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

Data Types

A **type** is a set of values (a domain) and a set of operations 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 values.

Reference variables or object variables that hold a reference(or address) to an object of a class(more on this later).

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

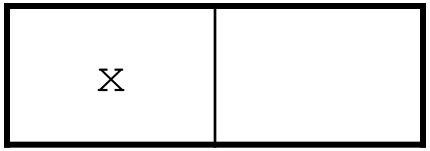
- **variable declaration**: Sets aside memory for storing a value.
  - Variables must be declared before they can be used.

- Syntax:

  type name;

    - The name is an *identifier*.

  - `int x;`



  - `double myGPA;`

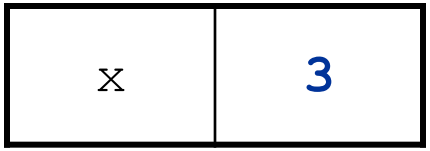
Assignment

- **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;`



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

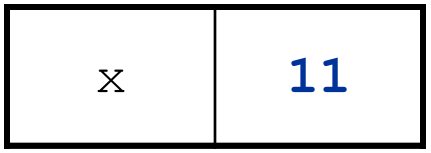
Using variables

- 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:




```
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 = **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;    // ???
```

Multiple Variables

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

- Syntax:

type name1, name 2, name3;

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

```
int x, y, z;  // declare three integers.
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`.
  - It is legal to:
    - create a `boolean` variable
    - pass a `boolean` value as a parameter
    - return a `boolean` value from methods
    - call a method that returns a `boolean` and use it as a test

```
int age = 18;
boolean minor    = (age < 21);
boolean 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.

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.**

```
public
{
    publ
    {
        final double PI = 3.14;
        System.out.println(PI);
        PI = 4.2; // This will cause a syntax error
    }
}
```

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