Lesson 1: Types, Variables, and Operators

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Lecture Goals

This lecture introduces the basics of Java programming: primitive data types, variables, operators, and simple program structure. By the end, students should be able to:

- Write and run a basic Java program.
- Understand how data is represented and manipulated.
- Use arithmetic and string operations.

1 Computer Architecture Overview

A computer system consists of three main parts:

- The **CPU** (central processing unit), which executes instructions.
- **Memory**, which stores both data and instructions.
- **Input/Output devices**, which communicate with the outside world.

Programs instruct the CPU to perform computations and move data between memory and registers.

2 Programming Languages and Java

Programming languages allow humans to describe computation in readable form. Java is a high-level, object-oriented language that compiles into bytecode, which runs on the Java Virtual Machine (JVM). This makes Java programs portable across platforms.

3 Basic Program Structure

A minimal Java program looks like this:

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

Key components:

- Every program must have a `class`.
- Execution begins in the `main()` method.
- `System.out.println()` outputs text to the console.

4 Variables and Data Types

A **variable** is a named memory location that stores data. Each variable has a **type** that defines what kind of data it can hold.

Type	Example
`boolean`	`true`, `false`
`int`	`12`
`double`	`7.86`
`String`	`"Hello World!"`

Example declarations:

```
String course = "Programming in Java";
double number = 2.11;
boolean isJanuary = true;
```

5 Assignment and Expressions

An assignment statement uses the operator `=`:

```
int x = 5;
x = x + 2; // now x holds 7
```

The right-hand side is evaluated first, and the result is stored in the variable on the left-hand side.

6 Operators and Precedence

Common arithmetic operators:

`+`, `-`, `*`, `/`, `%`

Operator precedence (from highest to lowest):

1. Parentheses `()`
2. Multiplication, division, modulus
3. Addition, subtraction

Example:

```
class SomeClass {
    public static void main(String[] args) {
        double result = 1.0 + 2.0 * 3.0;
        System.out.println(result); // prints 7.0
        result = result / 2.0;
        System.out.println(result); // prints 3.5
    }
}
```

7 String Concatenation

Strings can be combined using the + operator:

```
String text = "hello" + " world";
text = text + " number " + 5;
// result: "hello world number 5"
```

8 Example: Gravity Calculator

Example program to compute the position of a falling object using:

$$x(t) = \tfrac{1}{2}at^2 + v_i t + x_i$$

```
class GravityCalculator {
    public static void main(String[] arguments) {
        double gravity = -9.81; // Earth's gravity (m/s^2)
        double initialVelocity = 0.0;
        double fallingTime = 10.0;
        double initialPosition = 0.0;
        double finalPosition = 0.5 * gravity * fallingTime *
           fallingTime
                             + initialVelocity * fallingTime
                             + initialPosition;
        System.out.println("The object's position after "
            + fallingTime + " seconds is "
            + finalPosition + " m.");
    }
}
```

Summary

This lecture introduced:

- How to write and compile a simple Java program.
- Primitive types, variables, and expressions.
- Arithmetic and string operations.

9 Exercises

1. Write a Java program that prints your name and your favorite number on separate lines.

2. Modify the `Hello` program so it prints two lines of output: `"Hello World"` and `"Welcome to Java!"`.

3. Declare variables of each basic type (`int`, `double`, `boolean`, `String`) and assign values to them. Then print them to the console.

4. Create a program that computes and prints the sum, difference, product, and quotient of two numbers (for example, 12 and 5).

5. Write a Java program that converts a temperature in Celsius to Fahrenheit using the formula:
$$F = \frac{9}{5}C + 32$$
Print both the input temperature in Celsius and the result in Fahrenheit.

6. Given two integers, compute and print their average as a `double`. Make sure your program produces a decimal result even if both numbers are integers.

7. Write a short program that demonstrates the difference between integer division and floating-point division (e.g., `5 / 2` vs. `5.0 / 2`).

8. Modify the Gravity Calculator program to use a different initial velocity (e.g., `5.0`) and falling time (e.g., `20.0`). Observe how the output changes.

9. Create a program that concatenates three strings (for example, your first name, middle name, and last name) and prints the full name.

10. Challenge: Write a program that computes the result of the following expression and prints it:
$$\frac{(3+4)\times 5}{2}$$
Then modify the program to use variables `a`, `b`, `c`, and `d` for each number.