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Java

Module 4:
Classes and Objects

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Introduction

MIT Faculty Video:

“Classes and Objects”

Notes to Instructor:

https://www.youtube.com/watch?v=pTB0EiLXUC8

Open the MIT Faculty Video on Classes and Objects, and play it on the screen in the front of the class.

Module Objectives

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At the end of this module, participants will be able to:

- Define and apply the concept of Object-Oriented Programming
- Define and differentiate classes from instances
- Define the concept of Garbage Collection
- Explain the Java package structure and class path
- Create, use, and import classes
- Define the concept of a constructor and finalizer
- Identify and use access modifiers
- Identify and create static attributes and methods

Overview of Object-Oriented Programming

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- Object-Oriented Programming is a programming pattern that makes use of objects and their interactions to design and implement applications
- Objects are entities that serve as the basic building blocks of an object-oriented application
- An object is a self-contained entity with attributes and behaviors

Information Within an Object

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Each object defines three basic types of information:

Identity

- An object has to describe the features that will allow its users to distinguish it from other objects. It needs to have an identity. Even if two objects share the same features, each object has a unique identity.

Attributes

- An object must be able to describe itself. This type of information is stored in an object's attributes which forms the object's structure.

State

- An object must be able to describe its current condition, called its state. Object state is sometimes represented by the values of each of its attributes.

Classes vs. Instances

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- A *class* is a template for a specific object.
- A *class* defines the attributes and methods that all objects belonging to the class have.
- The attributes and methods of a class are called ‘fields’ or ‘members’.
- An *instance* refers to an object that is a member of a particular class. All objects that belong to a class are instances of that class.

Classes vs. Instances (cont.)

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Creating and Manipulating Instances of a Class

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- Instances of a class can be created by using the keyword **new**. This process is called ‘instantiation’.
- The ‘new’ keyword creates the object based on the specified class and returns a reference to the newly created object.
- The reference is then received by an appropriate identifier.

```
<Class Type> <Identifier> = new <Class
Type>(<Constructor Parameters>)

Person him = new Person(“John Doe”, 25, ‘M’);
```

i Refer to the ClassInstanceSample.java sample code.

Creating and Manipulating Instances of a Class (cont.)

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- Fields of object instances can be accessed through their identifiers names.
- Access to member fields and methods is done through the use of the ‘dot’ notation.

```
<reference>.<attribute name>
<reference>.<member method>(<parameters>);

him.setAge(23)
him.getName();
```

Refer to the ClassInstanceSample.java and Person.java sample code.

Custom Classes

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- A primary aspect of an Object-Oriented programming language is the ability to define customized classes.
- A class declaration is the basic building block of a Java application.
- All code is built and attached to a class declaration. There is no code that does not belong to a class.

Custom Classes (cont.)

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- A Java Class denotes a category of objects, and acts as a blueprint for creating such objects.
- Classes declare what *package* they belong to.
- Classes declare what classes to *import* from other packages.
- Fields (also known as *variables* or *attributes*) refer to the properties of the class.
- Methods (also known as *operations*) refer to behaviors that the class exhibits.
- The source file containing the class declaration must have the same name as its public class.

Package Structure and the Class Path

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- Packages are collections of classes.
- Packages are used to group classes together based on functionality or relationship.
- Classes can be assigned to a certain package by using the *package* keyword:

```
package <package_name>;
package sef.module4.samples;
```

- The package structure is representative of the directory structure where the class definition is located.

Package Structure and the Class Path (cont.)

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- Class path is a list of directories and JAR files that contain classes and other resources needed by a Java application to run.
- Classes not included in the class path cannot be used by Java during compiling, runtime, and other utilities.
- A class path can be set in many ways, but a common way involves setting the CLASSPATH environment variable in the command prompt.
- A class path can contain more than one directory path.

```
C:> set CLASSPATH=classpath1;classpath2…;
C:> set CLASSPATH=.;C:\SEF;
```

Importing Classes

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- A program can use external resources by importing it.
- Imported resources can be a single class or an entire package of classes
- The imported classes need to be visible in the class path in order to be accessible.

```
import <package_name>; OR import <class-name>;
import java.util.*;
import java.util.Calendar;
```

Activity 1 – Create a Java File

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- In this activity, you will:
  - Create a java file DateActivity.java inside the package sef.module4.activity
  - Import java.util.Date
  - Create instance d of Date using Date()
  - Print today's date

Garbage Collection

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- The keyword ‘new’ explicitly allocates resources for an object, but there is no explicit way of telling the system to ‘de-allocate’ an object.
- Garbage collection is the process of automatically clearing up the memory being used by objects that will no longer be used by the program.
- Invocation of the garbage collector is automatically determined by the Java Virtual Machine, depending on the need to do so.
- An application can ‘suggest’ that the system initiate garbage collection using *System.gc() or Runtime.getRuntime().gc().*

Garbage Collection (cont.)

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- Garbage collection is used by Java to:
  - Recover resources (particularly memory) that are much needed by an application.
  - Avoid dangling pointers.
  - Ensure program integrity.
- Dangling pointers are the occurrence of having variables or references pointing to objects in memory that are not of the appropriate type or value.

Garbage Collection (cont.)

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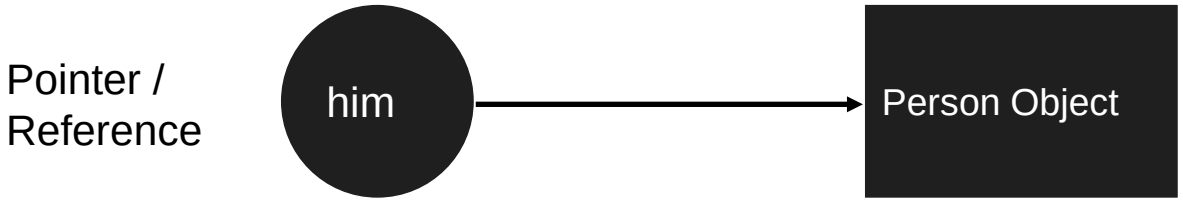
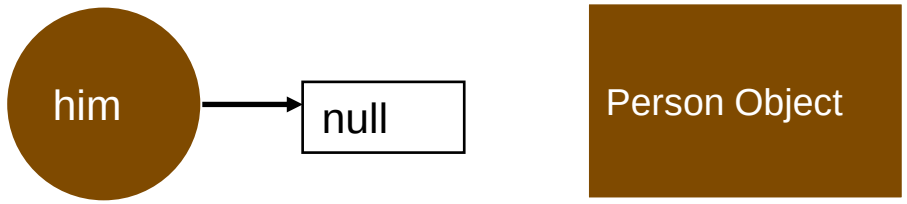
- Objects are safe from garbage collection if there is at least one reference variable that refers to the object

```
Person him = new Person();
```



- Objects are eligible for garbage collection when there are no more identifiers that refer to the object

```
him = null;
```



Concept of Constructor

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- Constructors are methods that set the initial state of an object
- Constructor name must be the same as the class name
- Constructor cannot return a value, not even **void**
- Constructors cannot be inherited
- If the class does not explicitly declare a constructor, it will default to a no parameter, do-nothing constructor

```
public class Cube1
{
   private int size;

   Cube1(int size)
   {
      this.size = size;
   }
   }
```

Concept of Finalizer

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- A finalizer is a special method that is executed to remove the object or resource from memory when it is no longer needed.
- The finalize() method is used by the garbage collector to free up memory from resources which are no longer needed.

```
protected void finalize() throws Throwable
   {
   try
        {
        close(); // close open files
        }
   finally
        {
        super.finalize();
        }
   }
```

Attributes and Behavior

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- Variables declared as part of the class represent the data that is contained by instances of this class
- The values stored by these variables represent the object's current 'attributes' or 'state'
- Methods declared as part of the class represent the operations that instances of the class can perform
- These operations are said to be the 'behavior' of the object

Member Modifiers

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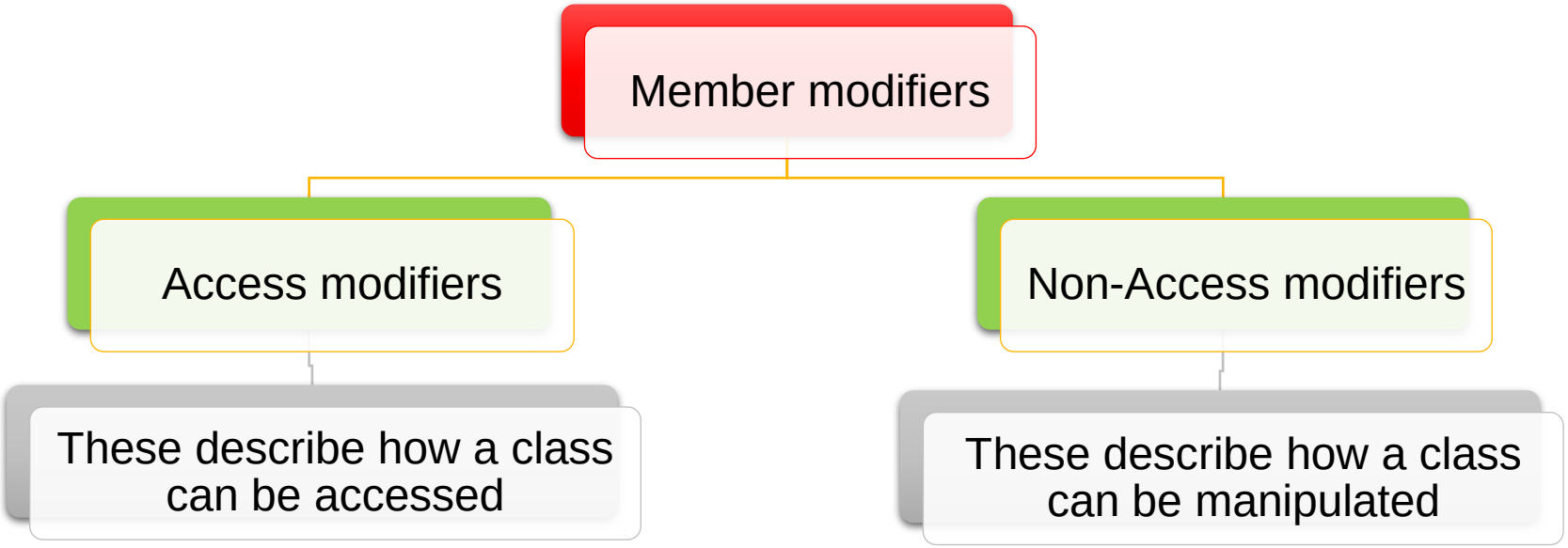
- Classes often need control on how their attributes and behaviors are accessed.
- Member modifiers allow this control.
- There are two types of member modifiers.



Access Modifiers

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- Access modifiers describes how a class can be accessed.
- There are four types of access modifiers. These are:

default / no modifier	• A class can be accessed by classes belonging to the same package
public	• A class member can be accessed by any class in any package
protected	• A class member can only be accessed by itself or its subclasses
private	• A class member can only be accessed by itself

Non-access Modifiers

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- Non-access modifiers - describes how a class can be manipulated.

static	• Member belonging to a class; shared by all instances of the class
final	• Member declared as a constant. It cannot be modified once declared
abstract	• Method is declared but is never instantiated. This modifier can be applied to methods to extend a class
strictfp	• Method implements strict floating-point arithmetic

Non-access Modifiers (cont.)

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- Non-access Modifiers - describes how a class can be manipulated.

synchronized	• Method is executed by only one thread at a time. It can be applied to blocks of code and methods
native	• Method implementation is written in other language. It can only be applied to methods.
transient	• An instance variable is not saved when its object is persisted or serialized. It can only be applied to variables
volatile	• Variable is modified asynchronously by concurrently running threads. It can be applied only to variables

Restrictions on Use of Modifiers

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- Not all combinations of instance and class variables and methods are allowed:
  - Instance methods can access instance variables and instance methods directly.
  - Instance methods can access class variables and class methods directly.
  - Class methods can access class variables and class methods directly.
  - Class methods cannot access instance variables or instance methods directly. Class methods also cannot use the this keyword as there is no instance for this to refer to.

Static Attributes and Methods

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- Static attributes and methods are associated to the class and are shared by all instances of the class
- Static attributes and methods are defined by using the keyword **static**
- Only static methods can directly access attributes and call methods that are also static
- Static members of a class can be accessed or are referenced by the class name

```
<Class Name>.<static member>
Calendar.getInstance();
```

Static Code Blocks

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- Code blocks can be marked off as static
- Static code blocks are executed only once when the class is loaded by the JVM for the first time
- Only static code blocks can directly access static attributes and methods

```
public class SampleClass{

        static{
                //your code here
        }

   }
```

Refer to the StaticSample2.java sample code.

Activity 2 – Create a Calculator

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- In this activity, you will:
  - Open the file ‘Calculator.java’ in the package sef.module4.activity
  - Read the instructions and create the code to complete this program

Questions and Comments

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- What questions or comments do you have?