

# Unit 1: Primitive Types Variables and Datatypes

Adapted from:

- 1) Building Java Programs: A Back to Basics Approach  
by Stuart Reges and Marty Stepp
- 2) Runestone CSAwesome Curriculum

This work is licensed under the  
[Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License](https://creativecommons.org/licenses/by-nc-sa/4.0/).

<https://longbaonguyen.github.io>

# Data Types

A **type** is a set of values (e.g. integers, floats, etc..) and a set of operations (e.g. +, -, \*, /, etc..) on them.

Data types can be categorized as either **primitive** or **reference**.

The primitive data types used in this course define the set of operations for numbers and Boolean(true or false) values.

**Reference variables or object variables** hold a reference(or address) to an object of a class(more on this in a future lecture).

# Primitive types

The primitive types on the Advanced Placement Computer Science A exam are:

- **int** - which store integers (whole numbers like 3, -76, 20393)
- **double** - which store floating point numbers (decimal numbers like 6.3, -0.9, and 60293.93032)
- **boolean** - which store Boolean values (either true or false).

# 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
- We will use **variables** to solve the above problems.

# 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

# Declaration

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

- Syntax:

**type name;**

- The name is an *identifier*.

– `int x;`



– `double myGPA;`



# Assignment

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

- Syntax:

**name = expression;**

```
- int x;  
  x = 3;
```

x	3
---	---

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

myGPA	3.25
-------	------

# 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
```

**string concatenation:**  
**string + number = concatenated string**  
**(more on this later)**

↓

- You can assign a value more than once:

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

x	11
---	----

```
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 = value;**

- `double myGPA = 3.95;`

myGPA	3.95
-------	------

- `int x = (12 - 3) * 2;`

x	18
---	----

# Assignment and algebra

- Assignment uses  $=$ , but it is not an algebraic equation.

$=$  means, *"store the value at right in variable at left"*

- The right side expression is evaluated first, and then its result is stored in the variable at left.

- What happens here?

```
int x = 3;
```

```
x = x + 2;    // no solutions  
                // mathematically  
                // not an equation!
```

x	5
---	---

# Multiple Variables

- Multiple variables of the same type can be declared and initialized at the same time.
- Syntax:

**type name1, name 2, name3;**

```
int x, y, z; // declare three integers.
```

**type name1 = value1, name2 = value2, name3 = value3;**

```
int a = 1, b = 2, c = 3; // declare and initialize  
                        // three integers.
```

# 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;`

myGPA	4.0
-------	-----

# Compiler errors

- Order matters.

```
- int x;
```

```
    7 = x; // ERROR: should be x = 7;
```

- 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);  
    }  
}
```



# Type boolean

- **boolean**: A logical type whose values are `true` and `false`.

```
int age = 22;  
boolean minor      = (age < 21);  
boolean lovesAPCS = true;  
System.out.println(minor); // false  
System.out.println(lovesAPCS); // true
```

# final

- The keyword **final** can be used in front of a variable declaration to make it a constant that cannot be changed. Constants are traditionally capitalized.

```
public class TestFinal
{
    public static void main(String[] args)
    {
        final double PI = 3.14;
        System.out.println(PI);
        PI = 4.2; // This will cause a syntax error
    }
}
```

# Naming variables

The name of the variable should describe the data it holds. A name like `score` helps make your code easier to read.

A name like `x` is not a good variable name in programming, because it gives no clues as to what kind of data it holds.

Do not name your variables crazy things like `thisIsAreallyLongName`, especially on the AP exam. You want to make your code easy to understand, not harder.

# Naming variables

The convention in Java and many programming languages is to always start a variable name with a lower case letter and then uppercase the first letter of each additional word.

Variable names **can not include spaces** so uppercasing the first letter of each additional word makes it easier to read the name. Uppercasing the first letter of each additional word is called **camel case**.

```
int numOfLives = 3; // camel case to highlight words
```

Another option is to use underscore symbol `_` to separate words, but you cannot have spaces in a variable name. Java is case sensitive so `playerScore` and `playerscore` are not the same.

```
int num_of_lives = 3; // use _ to highlight words.
```

# Keywords

- **keyword:** An identifier that you cannot use to name a variable because it already has a reserved meaning in Java.

abstract	default	if	private	this
boolean	do	implements	protected	throw
break	double	import	<b>public</b>	throws
byte	else	instanceof	return	transient
case	extends	int	short	try
catch	final	interface	<b>static</b>	<b>void</b>
char	finally	long	strictfp	volatile
<b>class</b>	float	native	super	while
const	for	new	switch	
continue	goto	package	synchronized	

# repl.it assignments

The following labs are repl.it assignments. Log on to your account to complete them. They are included here for your reference.

## Lab 1: Create Variables and Printing:

For you to do:

- Create a boolean variable called "isTrue" and set it to false
- Create a double variable called "money" and set it to 99999.99
- Print the variable "money" first
- Then print the variable "isTrue" **without skipping to the next line.**

# repl.it assignments

The following labs are repl.it assignments. Log on to your account to complete them. They are included here for your reference.

## Lab 2: Create Variables and Printing 2:

For you to do:

- Create a String variable called "name" and set it to "Chen"
- Create an integer variable called "age" and set it to 50
- Create an integer variable called "iq" and set it to the value of age (do NOT use ' = 50')
- Print the value of name
- Print the value of age without skipping a new line
- Print the value of iq

# repl.it assignments

The following labs are repl.it assignments. Log on to your account to complete them. They are included here for your reference.

## Lab 3: Create Variables and Printing them:

### Creating Variables and Printing Them

For you to do:

1. Create two String variables called `firstName` and `lastName` respectively.
2. Assign the String "Bob" to `firstName` and "Jones" to `lastName`.
3. Print `firstName` and `lastName`, one per line. Each should use a different print statement.



# References

1) Building Java Programs: A Back to Basics Approach by Stuart Reges and Marty Stepp

2) Runestone CSAwesome Curriculum:

<https://runestone.academy/runestone/books/published/csawesome/index.html>

For more tutorials/lecture notes in Java, Python, game programming, artificial intelligence with neural networks:

<https://longbaonguyen.github.io>