Working With Java Classes

(Importance scale: ****, Extremely important)

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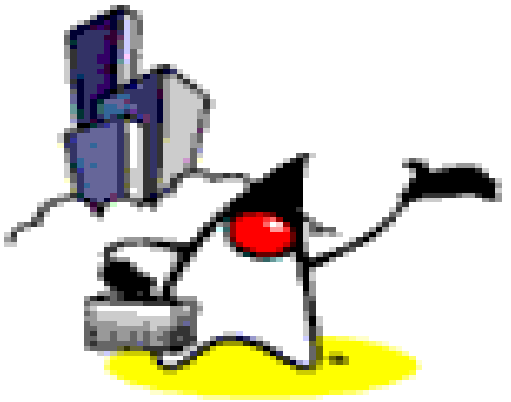
Objectives

- Explain object-oriented programming and some of its concepts
- Differentiate between classes and objects
- Differentiate between instance variables/methods and class(static) variables/methods
- Explain what methods are and how to call and pass parameters to methods
- Identify the scope of a variable
- Cast primitive data types and objects
- Compare objects and determine the class of an objects



Brief Introduction on OOP

What is Object-Oriented Programming (OOP)?

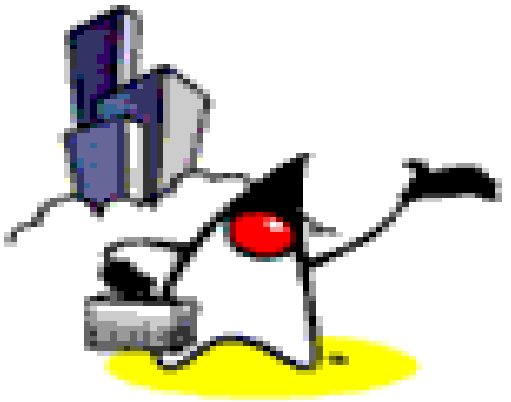
- Revolves around the concept of objects as the basic elements of your programs.
- These objects are characterized by their properties (sometimes called attributes) and behaviors.

Introduction to OOP

- Example of objects

Object	*Properties*	*Behavior*
Car	type of transmission manufacturer color	turning braking accelerating
Lion	Weight Color hungry or not hungry tamed or wild	roaring sleeping hunting

Objects in the physical world can easily be modeled as software objects using the properties as data and the behaviors as methods



Classes and Objects

Classes and Objects

- Class
  - Can be thought of as a template, a prototype or a blueprint of an object
  - Is the fundamental structure in object-oriented programming

- Member types of a class
  - Fields (they are also called properties or attributes)
    - Specify the data types defined by the class
  - Methods (behavior)
    - Specify the tasks to be performed

Classes and Objects

- Object (or object instance)
  - An object is an instance of a class
  - The property (field) values of an object instance is different from the ones of other object instances of a same class
  - Object instances of a same class share the same behavior (methods), however

Classes and Objects

- To differentiate between classes and objects, let us discuss an example:

Car Class		Object Car A	Object Car B
Instance Variables	Plate Number	ABC 111	XYZ 123
	Color	Blue	Red
	Manufacturer	Mitsubishi	Toyota
	Current Speed	50 km/h	100 km/h
Instance Methods	Accelerate Method		
	Turn Method		
	Brake Method		

Example: “Car” class

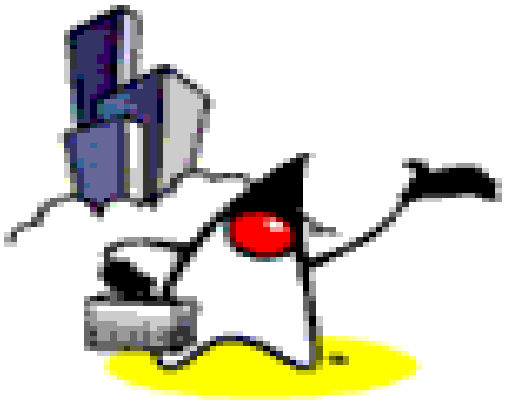
```
public class Car {

    // Fields - different values for different objects
    private String plateNumber;
    private String color;
    private String manufacturer;
    private int    speed;

    // Methods - common for all objects created from this class
    public void accelerate(){
        // Some code
    }

    public void turn(){
        // Some code
    }

    public void brake(){
        // Some code
    }
}
```

Classes and Reusability

- Classes provide the benefit of reusability.
- Software programmers can use a class over and over again to create many object instances.

What is Encapsulation?

- The scheme of hiding implementation details of a class
- The user of the class does not need to know the implementation details of a class
  - The user can call *brake()* method of the *Car* class without knowing how the method is implemented
- The implementation can change without affecting the user of the class



Creation of Object Instances with “new” keyword

Creation of Object Instance

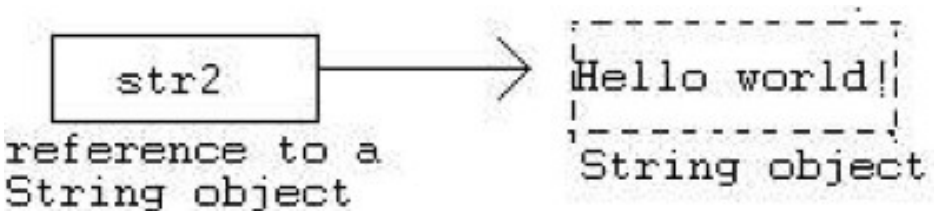
- To create an object instance of a class, we use the new operator.
- For example, if you want to create an instance of the class *String*, we write the following code,

```
String str2 = new String("Hello world!");
```

or

```
String str2 = "Hello world!";
```

- String class is a special (and only) class you can create an instance without using new keyword as shown above



Creation of Object Instance

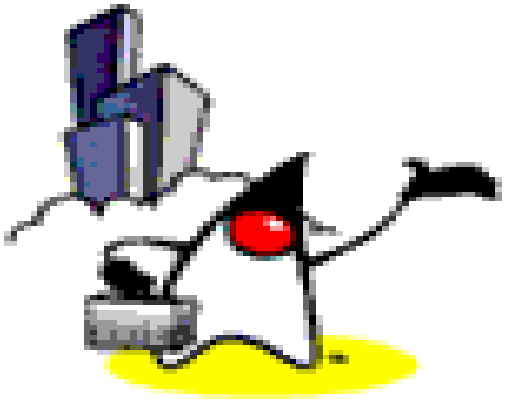
- The **new** operator
  - Allocates a memory for that object and returns a reference of that memory location to you.
  - When you create an object, you actually invoke the class' constructor method.
- The constructor method
  - It is a method where you place all the initializations
  - It has to have the same name as the class.

Example: Constructor Method of Car Class

```
public class Car {

    // Fields - different values for different objects
    private String plateNumber;
    private String color;
    private String manufacturer;
    private int    speed;

    // Constructor method
    public Car() {
       // Some initialization can be done here
    }

    // Methods - common for all objects created from this class
    public void accelerate(){
        // Some code
    }

    public void turn(){
        // Some code
    }

    public void brake(){
        // Some code
    }
}
```

Demo:

Exercise 1: Create an Object Instance using “new” keyword
1011_javase_class.zip



Methods (Instance methods & Static methods)

What is a Method?

- Method
  - It is a piece of code (set of statements) that can be called to perform some specific task.
- The following are characteristics of methods:
  - It can return one or no values
  - It may accept as many parameters it needs or no parameter at all. Parameters are also called arguments.
  - After the method has finished execution, it goes back to the method that called it.

Why Use Methods?

- Methods contain behavior of a class (business logic)
  - Taking a problem and breaking it into small, manageable tasks is critical to writing large programs.
  - We can do this in Java by creating methods to perform a manageable task

Two Types of Methods

- Instance (non-static) methods
  - Can be called only through an object instance - so it can be called only after object instance is created
    - [NameOfObject].[methodName]
  - More common than static methods
- Static methods
  - Object instance does not have to be created
  - Can be called through a class
    - [ClassName].[methodName]

Calling Instance (non-static) Methods

- To illustrate how to call methods, let's use the **`String`** class as an example.
- You can use the Java API documentation to see all the available methods in the String class.
- To call an instance method, we write the following,
  `nameOfObject.nameOfMethod( parameters );`

```
// Create object instance of String class
String strInstance1 = new String("I am object
instance of a String class");
// Call charAt instance method of String class
char x = strInstance1.charAt(2);
```

Calling Instance Methods

- Let's take two sample methods found in the String class

Method declaration	Definition
`public char charAt(int index)`	Returns the character at the specified index. An index ranges from 0 to length() - 1. The first character of the sequence is at index 0, the next at index 1, and so on, as for array indexing.
`public boolean equalsIgnoreCase (String anotherString)`	Compares this String to another String, ignoring case considerations. Two strings are considered equal ignoring case if they are of the same length, and corresponding characters in the two strings are equal ignoring case.

Example: Calling Instance Methods

```
// Create object instance of String class
String str1 = new String(“HELLO”);

// Call instance methof charAt().
// This will return the character H
// and store it to variable x.
char  x = str1.charAt(0);

// Create another object instance of String class
String str2 = new String(“hello”);

// Call instance methof equalsIgnoreCase().
// This will return a boolean value true.
boolean  result = str1.equalsIgnoreCase( str2 );
```

Calling Static Methods

- Static methods
  - > Static methods are invoked without creating an object instance (means without invoking the new keyword)
  - > Static methods are distinguished from instance methods in a class definition by the keyword static.

- To call a static method, just type,

```
Classname.staticMethodName(params);
```

Calling Static Methods

- Examples of static methods, we've used so far in our examples are

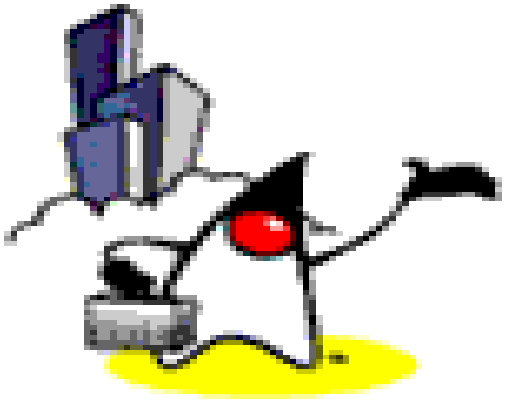
```
// The parseInt() is a static method of the Integer class
// It converts the String 10, to an integer
int i = Integer.parseInt("10");

// The toHexString() is a static method of the Integer class.
// It returns a String representation of the integer
// argument as an unsigned integer base 16
String hexEquivalent = Integer.toHexString( 10 );
```

When Static Method Are Used?

- When the logic and state does not involve specific object instance
  - > Computation method, for example
  - > add(int x, int y) method
- When the logic is a convenience without creating an object instance
  - > Integer.parseInt();

Demo:

Exercise 2: Static method & Instance Method
1011_javase_class.zip



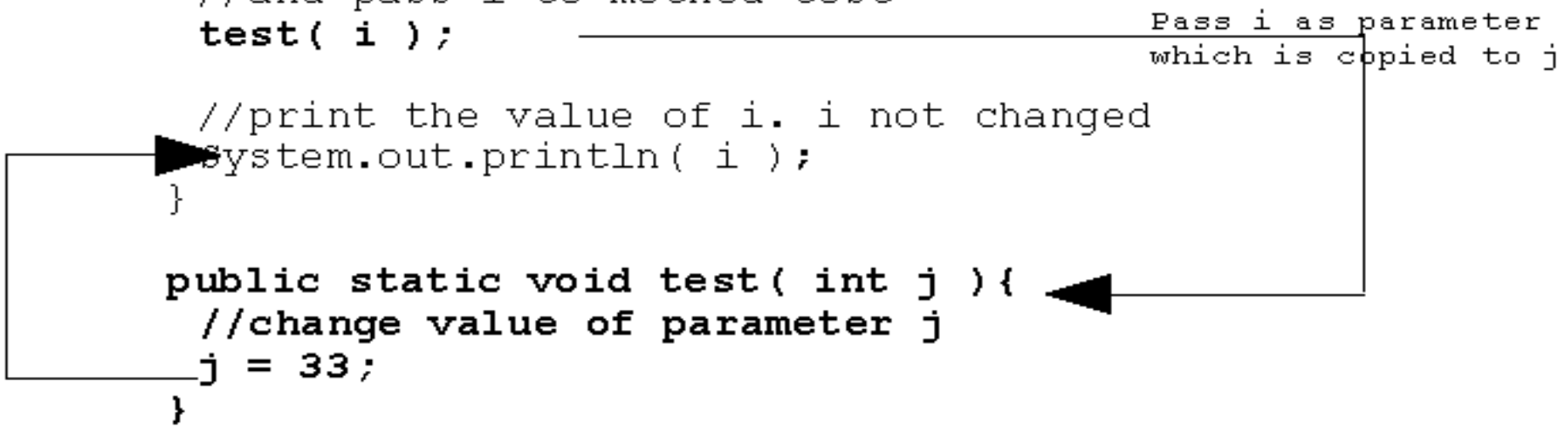
Parameter Passing (Pass-by-value & Pass-by-reference)

Parameter Passing

- Pass-by-Value
  - When a pass-by-value occurs, the method makes a copy of the value of the variable passed to the method. The method cannot accidentally modify the original argument even if it modifies the parameters during calculations.
  - All primitive data types when passed to a method are pass-by-value.

Pass-by-Value

```
public class TestPassByValue
{
      public static void main( String[] args ){
        int i = 10;
        //print the value of i
        System.out.println( i );

        //call method test
        //and pass i to method test
        test( i );

        //print the value of i. i not changed
        System.out.println( i );
      }

      public static void test( int j ){
        //change value of parameter j
        j = 33;
      }
}
```



Parameter Passing

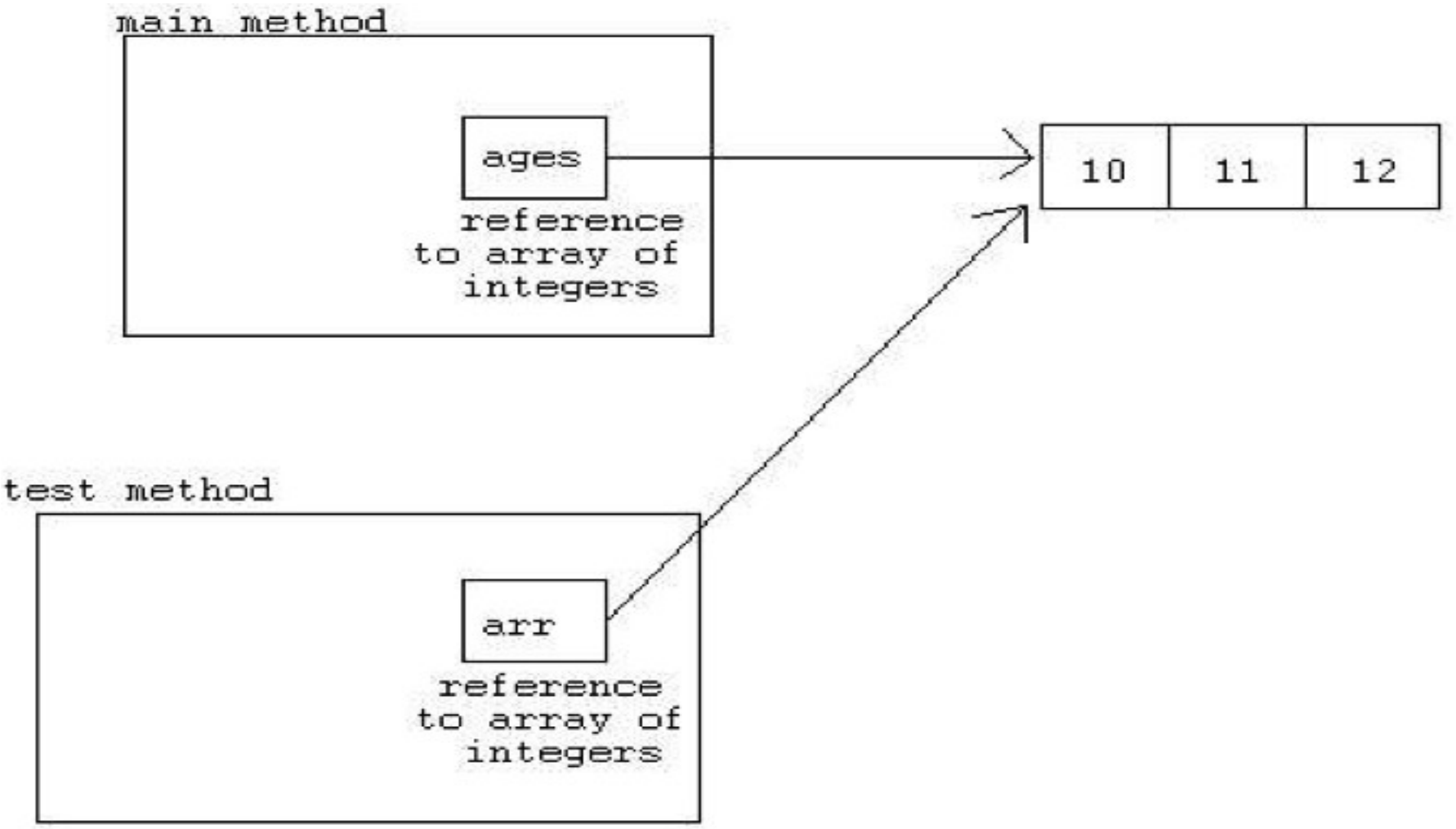
- Pass-by-Reference
  - When a pass-by-reference occurs, the reference to an object is passed to the calling method. This means that, the method makes a copy of the reference of the variable passed to the method.
  - However, unlike in pass-by-value, the method can modify the actual object that the reference is pointing to, since, although different references are used in the methods, the location of the data they are pointing to is the same.

Pass-by-Reference

```
class TestPassByReference
{
        public static void main( String[] args ){
                //create an array of integers
                int []ages  = {10, 11, 12};

                //print array values
                for( int i=0; i<ages.length; i++ ){
                        System.out.println( ages[i] );
                }

                //call test and pass reference to array
                test( ages );

                //print array values again
                for( int i=0; i<ages.length; i++ ){
                        System.out.println( ages[i] );
                }
        }

        public static void test( int[] arr ){
                //change values of array
                for( int i=0; i<arr.length; i++ ){
                        arr[i] = i + 50;
                }
        }
}
```

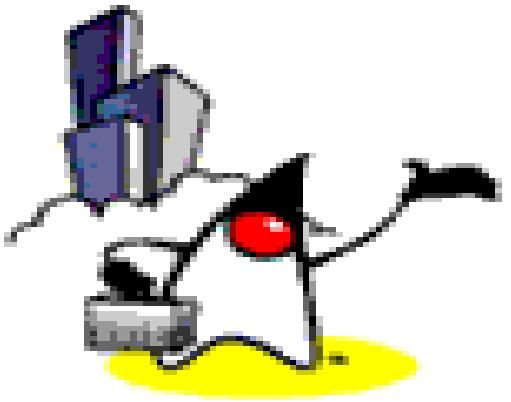
Pass ages as parameter which is copied to variable arr

Pass-by-Reference



Demo:

Exercise 3: “Pass by Value” & “Pass by Reference” 1011_javase_class.zip



Variables (Fields, Properties, Attributes)

Variables (Properties, Fields, Attributes)

- Data identifiers
- Are used to refer to specific values that are generated in a program--values that you want to keep around

Three Types of Variables

- There are three types of variables
  - Static variable (Also called as Class variable)
  - Non-static variable (Also called as Instance variable)
  - Local variable (Also called as automatic variable)
- The type of variable is determined by where the variable is declared
- The type of variable dictates where and how it can be used – this is called the scope of variable

Example: Types of Variables

```
public class Car {

    // Class (Static) variable
    private static String manufacturer = "Ford";

    // Instance (non-Static) variable
    private String plateNumber;
    private String color;

    public Car() {
    }

    public void accelerate(){
        // Local (automatic) variable
        int x = 10;
    }

}
```

Local Variable

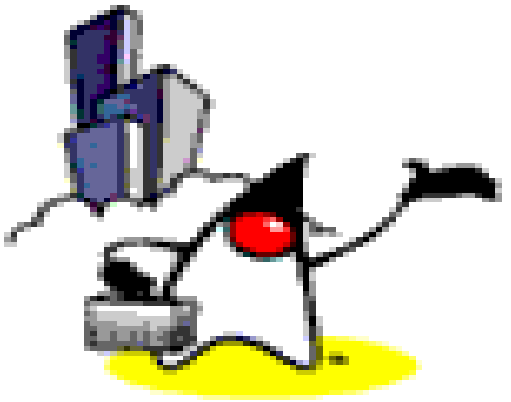
- Declared within a method body
- Visible only within the method body

Instance Variable

- Declared inside a class body but outside of any method bodies
- Exists per each object instance
  - Different object instances typically have different values
- Cannot be referenced within a static method
  - Because a static method by definition does not have an object instance

Static Variable

- Declared inside a class body but outside of any method bodies (same as Instance variable)
- Prepended with the *static* modifier (different from Instance variable)
- Exists per each class
- Shared by all object instances of the class



Scope of a Variable

Scope of a Variable

- The scope
  - > Determines where in the program the variable is accessible.
  - > Determines the lifetime of a variable or how long the variable can exist in memory.
  - > The scope is determined by where the variable declaration is placed in the program.

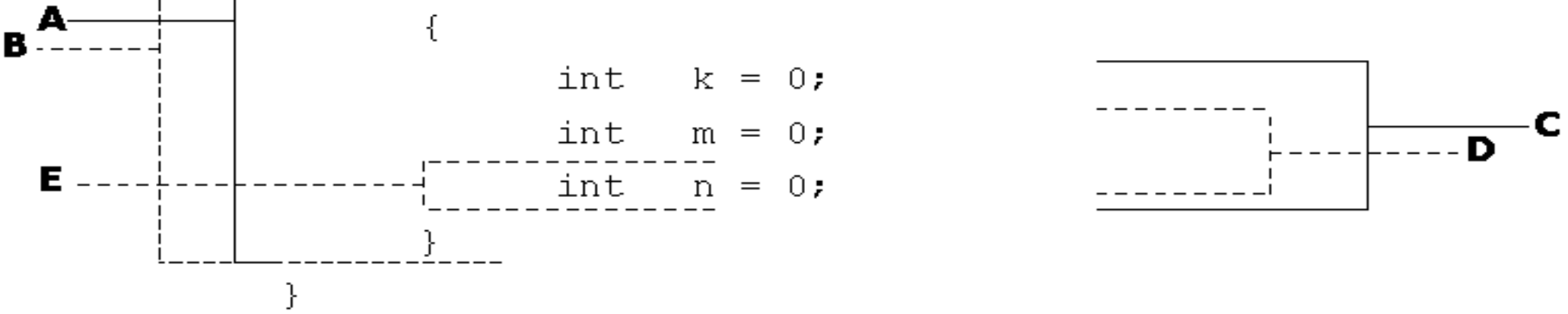
- To simplify things, just think of the scope as anything between the curly braces {...}. The outer curly braces are called the outer blocks, and the inner curly braces are called inner blocks.

Scope of a Variable

- A variable's scope is inside the block where it is declared, starting from the point where it is declared

Example 1

```
public class ScopeExample
{
    public static void main( String[] args ){
        int i = 0;
        int j = 0;

        //... some code here
        {
            int   k = 0;
            int   m = 0;
            int   n = 0;
        }
    }
}
```

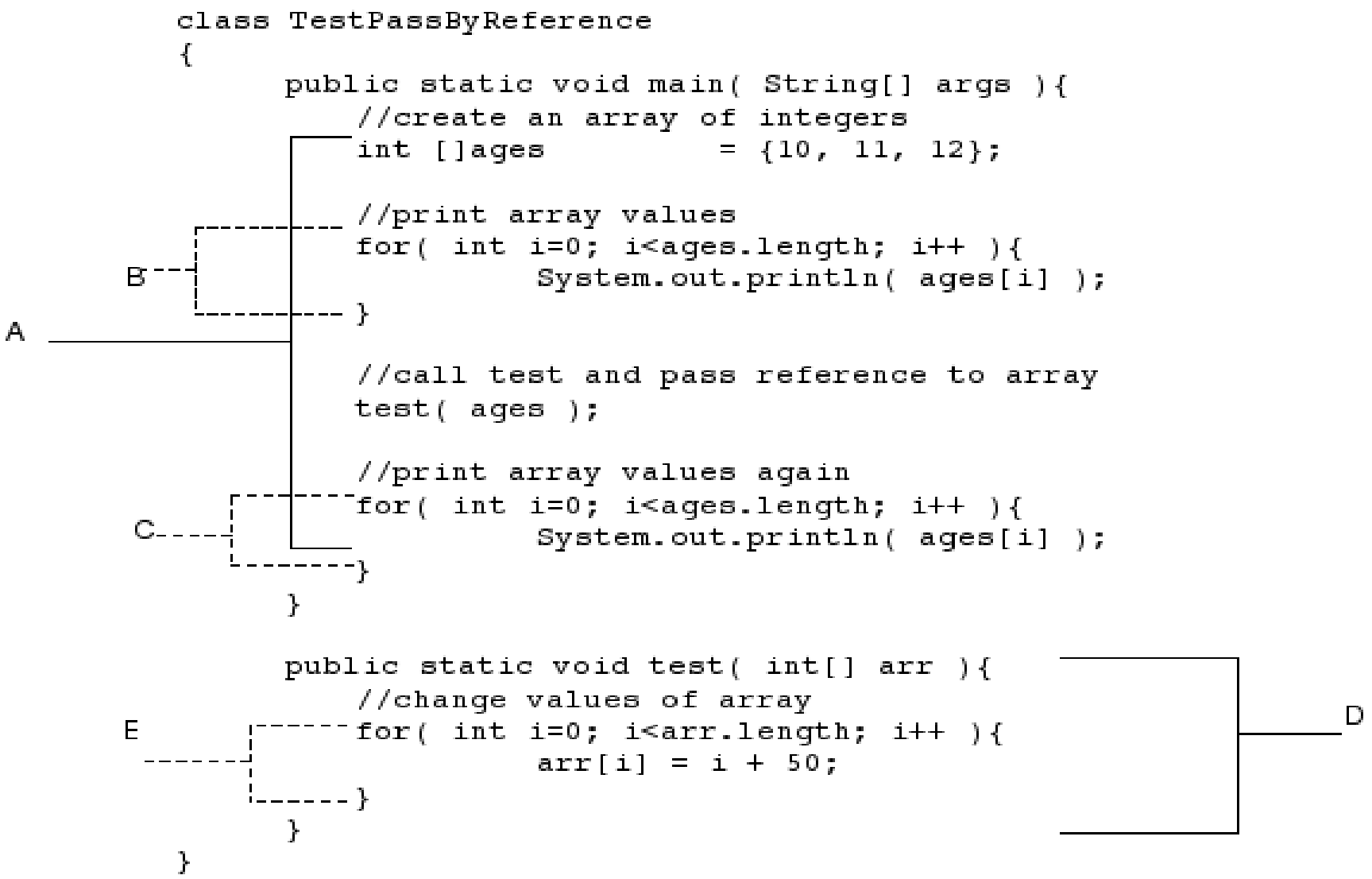


Example 1: Explanation

- The code we have in the previous slide represents five scopes indicated by the lines and the letters representing the scope.
- Given the variables i,j,k,m and n, and the five scopes A,B,C,D and E, we have the following scopes for each variable:
  - The scope of variable i is A.
  - The scope of variable j is B.
  - The scope of variable k is C.
  - The scope of variable m is D.
  - The scope of variable n is E.

Example 2

```
class TestPassByReference
{
        public static void main( String[] args ){
            //create an array of integers
            int []ages          = {10, 11, 12};

            //print array values
            for( int i=0; i<ages.length; i++ ){
                    System.out.println( ages[i] );
            }

            //call test and pass reference to array
            test( ages );

            //print array values again
            for( int i=0; i<ages.length; i++ ){
                    System.out.println( ages[i] );
            }
        }

        public static void test( int[] arr ){
            //change values of array
            for( int i=0; i<arr.length; i++ ){
                    arr[i] = i + 50;
            }
        }
}
```



Example 2: Explanation

- In the main method, the scopes of the variables are,
  - ages[] - scope A
  - i in B - scope B
  - i in C – scope C
- In the test method, the scopes of the variables are,
  - arr[] - scope D
  - i in E - scope E

Scope of a Variable

- When declaring variables, only one variable with a given identifier or name can be declared in a scope.
- That means that if you have the following declaration,

```
{
    int test = 10;
    int test = 20;
}
```

your compiler will generate an error since you should have unique names for your variables in one block.

Scope of a Variable

- However, you can have two variables of the same name, if they are not declared in the same block. For example,

```
public class Main {
    static int test = 0;

    public static void main(String[] args) {

        System.out.println(test);   // prints 0

        // test variable is defined in a new block
        {
            int test = 20;
            System.out.println(test);// prints 20
        }

        System.out.println(test);   // prints 0
    }
}
```

Scope of Variables

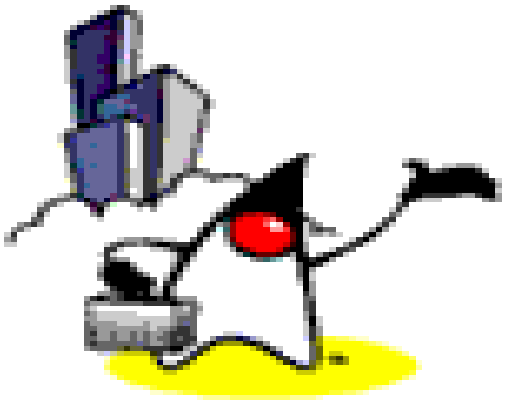
- Local (automatic) variable
  - Only valid from the line they are declared on until the closing curly brace of the method or code block within which they are declared
  - Most limited scope
- Instance variable
  - Valid as long as the object instance is alive
- Class (static) variable
  - In scope from the point the class is loaded into the JVM until the the class is unloaded.
  - Class are loaded into the JVM the first time the class is referenced

Coding Guidelines

- Avoid having variables of the same name declared inside one method to avoid confusion
- Use as limiting scope as possible

Demo:

Exercise 4: Scope of Variables
1011_javase_class.zip



Type Casting

Type Casting

- Type Casting
  - > Mapping type of an object to another
- To be discussed
  - > Casting primitives
  - > Casting objects

Casting Primitives

- Casting between primitives enables you to convert the value of one data from one primitive type to another primitive type.

- Types of Casting:
  - Implicit Casting
  - Explicit Casting

Implicit Casting

- Suppose we want to store a value of int data type to a variable of data type double.

```
int      numInt = 10;
double   numDouble = numInt; //implicit cast
```

In this example, since the destination variable's data type (double) holds a larger value than the value's data type (int), the data is implicitly casted to the destination variable's data type double without a problem since there is no loss of information

Implicit Casting

- Another example:

```
int       numInt1 = 1;
int       numInt2 = 2;

// result is implicitly casted to type double
double    numDouble = numInt1/numInt2;
```

Explicit Casting

- When we convert a data that has a large type to a smaller type, we must use an explicit cast because there is a possibility of losing information and Java compiler wants to make sure you know what you are doing

- Explicit casts take the following form:

```
(Type)value
```

where,

Type	- is the name of the type you're converting to
value	- is an expression that results in the value of the source type

Explicit Casting Examples

```
double   valDouble = 10.12;
// Without (int) casting, compiler error will occur
int      valInt = (int)valDouble;

// convert valDouble to int type
double x = 10.2;
int y = 2;

// Without (int) casting, compiler error will occur
int result = (int)(x/y);
```

Casting Objects

- Instances of classes also can be cast into instances of other classes, with one restriction: The source and destination classes must be related by inheritance; one class must be a subclass (child class) of the other.
  - We'll cover more about inheritance later.
- Casting objects is analogous to converting a primitive value to a larger type, some objects might not need to be cast explicitly.

Casting Objects

- To cast, prepend with (classname)

```
(classname)object
```

where,

classname is the name of the destination class &
object is a reference to the source object

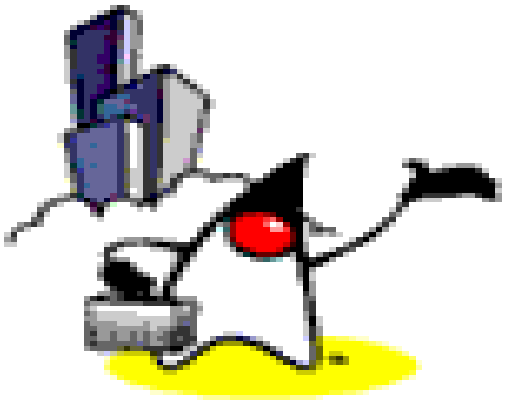
Casting Objects

- The following example casts an instance of the class VicePresident to an instance of the class Employee; VicePresident is a subclass of Employee with more information, which here defines that the VicePresident has executive washroom privileges.

```
Employee emp = new Employee();
VicePresident veep = new VicePresident();

// No cast needed for upward use because VicePresident is
// a subtype of Employee type, meaning any VicePresident
// is also a Employee type
emp = veep;

// Must cast explicitly because not all employee objects
// are VicePresident type
veep = (VicePresident)emp;
```

Demo:

Exercise 5: Type casting
1011_javase_class.zip



Primitives & Wrapper Types

Converting Primitive types to Objects and vice versa

- One thing you can't do under any circumstance is castting from an object to a primitive data type, or vice versa until JDK 5
  - As an alternative, the java.lang package includes classes that correspond to each primitive data type: Float, Boolean, Byte, and so on. We call them Wrapper classes.
- In JDK 5, the autoboxing and unboxing automatically handles the conversion

Wrapper Classes

- The Wrapper classes have the same names as the primitive data types, except that the class names begin with a capital letter
  - Integer is a wrapper class of the primitive int
  - Double is a wrapper class of the primitive double
  - Long is a wrapper class of the primitive long
- Using the classes that correspond to each primitive type, you can create an object that holds the same value.

Converting Primitive types to Objects (Wrapper) and vice versa

- The following statement creates an instance of the Integer class with the integer value 7801

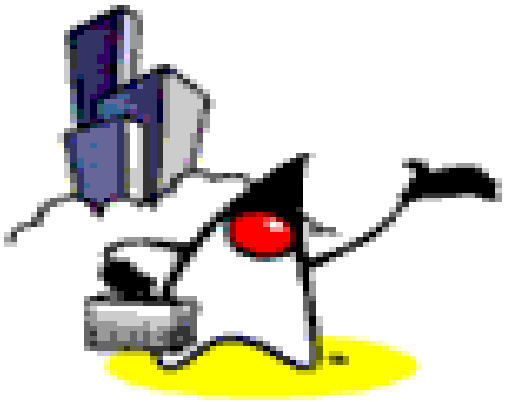
```
Integer dataCount = new Integer(7801);
```

- The following statement converts an Integer object to its primitive data type int. The result is an int with value 7801

```
int newCount = dataCount.intValue();
```

- A common translation you need in programs is converting a String to a numeric type, such as an int (Object->primitive)

```
String pennsylvania = "65000";

int penn = Integer.parseInt(pennsylvania);
```



Comparing Objects

Comparing Objects

- In our previous discussions, we learned about operators for comparing values—equal ==, not equal !=, less than <, and so on. Most of these operators work only on primitive types, not on objects.
- The exceptions to this rule are the operators for equality: == (equal) and != (not equal). When applied to objects, these operators don't do what you might first expect. Instead of checking whether one object has the same value as the other object, they determine whether both sides of the operator refer to the same object instance.

Comparing Objects

- Example:

```
1   class EqualsTest
2   {
3       public static void main(String[] arguments) {
4         String str1, str2;
5         str1 = "Free the bound periodicals.";
6         str2 = str1;
7         System.out.println("String1: " + str1);
8         System.out.println("String2: " + str2);
9         System.out.println("Same object? " + (str1 == str2)); //true
10        str2 = new String(str1);
11        System.out.println("String1: " + str1);
12        System.out.println("String2: " + str2);
13        System.out.println("Same object? " + (str1 == str2)); //false
14        System.out.println("Same value? " + str1.equals(str2));//true
15      }
16  }
```

Comparing Objects

- This program's output is as follows:

```
String1: Free the bound periodicals.
String2: Free the bound periodicals.
Same object? true
String1: Free the bound periodicals.
String2: Free the bound periodicals.
Same object? false
Same value? true
```

Comparing Objects

- NOTE on String class
  - Given the code:

```
String str1 = "Hello";
String str2 = "Hello";
```

  - These two references str1 and str2 will point to the same object. So comparing them with == results in true.
  - String literals are optimized in Java; if you create a string using a literal and then use another literal with the same characters, Java knows enough to give you the first String object instance back.
  - Both strings are the same objects

Comparing Objects

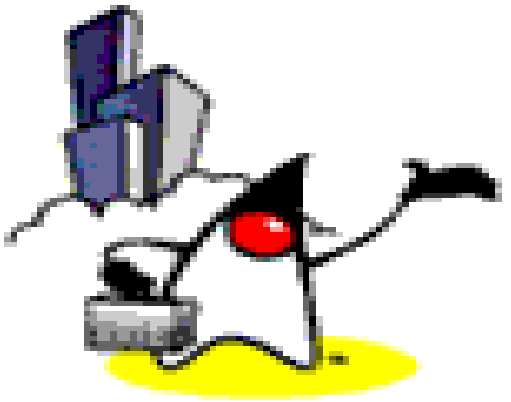
- NOTE on String class
  - Given the code:

```
String str1 = new String("Hello");
String str2 = new String("Hello");
```

  - These two references str1 and str2 will point to different object instances. So comparing them with == results in false.

Demo:

Exercise 6: Comparing Objects
1011_javase_class.zip



getClass() method & instanceof Operator

Determining the class of an object

- Want to find out what an object's class (type) is? Here's the way to do it.

- Suppose create an object of SomeClassName type

```
SomeClassName myObject =
                    new SomeClassName();
```

getClass() method

- The getClass() method returns a Class object instance
  - Every Class loaded in JVM is represented by a Class object
- Class class has a method called getName().
  - getName() returns a string representing the name of the class.

- For Example,

```
String name =
        myObject.getClass().getName();
```

instanceof operator

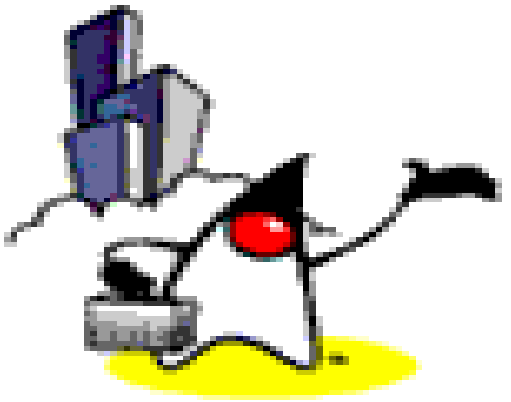
- The instanceof checks of an object is a instance of a particular class (type)

- For Example,

```
boolean ex1 = "Texas" instanceof String; // true
Object pt = new Point(10, 10);
boolean ex2 = pt instanceof String; // false
```

Demo:

Exercise 7: getClass() method & instanceof
1011_javase_class.zip



Summary

Summary

- Classes and Objects
  - Instance variables
  - Class Variables
- Object instance creation via *new* keyword
- Methods
  - Instance methods
  - Passing Variables in Methods (Pass-by-value, Pass-by-reference)
  - Static methods
- Scope of a variable
- Casting (object, primitive types)
- Converting Primitive Types to Objects and Vice Versa
- Comparing Objects
- Determining the Class of an Object

Thank you!

Check JavaPassion.com Codecamps!
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"Learn with Passion!"