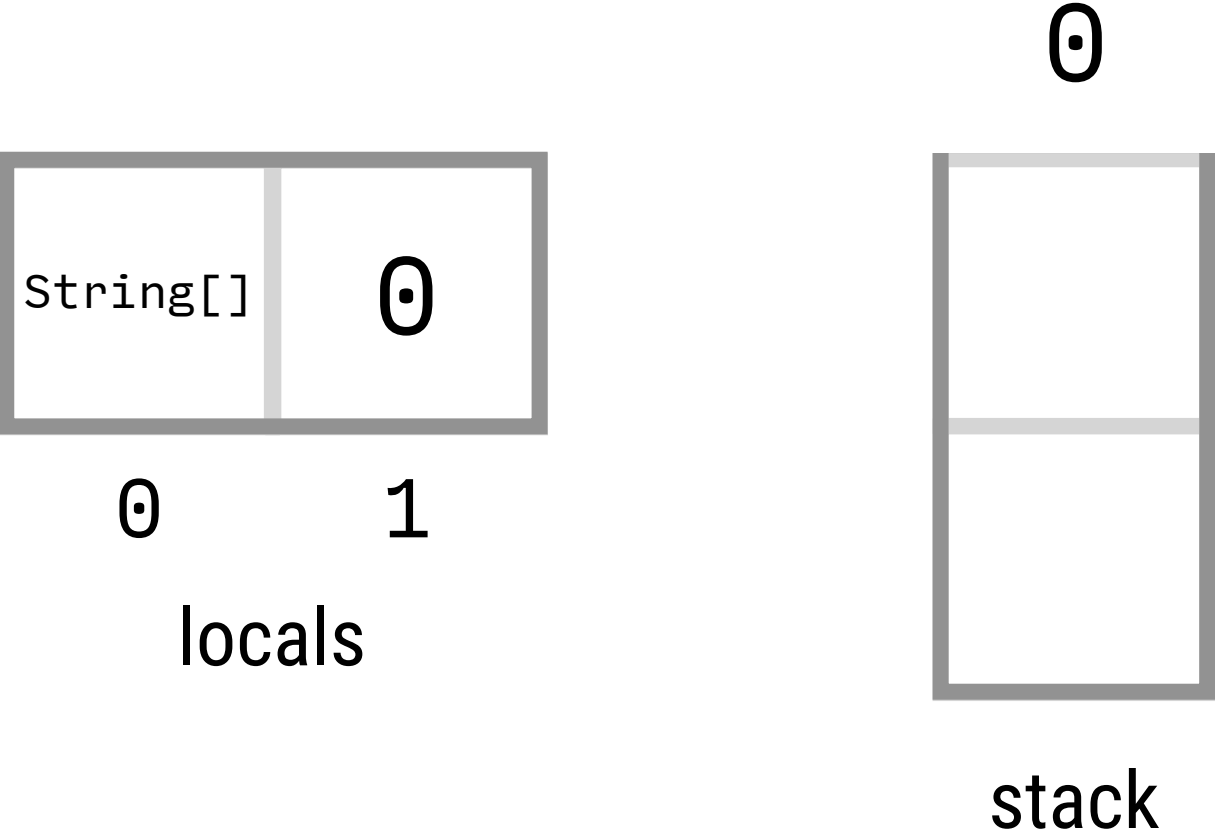


stack

if_icmpge 22

10

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```



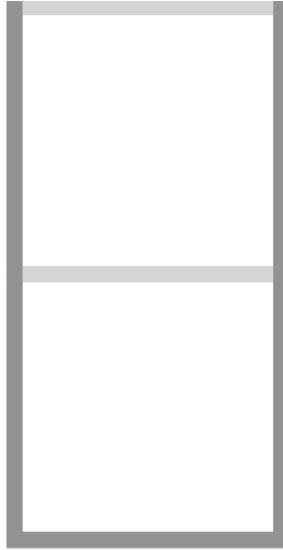
if_icmpge 22

10

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```



0 1
locals

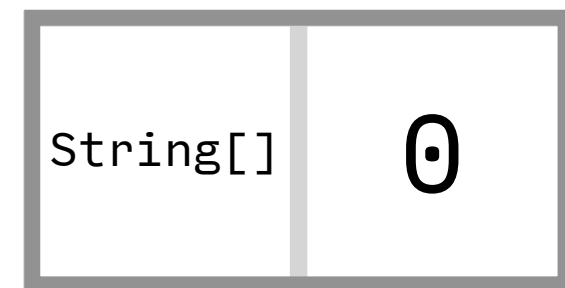


stack

if_icmpge 22

0 10

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```



0 1
locals



stack

if_icmpge 22

0 >= 10

```
public static void main(java.lang.String[]);
```

```
0: iconst_0
```

```
1: istore_1
```

```
2: iload_1
```

```
3: bipush            10
```

```
5: if_icmpge        22
```

```
8: getstatic        #2
```

// Field java/lang/System.out:Ljava/io/PrintStream;

```
11: ldc              #3
```

// String Hello

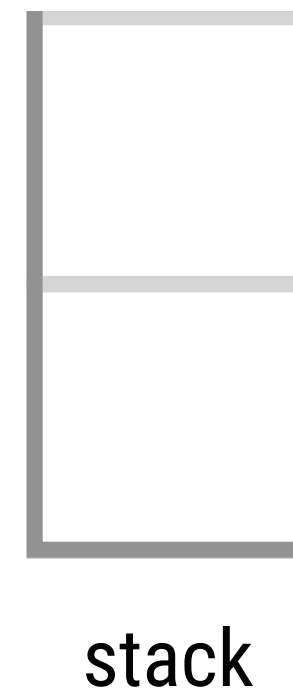
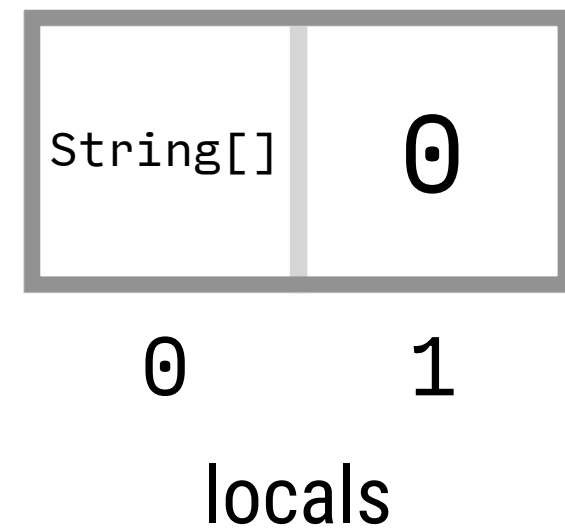
```
13: invokevirtual    #4
```

// Method java/io/PrintStream.println:(Ljava/lang/String;)V

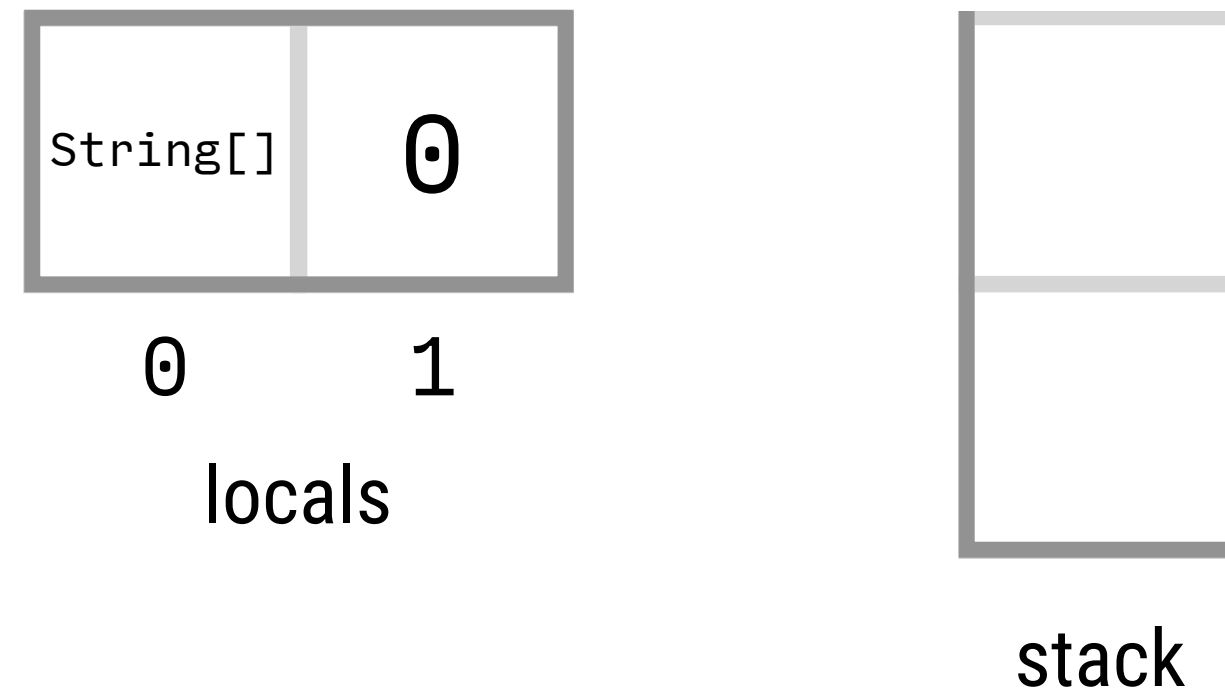
```
16: iinc             1, 1
```

```
19: goto             2
```

```
22: return
```



```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```



```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```

\$ javap -v Print

```
Classfile /Users/jw/Desktop/bytecodes/Print.class
  Last modified Oct 18, 2017; size 462 bytes
  MD5 checksum cf33844b3ed95ff736b59ba4b8417a0c
  Compiled from "Print.java"
public class Print
  minor version: 0
  major version: 52
  flags: ACC_PUBLIC, ACC_SUPER
Constant pool:
 #1 = Methodref      #6.#16    // java/lang/Object.<init>:()V
 #2 = Fieldref       #17.#18    // java/lang/System.out:Ljava/io/PrintStream;
 #3 = String         #19        // Hello
 #4 = Methodref      #20.#21    // java/io/PrintStream.println:(Ljava/lang/String;)V
 #5 = Class          #22        // Print
 #6 = Class          #23        // java/lang/Object
 #7 = Utf8           <init>
 #8 = Utf8           ()V
 #9 = Utf8           Code
#10 = Utf8           LineNumberTable
#11 = Utf8           main
#12 = Utf8           ([Ljava/lang/String;)V
#13 = Utf8           StackMapTable
#14 = Utf8           SourceFile
#15 = Utf8           Print.java
#16 = NameAndType    #7:#8      // "<init>:()V
#17 = Class          #24        // java/lang/System
#18 = NameAndType    #25:#26    // out:Ljava/io/PrintStream;
#19 = Utf8           Hello
#20 = Class          #27        // java/io/PrintStream
#21 = NameAndType    #28:#29    // println:(Ljava/lang/String;)V
#22 = Utf8           Print
#23 = Utf8           java/lang/Object
#24 = Utf8           java/lang/System
#25 = Utf8           out
#26 = Utf8           Ljava/io/PrintStream;
#27 = Utf8           java/io/PrintStream
#28 = Utf8           println
#29 = Utf8           (Ljava/lang/String;)V
{
  public Print();
    descriptor: ()V
    flags: ACC_PUBLIC
    Code:
      stack=1, locals=1, args_size=1
      0: aload_0
      1: invokespecial #1    // Method java/lang/Object.<init>:()V
      4: return
    LineNumberTable:
      line 1: 0

  public static void main(java.lang.String[]);
    descriptor: ([Ljava/lang/String;)V
    flags: ACC_PUBLIC, ACC_STATIC
    Code:
      stack=2, locals=2, args_size=1
      0: iconst_0
      1: istore_1
      2: iload_1
      3: bipush      10
      5: if_icmpge    22
      8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
     11: ldc         #3      // String Hello
     13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
     16: iinc        1, 1
     19: goto        2
     22: return
    LineNumberTable:
      line 3: 0
      line 4: 8
      line 3: 16
      line 6: 22
    StackMapTable: number_of_entries = 2
      frame_type = 252 /* append */
      offset_delta = 2
      locals = [ int ]
      frame_type = 250 /* chop */
      offset_delta = 19
}
SourceFile: "Print.java"
```

getstatic #2

Constant pool:

#1 = Methodref
#2 = Fieldref
#3 = String
#4 = Methodref
#5 = Class
#6 = Class
#7 = Utf8
#8 = Utf8
#9 = Utf8
#10 = Utf8
#11 = Utf8
#12 = Utf8
#13 = Utf8
#14 = Utf8
#15 = Utf8
#16 = NameAndType
#17 = Class
#18 = NameAndType
#19 = Utf8
#20 = Class
#21 = NameAndType
#22 = Utf8
#23 = Utf8
#24 = Utf8
#25 = Utf8
#26 = Utf8
#27 = Utf8
#28 = Utf8
#29 = Utf8

#6.#16 // java/lang/Object."<init>":()V
#17.#18 // java/lang/System.out:Ljava/io/PrintStream;
#19 // Hello
#20.#21 // java/io/PrintStream.println:(Ljava/lang/String;)V
#22 // Print
#23 // java/lang/Object
<init>
()V
Code
LineNumberTable
main
([Ljava/lang/String;)V
StackMapTable
SourceFile
Print.java
#7:#8 // "<init>":()V
#24 // java/lang/System
#25:#26 // out:Ljava/io/PrintStream;
Hello
#27 // java/io/PrintStream
#28:#29 // println:(Ljava/lang/String;)V
Print
java/lang/Object
java/lang/System
out
Ljava/io/PrintStream;
java/io/PrintStream
println
(Ljava/lang/String;)V

getstatic #2

Constant pool:

#1 = Methodref	#6.#16	// java/lang/Object."<init>":()V
#2 = Fieldref	#17.#18	// java/lang/System.out:Ljava/io/PrintStream;
#3 = String	#19	// Hello
#4 = Methodref	#20.#21	// java/io/PrintStream.println:(Ljava/lang/String;)V
#5 = Class	#22	// Print
#6 = Class	#23	// java/lang/Object
#7 = Utf8	<init>	
#8 = Utf8	()V	
#9 = Utf8	Code	
#10 = Utf8	LineNumberTable	
#11 = Utf8	main	
#12 = Utf8	([Ljava/lang/String;)V	
#13 = Utf8	StackMapTable	
#14 = Utf8	SourceFile	
#15 = Utf8	Print.java	
#16 = NameAndType	#7:#8	// "<init>":()V
#17 = Class	#24	// java/lang/System
#18 = NameAndType	#25:#26	// out:Ljava/io/PrintStream;
#19 = Utf8	Hello	
#20 = Class	#27	// java/io/PrintStream
#21 = NameAndType	#28:#29	// println:(Ljava/lang/String;)V
#22 = Utf8	Print	
#23 = Utf8	java/lang/Object	
#24 = Utf8	java/lang/System	
#25 = Utf8	out	
#26 = Utf8	Ljava/io/PrintStream;	
#27 = Utf8	java/io/PrintStream	
#28 = Utf8	println	
#29 = Utf8	(Ljava/lang/String;)V	

getstatic #2

Constant pool:

#1 = Methodref
#2 = Fieldref
#3 = String
#4 = Methodref
#5 = Class
#6 = Class
#7 = Utf8
#8 = Utf8
#9 = Utf8
#10 = Utf8
#11 = Utf8
#12 = Utf8
#13 = Utf8
#14 = Utf8
#15 = Utf8
#16 = NameAndType
#17 = Class
#18 = NameAndType
#19 = Utf8
#20 = Class
#21 = NameAndType
#22 = Utf8
#23 = Utf8
#24 = Utf8
#25 = Utf8
#26 = Utf8
#27 = Utf8
#28 = Utf8
#29 = Utf8

#6.#16 // java/lang/Object."<init>":()V
#17.#18 // java/lang/System.out:Ljava/io/PrintStream;
#19 // Hello
#20.#21 // java/io/PrintStream.println:(Ljava/lang/String;)V
#22 // Print
#23 // java/lang/Object
<init>
()V
Code
LineNumberTable
main
([Ljava/lang/String;)V
StackMapTable
SourceFile
Print.java
#7:#8 // "<init>":()V
#24 // java/lang/System
#25:#26 // out:Ljava/io/PrintStream;
Hello
#27 // java/io/PrintStream
#28:#29 // println:(Ljava/lang/String;)V
Print
java/lang/Object
java/lang/System
out
Ljava/io/PrintStream;
java/io/PrintStream
println
(Ljava/lang/String;)V

getstatic #2

Constant pool:

#1 = Methodref
#2 = **Fieldref**
#3 = String
#4 = Methodref
#5 = Class
#6 = Class
#7 = Utf8
#8 = Utf8
#9 = Utf8
#10 = Utf8
#11 = Utf8
#12 = Utf8
#13 = Utf8
#14 = Utf8
#15 = Utf8
#16 = NameAndType
#17 = **Class**
#18 = NameAndType
#19 = Utf8
#20 = Class
#21 = NameAndType
#22 = Utf8
#23 = Utf8
#24 = Utf8
#25 = Utf8
#26 = Utf8
#27 = Utf8
#28 = Utf8
#29 = Utf8

#6.#16 // java/lang/Object."<init>":()V
#17.#18 // java/lang/System.out:Ljava/io/PrintStream;
#19 // Hello
#20.#21 // java/io/PrintStream.println:(Ljava/lang/String;)V
#22 // Print
#23 // java/lang/Object
<init>
()V
Code
LineNumberTable
main
([Ljava/lang/String;)V
StackMapTable
SourceFile
Print.java
#7:#8 // "<init>":()V
#24 // java/lang/System
#25:#26 // out:Ljava/io/PrintStream;
Hello
#27 // java/io/PrintStream
#28:#29 // println:(Ljava/lang/String;)V
Print
java/lang/Object
java/lang/System
out
Ljava/io/PrintStream;
java/io/PrintStream
println
(Ljava/lang/String;)V

getstatic #2

Constant pool:

#1 = Methodref
#2 = **Fieldref**
#3 = String
#4 = Methodref
#5 = Class
#6 = Class
#7 = Utf8
#8 = Utf8
#9 = Utf8
#10 = Utf8
#11 = Utf8
#12 = Utf8
#13 = Utf8
#14 = Utf8
#15 = Utf8
#16 = NameAndType
#17 = **Class**
#18 = NameAndType
#19 = Utf8
#20 = Class
#21 = NameAndType
#22 = Utf8
#23 = Utf8
#24 = **Utf8**
#25 = Utf8
#26 = Utf8
#27 = Utf8
#28 = Utf8
#29 = Utf8

#6.#16 // java/lang/Object."<init>":()V
#17.#18 // java/lang/System.out:Ljava/io/PrintStream;
#19 // Hello
#20.#21 // java/io/PrintStream.println:(Ljava/lang/String;)V
#22 // Print
#23 // java/lang/Object
<init>
()V
Code
LineNumberTable
main
([Ljava/lang/String;)V
StackMapTable
SourceFile
Print.java
#7:#8 // "<init>":()V
#24 // java/lang/System
#25:#26 // out:Ljava/io/PrintStream;
Hello
#27 // java/io/PrintStream
#28:#29 // println:(Ljava/lang/String;)V
Print
java/lang/Object
java/lang/System
out
Ljava/io/PrintStream;
java/io/PrintStream
println
(Ljava/lang/String;)V

getstatic #2

Constant pool:

#1 = Methodref
#2 = Fieldref
#3 = String
#4 = Methodref
#5 = Class
#6 = Class
#7 = Utf8
#8 = Utf8
#9 = Utf8
#10 = Utf8
#11 = Utf8
#12 = Utf8
#13 = Utf8
#14 = Utf8
#15 = Utf8
#16 = NameAndType
#17 = Class
#18 = NameAndType
#19 = Utf8
#20 = Class
#21 = NameAndType
#22 = Utf8
#23 = Utf8
#24 = Utf8
#25 = Utf8
#26 = Utf8
#27 = Utf8
#28 = Utf8
#29 = Utf8

#6.#16 // java/lang/Object."<init>":()V
#17.#18 // java/lang/System.out:Ljava/io/PrintStream;
#19 // Hello
#20.#21 // java/io/PrintStream.println:(Ljava/lang/String;)V
#22 // Print
#23 // java/lang/Object
<init>
()V
Code
LineNumberTable
main
([Ljava/lang/String;)V
StackMapTable
SourceFile
Print.java
#7:#8 // "<init>":()V
#24 // java/lang/System
#25:#26 // out:Ljava/io/PrintStream;
Hello
#27 // java/io/PrintStream
#28:#29 // println:(Ljava/lang/String;)V
Print
java/lang/Object
java/lang/System
out
Ljava/io/PrintStream;
java/io/PrintStream
println
(Ljava/lang/String;)V

getstatic #2

Constant pool:

#1 = Methodref
#2 = Fieldref
#3 = String
#4 = Methodref
#5 = Class
#6 = Class
#7 = Utf8
#8 = Utf8
#9 = Utf8
#10 = Utf8
#11 = Utf8
#12 = Utf8
#13 = Utf8
#14 = Utf8
#15 = Utf8
#16 = NameAndType
#17 = Class
#18 = NameAndType
#19 = Utf8
#20 = Class
#21 = NameAndType
#22 = Utf8
#23 = Utf8
#24 = Utf8
#25 = Utf8
#26 = Utf8
#27 = Utf8
#28 = Utf8
#29 = Utf8

#6.#16 // java/lang/Object."<init>":()V
#17.#18 // java/lang/System.out:Ljava/io/PrintStream;
#19 // Hello
#20.#21 // java/io/PrintStream.println:(Ljava/lang/String;)V
#22 // Print
#23 // java/lang/Object
<init>
()V
Code
LineNumberTable
main
([Ljava/lang/String;)V
StackMapTable
SourceFile
Print.java
#7:#8 // "<init>":()V
#24 // java/lang/System
#25:#26 // out:Ljava/io/PrintStream;
Hello
#27 // java/io/PrintStream
#28:#29 // println:(Ljava/lang/String;)V
Print
java/lang/Object
java/lang/System
out
Ljava/io/PrintStream;
java/io/PrintStream
println
(Ljava/lang/String;)V

getstatic #2

Constant pool:

#1 = Methodref
#2 = Fieldref
#3 = String
#4 = Methodref
#5 = Class
#6 = Class
#7 = Utf8
#8 = Utf8
#9 = Utf8
#10 = Utf8
#11 = Utf8
#12 = Utf8
#13 = Utf8
#14 = Utf8
#15 = Utf8
#16 = NameAndType
#17 = Class
#18 = NameAndType
#19 = Utf8
#20 = Class
#21 = NameAndType
#22 = Utf8
#23 = Utf8
#24 = Utf8
#25 = Utf8
#26 = Utf8
#27 = Utf8
#28 = Utf8
#29 = Utf8

#6.#16 // java/lang/Object."<init>":()V
#17.#18 // java/lang/System.out:Ljava/io/PrintStream;
#19 // Hello
#20.#21 // java/io/PrintStream.println:(Ljava/lang/String;)V
#22 // Print
#23 // java/lang/Object
<init>
()V
Code
LineNumberTable
main
([Ljava/lang/String;)V
StackMapTable
SourceFile
Print.java
#7:#8 // "<init>":()V
#24 // java/lang/System
#25:#26 // out:Ljava/io/PrintStream;
Hello
#27 // java/io/PrintStream
#28:#29 // println:(Ljava/lang/String;)V
Print
java/lang/Object
java/lang/System
out
Ljava/io/PrintStream;
java/io/PrintStream
println
(Ljava/lang/String;)V

getstatic #2

Constant pool:

#1 = Methodref
#2 = Fieldref
#3 = String
#4 = Methodref
#5 = Class
#6 = Class
#7 = Utf8
#8 = Utf8
#9 = Utf8
#10 = Utf8
#11 = Utf8
#12 = Utf8
#13 = Utf8
#14 = Utf8
#15 = Utf8
#16 = NameAndType
#17 = Class
#18 = NameAndType
#19 = Utf8
#20 = Class
#21 = NameAndType
#22 = Utf8
#23 = Utf8
#24 = Utf8
#25 = Utf8
#26 = Utf8
#27 = Utf8
#28 = Utf8
#29 = Utf8

#6.#16 // java/lang/Object."<init>":()V
#17.#18 // java/lang/System.out:Ljava/io/PrintStream;
#19 // Hello
#20.#21 // java/io/PrintStream.println:(Ljava/lang/String;)V
#22 // Print
#23 // java/lang/Object
<init>
()V
Code
LineNumberTable
main
([Ljava/lang/String;)V
StackMapTable
SourceFile
Print.java
#7:#8 // "<init>":()V
#24 // java/lang/System
#25:#26 // out:Ljava/io/PrintStream;
Hello
#27 // java/io/PrintStream
#28:#29 // println:(Ljava/lang/String;)V
Print
java/lang/Object
java/lang/System
out
Ljava/io/PrintStream;
java/io/PrintStream
println
(Ljava/lang/String;)V

getstatic #2

Constant pool:

#1 = Methodref
#2 = Fieldref
#3 = String
#4 = Methodref
#5 = Class
#6 = Class
#7 = Utf8
#8 = Utf8
#9 = Utf8
#10 = Utf8
#11 = Utf8
#12 = Utf8
#13 = Utf8
#14 = Utf8
#15 = Utf8
#16 = NameAndType
#17 = Class
#18 = NameAndType
#19 = Utf8
#20 = Class
#21 = NameAndType
#22 = Utf8
#23 = Utf8
#24 = Utf8
#25 = Utf8
#26 = Utf8
#27 = Utf8
#28 = Utf8
#29 = Utf8

#6.#16 // java/lang/Object."<init>":()V
#17.#18 // java/lang/System.out:Ljava/io/PrintStream;
#19 // Hello
#20.#21 // java/io/PrintStream.println:(Ljava/lang/String;)V
#22 // Print
#23 // java/lang/Object
<init>
()V
Code
LineNumberTable
main
([Ljava/lang/String;)V
StackMapTable
SourceFile
Print.java
#7:#8 // "<init>":()V
#24 // java/lang/System
#25:#26 // out:Ljava/io/PrintStream;
Hello
#27 // java/io/PrintStream
#28:#29 // println:(Ljava/lang/String;)V
Print
java/lang/Object
java/lang/System
out
Ljava/io/PrintStream;
java/io/PrintStream
println
(Ljava/lang/String;)V

getstatic #2

Constant pool:

#1 = Methodref
#2 = Fieldref
#3 = String
#4 = Methodref
#5 = Class
#6 = Class
#7 = Utf8
#8 = Utf8
#9 = Utf8
#10 = Utf8
#11 = Utf8
#12 = Utf8
#13 = Utf8
#14 = Utf8
#15 = Utf8
#16 = NameAndType
#17 = Class
#18 = NameAndType
#19 = Utf8
#20 = Class
#21 = NameAndType
#22 = Utf8
#23 = Utf8
#24 = Utf8
#25 = Utf8
#26 = Utf8
#27 = Utf8
#28 = Utf8
#29 = Utf8

#6.#16 // java/lang/Object."<init>":()V
#17.#18 // java/lang/System.out:Ljava/io/PrintStream;
#19 // Hello
#20.#21 // java/io/PrintStream.println:(Ljava/lang/String;)V
#22 // Print
#23 // java/lang/Object
<init>
()V
Code
LineNumberTable
main
([Ljava/lang/String;)V
StackMapTable
SourceFile
Print.java
#7:#8 // "<init>":()V
#24 // java/lang/System
#25:#26 // out:Ljava/io/PrintStream;
Hello
#27 // java/io/PrintStream
#28:#29 // println:(Ljava/lang/String;)V
Print
java/lang/Object
java/lang/System
out
Ljava/io/PrintStream;
java/io/PrintStream
println
(Ljava/lang/String;)V

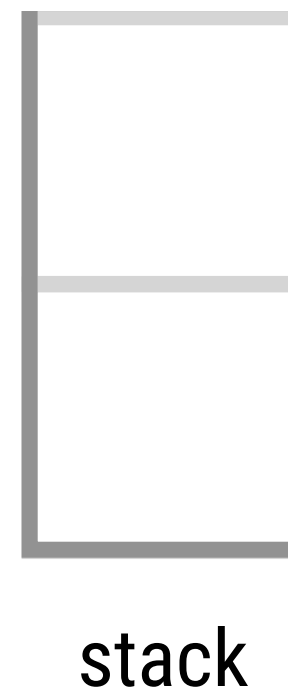
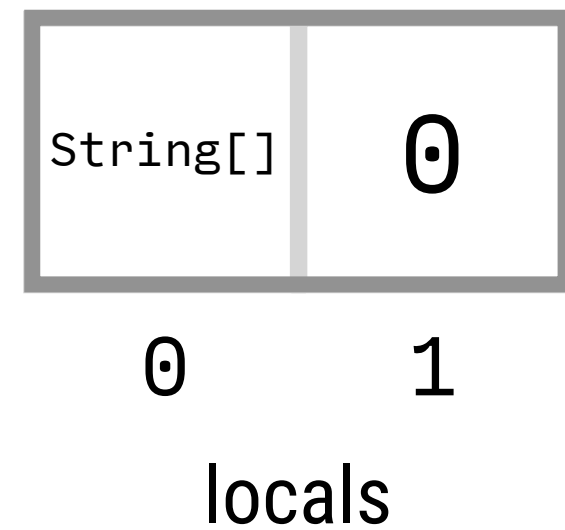
getstatic #2

Constant pool:

#1 = Methodref
#2 = Fieldref
#3 = String
#4 = Methodref
#5 = Class
#6 = Class
#7 = Utf8
#8 = Utf8
#9 = Utf8
#10 = Utf8
#11 = Utf8
#12 = Utf8
#13 = Utf8
#14 = Utf8
#15 = Utf8
#16 = NameAndType
#17 = Class
#18 = NameAndType
#19 = Utf8
#20 = Class
#21 = NameAndType
#22 = Utf8
#23 = Utf8
#24 = Utf8
#25 = Utf8
#26 = Utf8
#27 = Utf8
#28 = Utf8
#29 = Utf8

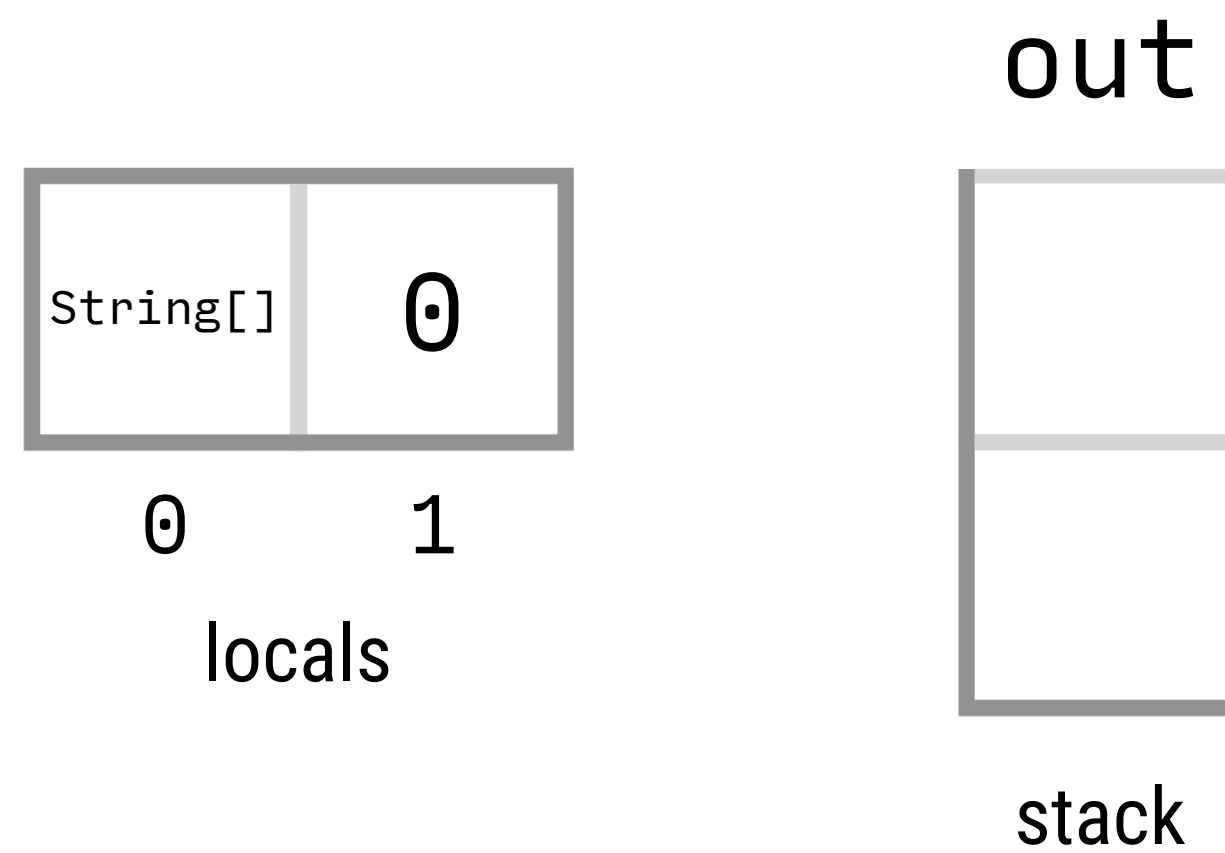
#6.#16 // java/lang/Object."<init>":()V
#17.#18 // java/lang/System.out:Ljava/io/PrintStream;
#19 // Hello
#20.#21 // java/io/PrintStream.println:(Ljava/lang/String;)V
#22 // Print
#23 // java/lang/Object
<init>
()V
Code
LineNumberTable
main
([Ljava/lang/String;)V
StackMapTable
SourceFile
Print.java
#7:#8 // "<init>":()V
#24 // java/lang/System
#25:#26 // out:Ljava/io/PrintStream;
Hello
#27 // java/io/PrintStream
#28:#29 // println:(Ljava/lang/String;)V
Print
java/lang/Object
java/lang/System
out
Ljava/io/PrintStream;
java/io/PrintStream
println
(Ljava/lang/String;)V

getstatic #2



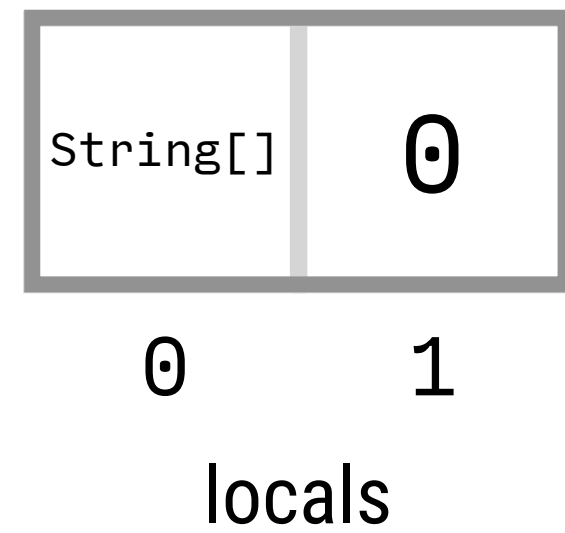
getstatic #2 (out)

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```



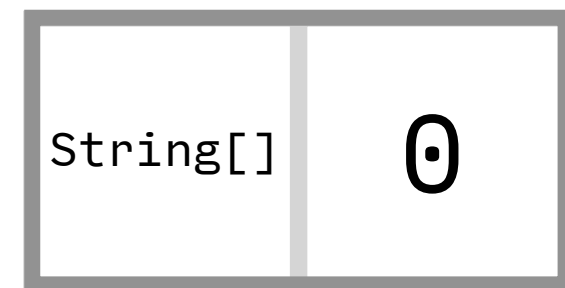
`getstatic #2`

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```



getstatic #2

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```

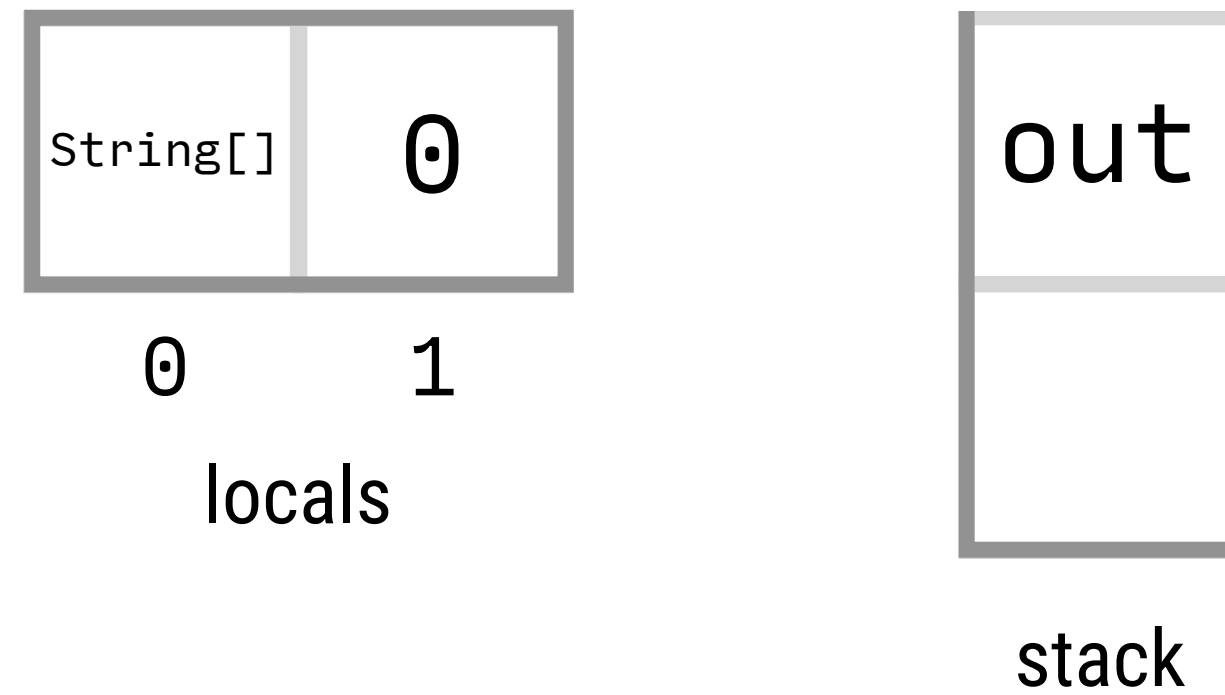


0 1
locals

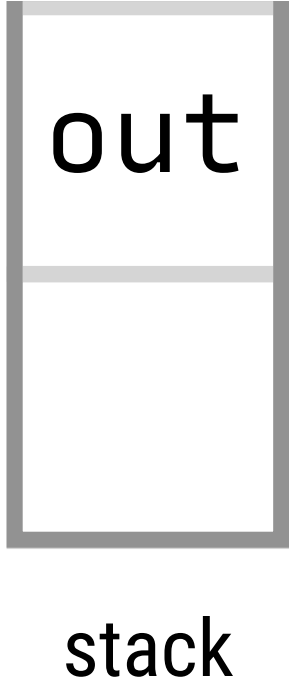
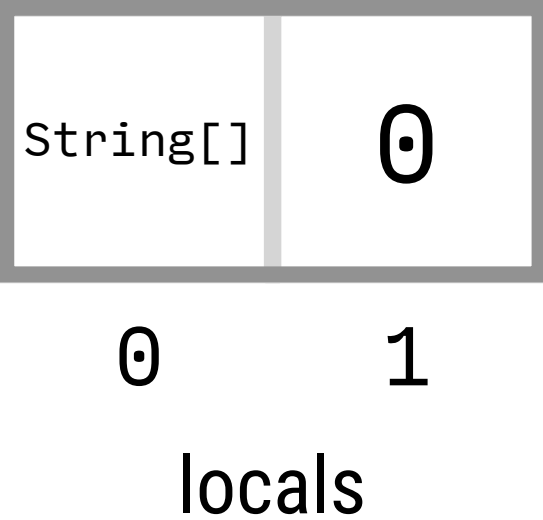


stack

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```

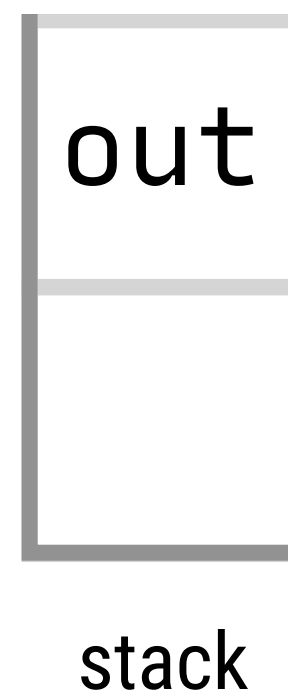
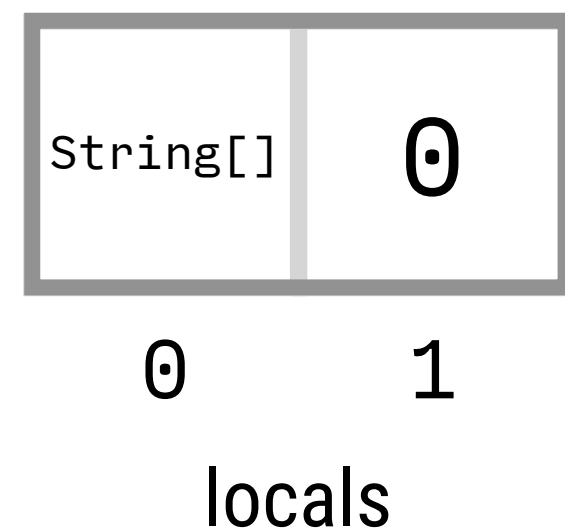


```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
11: ldc          #3      // String Hello
13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
16: iinc         1, 1
19: goto         2
22: return
```

ldc #3 (Hello)

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
11: ldc         #3      // String Hello
13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
16: iinc         1, 1
19: goto         2
22: return
```



ldc #3 (Hello)

load constant #3

```
public static void main(java.lang.String[]);
```

```
0: iconst_0
```

```
1: istore_1
```

```
2: iload_1
```

```
3: bipush      10
```

```
5: if_icmpge   22
```

```
8: getstatic   #2
```

```
11: ldc        #3
```

```
13: invokevirtual #4
```

```
16: iinc        1, 1
```

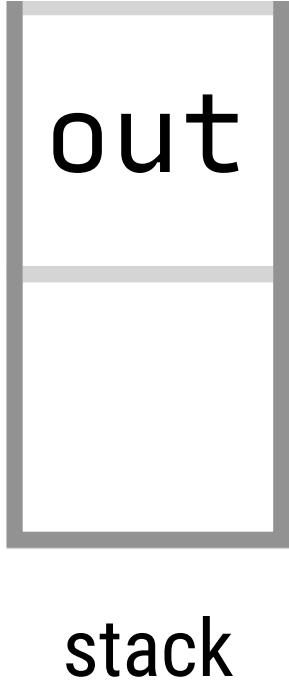
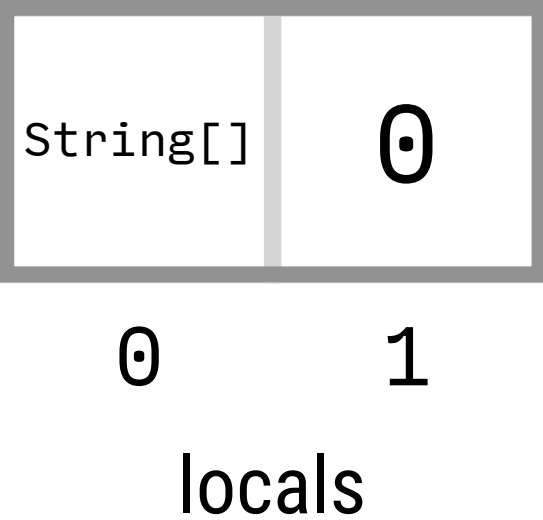
```
19: goto        2
```

```
22: return
```

```
// Field java/lang/System.out:Ljava/io/PrintStream;
```

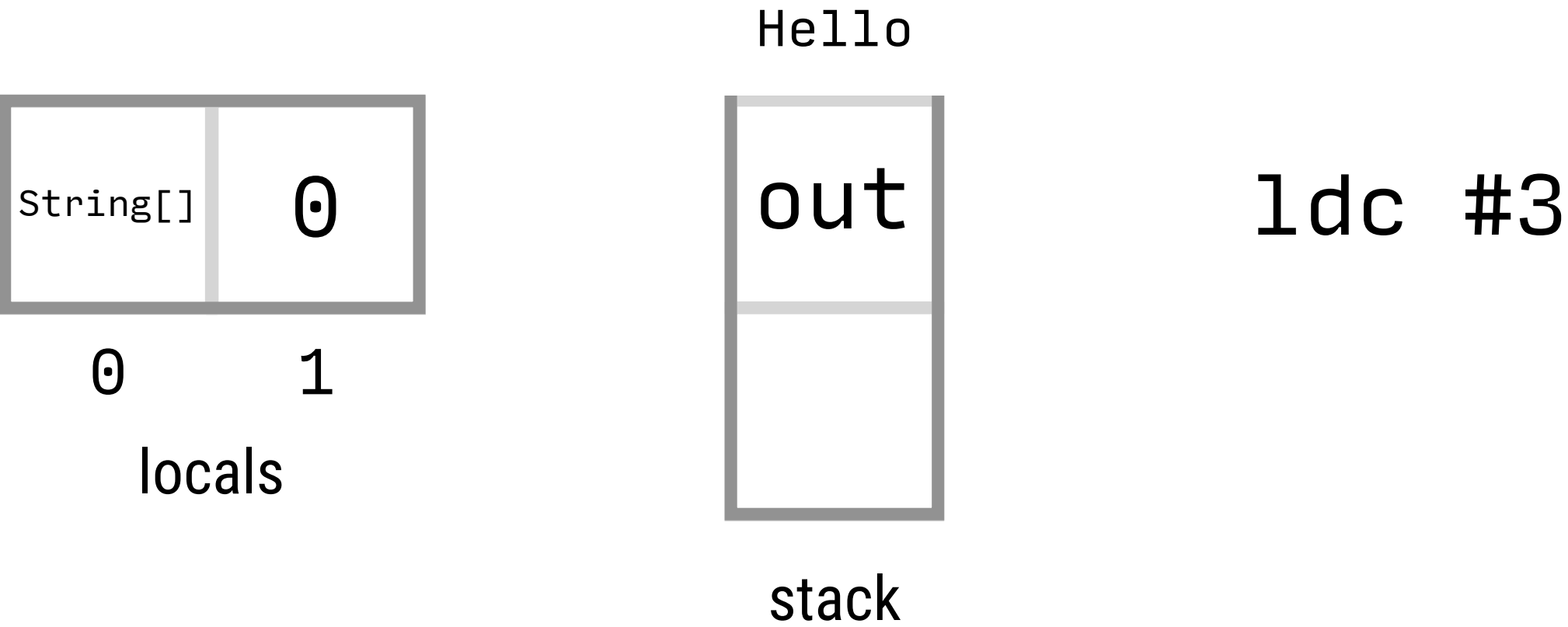
```
// String Hello
```

```
// Method java/io/PrintStream.println:(Ljava/lang/String;)V
```

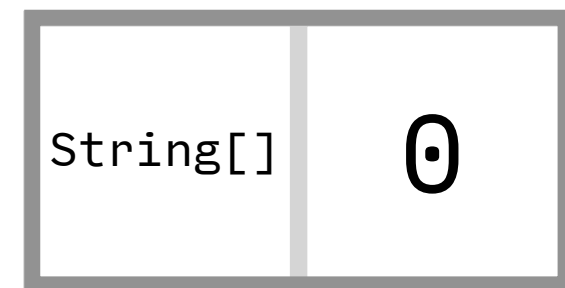


ldc #3 (Hello)

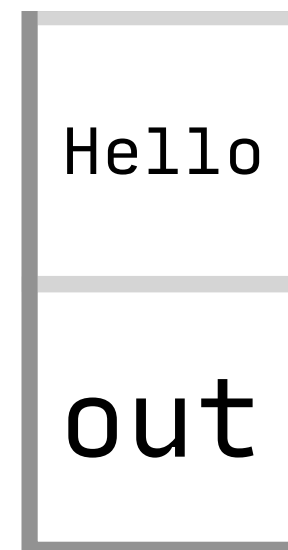
```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
11: ldc         #3      // String Hello
13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
16: iinc         1, 1
19: goto         2
22: return
```



```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
11: ldc         #3      // String Hello
13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
16: iinc         1, 1
19: goto         2
22: return
```



0 1
locals



stack

ldc #3

```
public static void main(java.lang.String[]);
```

```
0: iconst_0
```

```
1: istore_1
```

```
2: iload_1
```

```
3: bipush            10
```

```
5: if_icmpge        22
```

```
8: getstatic        #2
```

```
11: ldc              #3
```

```
13: invokevirtual    #4
```

```
16: iinc             1, 1
```

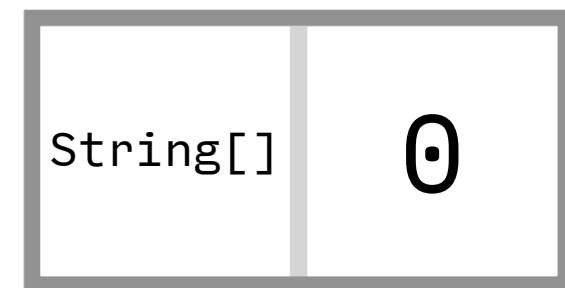
```
19: goto             2
```

```
22: return
```

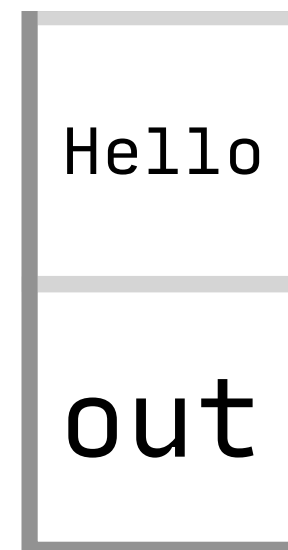
```
// Field java/lang/System.out:Ljava/io/PrintStream;
```

```
// String Hello
```

```
// Method java/io/PrintStream.println:(Ljava/lang/String;)V
```

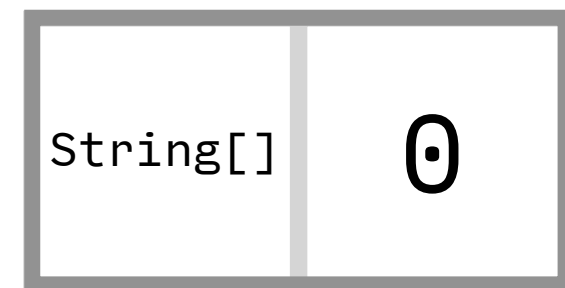


0 1
locals

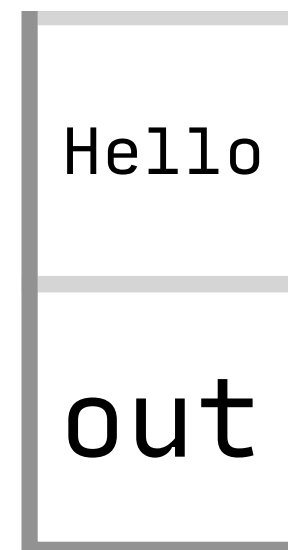


stack

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```

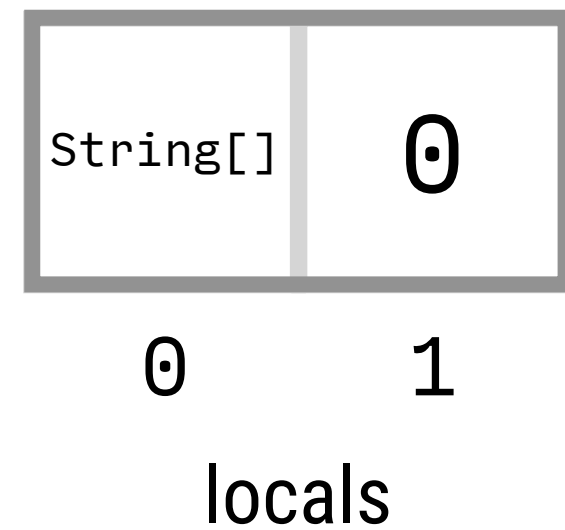


0 1
locals



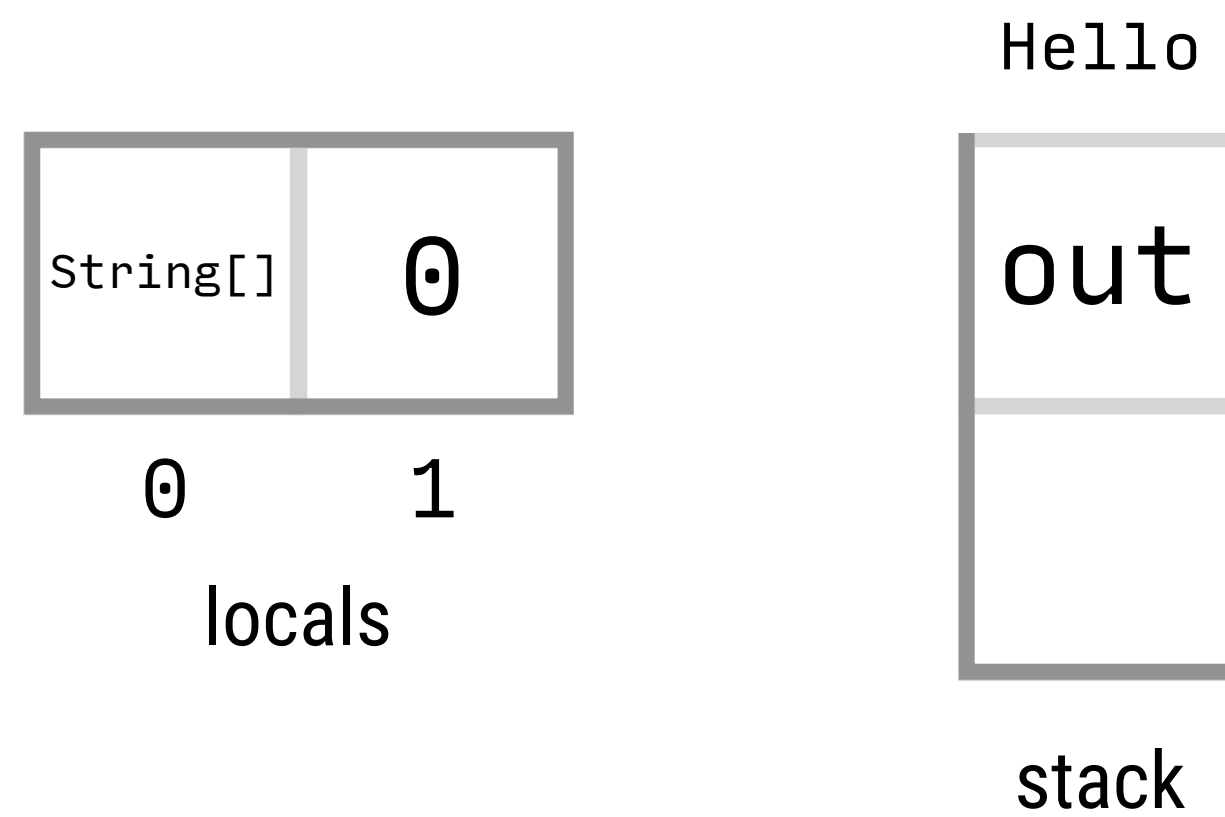
stack

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```



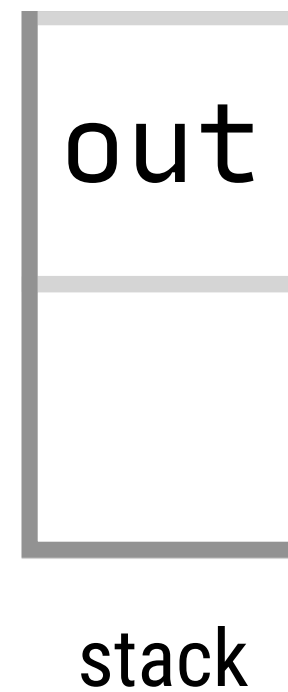
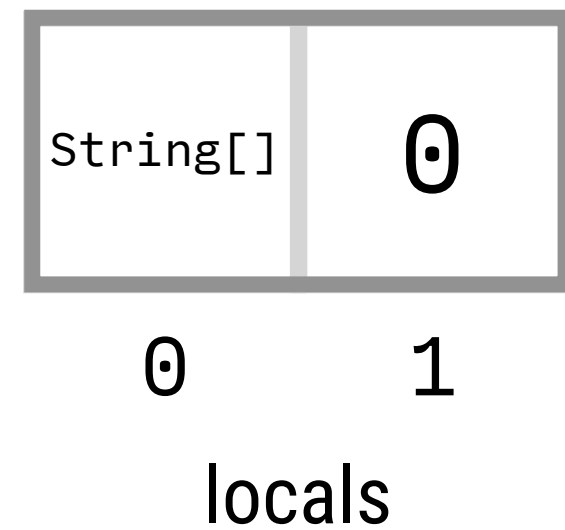
invokevirtual #4 (PrintStream.println)

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```

`invokevirtual #4 (PrintStream.println)`

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```



invokevirtual #4 (PrintStream.println)

Hello

```
public static void main(java.lang.String[]);
```

```
  0: iconst_0
```

```
  1: istore_1
```

```
  2: iload_1
```

```
  3: bipush      10
```

```
  5: if_icmpge    22
```

```
  8: getstatic    #2
```

// Field java/lang/System.out:Ljava/io/PrintStream;

```
 11: ldc          #3
```

// String Hello

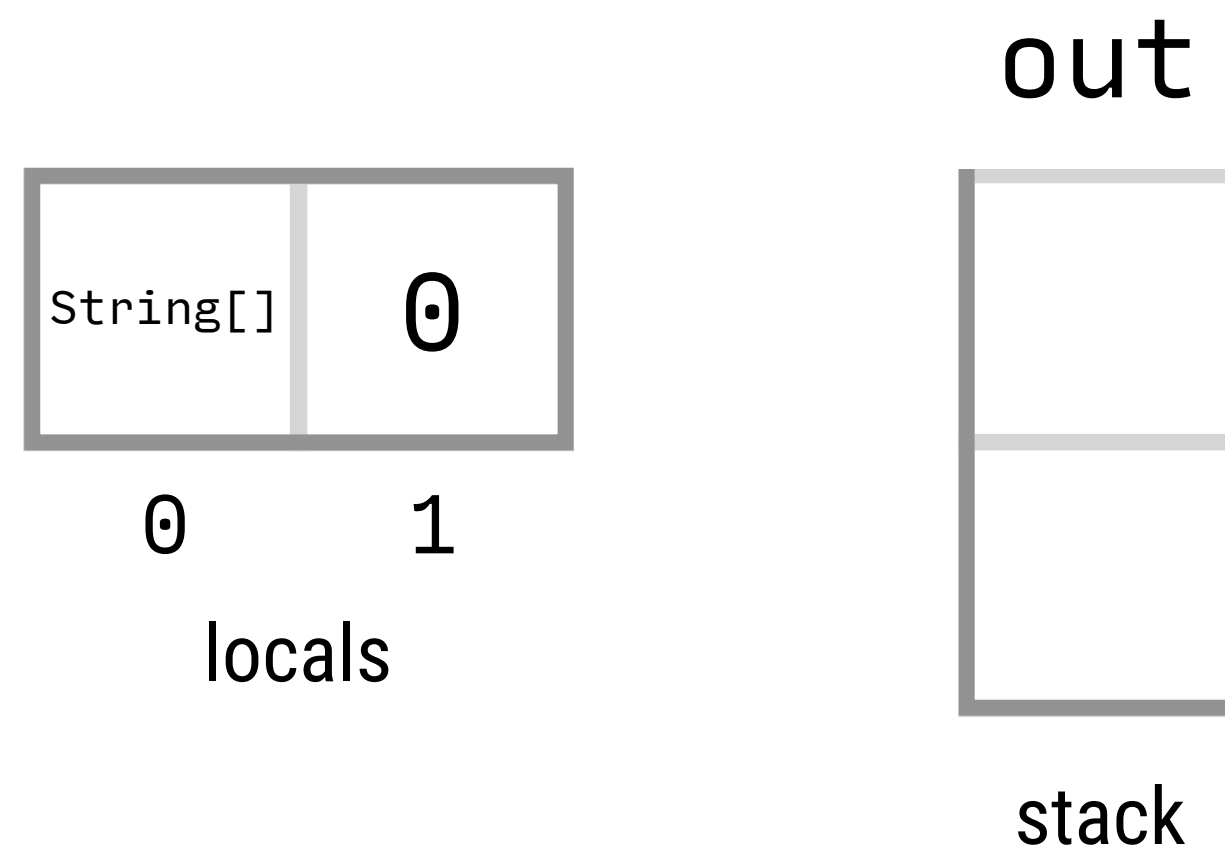
```
 13: invokevirtual #4
```

// Method java/io/PrintStream.println:(Ljava/lang/String;)V

```
 16: iinc          1, 1
```

```
 19: goto          2
```

```
 22: return
```



`invokevirtual #4 (PrintStream.println)`

Hello

```
public static void main(java.lang.String[]);
```

```
  0: iconst_0
```

```
  1: istore_1
```

```
  2: iload_1
```

```
  3: bipush      10
```

```
  5: if_icmpge    22
```

```
  8: getstatic    #2
```

// Field java/lang/System.out:Ljava/io/PrintStream;

```
 11: ldc          #3
```

// String Hello

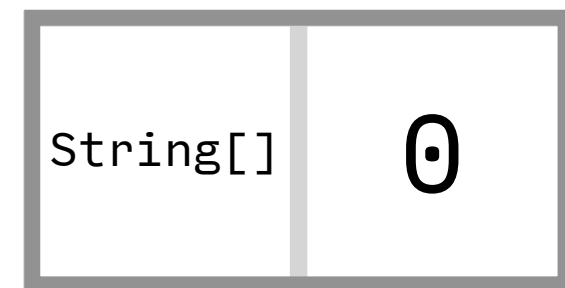
```
 13: invokevirtual #4
```

// Method java/io/PrintStream.println:(Ljava/lang/String;)V

```
 16: iinc         1, 1
```

```
 19: goto         2
```

```
 22: return
```



0 1
locals



stack

invokevirtual #4 (PrintStream.println)

out Hello

```
public static void main(java.lang.String[]);
```

```
  0: iconst_0
```

```
  1: istore_1
```

```
  2: iload_1
```

```
  3: bipush            10
```

```
  5: if_icmpge        22
```

```
  8: getstatic        #2
```

```
11: ldc              #3
```

```
13: invokevirtual #4
```

```
16: iinc             1, 1
```

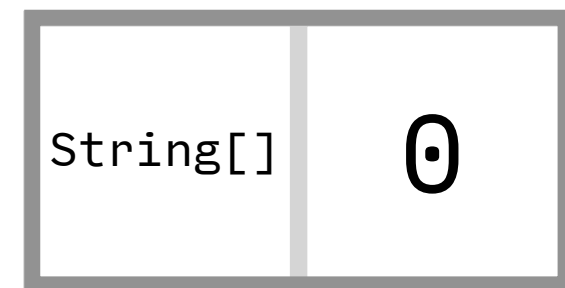
```
19: goto             2
```

```
22: return
```

```
// Field java/lang/System.out:Ljava/io/PrintStream;
```

```
// String Hello
```

```
// Method java/io/PrintStream.println:(Ljava/lang/String;)V
```

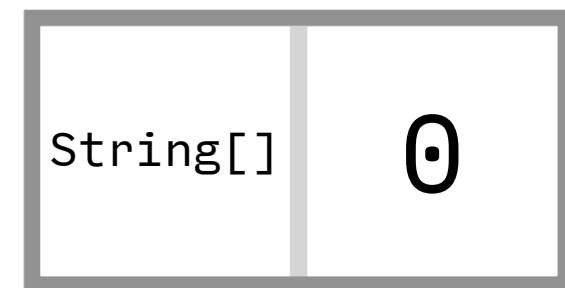


0 1
locals



stack

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```

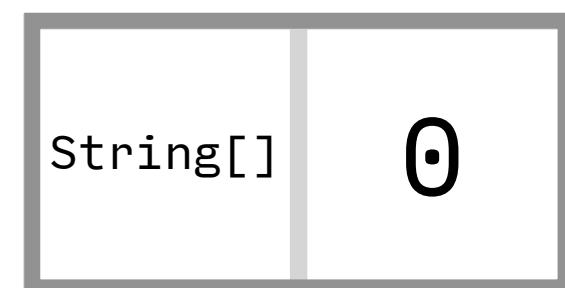


0 1
locals



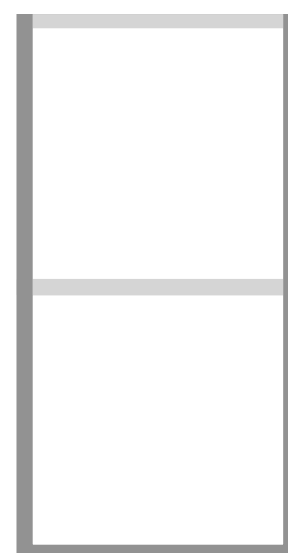
stack

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc        1, 1
 19: goto         2
 22: return
```



0 1

locals



stack

iinc 1, 1

```
public static void main(java.lang.String[]);
```

```
0: iconst_0
```

```
1: istore_1
```

```
2: iload_1
```

```
3: bipush            10
```

```
5: if_icmpge        22
```

```
8: getstatic       #2
```

```
// Field java/lang/System.out:Ljava/io/PrintStream;
```

```
11: ldc             #3
```

```
// String Hello
```

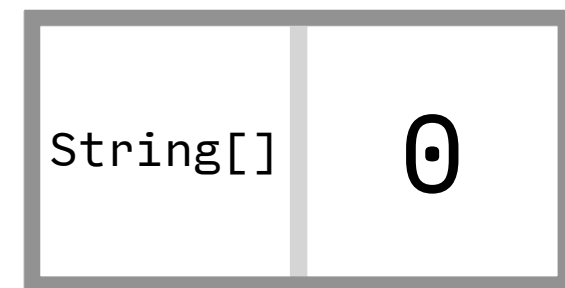
```
13: invokevirtual #4
```

```
// Method java/io/PrintStream.println:(Ljava/lang/String;)V
```

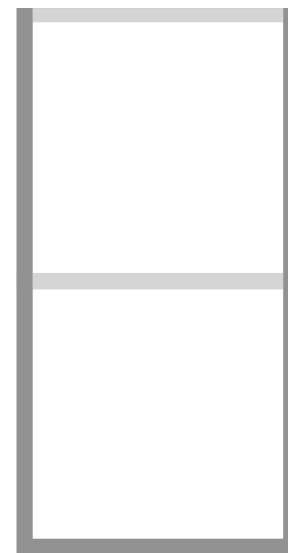
```
16: iinc            1, 1
```

```
19: goto            2
```

```
22: return
```



0 1
locals



stack

iinc 1, 1

int increment of local 1 by 1

```
public static void main(java.lang.String[]);
```

```
0: iconst_0
```

```
1: istore_1
```

```
2: iload_1
```

```
3: bipush            10
```

```
5: if_icmpge        22
```

```
8: getstatic       #2
```

// Field java/lang/System.out:Ljava/io/PrintStream;

```
11: ldc             #3
```

// String Hello

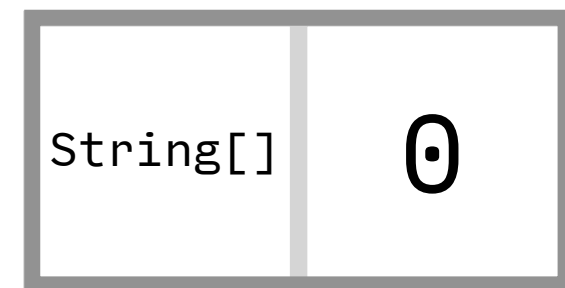
```
13: invokevirtual #4
```

// Method java/io/PrintStream.println:(Ljava/lang/String;)V

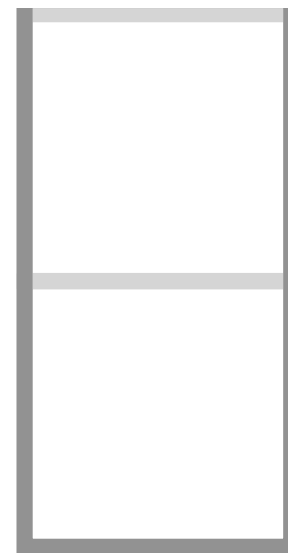
```
16: iinc            1, 1
```

```
19: goto            2
```

```
22: return
```

0 1
locals



stack

iinc 1, 1

```
public static void main(java.lang.String[]);
```

```
  0: iconst_0
```

```
  1: istore_1
```

```
  2: iload_1
```

```
  3: bipush      10
```

```
  5: if_icmpge    22
```

```
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
```

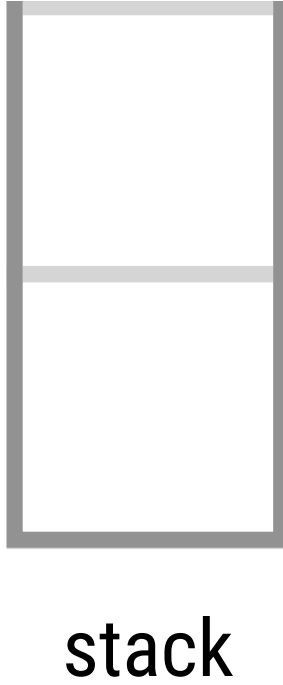
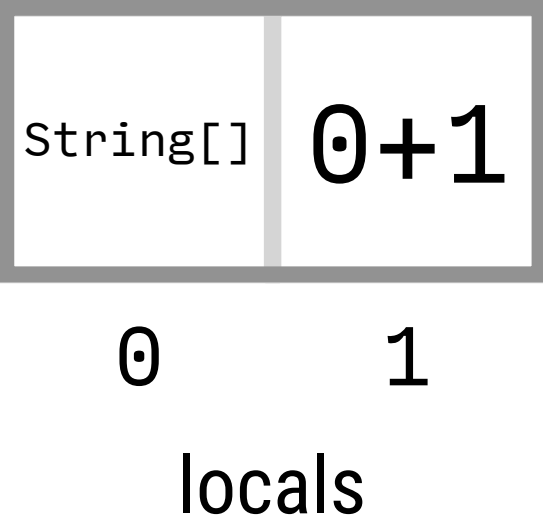
```
 11: ldc          #3      // String Hello
```

```
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
```

```
16: iinc         1, 1
```

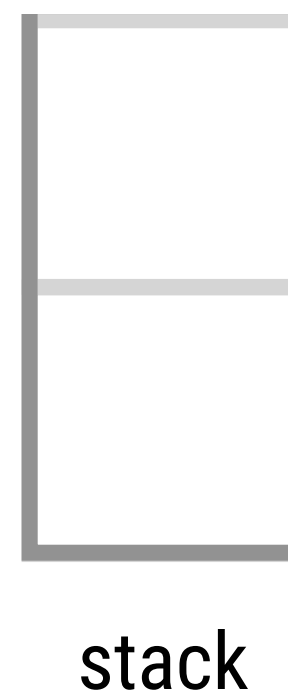
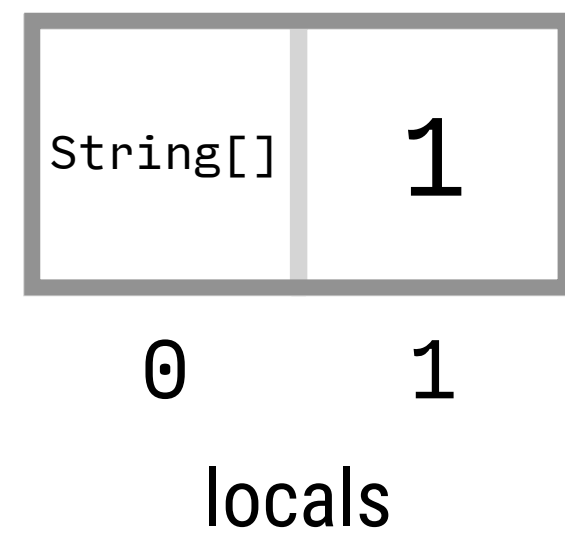
```
 19: goto         2
```

```
 22: return
```



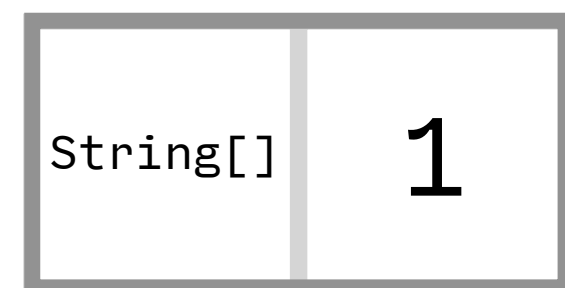
iinc 1, 1

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc        1, 1
 19: goto         2
 22: return
```



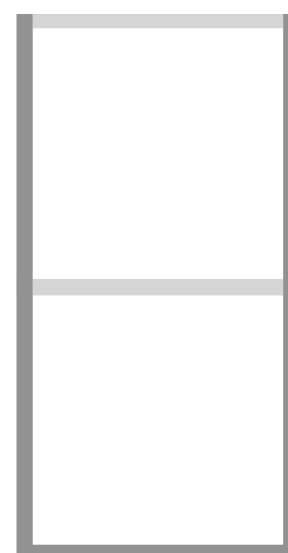
iinc 1, 1

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc        1, 1
 19: goto         2
 22: return
```



0 1

locals



stack

```
public static void main(java.lang.String[]);
```

```
0: iconst_0
```

```
1: istore_1
```

```
2: iload_1
```

```
3: bipush            10
```

```
5: if_icmpge        22
```

```
8: getstatic       #2        // Field java/lang/System.out:Ljava/io/PrintStream;
```

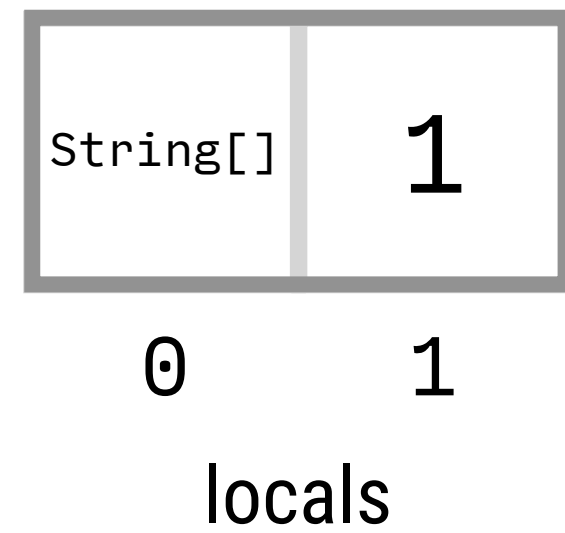
```
11: ldc             #3        // String Hello
```

```
13: invokevirtual   #4        // Method java/io/PrintStream.println:(Ljava/lang/String;)V
```

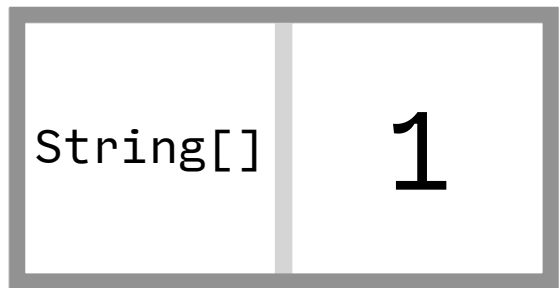
```
16: iinc            1, 1
```

```
19: goto            2
```

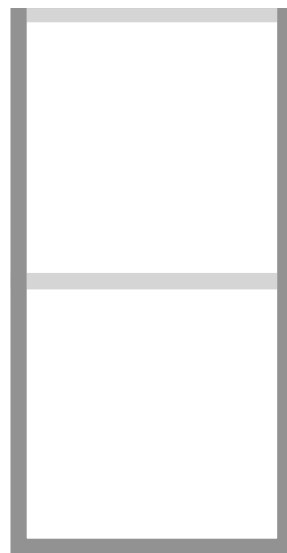
```
22: return
```



```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```



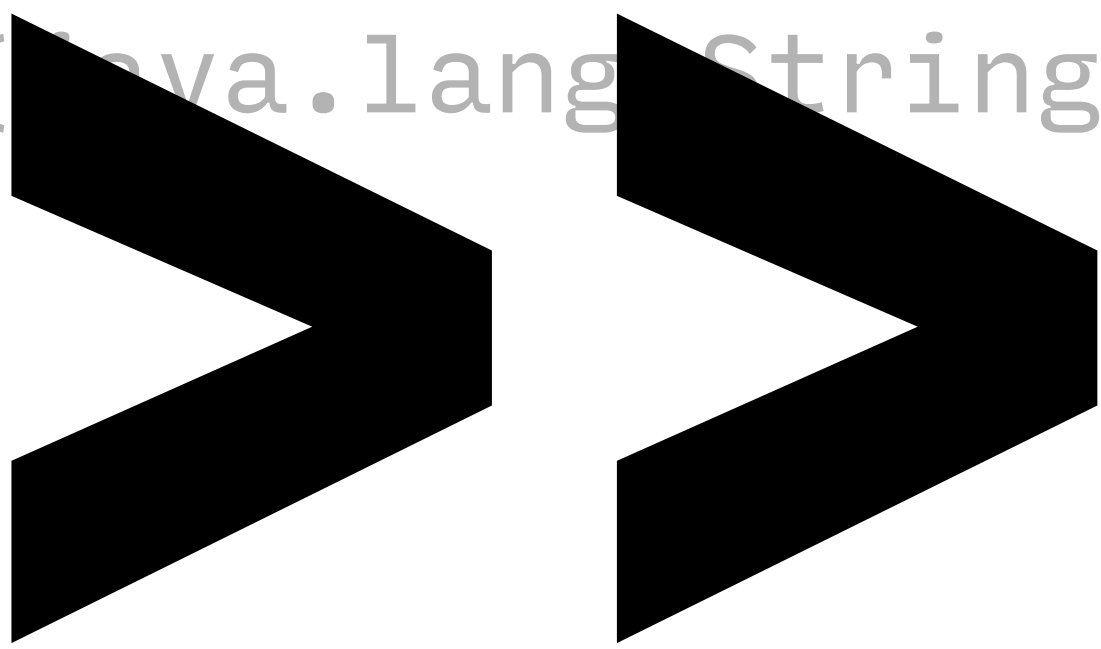
0 1
locals



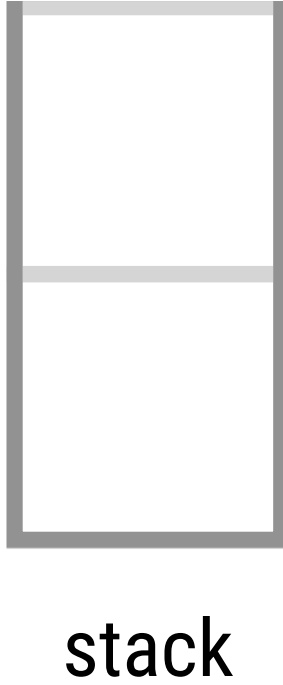
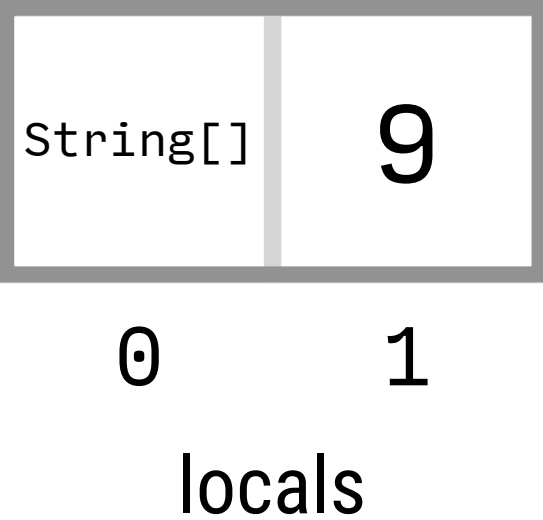
stack

```
public static void main(String[] args);
```

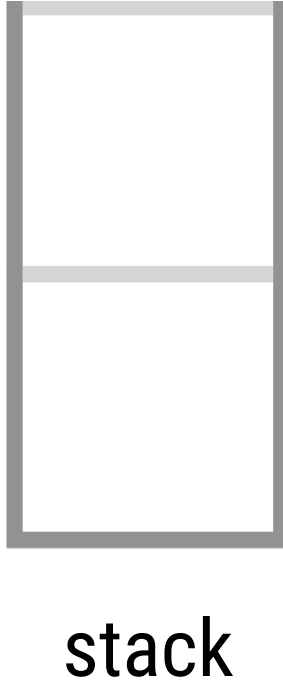
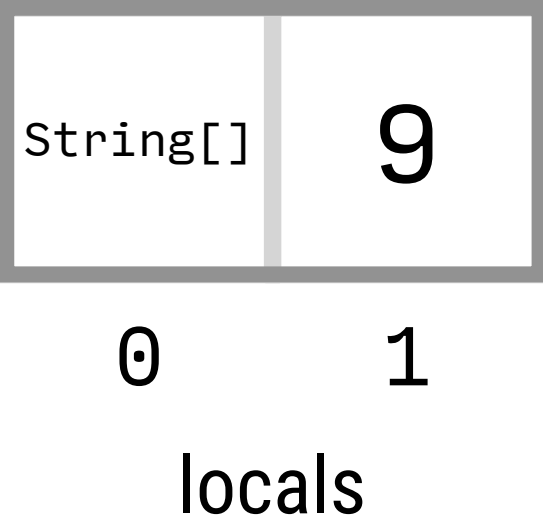
```
0:  iconst_0
1:  istore_1
2:  iload_1
3:  bipush   10
5:  if_icmpge 22
8:  getstatic #2    // Field java/lang/System.out:Ljava/io/PrintStream;
11: ldc      #3    // String Hello
13: invokevirtual #4 // Method java/io/PrintStream.println:(Ljava/lang/String;)V
16: iinc     1, 1
19: goto     2
22: return
```



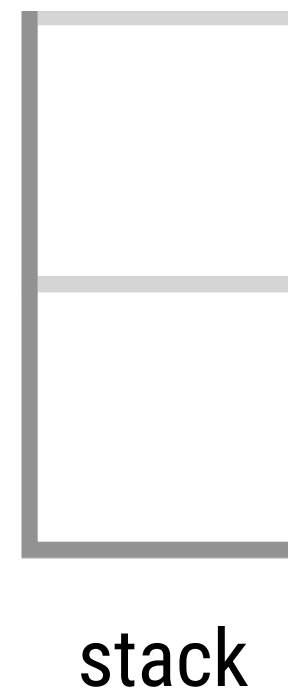
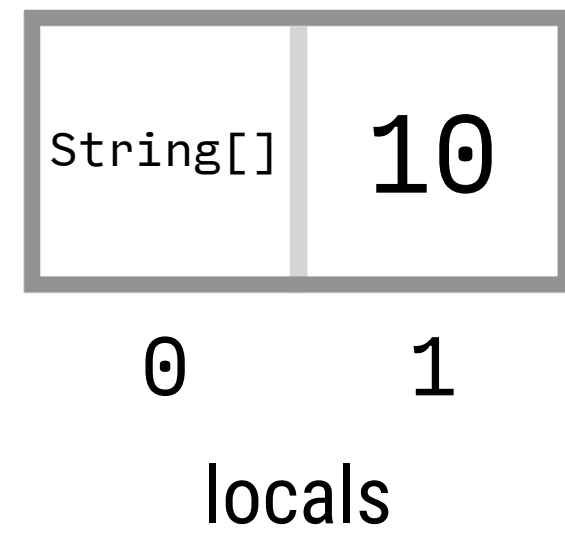
```
// Field java/lang/System.out:Ljava/io/PrintStream;
// String Hello
// Method java/io/PrintStream.println:(Ljava/lang/String;)V
```



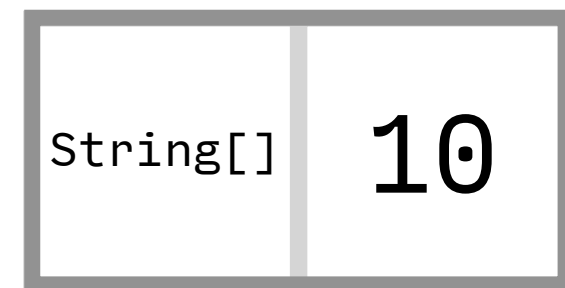
```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```



```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc        1, 1
 19: goto         2
 22: return
```

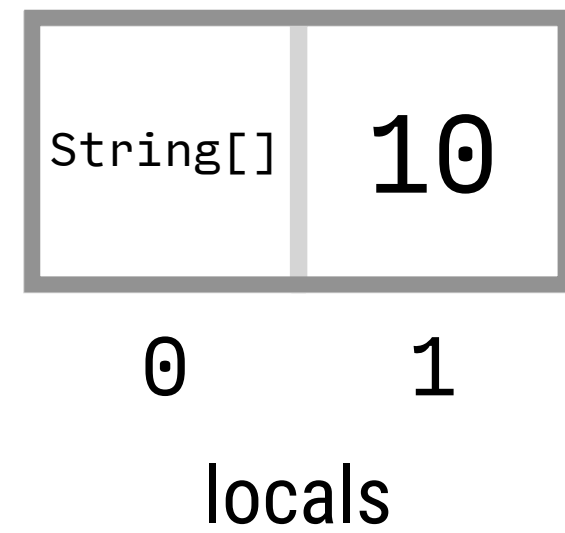


0 1
locals

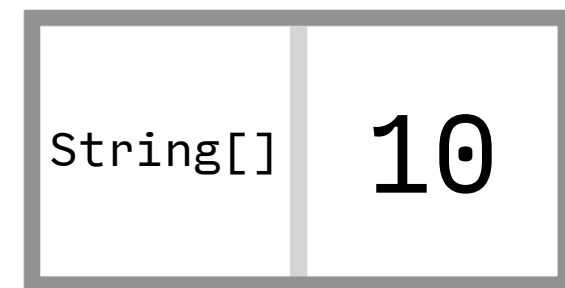


stack

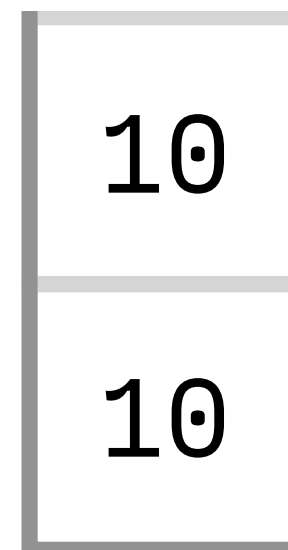
```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```



```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```

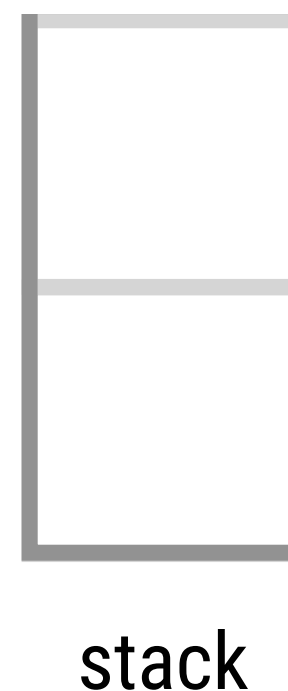
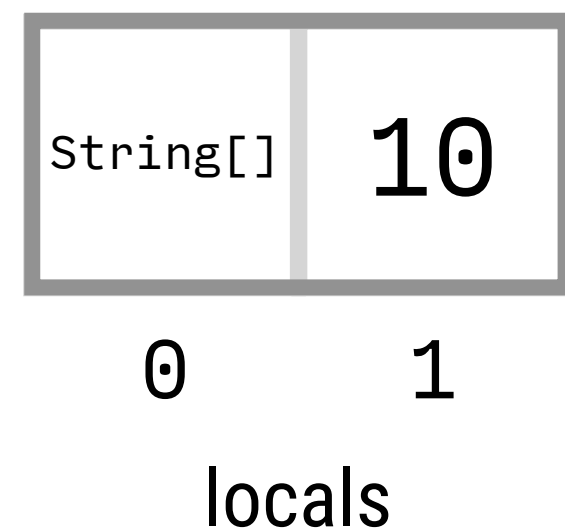


0 1
locals



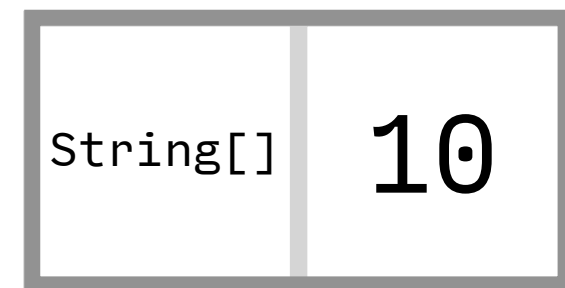
stack

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush           10
  5: if_icmpge         22
  8: getstatic         #2    // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc               #3    // String Hello
 13: invokevirtual     #4    // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc              1, 1
 19: goto              2
 22: return
```



10 >= 10

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```



0 1
locals



stack

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```

```
public static void main(java.lang.String[]);
  0: iconst_0
  1: istore_1
  2: iload_1
  3: bipush      10
  5: if_icmpge    22
  8: getstatic    #2      // Field java/lang/System.out:Ljava/io/PrintStream;
 11: ldc          #3      // String Hello
 13: invokevirtual #4      // Method java/io/PrintStream.println:(Ljava/lang/String;)V
 16: iinc         1, 1
 19: goto         2
 22: return
```

```
$ cat Primitives.java
```



```
$ cat Primitives.java
```

```
public class Primitives {  
    public static void asByte() {  
        for (byte i = 0; i < 10; i++) {  
            System.out.println("Hello");  
        }  
    }  
    public static void asShort() {  
        for (short i = 0; i < 10; i++) {  
            System.out.println("Hello");  
        }  
    }  
    public static void asInt() {  
        for (int i = 0; i < 10; i++) {  
            System.out.println("Hello");  
        }  
    }  
    public static void asLong() {  
        for (long i = 0L; i < 10L; i++) {  
            System.out.println("Hello");  
        }  
    }  
}
```

```
$ cat Primitives.java
```

```
public class Primitives {  
    public static void asByte() {  
        for (byte i = 0; i < 10; i++) {  
            System.out.println("Hello");  
        }  
    }  
    public static void asShort() {  
        for (short i = 0; i < 10; i++) {  
            System.out.println("Hello");  
        }  
    }  
    public static void asInt() {  
        for (int i = 0; i < 10; i++) {  
            System.out.println("Hello");  
        }  
    }  
    public static void asLong() {  
        for (long i = 0L; i < 10L; i++) {  
            System.out.println("Hello");  
        }  
    }  
}
```

```
$ javac Primitives.java
```

```
$ javac Primitives.java
```

```
$ javap -c Primitives
```

\$ javac Primitives.java

\$ javap -c Primitives

```
public class Primitives {
  public Primitives();
    Code:
      0: aload_0
      1: invokespecial #1          // Method java/lang/Object.<init>():V
      4: return

  public static void asByte();
    Code:
      0: iconst_0
      1: istore_0
      2: iload_0
      3: bipush      10
      5: if_icmpge    24
      8: getstatic    #2          // Field java/lang/System.out:Ljava/io/PrintStream;
     11: ldc          #3          // String Hello
     13: invokevirtual #4          // Method java/io/PrintStream.println:(Ljava/lang/String;)V
     16: iload_0
     17: iconst_1
     18: iadd
     19: i2b
     20: istore_0
     21: goto        2
     24: return

  public static void asShort();
    Code:
      0: iconst_0
      1: istore_0
      2: iload_0
      3: bipush      10
      5: if_icmpge    24
      8: getstatic    #2          // Field java/lang/System.out:Ljava/io/PrintStream;
     11: ldc          #3          // String Hello
     13: invokevirtual #4          // Method java/io/PrintStream.println:(Ljava/lang/String;)V
     16: iload_0
     17: iconst_1
     18: iadd
     19: i2s
     20: istore_0
     21: goto        2
     24: return

  public static void asInt();
    Code:
      0: iconst_0
      1: istore_0
      2: iload_0
      3: bipush      10
      5: if_icmpge    22
      8: getstatic    #2          // Field java/lang/System.out:Ljava/io/PrintStream;
     11: ldc          #3          // String Hello
     13: invokevirtual #4          // Method java/io/PrintStream.println:(Ljava/lang/String;)V
     16: iinc         0, 1
     19: goto        2
     22: return

  public static void asLong();
    Code:
      0: lconst_0
      1: lstore_0
      2: lload_0
      3: ldc2_w       #5          // long 101
      6: lcmp
      7: ifge        25
     10: getstatic    #2          // Field java/lang/System.out:Ljava/io/PrintStream;
     13: ldc          #3          // String Hello
     15: invokevirtual #4          // Method java/io/PrintStream.println:(Ljava/lang/String;)V
     18: lload_0
     19: lconst_1
     20: ladd
     21: lstore_0
     22: goto        2
     25: return
}
```

static void asByte();	static void asShort();	static void asInt();	static void asLong();
0: iconst_0	0: iconst_0	0: iconst_0	0: lconst_0
1: istore_0	1: istore_0	1: istore_0	1: lstore_0
2: iload_0	2: iload_0	2: iload_0	2: lload_0
3: bipush 10	3: bipush 10	3: bipush 10	3: ldc2_w #5
5: if_icmpge 24	5: if_icmpge 24	5: if_icmpge 22	6: lcmp
8: getstatic #2	8: getstatic #2	8: getstatic #2	7: ifge 25
11: ldc #3	11: ldc #3	11: ldc #3	10: getstatic #2
13: invokevirtual #4	13: invokevirtual #4	13: invokevirtual #4	13: ldc #3
16: iload_0	16: iload_0	16: iinc 0, 1	15: invokevirtual #4
17: iconst_1	17: iconst_1	19: goto 2	18: lload_0
18: iadd	18: iadd	22: return	19: lconst_1
19: i2b	19: i2s		20: ladd
20: istore_0	20: istore_0		21: lstore_0
21: goto 2	21: goto 2		22: goto 2
24: return	24: return		25: return

static void asByte();	static void asShort();	static void asInt();	static void asLong();
0: iconst_0	0: iconst_0	0: iconst_0	0: lconst_0
1: istore_0	1: istore_0	1: istore_0	1: lstore_0
2: iload_0	2: iload_0	2: iload_0	2: lload_0
3: bipush 10	3: bipush 10	3: bipush 10	3: ldc2_w #5
5: if_icmpge 24	5: if_icmpge 24	5: if_icmpge 22	6: lcmp
			7: ifge 25
8: getstatic #2	8: getstatic #2	8: getstatic #2	10: getstatic #2
11: ldc #3	11: ldc #3	11: ldc #3	13: ldc #3
13: invokevirtual #4	13: invokevirtual #4	13: invokevirtual #4	15: invokevirtual #4
16: iload_0	16: iload_0	16: iinc 0, 1	18: lload_0
17: iconst_1	17: iconst_1		19: lconst_1
18: iadd	18: iadd		20: ladd
19: i2b	19: i2s		21: lstore_0
20: istore_0	20: istore_0		
21: goto 2	21: goto 2	19: goto 2	22: goto 2
24: return	24: return	22: return	25: return

static void asByte();	static void asShort();	static void asInt();	static void asLong();
0: iconst_0	0: iconst_0	0: iconst_0	0: lconst_0
1: istore_0	1: istore_0	1: istore_0	1: lstore_0
2: iload_0	2: iload_0	2: iload_0	2: lload_0
3: bipush 10	3: bipush 10	3: bipush 10	3: ldc2_w #5
5: if_icmpge 24	5: if_icmpge 24	5: if_icmpge 22	6: lcmp
			7: ifge 25
8: getstatic #2	8: getstatic #2	8: getstatic #2	10: getstatic #2
11: ldc #3	11: ldc #3	11: ldc #3	13: ldc #3
13: invokevirtual #4	13: invokevirtual #4	13: invokevirtual #4	15: invokevirtual #4
16: iload_0	16: iload_0	16: iinc 0, 1	18: lload_0
17: iconst_1	17: iconst_1		19: lconst_1
18: iadd	18: iadd		20: ladd
19: i2b	19: i2s		21: lstore_0
20: istore_0	20: istore_0		
21: goto 2	21: goto 2	19: goto 2	22: goto 2
24: return	24: return	22: return	25: return

static void asByte();	static void asShort();	static void asInt();	static void asLong();
0: iconst_0	0: iconst_0	0: iconst_0	0: lconst_0
1: istore_0	1: istore_0	1: istore_0	1: lstore_0
2: iload_0	2: iload_0	2: iload_0	2: lload_0
3: bipush 10	3: bipush 10	3: bipush 10	3: ldc2_w #5
5: if_icmpge 24	5: if_icmpge 24	5: if_icmpge 22	6: lcmp
			7: ifge 25
8: getstatic #2	8: getstatic #2	8: getstatic #2	10: getstatic #2
11: ldc #3	11: ldc #3	11: ldc #3	13: ldc #3
13: invokevirtual #4	13: invokevirtual #4	13: invokevirtual #4	15: invokevirtual #4
16: iload_0	16: iload_0	16: iinc 0, 1	18: lload_0
17: iconst_1	17: iconst_1		19: lconst_1
18: iadd	18: iadd		20: ladd
19: i2b	19: i2s		21: lstore_0
20: istore_0	20: istore_0		
21: goto 2	21: goto 2	19: goto 2	22: goto 2
24: return	24: return	22: return	25: return

static void asByte();	static void asShort();	static void asInt();	static void asLong();
0: iconst_0	0: iconst_0	0: iconst_0	0: lconst_0
1: istore_0	1: istore_0	1: istore_0	1: lstore_0
2: iload_0	2: iload_0	2: iload_0	2: lload_0
3: bipush 10	3: bipush 10	3: bipush 10	3: ldc2_w #5
5: if_icmpge 24	5: if_icmpge 24	5: if_icmpge 22	6: lcmp
			7: ifge 25
8: getstatic #2	8: getstatic #2	8: getstatic #2	10: getstatic #2
11: ldc #3	11: ldc #3	11: ldc #3	13: ldc #3
13: invokevirtual #4	13: invokevirtual #4	13: invokevirtual #4	15: invokevirtual #4
16: iload_0	16: iload_0	16: iinc 0, 1	18: lload_0
17: iconst_1	17: iconst_1		19: lconst_1
18: iadd	18: iadd		20: ladd
19: i2b	19: i2s		21: lstore_0
20: istore_0	20: istore_0		
21: goto 2	21: goto 2	19: goto 2	22: goto 2
24: return	24: return	22: return	25: return

static void asByte();	static void asShort();	static void asInt();	static void asLong();
0: iconst_0	0: iconst_0	0: iconst_0	0: lconst_0
1: istore_0	1: istore_0	1: istore_0	1: lstore_0
2: iload_0	2: iload_0	2: iload_0	2: lload_0
3: bipush 10	3: bipush 10	3: bipush 10	3: ldc2_w #5
5: if_icmpge 24	5: if_icmpge 24	5: if_icmpge 22	6: lcmp
			7: ifge 25
8: getstatic #2	8: getstatic #2	8: getstatic #2	10: getstatic #2
11: ldc #3	11: ldc #3	11: ldc #3	13: ldc #3
13: invokevirtual #4	13: invokevirtual #4	13: invokevirtual #4	15: invokevirtual #4
16: iload_0	16: iload_0	16: iinc 0, 1	18: lload_0
17: iconst_1	17: iconst_1		19: lconst_1
18: iadd	18: iadd		20: ladd
19: i2b	19: i2s		21: lstore_0
20: istore_0	20: istore_0		
21: goto 2	21: goto 2	19: goto 2	22: goto 2
24: return	24: return	22: return	25: return

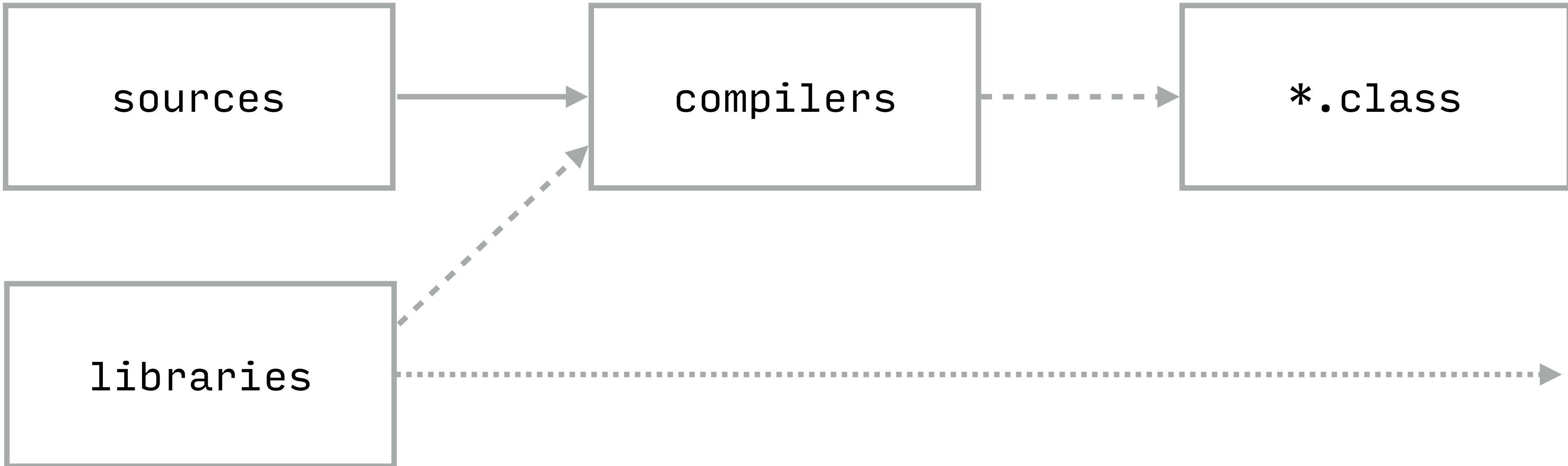
static void asByte();	static void asShort();	static void asInt();	static void asLong();
0: iconst_0	0: iconst_0	0: iconst_0	0: lconst_0
1: istore_0	1: istore_0	1: istore_0	1: lstore_0
2: iload_0	2: iload_0	2: iload_0	2: lload_0
3: bipush 10	3: bipush 10	3: bipush 10	3: ldc2_w #5
5: if_icmpge 24	5: if_icmpge 24	5: if_icmpge 22	6: lcmp
			7: ifge 25
8: getstatic #2	8: getstatic #2	8: getstatic #2	10: getstatic #2
11: ldc #3	11: ldc #3	11: ldc #3	13: ldc #3
13: invokevirtual #4	13: invokevirtual #4	13: invokevirtual #4	15: invokevirtual #4
16: iload_0	16: iload_0	16: iinc 0, 1	18: lload_0
17: iconst_1	17: iconst_1		19: lconst_1
18: iadd	18: iadd		20: ladd
19: i2b	19: i2s		21: lstore_0
20: istore_0	20: istore_0		
21: goto 2	21: goto 2	19: goto 2	22: goto 2
24: return	24: return	22: return	25: return

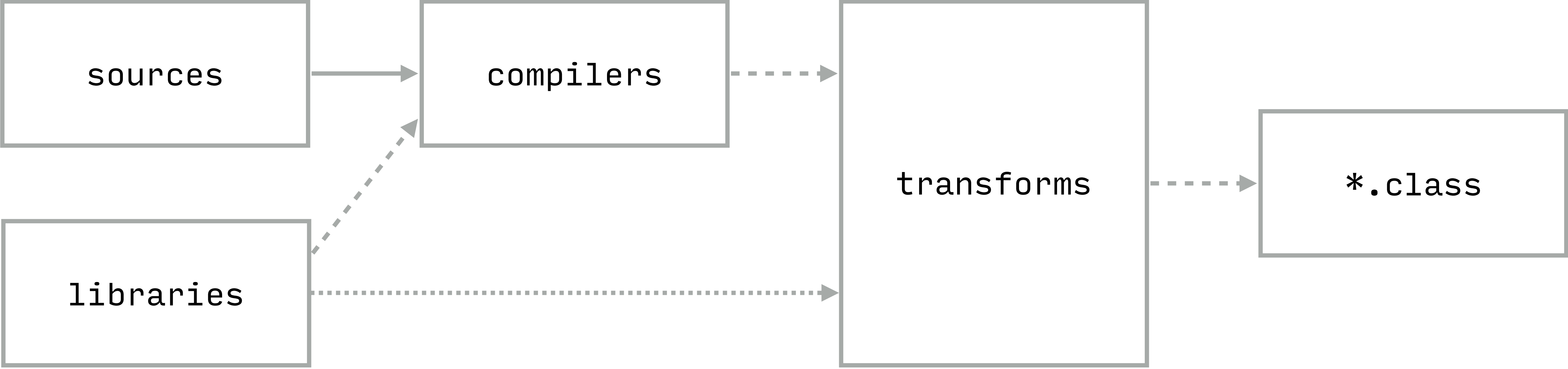
static void asByte();	static void asShort();	static void asInt();	static void asLong();
0: iconst_0	0: iconst_0	0: iconst_0	0: lconst_0
1: istore_0	1: istore_0	1: istore_0	1: lstore_0
2: iload_0	2: iload_0	2: iload_0	2: lload_0
3: bipush 10	3: bipush 10	3: bipush 10	3: ldc2_w #5
5: if_icmpge 24	5: if_icmpge 24	5: if_icmpge 22	6: lcmp
			7: ifge 25
8: getstatic #2	8: getstatic #2	8: getstatic #2	10: getstatic #2
11: ldc #3	11: ldc #3	11: ldc #3	13: ldc #3
13: invokevirtual #4	13: invokevirtual #4	13: invokevirtual #4	15: invokevirtual #4
16: iload_0	16: iload_0	16: iinc 0, 1	18: lload_0
17: iconst_1	17: iconst_1		19: lconst_1
18: iadd	18: iadd		20: ladd
19: i2b	19: i2s		21: lstore_0
20: istore_0	20: istore_0		
21: goto 2	21: goto 2	19: goto 2	22: goto 2
24: return	24: return	22: return	25: return

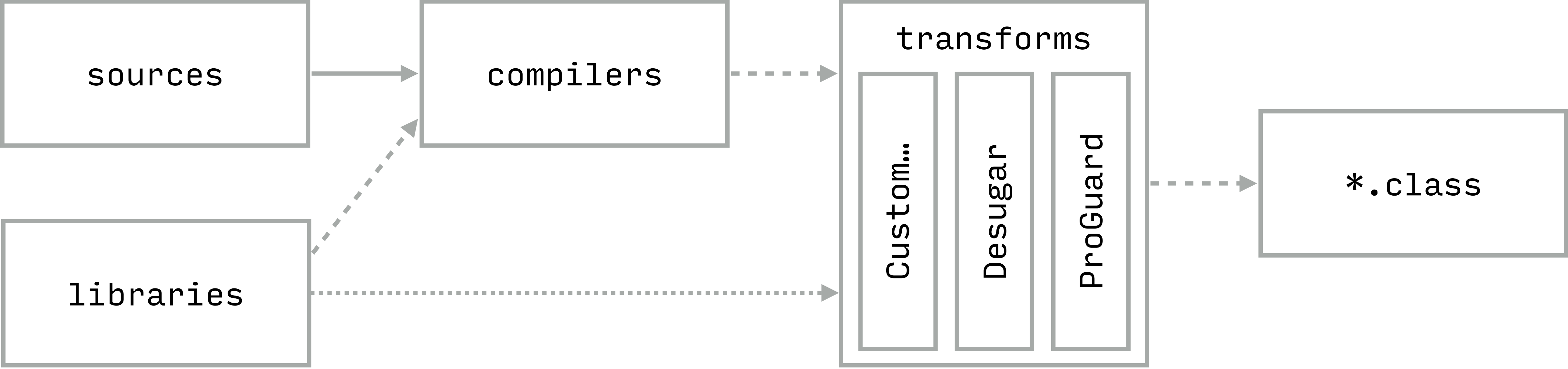
static void asByte();	static void asShort();	static void asInt();	static void asLong();
0: iconst_0	0: iconst_0	0: iconst_0	0: lconst_0
1: istore_0	1: istore_0	1: istore_0	1: lstore_0
2: iload_0	2: iload_0	2: iload_0	2: lload_0
3: bipush 10	3: bipush 10	3: bipush 10	3: ldc2_w #5
5: if_icmpge 24	5: if_icmpge 24	5: if_icmpge 22	6: lcmp
			7: ifge 25
8: getstatic #2	8: getstatic #2	8: getstatic #2	10: getstatic #2
11: ldc #3	11: ldc #3	11: ldc #3	13: ldc #3
13: invokevirtual #4	13: invokevirtual #4	13: invokevirtual #4	15: invokevirtual #4
16: iload_0	16: iload_0	16: iinc 0, 1	18: lload_0
17: iconst_1	17: iconst_1		19: lconst_1
18: iadd	18: iadd		20: ladd
19: i2b	19: i2s		21: lstore_0
20: istore_0	20: istore_0		
21: goto 2	21: goto 2	19: goto 2	22: goto 2
24: return	24: return	22: return	25: return

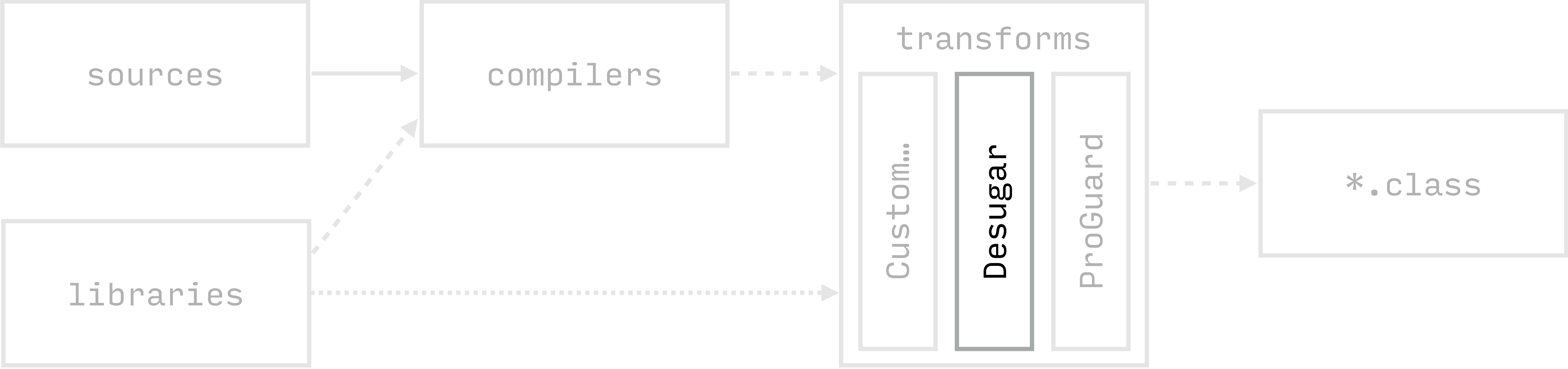
static void asByte();	static void asShort();	static void asInt();	static void asLong();
0: iconst_0	0: iconst_0	0: iconst_0	0: lconst_0
1: istore_0	1: istore_0	1: istore_0	1: lstore_0
2: iload_0	2: iload_0	2: iload_0	2: lload_0
3: bipush 10	3: bipush 10	3: bipush 10	3: ldc2_w #5
5: if_icmpge 24	5: if_icmpge 24	5: if_icmpge 22	6: lcmp
			7: ifge 25
8: getstatic #2	8: getstatic #2	8: getstatic #2	10: getstatic #2
11: ldc #3	11: ldc #3	11: ldc #3	13: ldc #3
13: invokevirtual #4	13: invokevirtual #4	13: invokevirtual #4	15: invokevirtual #4
16: iload_0	16: iload_0	16: iinc 0, 1	18: lload_0
17: iconst_1	17: iconst_1		19: lconst_1
18: iadd	18: iadd		20: ladd
19: i2b	19: i2s		21: lstore_0
20: istore_0	20: istore_0		
21: goto 2	21: goto 2	19: goto 2	22: goto 2
24: return	24: return	22: return	25: return

static void asByte();	static void asShort();	static void asInt();	static void asLong();
0: iconst_0	0: iconst_0	0: iconst_0	0: lconst_0
1: istore_0	1: istore_0	1: istore_0	1: lstore_0
2: iload_0	2: iload_0	2: iload_0	2: lload_0
3: bipush 10	3: bipush 10	3: bipush 10	3: ldc2_w #5
5: if_icmpge 24	5: if_icmpge 24	5: if_icmpge 22	6: lcmp
			7: ifge 25
8: getstatic #2	8: getstatic #2	8: getstatic #2	10: getstatic #2
11: ldc #3	11: ldc #3	11: ldc #3	13: ldc #3
13: invokevirtual #4	13: invokevirtual #4	13: invokevirtual #4	15: invokevirtual #4
16: iload_0	16: iload_0	16: iinc 0, 1	18: lload_0
17: iconst_1	17: iconst_1		19: lconst_1
18: iadd	18: iadd		20: ladd
19: i2b	19: i2s		21: lstore_0
20: istore_0	20: istore_0		
21: goto 2	21: goto 2	19: goto 2	22: goto 2
24: return	24: return	22: return	25: return













```
$ cat Java8.java
```

```
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```

```
public class Java8 {  
    public static Runnable sayHi(String name) {  
        return () -> System.out.println("Hello, " + name);  
    }  
}
```



```
$ cat Java8.java
```

```
public class Java8 {  
    public static Runnable sayHi(String name) {  
        return () -> System.out.println("Hello, " + name);  
    }  
}
```

```
$ javac Java8.java
```

```
$ javap -c -p Java8
```

```
$ javap -c -p Java8
```

```
public class Java8 {
```

```
    public static java.lang.Runnable sayHi(java.lang.String);
```

```
        Code:
```

```
            0: aload_0
```

```
            1: invokedynamic #2,  0      // InvokeDynamic #0:run:(Ljava/lang/String;)Ljava/lang/Runnable;
```

```
            6: areturn
```

```
private static void lambda$sayHi$0(java.lang.String);
```

```
    Code:
```

```
        0: getstatic      #3          // Field java/lang/System.out:Ljava/io/PrintStream;
```

```
        3: new           #4          // class java/lang/StringBuilder
```

```
        6: dup
```

```
        7: invokespecial #5          // Method java/lang/StringBuilder."<init>":()V
```

```
       10: ldc           #6          // String Hello,
```

```
       12: invokevirtual #7          // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;
```

```
       15: aload_0
```

```
       16: invokevirtual #7          // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;
```

```
       19: invokevirtual #8          // Method java/lang/StringBuilder.toString:()Ljava/lang/String;
```

```
       22: invokevirtual #9          // Method java/io/PrintStream.println:(Ljava/lang/String;)V
```

```
       25: return
```

```
}
```

```
$ javap -c -p Java8
```

```
public class Java8 {
```

```
    public static java.lang.Runnable sayHi(java.lang.String);
```

```
        Code:
```

```
            0: aload_0
```

```
            1: invokedynamic #2, 0 // InvokeDynamic #0:run:(Ljava/lang/String;)Ljava/lang/Runnable;
```

```
            6: areturn
```

```
private static void lambda$sayHi$0(java.lang.String);
```

```
    Code:
```

```
        0: getstatic      #3 // Field java/lang/System.out:Ljava/io/PrintStream;
```

```
        3: new           #4 // class java/lang/StringBuilder
```

```
        6: dup
```

```
        7: invokespecial #5 // Method java/lang/StringBuilder."<init>":()V
```

```
       10: ldc           #6 // String Hello,
```

```
       12: invokevirtual #7 // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/String;
```

```
       15: aload_0
```

```
       16: invokevirtual #7 // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/String;
```

```
       19: invokevirtual #8 // Method java/lang/StringBuilder.toString:()Ljava/lang/String;
```

```
       22: invokevirtual #9 // Method java/io/PrintStream.println:(Ljava/lang/String;)V
```

```
       25: return
```

```
}
```

```
$ javap -c -p Java8
```

```
public class Java8 {
```

```
    public static java.lang.Runnable sayHi(java.lang.String);
```

```
    Code:
```

```
        0: aload_0
```

```
        1: invokedynamic #2, 0 // InvokeDynamic #0:run:(Ljava/lang/String;)Ljava/lang/Runnable;
```

```
        6: areturn
```

```
private static void lambda$sayHi$0(java.lang.String);
```

```
    Code:
```

```
        0: getstatic      #3 // Field java/lang/System.out:Ljava/io/PrintStream;
```

```
        3: new           #4 // class java/lang/StringBuilder
```

```
        6: dup
```

```
        7: invokespecial #5 // Method java/lang/StringBuilder."<init>":()V
```

```
       10: ldc          #6 // String Hello,
```

```
       12: invokevirtual #7 // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/String;
```

```
       15: aload_0
```

```
       16: invokevirtual #7 // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/String;
```

```
       19: invokevirtual #8 // Method java/lang/StringBuilder.toString:()Ljava/lang/String;
```

```
       22: invokevirtual #9 // Method java/io/PrintStream.println:(Ljava/lang/String;)V
```

```
       25: return
```

```
}
```

```
$ javap -c -p Java8
```

```
public class Java8 {
```

```
    public static java.lang.Runnable sayHi(java.lang.String);
```

```
        Code:
```

```
            0: aload_0
```

```
            1: invokedynamic #2, 0      // InvokeDynamic #0:run:(Ljava/lang/String;)Ljava/lang/Runnable;
```

```
            6: areturn
```

```
private static void lambda$sayHi$0(java.lang.String);
```

```
    Code:
```

```
        0: getstatic      #3          // Field java/lang/System.out:Ljava/io/PrintStream;
```

```
        3: new           #4          // class java/lang/StringBuilder
```

```
        6: dup
```

```
        7: invokespecial #5          // Method java/lang/StringBuilder."<init>":()V
```

```
       10: ldc           #6          // String Hello,
```

```
       12: invokevirtual #7          // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;
```

```
       15: aload_0
```

```
       16: invokevirtual #7          // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;
```

```
       19: invokevirtual #8          // Method java/lang/StringBuilder.toString:()Ljava/lang/String;
```

```
       22: invokevirtual #9          // Method java/io/PrintStream.println:(Ljava/lang/String;)V
```

```
       25: return
```

```
}
```

```
$ git clone https://github.com/bazelbuild/bazel.git && cd bazel
```

```
$ git clone https://github.com/bazelbuild/bazel.git && cd bazel
```

```
$ brew install bazel
```



```
$ git clone https://github.com/bazelbuild/bazel.git && cd bazel
```

```
$ brew install bazel
```

```
$ bazel build //src/tools/android/java/com/google/devtools/build/android/desugar:Desugar_deploy.jar
```

```
$ git clone https://github.com/bazelbuild/bazel.git && cd bazel
```

```
$ brew install bazel
```

```
$ bazel build //src/tools/android/java/com/google/devtools/build/android/desugar:Desugar_deploy.jar
```

```
INFO: Found 1 target...
```

```
Target //src/tools/android/java/com/google/devtools/build/android/desugar:Desugar_deploy.jar up-to-date:  
  bazel-bin/src/tools/android/java/com/google/devtools/build/android/desugar/Desugar_deploy.jar
```

```
INFO: Elapsed time: 67.849s, Critical Path: 11.96s
```

```
$ git clone https://github.com/bazelbuild/bazel.git && cd bazel
```

```
$ brew install bazel
```

```
$ bazel build //src/tools/android/java/com/google/devtools/build/android/desugar:Desugar_deploy.jar
```

```
INFO: Found 1 target...
```

```
Target //src/tools/android/java/com/google/devtools/build/android/desugar:Desugar_deploy.jar up-to-date:  
  bazel-bin/src/tools/android/java/com/google/devtools/build/android/desugar/Desugar_deploy.jar
```

```
INFO: Elapsed time: 67.849s, Critical Path: 11.96s
```

```
$ git clone https://github.com/bazelbuild/bazel.git && cd bazel
```

```
$ brew install bazel
```

```
$ bazel build //src/tools/android/java/com/google/devtools/build/android/desugar:Desugar_deploy.jar
```

```
INFO: Found 1 target...
```

```
Target //src/tools/android/java/com/google/devtools/build/android/desugar:Desugar_deploy.jar up-to-date:  
  bazel-bin/src/tools/android/java/com/google/devtools/build/android/desugar/Desugar_deploy.jar
```

```
INFO: Elapsed time: 61.84s, Critical Path: 11.96s
```

app + C

```
$ git clone https://github.com/bazelbuild/bazel.git && cd bazel
```

```
$ brew install bazel
```

```
$ bazel build //src/tools/android/java/com/google/devtools/build/android/desugar:Desugar_deploy.jar
```

```
INFO: Found 1 target...
```

```
Target //src/tools/android/java/com/google/devtools/build/android/desugar:Desugar_deploy.jar up-to-date:  
  bazel-bin/src/tools/android/java/com/google/devtools/build/android/desugar/Desugar_deploy.jar
```

```
INFO: Elapsed time: 67.849s, Critical Path: 11.96s
```

```
$ git clone https://github.com/bazelbuild/bazel.git && cd bazel
```

```
$ brew install bazel
```

```
$ bazel build //src/tools/android/java/com/google/devtools/build/android/desugar:Desugar_deploy.jar
```

```
INFO: Found 1 target...
```

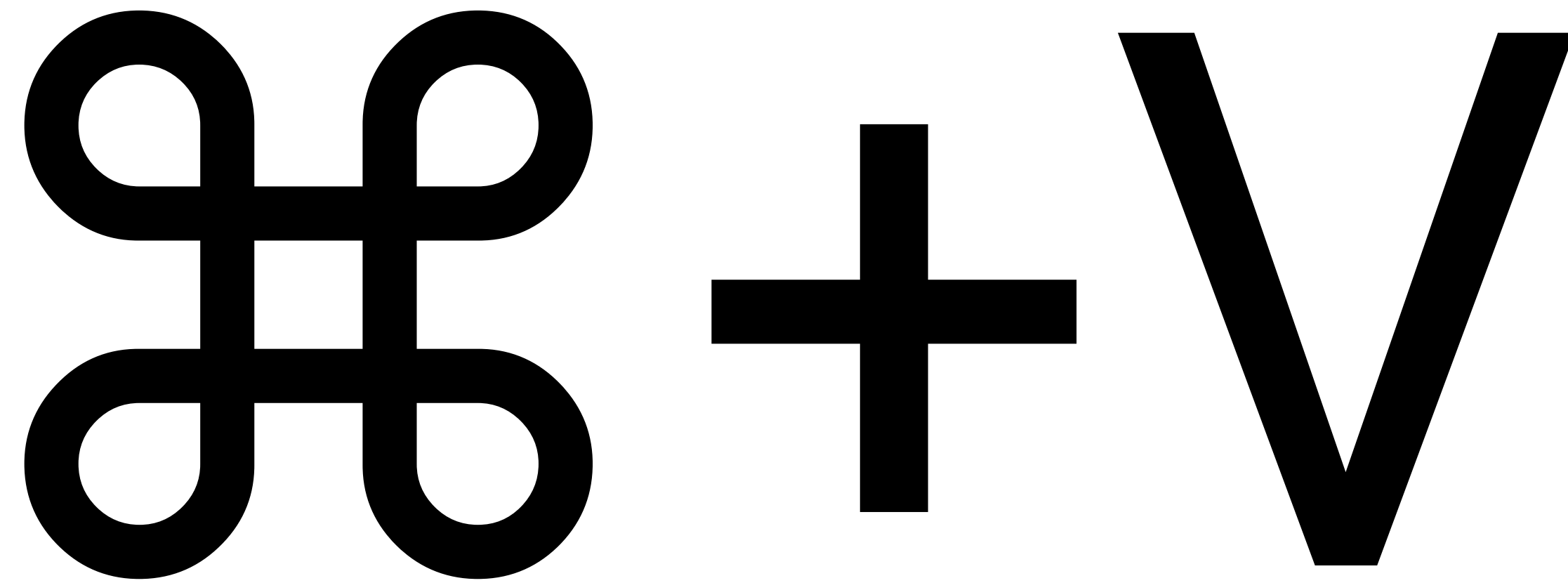
```
Target //src/tools/android/java/com/google/devtools/build/android/desugar:Desugar_deploy.jar up-to-date:  
  bazel-bin/src/tools/android/java/com/google/devtools/build/android/desugar/Desugar_deploy.jar
```

```
INFO: Elapsed time: 67.849s, Critical Path: 11.96s
```

```
$ cd ..
```

```
$ java -jar \  
    bazel/
```

```
$ java -jar \  
  bazel/
```




```
$ java -jar \  
    bazel/bazel-bin/src/tools/android/java/com/google/devtools/build/android/desugar/Desugar_deploy.jar
```

```
$ java -jar \  
    bazel/bazel-bin/src/tools/android/java/com/google/devtools/build/android/desugar/Desugar_deploy.jar \  
    --help
```

```
$ java -jar \
    bazel/bazel-bin/src/tools/android/java/com/google/devtools/build/android/desugar/Desugar_deploy.jar \
    --help
```

Options category 'input':

- bootclasspath_entry (a valid filesystem path; may be used multiple times)
Bootclasspath that was used to compile the --input Jar with, like javac's -bootclasspath flag (required).
- classpath_entry (a valid filesystem path; may be used multiple times)
Ordered classpath (Jar or directory) to resolve symbols in the --input Jar, like javac's -cp flag.
- input [-i] (a valid filesystem path; may be used multiple times)
Input Jar or directory with classes to desugar (required, the n-th input is paired with the n-th output).

Options category 'misc':

- [no]best_effort_tolerate_missing_deps (a boolean; default: "true")
Whether to tolerate missing dependencies on the classpath in some cases.
You should strive to set this flag to false.
- [no]copy_bridges_from_classpath (a boolean; default: "false")
Copy bridges from classpath to desugared classes.
- [no]desugar_interface_method_bodies_if_needed (a boolean; default: "true")
Rewrites default and static methods in interfaces if --min_sdk_version < 24. This only works correctly if subclasses of rewritten interfaces as well as uses of static interface methods are run through this tool as well.
- [no]desugar_try_with_resources_if_needed (a boolean; default: "true")
Rewrites try-with-resources statements if --min_sdk_version < 19.
- [no]desugar_try_with_resources_omit_runtime_classes (a boolean; default: "false")
Omits the runtime classes necessary to support try-with-resources from the output. This property has effect only if --desugar_try_with_resources_if_needed is used.
- [no]emit_dependency_metadata_as_needed (a boolean; default: "false")
Whether to emit META-INF/desugar_deps as needed for later consistency checking.
- min_sdk_version (an integer; default: "1")
Minimum targeted sdk version. If >= 24, enables default methods in interfaces.
- [no]rewrite_calls_to_long_compare (a boolean; default: "false")
Rewrite calls to Long.compare(long, long) to the JVM instruction lcmp regardless of --min_sdk_version.
- [no]verbose [-v] (a boolean; default: "false")
Enables verbose debugging output.

Options category 'output':

- output [-o] (a valid filesystem path; may be used multiple times)
Output Jar or directory to write desugared classes into (required, the n-th output is paired with the n-th input, output must be a Jar if input is a Jar).

```
$ mkdir desugared
```

```
$ mkdir desugared
```

```
$ java -jar \  
    bazel/bazel-bin/src/tools/android/java/com/google/devtools/build/android/desugar/Desugar_deploy.jar
```

```
$ mkdir desugared
```

```
$ java -jar \  
    bazel/bazel-bin/src/tools/android/java/com/google/devtools/build/android/desugar/Desugar_deploy.jar \  
    --bootclasspath_entry /Library/Java/JavaVirtualMachines/jdk1.8.0_151.jdk/Contents/Home/jre/lib/rt.jar
```

```
$ mkdir desugared
```

```
$ java -jar \  
    bazel/bazel-bin/src/tools/android/java/com/google/devtools/build/android/desugar/Desugar_deploy.jar \  
    --bootclasspath_entry /Library/Java/JavaVirtualMachines/jdk1.8.0_151.jdk/Contents/Home/jre/lib/rt.jar \  
    --input .
```

```
$ mkdir desugared
```

```
$ java -jar \  
    bazel/bazel-bin/src/tools/android/java/com/google/devtools/build/android/desugar/Desugar_deploy.jar \  
    --bootclasspath_entry /Library/Java/JavaVirtualMachines/jdk1.8.0_151.jdk/Contents/Home/jre/lib/rt.jar \  
    --input . \  
    --output desugared
```



```
$ mkdir desugared
```

```
$ java -jar \  
    bazel/bazel-bin/src/tools/android/java/com/google/devtools/build/android/desugar/Desugar_deploy.jar \  
    --bootclasspath_entry /Library/Java/JavaVirtualMachines/jdk1.8.0_151.jdk/Contents/Home/jre/lib/rt.jar \  
    --input . \  
    --output desugared
```

```
$ tree
```

```
.  
├── Java8.class  
├── Java8.java  
├── bazel  
│   └── <snipped>  
└── desugared  
    ├── Java8$$Lambda$0.class  
    └── Java8.class
```

```
$ javap -c -p desugared/Java8.class
```

```
$ javap -c -p desugared/Java8.class
```

```
public class Java8 {  
    public static java.lang.Runnable sayHi(java.lang.String);  
    Code:  
        0: new                #13      // class Java8$$Lambda$0  
        3: dup  
        4: aload_0  
        5: invokespecial  #16      // Method Java8$$Lambda$0."<init>":(Ljava/lang/String;)V  
        8: areturn
```

```
    static void lambda$sayHi$0$Lambda(java.lang.String);  
    Code:  
        0: getstatic      #3      // Field java/lang/System.out:Ljava/io/PrintStream;  
        3: new            #4      // class java/lang/StringBuilder  
        6: dup  
        7: invokespecial  #5      // Method java/lang/StringBuilder."<init>":()V  
       10: ldc            #6      // String Hello,  
       12: invokevirtual  #7      // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;  
       15: aload_0  
       16: invokevirtual  #7      // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;  
       19: invokevirtual  #8      // Method java/lang/StringBuilder.toString:()Ljava/lang/String;  
       22: invokevirtual  #9      // Method java/io/PrintStream.println:(Ljava/lang/String;)V  
       25: return
```

```
}
```

```
$ javap -c -p desugared/Java8.class
```

```
public class Java8 {  
    public static java.lang.Runnable sayHi(java.lang.String);  
    Code:  
        0: new                #13      // class Java8$$Lambda$0  
        3: dup  
        4: aload_0  
        5: invokespecial    #16      // Method Java8$$Lambda$0."<init>":(Ljava/lang/String;)V  
        8: areturn
```

```
static void lambda$sayHi$0$Lambda(java.lang.String);
```

```
    Code:  
        0: getstatic        #3        // Field java/lang/System.out:Ljava/io/PrintStream;  
        3: new              #4        // class java/lang/StringBuilder  
        6: dup  
        7: invokespecial    #5        // Method java/lang/StringBuilder."<init>":()V  
       10: ldc              #6        // String Hello,  
       12: invokevirtual    #7        // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;  
       15: aload_0  
       16: invokevirtual    #7        // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;  
       19: invokevirtual    #8        // Method java/lang/StringBuilder.toString:()Ljava/lang/String;  
       22: invokevirtual    #9        // Method java/io/PrintStream.println:(Ljava/lang/String;)V  
       25: return
```

```
}
```

```
$ javap -c -p desugared/Java8.class
public class Java8 {
    public static java.lang.Runnable sayHi(java.lang.String);
        Code:
            0: new                #13      // class Java8$$Lambda$0
            3: dup
            4: aload_0
            5: invokespecial      #16      // Method Java8$$Lambda$0."<init>":(Ljava/lang/String;)V
            8: areturn

    static void lambda$sayHi$0$Lambda(java.lang.String);
        <snipped>
}
```

```
$ javap -c -p desugared/Java8.class
public class Java8 {
    public static java.lang.Runnable sayHi(java.lang.String);
    Code:
        0: new                #13      // class Java8$$Lambda$0
        3: dup
        4: aload_0
        5: invokespecial      #16      // Method Java8$$Lambda$0."<init>":(Ljava/lang/String;)V
        8: areturn

    static void lambda$sayHi$0$Lambda(java.lang.String);
    <snipped>
}
```

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$ javap -c -p desugared/Java8.class
public class Java8 {
    public static java.lang.Runnable sayHi(java.lang.String);
        Code:
            0: new                #13      // class Java8$$Lambda$0
            3: dup
            4: aload_0
            5: invokespecial      #16      // Method Java8$$Lambda$0."<init>":(Ljava/lang/String;)V
            8: areturn

    static void lambda$sayHi$0$Lambda(java.lang.String);
        <snipped>
}
```

```
$ javap -c -p desugared/Java8.class
public class Java8 {
    public static java.lang.Runnable sayHi(java.lang.String);
        Code:
            0: new                #13      // class Java8$$Lambda$0
            3: dup
            4: aload_0
            5: invokespecial    #16      // Method Java8$$Lambda$0."<init>":(Ljava/lang/String;)V
            8: areturn

    static void lambda$sayHi$0$Lambda(java.lang.String);
        <snipped>
}
```



```
$ javap -c -p desugared/Java8.class
public class Java8 {
    public static java.lang.Runnable sayHi(java.lang.String);
        Code:
            0: new           #13      // class Java8$$Lambda$0
            3: dup
            4: aload_0
            5: invokespecial #16      // Method Java8$$Lambda$0."<init>":(Ljava/lang/String;)V
            8: areturn

    static void lambda$sayHi$0$Lambda(java.lang.String);
        <snipped>
}
```

```
$ javap -c -p desugared/Java8.class
public class Java8 {
    public static java.lang.Runnable sayHi(java.lang.String);
    Code:
        0: new           #13      // class Java8$$Lambda$0
        3: dup
        4: aload_0
        5: invokespecial #16      // Method Java8$$Lambda$0."<init>":(Ljava/lang/String;)V
        8: areturn

    static void lambda$sayHi$0$Lambda(java.lang.String);
    <snipped>
}
```

```
$ javap -c -p 'desugared/Java8$$Lambda$0.class'
```

```
$ javap -c -p 'desugared/Java8$$Lambda$0.class'
final class Java8$$Lambda$0 implements java.lang.Runnable {
    private final java.lang.String arg$1;

    Java8$$Lambda$0(java.lang.String);
        Code:
            0: aload_0
            1: invokespecial #13    // Method java/lang/Object."<init>":()V
            4: aload_0
            5: aload_1
            6: putfield      #15    // Field arg$1:Ljava/lang/String;
            9: return

    public void run();
        Code:
            0: aload_0
            1: getfield      #15    // Field arg$1:Ljava/lang/String;
            4: invokestatic  #21    // Method Java8.lambda$sayHi$0$Lambda:(Ljava/lang/String;)V
            7: return
}
```

```
$ javap -c -p 'desugared/Java8$$Lambda$0.class'
```

```
final class Java8$$Lambda$0 implements java.lang.Runnable {  
    private final java.lang.String arg$1;
```

```
    Java8$$Lambda$0(java.lang.String);
```

```
    Code:
```

```
        0: aload_0  
        1: invokespecial #13      // Method java/lang/Object."<init>":()V  
        4: aload_0  
        5: aload_1  
        6: putfield      #15      // Field arg$1:Ljava/lang/String;  
        9: return
```

```
    public void run();
```

```
    Code:
```

```
        0: aload_0  
        1: getfield      #15      // Field arg$1:Ljava/lang/String;  
        4: invokestatic  #21      // Method Java8.lambda$sayHi$0$Lambda:(Ljava/lang/String;)V  
        7: return
```

```
}
```

```
$ javap -c -p 'desugared/Java8$$Lambda$0.class'
final class Java8$$Lambda$0 implements java.lang.Runnable {
    private final java.lang.String arg$1;

    Java8$$Lambda$0(java.lang.String);
    Code:
        0: aload_0
        1: invokespecial #13      // Method java/lang/Object."<init>":()V
        4: aload_0
        5: aload_1
        6: putfield      #15      // Field arg$1:Ljava/lang/String;
        9: return

    public void run();
    Code:
        0: aload_0
        1: getfield      #15      // Field arg$1:Ljava/lang/String;
        4: invokestatic  #21      // Method Java8.lambda$sayHi$0$Lambda:(Ljava/lang/String;)V
        7: return
}
```

```
$ javap -c -p 'desugared/Java8$$Lambda$0.class'
final class Java8$$Lambda$0 implements java.lang.Runnable {
    private final java.lang.String arg$1;

    Java8$$Lambda$0(java.lang.String);
        Code:
            0: aload_0
            1: invokespecial #13      // Method java/lang/Object."<init>":()V
            4: aload_0
            5: aload_1
            6: putfield      #15      // Field arg$1:Ljava/lang/String;
            9: return

    public void run();
        Code:
            0: aload_0
            1: getfield      #15      // Field arg$1:Ljava/lang/String;
            4: invokestatic  #21      // Method Java8.lambda$sayHi$0$Lambda:(Ljava/lang/String;)V
            7: return
}
```

```
$ javap -c -p 'desugared/Java8$$Lambda$0.class'
final class Java8$$Lambda$0 implements java.lang.Runnable {
    private final java.lang.String arg$1;

    Java8$$Lambda$0(java.lang.String);
    Code:
        0: aload_0
        1: invokespecial #13    // Method java/lang/Object."<init>":()V
        4: aload_0
        5: aload_1
        6: putfield      #15    // Field arg$1:Ljava/lang/String;
        9: return

    public void run();
    Code:
        0: aload_0
        1: getfield      #15    // Field arg$1:Ljava/lang/String;
        4: invokestatic  #21    // Method Java8.lambda$sayHi$0$Lambda:(Ljava/lang/String;)V
        7: return
}
```



```
$ javap -c -p 'desugared/Java8$$Lambda$0.class'
final class Java8$$Lambda$0 implements java.lang.Runnable {
    private final java.lang.String arg$1;

    Java8$$Lambda$0(java.lang.String);
    Code:
        0: aload_0
        1: invokespecial #13    // Method java/lang/Object."<init>":()V
        4: aload_0
        5: aload_1
        6: putfield      #15    // Field arg$1:Ljava/lang/String;
        9: return

    public void run();
    Code:
        0: aload_0
        1: getfield      #15    // Field arg$1:Ljava/lang/String;
        4: invokestatic  #21    // Method Java8.lambda$sayHi$0$Lambda:(Ljava/lang/String;)V
        7: return
}
```

```
$ javap -c -p 'desugared/Java8$$Lambda$0.class'
final class Java8$$Lambda$0 implements java.lang.Runnable {
    private final java.lang.String arg$1;

    Java8$$Lambda$0(java.lang.String);
        Code:
            0: aload_0
            1: invokespecial #13      // Method java/lang/Object."<init>":()V
            4: aload_0
            5: aload_1
            6: putfield      #15      // Field arg$1:Ljava/lang/String;
            9: return

    public void run();
        Code:
            0: aload_0
            1: getfield      #15      // Field arg$1:Ljava/lang/String;
            4: invokestatic  #21      // Method Java8.lambda$sayHi$0$Lambda:(Ljava/lang/String;)V
            7: return
}
```

```
$ javap -c -p 'desugared/Java8$$Lambda$0.class'
final class Java8$$Lambda$0 implements java.lang.Runnable {
    private final java.lang.String arg$1;

    Java8$$Lambda$0(java.lang.String);
    Code:
        0: aload_0
        1: invokespecial #13    // Method java/lang/Object."<init>":()V
        4: aload_0
        5: aload_1
        6: putfield      #15    // Field arg$1:Ljava/lang/String;
        9: return

    public void run();
    Code:
        0: aload_0
        1: getfield      #15    // Field arg$1:Ljava/lang/String;
        4: invokestatic  #21    // Method Java8.lambda$sayHi$0$Lambda:(Ljava/lang/String;)V
        7: return
}
```

```
$ javap -c -p 'desugared/Java8$$Lambda$0.class'
final class Java8$$Lambda$0 implements java.lang.Runnable {
    private final java.lang.String arg$1;

    Java8$$Lambda$0(java.lang.String);
        Code:
            0: aload_0
            1: invokespecial #13      // Method java/lang/Object."<init>":()V
            4: aload_0
            5: aload_1
            6: putfield      #15      // Field arg$1:Ljava/lang/String;
            9: return

    public void run();
        Code:
            0: aload_0
            1: getfield      #15      // Field arg$1:Ljava/lang/String;
            4: invokestatic  #21      // Method Java8.lambda$sayHi$0$Lambda:(Ljava/lang/String;)V
            7: return
}
```

```
$ javap -c -p 'desugared/Java8$$Lambda$0.class'
```

```
final class Java8$$Lambda$0 implements java.lang.Runnable {  
    private final java.lang.String arg$1;
```

```
    Java8$$Lambda$0(java.lang.String);
```

```
    Code:
```

```
        0: aload_0  
        1: invokespecial #13    // Method java/lang/Object."<init>":()V  
        4: aload_0  
        5: aload_1  
        6: putfield      #15    // Field arg$1:Ljava/lang/String;  
        9: return
```

```
    public void run();
```

```
    Code:
```

```
        0: aload_0  
        1: getfield      #15    // Field arg$1:Ljava/lang/String;  
        4: invokestatic  #21    // Method Java8.lambda$sayHi$0$Lambda:(Ljava/lang/String;)V  
        7: return
```

```
}
```

```
$ javap -c -p 'desugared/Java8$$Lambda$0.class'
final class Java8$$Lambda$0 implements java.lang.Runnable {
    private final java.lang.String arg$1;

    Java8$$Lambda$0(java.lang.String);
        Code:
            0: aload_0
            1: invokespecial #13      // Method java/lang/Object."<init>":()V
            4: aload_0
            5: aload_1
            6: putfield      #15      // Field arg$1:Ljava/lang/String;
            9: return

    public void run();
        Code:
            0: aload_0
            1: getfield      #15      // Field arg$1:Ljava/lang/String;
            4: invokestatic  #21      // Method Java8.lambda$sayHi$0$Lambda:(Ljava/lang/String;)V
            7: return
}
```

```
$ javap -c -p 'desugared/Java8$$Lambda$0.class'
final class Java8$$Lambda$0 implements java.lang Runnable {
    private final java.lang.String arg$1;

    Java8$$Lambda$0(java.lang.String);
    Code:
        0: aload_0
        1: invokespecial #13    // Method java/lang/Object."<init>":()V
        4: aload_0
        5: aload_1
        6: putfield      #15    // Field arg$1:Ljava/lang/String;
        9: return

    public void run();
    Code:
        0: aload_0
        1: getfield      #15    // Field arg$1:Ljava/lang/String;
        4: invokestatic  #21    // Method Java8.lambda$sayHi$0$Lambda:(Ljava/lang/String;)V
        7: return
}
```

```
$ javap -c -p 'desugared/Java8$$Lambda$0.class'
final class Java8$$Lambda$0 implements java.lang.Runnable {
    private final java.lang.String arg$1;

    Java8$$Lambda$0(java.lang.String);
        Code:
            0: aload_0
            1: invokespecial #13      // Method java/lang/Object."<init>":()V
            4: aload_0
            5: aload_1
            6: putfield      #15      // Field arg$1:Ljava/lang/String;
            9: return

    public void run();
        Code:
            0: aload_0
            1: getfield      #15      // Field arg$1:Ljava/lang/String;
            4: invokestatic  #21      // Method Java8.lambda$sayHi$0$Lambda:(Ljava/lang/String;)V
            7: return
}
```



```
public class Java8 {  
    public static Runnable sayHi(String name) {  
        return () -> System.out.println("Hello, " + name);  
    }  
}
```

```
public class Java8 {  
    public static Runnable sayHi(String name) {  
        return () -> lambda$sayHi$0(name);  
    }  
  
    static void lambda$sayHi$0(String name) {  
        System.out.println("Hello, " + name);  
    }  
}
```

```
public class Java8 {  
    public static Runnable sayHi(String name) {  
        return new Java8$$Lambda$0(name);  
    }  
  
    static void lambda$sayHi$0$Lambda(String name) {  
        System.out.println("Hello, " + name);  
    }  
}  
  
final class Java8$$Lambda$0 implements Runnable {  
    private final String arg$1;  
  
    Java8$$Lambda$0(String arg$1) {  
        this.arg$1 = arg$1;  
    }  
  
    @Override public void run() {  
        Java8.lambda$sayHi$0$Lambda(arg$1e);  
    }  
}
```

```
public class Java8 {  
    public static Runnable sayHi(String name) {  
        return new Java8$$Lambda$0(name);  
    }  
  
    static void lambda$sayHi$0$Lambda(String name) {  
        System.out.println("Hello, " + name);  
    }  
}
```

```
final class Java8$$Lambda$0 implements Runnable {  
    private final String arg$1;  
  
    Java8$$Lambda$0(String arg$1) {  
        this.arg$1 = arg$1;  
    }  
  
    @Override public void run() {  
        Java8.lambda$sayHi$0$Lambda(arg$1e);  
    }  
}
```

```
$ cat KotlinLambda.kt
```

```
$ cat KotlinLambda.kt
```

```
fun sayHi(name: String) = Runnable { println("Hello, $name" ) }
```

```
$ cat KotlinLambda.kt  
fun sayHi(name: String) = Runnable { println("Hello, $name" ) }  
  
$ kotlinc KotlinLambda.kt
```

```
$ cat KotlinLambda.kt
```

```
fun sayHi(name: String) = Runnable { println("Hello, $name" ) }
```

```
$ kotlinc KotlinLambda.kt
```

```
$ tree
```

```
.  
├── KotlinLambda.kt  
├── KotlinLambdaKt$sayHi$1.class  
├── KotlinLambdaKt.class  
└── META-INF  
    └── main.kotlin_module
```



```
$ javap -c -p KotlinLambdaKt
```

```
$ javap -c -p KotlinLambdaKt
```

```
public final class KotlinLambdaKt {
```

```
    public static final java.lang.Runnable sayHi(java.lang.String);
```

```
    Code:
```

```
        0: aload_0
```

```
        1: ldc          #9      // String name
```

```
        3: invokestatic #15     // Method kotlin/jvm/internal/Intrinsics.checkNotNull:(Ljava/lang/String;)V
```

```
        6: new          #17     // class KotlinLambdaKt$sayHi$1
```

```
        9: dup
```

```
       10: aload_0
```

```
       11: invokespecial #21     // Method KotlinLambdaKt$sayHi$1."<init>":(Ljava/lang/String;)V
```

```
       14: checkcast   #23     // class java/lang/Runnable
```

```
       17: areturn
```

```
}
```

```
$ javap -c -p KotlinLambdaKt
```

```
public final class KotlinLambdaKt {
```

```
    public static final java.lang.Runnable sayHi(java.lang.String);
```

```
    Code:
```

```
        0: aload_0
```

```
        1: ldc          #9      // String name
```

```
        3: invokestatic #15     // Method kotlin/jvm/internal/Intrinsics.checkNotNull:(Ljava/lang/String;)V
```

```
        6: new          #17     // class KotlinLambdaKt$sayHi$1
```

```
        9: dup
```

```
       10: aload_0
```

```
       11: invokespecial #21     // Method KotlinLambdaKt$sayHi$1."<init>":(Ljava/lang/String;)V
```

```
       14: checkcast   #23     // class java/lang/Runnable
```

```
       17: areturn
```

```
}
```

```
$ javap -c -p KotlinLambdaKt
```

```
public final class KotlinLambdaKt {
```

```
    public static final java.lang Runnable sayHi(java.lang.String);
```

```
    Code:
```

```
        0: aload_0
```

```
        1: ldc          #9      // String name
```

```
        3: invokestatic #15     // Method kotlin/jvm/internal/Intrinsics.checkNotNull:(Ljava/lang/
```

```
        6: new          #17     // class KotlinLambdaKt$sayHi$1
```

```
        9: dup
```

```
       10: aload_0
```

```
       11: invokespecial #21     // Method KotlinLambdaKt$sayHi$1."<init>":(Ljava/lang/String;)V
```

```
       14: checkcast   #23     // class java/lang/Runnable
```

```
       17: areturn
```

```
}
```

```
$ javap -c -p KotlinLambdaKt
```

```
public final class KotlinLambdaKt {
```

```
    public static final java.lang.Runnable sayHi(java.lang.String);
```

```
    Code:
```

```
        0: aload_0
```

```
        1: ldc          #9      // String name
```

```
        3: invokestatic #15     // Method kotlin/jvm/internal/Intrinsics.checkNotNull:(Ljava/lang/String;)V
```

```
        6: new          #17     // class KotlinLambdaKt$sayHi$1
```

```
        9: dup
```

```
       10: aload_0
```

```
       11: invokespecial #21     // Method KotlinLambdaKt$sayHi$1."<init>":(Ljava/lang/String;)V
```

```
       14: checkcast    #23     // class java/lang/Runnable
```

```
       17: areturn
```

```
}
```

```
$ javap -c -p KotlinLambdaKt
```

```
public final class KotlinLambdaKt {
```

```
    public static final java.lang.Runnable sayHi(java.lang.String);
```

```
    Code:
```

```
        0: aload_0
```

```
        1: ldc          #9      // String name
```

```
        3: invokestatic #15     // Method kotlin/jvm/internal/Intrinsics.checkNotNull:(Ljava/lang/String;)V
```

```
        6: new          #17     // class KotlinLambdaKt$sayHi$1
```

```
        9: dup
```

```
       10: aload_0
```

```
       11: invokespecial #21     // Method KotlinLambdaKt$sayHi$1."<init>":(Ljava/lang/String;)V
```

```
       14: checkcast    #23     // class java/lang/Runnable
```

```
       17: areturn
```

```
}
```

```
$ javap -c -p 'KotlinLambdaKt$sayHi$1'
```

```
$ javap -c -p 'KotlinLambdaKt$sayHi$1'
```

```
final class KotlinLambdaKt$sayHi$1 implements java.lang.Runnable {  
    final java.lang.String $name;
```

```
    KotlinLambdaKt$sayHi$1(java.lang.String);
```

```
    Code:
```

```
        0: aload_0  
        1: aload_1  
        2: putfield      #23      // Field $name:Ljava/lang/String;  
        5: aload_0  
        6: invokespecial #43      // Method java/lang/Object."<init>":()V  
        9: return
```

```
    public final void run();
```

```
    Code:
```

```
        0: new           #10      // class java/lang/StringBuilder  
        3: dup  
        4: invokespecial #13      // Method java/lang/StringBuilder."<init>":()V  
        7: ldc           #15      // String Hello,  
        9: invokevirtual #19      // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;  
       12: aload_0  
       13: getfield      #23      // Field $name:Ljava/lang/String;  
       16: invokevirtual #19      // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;  
       19: invokevirtual #27      // Method java/lang/StringBuilder.toString:()Ljava/lang/String;  
       22: astore_1  
       23: getstatic     #33      // Field java/lang/System.out:Ljava/io/PrintStream;  
       26: aload_1  
       27: invokevirtual #39      // Method java/io/PrintStream.println:(Ljava/lang/Object;)V  
       30: return
```

```
}
```



```
$ javap -c -p 'KotlinLambdaKt$sayHi$1'
```

```
final class KotlinLambdaKt$sayHi$1 implements java.lang.Runnable {  
    final java.lang.String $name;
```

```
    KotlinLambdaKt$sayHi$1(java.lang.String);
```

```
    Code:
```

```
        0: aload_0  
        1: aload_1  
        2: putfield      #23      // Field $name:Ljava/lang/String;  
        5: aload_0  
        6: invokespecial #43      // Method java/lang/Object."<init>":()V  
        9: return
```

```
public final void run();
```

```
    Code:
```

```
        0: new           #10      // class java/lang/StringBuilder  
        3: dup  
        4: invokespecial #13      // Method java/lang/StringBuilder."<init>":()V  
        7: ldc           #15      // String Hello,  
        9: invokevirtual #19      // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;  
       12: aload_0  
       13: getfield      #23      // Field $name:Ljava/lang/String;  
       16: invokevirtual #19      // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;  
       19: invokevirtual #27      // Method java/lang/StringBuilder.toString:()Ljava/lang/String;  
       22: astore_1  
       23: getstatic     #33      // Field java/lang/System.out:Ljava/io/PrintStream;  
       26: aload_1  
       27: invokevirtual #39      // Method java/io/PrintStream.println:(Ljava/lang/Object;)V  
       30: return
```

```
}
```

```
$ javap -c -p 'KotlinLambdaKt$sayHi$1'
```

```
final class KotlinLambdaKt$sayHi$1 implements java.lang.Runnable {  
    final java.lang.String $name;
```

```
    KotlinLambdaKt$sayHi$1(java.lang.String);
```

```
    Code:
```

```
        0: aload_0  
        1: aload_1  
        2: putfield      #23      // Field $name:Ljava/lang/String;  
        5: aload_0  
        6: invokespecial #43      // Method java/lang/Object."<init>":()V  
        9: return
```

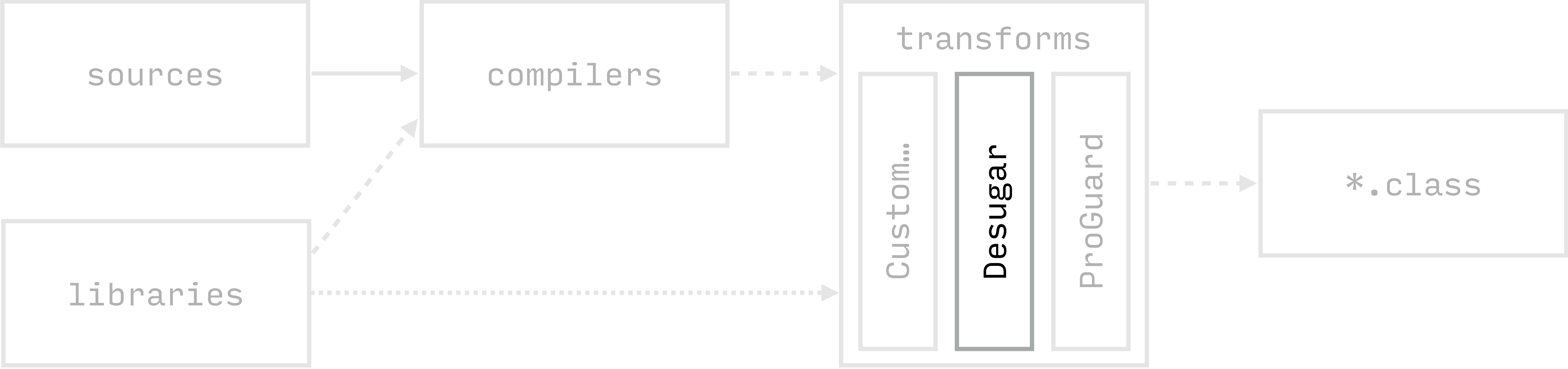
```
public final void run();
```

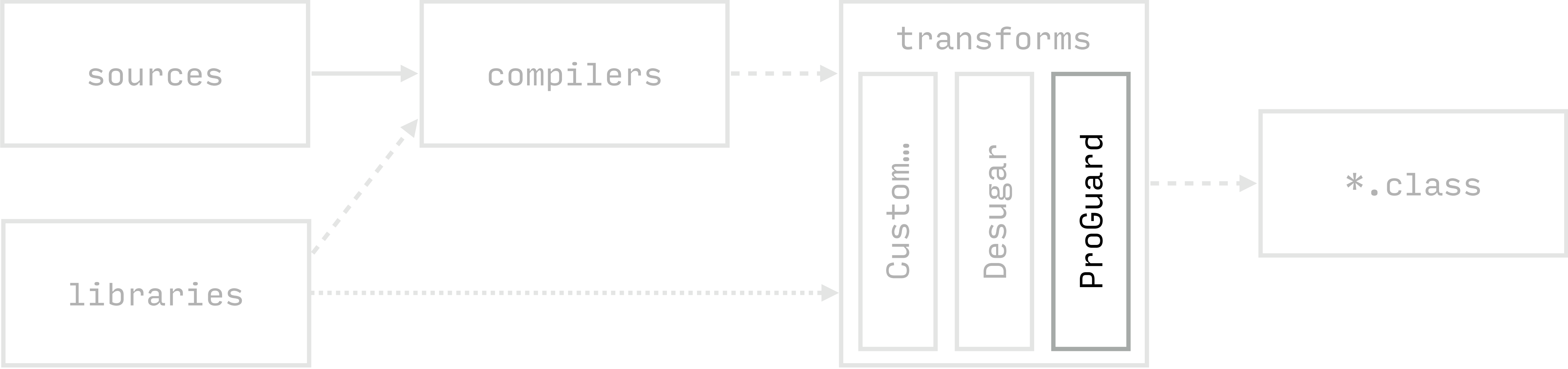
```
    Code:
```

```
        0: new           #10      // class java/lang/StringBuilder  
        3: dup  
        4: invokespecial #13      // Method java/lang/StringBuilder."<init>":()V  
        7: ldc           #15      // String Hello,  
        9: invokevirtual #19      // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;  
       12: aload_0  
       13: getfield      #23      // Field $name:Ljava/lang/String;  
       16: invokevirtual #19      // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;  
       19: invokevirtual #27      // Method java/lang/StringBuilder.toString:()Ljava/lang/String;  
       22: astore_1  
       23: getstatic     #33      // Field java/lang/System.out:Ljava/io/PrintStream;  
       26: aload_1  
       27: invokevirtual #39      // Method java/io/PrintStream.println:(Ljava/lang/Object;)V  
       30: return
```

```
}
```











```
$ cat KotlinSafeLet.kt
```



```
$ cat KotlinSafeLet.kt  
fun sayHi(name: String?) {  
    name?.let { println("Hello, $it") }  
}
```

```
$ cat KotlinSafeLet.kt  
fun sayHi(name: String?) {  
    name?.let { println("Hello, $it") }  
}
```

```
$ kotlinc KotlinSafeLet.kt
```

```
$ javap -c KotlinSafeLetKt
```

```
$ javap -c KotlinSafeLetKt
```

```
public final class KotlinSafeLetKt {
```

```
    public static final void sayHi(java.lang.String);
```

```
    Code:
```

```
        0: aload_0
```

```
        1: dup
```

```
        2: ifnull          38
```

```
        5: astore_1
```

```
        6: aload_1
```

```
        7: astore_2
```

```
        8: new            #9      // class java/lang/StringBuilder
```

```
       11: dup
```

```
       12: invokespecial #13      // Method java/lang/StringBuilder."<init>":()V
```

```
       15: ldc            #15      // String Hello,
```

```
       17: invokevirtual #19      // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;
```

```
       20: aload_2
```

```
       21: invokevirtual #19      // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;
```

```
       24: invokevirtual #23      // Method java/lang/StringBuilder.toString:()Ljava/lang/String;
```

```
       27: astore_3
```

```
       28: getstatic      #29      // Field java/lang/System.out:Ljava/io/PrintStream;
```

```
       31: aload_3
```

```
       32: invokevirtual #35      // Method java/io/PrintStream.println:(Ljava/lang/Object;)V
```

```
       35: goto          39
```

```
       38: pop
```

```
       39: return
```

```
}
```

```
$ javap -c KotlinSafeLetKt
```

```
public final class KotlinSafeLetKt {
```

```
    public static final void sayHi(java.lang.String);
```

```
    Code:
```

```
        0: aload_0
```

```
        1: dup
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       38: pop
```

```
       39: return
```

```
}
```

```
$ javap -c KotlinSafeLetKt
```

```
public final class KotlinSafeLetKt {
```

```
    public static final void sayHi(java.lang.String);
```

```
    Code:
```

```
        0: aload_0
```

```
        1: dup
```

```
        2: ifnull          38
```

```
        5: astore_1
```

```
        6: aload_1
```

```
        7: astore_2
```

```
        8: new             #9      // class java/lang/StringBuilder
```

```
       11: dup
```

```
       12: invokespecial  #13      // Method java/lang/StringBuilder."<init>":()V
```

```
       15: ldc           #15      // String Hello,
```

```
       17: invokevirtual #19      // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;
```

```
       20: aload_2
```

```
       21: invokevirtual #19      // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;
```

```
       24: invokevirtual #23      // Method java/lang/StringBuilder.toString:()Ljava/lang/String;
```

```
       27: astore_3
```

```
       28: getstatic     #29      // Field java/lang/System.out:Ljava/io/PrintStream;
```

```
       31: aload_3
```

```
       32: invokevirtual #35      // Method java/io/PrintStream.println:(Ljava/lang/Object;)V
```

```
       35: goto          39
```

```
       38: pop
```

```
       39: return
```

```
}
```

```
$ mkdir proguarded
```

```
$ mkdir proguarded
```

```
$ java -jar proguard-base-5.3.3.jar
```

```
$ mkdir proguarded
```

```
$ java -jar proguard-base-5.3.3.jar \  
    -libraryjars /Library/Java/JavaVirtualMachines/jdk1.8.0_151.jdk/Contents/Home/jre/lib/rt.jar
```



```
$ mkdir proguarded
```

```
$ java -jar proguard-base-5.3.3.jar \  
    -libraryjars /Library/Java/JavaVirtualMachines/jdk1.8.0_151.jdk/Contents/Home/jre/lib/rt.jar \  
    -libraryjars kotlin-stdlib-1.1.51.jar:annotations-15.0.jar
```

```
$ mkdir proguarded
```

```
$ java -jar proguard-base-5.3.3.jar \  
    -libraryjars /Library/Java/JavaVirtualMachines/jdk1.8.0_151.jdk/Contents/Home/jre/lib/rt.jar \  
    -libraryjars kotlin-stdlib-1.1.51.jar:annotations-15.0.jar \  
    -injars *.class
```

```
$ mkdir proguarded
```

```
$ java -jar proguard-base-5.3.3.jar \  
  -libraryjars /Library/Java/JavaVirtualMachines/jdk1.8.0_151.jdk/Contents/Home/jre/lib/rt.jar \  
  -libraryjars kotlin-stdlib-1.1.51.jar:annotations-15.0.jar \  
  -injars *.class \  
  -outjars proguarded
```

```
$ mkdir proguarded
```

```
$ java -jar proguard-base-5.3.3.jar \  
  -libraryjars /Library/Java/JavaVirtualMachines/jdk1.8.0_151.jdk/Contents/Home/jre/lib/rt.jar \  
  -libraryjars kotlin-stdlib-1.1.51.jar:annotations-15.0.jar \  
  -injars *.class \  
  -outjars proguarded \  
  -keep 'class ** { *; }'
```

```
$ mkdir proguarded
```

```
$ java -jar proguard-base-5.3.3.jar \  
  -libraryjars /Library/Java/JavaVirtualMachines/jdk1.8.0_151.jdk/Contents/Home/jre/lib/rt.jar \  
  -libraryjars kotlin-stdlib-1.1.51.jar:annotations-15.0.jar \  
  -injars *.class \  
  -outjars proguarded \  
  -keep 'class ** { *; }'
```

```
$ tree
```

```
.  
├── KotlinSafeLet.kt  
├── KotlinSafeLetKt.class  
├── META-INF  
│   └── main.kotlin_module  
└── proguarded  
    └── KotlinSafeLetKt.class
```

```
$ javap -c proguarded/KotlinSafeLetKt.class
```

```
$ javap -c proguarded/KotlinSafeLetKt.class
```

```
public final class KotlinSafeLetKt {  
    public static final void sayHi(java.lang.String);
```

```
    Code:
```

```
        0: aload_0  
        1: ifnull          28  
        4: new             #6      // class java/lang/StringBuilder  
        7: dup  
        8: ldc             #1      // String Hello,  
       10: invokespecial   #10     // Method java/lang/StringBuilder."<init>":(Ljava/lang/String;)V  
       13: aload_0  
       14: invokevirtual   #11     // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;  
       17: invokevirtual   #12     // Method java/lang/StringBuilder.toString:()Ljava/lang/String;  
       20: astore_0  
       21: getstatic       #8      // Field java/lang/System.out:Ljava/io/PrintStream;  
       24: aload_0  
       25: invokevirtual   #9      // Method java/io/PrintStream.println:(Ljava/lang/Object;)V  
       28: return
```

```
}
```

```
$ javap -c proguarded/KotlinSafeLetKt.class
```

```
public final class KotlinSafeLetKt {  
    public static final void sayHi(java.lang.String);
```

```
    Code:
```

```
        0: aload_0  
        1: ifnull          28  
        4: new             #6      // class java/lang/StringBuilder  
        7: dup  
        8: ldc             #1      // String Hello,  
       10: invokespecial   #10     // Method java/lang/StringBuilder."<init>":(Ljava/lang/String;)V  
       13: aload_0  
       14: invokevirtual   #11     // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;  
       17: invokevirtual   #12     // Method java/lang/StringBuilder.toString:()Ljava/lang/String;  
       20: astore_0  
       21: getstatic       #8      // Field java/lang/System.out:Ljava/io/PrintStream;  
       24: aload_0  
       25: invokevirtual   #9      // Method java/io/PrintStream.println:(Ljava/lang/Object;)V  
       28: return
```

```
}
```



```
$ javap -c proguarded/KotlinSafeLetKt.class
```

```
public final class KotlinSafeLetKt {  
    public static final void sayHi(java.lang.String);
```

```
    Code:
```

```
        0: aload_0  
        1: ifnull          28  
        4: new             #6      // class java/lang/StringBuilder  
        7: dup  
        8: ldc            #1      // String Hello,  
       10: invokespecial  #10     // Method java/lang/StringBuilder."<init>":(Ljava/lang/String;)V  
       13: aload_0  
       14: invokevirtual  #11     // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;  
       17: invokevirtual  #12     // Method java/lang/StringBuilder.toString:()Ljava/lang/String;  
       20: astore_0  
       21: getstatic      #8      // Field java/lang/System.out:Ljava/io/PrintStream;  
       24: aload_0  
       25: invokevirtual  #9      // Method java/io/PrintStream.println:(Ljava/lang/Object;)V  
       28: return
```

```
}
```

```
$ javap -c proguarded/KotlinSafeLetKt.class
```

```
public final class KotlinSafeLetKt {  
    public static final void sayHi(java.lang.String);
```

```
    Code:
```

```
        0: aload_0  
        1: ifnull          28  
        4: new             #6      // class java/lang/StringBuilder  
        7: dup  
        8: ldc             #1      // String Hello,  
       10: invokespecial   #10     // Method java/lang/StringBuilder."<init>":(Ljava/lang/String;)V  
       13: aload_0  
       14: invokevirtual   #11     // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;  
       17: invokevirtual   #12     // Method java/lang/StringBuilder.toString:()Ljava/lang/String;  
       20: astore_0  
       21: getstatic       #8      // Field java/lang/System.out:Ljava/io/PrintStream;  
       24: aload_0  
       25: invokevirtual   #9      // Method java/io/PrintStream.println:(Ljava/lang/Object;)V  
       28: return
```

```
}
```

```
$ javap -c proguarded/KotlinSafeLetKt.class
```

```
public final class KotlinSafeLetKt {  
    public static final void sayHi(java.lang.String);
```

```
    Code:
```

```
        0: aload_0  
        1: ifnull          28  
        4: new             #6      // class java/lang/StringBuilder  
        7: dup  
        8: ldc             #1      // String Hello,  
       10: invokespecial   #10     // Method java/lang/StringBuilder."<init>":(Ljava/lang/String;)V  
       13: aload_0  
       14: invokevirtual   #11     // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;  
       17: invokevirtual   #12     // Method java/lang/StringBuilder.toString:()Ljava/lang/String;  
       20: astore_0  
       21: getstatic       #8      // Field java/lang/System.out:Ljava/io/PrintStream;  
       24: aload_0  
       25: invokevirtual   #9      // Method java/io/PrintStream.println:(Ljava/lang/Object;)V  
       28: return
```

```
}
```

```
$ javap -c proguarded/KotlinSafeLetKt.class
```

```
public final class KotlinSafeLetKt {  
    public static final void sayHi(java.lang.String);
```

```
    Code:
```

```
        0: aload_0  
        1: ifnull          28  
        4: new             #6      // class java/lang/StringBuilder  
        7: dup  
        8: ldc             #1      // String Hello,  
       10: invokespecial  #10      // Method java/lang/StringBuilder."<init>":(Ljava/lang/String;)V  
       13: aload_0  
       14: invokevirtual  #11      // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;  
       17: invokevirtual  #12      // Method java/lang/StringBuilder.toString:()Ljava/lang/String;  
       20: astore_0  
       21: getstatic      #8      // Field java/lang/System.out:Ljava/io/PrintStream;  
       24: aload_0  
       25: invokevirtual  #9      // Method java/io/PrintStream.println:(Ljava/lang/Object;)V  
       28: return
```

```
}
```

```
$ javap -c proguarded/KotlinSafeLetKt.class
```

```
public final class KotlinSafeLetKt {  
    public static final void sayHi(java.lang.String);
```

```
    Code:
```

```
        0: aload_0  
        1: ifnull          28  
        4: new             #6      // class java/lang/StringBuilder  
        7: dup  
        8: ldc             #1      // String Hello,  
       10: invokespecial  #10     // Method java/lang/StringBuilder."<init>":(Ljava/lang/String;)V  
       13: aload_0  
       14: invokevirtual  #11     // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;  
       17: invokevirtual  #12     // Method java/lang/StringBuilder.toString:()Ljava/lang/String;  
       20: astore_0  
       21: getstatic      #8      // Field java/lang/System.out:Ljava/io/PrintStream;  
       24: aload_0  
       25: invokevirtual  #9      // Method java/io/PrintStream.println:(Ljava/lang/Object;)V  
       28: return
```

```
}
```

```
$ javap -c proguarded/KotlinSafeLetKt.class
```

```
public final class KotlinSafeLetKt {  
    public static final void sayHi(java.lang.String);
```

```
    Code:
```

```
        0: aload_0
```

```
        1: ifnull          28
```

```
        4: new             #6      // class java/lang/StringBuilder
```

```
        7: dup
```

```
        8: ldc             #1      // String Hello,
```

```
       10: invokespecial  #10     // Method java/lang/StringBuilder."<init>":(Ljava/lang/String;)V
```

```
       13: aload_0
```

```
       14: invokevirtual #11     // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;
```

```
       17: invokevirtual #12     // Method java/lang/StringBuilder.toString:()Ljava/lang/String;
```

```
       20: astore_0
```

```
       21: getstatic     #8      // Field java/lang/System.out:Ljava/io/PrintStream;
```

```
       24: aload_0
```

```
       25: invokevirtual #9      // Method java/io/PrintStream.println:(Ljava/lang/Object;)V
```

```
       28: return
```

```
}
```



```
$ javap -c proguarded/KotlinSafeLetKt.class
```

```
public final class KotlinSafeLetKt {  
    public static final void sayHi(java.lang.String);
```

```
    Code:
```

```
        0: aload_0  
        1: ifnull          28  
        4: new             #6      // class java/lang/StringBuilder  
        7: dup  
        8: ldc             #1      // String Hello,  
       10: invokespecial   #10     // Method java/lang/StringBuilder."<init>":(Ljava/lang/String;)V  
       13: aload_0  
       14: invokevirtual   #11     // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;  
       17: invokevirtual   #12     // Method java/lang/StringBuilder.toString:()Ljava/lang/String;  
       20: astore_0  
       21: getstatic       #8      // Field java/lang/System.out:Ljava/io/PrintStream;  
       24: aload_0  
       25: invokevirtual   #9      // Method java/io/PrintStream.println:(Ljava/lang/Object;)V  
       28: return
```

```
}
```

```
$ javap -c proguarded/KotlinSafeLetKt.class
```

```
public final class KotlinSafeLetKt {  
    public static final void sayHi(java.lang.String);
```

```
    Code:
```

```
        0: aload_0  
        1: ifnull          28  
        4: new             #6      // class java/lang/StringBuilder  
        7: dup  
        8: ldc             #1      // String Hello,  
       10: invokespecial   #10     // Method java/lang/StringBuilder."<init>":(Ljava/lang/String;)V  
       13: aload_0  
       14: invokevirtual   #11     // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;  
       17: invokevirtual   #12     // Method java/lang/StringBuilder.toString:()Ljava/lang/String;  
       20: astore_0  
       21: getstatic       #8      // Field java/lang/System.out:Ljava/io/PrintStream;  
       24: aload_0  
       25: invokevirtual   #9      // Method java/io/PrintStream.println:(Ljava/lang/Object;)V  
       28: return
```

```
}
```



```
$ javap -c proguarded/KotlinSafeLetKt.class
```

```
public final class KotlinSafeLetKt {  
    public static final void sayHi(java.lang.String);
```

```
    Code:
```

```
        0: aload_0  
        1: ifnull          28  
        4: new             #6      // class java/lang/StringBuilder  
        7: dup  
        8: ldc             #1      // String Hello,  
       10: invokespecial   #10     // Method java/lang/StringBuilder."<init>":(Ljava/lang/String;)V  
       13: aload_0  
       14: invokevirtual   #11     // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;  
       17: invokevirtual   #12     // Method java/lang/StringBuilder.toString:()Ljava/lang/String;  
       20: astore_0  
       21: getstatic       #8      // Field java/lang/System.out:Ljava/io/PrintStream;  
       24: aload_0  
       25: invokevirtual   #9      // Method java/io/PrintStream.println:(Ljava/lang/Object;)V  
       28: return
```

```
}
```

```
$ javap -c proguarded/KotlinSafeLetKt.class
```

```
public final class KotlinSafeLetKt {  
    public static final void sayHi(java.lang.String);
```

```
    Code:
```

```
        0: aload_0  
        1: ifnull          28  
        4: new             #6      // class java/lang/StringBuilder  
        7: dup  
        8: ldc             #1      // String Hello,  
       10: invokespecial  #10      // Method java/lang/StringBuilder."<init>":(Ljava/lang/String;)V  
       13: aload_0  
       14: invokevirtual  #11      // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;  
       17: invokevirtual  #12      // Method java/lang/StringBuilder.toString:()Ljava/lang/String;  
       20: astore_0  
       21: getstatic      #8      // Field java/lang/System.out:Ljava/io/PrintStream;  
       24: aload_0  
       25: invokevirtual  #9      // Method java/io/PrintStream.println:(Ljava/lang/Object;)V  
       28: return
```

```
}
```

```
$ javap -c proguarded/KotlinSafeLetKt.class
```

```
public final class KotlinSafeLetKt {  
    public static final void sayHi(java.lang.String);
```

```
    Code:
```

```
        0: aload_0  
        1: ifnull          28  
        4: new             #6      // class java/lang/StringBuilder  
        7: dup  
        8: ldc             #1      // String Hello,  
       10: invokespecial   #10     // Method java/lang/StringBuilder."<init>":(Ljava/lang/String;)V  
       13: aload_0  
       14: invokevirtual   #11     // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;  
       17: invokevirtual   #12     // Method java/lang/StringBuilder.toString:()Ljava/lang/String;  
       20: astore_0  
       21: getstatic       #8      // Field java/lang/System.out:Ljava/io/PrintStream;  
       24: aload_0  
       25: invokevirtual   #9      // Method java/io/PrintStream.println:(Ljava/lang/Object;)V  
       28: return
```

```
}
```

```
$ javap -c proguarded/KotlinSafeLetKt.class
```

```
public final class KotlinSafeLetKt {  
    public static final void sayHi(java.lang.String);
```

```
    Code:
```

```
        0: aload_0  
        1: ifnull          28  
        4: new             #6      // class java/lang/StringBuilder  
        7: dup  
        8: ldc             #1      // String Hello,  
       10: invokespecial   #10     // Method java/lang/StringBuilder."<init>":(Ljava/lang/String;)V  
       13: aload_0  
       14: invokevirtual   #11     // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;  
       17: invokevirtual   #12     // Method java/lang/StringBuilder.toString:()Ljava/lang/String;  
       20: astore_0  
       21: getstatic       #8      // Field java/lang/System.out:Ljava/io/PrintStream;  
       24: aload_0  
       25: invokevirtual   #9      // Method java/io/PrintStream.println:(Ljava/lang/Object;)V  
       28: return
```

```
}
```

```
public static final void sayHi(java.lang.String);
```

```
kotlinc:
```

```
0: aload_0
1: dup
2: ifnull          38
5: astore_1
6: aload_1
7: astore_2
8: new             #9
11: dup
12: invokespecial  #13
15: ldc            #15
17: invokevirtual #19
20: aload_2
21: invokevirtual #19
24: invokevirtual #23
27: astore_3
28: getstatic     #29
31: aload_3
32: invokevirtual #35
35: goto         39
38: pop
39: return
```

```
kotlinc+ProGuard:
```

```
0: aload_0
1: ifnull          28
4: new             #6
7: dup
8: ldc            #1
10: invokespecial #10
13: aload_0
14: invokevirtual #11
17: invokevirtual #12
20: astore_0
21: getstatic     #8
24: aload_0
25: invokevirtual #9
28: return
```

```
public static final void sayHi(java.lang.String);
```

```
kotlinc:
```

```
0: aload_0
```

```
1: dup
```

```
2: ifnull          38
```

```
5: astore_1
```

```
6: aload_1
```

```
7: astore_2
```

```
8: new             #9
```

```
11: dup
```

```
12: invokespecial  #13
```

```
15: ldc            #15
```

```
17: invokevirtual #19
```

```
20: aload_2
```

```
21: invokevirtual #19
```

```
24: invokevirtual #23
```

```
27: astore_3
```

```
28: getstatic     #29
```

```
31: aload_3
```

```
32: invokevirtual #35
```

```
35: goto          39
```

```
38: pop
```

```
39: return
```

```
kotlinc+ProGuard:
```

```
0: aload_0
```

```
1: ifnull          28
```

```
4: new             #6
```

```
7: dup
```

```
8: ldc            #1
```

```
10: invokespecial #10
```

```
13: aload_0
```

```
14: invokevirtual #11
```

```
17: invokevirtual #12
```

```
20: astore_0
```

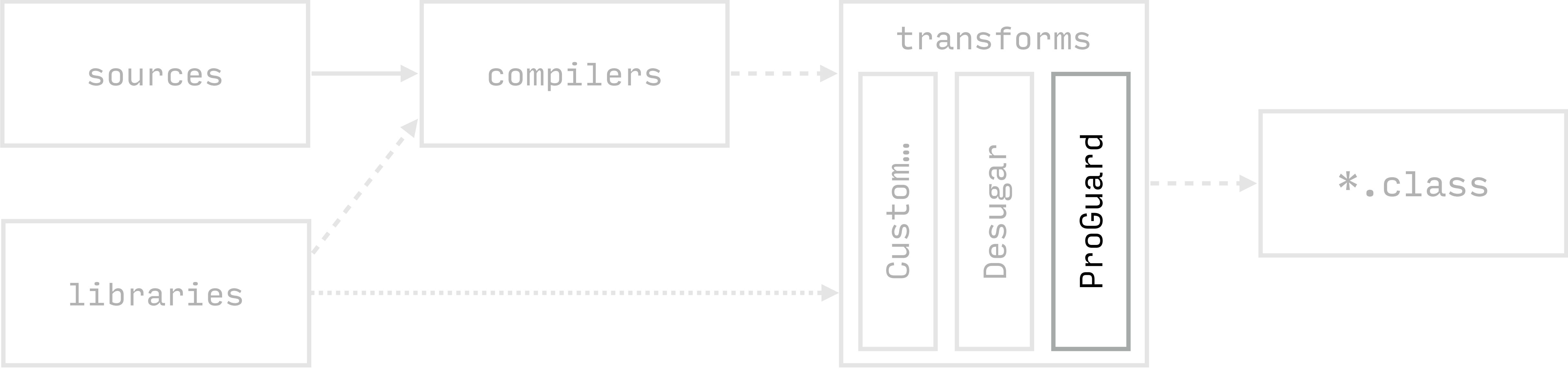
```
21: getstatic     #8
```

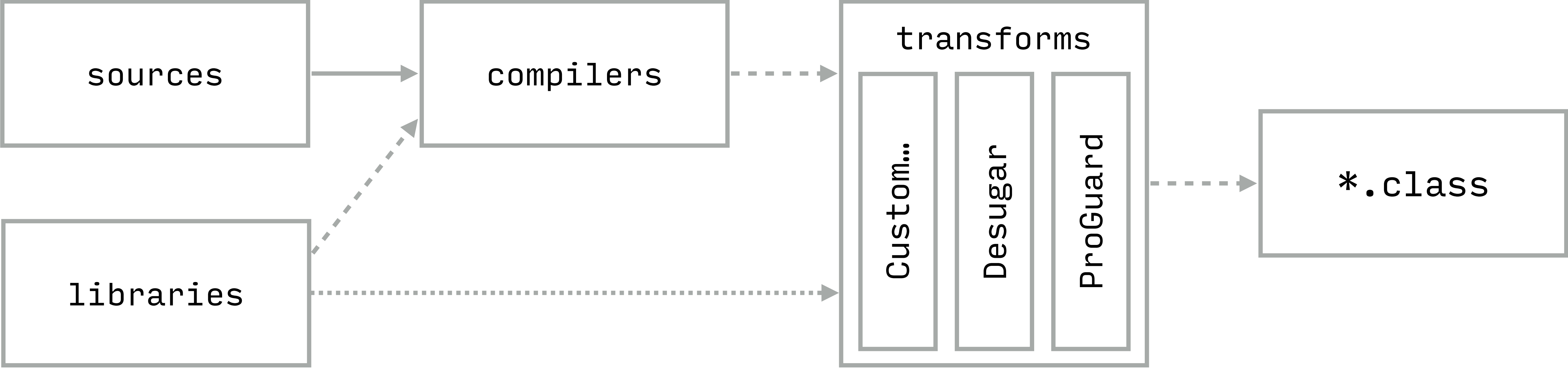
```
24: aload_0
```

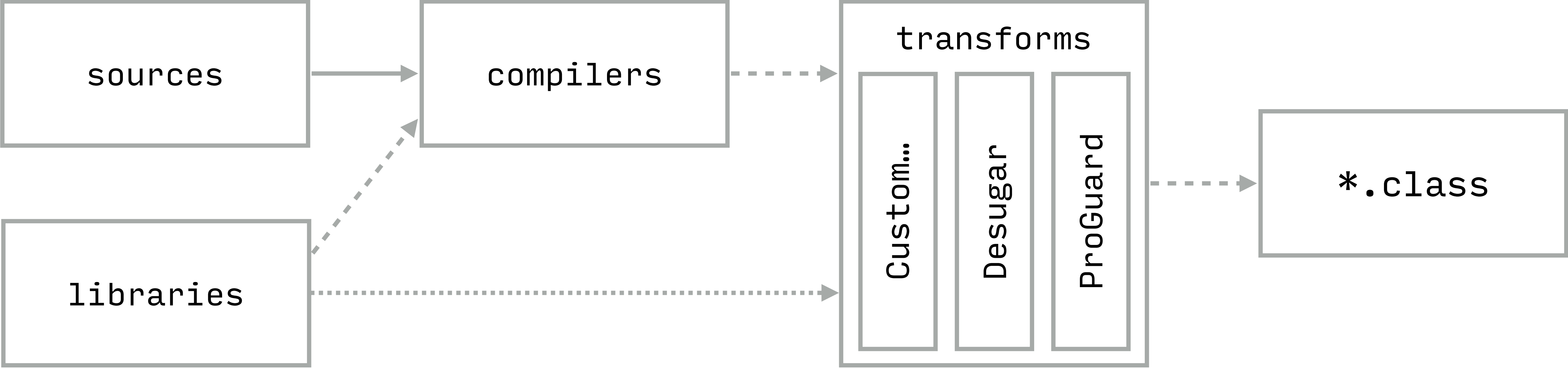
```
25: invokevirtual #9
```

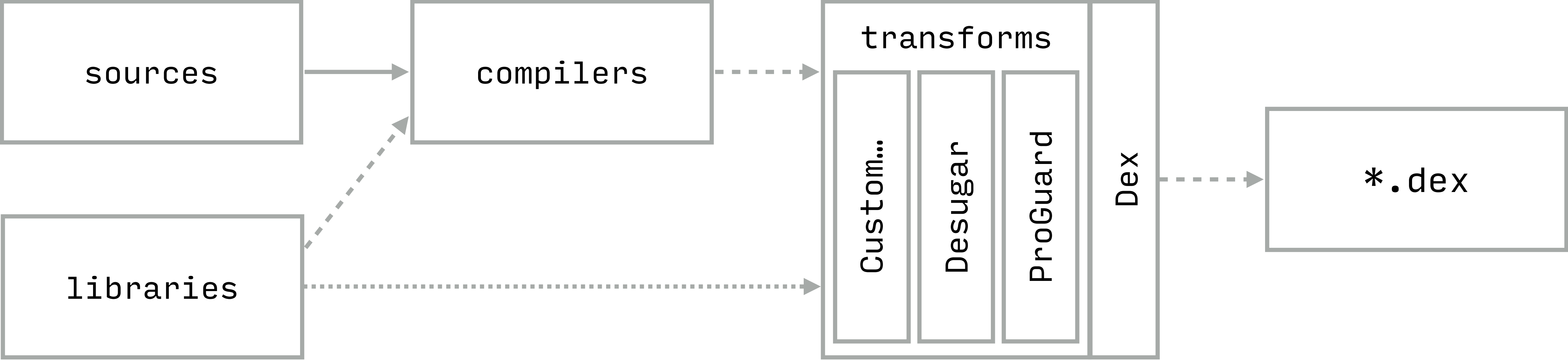
```
28: return
```













```
$ mkdir dexed
```

```
$ mkdir dexed
```

```
$ $ANDROID_HOME/build-tools/27.0.0/dx
```

```
$ mkdir dexed
```

```
$ $ANDROID_HOME/build-tools/27.0.0/dx \
  --dex
```

```
$ mkdir dexed
```

```
$ $ANDROID_HOME/build-tools/27.0.0/dx \
  --dex \
  --output=dexed
```



```
$ mkdir dexed
```

```
$ $ANDROID_HOME/build-tools/27.0.0/dx \  
  --dex \  
  --output=dexed \  
  proguarded
```

```
$ mkdir dexed
```

```
$ $ANDROID_HOME/build-tools/27.0.0/dx \
  --dex \
  --output=dexed \
  proguarded
```

```
$ tree
```

```
.
├── KotlinSafeLet.kt
├── KotlinSafeLetKt.class
├── META-INF
│   └── main.kotlin_module
├── dexed
│   └── classes.dex
└── proguarded
    └── KotlinSafeLetKt.class
```

```
$ $ANDROID_HOME/build-tools/27.0.0/dexdump -d dexed/classes.dex
```

```
$ $ANDROID_HOME/build-tools/27.0.0/dexdump -d dexed/classes.dex
```

```
Opened 'dex/classes.dex', DEX version '035'
```

```
Class #0 -
  Class descriptor : 'LKotlinSafeLetKt;'
  Access flags     : 0x0011 (PUBLIC FINAL)
  Superclass      : 'Ljava/lang/Object;'
  Interfaces      : -
  Static fields   : -
  Instance fields : -
  Direct methods  : -
    #0            : (in LKotlinSafeLetKt;)
      name        : 'sayHi'
      type        : '(Ljava/lang/String;)V'
      access      : 0x0019 (PUBLIC STATIC FINAL)
      code        : -
      registers   : 3
      ins         : 1
      outs        : 2
      insns size  : 23 16-bit code units
000150:          |[000150] KotlinSafeLetKt.sayHi:(Ljava/lang/String;)V
000160: 3802 1600    |[0000: if-eqz v2, 0016 // +0016
000164: 2200 0400    |[0002: new-instance v0, Ljava/lang/StringBuilder; // type@0004
000168: 1a01 0100    |[0004: const-string v1, "Hello, " // string@0001
00016c: 7020 0200 1000 |[0006: invoke-direct {v0, v1}, Ljava/lang/StringBuilder;.<init>:(Ljava/lang/String;)V // method@0002
000172: 6e20 0300 2000 |[0009: invoke-virtual {v0, v2}, Ljava/lang/StringBuilder;.append:(Ljava/lang/String;)Ljava/lang/StringBu
000178: 0c00         |[000c: move-result-object v0
00017a: 6e10 0400 0000 |[000d: invoke-virtual {v0}, Ljava/lang/StringBuilder;.toString:()Ljava/lang/String; // method@0004
000180: 0c00         |[0010: move-result-object v0
000182: 6201 0000    |[0011: sget-object v1, Ljava/lang/System;.out:Ljava/io/PrintStream; // field@0000
000186: 6e20 0100 0100 |[0013: invoke-virtual {v1, v0}, Ljava/io/PrintStream;.println:(Ljava/lang/Object;)V // method@0001
00018c: 0e00         |[0016: return-void
      catches     : (none)
      positions   :
      locals      :

  Virtual methods -
  source_file_idx : -1 (unknown)
```

```
$ $ANDROID_HOME/build-tools/27.0.0/dexdump -d dexed/classes.dex
```

```
Opened 'dex/classes.dex', DEX version '035'
```

```
Class #0      -
  Class descriptor : 'LKotlinSafeLetKt;'
  Access flags     : 0x0011 (PUBLIC FINAL)
  Superclass      : 'Ljava/lang/Object;'
  Interfaces      -
  Static fields    -
  Instance fields  -
  Direct methods   -
    #0            : (in LKotlinSafeLetKt;)
      name        : 'sayHi'
      type        : '(Ljava/lang/String;)V'
      access      : 0x0019 (PUBLIC STATIC FINAL)
      code        -
      registers   : 3
      ins         : 1
      outs        : 2
      insns size  : 23 16-bit code units
000150:      | [000150] KotlinSafeLetKt.sayHi:(Ljava/lang/String;)V
000160: 3802 1600      | 0000: if-eqz v2, 0016 // +0016
000164: 2200 0400      | 0002: new-instance v0, Ljava/lang/StringBuilder; // type@0004
000168: 1a01 0100      | 0004: const-string v1, "Hello, " // string@0001
00016c: 7020 0200 1000 | 0006: invoke-direct {v0, v1}, Ljava/lang/StringBuilder;.<init>:(Ljava/lang/String;)V // method@0002
000172: 6e20 0300 2000 | 0009: invoke-virtual {v0, v2}, Ljava/lang/StringBuilder;.append:(Ljava/lang/String;)Ljava/lang/StringBu
000178: 0c00           | 000c: move-result-object v0
00017a: 6e10 0400 0000 | 000d: invoke-virtual {v0}, Ljava/lang/StringBuilder;.toString:()Ljava/lang/String; // method@0004
000180: 0c00           | 0010: move-result-object v0
000182: 6201 0000      | 0011: sget-object v1, Ljava/lang/System;.out:Ljava/io/PrintStream; // field@0000
000186: 6e20 0100 0100 | 0013: invoke-virtual {v1, v0}, Ljava/io/PrintStream;.println:(Ljava/lang/Object;)V // method@0001
00018c: 0e00           | 0016: return-void
      catches     : (none)
      positions   :
      locals      :

  Virtual methods -
  source_file_idx : -1 (unknown)
```

[000150] KotlinSafeLetKt.sayHi:(Ljava/lang/String;)V

0000: if-eqz v2, 0016

0002: new-instance v0, Ljava/lang/StringBuilder;

0004: const-string v1, "Hello, "

0006: invoke-direct {v0, v1}, Ljava/lang/StringBuilder;.<init>:(Ljava/lang/String;)V

0009: invoke-virtual {v0, v2}, Ljava/lang/StringBuilder;.append:(Ljava/lang/String;)Ljava/lang/

000c: move-result-object v0

000d: invoke-virtual {v0}, Ljava/lang/StringBuilder;.toString():Ljava/lang/String;

0010: move-result-object v0

0011: sget-object v1, Ljava/lang/System;.out:Ljava/io/PrintStream;

0013: invoke-virtual {v1, v0}, Ljava/io/PrintStream;.println:(Ljava/lang/Object;)V

0016: return-void

[000150] KotlinSafeLetKt.sayHi:(Ljava/lang/String;)V

0000: if-eqz v2, 0016

0002: new-instance v0, Ljava/lang/StringBuilder;

0004: const-string v1, "Hello, "

0006: invoke-direct {v0, v1}, Ljava/lang/StringBuilder;.<init>:(Ljava/lang/String;)V

0009: invoke-virtual {v0, v2}, Ljava/lang/StringBuilder;.append:(Ljava/lang/String;)Ljava/lang/

000c: move-result-object v0

000d: invoke-virtual {v0}, Ljava/lang/StringBuilder;.toString():Ljava/lang/String;

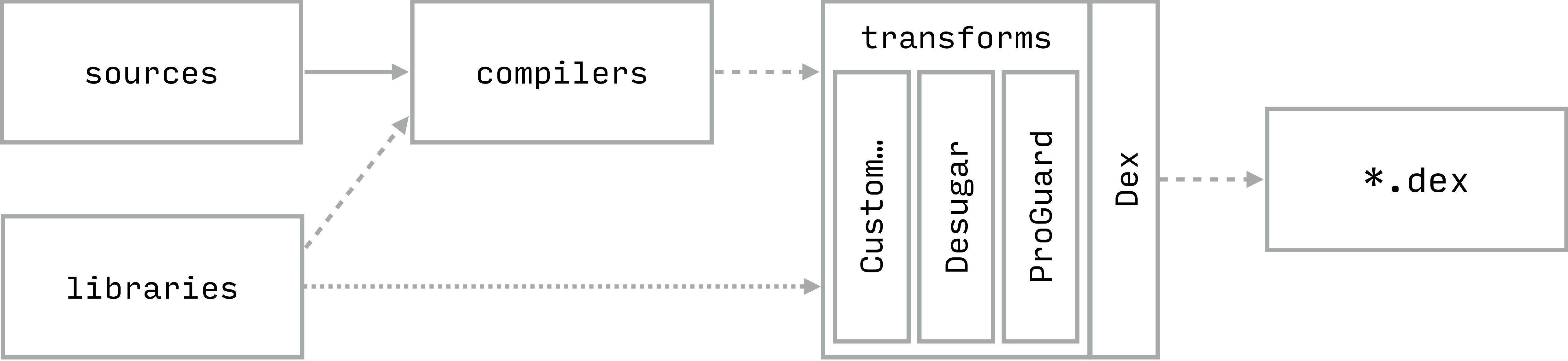
0010: move-result-object v0

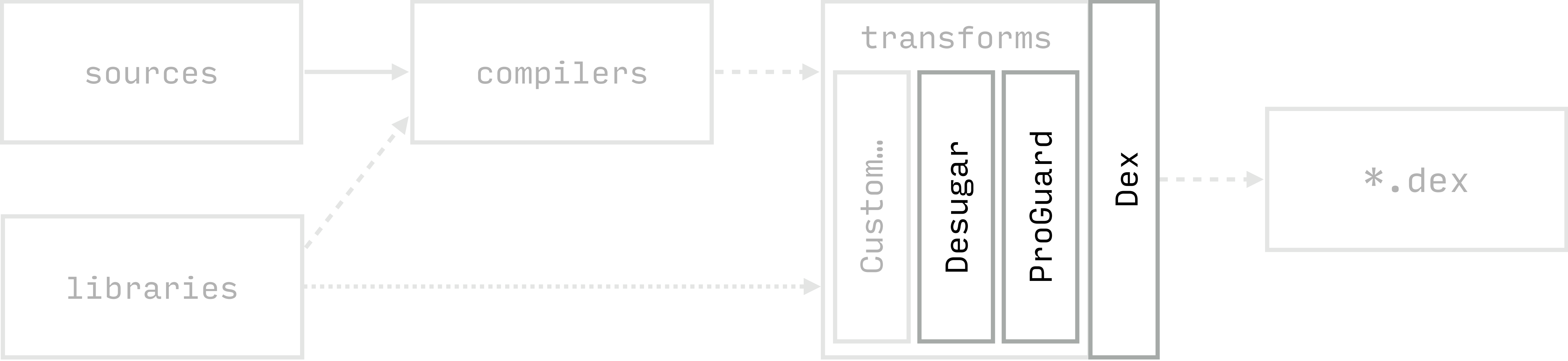
0011: sget-object v1, Ljava/lang/System;.out:Ljava/io/PrintStream;

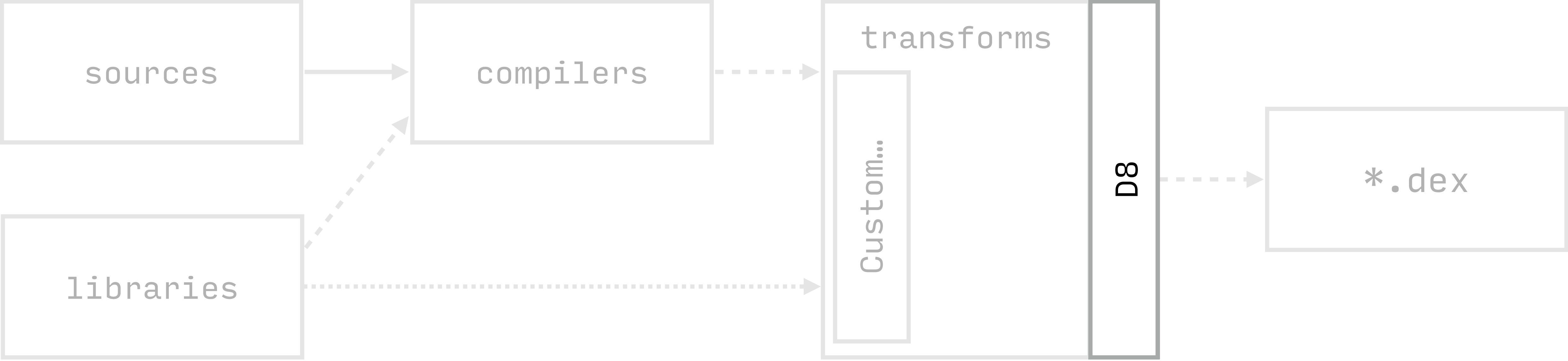
0013: invoke-virtual {v1, v0}, Ljava/io/PrintStream;.println:(Ljava/lang/Object;)V

0016: return-void









```
$ cat Java8.java
```

```
public class Java8 {  
    public static Runnable sayHi(String name) {  
        return () -> System.out.println("Hello, " + name);  
    }  
}
```

```
$ javac Java8.java
```

```
$ git clone https://chromium.googlesource.com/chromium/tools/depot_tools.git
```

```
$ export PATH=$PATH:`pwd`/depot_tools
```

```
$ git clone https://r8.googlesource.com/r8 && cd r8
```

```
$ tools/gradle.py d8
```

```
$ cd ..
```

```
$ java -jar d8/build/libs/d8.jar --help
```

```
$ java -jar d8/build/libs/d8.jar --help
```

```
Usage: d8 [options] <input-files>
```

```
where <input-files> are any combination of dex, class, zip, jar, or apk files  
and options are:
```

<code>--debug</code>	# Compile with debugging information (default).
<code>--release</code>	# Compile without debugging information.
<code>--output <file></code>	# Output result in <outfile>.
	# <file> must be an existing directory or a zip file.
<code>--lib <file></code>	# Add <file> as a library resource.
<code>--classpath <file></code>	# Add <file> as a classpath resource.
<code>--min-api</code>	# Minimum Android API level compatibility
<code>--intermediate</code>	# Compile an intermediate result intended for later # merging.
<code>--file-per-class</code>	# Produce a separate dex file per class
<code>--main-dex-list <file></code>	# List of classes to place in the primary dex file.
<code>--version</code>	# Print the version of d8.
<code>--help</code>	# Print this message.

```
$ mkdir d8ed
```



```
$ mkdir d8ed
```

```
$ java -jar d8/build/libs/d8.jar --release \  
    --output d8ed \  
    *.class
```

```
$ mkdir d8ed
```

```
$ java -jar d8/build/libs/d8.jar --release \  
    --output d8ed \  
    *.class
```

```
$ tree
```

```
.  
├── Java8.class  
├── Java8.java  
├── d8ed  
│   └── classes.dex  
├── depot_tools  
│   └── <snipped>  
└── r8  
    └── <snipped>
```

```
$ $ANDROID_HOME/build-tools/27.0.0/dexdump -d d8ed/classes.dex
```

\$ \$ANDROID_HOME/build-tools/27.0.0/dexdump -d d8ed/classes.dex

```
Opened 'd8/classes.dex', DEX version '035'
Class #0
  Class descriptor : 'Ljava8;'
  Access flags     : 0x0001 (PUBLIC)
  Superclass      : 'Ljava/lang/Object;'
  Interfaces       -
  Static fields    -
  Instance fields  -
  Direct methods   -
  #0              : (in LJava8;)
    name          : '<init>'
    type          : '()V'
    access        : 0x10001 (PUBLIC CONSTRUCTOR)
    code          -
    registers     : 1
    ins           : 1
    outs          : 1
    insns size    : 4 16-bit code units
000228:          [[000228] Java8.<init>:()V
000238: 7010 0600 0000 [[0000: invoke-direct {v0}, Ljava/lang/Object;.<init>:()V // method@0006
00023e: 0e00           [0003: return-void
    catches       : (none)
    positions     :
    0x0000 line=1
    locals        :
    0x0000 - 0x0004 reg=0 this LJava8;

  #1              : (in LJava8;)
    name          : 'sayHi'
    type          : '(Ljava/lang/String;)Ljava/lang/Runnable;'
    access        : 0x0009 (PUBLIC STATIC)
    code          -
    registers     : 2
    ins           : 1
    outs          : 2
    insns size    : 6 16-bit code units
00020c:          [[00020c] Java8.sayHi:(Ljava/lang/String;)Ljava/lang/Runnable;
00021c: 2200 0000       [0000: new-instance v0, L-$$Lambda$Java8$W0ehijVa4A390Y5RF_Bxn0CuvMs; // type@0000
000220: 7020 0000 1000 [0000: invoke-direct {v0, v1}, L-$$Lambda$Java8$W0ehijVa4A390Y5RF_Bxn0CuvMs;.<init>:(Ljava/lang/String;)V // method@0000
00022e: 1100           [0005: return-object v0
    catches       : (none)
    positions     :
    0x0000 line=3
    locals        :

  #2              : (in LJava8;)
    name          : 'lambda$sayHi$0'
    type          : '(Ljava/lang/String;)V'
    access        : 0x1008 (STATIC SYNTHETIC)
    code          -
    registers     : 4
    ins           : 1
    outs          : 2
    insns size    : 23 16-bit code units
000240:          [[000240] Java8.lambda$sayHi$0:(Ljava/lang/String;)V
000250: 6200 0100       [0000: sget-object v0, Ljava/lang/System;.out:Ljava/io/PrintStream; // field@0001
000254: 2201 0600       [0002: new-instance v1, Ljava/lang/StringBuilder; // type@0006
000258: 7010 0700 0100 [0004: invoke-direct {v1}, Ljava/lang/StringBuilder;.<init>:()V // method@0007
00025e: 1a02 0100       [0007: const-string v2, "Hello, " // string@0001
000262: 6e20 0800 2100 [0009: invoke-virtual {v1, v2}, Ljava/lang/StringBuilder;.append:(Ljava/lang/String;)Ljava/lang/StringBuilder; // method@0008
000268: 6e20 0800 3100 [000a: invoke-virtual {v1, v3}, Ljava/lang/StringBuilder;.append:(Ljava/lang/String;)Ljava/lang/StringBuilder; // method@0008
00026e: 6e10 0900 0100 [000f: invoke-virtual {v1}, Ljava/lang/StringBuilder;.toString:()Ljava/lang/String; // method@0009
000274: 0c03           [0012: move-result-object v3
000276: 6e20 0500 3000 [0013: invoke-virtual {v0, v3}, Ljava/io/PrintStream;.println:(Ljava/lang/String;)V // method@0005
00027c: 0e00           [0016: return-void
    catches       : (none)
    positions     :
    0x0000 line=3
    locals        :

Class #1
  Class descriptor : 'L-$$Lambda$Java8$W0ehijVa4A390Y5RF_Bxn0CuvMs;'
  Access flags     : 0x1010 (FINAL SYNTHETIC)
  Superclass      : 'Ljava/lang/Object;'
  Interfaces       -
  #0              : 'Ljava/lang/Runnable;'
  Static fields    -
  Instance fields  -
  #0              : (in L-$$Lambda$Java8$W0ehijVa4A390Y5RF_Bxn0CuvMs;)
    name          : 'fs0'
    type          : 'Ljava/lang/String;'
    access        : 0x1012 (PRIVATE FINAL SYNTHETIC)
  Direct methods   -
  #0              : (in L-$$Lambda$Java8$W0ehijVa4A390Y5RF_Bxn0CuvMs;)
    name          : '<init>'
    type          : '(Ljava/lang/String;)V'
    access        : 0x11001 (PUBLIC SYNTHETIC CONSTRUCTOR)
    code          -
    registers     : 2
    ins           : 2
    outs          : 1
    insns size    : 6 16-bit code units
0001d4:          [[0001d4] -..Lambda.Java8.W0ehijVa4A390Y5RF_Bxn0CuvMs.<init>:(Ljava/lang/String;)V
0001e4: 7010 0600 0000 [0000: invoke-direct {v0}, Ljava/lang/Object;.<init>:()V // method@0006
0001ea: 5d01 0000       [0003: iput-object v1, v0, L-$$Lambda$Java8$W0ehijVa4A390Y5RF_Bxn0CuvMs;.fs0:Ljava/lang/String; // field@0000
0001ee: 0e00           [0005: return-void
    catches       : (none)
    positions     :
    locals        :

  Virtual methods -
  #0              : (in L-$$Lambda$Java8$W0ehijVa4A390Y5RF_Bxn0CuvMs;)
    name          : 'run'
    type          : '()V'
    access        : 0x0011 (PUBLIC FINAL)
    code          -
    registers     : 1
    ins           : 1
    outs          : 1
    insns size    : 6 16-bit code units
0001f0:          [[0001f0] -..Lambda.Java8.W0ehijVa4A390Y5RF_Bxn0CuvMs.run:()V
000200: 5400 0000       [0000: iget-object v0, v0, L-$$Lambda$Java8$W0ehijVa4A390Y5RF_Bxn0CuvMs;.fs0:Ljava/lang/String; // field@0000
000204: 7110 0300 0000 [0002: invoke-static {v0}, LJava8;.lambda$sayHi$0:(Ljava/lang/String;)V // method@0003
00020a: 0e00           [0005: return-void
    catches       : (none)
    positions     :
    locals        :

source_file_idx  : 17 (lambda)

Virtual methods -
source_file_idx  : 2 (Java8.java)
```

Class #0

Class descriptor : 'Ljava8;'

Superclass : 'Ljava/lang/Object;'

Direct methods

#0 : (in LJava8;)

name : '<init>'

type : '()V'

#1 : (in LJava8;)

name : 'sayHi'

type : '(Ljava/lang/String;)Ljava/lang/Runnable;'

#2 : (in LJava8;)

name : 'lambda\$sayHi\$0'

type : '(Ljava/lang/String;)V'

Class #0

Class descriptor : 'Ljava8;'

Superclass : 'Ljava/lang/Object;'

Direct methods

#0 : (in LJava8;)

name : '<init>'

type : '()V'

#1 : (in LJava8;)

name : 'sayHi'

type : '(Ljava/lang/String;)Ljava/lang/Runnable;'

#2 : (in LJava8;)

name : 'lambda\$sayHi\$0'

type : '(Ljava/lang/String;)V'

Class #1

Class descriptor : 'L-\$\$Lambda\$Java8\$W0ehijVa4A390Y5RF_Bxn0CuvMs;'

Superclass : 'Ljava/lang/Object;'

Interfaces

#0 : 'Ljava/lang/Runnable;'

Instance fields

#0

name : 'f\$0'

type : 'Ljava/lang/String;'

Direct methods

#0

name : '<init>'

type : '(Ljava/lang/String;)V'

Virtual methods

#0

name : 'run'

type : '()V'

Class #1

Class descriptor : 'L-\$\$Lambda\$Java8\$W0ehijVa4A390Y5RF_Bxn0CuvMs;'

Superclass : 'Ljava/lang/Object;'

Interfaces

#0 : 'Ljava/lang/Runnable;'

Instance fields

#0

name : 'f\$0'

type : 'Ljava/lang/String;'

Direct methods

#0

name : '<init>'

type : '(Ljava/lang/String;)V'

Virtual methods

#0

name : 'run'

type : '()V'


```
$ cat KotlinSafeLet.kt
fun sayHi(name: String?) {
    name?.let { println("Hello, $it") }
}
```

```
$ kotlinc KotlinSafeLet.kt
```

```
$ javap -c KotlinSafeLetKt
```

```
public final class KotlinSafeLetKt {  
    public static final void sayHi(java.lang.String);
```

```
    Code:
```

```
        0: aload_0  
        1: dup  
        2: ifnull          38  
        5: astore_1  
        6: aload_1  
        7: astore_2  
        8: new            #9      // class java/lang/StringBuilder  
       11: dup  
       12: invokespecial  #13      // Method java/lang/StringBuilder."<init>":()V  
       15: ldc          #15      // String Hello,  
       17: invokevirtual #19      // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;  
       20: aload_2  
       21: invokevirtual #19      // Method java/lang/StringBuilder.append:(Ljava/lang/String;)Ljava/lang/StringBuilder;  
       24: invokevirtual #23      // Method java/lang/StringBuilder.toString:()Ljava/lang/String;  
       27: astore_3  
       28: getstatic    #29      // Field java/lang/System.out:Ljava/io/PrintStream;  
       31: aload_3  
       32: invokevirtual #35      // Method java/io/PrintStream.println:(Ljava/lang/Object;)V  
       35: goto        39  
       38: pop  
       39: return
```

```
}
```

```
$ d8/build/libs/d8.jar --release \  
  --output d8ed \  
  KotlinSafeLetKt.class
```

```
$ d8/build/libs/d8.jar --release \  
  --output d8ed \  
  KotlinSafeLetKt.class
```

```
$ $ANDROID_HOME/build-tools/27.0.0/dexdump -d d8ed/classes.dex
```

```
$ d8/build/libs/d8.jar --release \
  --output d8ed \
  KotlinSafeLetKt.class
```

```
$ $ANDROID_HOME/build-tools/27.0.0/dexdump -d d8ed/classes.dex
```

```
Opened 'd8/classes.dex', DEX version '035'
```

```
Class #0
  Class descriptor : 'LKotlinSafeLetKt;'
  Access flags     : 0x0011 (PUBLIC FINAL)
  Superclass      : 'Ljava/lang/Object;'
  Interfaces      :
  Static fields   :
  Instance fields :
  Direct methods  :
    #0
      name         : 'sayHi'
      type         : '(Ljava/lang/String;)V'
      access       : 0x0019 (PUBLIC STATIC FINAL)
      code         :
      registers    : 3
      ins         : 1
      outs        : 2
      insns size   : 25 16-bit code units

0001a4: |[0001a4] KotlinSafeLetKt.sayHi:(Ljava/lang/String;)V
0001b4: 3802 1800 |0000: if-eqz v2, 0018 // +0018
0001b8: 2200 0500 |0002: new-instance v0, Ljava/lang/StringBuilder; // type@0005
0001bc: 7010 0200 0000 |0004: invoke-direct {v0}, Ljava/lang/StringBuilder;.<init>:()V // method@0002
0001c2: 1a01 0300 |0007: const-string v1, "Hello, " // string@0003
0001c6: 6e20 0300 1000 |0009: invoke-virtual {v0, v1}, Ljava/lang/StringBuilder;.append:(Ljava/lang/String;)Ljava/lang/StringBuilder; // method@0003
0001cc: 6e20 0300 2000 |000c: invoke-virtual {v0, v2}, Ljava/lang/StringBuilder;.append:(Ljava/lang/String;)Ljava/lang/StringBuilder; // method@0003
0001d2: 6e10 0400 0000 |000f: invoke-virtual {v0}, Ljava/lang/StringBuilder;.toString:()Ljava/lang/String; // method@0004
0001d8: 0c02 |0012: move-result-object v2
0001da: 6200 0000 |0013: sget-object v0, Ljava/lang/System;.out:Ljava/io/PrintStream; // field@0000
0001de: 6e20 0100 2000 |0015: invoke-virtual {v0, v2}, Ljava/io/PrintStream;.println:(Ljava/lang/Object;)V // method@0001
0001e4: 0e00 |0018: return-void

      catches      : (none)
      positions     :
      0x0002 line=2
      locals       :

Virtual methods :
source_file_idx : 4 (KotlinSafeLet.kt)
```

[0001a4] KotlinSafeLetKt.sayHi:(Ljava/lang/String;)V

0000: if-eqz v2, 0018

0002: new-instance v0, Ljava/lang/StringBuilder;

0004: invoke-direct {v0}, Ljava/lang/StringBuilder;<init>:()V

0007: const-string v1, "Hello, "

0009: invoke-virtual {v0, v1}, Ljava/lang/StringBuilder;.append:(Ljava/lang/String;)Ljava/lang/String;

000c: invoke-virtual {v0, v2}, Ljava/lang/StringBuilder;.append:(Ljava/lang/String;)Ljava/lang/String;

000f: invoke-virtual {v0}, Ljava/lang/StringBuilder;.toString:()Ljava/lang/String;

0012: move-result-object v2

0013: sget-object v0, Ljava/lang/System;.out:Ljava/io/PrintStream;

0015: invoke-virtual {v0, v2}, Ljava/io/PrintStream;.println:(Ljava/lang/Object;)V

0018: return-void

[0001a4] KotlinSafeLetKt.sayHi:(Ljava/lang/String;)V

0000: if-eqz v2, 0018

0002: new-instance v0, Ljava/lang/StringBuilder;

0004: invoke-direct {v0}, Ljava/lang/StringBuilder;<init>:()V

0007: const-string v1, "Hello, "

0009: invoke-virtual {v0, v1}, Ljava/lang/StringBuilder;.append:(Ljava/lang/String;)Ljava/lang/String;

000c: invoke-virtual {v0, v2}, Ljava/lang/StringBuilder;.append:(Ljava/lang/String;)Ljava/lang/String;

000f: invoke-virtual {v0}, Ljava/lang/StringBuilder;.toString:()Ljava/lang/String;

0012: move-result-object v2

0013: sget-object v0, Ljava/lang/System;.out:Ljava/io/PrintStream;

0015: invoke-virtual {v0, v2}, Ljava/io/PrintStream;.println:(Ljava/lang/Object;)V

0018: return-void

[0001a4] KotlinSafeLetKt.sayHi:(Ljava/lang/String;)V

0000: if-eqz v2, 0018

0002: new-instance v0, Ljava/lang/StringBuilder;

0004: invoke-direct {v0}, Ljava/lang/StringBuilder;<init>:()V

0007: const-string v1, "Hello, "

0009: invoke-virtual {v0, v1}, Ljava/lang/StringBuilder;.append:(Ljava/lang/String;)Ljava/lang/

000c: invoke-virtual {v0, v2}, Ljava/lang/StringBuilder;.append:(Ljava/lang/String;)Ljava/lang/

000f: invoke-virtual {v0}, Ljava/lang/StringBuilder;.toString:()Ljava/lang/String;

0012: move-result-object v2

0013: sget-object v0, Ljava/lang/System;.out:Ljava/io/PrintStream;

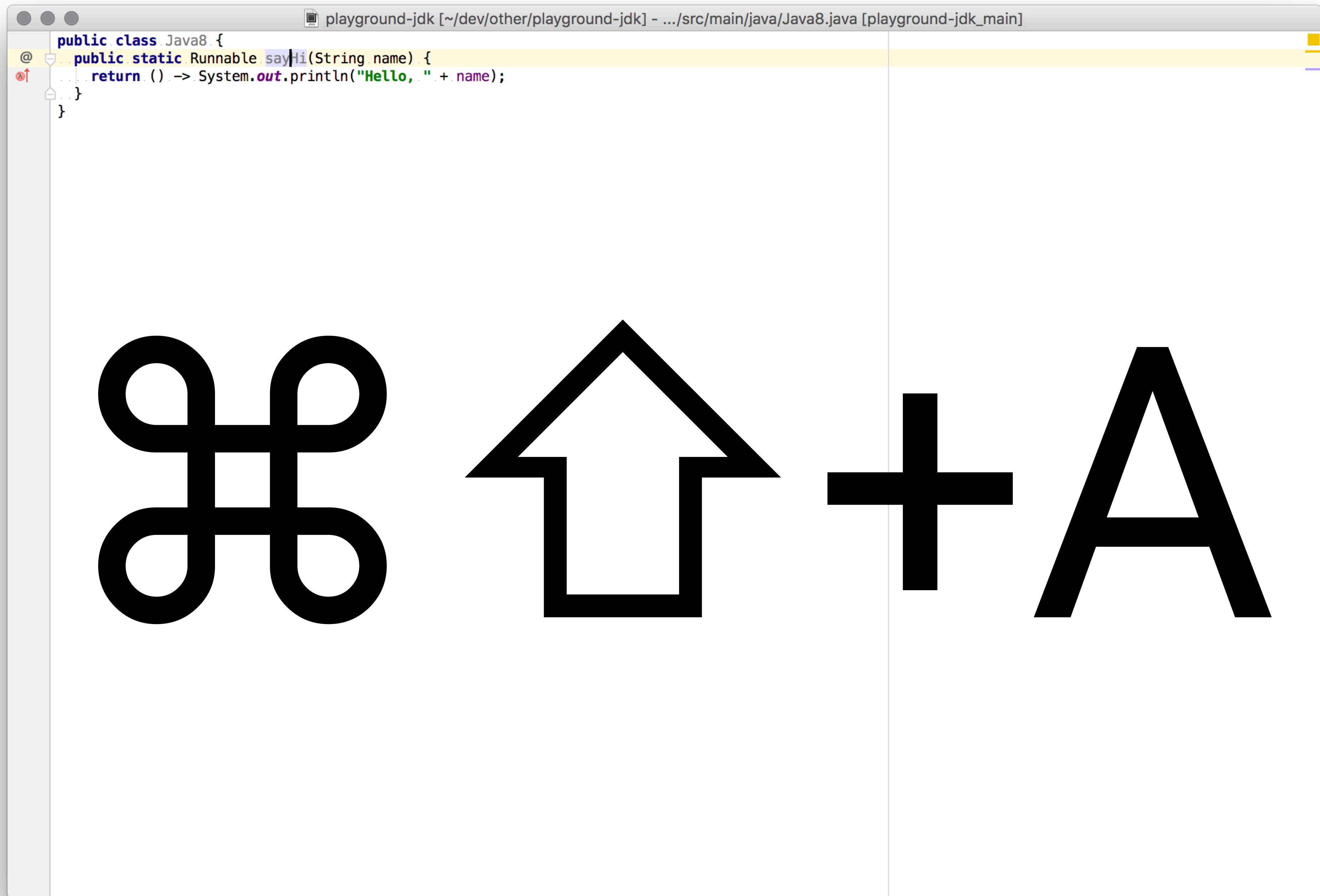
0015: invoke-virtual {v0, v2}, Ljava/io/PrintStream;.println:(Ljava/lang/Object;)V

0018: return-void

playground-jdk [~/dev/other/playground-jdk] - .../src/main/java/Java8.java [playground-jdk_main]

@
↑

```
public class Java8 {  
    public static Runnable sayHi(String name) {  
        return () -> System.out.println("Hello, " + name);  
    }  
}
```



playground-jdk [~/dev/other/playground-jdk] - .../src/main/java/Java8.java [playground-jdk_main]

```
public class Java8 {  
    @ public static Runnable sayHi(String name) {  
        return () -> System.out.println("Hello, " + name);  
    }  
}
```

Enter action or option name: ☐ Include disabled actions ⌘A

🔍 sby

×

Show BytecodeView

Editor Tabs: Sort Tabs By FilenameOFF

Add Selection for Next Occurrence ^GFind

Debug Log Settings...Help

Select All Occurrences ^⌘GFind

Symbol... ⌘O

File Structure ⌘F12

Implementation(s) ⌘B

Related Symbol... ^⌘↑

Select In... ⌘F1

Super Method ⌘U

Bitwise operation issues: Shift operation by ...ON

Bitwise operation issues: Shift operation by ...ON

Goto by Name Actions

Goto by Reference Actions

Goto by Reference Actions

Goto by Reference Actions

Goto by Reference Actions

Goto by Reference Actions

Press ⌘↑ or ⌘↓ to navigate through the search history

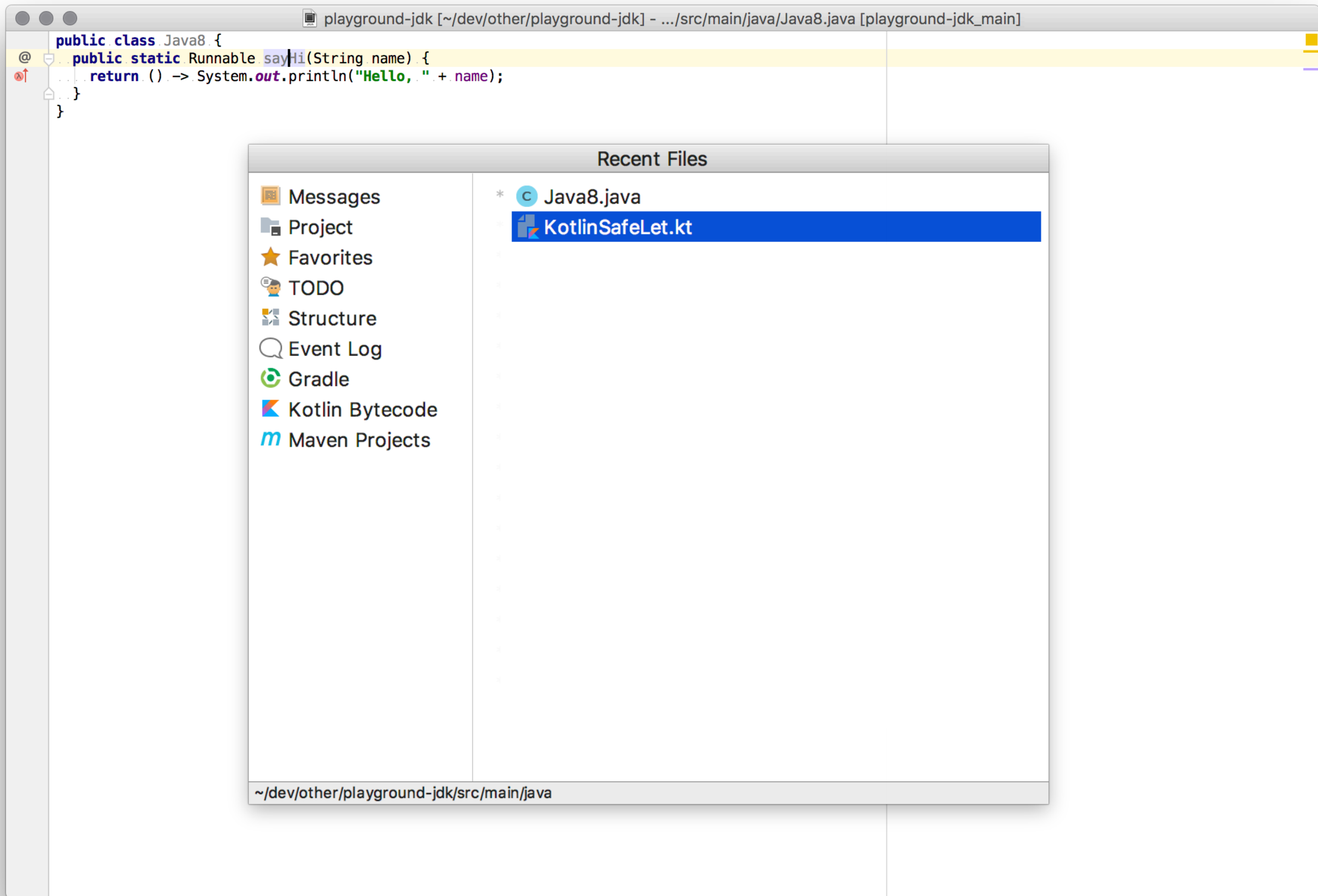
```
playground-jdk [~/dev/other/playground-jdk] - .../src/main/java/Java8.java [playground-jdk_main]

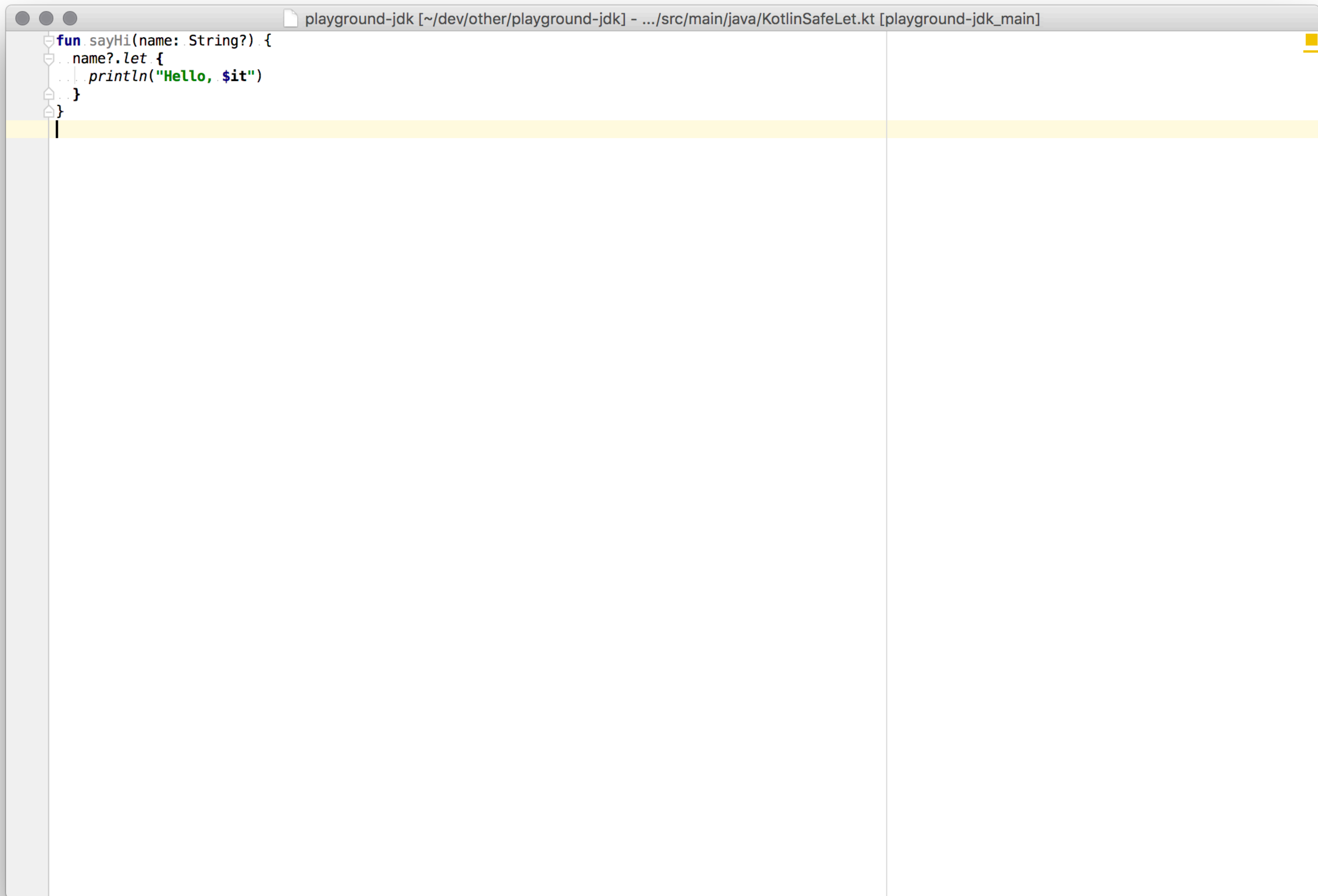
public class Java8 {
    @ public static Runnable sayHi(String name) {
        return () -> System.out.println("Hello, " + name);
    }
}

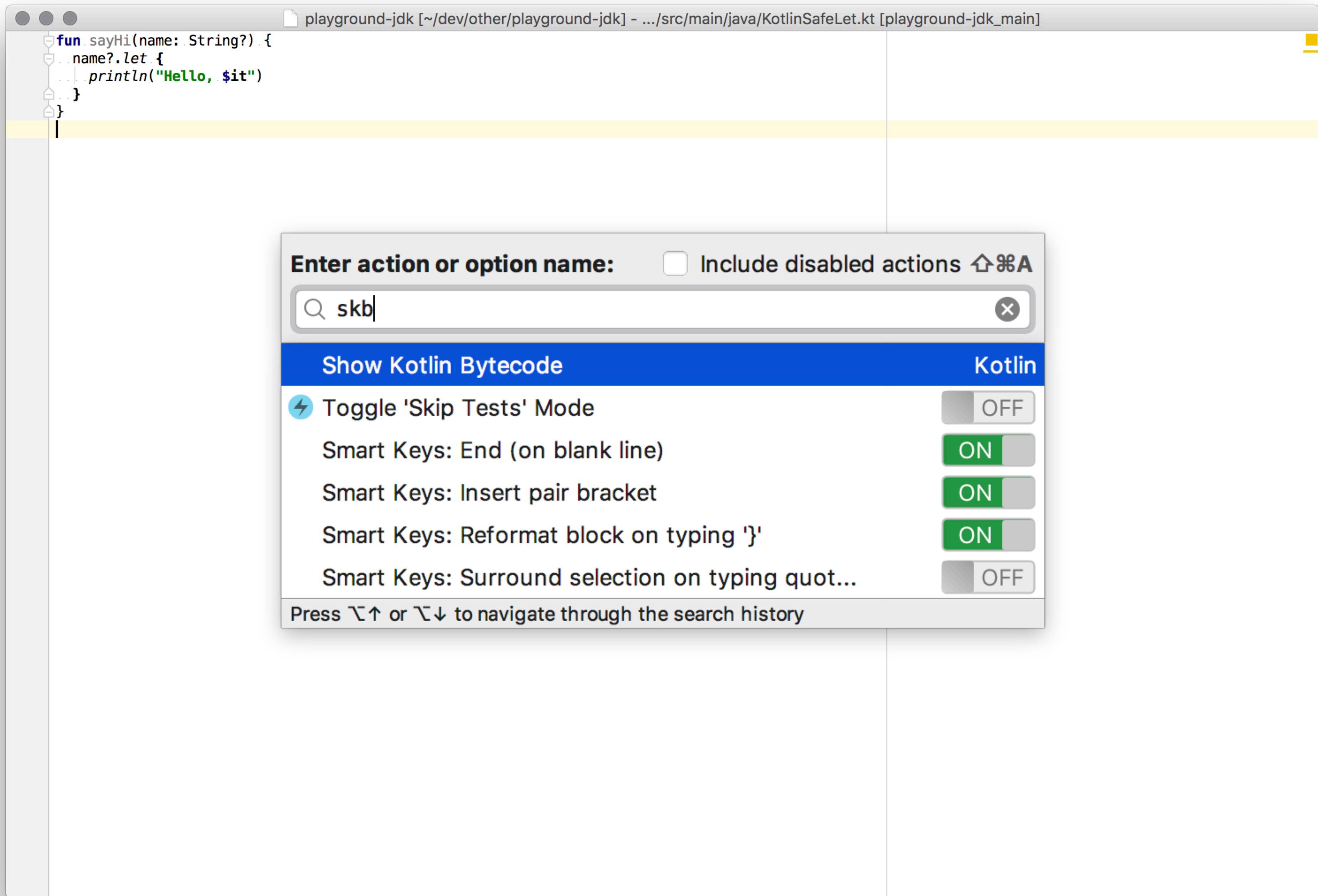
Java8 Bytecode

// access flags 0x9
public static sayHi(Ljava/lang/String;)Ljava/lang/Runnable;
L0
LINENUMBER 3 L0
ALOAD 0
INVOKEDYNAMIC run(Ljava/lang/String;)Ljava/lang/Runnable; [
    // handle kind 0x6 : INVOKESTATIC
    java/lang/invoke/LambdaMetafactory.metafactory(Ljava/lang/invoke/MethodHandles$Lookup;Ljava/lang/String;Ljava/lang/invoke/Met
    // arguments:
    ()V,
    // handle kind 0x6 : INVOKESTATIC
    Java8.lambda$sayHi$0(Ljava/lang/String;)V,
    ()V
]
ARETURN
L1
LOCALVARIABLE name Ljava/lang/String; L0 L1 0
MAXSTACK = 1
MAXLOCALS = 1

// access flags 0x100A
private static synthetic lambda$sayHi$0(Ljava/lang/String;)V
L0
LINENUMBER 3 L0
GETSTATIC java/lang/System.out : Ljava/io/PrintStream;
NEW java/lang/StringBuilder
DUP
INVOKESPECIAL java/lang/StringBuilder.<init> ()V
LDC "Hello, "
INVOKEVIRTUAL java/lang/StringBuilder.append (Ljava/lang/String;)Ljava/lang/StringBuilder;
ALOAD 0
INVOKEVIRTUAL java/lang/StringBuilder.append (Ljava/lang/String;)Ljava/lang/StringBuilder;
INVOKEVIRTUAL java/lang/StringBuilder.toString ()Ljava/lang/String;
INVOKEVIRTUAL java/io/PrintStream.println (Ljava/lang/String;)V
RETURN
L1
LOCALVARIABLE name Ljava/lang/String; L0 L1 0
MAXSTACK = 3
MAXLOCALS = 1
}
```







playground-jdk [~/dev/other/playground-jdk] - .../src/main/java/KotlinSafeLet.kt [playground-jdk_main]

```
fun sayHi(name: String?) {  
    name?.let {  
        println("Hello, $it")  
    }  
}
```

Kotlin Bytecode

Decompile ☒ Inline ☒ Optimization ☒ Assertions ☐ IR ☐ JVM 8 target

```
public final class KotlinSafeLetKt {  
  
    // access flags 0x19  
    public final static sayHi(Ljava/lang/String;)V  
        @Lorg/jetbrains/annotations/Nullable;() // invisible, parameter 0  
    L0  
        LINENUMBER 2 L0  
        ALOAD 0  
        DUP  
        IFNULL L1  
        ASTORE 1  
    L2  
        ALOAD 1  
        ASTORE 2  
    L3  
        LINENUMBER 3 L3  
        NEW java/lang/StringBuilder  
        DUP  
        INVOKESPECIAL java/lang/StringBuilder.<init> ()V  
        LDC "Hello, "  
        INVOKEVIRTUAL java/lang/StringBuilder.append (Ljava/lang/String;)Ljava/lang/StringBuilder;  
        ALOAD 2  
        INVOKEVIRTUAL java/lang/StringBuilder.append (Ljava/lang/String;)Ljava/lang/StringBuilder;  
        INVOKEVIRTUAL java/lang/StringBuilder.toString ()Ljava/lang/String;  
        ASTORE 3  
    L4  
        GETSTATIC java/lang/System.out : Ljava/io/PrintStream;  
        ALOAD 3  
        INVOKEVIRTUAL java/io/PrintStream.println (Ljava/lang/Object;)V  
    L5  
    L6  
        LINENUMBER 4 L6  
    L7  
        NOP  
    L8  
        LINENUMBER 2 L8  
    L9  
        GOTO L10  
    L1  
        POP  
    L10  
    L11  
        LINENUMBER 5 L11  
        RETURN
```


playground-jdk [~/dev/other/playground-jdk] - .../src/main/java/KotlinSafeLet.kt [playground-jdk_main]

fun sayHi(name: String?) {
 name?.let {
 println("Hello, \$it")
 }
}

Kotlin Bytecode

Decompile

☒ Inline

☒ Optimization

☒ Assertions

☐ IR

☐ JVM 8 target

```
public final class KotlinSafeLetKt {  
  
    ...// access.flags 0x19  
    ...public final static sayHi(Ljava/lang/String;)V  
    ...@Lorg/jetbrains/annotations/Nullable;()// invisible, parameter 0  
    ...L0  
    ...LINENUMBER 2 L0  
    ...ALOAD 0  
    ...DUP  
    ...IFNULL L1  
    ...ASTORE 1  
    ...L2  
    ...ALOAD 1  
    ...ASTORE 2  
    ...L3  
    ...LINENUMBER 3 L3  
    ...NEW java/lang/StringBuilder  
    ...DUP  
    ...INVOKESPECIAL java/lang/StringBuilder.<init> ()V  
    ...LDC "Hello, "  
    ...INVOKEVIRTUAL java/lang/StringBuilder.append (Ljava/lang/String;)Ljava/lang/StringBuilder;  
    ...ALOAD 2  
    ...INVOKEVIRTUAL java/lang/StringBuilder.append (Ljava/lang/String;)Ljava/lang/StringBuilder;  
    ...INVOKEVIRTUAL java/lang/StringBuilder.toString ()Ljava/lang/String;  
    ...ASTORE 3  
    ...L4  
    ...GETSTATIC java/lang/System.out : Ljava/io/PrintStream;  
    ...ALOAD 3  
    ...INVOKEVIRTUAL java/io/PrintStream.println (Ljava/lang/Object;)V  
    ...L5  
    ...L6  
    ...LINENUMBER 4 L6  
    ...L7  
    ...NOP  
    ...L8  
    ...LINENUMBER 2 L8  
    ...L9  
    ...GOTO L10  
    ...L1  
    ...POP  
    ...L10  
    ...L11  
    ...LINENUMBER 5 L11  
    ...RETURN
```

```
$ tree app/build
```

```
app/build
```

```
├── intermediates
│   ├── classes
│   └── transforms
│       ├── desugar
│       ├── dex
│       └── proguard
├── outputs
│   └── apk
└── tmp
    └── kotlin-classes
```

class files for Java + apt sources

backported language features

dalvik bytecode

stripped, optimized, obfuscated classes

final APKs

class files for Kotlin sources

Java Bytecode

- VM structure:
<https://docs.oracle.com/javase/specs/jvms/se9/html/jvms-2.html>
- Bytecode reference:
<https://docs.oracle.com/javase/specs/jvms/se9/html/jvms-6.html>

Dalvik Bytecode

- Dex format:
<https://source.android.com/devices/tech/dalvik/dex-format>
- Bytecode reference:
<https://source.android.com/devices/tech/dalvik/dalvik-bytecode>

Exploring Java Hidden Costs



Jake Wharton

Eliminating Code Overhead

Jake Wharton



@jessewilson

Dex Ed

DEVOXX™

Memories of Android

(based on a talk and articles by Dianne Hackborn)

Romain Guy
Chet Haase

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google.com/+ChetHaase

@romainguy
@chethaase

Exploring Java Hidden Tests

youtu.be/WALV33rWye4

 Jake Wharton

Eliminating Out of Order Head

youtu.be/b6zKBZcg5fk



@jessewilson

youtu.be/v4Ewjqr9XI

Dex Ed

DEVOXX™

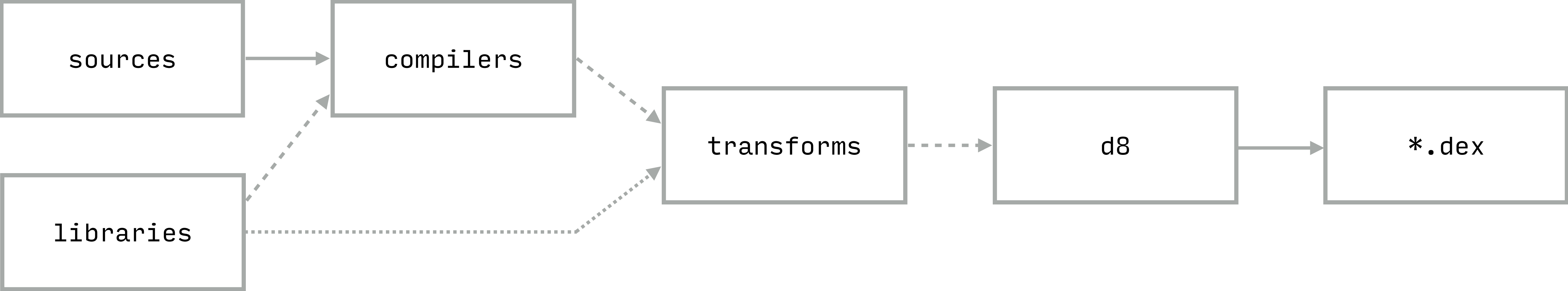
Mem
(based on a talk and articles by Dianne Hackborn)

youtu.be/Ho-anLsWvJo

Romain Guy
Chet Haase

google.com/+RomainGuy
google.com/+ChetHaase

@romainguy
@chethaase



```
$ cat Intrinsic.java
```

```
class Intrinsic {  
    static double doMath(double x, int y) {  
        return Math.sqrt(x) + y;  
    }  
}
```



```
$ cat Intrinsic.java
```

```
class Intrinsic {  
    static double doMath(double x, int y) {  
        return Math.sqrt(x) + y;  
    }  
}
```

```
$ javac Intrinsic.java
```

```
$ javap -c Intrinsic
```

```
class Intrinsic {  
    static double doMath(double, double);  
    Code:  
        0: dload_0  
        1: invokestatic    #2          // Method java/lang/Math.sqrt:(D)D  
        4: dload_2  
        5: dadd  
        6: dreturn  
}
```

```
$ cat Intrinsic.java
```

```
class Intrinsic {  
    static double doMath(double x, int y) {  
        return Math.sqrt(x) + y;  
    }  
}
```

```
$ javac Intrinsic.java
```

```
$ javap -c Intrinsic
```

```
class Intrinsic {  
    static double doMath(double, double);  
    Code:  
        0: dload_0  
        1: invokestatic #2    // Method java/lang/Math.sqrt:(D)D  
        4: dload_2  
        5: dadd  
        6: dreturn  
}
```

```
$ $ANDROID_HOME/build-tools/27.0.0/dx --dex --output . *.class
```

```
$ $ANDROID_HOME/build-tools/27.0.0/dexdump -d classes.dex
```

```
Opened 'classes.dex', DEX version '035'
```

```
Class #0
  Class descriptor : 'LIntrinsic;'
  Access flags     : 0x0000 ()
  Superclass      : 'Ljava/lang/Object;'
  Direct methods
    #0
      name         : 'doMath'
      type         : '(DD)D'
      access       : 0x0009 (PUBLIC STATIC)
      code
        registers  : 6
        ins        : 4
        outs       : 2
        insns size : 6 16-bit code units
```

```
00012c: |[00012c] Intrinsic.doMath:(DD)D
00013c: 7120 0200 3200 |0000: invoke-static {v2, v3}, Ljava/lang/Math;.sqrt:(D)D // method@0002
000142: 0b00 |0003: move-result-wide v0
000144: cb40 |0004: add-double/2addr v0, v4
000146: 1000 |0005: return-wide v0
```

```
  catches        : (none)
  positions       :
    0x0000 line=3
  locals         :
```

```
Virtual methods -
source_file_idx  : 4 (Intrinsic.java)
```

```
$ $ANDROID_HOME/build-tools/27.0.0/dx --dex --output . *.class
```

```
$ $ANDROID_HOME/build-tools/27.0.0/dexdump -d classes.dex
```

```
Opened 'classes.dex', DEX version '035'
```

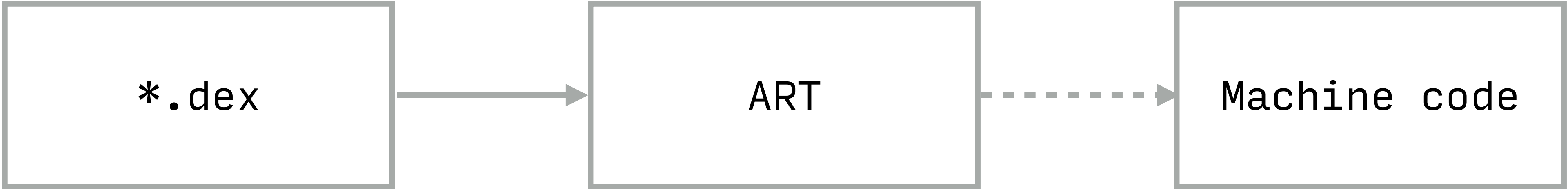
```
Class #0
-
Class descriptor : 'LIntrinsic;'
Access flags     : 0x0000 ()
Superclass       : 'Ljava/lang/Object;'
Direct methods
-
#0
: (in LIntrinsic;)
name             : 'doMath'
type             : '(DD)D'
access           : 0x0009 (PUBLIC STATIC)
code
-
registers        : 6
ins              : 4
outs             : 2
insns size       : 6 16-bit code units
```

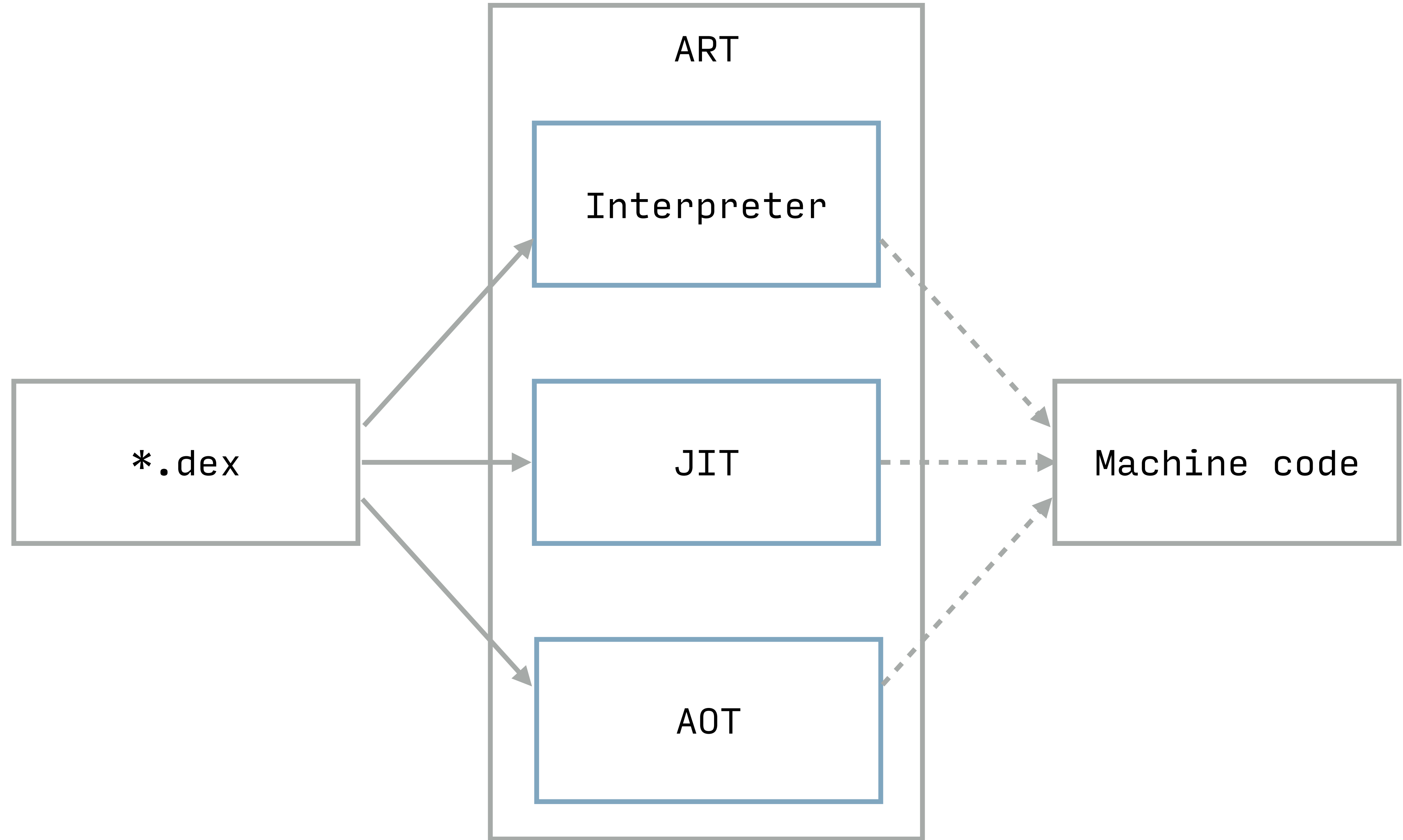
```
00012c: |[00012c] Intrinsic.doMath:(DD)D
00013c: 7120 0200 3200 |0000: invoke-static {v2, v3}, Ljava/lang/Math;.sqrt:(D)D // method@0002
000142: 0b00           |0003: move-result-wide v0
000144: cb40           |0004: add-double/2addr v0, v4
000146: 1000           |0005: return-wide v0
```

```
catches         : (none)
positions        :
0x0000 line=3
locals          :
```

```
Virtual methods
-
source_file_idx  : 4 (Intrinsic.java)
```

*.dex





```
$ adb push out/classes.dex /sdcard/classes.dex
```



```
$ adb push out/classes.dex /sdcard/classes.dex
```

```
$ adb shell dex2oat
```

```
$ adb push out/classes.dex /sdcard/classes.dex
```

```
$ adb shell dex2oat \  
    --dex-file=/sdcard/classes.dex
```

```
$ adb push out/classes.dex /sdcard/classes.dex
```

```
$ adb shell dex2oat \  
  --dex-file=/sdcard/classes.dex \  
  --out-file=/sdcard/classes.oat
```

```
$ adb push out/classes.dex /sdcard/classes.dex
```

```
$ adb shell dex2oat \  
  --dex-file=/sdcard/classes.dex \  
  --out-file=/sdcard/classes.oat
```

```
$ adb shell oatdump --oat-file=/sdcard/classes.oat
```

```
oat
151
LOCATION:
/sdcard/classes.oat

CHECKSUM:
0x777f6479

INSTRUCTION SET:
Thumb2

INSTRUCTION SET FEATURES:
-div,-atomic_ldrd_strd,-armv8a

DEX FILE COUNT:
1

EXECUTABLE OFFSET:
0x00001000

INTERPRETER TO INTERPRETER BRIDGE OFFSET:
0x00000000

INTERPRETER TO COMPILED CODE BRIDGE OFFSET:
0x00000000

JNI DLSYM LOOKUP OFFSET:
0x00000000

QUICK GENERIC JNI TRAMPOLINE OFFSET:
0x00000000

QUICK INT CONFLICT TRAMPOLINE OFFSET:
0x00000000

QUICK RESOLUTION TRAMPOLINE OFFSET:
0x00000000

QUICK TO INTERPRETER BRIDGE OFFSET:
0x00000000

IMAGE PATCH DELTA:
10551936 (0x0fc9000)

IMAGE FILE LOCATION DAT CHECKSUM:
0x001c0cd

IMAGE FILE LOCATION DAT BEGIN:
0x717d3000

KEY VALUE STORE:
classpath = PCLE[]
compiler-filter = speed
concurrent-copying = true
debuggable = false
dex-opts=none = --dex-file=/sdcard/classes.dex --out-file=/sdcard/classes.oat
dex-opt-host = Arm
image-location = /data/dalvik-cache/arm/system/framework#boot.art:/data/dalvik-cache/arm/system/framework#boot-core-libart.art:/data/dalvik-cache/arm/system/framework#boot-conscrypt.art:/data/dalvik-cache/arm/system/framework#boot-dshhttp.art:/data/dalvik-cache/arm/system/framework#boot-bouncycastle.art:/data/dalvik-cache/arm/system/framework#boot-apache-xml.art:/data/dalvik-cache/arm/system/framework#boot-legacy-test.art:/data/dalvik-cache/arm/system/framework#boot-ext.art:/data/dalvik-cache/arm/system/framework#boot-framework.art:/data/dalvik-cache/arm/system/framework#boot-telephony-common.art:/data/dalvik-cache/arm/system/framework#boot-vsi-jcommon.art:/data/dalvik-cache/arm/system/framework#boot-is-common.art:/data/dalvik-cache/arm/system/framework#boot-android.hidl.manager-V1.0-java.art:/data/dalvik-cache/arm/system/framework#boot-com.google.vr-platform.art
native-debuggable = false
pic = false

SIZE:
4182

Dex file data for /sdcard/classes.dex
Num string ids: 11
Num method ids: 4
Num field ids: 0
Num type ids: 5
Num class defs: 1
Unique strings loaded from dex code: 0
Total strings loaded from dex code: 0
Number of unique dex code items: 2
Total number of dex code bytes: 20

Layout data
SectionTypeCode:LayoutTypeSometimesUsed(0-0) LayoutTypeStartupOnly(0-0) LayoutTypeHot(0-0) LayoutTypeUsedOnce(0-0) LayoutTypeUnused(0-0)
SectionTypeStrings:LayoutTypeSometimesUsed(0-0) LayoutTypeStartupOnly(0-0) LayoutTypeHot(0-0) LayoutTypeUsedOnce(0-0) LayoutTypeUnused(0-0)

Cumulative dex file data
Num string ids: 11
Num method ids: 4
Num field ids: 0
Num type ids: 5
Num class defs: 1
Unique strings loaded from dex code: 0
Total strings loaded from dex code: 0
Number of unique dex code items: 2
Total number of dex code bytes: 20

Dependencies of /sdcard/classes.dex:
Ljava/lang/Math; must be resolved with access flags 1
Ljava/lang/Object; must be resolved with access flags 1
Ljava/lang/Metric$Metric() is expected to be in class Ljava/lang/Math;, have the access flags 0
Ljava/lang/Object;~<init>()V is expected to be in class Ljava/lang/Object;, have the access flags 1

OatDexFile:
location: /sdcard/classes.dex
checksum: 0xcdb450
dex-file: 0x00000001..0x00000020
type-table: 0x00000020..0x00000027
0: intrinsic (offset=0x0000007c) (type_idx=1) (StatusInitialized) (OutClassAllCompiled)
0: void intrinsic.<init>() (dex_method_idx=0)
DEX CODES
0x0000: 7100 0300 0000 | invoke-direct [v0], void java.lang.Object.<init>() // method03
0x0001: 0000 | return-void
OatMethodOffsets (offset=0x00000000)
code offset: 0x00001019
OatQuickMethodHeader (offset=0x00001000)
vmmap table: (offset=0x00000000)
Optimized CodeInfo (number_of_dex_registers=0, number_of_stack_maps=0)
StackMapEncoding (native_pc_bit_offset=0, dex_pc_bit_offset=0, dex_register_map_bit_offset=1, inline_info_bit_offset=1, register_mask_bit_offset=1, stack_mask_index_bit_offset=1, total_bit_size=1)
 DexRegisterLocationCatalog (number_of_entries=0, size_in_bytes=0)

QuickMethodInfo
frame_size_in_bytes: 0
core_spill_mask: 0x00004020 (<r5, r14)
fp_spill_mask: 0x00000000
vr_stack_locations:
ins: v[sp + #4]
method: v[sp + #0]
outs: v[sp + #4]

CODE (code_offset=0x00001019 size_offset=0x00001014 size=2)...
0x00001019: 4770 | bx lr
1: double Intrinsic.doMath(double, double) (dex_method_idx=1)

DEX CODES
0x0000: 7100 0200 3200 | invoke-static [v2, v3], double java.lang.Math.sqrt(double) // method02
0x0001: 0000 | move-result-wide v0
0x0002: 0040 | add-double/2addr v0, v4
0x0003: 1000 | return-wide v0
OatMethodOffsets (offset=0x00000004)
code offset: 0x00001039
OatQuickMethodHeader (offset=0x00001000)
vmmap table: (offset=0x00000000)
Optimized CodeInfo (number_of_dex_registers=0, number_of_stack_maps=0)
StackMapEncoding (native_pc_bit_offset=0, dex_pc_bit_offset=0, dex_register_map_bit_offset=1, inline_info_bit_offset=1, register_mask_bit_offset=1, stack_mask_index_bit_offset=1, total_bit_size=1)
 DexRegisterLocationCatalog (number_of_entries=0, size_in_bytes=0)

QuickMethodInfo
frame_size_in_bytes: 0
core_spill_mask: 0x00004020 (<r5, r14)
fp_spill_mask: 0x00000000
vr_stack_locations:
locals: v[sp + #4204087270] v[sp + #4204087280]
ins: v[sp + #4] v[sp + #0] v[sp + #0] v[sp + #12] v[sp + #16]
method: v[sp + #0]
outs: v[sp + #4] v[sp + #8]

CODE (code_offset=0x00001039 size_offset=0x00001034 size=10)...
0x00001039: ead1bcd | vshort.f64 db, db | vshort.f64 db, db
0x0000103c: ee31bd00 | vadd.f64 db, d1, db
0x00001040: 4770 | bx lr

OAT FILE STATS:
Dumping cumulative use of 70 annotated bytes
Code = 12 (15% of total)
QuickMethodHeader = 40 (51% of total)
CodeInfoEncoding = 10 (13% of total)
CodeInfoLocationCatalog = 0 (0% of total)
CodeInfoFromRegisterMap = 0 (0% of total)
CodeInfoFromStackMaps = 0 (0% of total)
CodeInfoFromRegisterMasks = 0 (0% of total)
CodeInfoFromInvokeInfo = 0 (0% of total)
CodeInfoFromStackMap = 0 (0% of total)
StackMapNativePc = 0 (nawk of stack map)
StackMapDexPcEncoding = 0 (nawk of stack map)
StackMapDexRegisterMap = 0 (nawk of stack map)
StackMapInlineInfoIndex = 0 (nawk of stack map)
StackMapRegisterMaskIndex = 0 (nawk of stack map)
StackMapStackMaskIndex = 0 (nawk of stack map)
CodeInfoInlineInfo = 0 (0% of total)
InlineInfoMethodIndexIndex = 0 (nawk of inline info)
InlineInfoPc = 0 (nawk of inline info)
InlineInfoExtraData = 0 (nawk of inline info)
InlineInfoFromRegisterMap = 0 (nawk of inline info)
InlineInfoFromSet = 0 (nawk of inline info)
```

```

1: double Intrinsic.doMath(double, double) (dex_method_idx=1)
  DEX CODE:
    0x0000: 7120 0200 3200          | invoke-static {v2, v3}, double java.lang.Math.sqrt(double)
    0x0003: 0b00                    | move-result-wide v0
    0x0004: cb40                    | add-double/2addr v0, v4
    0x0005: 1000                    | return-wide v0
  OatMethodOffsets (offset=0x00000584)
    code_offset: 0x00001039
  OatQuickMethodHeader (offset=0x00001020)
    vmap_table: (offset=0x00000ab0)
      Optimized CodeInfo (number_of_dex_registers=6, number_of_stack_maps=0)
        StackMapEncoding (native_pc_bit_offset=0, dex_pc_bit_offset=0,
          dex_register_map_bit_offset=1, inline_info_bit_offset=1, register_mask_bit_offset=1,
          stack_mask_index_bit_offset=1, total_bit_size=1)
        DexRegisterLocationCatalog (number_of_entries=0, size_in_bytes=0)
  QuickMethodFrameInfo
    frame_size_in_bytes: 0
    core_spill_mask: 0x00004020 (r5, r14)
    fp_spill_mask: 0x00000000
    vr_stack_locations:
      locals: v0[sp + #4294967276] v1[sp + #4294967280]
      ins: v2[sp + #4] v3[sp + #8] v4[sp + #12] v5[sp + #16]
      method*: v6[sp + #0]
      outs: v0[sp + #4] v1[sp + #8]
  CODE: (code_offset=0x00001039 size_offset=0x00001034 size=10)...
    0x00001038: eeb10bc0          vsqrt.f64 d0, d0
    0x0000103c: ee310b00          vadd.f64 d0, d1, d0
    0x00001040: 4770                bx lr

```

```

1: double Intrinsic.doMath(double, double) (dex_method_idx=1)
DEX CODE:
  0x0000: 7120 0200 3200          | invoke-static {v2, v3}, double java.lang.Math.sqrt(double)
  0x0003: 0b00                  | move-result-wide v0
  0x0004: cb40                  | add-double/2addr v0, v4
  0x0005: 1000                  | return-wide v0
OatMethodOffsets (offset=0x00000584)
  code_offset: 0x00001039
OatQuickMethodHeader (offset=0x00001020)
  vmap_table: (offset=0x00000ab0)
    Optimized CodeInfo (number_of_dex_registers=6, number_of_stack_maps=0)
      StackMapEncoding (native_pc_bit_offset=0, dex_pc_bit_offset=0,
        dex_register_map_bit_offset=1, inline_info_bit_offset=1, register_mask_bit_offset=1,
        stack_mask_index_bit_offset=1, total_bit_size=1)
      DexRegisterLocationCatalog (number_of_entries=0, size_in_bytes=0)
QuickMethodFrameInfo
  frame_size_in_bytes: 0
  core_spill_mask: 0x00004020 (r5, r14)
  fp_spill_mask: 0x00000000
  vr_stack_locations:
    locals: v0[sp + #4294967276] v1[sp + #4294967280]
    ins: v2[sp + #4] v3[sp + #8] v4[sp + #12] v5[sp + #16]
    method*: v6[sp + #0]
    outs: v0[sp + #4] v1[sp + #8]
CODE: (code_offset=0x00001039 size_offset=0x00001034 size=10)...
  0x00001038: eeb10bc0          vsqrt.f64 d0, d0
  0x0000103c: ee310b00          vadd.f64 d0, d1, d0
  0x00001040: 4770             bx lr

```

```

1: double Intrinsic.doMath(double, double) (dex_method_idx=1)
DEX CODE:
    0x0000: 7120 0200 3200          | invoke-static {v2, v3}, double java.lang.Math.sqrt(double)
    0x0003: 0b00                  | move-result-wide v0
    0x0004: cb40                  | add-double/2addr v0, v4
    0x0005: 1000                  | return-wide v0
OatMethodOffsets (offset=0x00000584)
    code_offset: 0x00001039
OatQuickMethodHeader (offset=0x00001020)
    vmap_table: (offset=0x00000ab0)
        Optimized CodeInfo (number_of_dex_registers=6, number_of_stack_maps=0)
            StackMapEncoding (native_pc_bit_offset=0, dex_pc_bit_offset=0,
                dex_register_map_bit_offset=1, inline_info_bit_offset=1, register_mask_bit_offset=1,
                stack_mask_index_bit_offset=1, total_bit_size=1)
            DexRegisterLocationCatalog (number_of_entries=0, size_in_bytes=0)
QuickMethodFrameInfo
    frame_size_in_bytes: 0
    core_spill_mask: 0x00004020 (r5, r14)
    fp_spill_mask: 0x00000000
    vr_stack_locations:
        locals: v0[sp + #4294967276] v1[sp + #4294967280]
        ins: v2[sp + #4] v3[sp + #8] v4[sp + #12] v5[sp + #16]
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  QuickMethodFrameInfo
    frame_size_in_bytes: 0
    core_spill_mask: 0x00004020 (r5, r14)
    fp_spill_mask: 0x00000000
    vr_stack_locations:
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    method*: v6[sp + #0]
    outs: v0[sp + #4] v1[sp + #8]
CODE: (code_offset=0x00001040 size_offset=0x0000103c size=12)...
  0x00001040: F20F51D0      sqrtsd xmm2, xmm0
  0x00001044: F20F58CA      addsd xmm1, xmm2
  0x00001048: 0F28C1      movaps xmm0, xmm1
  0x0000104b: C3          ret

```

Sinking Your Teeth Into Bytecode

@JakeWharton