Using Classes

GEEN163 Introduction to Computer Programming

"Unless in communicating with it one says exactly what one means, trouble is bound to result."

Alan Turing

talking about computers

Homework

- The second programming assignment has been posted on Blackboard
- Programs are due at midnight Friday, September 2, 2016

MyCodeLab

- Answer the TuringsCraft questions for sections 2.3.1 – 2.3.5 and 3.2 – 3.7
- Due by midnight on Thursday, September 1, 2016
- You will earn 4 points for each correct answer up to a maximum of 100 points
- You can retry incorrect answers

Defining Your Own Data Type

- Java provides several simple data types that are supported natively by the hardware
  - int, double, char, float
- You can make your own data types to hold more complex information

Declaring an Object

- Imagine we have a class **`Widget`**
- We can declare an object of type **`Widget`** just like we declare a variable to be an int or a double.

```
Widget  lizard;
int     moose;
Widget  newt, salamander;
```

- lizard, newt and salamander are objects of the type Widget

Reference Variables

- When you declare a primitive data item, such as a double or int, Java reserves some memory to store the data
- When you declare an object, Java does **not** reserve space for the object until it is created
- You can instantiate a new object with the keyword **new**

Instantiating Objects

```
Widget  gnu = new Widget();
Widget  zebra;
zebra = new Widget();
```

- After the word "**new**" is a call to a constructor method that creates the object
- The constructor method may or may not have parameters

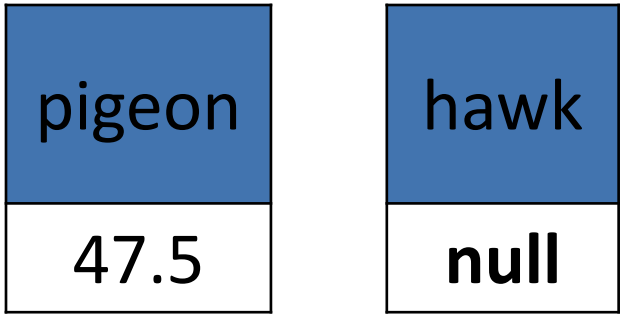
null

- null is a Java keyword that means “nothing”
- If you define a reference variable and do not create an object, the variable is automatically set to null
- If an object reference is set to the value null, it means there is no object

```
Widget pig = new Widget();
     . . .
pig  = null;
```

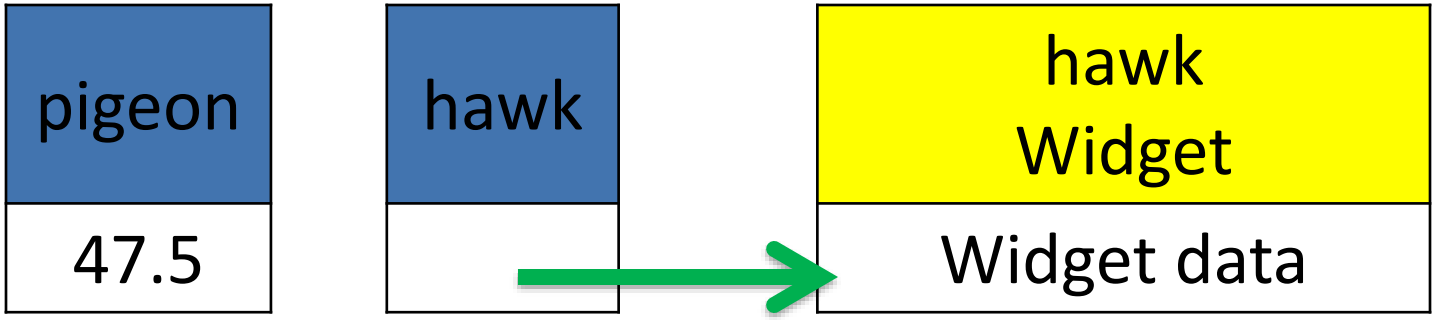
Reference Variables

```
double  pigeon = 47.5;
Widget  hawk;
```



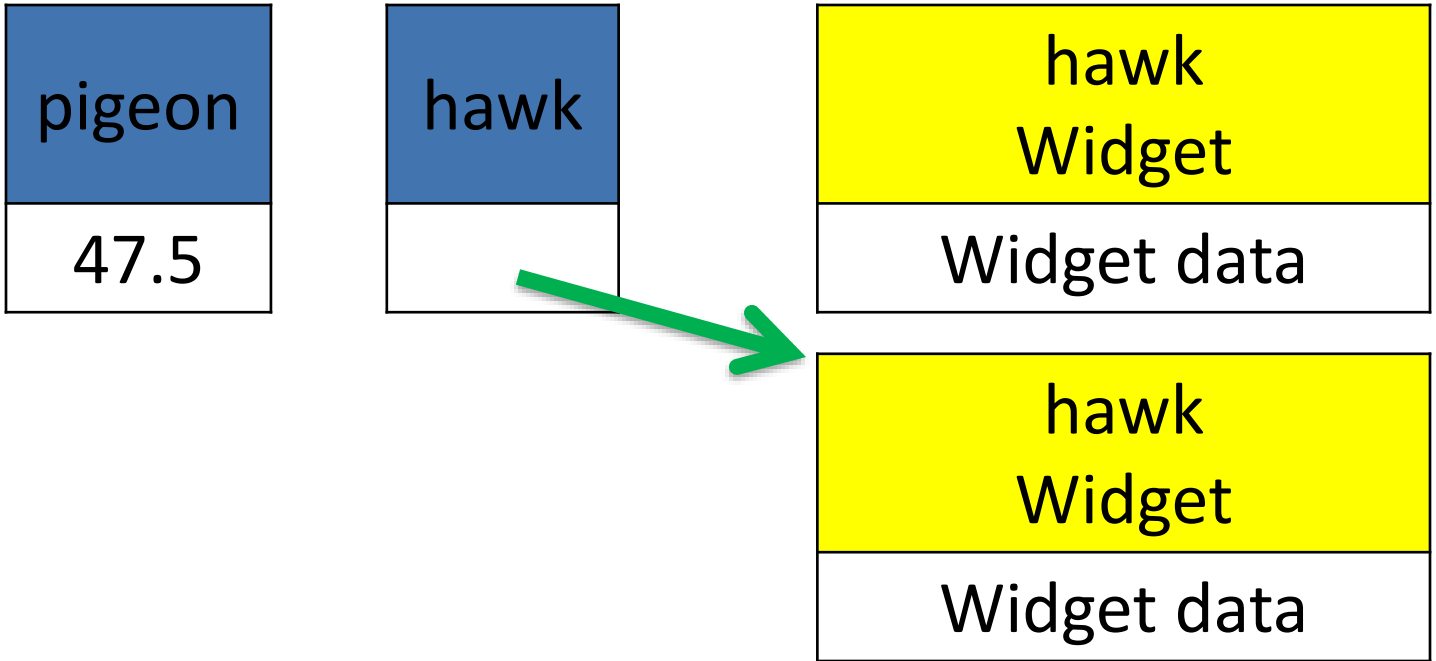
Reference Variables

```
double  pigeon = 47.5;
Widget  hawk;
hawk = new Widget();
```



Reference Variables

```
double  pigeon = 47.5;
Widget  hawk;
hawk = new Widget();
          . . .
hawk = new Widget();// later in program
```



Garbage Collection

- Sometimes during the execution of a Java program, an object becomes unusable

```
Widget pig = new Widget();
pig  = new Widget();  // 2nd object
```

- The original pig Widget is no longer accessible and becomes wasted space
- Periodically Java performs garbage collection to reclaim unusable object space

Name Rules

- By tradition, the names of classes start with an upper case letter and rest is lower case
- The name of a variable (object or primitive) is all lower case
- If you create a variable name from two English words, capitalize the first letter of the second English word

You create objects using the Java keyword

A. new
B. object
C. class
D. public

Class Content

A class contains:

- **Data** – classes can contain multiple values
  - Variables in a class are called **instance variables** or **fields**
- **Actions** – classes have **methods** that can do things relating to the data

Class Data

- A class or object can contain multiple data values often called **fields** or **instance variables**
- Data can be primitive data types, such as double or int, or other objects
- A class encapsulates data values that form a logical entity, such as
  - Information about a student in class
  - Data received from a network
  - A clickable button in a program

Methods of a Class

- A class can have methods which define actions the class can take on its data
- A Java program has a **main** method that is the first to execute when the program starts

Static or Dynamic

- Methods and data of a class can be either static or non-static
- The keyword **static** specifies a static item
- Static data or methods belong to the class
  - All objects share static data and methods
- Dynamic (or non-static) data or methods belong to an object
  - Each object has its own copy

Many Objects of a Class

- You can make many objects of a class
- Each class exists only once in a program
- There is only one copy of static data in the class
- Each object has its own copy of the object data
- If you had a Book class, you might make many objects of the Book with different titles

static and non-static Method Calls

- Static methods are called on the class, not a specific object
- `Math.sqrt()` and `System.in` are static
- non-static methods are called on an object of the class, not the class itself

```
java.util.Scanner keyboard =
      new java.util.Scanner(System.in);
myVar = keyboard.nextDouble();
```

Period

- You can reference a class or object's data or methods by putting a period after the class or object name
- method of the Math class

```
Math.sin( dog );
```

- data field of Math class

```
Math.PI;
```

- method of the keyboard Scanner object

```
keyboard.nextDouble();
```

The method **`weight`** is

```
Widget goat = new Widget();
int pounds = goat.weight();
```

A. static
B. dynamic
C. both
D. neither

Math class

- The Math class contains many methods for computing mathematical functions
- There is little data in the Math class
- The Math class does have two constants, Math.PI and Math.E
- The Math class has only static methods
- You never need to make a Math object

Scanner class

- The java.util.Scanner class is used to read numbers from an input source
- You have to create a Scanner object
- When you create a Scanner object, you specify where the input is coming from
- The methods we call on Scanner objects are non-static methods

String

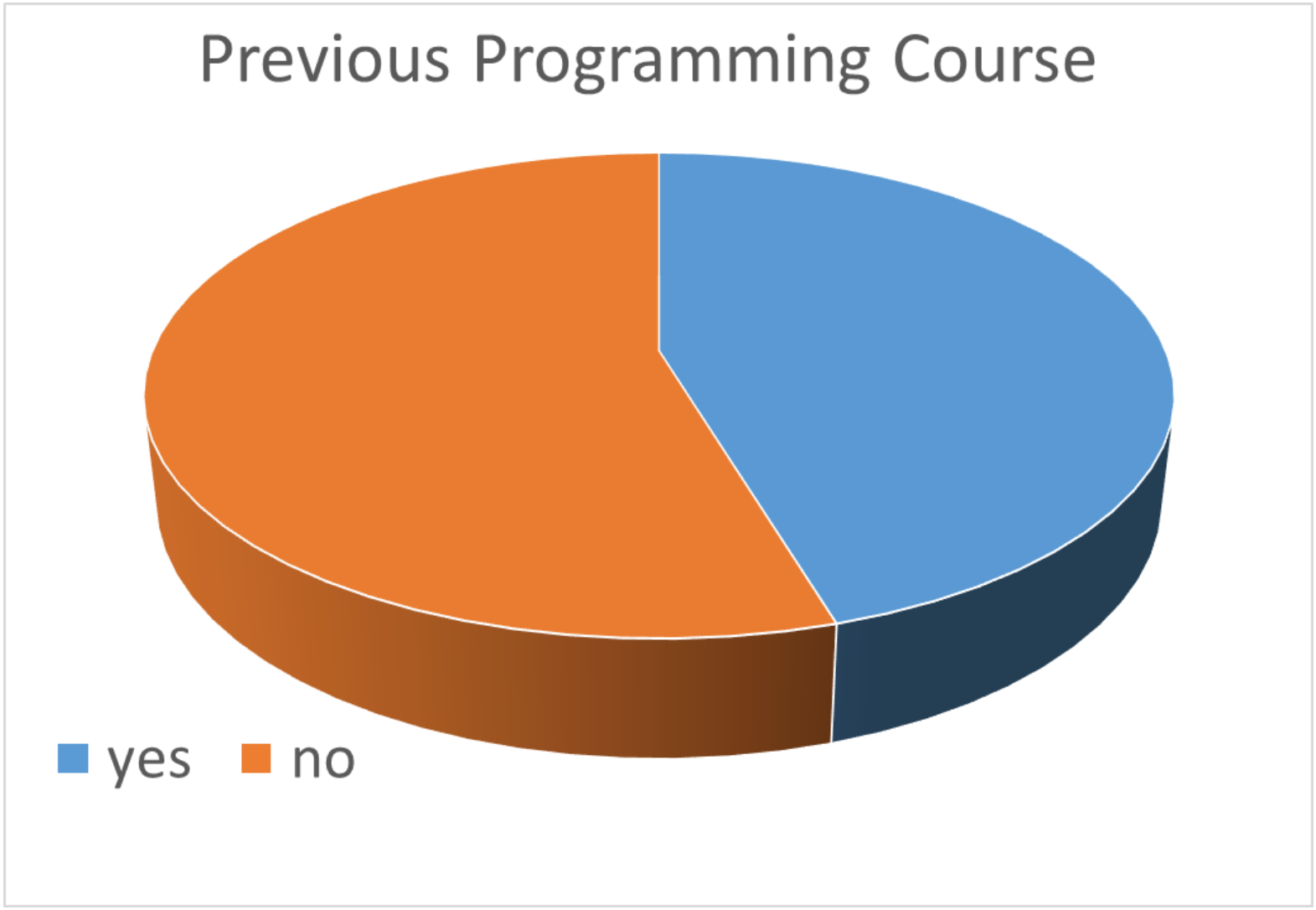
- **`String`** is a Java class
- The String class is special in that you can create a string object just by putting letters inside of double quotes

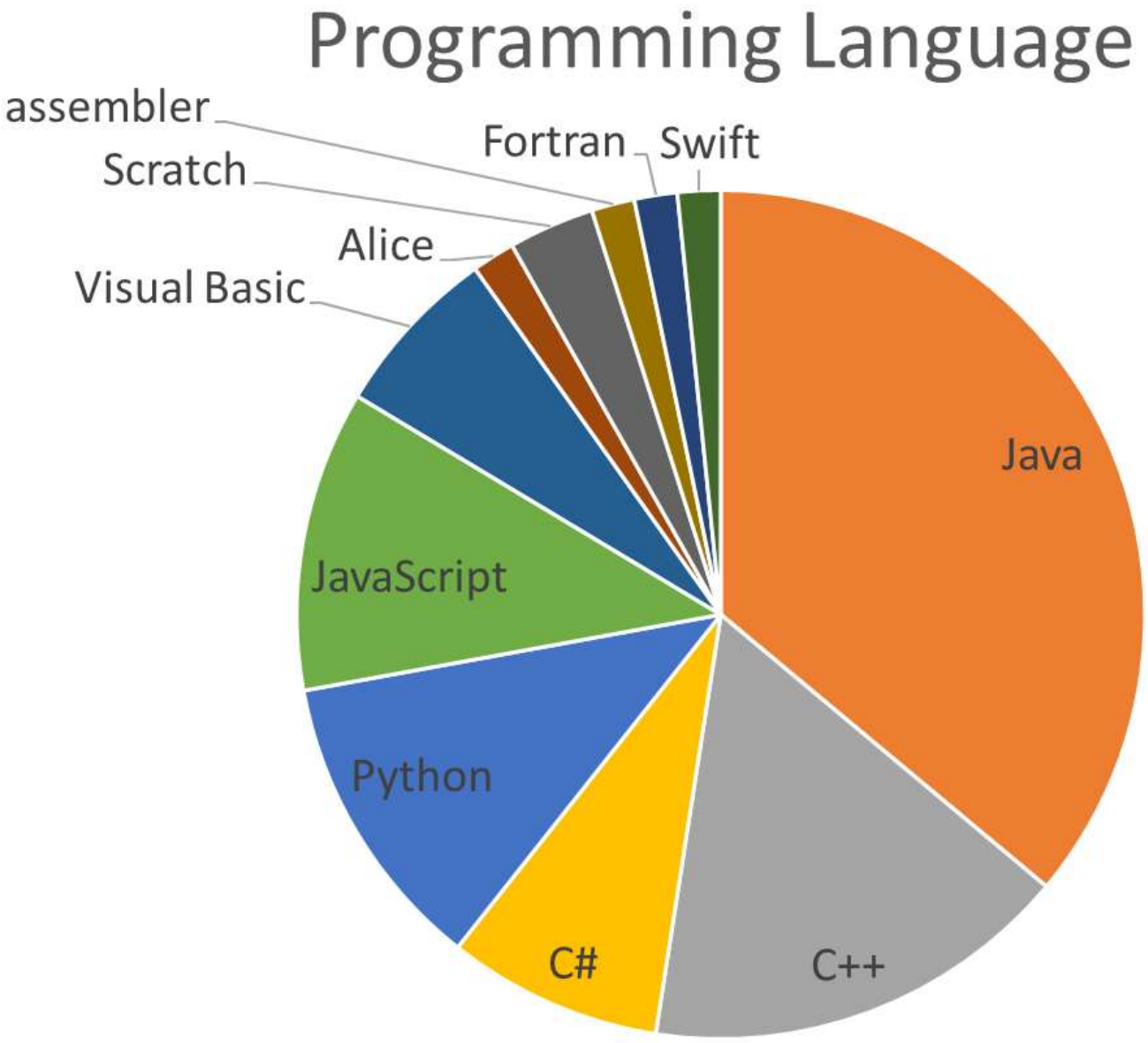
```
String dog = "Bow Wow";
String dog = new String("Bow Wow");
```

The main method of your program

A. is a method of your program's class
B. is a method of your program's object
C. all the above
D. none of the above

Survey Results




Programming Language
assembler
Scratch
Alice
Visual Basic
Fortran
Swift
Java
JavaScript
Python
C#
C++

Function Concept in Math

Function definition

$$f(x) = 5x - 3$$

Parameter of function

Name of function

When x = 1, f (x) = 2 is the returned value.

When x = 4, f (x) = 17 is the returned value.

The result of the function is determined by the function definition and by the values of the parameters

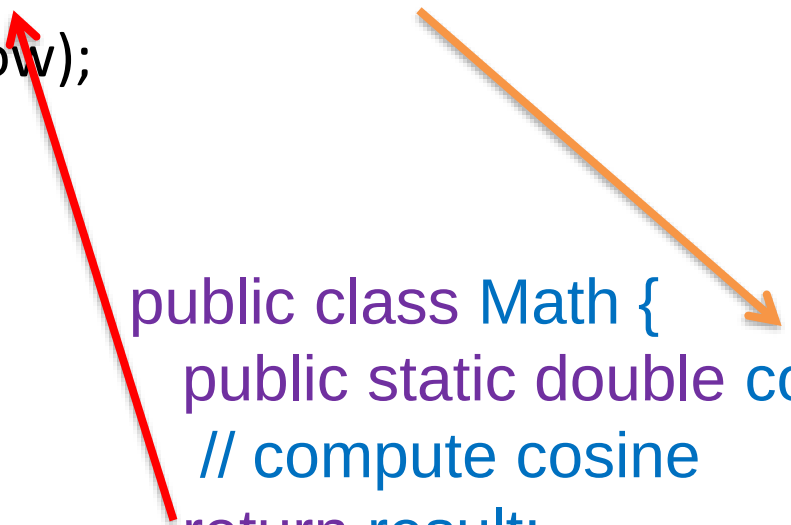
Would a rose by any other name …

- In Java, the name **method** and **function** are sometimes used interchangeably
- A **method** refers to a function in an Object-Oriented language, like Java
- The words **procedure** and **subroutine** are also names for methods, usually void methods

Transfer of Execution

```
public class Demo {
  public static void main( String[ ] stuff) {
  double theta = 1.047;
  double cow = 2.0*Math.cos(theta);
  System.out.println(cow);
  }
}
```

```
public class Math {
   public static double cos(double xyz) {
    // compute cosine
   return result;
  }
```



Keeping it Simple

- It is good programming practice to divide large programs into smaller manageable methods
- A method is a part of a program that performs a specific function
- Methods should be kept small enough to be understandable

Same Function, Different Data

- Methods are particularly useful when you are going to perform the same operation several times with different data
- The author of the Math.cos method did not know what angle you were going to use
- You can call the Math.cos method to get the cosine of any angle

```
cow = Math.cos( frog ) + Math.cos( toad );
```

Your programs

A. Always contain methods
B. Can use methods from other programs
C. Can have many methods
D. All of the above
E. None of the above

Using Methods and Classes

- Many valuable Java classes and methods have been written
- The standard Java library has many classes and more libraries are available
- You can create your own classes and methods
- Using existing classes and methods allows you to create exciting programs with far less effort

Method Parameters

- Data can be passed to a method

```
double dog = 25.0, cat;
cat = Math.sqrt( dog );
```

- Data passed to a method is called a parameter or argument

Multiple Parameters

- Method can have any number of parameters
- Some methods, such as **`nextInt()`** have no parameters
- Other methods have multiple parameters

```
double rat = 3.0, mouse = 2.0, vole;
vole = Math.pow( mouse, rat );
```

- Parameters are separated by commas

Example Method

```
public class FirstMethod {
    public static void main(String[] unused) {
        int rabbit = 3, pika = 5;
        rabbit = bunny( pika ) + 7;
        System.out.println("rabbit is "+rabbit);
    }

    static int bunny( int hare ) {
        int cottontail;
        System.out.println("hare is "+hare);
        cottontail = hare * 2;
        return cottontail;
    }
}
```

Value Returning Methods

- Some methods return a value
- For example, Math.sqrt(dog) returns the square root of dog
- Methods that return a value are generally used in an equation

```
cat = Math.sqrt( dog ) * 47.9;
```

Methods in Equations

- When a method returns a value, the value logically replaces the method call in an equation
- The normal rules of priority apply
- The parameters to a method are always inside parenthesis, so if the parameter is an equation, it is calculated before calling the method

Equation Evaluation

```
double root, a = 2.0, b = -4.0, c = -6.0;
root = (-b + Math.sqrt( b*b – 4.0*a*c) ) / (2 * a);
root = (-b + Math.sqrt( 16.0 – 4.0*a*c) ) / (2 * a);
root = (-b + Math.sqrt(16.0 – 8.0*c) ) / (2 * a);
root = (-b + Math.sqrt(16.0 + 48.0) ) / (2 * a);
root = (-b + Math.sqrt( 64.0) ) / (2 * a);
root = (-b + 8.0) / (2 * a);
root = 12.0 / (2 * a);
root = 12.0 / 4.0;
root = 3.0;
```

What is the value of cow?

```
double dog = 25.0, goat = 2.0;
double cow;
cow = (3.0 + Math.sqrt( dog )) /goat;
```

A. 2.0

B. 4.0

C. 15.5

D. 25.0

void methods

- A method that does not return a value is said to be a void method
- void methods usually appear on a line by themselves and not in equations

```
System.out.println("println is a void method");
```

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