เรื่องที่ 2 ภาษาจาวา กับ การเขียนโปรแกรมเชิงวัตถุ

ENGCE174 การเขียนโปรแกรมเชิงวัตถุ (Object-oriented programming)

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What is Java?

Java is a popular programming language, created in 1995.

It is owned by Oracle, and more than 3 billion devices run Java.

It is used for:

- Mobile applications (specially Android apps)
- Desktop applications
- Web applications
- Web servers and application servers
- Games
- Database connection
- And much, much more!

Why Use Java?

- Java works on different platforms (Windows, Mac, Linux, Raspberry Pi, etc.)
- It is one of the most popular programming language in the world
- It has a large demand in the current job market
- It is easy to learn and simple to use
- It is open-source and free
- It is secure, fast and powerful
- It has a huge community support (tens of millions of developers)
- Java is an object oriented language which gives a clear structure to programs and allows code to be reused, lowering development costs
- As Java is close to C++ and C#, it makes it easy for programmers to switch to Java or vice versa

Java Quickstart

In Java, every application begins with a class name, and that class must match the filename.

Let's create our first Java file, called Main.java, which can be done in any text editor (like Notepad).

The file should contain a "Hello World" message, which is written with the following code:

Main.java

```
public class Main {
  public static void main(String[] args) {
    System.out.println("Hello World");
  }
}
```

Java Syntax

In the previous chapter, we created a Java file called Main.java, and we used the following code to print "Hello World" to the screen:

Main.java

```
public class Main {
  public static void main(String[] args) {
    System.out.println("Hello World");
  }
}
```

Example explained

Every line of code that runs in Java must be inside a class. In our example, we named the class Main. A class should always start with an uppercase first letter.

Note: Java is case-sensitive: "MyClass" and "myclass" has different meaning.

The name of the java file must match the class name. When saving the file, save it using the class name and add ".java" to the end of the filename. To run the example above on your computer, make sure that Java is properly installed: Go to the Get Started Chapter for how to install Java. The output should be:

```
Hello World
```

The main Method

The main() method is required and you will see it in every Java program:

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

Any code inside the main() method will be executed. Don't worry about the keywords before and after main. You will get to know them bit by bit while reading this tutorial.

For now, just remember that every Java program has a class name which must match the filename, and that every program must contain the main() method.

System.out.println()

Inside the main() method, we can use the println() method to print a line of text to the screen:

```
public static void main(String[] args) {
  System.out.println("Hello World");
}
```

Test Yourself With Exercises

Insert the missing part of the code below to output "Hello World".

```
public class MyClass {
  public static void main(String[] args) {
    ____ . ____ . ____ ("Hello World");
  }
}
```

Print Text

You learned from the previous chapter that you can use the `println()` method to output values or print text in Java:

```
System.out.println("Hello World!");
```

Print Text

You can add as many `println()` methods as you want. Note that it will add a new line for each method:

```
System.out.println("Hello World!");
System.out.println("I am learning Java.");
System.out.println("It is awesome!");
```

Double Quotes

When you are working with text, it must be wrapped inside double quotations marks "".

If you forget the double quotes, an error occurs:

```
System.out.println("This sentence will work!");

System.out.println(This sentence will produce an error);
```

The Print() Method

There is also a `print()` method, which is similar to `println()`.

The only difference is that it does not insert a new line at the end of the output:

```
System.out.print("Hello World! ");
System.out.print("I will print on the same line.");
```

Print Numbers

You can also use the `println()` method to print numbers.

However, unlike text, we don't put numbers inside double quotes:

```
System.out.println(3);
System.out.println(358);
System.out.println(50000);
```

Print Numbers

You can also perform mathematical calculations inside the `println()` method:

```
System.out.println(3 + 3);
```

```
6
```

```
System.out.println(2 * 5);
```

```
10
```

Java Comments

Comments can be used to explain Java code, and to make it more readable. It can also be used to prevent execution when testing alternative code.

Single-line Comments

Single-line comments start with two forward slashes (//).

Any text between // and the end of the line is ignored by Java (will not be executed).

This example uses a single-line comment before a line of code:

```
// This is a comment
System.out.println("Hello World");
```

This example uses a single-line comment at the end of a line of code:

```
System.out.println("Hello World"); // This is a comment
```

Java Multi-line Comments

Multi-line comments start with /* and ends with */.

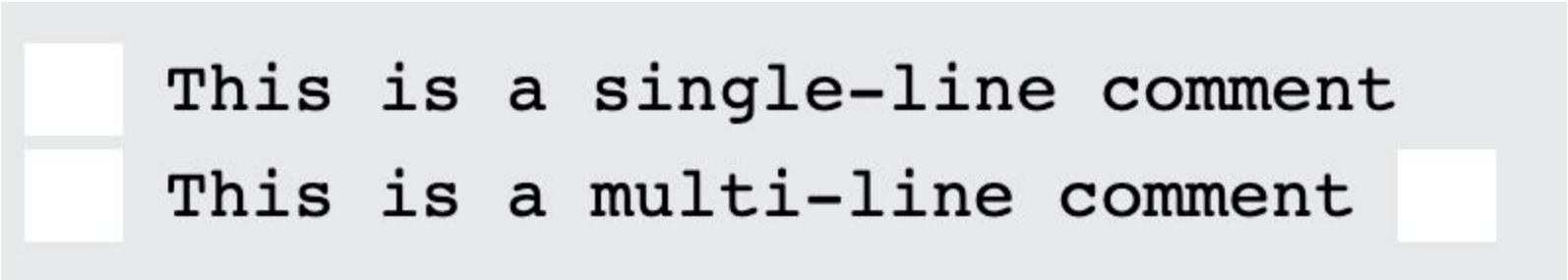
Any text between /* and */ will be ignored by Java.

This example uses a multi-line comment (a comment block) to explain the code:

```
/* The code below will print the words Hello World
to the screen, and it is amazing */
System.out.println("Hello World");
```

Test Yourself With Exercises

Insert the missing part to create two types of comments.



Java Variables

Variables are containers for storing data values.

In Java, there are different types of variables, for example:

- `String` - stores text, such as "Hello". String values are surrounded by double quotes
- `int` - stores integers (whole numbers), without decimals, such as 123 or -123
- `float` - stores floating point numbers, with decimals, such as 19.99 or -19.99
- `char` - stores single characters, such as 'a' or 'B'. Char values are surrounded by single quotes
- `boolean` - stores values with two states: true or false

Declaring (Creating) Variables

To create a variable, you must specify the type and assign it a value:

Syntax

```
type variableName = value;
```

Declaring (Creating) Variables

Where *type* is one of Java's types (such as `int` or `String`), and *variableName* is the name of the variable (such as x or name). The equal sign is used to assign values to the variable.

To create a variable that should store text, look at the following example:

Create a variable called name of type `String` and assign it the value "John":

```
String name = "John";
System.out.println(name);
```

Declaring (Creating) Variables

To create a variable that should store a number, look at the following example:

Create a variable called myNum of type `int` and assign it the value 15:

```
int myNum = 15;
System.out.println(myNum);
```

Declaring (Creating) Variables

You can also declare a variable without assigning the value, and assign the value later:

```
int myNum;
myNum = 15;
System.out.println(myNum);
```

Declaring (Creating) Variables

Note that if you assign a new value to an existing variable, it will overwrite the previous value:

Change the value of `myNum` from `15` to `20`:

```
int myNum = 15;
myNum = 20;  // myNum is now 20
System.out.println(myNum);
```

Final Variables

If you don't want others (or yourself) to overwrite existing values, use the `final` keyword (this will declare the variable as "final" or "constant", which means unchangeable and read-only):

```
final int myNum = 15;
myNum = 20;  // will generate an error: cannot assign a value to a final variable
```

```
Main.java:4: error: cannot assign a value to final variable myNum
    myNum = 20;
          ^
1 error
```

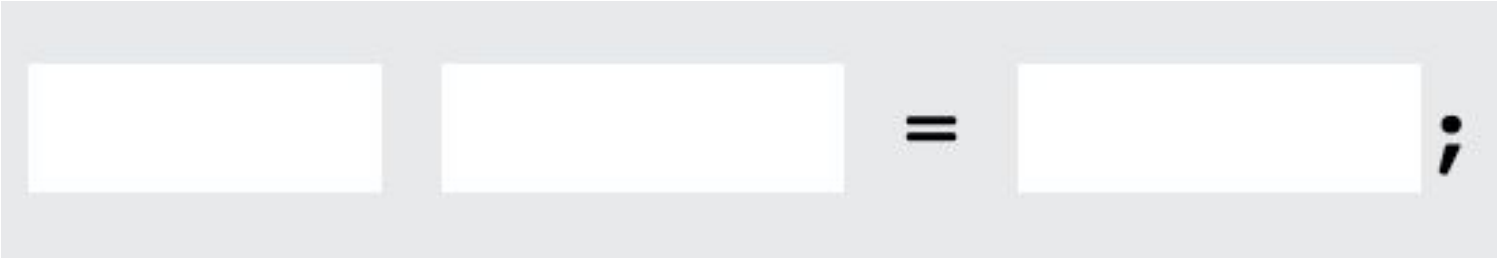
Other Types

A demonstration of how to declare variables of other types:

```
int myNum = 5;
float myFloatNum = 5.99f;
char myLetter = 'D';
boolean myBool = true;
String myText = "Hello";
```

Test Yourself With Exercises

Create a variable named `carName` and assign the value `Volvo` to it.



Display Variables

The `println()` method is often used to display variables.

To combine both text and a variable, use the `+` character:

```
String name = "John";
System.out.println("Hello " + name);
```

```
Hello John
```

Display Variables

You can also use the + character to add a variable to another variable:

```
String firstName = "John ";
String lastName = "Doe";
String fullName = firstName + lastName;
System.out.println(fullName);
```

```
John Doe
```

Display Variables

For numeric values, the `+` character works as a mathematical operator (notice that we use `int` (integer) variables here):

```
int x = 5;
int y = 6;
System.out.println(x + y); // Print the value of x + y
```

```
11
```

Declare Many Variables

To declare more than one variable of the same type, you can use a comma-separated list:

Instead of writing:

```
int x = 5;
int y = 6;
int z = 50;
System.out.println(x + y + z);
```

You can simply write:

```
int x = 5, y = 6, z = 50;
System.out.println(x + y + z);
```

One Value to Multiple Variables

You can also assign the same value to multiple variables in one line:

```
int x, y, z;
x = y = z = 50;
System.out.println(x + y + z);
```

```
150
```

Test Yourself With Exercises

Fill in the missing parts to create three variables of the same type, using a comma-separated list:

```
    x = 5   y = 6   z = 50;
```

Identifiers

All Java variables must be identified with unique names.

These unique names are called identifiers.

Identifiers can be short names (like x and y) or more descriptive names (age, sum, totalVolume).

Note: It is recommended to use descriptive names in order to create understandable and maintainable code:

```
// Good
int minutesPerHour = 60;

// OK, but not so easy to understand what m actually is
int m = 60;
```

Identifiers

```
public class Main {
  public static void main(String[] args) {
    // Good
    int minutesPerHour = 60;

    // OK, but not so easy to understand what m actually is
    int m = 60;

    System.out.println(minutesPerHour);
    System.out.println(m);
  }
}
```

Identifiers

The general rules for naming variables are:

- Names can contain letters, digits, underscores, and dollar signs
- Names must begin with a letter
- Names should start with a lowercase letter and it cannot contain whitespace
- Names can also begin with $ and _ (but we will not use it in this tutorial)
- Names are case sensitive ("myVar" and "myvar" are different variables)
- Reserved words (like Java keywords, such as `int` or `boolean`) cannot be used as names

Java Data Types

As explained in the previous chapter, a variable in Java must be a specified data type:

```
int myNum = 5;                  // Integer (whole number)
float myFloatNum = 5.99f;       // Floating point number
char myLetter = 'D';            // Character
boolean myBool = true;          // Boolean
String myText = "Hello";        // String
```

Java Data Types

```
public class Main {
  public static void main(String[] args) {
    int myNum = 5;                  // integer (whole number)
    float myFloatNum = 5.99f;       // floating point number
    char myLetter = 'D';            // character
    boolean myBool = true;          // boolean
    String myText = "Hello";        // String
    System.out.println(myNum);
    System.out.println(myFloatNum);
    System.out.println(myLetter);
    System.out.println(myBool);
    System.out.println(myText);
  }
}
```

```
5
5.99
D
true
Hello
```

Java Data Types

Data types are divided into two groups:

- Primitive data types - includes `byte`, `short`, `int`, `long`, `float`, `double`, `boolean` and `char`
- Non-primitive data types - such as `String`, Arrays and Classes (you will learn more about these in a later chapter)

Primitive Data Types

A primitive data type specifies the size and type of variable values, and it has no additional methods.

There are eight primitive data types in Java:

Data Type	Size	Description
`byte`	1 byte	Stores whole numbers from -128 to 127
`short`	2 bytes	Stores whole numbers from -32,768 to 32,767
`int`	4 bytes	Stores whole numbers from -2,147,483,648 to 2,147,483,647
`long`	8 bytes	Stores whole numbers from -9,223,372,036,854,775,808 to 9,223,372,036,854,775,807
`float`	4 bytes	Stores fractional numbers. Sufficient for storing 6 to 7 decimal digits
`double`	8 bytes	Stores fractional numbers. Sufficient for storing 15 decimal digits
`boolean`	1 bit	Stores true or false values
`char`	2 bytes	Stores a single character/letter or ASCII values

Test Yourself With Exercises

Add the correct data type for the following variables:

```
myNum = 9;
myFloatNum = 8.99f;
myLetter = 'A';
myBool = false;
myText = "Hello World";
```

Numbers

Primitive number types are divided into two groups:

Integer types stores whole numbers, positive or negative (such as 123 or -456), without decimals. Valid types are `byte`, `short`, `int` and `long`. Which type you should use, depends on the numeric value.

Floating point types represents numbers with a fractional part, containing one or more decimals. There are two types: `float` and `double`.

Even though there are many numeric types in Java, the most used for numbers are `int` (for whole numbers) and `double` (for floating point numbers). However, we will describe them all as you continue to read.

Integer Types

Byte

The `byte` data type can store whole numbers from -128 to 127. This can be used instead of `int` or other integer types to save memory when you are certain that the value will be within -128 and 127:

```
byte myNum = 100;
System.out.println(myNum);
```

Integer Types

Short

The `short` data type can store whole numbers from -32768 to 32767:

```
short myNum = 5000;
System.out.println(myNum);
```

Integer Types

Int

The `int` data type can store whole numbers from -2147483648 to 2147483647. In general, and in our tutorial, the `int` data type is the preferred data type when we create variables with a numeric value.

```
int myNum = 100000;
System.out.println(myNum);
```

Integer Types

Long

The `long` data type can store whole numbers from -9223372036854775808 to 9223372036854775807. This is used when int is not large enough to store the value. Note that you should end the value with an "L":

```
long myNum = 15000000000L;
System.out.println(myNum);
```

Floating Point Types

You should use a floating point type whenever you need a number with a decimal, such as 9.99 or 3.14515.

The `float` and `double` data types can store fractional numbers. Note that you should end the value with an "f" for floats and "d" for doubles:

Float Example

```
float myNum = 5.75f;
System.out.println(myNum);
```

Double Example

```
double myNum = 19.99d;
System.out.println(myNum);
```

Float OR Double ?????

Use `float` or `double`?

The precision of a floating point value indicates how many digits the value can have after the decimal point. The precision of `float` is only six or seven decimal digits, while `double` variables have a precision of about 15 digits. Therefore it is safer to use `double` for most calculations.

Scientific Numbers

A floating point number can also be a scientific number with an "e" to indicate the power of 10:

```
float f1 = 35e3f;
double d1 = 12E4d;
System.out.println(f1);
System.out.println(d1);
```

```
35000.0
120000.0
```

Boolean Types

Very often in programming, you will need a data type that can only have one of two values, like:

- YES / NO
- ON / OFF
- TRUE / FALSE

For this, Java has a `boolean` data type, which can only take the values `true` or `false`:

```
boolean isJavaFun = true;
boolean isFishTasty = false;
System.out.println(isJavaFun);      // Outputs true
System.out.println(isFishTasty);    // Outputs false
```

Boolean Types

```
public class Main {
   public static void main(String[] args) {
      boolean isJavaFun = true;
      boolean isFishTasty = false;
      System.out.println(isJavaFun);
      System.out.println(isFishTasty);
   }
}
```

```
true
false
```

Boolean Types

Boolean values are mostly used for conditional testing.

You will learn much more about booleans and conditions later in this tutorial.

Characters

The `char` data type is used to store a single character. The character must be surrounded by single quotes, like 'A' or 'c':

```
char myGrade = 'B';
System.out.println(myGrade);
```

Characters

Alternatively, if you are familiar with ASCII values, you can use those to display certain characters:

```
char myVar1 = 65, myVar2 = 66, myVar3 = 67;
System.out.println(myVar1);
System.out.println(myVar2);
System.out.println(myVar3);
```

```
A
B
C
```

Characters

Tip: A list of all ASCII values can be found in our ASCII Table Reference.

The ASCII Character Set

ASCII stands for the "American Standard Code for Information Interchange".

It was designed in the early 60's, as a standard character set for computers and electronic devices.

ASCII is a 7-bit character set containing 128 characters.

It contains the numbers from 0-9, the upper and lower case English letters from A to Z, and some special characters.

The character sets used in modern computers, in HTML, and on the Internet, are all based on ASCII.

The following tables list the 128 ASCII characters and their equivalent number.

Characters

ASCII Printable Characters

Char	Number	Description
	0 - 31	Control characters (see below)
	32	space
!	33	exclamation mark
"	34	quotation mark
#	35	number sign
$	36	dollar sign
%	37	percent sign
&	38	ampersand
'	39	apostrophe
(	40	left parenthesis
)	41	right parenthesis
*	42	asterisk
+	43	plus sign
,	44	comma
-	45	hyphen
.	46	period
/	47	slash
0	48	digit 0
1	49	digit 1
2	50	digit 2
3	51	digit 3
4	52	digit 4
5	53	digit 5
6	54	digit 6
7	55	digit 7
8	56	digit 8
9	57	digit 9
:	58	colon
;	59	semicolon
<	60	less-than
=	61	equals-to
>	62	greater-than
?	63	question mark
@	64	at sign
A	65	uppercase A
B	66	uppercase B
C	67	uppercase C
D	68	uppercase D
E	69	uppercase E

Characters

Strings

The `String` data type is used to store a sequence of characters (text). String values must be surrounded by double quotes:

```
String greeting = "Hello World";
System.out.println(greeting);
```

```
Hello World
```

Characters

The String type is so much used and integrated in Java, that some call it "the special ninth type".

A String in Java is actually a non-primitive data type, because it refers to an object. The String object has methods that are used to perform certain operations on strings. Don't worry if you don't understand the term "object" just yet. We will learn more about strings and objects in a later chapter.

Non-Primitive Data Types

Non-primitive data types are called reference types because they refer to objects.

The main difference between primitive and non-primitive data types are:

- Primitive types are predefined (already defined) in Java. Non-primitive types are created by the programmer and is not defined by Java (except for `String`).
- Non-primitive types can be used to call methods to perform certain operations, while primitive types cannot.
- A primitive type has always a value, while non-primitive types can be `null`.
- A primitive type starts with a lowercase letter, while non-primitive types starts with an uppercase letter.
- The size of a primitive type depends on the data type, while non-primitive types have all the same size.

Examples of non-primitive types are Strings, Arrays, Classes, Interface, etc. You will learn more about these in a later chapter.

Java Type Casting

ype casting is when you assign a value of one primitive data type to another type.

In Java, there are two types of casting:

- Widening Casting (automatically) - converting a smaller type to a larger type size
  `byte` -> `short` -> `char` -> `int` -> `long` -> `float` -> `double`

- Narrowing Casting (manually) - converting a larger type to a smaller size type
  `double` -> `float` -> `long` -> `int` -> `char` -> `short` -> `byte`

Widening Casting

Widening casting is done automatically when passing a smaller size type to a larger size type:

```
public class Main {
  public static void main(String[] args) {
    int myInt = 9;
    double myDouble = myInt; // Automatic casting: int to double

    System.out.println(myInt);      // Outputs 9
    System.out.println(myDouble);   // Outputs 9.0
  }
}
```

Narrowing Casting

Narrowing casting must be done manually by placing the type in parentheses in front of the value:

```
public class Main {
  public static void main(String[] args) {
    double myDouble = 9.78d;
    int myInt = (int) myDouble; // Manual casting: double to int

    System.out.println(myDouble);   // Outputs 9.78
    System.out.println(myInt);      // Outputs 9
  }
}
```

Java Operators

Operators are used to perform operations on variables and values.

In the example below, we use the + operator to add together two values:

```
int x = 100 + 50;
```

Java Operators

Although the + operator is often used to add together two values, like in the example above, it can also be used to add together a variable and a value, or a variable and another variable:

```
int sum1 = 100 + 50;          // 150 (100 + 50)
int sum2 = sum1 + 250;        // 400 (150 + 250)
int sum3 = sum2 + sum2;       // 800 (400 + 400)
```

Java Operators

Java divides the operators into the following groups:

- Arithmetic operators
- Assignment operators
- Comparison operators
- Logical operators
- Bitwise operators

Arithmetic Operators

Arithmetic operators are used to perform common mathematical operations.

Operator	Name	Description	Example
+	Addition	Adds together two values	x + y
-	Subtraction	Subtracts one value from another	x - y
*	Multiplication	Multiplies two values	x * y
/	Division	Divides one value by another	x / y
%	Modulus	Returns the division remainder	x % y
++	Increment	Increases the value of a variable by 1	++x
--	Decrement	Decreases the value of a variable by 1	--x

Java Assignment Operators

Assignment operators are used to assign values to variables.

In the example below, we use the assignment operator (=) to assign the value 10 to a variable called x:

```
int x = 10;
```

The addition assignment operator (+=) adds a value to a variable:

```
int x = 10;
x += 5;
```

Java Assignment Operators

A list of all assignment operators:

Operator	Example	Same As
=	x = 5	x = 5
+=	x += 3	x = x + 3
-=	x -= 3	x = x - 3
*=	x *= 3	x = x * 3
/=	x /= 3	x = x / 3
%=	x %= 3	x = x % 3
&=	x &= 3	x = x & 3
|=	x |= 3	x = x | 3
^=	x ^= 3	x = x ^ 3
>>=	x >>= 3	x = x >> 3
<<=	x <<= 3	x = x << 3

Java Comparison Operators

Comparison operators are used to compare two values. This is important in programming, because it helps us to find answers and make decisions.

The return value of a comparison is either `true` or `false`. These values are known as Boolean values, and you will learn more about them in the Booleans and If..Else chapter.

In the following example, we use the greater than operator (`>`) to find out if 5 is greater than 3:

```
int x = 5;
int y = 3;
System.out.println(x > y); // returns true, because 5 is higher than 3
```

Java Comparison Operators

Operator	Name	Example
==	Equal to	x == y
!=	Not equal	x != y
>	Greater than	x > y
<	Less than	x < y
>=	Greater than or equal to	x >= y
<=	Less than or equal to	x <= y

Java Logical Operators

You can also test for `true` or `false` values with logical operators.

Logical operators are used to determine the logic between variables or values:

Operator	Name	Description	Example
&&	Logical and	Returns true if both statements are true	x < 5 && x < 10
||	Logical or	Returns true if one of the statements is true	x < 5 || x < 4
!	Logical not	Reverse the result, returns false if the result is true	!(x < 5 && x < 10)

Test Yourself With Exercises

Multiply `10` with `5`, and print the result.

```
System.out.println(10    5);
```

Java Strings

Strings are used for storing text.

A `String` variable contains a collection of characters surrounded by double quotes:

Create a variable of type `String` and assign it a value:

```
String greeting = "Hello";
```

String Length

A String in Java is actually an object, which contain methods that can perform certain operations on strings. For example, the length of a string can be found with the `length()` method:

```
String txt = "ABCDEFGHIJKLMNOPQRSTUVWXYZ";
System.out.println("The length of the txt string is: " + txt.length());
```

```
The length of the txt string is: 26
```

More String Methods

There are many string methods available, for example `toUpperCase()` and `toLowerCase()`:

```
String txt = "Hello World";
System.out.println(txt.toUpperCase());   // Outputs "HELLO WORLD"
System.out.println(txt.toLowerCase());   // Outputs "hello world"
```

Finding a Character in a String

The `indexOf()` method returns the index (the position) of the first occurrence of a specified text in a string (including whitespace):

```
String txt = "Please locate where 'locate' occurs!";
System.out.println(txt.indexOf("locate")); // Outputs 7
```

Java counts positions from zero.

0 is the first position in a string, 1 is the second, 2 is the third ...

Test Yourself With Exercises

Fill in the missing part to create a `greeting` variable of type `String` and assign it the value `Hello`.

String Concatenation

The + operator can be used between strings to combine them. This is called concatenation:

```
String firstName = "John";
String lastName = "Doe";
System.out.println(firstName + " " + lastName);
```

```
John Doe
```

Note that we have added an empty text (" ") to create a space between firstName and lastName on print.

String Concatenation

You can also use the `concat()` method to concatenate two strings:

```
String firstName = "John ";
String lastName = "Doe";
System.out.println(firstName.concat(lastName));
```

Adding Numbers and Strings

WARNING!

Java uses the + operator for both addition and concatenation.

Numbers are added. Strings are concatenated.

If you add two numbers, the result will be a number:

```
int x = 10;
int y = 20;
int z = x + y;  // z will be 30 (an integer/number)
```

Adding Numbers and Strings

If you add two strings, the result will be a string concatenation:

```
String x = "10";
String y = "20";
String z = x + y;  // z will be 1020 (a String)
```

Adding Numbers and Strings

If you add a number and a string, the result will be a string concatenation:

```
String x = "10";
int y = 20;
String z = x + y;   // z will be 1020 (a String)
```

Strings - Special Characters

Because strings must be written within quotes, Java will misunderstand this string, and generate an error:

```
String txt = "We are the so-called "Vikings" from the north.";
```

The solution to avoid this problem, is to use the backslash escape character.

The backslash (\) escape character turns special characters into string characters:

Escape character	Result	Description
\'	'	Single quote
\"	"	Double quote
\\	\	Backslash

Strings - Special Characters

The sequence \" inserts a double quote in a string:

```
String txt = "We are the so-called \"Vikings\" from the north.";
```

The sequence \' inserts a single quote in a string:

```
String txt = "It\'s alright.";
```

Strings - Special Characters

The sequence \\ inserts a single backslash in a string:

```
String txt = "The character \\ is called backslash.";
```

Strings - Special Characters

Other common escape sequences that are valid in Java are:

Code	Result
\n	New Line
\r	Carriage Return
\t	Tab
\b	Backspace
\f	Form Feed

Java Math

The Java Math class has many methods that allows you to perform mathematical tasks on numbers.

Math.max(*x*,*y*)

The `Math.max(x,y)` method can be used to find the highest value of *x* and *y*:

```
Math.max(5, 10);
```

Math.min(*x*,*y*)

The `Math.min(x,y)` method can be used to find the lowest value of *x* and *y*:

```
Math.min(5, 10);
```

Math.sqrt(*x*)

The `Math.sqrt(x)` method returns the square root of *x*:

```
Math.sqrt(64);
```

Math.abs(*x*)

The `Math.abs(x)` method returns the absolute (positive) value of *x*:

```
Math.abs(-4.7);
```

Random Numbers

`Math.random()` returns a random number between 0.0 (inclusive), and 1.0 (exclusive):

```
Math.random();
```

To get more control over the random number, for example, if you only want a random number between 0 and 100, you can use the following formula:

```
int randomNum = (int)(Math.random() * 101);  // 0 to 100
```

Test Yourself With Exercises

Use the correct method to find the highest value of x and y.

```
int x = 5;
int y = 10;
Math.     (x, y);
```

Java Booleans

ery often, in programming, you will need a data type that can only have one of two values, like:

- YES / NO
- ON / OFF
- TRUE / FALSE

For this, Java has a `boolean` data type, which can store `true` or `false` values.

Boolean Values

A boolean type is declared with the `boolean` keyword and can only take the values `true` or `false`:

```
boolean isJavaFun = true;
boolean isFishTasty = false;
System.out.println(isJavaFun);      // Outputs true
System.out.println(isFishTasty);    // Outputs false
```

Boolean Expression

A Boolean expression is a Java expression that returns a Boolean value: `true` or `false`.

This is useful when we want to compare values to find answers.

For example, you can use a comparison operator, such as the greater than (`>`) operator, to find out if an expression (or a variable) is `true`:

```
int x = 10;
int y = 9;
System.out.println(x > y); // returns true, because 10 is higher than 9
```

Or even easier:

```
System.out.println(10 > 9); // returns true, because 10 is higher than 9
```

Boolean Expression

In the examples below, we use the equal to (==) operator to evaluate an expression:

```
int x = 10;
System.out.println(x == 10); // returns true, because the value of x is equal to 10
```

```
System.out.println(10 == 15); // returns false, because 10 is not equal to 15
```

Real Life Example

et's think of a "real life example" where we need to find out if a person is old enough to vote.

In the example below, we use the `>=` comparison operator to find out if the age (`25`) is greater than OR equal to the voting age limit, which is set to `18`:

```
int myAge = 25;
int votingAge = 18;
System.out.println(myAge >= votingAge);
```

The Boolean value of an expression is the basis for all Java comparisons and conditions.

You will learn more about conditions in the next chapter.

Test Yourself With Exercises

Fill in the missing parts to print the values `true` and `false`:

```
          isJavaFun = true;
          isFishTasty = false;
System.out.println(isJavaFun);
System.out.println(isFishTasty);
```

Java Conditions and If Statements

Java supports the usual logical conditions from mathematics:

- Less than: `a < b`
- Less than or equal to: `a <= b`
- Greater than: `a > b`
- Greater than or equal to: `a >= b`
- Equal to `a == b`
- Not Equal to: `a != b`

You can use these conditions to perform different actions for different decisions.

Java has the following conditional statements:

- Use `if` to specify a block of code to be executed, if a specified condition is true
- Use `else` to specify a block of code to be executed, if the same condition is false
- Use `else if` to specify a new condition to test, if the first condition is false
- Use `switch` to specify many alternative blocks of code to be executed

The if Statement

Use the `if` statement to specify a block of Java code to be executed if a condition is `true`.

```
if (condition) {
  // block of code to be executed if the condition is true
}
```

Note that `if` is in lowercase letters. Uppercase letters (If or IF) will generate an error.

The if Statement

In the example below, we test two values to find out if 20 is greater than 18. If the condition is `true`, print some text:

```
if (20 > 18) {
  System.out.println("20 is greater than 18");
}
```

The if Statement

We can also test variables:

```
int x = 20;
int y = 18;
if (x > y) {
  System.out.println("x is greater than y");
}
```

The if Statement

Example explained

In the example above we use two variables, x and y, to test whether x is greater than y (using the > operator). As x is 20, and y is 18, and we know that 20 is greater than 18, we print to the screen that "x is greater than y".

The else Statement

Use the `else` statement to specify a block of code to be executed if the condition is `false`.

Syntax

```
if (condition) {
  // block of code to be executed if the condition is true
} else {
  // block of code to be executed if the condition is false
}
```

The else Statement

```
int time = 20;
if (time < 18) {
  System.out.println("Good day.");
} else {
  System.out.println("Good evening.");
}
// Outputs "Good evening."
```

Example explained

In the example above, time (20) is greater than 18, so the condition is `false`. Because of this, we move on to the `else` condition and print to the screen "Good evening". If the time was less than 18, the program would print "Good day".

The else if Statement

Use the `else if` statement to specify a new condition if the first condition is `false`.

Syntax

```
if (condition1) {
  // block of code to be executed if condition1 is true
} else if (condition2) {
  // block of code to be executed if the condition1 is false and condition2 is true
} else {
  // block of code to be executed if the condition1 is false and condition2 is false
}
```

The else if Statement

```
int time = 22;
if (time < 10) {
  System.out.println("Good morning.");
} else if (time < 20) {
  System.out.println("Good day.");
} else {
  System.out.println("Good evening.");
}
// Outputs "Good evening."
```

Test Yourself With Exercises

Print "Hello World" if x is greater than y.

```
int x = 50;
int y = 10;
   (x   y) {
  System.out.println("Hello World");
}
```

Short Hand If...Else

There is also a short-hand if else, which is known as the ternary operator because it consists of three operands.

It can be used to replace multiple lines of code with a single line, and is most often used to replace simple if else statements:

Syntax

```
variable = (condition) ? expressionTrue :  expressionFalse;
```

Short Hand If...Else

Instead of writing:

```
int time = 20;
if (time < 18) {
  System.out.println("Good day.");
} else {
  System.out.println("Good evening.");
}
```

You can simply write:

```
int time = 20;
String result = (time < 18) ? "Good day." : "Good evening.";
System.out.println(result);
```

Test Yourself With Exercises

Insert the missing parts to complete the following "short hand if...else" statement:

```
int time = 20;
String result =  time < 18    "Good day."   "Good evening.";
System.out.println(result);
```

Java Switch Statements

Instead of writing many `if..else` statements, you can use the `switch` statement.

The `switch` statement selects one of many code blocks to be executed:

This is how it works:

- The `switch` expression is evaluated once.
- The value of the expression is compared with the values of each `case`.
- If there is a match, the associated block of code is executed.
- The `break` and `default` keywords are optional, and will be described later in this chapter

Syntax

```
switch(expression) {
  case x:
    // code block
    break;
  case y:
    // code block
    break;
  default:
    // code block
}
```

Java Switch Statements

The example below uses the weekday number to calculate the weekday name:

```
int day = 4;
switch (day) {
  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;
}
// Outputs "Thursday" (day 4)
```

The break Keyword

When Java reaches a `break` keyword, it breaks out of the switch block.

This will stop the execution of more code and case testing inside the block.

When a match is found, and the job is done, it's time for a break. There is no need for more testing.

A break can save a lot of execution time because it "ignores" the execution of all the rest of the code in the switch block.

The default Keyword

The `default` keyword specifies some code to run if there is no case match:

Note that if the `default` statement is used as the last statement in a switch block, it does not need a break.

```
int day = 4;
switch (day) {
  case 6:
    System.out.println("Today is Saturday");
    break;
  case 7:
    System.out.println("Today is Sunday");
    break;
  default:
    System.out.println("Looking forward to the Weekend");
}
// Outputs "Looking forward to the Weekend"
```

Test Yourself With Exercises

Insert the missing parts to complete the following `switch` statement.

```
int day = 2;
switch (     ) {
   case 1:
     System.out.println("Saturday");
     break;
   case 2:
     System.out.println("Sunday");
     break;
}
```

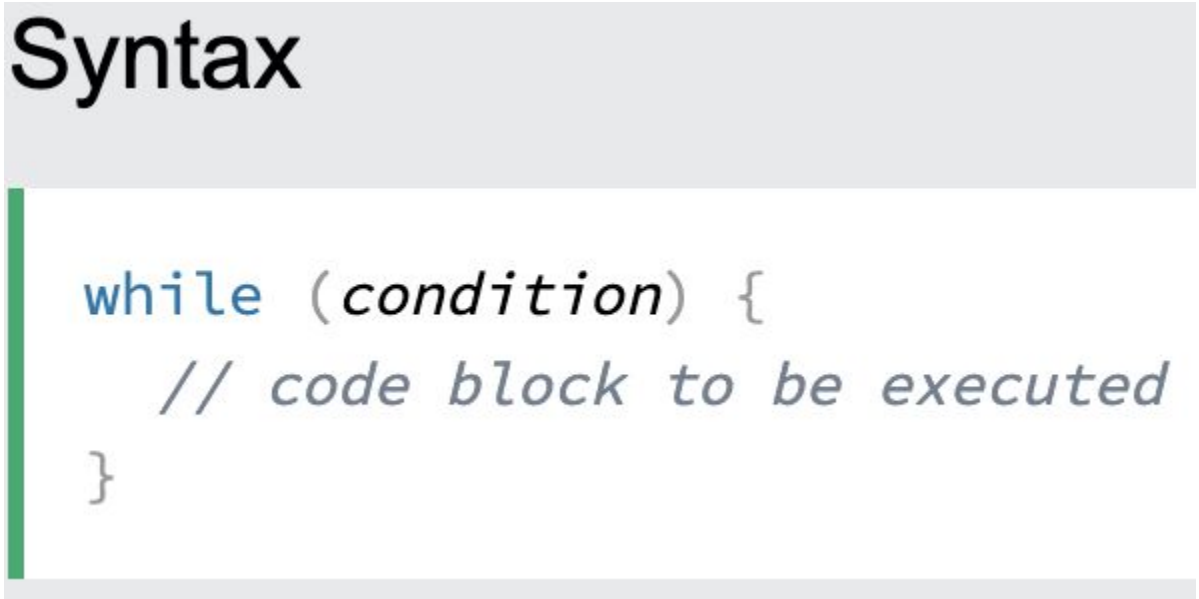
Loops

Loops can execute a block of code as long as a specified condition is reached.

Loops are handy because they save time, reduce errors, and they make code more readable.

Java While Loop

The `while` loop loops through a block of code as long as a specified condition is `true`:



Java While Loop

In the example below, the code in the loop will run, over and over again, as long as a variable (i) is less than 5:

```
int i = 0;
while (i < 5) {
  System.out.println(i);
  i++;
}
```

```
0
1
2
3
4
```

Note: Do not forget to increase the variable used in the condition, otherwise the loop will never end!

The Do/While Loop

The `do/while` loop is a variant of the `while` loop. This loop will execute the code block once, before checking if the condition is true, then it will repeat the loop as long as the condition is true.

Syntax

```
do {
  // code block to be executed
}
while (condition);
```

The Do/While Loop

The example below uses a `do/while` loop. The loop will always be executed at least once, even if the condition is false, because the code block is executed before the condition is tested:

Do not forget to increase the variable used in the condition, otherwise the loop will never end!

```
int i = 0;
do {
  System.out.println(i);
  i++;
}
while (i < 5);
```

```
0
1
2
3
4
```

Test Yourself With Exercises

Print `i` as long as `i` is less than 6.

```
int i = 1;
      (i < 6) {
  System.out.println(i);
     ;
}
```

Java For Loop

When you know exactly how many times you want to loop through a block of code, use the `for` loop instead of a `while` loop:

Syntax

```
for (statement 1; statement 2; statement 3) {
  // code block to be executed
}
```

Java For Loop

Statement 1 is executed (one time) before the execution of the code block.

Statement 2 defines the condition for executing the code block.

Statement 3 is executed (every time) after the code block has been executed.

The example below will print the numbers 0 to 4:

```
for (int i = 0; i < 5; i++) {
  System.out.println(i);
}
```

Java For Loop

This example will only print even values between 0 and 10:

```
for (int i = 0; i <= 10; i = i + 2) {
  System.out.println(i);
}
```

```
0
2
4
6
8
10
```

Test Yourself With Exercises

Use a `for` loop to print "Yes" 5 times.

```
    (int i = 0; i < 5;    ) {
  System.out.println(      );
}
```

For-Each Loop

There is also a "for-each" loop, which is used exclusively to loop through elements in an array:

```
for (type variableName : arrayName) {
  // code block to be executed
}
```

For-Each Loop

The following example outputs all elements in the cars array, using a "for-each" loop:

```
String[] cars = {"Volvo", "BMW", "Ford", "Mazda"};
for (String i : cars) {
  System.out.println(i);
}
```

```
Volvo
BMW
Ford
Mazda
```

Note: Don't worry if you don't understand the example above. You will learn more about Arrays in the Java Arrays chapter.

Java Break

You have already seen the `break` statement used in an earlier chapter of this tutorial. It was used to "jump out" of a `switch` statement.

The `break` statement can also be used to jump out of a loop.

This example stops the loop when i is equal to 4:

```
for (int i = 0; i < 10; i++) {
  if (i == 4) {
    break;
  }
  System.out.println(i);
}
```

Java Continue

The `continue` statement breaks one iteration (in the loop), if a specified condition occurs, and continues with the next iteration in the loop.

This example skips the value of 4:

```
for (int i = 0; i < 10; i++) {
  if (i == 4) {
    continue;
  }
  System.out.println(i);
}
```

Break and Continue in While Loop

You can also use `break` and `continue` in while loops:

```
int i = 0;
while (i < 10) {
  System.out.println(i);
  i++;
  if (i == 4) {
    break;
  }
}
```

Break and Continue in While Loop

```java
int i = 0;
while (i < 10) {
  if (i == 4) {
    i++;
    continue;
  }
  System.out.println(i);
  i++;
}
```

```
0
1
2
3
5
6
7
8
9
```

Test Yourself With Exercises

Stop the loop if `i` is 5.

```
for (int i = 0; i < 10; i++) {
  if (i == 5) {
     ;
  }
  System.out.println(i);
}
```