Introduction to Java

Today, we'll take a first look at Java programs. We will also see some ways to use generative artificial intelligence (GenAI) tools in this course, especially if you're new to Java.

Throughout the course, we will occasionally use GenAI tools, being careful to still build foundational understanding and skills. In both education and industry, we want GenAI tools to ***support***, not undermine, our goals. We'll also discuss how GenAI tools are currently used in industry, including best practices and ethical considerations.

You'll work in pairs today; next time, you'll work in larger teams. If you're new to Java, work with someone else who is new to Java. And if you already have some Java experience, find a partner with a similar level of Java experience.

Content Learning Targets

After completing this activity, you should be able to say:

- I can identify components of simple Java programs.
- I can write Java code to declare int and double variables.
- I can explain what it means to assign a value to a variable.
- I can evaluate Java expressions that use the % operator with integers.
- I can explain the difference between integer and floating-point division.
- I can identify operator precedence for addition, division, and assignment.
- I can name Java's primitive data types and give examples of each one.
- I can identify illegal assignment statements, and explain why they are illegal.
- I can use GenAI tools to learn about Java syntax and features.

Process Skill Goals

During the activity, you should make progress toward:

- Leveraging prior knowledge and experience of other students. (Teamwork)

Facilitation Notes

This activity is for the first day of class. Prereq: some programming experience, e.g., CSSE 120.

Questions that ask students to explain (or to describe) are good for reporting out. It's important that teams hear multiple perspectives on these concepts.

Key questions: #2, #7, #8, #16, #17

Source files: *HelloWorld.java*, *ConvertToJava.java*, *JavaExamples.java*

Model 1 Welcome to Java!

Questions (10 min) Start time:

Find the file `WelcomeToJava.java` in the `src` folder.

1. What do you notice about the name of the class? What happens when you try changing it?

The class name, `WelcomeToJava`, matches the name of the file. If you try changing the class name to something else, the IDE warns you with a red squiggly underline that this is an error. The file and class names must match.

2. What is the purpose of the first 14 lines? What is the purpose of the blank lines?

The first 14 lines describe what the program does and who wrote it.
The blank lines make it easier to read the program (Java ignores them).

3. Describe in your own words what `System.out.println` does. Be very specific.

The `println` method displays a message on the screen, followed by a newline character. When you run the `WelcomeToJava` program, it prints an integer value (x) and the value of its square.

Model 2 Variables and Operators

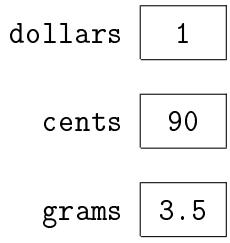
Most programs store and manipulate data values. We use ***variables*** to give values meaningful names. The following code ***declares*** three variables and ***assigns*** them (using the = operator). Each variable is stored in the computer's memory, represented by the boxes on the right.

Java code

```
int dollars;
int cents;
double grams;

dollars = 1;
cents = 90;
grams = 3.5;
```

Computer memory



Questions (15 min) Start time:

4. Identify the Java ***keyword*** used in a variable declaration to indicate

a) an integer: int

b) a real number: double

5. What would you expect the following statements to print out?

a) `System.out.println(dollars);` 1

b) `System.out.println(cents);` 90

c) `System.out.println(grams);` 3.5

6. In the previous question, how does the third printed line (c) differ from the first two?

The third line prints a double, and the first two print an integer.

7. What do you think is the purpose of a variable declaration?

It tells the computer how to interpret and display the value.

8. In your own words, explain how you should read the = sign in Java. For example, the Java statement `x = a + b;` should be read out loud as "x _____ a plus b".

Answers may include "x *gets* a plus b", "x *becomes* a plus b", etc.

9. Find the `// === Model 2 ===` comment in `WelcomeToJava.java`. Work through the predict-and-run exercises.

a) Notice the Java order of operations.

b) For the dividend and divisor example, try changing their values and see what you get. What do you think the / and % Java operators do, given two integers?

The / operator for integers divides and rounds down. The %, called the remainder (a.k.a. modulo) operator, computes the remainder (like in long division). We read `x % y` as "x mod y". For more on Java's arithmetic operators, consult the Oracle docs.

c) For the directly-printed division examples that follow, do any results surprise you? What do you think is the general pattern for how Java handles division?

It might surprise you to learn that Java rounds down when dividing an integer by an integer. Also, adding a decimal point to either number, even without digits after the decimal, makes Java perform floating-point arithmetic.

Model 3 Primitive Types

Keyword	Size	Min Value	Max Value	Example
`byte`	1 byte	-128	127	`(byte) 123`
`short`	2 bytes	$-32,768$	$32,767$	`(short) 12345`
`int`	4 bytes	-2^{31}	$2^{31}-1$	`1234567890`
`long`	8 bytes	-2^{63}	$2^{63}-1$	`123456789012345L`
`float`	4 bytes	-3.4×10^{38}	3.4×10^{38}	`3.14159F`
`double`	8 bytes	-1.8×10^{308}	1.8×10^{308}	`3.141592653589793`
`boolean`	1 byte	N/A	N/A	`true`
`char`	2 bytes	0	65,535	`'A'`

Note that 1 byte is 8 bits, i.e., eight "ones and zeros" in computer memory. Since there are only two possible values for each bit, you can represent $2^8 = 256$ possible values with 1 byte.

Questions (15 min) Start time:

10. Which of the primitive types are integers? Which are floating-point?

Integers: byte, short, int, long. Floating-point: float, double.

11. Why do primitive types have ranges of values? What determines the range of a type?

The range of values depends on the size, i.e., how many bytes are used to store the value.

12. Since a `byte` can represent 256 different numbers, why is its max value 127 and not 128?

One of the 256 values is the number zero. So 128 negatives, plus 1 zero, plus 127 positives equals 256 values.

13. What is the data type for each of the following values?

1.14159	double	7.2E-4	double	-128	int
0	int	0.0	double	'0'	char
-1.0F	float	-13L	long	false	boolean
123	int	'H'	char	true	boolean

14. Based on these examples, when does Java let you assign one type of primitive to another?

```
int int_ = 3;
long long_ = 3L;
float float_ = 3.0F;
double double_ = 3.0;

int_ = int_;
int_ = long_;      // illegal
int_ = float_;     // illegal
int_ = double_;    // illegal

long_ = int_;
long_ = long_;
long_ = float_;    // illegal
long_ = double_;   // illegal

float_ = int_;
float_ = long_;
float_ = float_;
float_ = double_;  // illegal

double_ = int_;
double_ = long_;
double_ = float_;
double_ = double_;

int_ = '0';
int_ = false;      // illegal
double_ = '0';
double_ = false;   // illegal
```

The types have to be compatible (e.g., you can't assign numeric to boolean), and you can only assign from smaller to larger (e.g., from float to double, or int to double).

15. Given the following variable declarations, which of the assignments are not allowed?

```
byte miles;
short minutes;
int checking;
long days;
float total;
double sum;
boolean flag;
char letter;
```

```
checking = 56000;
total = 0;
sum = total;
total = sum;
checking = miles;
sum = checking;
flag = minutes;
days = '0';
```

All are okay except:

```
total = sum;
flag = minutes;
```

Note that assigning `'0'` to `days` is legal, but the value is actually stored as 48L (Unicode for the digit zero character).

Model 4 Generative AI Tools for Software Development

Questions (20 min) Start time:

If you are **new to Java**, complete #16. If you are **already familiar** with Java, complete #17.

16. GenAI tools can help you switch from another programming language to Java.

a) Open the provided `ConvertToJava.java` file.

b) Find a short function or code snippet (ideally, one you wrote) in a non-Java language with which you are familiar.

c) Have a GenAI tool (e.g., Claude, ChatGPT, Gemini) convert your code into Java (sample).

d) Test the Java version: copy/paste into `ConvertToJava.java` and modify the method call.

e) If the response doesn't explain the changes, ask. **What similarities and differences do you notice?** (**Tip**: Repeat for other non-Java code to help you adapt to Java syntax.)

f) When you finish this activity, take a look at `JavaExamples.java` and review.

Answers will vary. Coming from Python, some differences include Java's required variable type declarations, the use of curly braces and semicolons instead of whitespace, and the change in syntax for function/method headers.

17. GenAI tools can help you learn about different ways to solve a problem using Java.

a) Open `JavaExamples.java` and look through the provided example methods.

b) Choose one method, and try to solve the same problem in a different way using your current knowledge of Java. Write your new version as a separate method with a similar name, and test it by calling it from the `main` method. (If you have trouble coming up with a completely new approach, it's OK to just make a small change.)

c) Copy/paste the original method into a GenAI chat tool such as Claude, ChatGPT, or Gemini, along with the prompt, "Give me different ways to implement this Java method." Review the responses. As time allows, repeat for other methods.

d) **What new Java features/syntax did you learn?** Jot down some notes below. Which alternative do you like the best, and why? (**Tip**: Repeat with other Java code you've written.)

e) When you finish this activity, take a look at the first homework assignment.

Answers will vary. GenAI tools might suggest ternary operators, switches, StringBuilder, enumerations, lambdas, etc., mostly inappropriate or overkill for the problems at hand. These are probably new if you're coming from AP Computer Science or similar.