Overview

Statements

Purposes of statements:

Declaring variables and assigning values.

Control **whether** code will be executed.

Control **how often** code will be executed.

Statements: General syntax

Statement's body terminated by “;”

```
{statement};
```

Statement examples: Declaring and assigning variables

Variable declaration:

```
int a;
```

Value assignment:

```
a = 33;
```

Combined declaration and assignment:

```
int a = 33;
```

Expression vs. statement

Expression:

```
a - 4
```

Statement:

```
b = a - 4;
```

Notice the trailing “ ; ”.

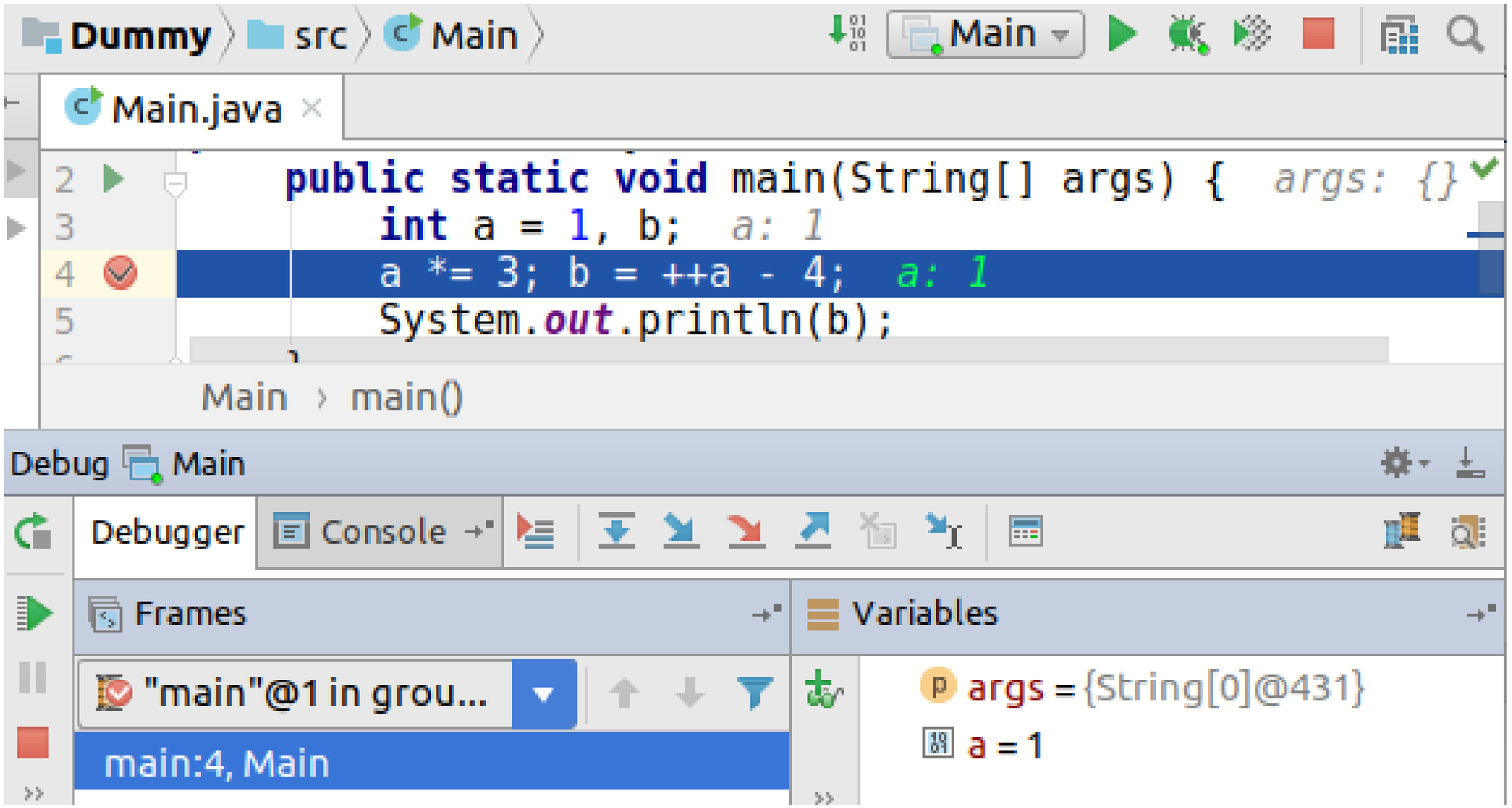
Multiple statements per line

```
a = b + 3; b = a - 4;
```

Discouraged by good coding practices:

- Poor readability
- Hampers debugging

Debugging multiple statements per line



Class scope

- Variable being defined on class level.
- Visible to all methods.

```
public class X {
  // Class variable
  static int i = 3;

  public static void main(String[] args) {
    System.out.println("main: i=" + i);
    someMethod();
  }
  public static void someMethod() {
    System.out.println("someMethod: i=" + i);
  }
}
```

Method local variable scope

- Method scope being delimited by the { ... } block
- A variable's visibility is restricted to its block:

```
public class X {
  public static void main(String[] args) {
    int i = 1; // Visible in current method
    System.out.println("i=" + i);
    someMethod(); // Method call
  }
  public static void someMethod() {
    int j = 3;
    System.out.println("j=" + j);

    int i = 17; // No conflict with i in main(...)
    System.out.println("i=" + i);
  }
}
```

Blocks

```
public static void main(String[] args) {
  double initialAmount = 34;
  { // first block
    final double interestRate = 1.2; // 1.2%
    System.out.println("Interest:" + initialAmount * interestRate / 100);
  }
  { // second block
    final double interestRate = 0.8; // 0.8%
    System.out.println("Interest:" + initialAmount * interestRate / 100);
  }
}
```

• Defining scopes • Unit of work	• `if`: Conditional block execution. • `for` / `while`: Repeated block execution.

Overview

Statements

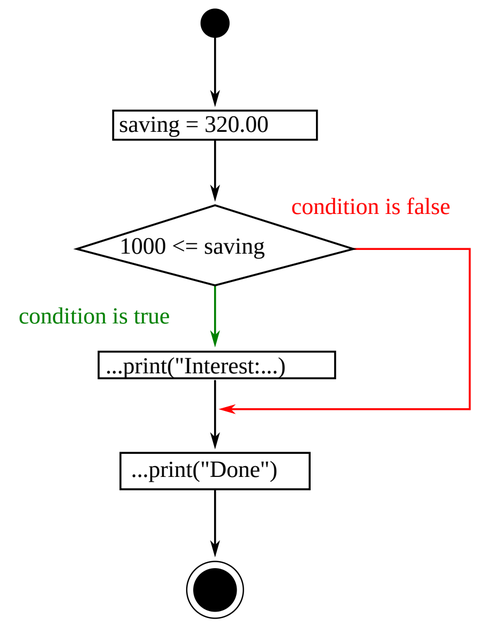
➟ The if conditional statement

Conditional block execution

```
double saving = 320.00;

if (1000 <= saving) {
  // Rich customer, 1,2% interest ra
  System.out.println(
    "Interest:" + 1.2 * saving / 100
}
System.out.println("Done!");
```

```
Done!
```



`if` syntax

```
if (booleanExpression)
  (block | statement)
```

Overview

Statements

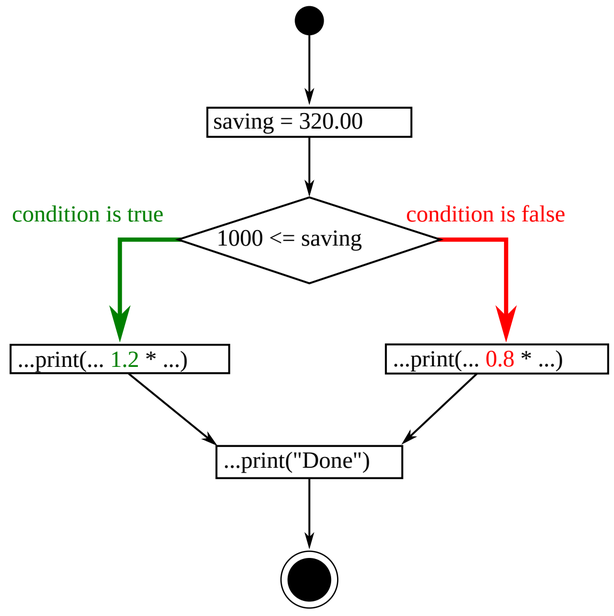
- The if conditional statement
  - if-then-`else`

if … else

```
double saving = 320.00;

if (1000 <= saving ❶)  { ❷
  // Rich customer, 1,2% interest rate
  System.out.println(
     "Interest:" + 1.2 * saving / 100);
} ❸ else { ❹
  // Joe customer, 0.8%
  // standard interest rate
  System.out.println(
    "Interest:" + 0.8 * saving / 100);
}
System.out.println("Done!");
```

```
Interest:2.56
Done!
```



`if ... else` syntax

```
if (booleanExpression)
   (block | statement)
[else
   (block | statement) ]  (1)
```

Best practices comparing for equality

Use

```
if (4 == variable) ...
```

in favour of:

```
if (variable == 4) ...  1
```

Followup exercises

Single statement branches

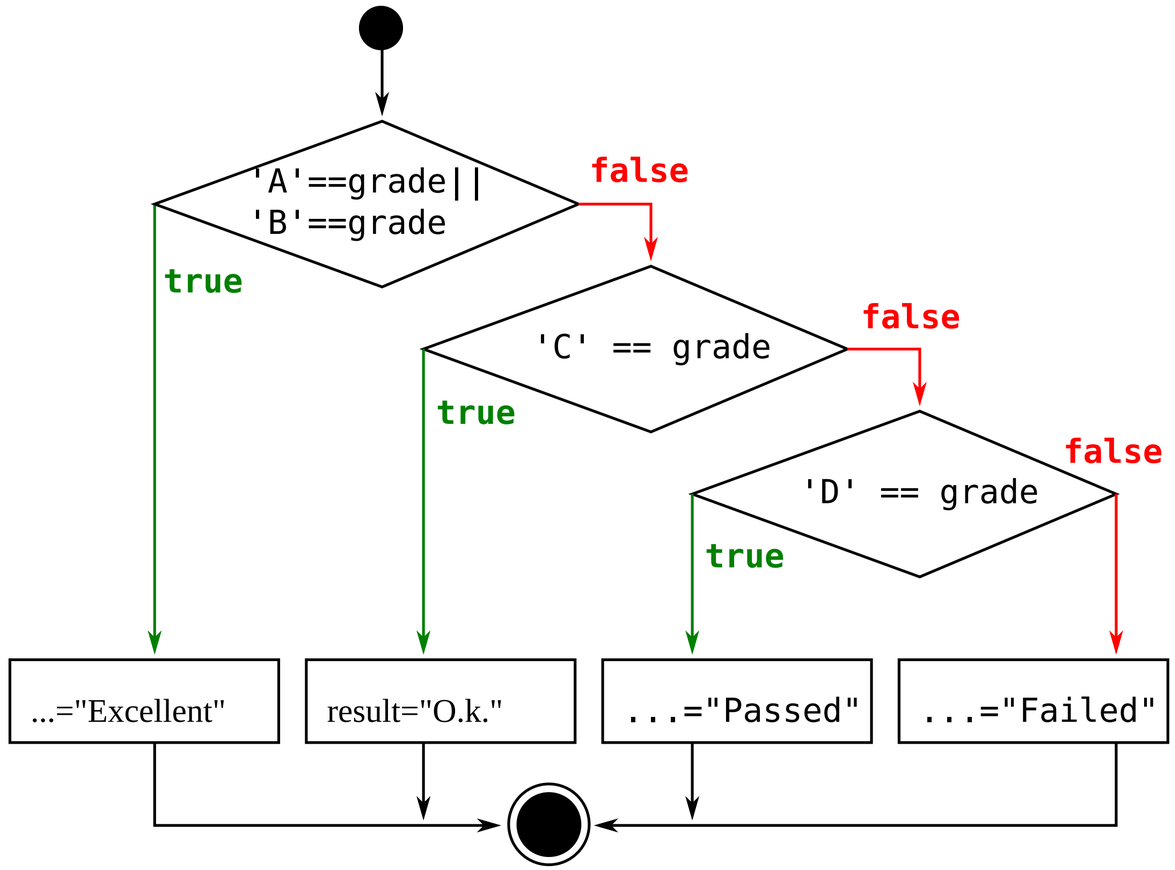
Branches containing exactly one statement don't require a block definition.

```
double initialAmount = 3200;

if (100000 <= initialAmount)
  System.out.println("Interest:" + 1.2 * initialAmount / 100);
else if (1000 <= initialAmount)
  System.out.println("Interest:" + 0.8 * initialAmount / 100);
else
  System.out.println("Interest:" + 0);
```

Nested `if ... else`

```
if ('A' == grade || 'B' == grade)
   result = "Excellent";
} else {
   if ('C' == grade) {
      result = "O.k.";
   } else {
      if ('D' == grade) {
         result = "Passed";
      } else {
         result = "Failed";
      }
   }
}
```



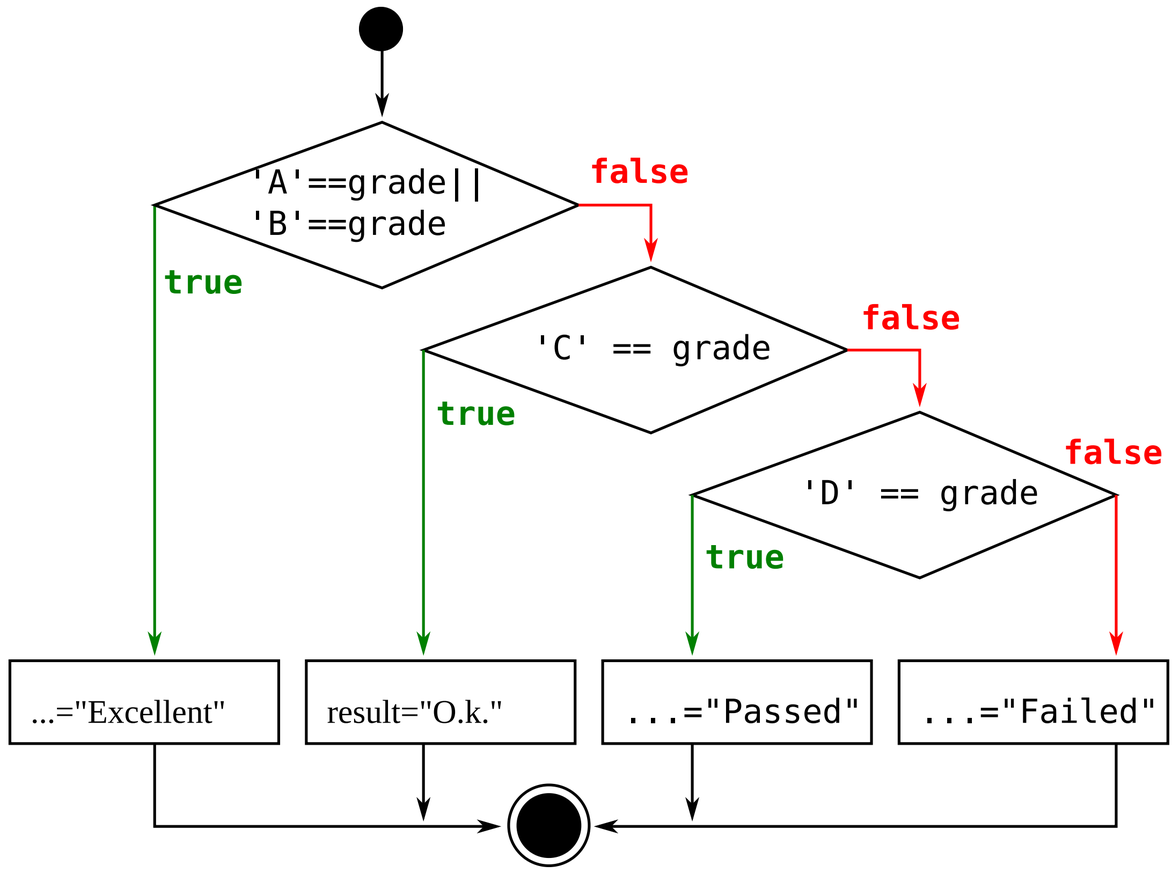
Overview

Statements

- The if conditional statement
- Using `else if`

Enhanced readability: `if ... else if ... else`

```
if ('A' == grade || 'B' == grade)
   result = "Excellent";
} else if ('C' == grade) {
   result = "O.k.";
} else if ('D' == grade) {
   result = "Passed";
} else {
   result = "Failed";
}
```



`if ... else if ... else` syntax

```
if (booleanExpression)
   (block | statement)
[else if (booleanExpression)
   (block | statement) ]* (1)
[else
  (block | statement) ] (2)
```

Followup exercise

57. Replacing `else if (...){...}` by nested `if ... else` statements

User input recipe

```java
import java.util.Scanner;

public class App {
  public static void main(String[] args){

    final Scanner scan =
        new Scanner(System.in);
    System.out.print("Enter a value:");
    final int value = scan.nextInt();
    System.out.println("You entered "
       + value);
  }
}
```

```
Enter a value:123
You entered 123
```

See `nextBoolean()`, `nextByte()` and friends.

Followup exercises

58. Post modifying an exam's marking
59. At the bar
60. Roman numerals

Converting numbers to day’s names

Task: Convert day's numbers to day's names

1	Monday
2	Tuesday
3	Wednesday
4	Thursday
5	Friday
6	Saturday
7	Sunday

Numbers to day's names: The hard way

```
final Scanner scan = new Scanner(System.in));
System.out.print("Enter a weekday number (1=Monday, 2=Tuesday,...) : ");

final int number = scan.nextInt();

if (1 == number) {
   System.out.println("Monday");
} else if (2 == number) {
   System.out.println("Tuesday");
   ...

} else if (7 == number) {
   System.out.println("Sunday");
} else {
   System.out.println("Invalid number " + number);
}
```

Followup exercise

61. Leap years

Overview

Statements

- The `switch` statement

Better: Using `switch`

```
...
switch(number) {
    case 1: System.out.println("Monday"); break;
    case 2: System.out.println("Tuesday"); break;
    case 3: System.out.println("Wednesday"); break;
    case 4: System.out.println("Thursday"); break;
    case 5: System.out.println("Friday"); break;
    case 6: System.out.println("Saturday"); break;
    case 7: System.out.println("Sunday"); break;

    default: System.out.println("Invalid number " + number); break;
} ...
```

```
Enter a weekday number (1=Monday, 2=Tuesday,...) : 6
Saturday
```

`switch` Syntax

```
switch(expression) {
[case value_1 :
    [statement]*
    [break;] ]
[case value_2 :
    [statement]*
    [break;] ]
  ...
[case value_n :
    [statement]*
    [break;] ]
[default:
    [statement]*
    [break;] ]
}
```

Followup exercises

62. Why “break”?

63. Extending to month days

Switching on strings

```
String month, season; ... // Since Java 7: String based
  case
labels switch(month) { case "March": case "April": case "May": season = "Spring"; break; case "June": case "July":
case "August": season = "Summer"; break; case "September": case "October": case "November": season = "Autumn";
break; case "December": case "January": case "February": season = "Winter"; break; } }
```

Followup exercises

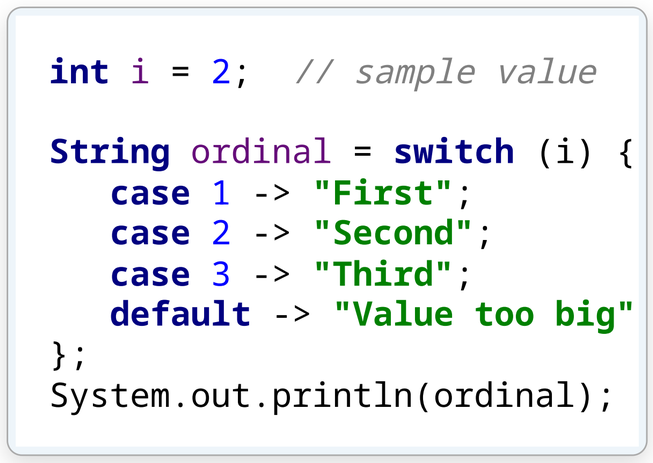
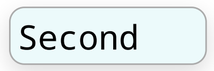
64. Converting day's names to numbers.
65. Day categories.
66. Roman numerals, using `switch`

`switch` expressions

```
switch(number) {
  case 1: System.out.println("Monday"); break;
  case 2: System.out.println("Tuesday"); break;
          ...
  case 7: System.out.println("Sunday"); break;
  default: System.out.println("Invalid number " + numbe
}
```

```
switch(number) {
  case 1 -> System.out.println("Monday");
  case 2 -> System.out.println("Tuesday");
          ...
  case 7 -> System.out.println("Sunday");
  default -> System.out.println("Invalid number " + numb
}
```

Assigning `switch` expressions

Code	Output
	

```java
int i = 2;  // sample value

String ordinal = switch (i) {
   case 1 -> "First";
   case 2 -> "Second";
   case 3 -> "Third";
   default -> "Value too big"
};
System.out.println(ordinal);
```

```
Second
```

Allowed types for `switch` statements

- Integer types, related by boxing / unboxing:
  - `byte` and `Byte`
  - `short` and `Short`
  - `int` and `Integer`
  - `char` and `Character`
- `String`
- `enum` types

Allowed labels

```
int wed = 3;

int number = 6;

switch(number) {
   case 1 -> System.out.println("Monday");       // o.k., constant int literal
  case 1 + 1 -> System.out.println("Tuesday"); // o.k. constant int expression
  case wed -> System.out.println("Wednesday"); // Error: Constant expression required
      ...
```

Overview

Statements

➟ Loops

Why loops?

Objective: Execute the same statement multiple times.

"Solution": Copy / paste the statement in question:

```
System.out.println("Do not copy!");
System.out.println("Do not copy!");
System.out.println("Do not copy!");
System.out.println("Do not copy!");
```

Problem: Desired number of repetitions must be known at compile time.

Number of repetitions given by user input

```
System.out.print("Enter desired number of repetitions: ");
final int repetitions = scan.nextInt();
switch(repetitions) {  // Employing fall-through
    case 5: System.out.println("Do not copy!");
    case 4: System.out.println("Do not copy!");
    case 3: System.out.println("Do not copy!");
    case 2: System.out.println("Do not copy!");
    case 1: System.out.println("Do not copy!");   }
```

Limited and clumsy workaround.

Overview

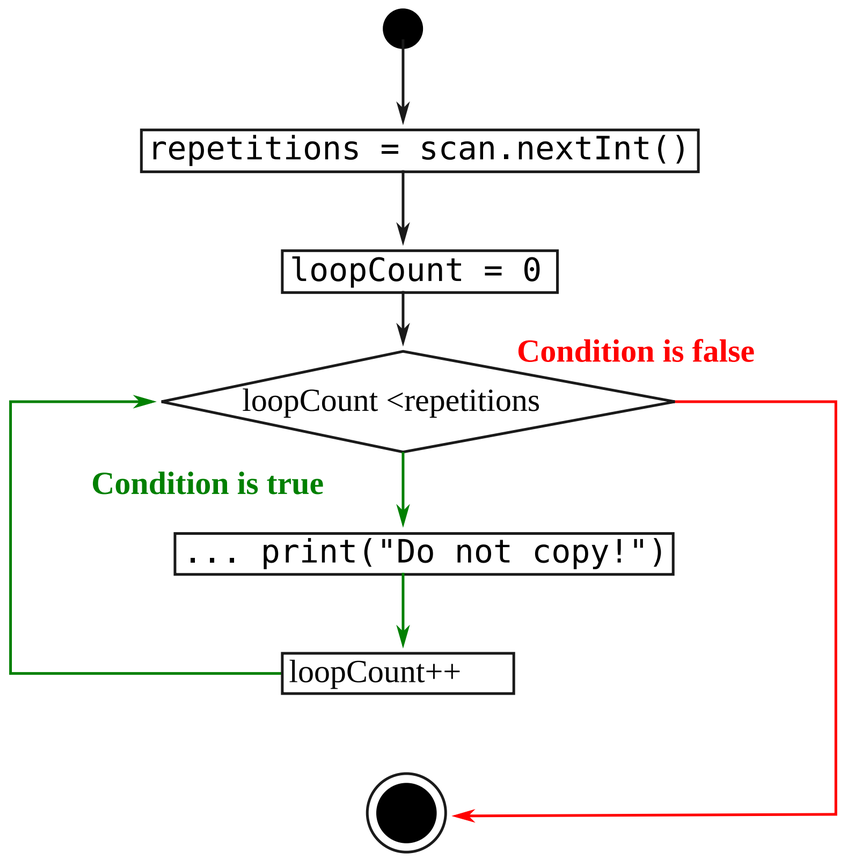
- Statements
  - Loops
    - `while`

A `while` loop

```
final int repetitions = scan.nextInt(); 1
int loopCount = 0; 2

while (loopCount < repetitions 3) {
   System.out.println("Do not copy!"); 4
   loopCount++; 5
}
```

```
Do not copy!
Do not copy!
Do not copy!
```



Combining increment and termination condition

Code	Execution

`System.out.print("Enter repetitions: "`
`final int repetitions = scan.nextInt()`
`int loopCounter = 0;`
 	
`while (loopCounter++ < repetitions) {`
`  System.out.println("Do not copy!");`
`}`
	`Enter repetitions: 3`
	`Do not copy!`
	`Do not copy!`
	`Do not copy!`

`while` syntax

```
while (booleanExpression)
   (block | statement)
```

Empty `while` body

```
int threeSeries = 1;

while ((threeSeries *=3 ) < 100);

System.out.println(threeSeries);
```

Exercise: Guess resulting output.

Followup exercises

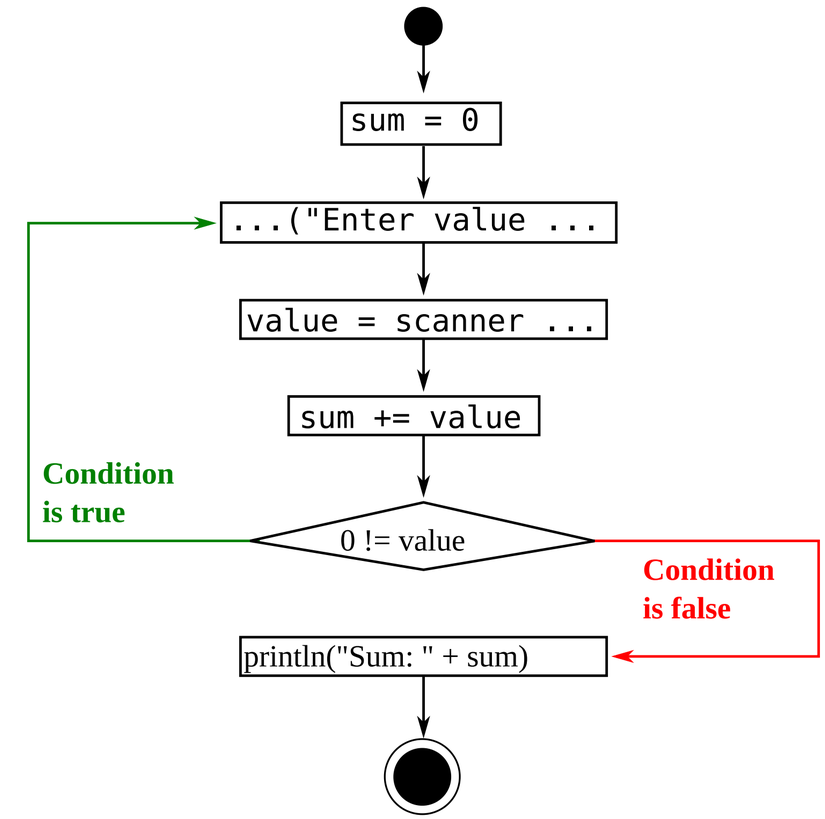
67. Generating square numbers

68. Calculating factorial

A `do ... while` loop

```
int sum = 0, value;
do {
  System.out.print(
    "Enter value, 0 to terminate: ");
  value = scan.nextInt();
  sum += value;
} while (0 != value);
System.out.println("Sum: " + sum);
```

```
Enter value, 0 to terminate: 3
Enter value, 0 to terminate: 1
Enter value, 0 to terminate: 0
Sum: 4
```



`do ... while` syntax

```
do
  (block | statement)
while (booleanExpression);
```

Followup exercises

69. Even or odd?

70. Square root approximation

Overview

- Statements
  - Loops
    - `for`

Frequent usage of `while`

```
int i = 0; (1)

while (i < 5 (2)) {
    ...
    i++; (3)
}
```

(1) Declaring and initializing a loop termination variable.

(2) Check for loop termination.

(3) Loop progression control

Nice to have: **More concise syntax**

Replacing `while` by `for`

```
for (int i = 0 (1); i < 5 (2); i++ (3)) {
  ...
}
```

```
int i = 0; (1)

while (i < 5 (2)) {
   ...
   i++; (3)
}
```

`for` syntax

```
for ( init ; booleanExpression ; update )
  (block | statement)
```

`for` variable scope

```
// i being defined within
// loop's scope

for (int i = 0 ; i < 3; i++) {
    System.out.println(i);
}
// Error: i undefined outside
// loop's body
System.out.println(i);
```

```
// i being defined in
// «current» scope

int i;
for (i = 0; i < 3; i++) {
    System.out.println(i);
}
System.out.println(i); // o.K
```

`for` variable scope equivalence

```
for (int i = 0 ; i < 3; i++) {
    System.out.println(i);
}

// i undefined in outer scope
```

```
{ // Beginning block scope
  int i = 0;
  for (; i < 3; i++) {
    System.out.println(i);
  }
} // Ending block scope

// i undefined in outer scope
```

`for` vs. while relationship

`while ( expression )` `  (block | statement)`	`for ( ;expression ;)` `  (block | statement)`

Observation: `for (...)` is more general than `while(...)`.

Followup exercises

71. Printing numbers

72. Printing just even numbers

Nested loops 1

```
for (int i = 1; i <= 2; i++) {
  for (int j = 1; j <= 3; j++) {
    System.out.print("(" + i + "|" + j + ") "
  }
  System.out.println(); // newline
}
```

```
(1|1) (1|2) (1|3)
(2|1) (2|2) (2|3)
```

Nested loops 2

```
for (int i = 0; i < 6; i++) {
  for (int j = 0; j < i; j++) {
    System.out.print(i + j + " ")
  }
  System.out.println(); // newlir
}
```

```
1
2 3
3 4 5
4 5 6 7
5 6 7 8 9
```

Better readability: `row` and `column` in favour of `i` and `j`

```
// What do i and j actually represent?

for (int i = 0; i < 6; i++) {
  for (int j = 0; j < i; j++) {
     System.out.print(i + j + " ");
  }
  System.out.println();
}
```

```
// Improved code comprehension.

for (int row = 0; row < 6; row++) {
  for (int column = 0;
        column < row; column++) {
    System.out.print(
         row + column + " ");
  }
  System.out.println();
}
```

Followup exercises

73. Merry Xmas
74. More fun with Xmas trees
75. A basic square number table
76. Tidy up the mess!
77. HTML-ify me
78. Auxiliary Example, part 1: A multiplication table
79. Auxiliary Example, part 2: Avoiding redundant entries
80. Creating a “real” square table
81. Creating a sophisticated HTML version of your square table

Overview

- Statements
  - Loops
    - `for`
      - Loops and calculations

Calculating values

```java
final int LIMIT = 5;
int sum = 0;

for (int i = 1; i <= LIMIT; i++) {
    sum += i;
}

System.out.println("1 + ... + " + LIMIT + " = " + su
```

```
1 + ... + 5 = 15
```

Followup exercises

82. Display all summands
83. Playing lottery
84. Guessing numbers
85. Smallest multiple
86. Smallest multiple, purely algebraic solution
87. Pythagorean triples
88. Avoiding duplicates and gaining performance

Overview

Statements

➟ Using automated tests.

Response to coding errors

Given a day of the week encoded as 0=Sun, 1=Mon, 2=Tue, ...6=Sat, and a boolean indicating if we are on vacation, return a string of the form "7:00" indicating when the alarm clock should ring. Weekdays, the alarm should be "7:00" and on the weekend it should be "10:00". Unless we are on vacation -- then on weekdays it should be "10:00" and weekends it should be "off".

alarmClock(1, false) → "7:00"
alarmClock(5, false) → "7:00"
alarmClock(0, false) → "10:00"

Go ...Save, Compile, Run (ctrl-enter)

```
public String alarmClock(int day, boolean vacation) {

  switch(day) {

    case 1:
    case 2:
    case 3:
    case 4:

      return vacation? "10:00" : "7:00";

  }
  return vacation? "off" : "10:00";

}
```

Expected	Run		
alarmClock(1, false) → "7:00"	"7:00"	OK	
alarmClock(5, false) → "7:00"	"10:00"	X	
alarmClock(0, false) → "10:00"	"10:00"	OK	
alarmClock(6, false) → "10:00"	"10:00"	OK	
alarmClock(0, true) → "off"	"off"	OK	
alarmClock(6, true) → "off"	"off"	OK	
alarmClock(1, true) → "10:00"	"10:00"	OK	
alarmClock(3, true) → "10:00"	"10:00"	OK	
alarmClock(5, true) → "10:00"	"off"	X	
other tests		OK	

Unit test concept

- Will be explained in detail.
- Idea: Feed in samples, check results for correctness.
- Previous slide: Logic-1 > alarmClock
- Sample project at MI Gitlab.

alarmClock(...) with errors

```
public class AlarmClock {
  /** Given a day of the week encoded as 0=Sun, 1=Mon,...
   */
  static (1) public String alarmClock(int day, boolean vacation) {
    switch (day) {
      case 1:
        ...
    if (vacation) {
      return "off";
    } else {
      return "10:00"; ...
```

Testing alarmClock(...)

```
public class AlarmClockTest {
  @Test (1)
  public void test_1_false() {
         Assert.assertEquals( "7:00", AlarmClock.alarmClock(1, false));
  }
  ...

@Test
public void test_0_false() {
         Assert.assertEquals("10:00", AlarmClock.alarmClock(0, false));
}  ...
```

Expected result

Input parameter

Testing alarmClock(...) details

```
public class AlarmClockTest {                          Input parameter
  @Test                                                    |    |
  public void test_1_false() {                             ▼    ▼
         final String result = AlarmClock.alarmClock(1, false);
                               └──────────────────────────┐
                                                          ▼
         Assert.assertEquals( "7:00", result);
}                                      ▲
...                                    |
                    Expected result
```