Welcome to CS 101!

Introduction to Java Programming

Jamal Abdul Nasir

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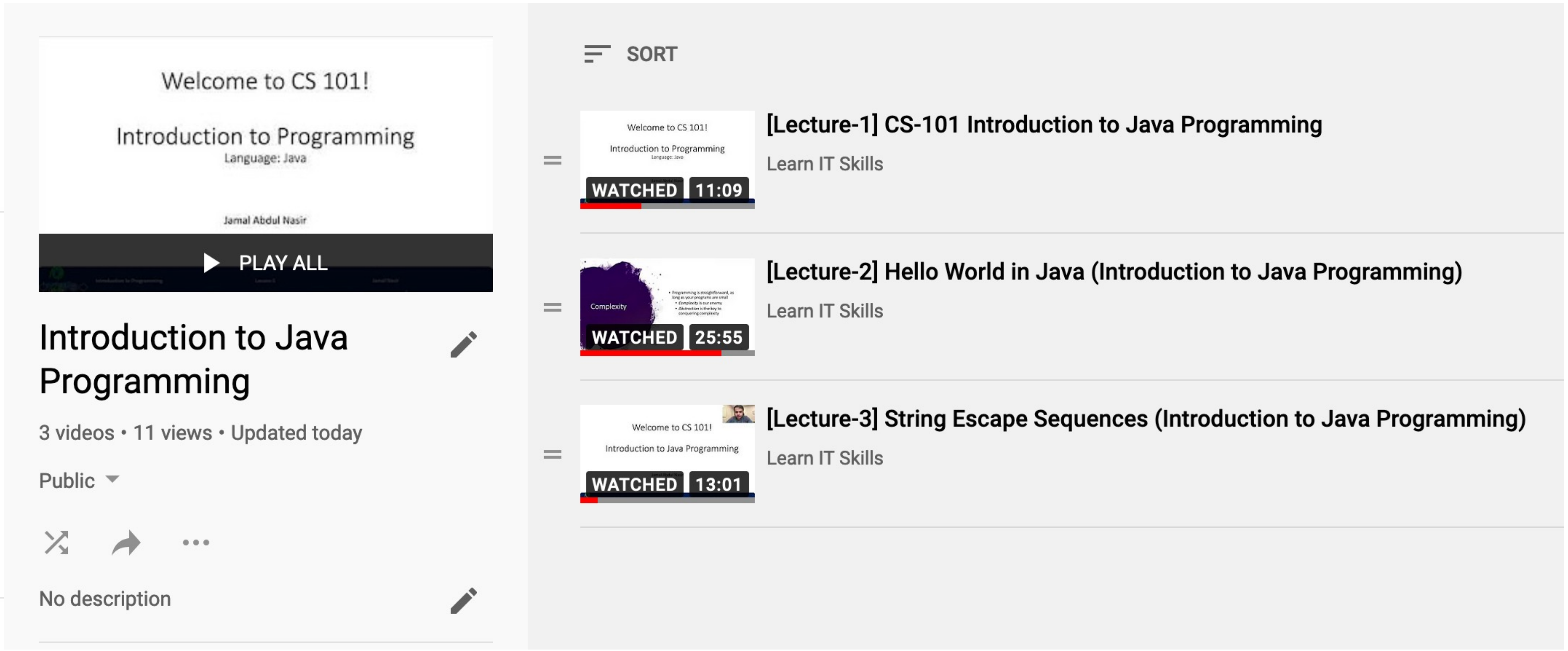

Welcome to CS 101!

Introduction to Programming

Language: Java

Jamal Abdul Nasir

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`System.out.println`

- A statement that prints a line of output on the console.
  - pronounced "print-linn”
- Three ways to use `System.out.println` :
  - `System.out.println("`**text**`");`
    Prints the given message as output.
  - `System.out.println(text);`
    Prints the value of variable ‘text’
  - `System.out.println();`
    Prints a blank line of output.

Strings

- A sequence of text characters.
  - Starts and ends with a " (quotation mark character).
    - The quotes do not appear in the output.
  - Examples:

```
"hello"
"This is a string.  It's very long!"
```

Escape sequences

- **escape sequence**: A special sequence of characters used to represent certain special characters in a string.

`\t`	tab character
`\n`	new line character
`\"`	quotation mark character
`\\`	backslash character

Escape sequences

- Example:

```
System.out.println("\\hello\nhow\tare \"you\"?\\\\");
```

- Output:

```
\hello
how	are "you"?\\
```

Expressions and Variables

The computer's view

The computer's view

- Internally, computers store everything as 1's and 0's
  - Example:

```
h      → 0110100
"hi"   → 01101000110101
104    → 0110100
```

- How can the computer tell the difference between an `h` and `104`?

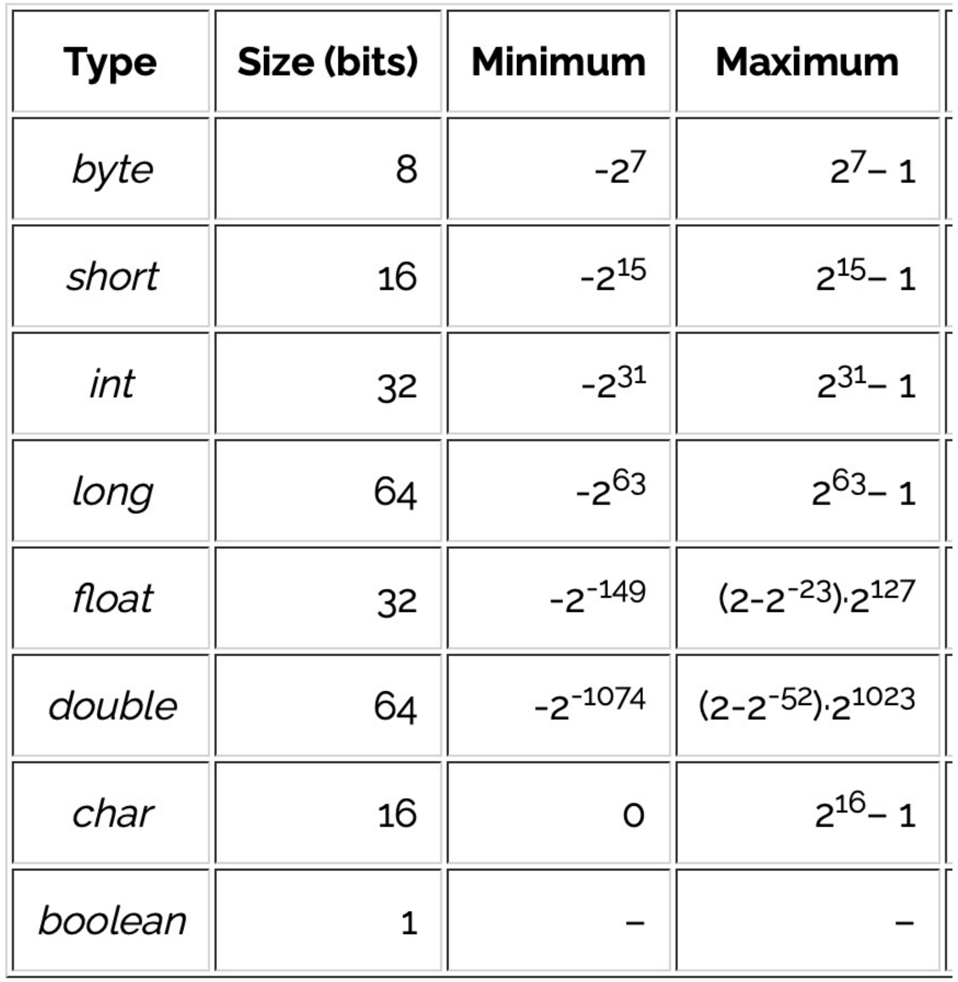
- **type**: A category or set of data values.
  - Constrains the operations that can be performed on data
  - Many languages ask the programmer to specify types
  - Examples: integer, real number, string

Java's primitive types

- **Primitive types**: 8 simple types for numbers, text, etc.
  - Java also has **object types**, which we'll talk about later

Name	**Description**		**Examples**
`int`	integers	(up to $2^{31} - 1$)	`42, -3, 0, 926394`
`double`	real numbers	(up to 10^{308})	`3.1, -0.25, 9.4e3`
`char`	single text characters		`'a', 'X', '?', '\n'`
`boolean`	logical values		`true, false`

Java's primitive types



Type	Size (bits)	Minimum	Maximum
byte	8	-2^{7}	$2^{7}-1$
short	16	-2^{15}	$2^{15}-1$
int	32	-2^{31}	$2^{31}-1$
long	64	-2^{63}	$2^{63}-1$
float	32	-2^{-149}	$(2-2^{-23})\cdot 2^{127}$
double	64	-2^{-1074}	$(2-2^{-52})\cdot 2^{1023}$
char	16	0	$2^{16}-1$
boolean	1	–	–

Integer or real number?

- Which category is more appropriate?

integer (`int`)	real number (`double`)

1. Temperature in degrees Celsius
2. The population of lemmings
3. Your grade point average
4. A person's age in years
5. A person's weight in pounds
6. A person's height in meters
7. Number of miles traveled
8. Number of dry days in the past month
9. Your locker number
10. Number of seconds left in a game
11. The sum of a group of integers
12. The average of a group of integers

- credit: Kate Deibel

Expressions

- **expression**: A value or operation that computes a value.
  - Examples:

    ```
    1 + 4 * 5
    (7 + 2) * 6 / 3
    42
    "Hello, world!"
    ```

  - The simplest expression is a *literal value*.
  - A complex expression can use operators and parentheses.

Arithmetic operators

- **operator**: Combines multiple values or expressions.

`+`	addition
`-`	subtraction (or negation)
`*`	multiplication
`/`	division
`%`	modulus (a.k.a. remainder)

- As a program runs, its expressions are *evaluated*.
  - `1 + 1` evaluates to `2`
  - `System.out.println(3 * 4);` prints `12`
    - How would we print the text `3 * 4` ?

Integer division with /

- When we divide integers, the quotient is also an integer.
  - `14 / 4` is `3`, not `3.5`

```
        3               4                 52
    ______          ______           ________
4 ) 14         10 ) 45          27 ) 1425
    12              40               135
    --              --               ---
     2               5                 75
                                       54
                                       --
                                       21
```

- More examples:
  - `32 / 5` is
  - `84 / 10` is `8`
  - `156 / 100` is `1`

  - Dividing by 0 causes an error when your program runs.

Integer remainder with `%`

- The `%` operator computes the remainder from integer division.
  - `14 % 4` is `2`
  - `218 % 5` is `3`

```
        3                  43
  4 ) 14             5 ) 218
      12                 20
       2                  18
                          15
                           3
```

What is the result?

```
45 % 6
2 % 2
8 % 20
11 % 0
```

- Applications of `%` operator:
  - Obtain last digit of a number: `230857 % 10` is `7`
  - Obtain last 4 digits: `658236489 % 10000` is `6489`
  - See whether a number is odd: `7 % 2` is `1`, `42 % 2` is `0`

Remember PEMDAS?

- **precedence**: Order in which operators are evaluated.
  - Generally operators evaluate left-to-right.
    `1 - 2 - 3` is `(1 - 2) - 3` which is `-4`
  - But `* / %` have a higher level of precedence than `+ -`

```
1 + 3 * 4            is 13

6 + 8 / 2 * 3
6 +   4   * 3
6 +     12           is 18
```

  - Parentheses can force a certain order of evaluation:

```
(1 + 3) * 4          is 16
```

  - Spacing does not affect order of evaluation

```
1+3 * 4-2            is 11
```

Precedence examples

```
1 * 2 + 3 * 5 % 4
 \_/
  |
  2   + 3 * 5 % 4
         \_/
          |
  2   +  15   % 4
           \___/
             |
  2   +      3
   \_________/
        |
        5
```

```
1 + 8 / 3 * 2 - 9
     \_/
      |
1 +   2   * 2 - 9
       \___/
         |
1 +      4    - 9
 \_______/
     |
     5        - 9
      \_______/
          |
          -4
```

Precedence questions

- What values result from the following expressions?
  - `9 / 5`
  - `695 % 20`
  - `7 + 6 * 5`
  - `7 * 6 + 5`
  - `248 % 100 / 5`
  - `6 * 3 - 9 / 4`
  - `(5 - 7) * 4`
  - `6 + (18 % (17 - 12))`

Real numbers (type `double`)

- Examples: `6.022`, `-42.0`, `2.143e17`
  - Placing `.0` or `.` after an integer makes it a `double`.
- The operators `+ - * / % ()` all still work with `double`.
  - `/` produces an exact answer: `15.0 / 2.0` is `7.5`
  - Precedence is the same: `()` before `* / %` before `+ -`

Real number example

```
 2.0 * 2.4 + 2.25 * 4.0 / 2.0
    \_____/
       |
     4.8     + 2.25 * 4.0 / 2.0
                  \_____/
                     |
     4.8     +      9.0    / 2.0
                       \________/
                            |
     4.8     +             4.5
         \___________________/
                   |
                  9.3
```

Precision in real numbers

- The computer internally represents real numbers in an imprecise way.

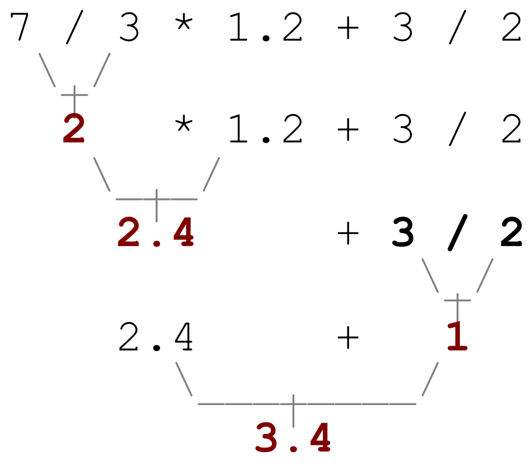
- Example:

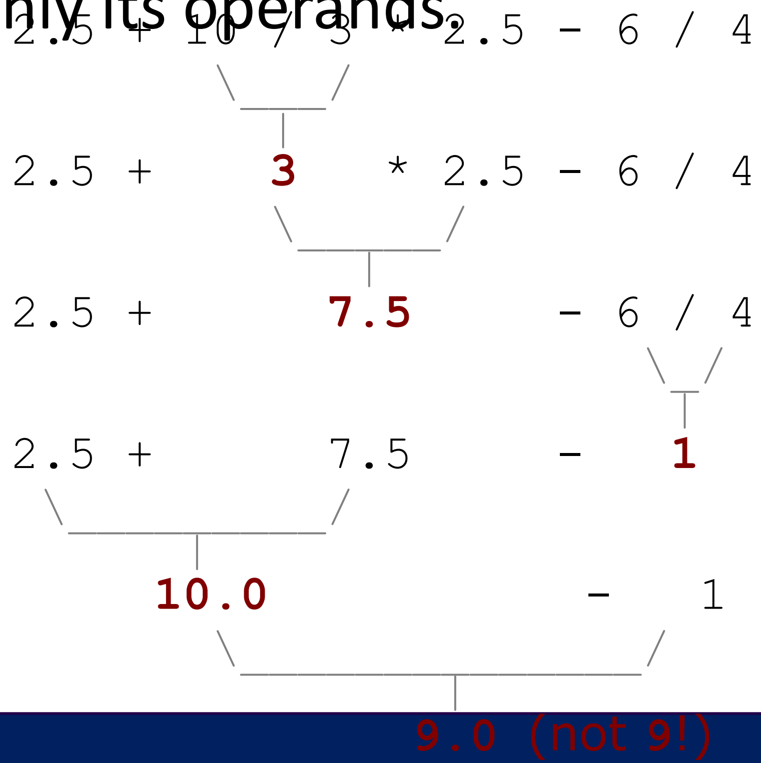
```
System.out.println(0.1 + 0.2);
```

  - The output is `0.30000000000000004`!

Mixing types

- When `int` and `double` are mixed, the result is a `double`.
  - `4.2 * 3` is `12.6`
- The conversion is per-operator, affecting only its operands.





  - `3 / 2` is `1` above, not `1.5`.

String concatenation

- **string concatenation**: Using + between a string and another value to make a longer string.

```
"hello" + 42     is "hello42"
1 + "abc" + 2    is "1abc2"
"abc" + 1 + 2    is "abc12"
1 + 2 + "abc"    is "3abc"
"abc" + 9 * 3    is "abc27"
"1" + 1          is "11"
4 - 1 + "abc"    is "3abc"
```

- Use + to print a string and an expression's value together.
  - `System.out.println("Grade: " + (95.1 + 71.9) / 2);`
  - Output: `Grade: 83.5`

Variables

Receipt example

What's bad about the following code?

```
public class Receipt {
    public static void main(String[] args) {
        // Calculate total owed, assuming 8% tax / 15% tip
        System.out.println("Subtotal:");
        System.out.println(38 + 40 + 30);
        System.out.println("Tax:");
        System.out.println((38 + 40 + 30) * .08);
        System.out.println("Tip:");
        System.out.println((38 + 40 + 30) * .15);
        System.out.println("Total:");
        System.out.println(38 + 40 + 30 +
                           (38 + 40 + 30) * .08 +
                           (38 + 40 + 30) * .15);
    }
}
```

- The subtotal expression `(38 + 40 + 30)` is repeated
- So many `println` statements

Variables

- **Variable**: A piece of the computer's memory that is given a name and type, and can store a value.
  - Like preset stations on a car stereo, or cell phone speed dial:

  - Steps for using a variable:
    - *Declare* it - state its name and type
    - *Initialize* it - store a value into it
    - *Use* it - print it or use it as part of an expression

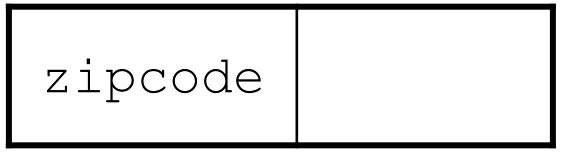
Variable Declaration

- **variable declaration:** Sets aside memory for storing a value.
  - Variables must be declared before they can be used.

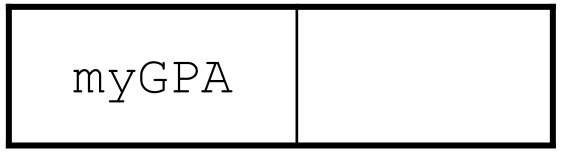
- Syntax:

  type name;

  - `int zipcode;`



  - `double myGPA;`



Variable Assignment

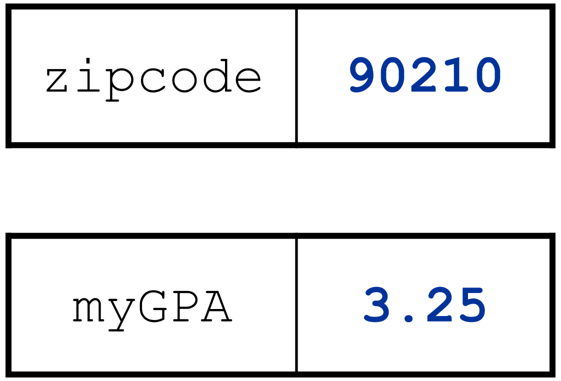
- **Assignment**: Stores a value into a variable.
  - The value can be an expression; the variable stores its result.

- Syntax:

  name = expression;

  -
    ```
    int zipcode;
    zipcode = 90210;
    ```

  -
    ```
    double myGPA;
    myGPA = 1.0 + 2.25;
    ```



Using variables

- Once given a value, a variable can be used in expressions:

```
int x;
x = 3;
System.out.println("x is " + x);        // x is 3
System.out.println(5 * x - 1);          // 14
```

- You can assign a value more than once:

x	11

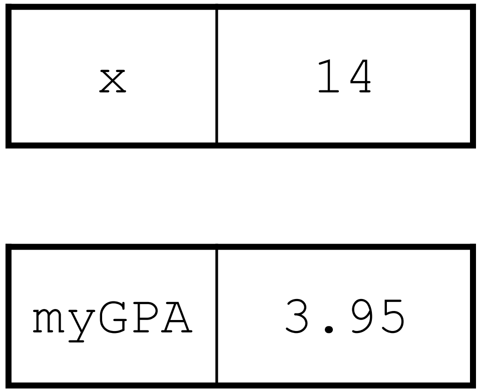
```
int x;
x = 3;
System.out.println(x + " here");        // 3 here

x = 4 + 7;
System.out.println("now x is " + x);  // now x is 11
```

Declaration/initialization

- A variable can be declared/initialized in one statement.
- Syntax:

  type name = expression;

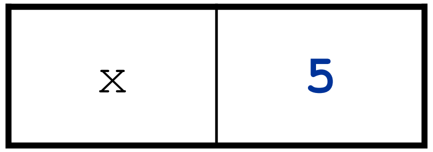
  - `int x = (11 % 3) + 12;`
  - `double myGPA = 3.95;`



Assignment vs. algebra

- Assignment uses `=` , but it is not an algebraic equation.
  - `=` means, *"store the value at right in variable at left"*
  - `x = 3;` means, *"`x` becomes `3`"* or *"`x` should now store `3`"*
- **ERROR**: `3 = 1 + 2;` is an illegal statement, because `3` is not a variable.
- What happens here?

```
int x = 3;
x = x + 2;    // ???
```



Assignment exercise

- What is the output of the following Java code?

```
int x;
x = 3;
int y = x;
x = 5;
y = y + x;
System.out.println(x);
System.out.println(y);
```

Assignment and types

- A variable can only store a value of its own type.
  - `int x = 2.5;      // ERROR: incompatible types`

- An `int` value can be stored in a `double` variable.
  - The value is converted into the equivalent real number.
  - `double myGPA = 4;`
  - `double avg = 11 / 2;`
    - Why does `avg` store `5.0` and not `5.5` ?

myGPA	4.0

avg	**5.0**

Compiler errors

- A variable can't be used until it is assigned a value.

  -
    ```
    int x;
    System.out.println(x);    // ERROR: x has no value
    ```

- You may not declare the same variable twice.

  -
    ```
    int x;
    int x;                    // ERROR: x already exists
    ```

  -
    ```
    int x = 3;
    int x = 5;                // ERROR: x already exists
    ```
    - How can this code be fixed?

Printing a variable's value

- Use + to print a string and a variable's value on one line.

  -
    ```
    double grade = (95.1 + 71.9 + 82.6) / 3.0;
    System.out.println("Your grade was " + grade);

    int students = 11 + 17 + 4 + 19 + 14;
    System.out.println("There are " + students +
                       " students in the course.");
    ```
  - Output:

    ```
    Your grade was 83.2
    There are 65 students in the course.
    ```

Receipt question

Improve the receipt program using variables.

```
public class Receipt {
    public static void main(String[] args) {
        // Calculate total owed, assuming 8% tax / 15% tip
        System.out.println("Subtotal:");
        System.out.println(38 + 40 + 30);

        System.out.println("Tax:");
        System.out.println((38 + 40 + 30) * .08);

        System.out.println("Tip:");
        System.out.println((38 + 40 + 30) * .15);

        System.out.println("Total:");
        System.out.println(38 + 40 + 30 +
                           (38 + 40 + 30) * .15 +
                           (38 + 40 + 30) * .08);
    }
}
```

Receipt answer

```
public class Receipt {
    public static void main(String[] args) {
        // Calculate total owed, assuming 8% tax / 15% tip
        int subtotal = 38 + 40 + 30;
        double tax = subtotal * .08;
        double tip = subtotal * .15;
        double total = subtotal + tax + tip;

        System.out.println("Subtotal: " + subtotal);
        System.out.println("Tax: " + tax);
        System.out.println("Tip: " + tip);
        System.out.println("Total: " + total);
    }
}
```

The End

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