**Source File Declaration Rules:**

●One public class per source code file

●If there is a public class in the file, the name of the file must match the public class name

●If the class is the part of a package, the package statement should be the first line of the source code before any import statements.’

●If there are import statements, they must go between the package name (if there is one) and class declaration

**Java Program Compilation And Execution:**

**Using The javac and java commands:**

**Compiling With Javac:**

The javac command is used to invoke java’s compiler. You can specify many options when running javac.

And what are those options like:

For instances, there are options to generate debugging information or compiler warning.

javac [options] [source-files]

Some of the examples of javac command:

Javac -help

Javac -version foo.java Bar.java

The first invocation does not compile any files, but prints a summary of valid options.

The second invocation passes the compiler an option, (-version, which prints the version of the compiler they are using) and passes the compiler two java files to compile, (foo.java and bar.java). Whenever, you are specifying multiple options, they must be separated by spaces.

**Launching Applications With Java: java command:**

The java command is used to invoke the java virtual machine.

**Import:**

In Java, the import statement is used to bring certain classes or the entire packages, into visibility. As soon as imported, a class can be referred to directly by using only its name. (Whether the package or class is library package or class, or user defined package or class, does not matter)

The import statement is a convenience to the programmer and is not technically needed to write complete Java program. If you are going to refer to some few dozen classes into your application, the import statement will save a lot of time and typing also.

**Static Import:**for instance, consider the following sample program:

**import static java.lang.System.out;**

**import static java.lang.Integer.\*;**

**public class TestStaticImport**

**{**

**public static void main(String[] args)**

**{**

**out.println(MAX\_VALUE);**

**out.println(toHexString(42));**

**}**

**}**

Let’s look what’s happening in the code that’s using the static import.

* Even through the feature is static import, the syntax must be import static followed by the fully qualified name of the static member you want to import. Or, you could use wildcard. (**like, import static java.lang.Integer.\*; here, \* is the wildcard)**
* What does static import actually mean? For instance, **import static java.lang.Integer.\*;** it says I want to do static imports of all the static members.
* Now, we are fully seeing the benefits of static import features. First, it imports all the static members, second, We did not have to type System in System.out.println. Second thing, we don’t need to type the Integer in Integer.MAX\_VALUE. So, in this line, we were able to use a short cut for a static\_method and a constant.

(However, in the last case, where we don’t have to import the integer in Integer.MAX\_VALUE, watch out for the ambiguously named static members. For instance, if your program does a static import for both the classes Integer and Long, referring to the MAX\_VALUE will cause a compiler error. Since, for both classes static definition of MAX\_VALUE is present and compiler does not know which MAX\_VALUE you are referring.)

**Wildcard Concept In import:**

As you have seen, when using import and import static statements, sometimes you can use the wildcard character \* to do the simple searching (for a function or constant) for you. **(with the use of \* character, you can search through a package or within a class). you can say this:**

**import java.util.\*; //ok, to search the whole java.util packages**

In a similar vein, if you want to search the java.lang.Integer class for static members, you can say that:

**import static java.lang.integer.\*;**

But, you cannot create broader searches. For instance, you cannot use an import to search through the entire java API;

**import java.\*;**

**Data Types In Java:**

**Primitive Data Types:**



Note, In java, char is of 2 bytes.

**User Defined Data Type:**Probably enum is one of the user defined datatype. As of java 5, java lets you restrict a variable to have one of the predefined values. In other words, one value from an enumerated list.

Using enum can help in reducing the bugs in your code.

For instance, in your coffee shop application, you might want to restrict your coffee size size selections to BIG, HUGE, and OVERWHELMING. If you let and order for a **LARGE** or **GRANDE** slip in, it might cause an error.

An enum can be defined as the following:

**enum coffeesize={BIG, HUGE, OVERWHEELMING};**

It’s not required that enum constants be all in caps, but borrowing from the Oracle code conventions, **that constants are named in caps**, it’s a good idea.

**Now, enum could be declared out side of a class, it could be declared within a class as a class member, or enum can be declared as their own separate class.**

**An Example: (when enum is declared outside of any class)**

enum CoffeeSize{BIG, HUGE, OVERWHELMING}

//no semicolon at the end

//this cannot be private or protected

class Coffee

{

CoffeeSize size;

}

public class CoffeeTest1

{

public static void main(String args[])

{

Coffee drink=new Coffee();

drink.size=CoffeeSize.BIG;

System.out.println("The drink size is: "+drink.size);

}

}

**Note the following things:**

1. Both class Coffee and CoffeeTest1 is in the same package. No access specifier is specified to the class Coffee as well as it’s members. Hence, the scope, the package default. For class Coffee as well as the variable size in it. Hence,   
     
   drink.size=CoffeeSize.BIG can be accessed.
2. We have a enum outside the class’s scope.
3. The way in which we can access one of the newly defined values.
4. note that thing. Java language designers make it optional to put a semicolon at the end of the enum declaration. So, what gets created when you make an enum? The most important thing to remember that an enum is not string or int. Each of the enumerated CoffeeSize typesare actually an instance of CoffeeSize. Think of an enum as a kind of class that looks something like this (not exactly though)

**class CoffeeSize**

**{**

**public static final CoffeeSize BIG=new CoffeeSize(“BIG”,0);**

**public static final CoffeeSize HUGE=new CoffeeSize(“HUGE”,1);**

**public static final CoffeeSize OVERWHELMING=new CoffeeSize(“OVERWHELMING”,”2”);**

**CoffeeSize(String enumName, int index)**

**{**

**//stuff here**

**}**

**}**

**How can we know more about it?**

public enum Constants {

ONE,

TWO,

THREE;

}

Compiling the above enum and disassembling resulting class file with javap gives the following: (Now, javap disassembles the machine code generated, as disassembling (Compiling the above enum and disassembling resulting class file with javap gives the following)

Compiled from "Constants.java"

**public final class Constants extends java.lang.Enum{**

**public static final Constants ONE;**

**public static final Constants TWO;**

**public static final Constants THREE;**

**public static Constants[] values();**

**public static Constants valueOf(java.lang.String);**

**static {};**

**}**

The disassemble shows that that each field of an enum is an instance of the Constants enum class. (Further analysis with javap will reveal that each field is initialized by creating a new object by calling the new Constants(String) constructor in the static initialization block.)

Therefore, we can tell that each enum field that we create will be at least as much as the overhead of creating an object in the JVM.

**Declaring Constructors, Methods, Variables In An Enum:**

Because, enum is a special kind of class, you can do more than just list the enumerated constant values. You can add constructors, instance variables, methods and something really strange known as a constant specific class body. To understand, why you might need more in your enum, think about the particular scenario: imagine you want to know the actual size, in ounces, that map to the three CoffeeSize constants. Now, you could make some kind of lookup table using some other data structures. But that will be a poor design and hard to maintain. The simplest way to treat your enum values as objects, each of which can have its own instance variables and own values.

enum CoffeeSize

{

BIG(8), HUGE(10), OVERWHELMING(16);

private int ounces;

CoffeeSize(int ounces)

{

this.ounces=ounces;

}

public int getOunces()

{

return ounces;

}

}

public class Coffee

{

CoffeeSize size;

public static void main(String[] args)

{

Coffee drink1=new Coffee();

drink1.size=CoffeeSize.BIG;

System.out.println("In "+drink1.size+" we get "+drink1.size.getOunces());

}

}

Which produces: In BIG we get 8

There are some points to know:

●You can never invoke an enum constructor directly. The enum constructor is invoked automatically, with the arguments you defined after the constant value.

●You can define more than one argument to the constructor, and you can overload the enum constructors. Just as you overload a normal class constructor.

**Variable Declarations:**there are two types of variables in java.   
  
**Primitives:** a **primitive** can be one of the eight types. Char, boolean, short, int, long, double or float. Once, a primitive has been declared, its primitive type can never be changed. Although in most cases, its value can be changed.

Now, java char has 2 bytes

**Reference Variables:** a reference variable is used to refer to an object. A reference variable is declared to be a specific type and that type can never be changed. A reference variable can be used to refer to any other objects of the declared type or of a subtype of the declared type.

**Pass By Reference Concept In Java:  
  
If Java uses the pass-by reference, why won't a swap function work?**  
A: Java does manipulate objects by reference, and all object variables are references. However, Java doesn't pass method arguments by reference; it passes them by value.  
  
Take the badSwap() method for example:  
  
public void badSwap(int var1, int var2)  
{  
 int temp = var1;  
 var1 = var2;  
 var2 = temp;  
}  
When badSwap() returns, the variables passed as arguments will still hold their original values. The method will also fail if we change the arguments type from int to Object, since Java passes object references by value as well.

so , what does that mean?

**import java.util.Vector;**

**public class Test**

**{**

**public static void addInContainer(Vector<Integer> container)**

**{**

**container.add(20);**

**container.add(30);**

**}**

**public static void main(String args[])**

**{**

**Vector<Integer> container=new Vector<>();**

**container.add(10);**

**//Now, print the values**

**for(int i=0;i<container.size();i++)**

**{**

**System.out.print(container.elementAt(i)+" ");**

**}**

**System.out.println();**

**addInContainer(container);**

**System.out.println("After calling addInContainer");**

**for(int i=0;i<container.size();i++)**

**{**

**System.out.print(container.elementAt(i)+" ");**

**}**

**System.out.println();**

**}**

**}**

**This will print:**

10   
After calling addInContainer  
10 20 30

**import java.util.Vector;**

**public class Test**

**{**

**public void swap(Vector<Integer> container)**

**{**

**Vector<Integer> container2=new Vector<Integer>();**

**container=container2;**

**}**

**public static void main(String args[])**

**{**

**Vector<Integer> container=new Vector<>();**

**container.add(10);**

**container.add(20);**

**container.add(30);**

**//Now, print the values**

**for(int i=0;i<container.size();i++)**

**{**

**System.out.print(container.elementAt(i)+" ");**

**}**

**System.out.println();**

**System.out.println("After swap function is called");**

**for(int i=0;i<container.size();i++)**

**{**

**System.out.print(container.elementAt(i)+" ");**

**}**

**System.out.println();**

**}**

**}**

**This will print:**

10 20 30   
After swap function is called  
10 20 30

**So, what do you learn:**

1. Java does not pass primitive data types as reference as function arguments
2. For Objects, java passes references in a copy by value approach.

**Packages In Java:**

**There are two kinds of packages:**

1) User defined package: The package we create is called user-defined package.

2) Built-in package: The already defined package like java.io.\*, java.lang.\* etc are known as built-in packages.

**If a class is under a package, the statement package …; should be the first statement.**

**Consider the following example:**

package cert;

public class sludge

{

public void testit(){System.out.println(“Sludge”)};

}

In this class, **package cert;** should be the first statement. All imports come later.

**Sub packages in Java**

A package inside another package is known as sub package. For example If I create a package inside letmecalculate package then that will be called sub package.

Lets say I have created another package inside letmecalculate and the sub package name is multiply. So if I create a class in this subpackage it should have this package declaration in the beginning:

**package letmecalculate.multiply;**

**Note:** If you don’t declare a package for a class, it will be part of default package.

java is a package centric language, the developers assumed that for **good organization and for named scoping**, you would put all your classes into packages. And, this is right, Otherwise, consider the following situation. Three different programmers which are in the same company but working on different projects,define their own utilities class. Now, if those classes are not declared in any of the explicit package, and are in the class path, there is no way to tell JVM or compiler which one you are trying to reference.

Oracle suggests/recommends that developer use **reverse domain names appended with division and/or project names. For example, if your domain name is anonymous.com your package name should start with com.anonymous.**

**Class Declarations And Modifiers:**

Class modifiers are fall into two types:

**Access Modifiers. (public, private, protected)**

**Non access modifiers. (strictfp, final and abstract)**

**Access Modifier:**Now, though there is three access modifiers, public, private and protected, there are four levels of access controls. As the fourth one is default or package access when you don’t use any of the chosen access modifiers. (private, protected, public)

However, all the four access modifiers are for class variables and functions. For a class, there is two access modifiers. **Public and Default**

**What does that mean? A class has only two access specifiers, while a variable can have all the four access specifiers.**

**Public access modifier:**

When a method or variable member is declared public, it means all other classes, regardless of the package they belong to, can access the member. (Assuming that the class itself is visible)

**package cert;**

**public class sludge**

**{**

**public void testit(){System.out.println(“Sludge”)};**

**}**

**package book;**

**import cert.\*;  
class Goo**

**{**

**public static void main(String args[])**

**{**

**sludge o=new sludge();**

**O.testIt();**

**}**

**}**

As you can see, Goo and sludge are in different packages. However, Goo can invoke the method in sludge without problems, because, both the sludge class and it’s testIt() method are made public.

**But, if you make the following changes, it will not even compile:**

**Goo.java**

/\*

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\* and open the template in the editor.

\*/

package book;

import cert.\*;

public class Goo

{

public static void main(String[] args)

{

Sludge o=new Sludge();

o.testIt();

}

}

**Cert.java**

/\*

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\* To change this template file, choose Tools | Templates

\* and open the template in the editor.

\*/

package cert;

/\*\*

\*

\* @author Reve

\*/

public class Sludge

{

//it's access specifier is made package default

void testIt()

{

System.out.println("Sludge");

}

}

You cannot even compile it.

It will give the compilation error for following line in Goo.java

**o.testIt(); as testIt has default access.**

**Now, if you change the class definition to the following:**

**Goo.java**

/\*

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\* To change this template file, choose Tools | Templates

\* and open the template in the editor.

\*/

package book;

import cert.\*;

public class Goo

{

public static void main(String[] args)

{

Sludge o=new Sludge();

o.testIt();

}

}

**Cert.java**

/\*

\* To change this license header, choose License Headers in Project Properties.

\* To change this template file, choose Tools | Templates

\* and open the template in the editor.

\*/

package cert;

/\*\*

\*

\* @author Reve

\*/

class Sludge

{

//it's access specifier is made package default

public void testIt()

{

System.out.println("Sludge");

}

}

It will give compilation error, too. But, in this line:

**Sludge o=new Sludge();**

Note: main must be contained under a public class. (Thus, every java project **(does not matter if it consists of even one file should contain at least one public class)**

**Private access modifiers:**

Members marked private cannot be accessed by code in other class other than the class in which the private member is declared.   
  
  
**Now, Note that,** a private method of a super class cannot be overridden by a subclass since, it is not inheriting it.

**Now, note that,** private access modifier cannot be applied to a class

**Protected Access modifiers:**

The protected and default access control levels are almost identical. But, with one critical difference. A default member may be accessed only if the class accessing the member belongs to thee same package. Whereas, a protected member can be accessed (through inheritance) by a subclass if the subclass is in a different package.

**Any class could only see the protected members through inheritance.**

**Non Access Modifiers Of A Class:**

strictfp, final and abstract. (what is native? Native is a modifier used on a function name. But it finally uses the native interface to reuse the functions defined in other languages)

**Final Class:**when used in a class declaration, the final keyword means the class cannot be sub classed. In other words, no other class can ever extend a final class. And trying to do so will generate **Compilation error. In other words, no other class can ever extend.** You should make a final class only if you need an absolute guarantee that none of the methods in that class will ever be overridden.

**Many classes in java core libraries are final. Like, String class.** Imagine the havoc if you could not guarantee how a string object would work on any given system your application is running on.

**However, in practice, we will almost never make a final class.** A final class obliterates a key benefit of OO -extensibility. So, unless if you have a serious safety or security issue, you should not do this.

**Final Functions:**

prevents a method from being overridden in a subclass.

**Final Arguments:**

Final keyword can also be used in case of an argument. The concept is similar to const argument in c++. **A new value cannot be assigned to the variable. If that is passed ass a final argument.**

**Abstract Class:**

An abstract class can never be instantiated. So, it’s purpose is it has to be extended.

**So, conceptually where it is useful?**

Imagine you have a class car that has generic methods common to all vehicles. But, you don’t want anyone to actually create a generic, abstract class object.

Or, the bank account example.

**abstract class Car**

**{**

**private double Price;**

**private String model;**

**private String year;**

**private abstract void goFast();**

**private abstract void goUpHill();**

**private abstract void impressNeighbours();**

**}**

**Some points about abstract class:**

* Even a single method is abstract in a normal class, that class has to be defined as abstract.
* However, you can have non abstract methods in a abstract class. For example, you might have methods that should not change from Car Type to Car Type such as getColor() or setPrice(). **By putting non-abstract methods in a abstract class, you give all concrete subclasses inherited method implementation.**
* **An interface cannot be abstract**
* **A variable cannot be abstract.**

**Strictfp modifier:**

**strictfp** is a keyword in java used for restricting floating-point calculations and ensuring same result on every platform while performing operations in the floating-point variable.  
Floating point calculations are platform dependent i.e. different output(floating-point values) is achieved when a class file is run on different platforms(16/32/64 bit processors). To solve this types of issue, strictfp keyword was introduced in JDK 1.2 version by following [IEEE 754](https://en.wikipedia.org/wiki/IEEE_floating_point) standards for floating-point calculations.

**Important points:**

* strictfp modifier is used with classes, interfaces and methods only.

**strictfp class Test**

**{**

**// all concrete methods here are**

**// implicitly strictfp.**

**}**

**strictfp interface Test**

**{**

**// all methods here becomes implicitly**

**// strictfp when used during inheritance.**

**}**

**class Car**

**{**

**// strictfp applied on a concrete method**

**strictfp void calculateSpeed(){}**

**}**

* strictfp modifier cannot be used with variables.
* When a class or an interface is declared with strictfp modifier, then all methods declared in the class/interface, and all nested types declared in the class, are implicitly strictfp.
* strictfp cannot be used with abstract methods. However, it can be used with abstract classes/interfaces. **(since, only concrete methods can be strictfp)**
* Since methods of an interface are implicitly abstract, strictfp cannot be used with any method inside an interface. **(Because, strictfp can only be used with concrete functions)**

**Example 1:**

**strictfp interface Test**

**{**

**double sum();**

**double mul();**

**}**

It is allowed

**Example 2:  
  
 strictfp interface Test**

**{**

**double sum();**

**strictfp double mul(); // compile-time error here**

**}**

It is not.

**Example 3:**

//Java program to illustrate strictfp modifier

**public class Test**

**{**

**// calculating sum using strictfp modifier**

**public strictfp double sum()**

**{**

**double num1 = 10e+10;**

**double num2 = 6e+08;**

**return (num1+num2);**

**}**

**public static strictfp void main(String[] args)**

**{**

**Test t = new Test();**

**System.out.println(t.sum());**

**}**

**}**

**User Interfaces:**When you create an interface, you are defining what a class can do without saying how the class will do it.

Any class type that implements the interface must write code for all methods.

**Difference between interface and abstract class:**

Now, abstract class-inheritance-is a relationship, Whereas, modular kitchen is implemented by normal kitchen

However, except the theoretical part, technically consider interface as a 100% abstract class

**Some Points For Interfaces:**

* All interface methods are implicitly public and abstract. In other words, you do not need to type public or abstract modifiers in the method declaration, but the method will always be public and abstract.
* All variables defined in an interface must be public, static and final. **(and these modifiers are not implicit. You have to mention it).** In other words, **interfaces can only have constants, not instance variables.**
* However, unlike, the variables, which should be **public, static and final,** interfaces method should not be static.
* Because, interface methods are abstract, they cannot be marked as final.
* **An interface can extend one or more other interfaces.**
* An interface cannot extend anything but another interface.
* **An interface cannot implements another interface or class.**
* An interface must be declared with the keyword interface

Like the following:  
 **public interface bouncable**

**{**

**void bounce();**

**void setbouncefactor(int bf);**

**}**

* Because, interface methods are abstract (implicitly), we cannot use **final, strictfp or native modifiers with them.**Final methods cannot be abstract.

strictfp modifer must be applied on concrete functions

native keyword is used to declare a function which is defined elsewhere. It cannot have a combination with abstract.

* Interface types can be used polymorphically.
* **Further Note:** the following is a legal interface declaration:

**public abstract interface Rollable()**

**{**

**//the variables (which must be static, public and final)**

**//the methods (which are implicitly public and abstract)**

**}**

However, typing in the **abstract modifier** is considered redundant.

**Static KeyWord In Java:**static is a non-access modifier in Java which is applicable for the following:

blocks

variables

methods

nested classes

**Static Blocks:**

1. The code inside static block is executed only once: the first time you make an object of that class or the first time you access a static member of that class (even if you never make an object of that class). For example, check output of following Java program.

**First Example:**

// filename: Main.java

**class Test {**

**static int i;**

**int j;**

**// start of static block**

**static {**

**i = 10;**

**System.out.println("static block called ");**

**}**

**// end of static block**

**}**

**class Main {**

**public static void main(String args[]) {**

**// Although we don't have an object of Test, static block is**

**// called because i is being accessed in following statement.**

**System.out.println(Test.i);**

**}**

**}**

**Output:**

static block called

1. Also, static blocks are executed before constructors. For example, check output of following Java program:

**Another Example:**

// filename: Main.java

**class Test {**

**static int i;**

**int j;**

**static {**

**i = 10;**

**System.out.println("static block called ");**

**}**

**Test(){**

**System.out.println("Constructor called");**

**}**

**}**

**class Main {**

**public static void main(String args[]) {**

**// Although we have two objects, static block is executed only once.**

**Test t1 = new Test();**

**Test t2 = new Test();**

**}**

**}**

**Output:**

static block called

Constructor called

Constructor called

**Multiple Static Blocks:**

They execute in the given order which means the first static block executes before second static block. That’s the reason, values initialized by first block are overwritten by second block.

**class JavaExample2{**

**static int num;**

**static String mystr;**

**//First Static block**

**static{**

**System.out.println("Static Block 1");**

**num = 68;**

**mystr = "Block1";**

**}**

**//Second static block**

**static{**

**System.out.println("Static Block 2");**

**num = 98;**

**mystr = "Block2";**

**}**

**public static void main(String args[])**

**{**

**System.out.println("Value of num: "+num);**

**System.out.println("Value of mystr: "+mystr);**

**}**

**}**

**Static blocks’ Major Use:**If a class has static members that require complex initialization, a static block is the tool to use. Suppose you need a static map of some kind (the purpose is irrelevant here). You can declare it in-line like this:

**public static final Map<String, String> initials = new HashMap<String, String>();**

However, if you want to populate it once, you can't do that with an in-line declaration. For that, you need a static block:

**public static final Map<String, String> initials = new HashMap<String, String>();**

**static**

**{**

**initials.put("AEN", "Alfred E. Newman");**

**// etc.**

**}**

**Note:** This is the way to populate a map in a fixed manner. Otherwise, it is needed to be populated whenever we create an instance

Don’t get confused in the concept. We could very much do the following:

import java.util.HashMap;

class FinalMapTest

{

public static final HashMap<String,Integer> NameRollMap=new HashMap<>();

public void populateMap()

{

NameRollMap.put("Sayak",1);

}

}

public class Trial

{

public static void main(String args[])

{

FinalMapTest mapTest=new FinalMapTest();

mapTest.populateMap();

}

}

However, if you want to be more protective:

**public static final Map<String, String> initials;**

**static**

**{**

**HashMap<String, String> map = new HashMap<String, String>()**

**map.put("AEN", "Alfred E. Newman");**

**// etc.**

**initials = Collections.unmodifiableMap(map);**

**}**

Now, unmodifiableMap returns an unmodifiable view of the map.

**Another use could be System.loadLibrary() to link a native DDL (Dynamically Linked library) dynamically.**

**Static Functions:**

When a variable is declared as static, then a single copy of variable is created and shared among all objects at class level. Static variables are, essentially, global variables. All instances of the class share the same static variable.

**Important points for static variables :-**

* We can create static variables at class-level only.   
    
  (What does that mean? It means in java,

Static variables cannot be created to locally of a function in java. Can be created in c++.

class Test {

public static void main(String args[]) {

System.out.println(fun());

}

static int fun()

{

static int x= 10; //Error: Static local variables are not allowed

return x--;

}

}

**This is not allowed in java.**

* static block and static variables are executed in order they are present in a program.

Below is the java program to demonstrate that static block and static variables are executed in order they are present in a program.

// java program to demonstrate execution

// of static blocks and variables

class Test

{

// static variable

static int a = m1();

// static block

static {

System.out.println("Inside static block");

}

// static method

static int m1() {

System.out.println("from m1");

return 20;

}

// static method(main !!)

public static void main(String[] args)

{

System.out.println("Value of a : "+a);

System.out.println("from main");

}

}

**Can Static Members Of A Class Be Accessed Through Non Static Instance Function?**

Yes.

**Static Methods:**

static methods are the methods in Java that can be called without creating an object of class. They are referenced by the class name itself or reference to the Object of that class.

public static void geek(String name)

{

// code to be executed....

}

// Must have static modifier in their declaration.

// Return type can be int, float, String or user defined data type.

**Memory Allocation:**

They are stored in Permanent Generation space of heap as they are associated to the class in which they reside not to the objects of that class. But their local variables and the passed argument(s) to them are stored in the stack. Since they belong to the class so they can be called to without creating the object of the class.

**Important Points:**

Static method(s) are associated to the class in which they reside i.e. they can be called even without creating an instance of the class i.e **ClassName.methodName(args).**

* They are designed with aim to be shared among all Objects created from the same class.
* Static methods can not be overridden. But can be overloaded since they are resolved using static binding by compiler at compile time.
* A non static function cannot be from a static function without using an object.
* This reference does not exist for static functions.

**Static nested classes :**

We can not declare top-level class with a static modifier, but can declare nested classes as static. Such type of classes are called Nested static classes.

**What are the differences between static and non-static nested classes?**

Following are major differences between static nested class and non-static nested class. Non-static nested class is also called Inner Class.

1) Nested static class doesn’t need reference of Outer class, but Non-static nested class or Inner class requires Outer class reference.

/\* Java program to demonstrate how to implement static and non-static

classes in a java program. \*/

class OuterClass{

private static String msg = "GeeksForGeeks";

// Static nested class

public static class NestedStaticClass{

// Only static members of Outer class is directly accessible in nested

// static class

public void printMessage() {

// Try making 'message' a non-static variable, there will be

// compiler error

System.out.println("Message from nested static class: " + msg);

}

}

// non-static nested class - also called Inner class

public class InnerClass{

// Both static and non-static members of Outer class are accessible in

// this Inner class

public void display(){

System.out.println("Message from non-static nested class: "+ msg);

}

}

}

class Main

{

// How to create instance of static and non static nested class?

public static void main(String args[]){

// create instance of nested Static class

OuterClass.NestedStaticClass printer = new OuterClass.NestedStaticClass();

// call non static method of nested static class

printer.printMessage();

// In order to create instance of Inner class we need an Outer class

// instance. Let us create Outer class instance for creating

// non-static nested class

OuterClass outer = new OuterClass();

OuterClass.InnerClass inner = outer.new InnerClass();

// calling non-static method of Inner class

inner.display();

// we can also combine above steps in one step to create instance of

// Inner class

OuterClass.InnerClass innerObject = new OuterClass().new InnerClass();

// similarly we can now call Inner class method

innerObject.display();

}

}

Now, look at this:

**OuterClass.NestedStaticClass printer = new OuterClass.NestedStaticClass();**

**printer.printMessage();**

For instantiating static inner class, we need not a reference of Outerclass which has to be instantiated with OuterClass’s object.

2) Inner class(or non-static nested class) can access both static and non-static members of Outer class. A static class cannot access non-static members of the Outer class. It can access only static members of Outer class.

**Programming Paradigm, OOP:**

**What is Programming Paradigm?**

Answer) Programming paradigm is a fundamental style of computer programming. It is a way of building the structures and functions around the program.

**Object Oriented Programming Paradigm:**

**Answer)**

OOP treats data as a critical element and does not allow data to flow freely around the system.

OOP ties data close to the function which operates on it

OOP allows decomposition of a function into a set of entities called objects(runtime instance of class) and builds data data around them

The data of an object can be accessed only by the function associated with the objects.

One object can communicate with other objects using function of that object.

**Describe four key concepts of object oriented programming.**

Answer) The four key concepts of object oriented programming is 1) Encapsulation 2) Abstraction 3) Inheritance 4) Polymorphism

**1) Encapsulation:** The wrapping up of data and methods into a single unit (called class) is known as encapsulation. Data encapsulation is the most striking feature of a class. The data is not accessible to the outside world. Only those methods, which are wrapped in the class, can access it.

So, these methods (which are wrapped in the class) provides the object's data and the program. This insulation of the data from direct access by the program is called 'data hiding'. (Private data members are example of data encapsulation)

**2) Abstraction:** Abstraction refers to the act of representing essential features of a class and omit the unnecessary details about it. For instance, when we think about a car, we don't consider all the irrelevant details like how the break actually works or how the Bluetooth device is installed in the

car, how it provides all the cool features. We think it as a transport medium which could take us from one place to another place. That is abstraction.

Now, the difference between abstraction and encapsulation:

One is mechanism hiding and another is data hiding.

**3) Inheritance:** Inheritance is a way by which a newly defined class inherits attributes and behaviour of an existing class along with its own properties.

Using inheritance the hierarchical relationships are established.

Inheritance allows the re usability of an existing operations and extending the basic unit of the a class without creating it from the scratch.

**Some more points about Inheritance:**

Inheritance is a “is a” relationship (not a “has a” relationship)

Like: we can say “A four-wheeler is a car” (It's a real “is a” relationship)

But, we cannot say, “A steering wheel is a car” (It's a “has a” relationship)

(A has a relationship is used in composition. An example of composition: A structure with in a

structure as a member)

Inheritance promotes both. Polymorphism and code re usability.

**4) Polymorphism:** Polymorphism is sharing a common interface for multiple types but having different implementation for different types.

In OOP, polymorphism is a technique where objects of classes belonging to

the same hierarchical tree may posses interface bearing the same name but each having different behaviors.

It is the way of inheriting when useful, overriding when not useful.

It allows automatically do the current behaviour even if we are working with

many different forms

**Define class.**

Answer) Class is a static definition of new type as a collection of data and associated operations from which runtime instances called objects can be created.

**Define object.**

Answer) Object is runtime instance of a conceptual framework encapsulating typed data and typed operations that correspond to a real world entity or thing for the purpose of computer modeling.

**Constructors:  
  
Default Constructor:**

class NoteBook{

/\*This is default constructor. A constructor does

\* not have a return type and it's name

\* should exactly match with class name

\*/

NoteBook(){

System.out.println("Default constructor");

}

public void mymethod()

{

System.out.println("Void method of the class");

}

public static void main(String args[]){

/\* new keyword creates the object of the class

\* and invokes constructor to initialize object

\*/

NoteBook obj = new NoteBook();

obj.mymethod();

}

}

**Now, Some Notes About Constructor:**

* If you don’t provide a default constructor, compiler will include one.
* However, if you overload it and instead of providing a no-arg constructor/default constructor, you provide a parametric constructor, you can no more call the default constructor.

**Consider the following program:**

class Example{

Example(int i, int j){

System.out.print("parameterized constructor");

}

Example(int i, int j, int k){

System.out.print("parameterized constructor");

}

public static void main(String args[]){

Example obj = new Example();

}

}

**This will generate the following output:**

Exception in thread "main" java.lang.Error: Unresolved compilation

problem: The constructor Example() is undefined

**Parametric Constructor:**class Example{

//Default constructor

Example(){

System.out.println("Default constructor");

}

/\* Parameterized constructor with

\* two integer arguments

\*/

Example(int i, int j){

System.out.println("constructor with Two parameters");

}

/\* Parameterized constructor with

\* three integer arguments

\*/

Example(int i, int j, int k){

System.out.println("constructor with Three parameters");

}

/\* Parameterized constructor with

\* two arguments, int and String

\*/

Example(int i, String name){

System.out.println("constructor with int and String param");

}

public static void main(String args[]){

//This will invoke default constructor

Example obj = new Example();

/\* This will invoke the constructor

\* with two int parameters

\*/

Example obj2 = new Example(12, 12);

/\* This will invoke the constructor

\* with three int parameters

\*/

Example obj3 = new Example(1, 2, 13);

/\* This will invoke the constructor

\* with int and String parameters

\*/

Example obj4 = new Example(1,"BeginnersBook");

}

**Copy Constructor:**

Now, like c++, java also supports copy constructor. But, unlike c++ compiler, java compiler does not include a default definition of of copy constructor.

**Example:**

class Complex {

private double re, im;

// A normal parametrized constructor

public Complex(double re, double im) {

this.re = re;

this.im = im;

}

// copy constructor

Complex(Complex c) {

System.out.println("Copy constructor called");

re = c.re;

im = c.im;

}

// Overriding the toString of Object class

@Override

public String toString() {

return "(" + re + " + " + im + "i)";

}

}

public class Main {

public static void main(String[] args) {

Complex c1 = new Complex(10, 15);

// Following involves a copy constructor call

Complex c2 = new Complex(c1);

// Note that following doesn't involve a copy constructor call as

// non-primitive variables are just references.

Complex c3 = c2;

System.out.println(c2); // toString() of c2 is called here

}

}

Now, you can twist the argument passing a little:

**Check the Following Example:**

class Complex {

private double re, im;

// A normal parametrized constructor

public Complex(double re, double im) {

this.re = re;

this.im = im;

}

// copy constructor

Complex(final Complex c) {

System.out.println("Copy constructor called");

re = c.re;

im = c.im;

}

// Overriding the toString of Object class

@Override

public String toString() {

return "(" + re + " + " + im + "i)";

}

}

public class Example2{

public static void main(String[] args) {

Complex c1 = new Complex(10, 15);

// Following involves a copy constructor call

Complex c2 = new Complex(c1);

// Note that following doesn't involve a copy constructor call as

// non-primitive variables are just references.

Complex c3 = c2;

System.out.println(c2); // toString() of c2 is called here

}

}

**See, you can make the reference final. That is like you can have definition. This is unlike c++ , again. Since, c++ provides a default definition of copy constructor, there’s a standard of it. If you are overloading copy constructor, you have to follow the standard. Here, the case is different. As java compiler does not provide default definition of copy constructor.**

**This Reference:**

**1. Using ‘this’ keyword to refer current class instance variables**

//Java code for using 'this' keyword to

//refer current class instance variables

class Test

{

int a;

int b;

// Parameterized constructor

Test(int a, int b)

{

this.a = a;

this.b = b;

}

void display()

{

//Displaying value of variables a and b

System.out.println("a = " + a + " b = " + b);

}

public static void main(String[] args)

{

Test object = new Test(10, 20);

object.display();

}

}

**2. Using this() to invoke current class constructor**

// Java code for using this() to

// invoke current class constructor

class Test

{

int a;

int b;

//Default constructor

Test()

{

this(10, 20);

System.out.println("Inside default constructor \n");

}

//Parameterized constructor

Test(int a, int b)

{

this.a = a;

this.b = b;

System.out.println("Inside parameterized constructor");

}

public static void main(String[] args)

{

Test object = new Test();

}

}

**Super Keyword In Java:**

1. **Use of super with variables:**

This scenario occurs when a derived class and base class has same data members. In that case there is a possibility of ambiguity for the JVM. We can understand it more clearly using this code snippet:

**/\* Base class vehicle \*/**

**class Vehicle**

**{**

**int maxSpeed = 120;**

**}**

**/\* sub class Car extending vehicle \*/**

**class Car extends Vehicle**

**{**

**int maxSpeed = 180;**

**void display()**

**{**

**/\* print maxSpeed of base class (vehicle) \*/**

**System.out.println("Maximum Speed: " + super.maxSpeed);**

**}**

**}**

**/\* Driver program to test \*/**

**class Test**

**{**

**public static void main(String[] args)**

**{**

**Car small = new Car();**

**small.display();**

**}**

**}**

**Output:**

Maximum Speed: 120

In the above example, both base class and subclass have a member maxSpeed. We could access maxSpeed of base class in sublcass using super keyword.

1. **Use of super with methods:**

This is used when we want to call parent class method. So whenever a parent and child class have same named methods then to resolve ambiguity we use super keyword. This code snippet helps to understand the said usage of super keyword.

**/\* Base class Person \*/**

**class Person**

**{**

**void message()**

**{**

**System.out.println("This is person class");**

**}**

**}**

**/\* Subclass Student \*/**

**class Student extends Person**

**{**

**void message()**

**{**

**System.out.println("This is student class");**

**}**

**// Note that display() is only in Student class**

**void display()**

**{**

**// will invoke or call current class message() method**

**message();**

**// will invoke or call parent class message() method**

**super.message();**

**}**

**}**

**/\* Driver program to test \*/**

**class Test**

**{**

**public static void main(String args[])**

**{**

**Student s = new Student();**

**// calling display() of Student**

**s.display();**

**}**

**}**

**Output:**

This is student class

This is person class

In the above example, we have seen that if we only call method message() then, the current class message() is invoked but with the use of super keyword, message() of superclass could also be invoked.

1. **Use of super with constructors:**super keyword can also be used to access the parent class constructor. One more important thing is that, ‘’super’ can call both parametric as well as non parametric constructors depending upon the situation. Following is the code snippet to explain the above concept:

**/\* superclass Person \*/**

**class Person**

**{**

**Person()**

**{**

**System.out.println("Person class Constructor");**

**}**

**}**

**/\* subclass Student extending the Person class \*/**

**class Student extends Person**

**{**

**Student()**

**{**

**// invoke or call parent class constructor**

**super();**

**System.out.println("Student class Constructor");**

**}**

**}**

**/\* Driver program to test\*/**

**class Test**

**{**

**public static void main(String[] args)**

**{**

**Student s = new Student();**

**}**

**}**

**Output:**

Person class Constructor

Student class Constructor

In the above example we have called the superclass constructor using keyword ‘super’ via subclass constructor.

**Other Important points:**

* Call to super() must be first statement in Derived(Student) Class constructor.

For Example, The following will generate error:

**/\* superclass Person \*/**

**class Person**

**{**

**Person()**

**{**

**System.out.println("Person class Constructor");**

**}**

**}**

**/\* subclass Student extending the Person class \*/**

**class Student extends Person**

**{**

**Student()**

**{**

**System.out.println("Student class Constructor");**

**super();**

**}**

**}**

**/\* Driver program to test\*/**

**class SuperExample**

**{**

**public static void main(String[] args)**

**{**

**Student s = new Student();**

**}**

**}**

* **If a constructor does not explicitly invoke a superclass constructor, the Java compiler automatically inserts a call to the no-argument constructor of the superclass. If the superclass does not have a no-argument constructor, you will get a compile-time error.** Object does have such a constructor, so if Object is the only superclass, there is no problem.
* If a subclass constructor invokes a constructor of its superclass, either explicitly or implicitly, you might think that a whole chain of constructors called, all the way back to the constructor of Object. This, in fact, is the case. It is called **constructor chaining.**
* You can use super only to access a method in a class’s superclass, not the superclass of the superclass. That is you cannot say **super.super.doStuff()**

**Initializer Block In Java:**In a Java program, operations can be performed on methods, constructors and initialization blocks. Instance Initialization Blocks or IIB are used to initialize instance variables. IIBs are executed before constructors. They run each time when object of the class is created.

Initialization blocks are executed whenever the class is initialized and before constructors are invoked.

They are typically placed above the constructors within braces.

It is not at all necessary to include them in your classes.

**1st Example:**

**// Java program to illustrate**

**// Instance Initialization Block**

**class GfG**

**{**

**// Instance Initialization Block**

**{**

**System.out.println("IIB block");**

**}**

**// Constructor of GfG class**

**GfG()**

**{**

**System.out.println("Constructor Called");**

**}**

**public static void main(String[] args)**

**{**

**GfG a = new GfG();**

**}**

**}**

**Output:**

IIB block

Constructor Called

We can also have multiple IIBs in a single class. If compiler finds multiple IIBs, then they all are executed from top to bottom i.e. the IIB which is written at top will be executed first.

**2nd Example:**

**// Java program to illustrate**

**// execution of multiple**

**// Instance Initialization Blocks**

**// in one program**

**class GfG**

**{**

**// Instance Initialization Block - 1**

**{**

**System.out.println("IIB1 block");**

**}**

**// Instance Initialization Block - 2**

**{**

**System.out.println("IIB2 block");**

**}**

**// Constructor of class GfG**

**GfG()**

**{**

**System.out.println("Constructor Called");**

**}**

**// Instance Initialization Block - 3**

**{**

**System.out.println("IIB3 block");**

**}**

**// main function**

**public static void main(String[] args)**

**{**

**GfG a = new GfG();**

**}**

**}**

**Output :**

IIB1 block

IIB2 block

IIB3 block

Constructor Called

**Rules For Constructor:**

* Constructors can use any access modifier (public, private, protected) including private. A private constructor means only code with in the class itself can instantiate an object of that type. So, if private constructor class wants to allow an instance of the class to be used, the class must provide a static method or variable that allows an instance created from within the class.   
    
  (private constructor or protected constructor both are used in singleton design pattern)
* The constructor name must match the name of the class
* Constructors must not have a return type.
* It’s legal (though stupid) to have a method with the same name as the class, but that does not make it a constructor. If you see a return type, it’s a method rather than constructor. In fact, you can have both a method and a constructor with the same name-the name of the class-in the same class. That’s not a problem in java (in c++, you are not allowed to that)
* If you don’t type a constructor to your class code, a default constructor will be automatically generated by the compiler.
* The default constructor is always a no arg constructor.
* If you want a no arg constructor and instead of overloading it, you have provided any other constructor (parametric or copy), compiler will not provide a no arg constructor any more.
* Every derived class constructor should have called to super class constructor using super keyword and it should be the first statement. if you explicitly use super keyword to call base class constructor, it should be the very first statement. Otherwise, it will give you compilation error.
* If you don’t call base class constructor from derived class constructor, compiler will include an implicit call to the base class’s no arg constructor. Now, if base class has no constructor, it is fine. (as compiler will include one by default) However, if base class provides other constructor but does not provide a default constructor, it will result a compilation error.
* A no arg constructor is not necessarily the default (that is, compiler supplied) constructor, although the default constructor is always a no arg constructor. Although the default constructor is always a no arg constructor, you are free to put in your own no arg constructor.
* Abstract class have constructors, and those constructors are always called when a concrete subclass is instantiated.
* Interfaces do not have constructors. Interfaces are not part of an object’s inheritance tree.
* The only way a constructor can be invoked is from within another constructor. In other words, you cant write code that actually calls a constructor as follows:  
  class Horse

{

Horse(){}

void doStuff()

{

Horse();

//calling the constructor-illegal

}

}

* You can always access a base class’s static member or static method from derived class’s non static method using super keyword, but, you can neither access base class’s non static variable or method nor access base class’s static method or static variable from Derived class’s static method.

**First Example:**

class Base

{

static int a;

static

{

a=10;

}

Base()

{

System.out.println("Base class constructor");

}

}

class Derived extends Base

{

Derived()

{

System.out.println("Derived class constructor");

}

void accessBaseStaticVariable()

{

System.out.println("The base class's a:"+super.a);

}

}

public class SuperExample2

{

public static void main(String argss[])

{

Derived derived=new Derived();

derived.accessBaseStaticVariable();

}

}

**This will compile fine and generate the following output:**

Base class constructor

Derived class constructor

The base class's a:10

**Second Example:**

class Base

{

int a;

Base()

{

a=10;

}

Base(int a)

{

this.a=a;

}

void seta(int a)

{

this.a=a;

}

}

class Derived extends Base

{

int b;

Derived()

{

b=10;

}

Derived(int b)

{

this.b=b;

}

static void setAOfBase(int a)

{

super.seta(a);

}

}

public class SuperExample3

{

public static void main(String args[])

{

Derived.setAOfBase(20);

}

}

**This will generate compilation error.**

SuperExample3.java:30: error: non-static variable super cannot be referenced from a static context

super.seta(a);

**Overloading and Overriding:**

**Overriding:**

Any time a class inherits a method form a super class, you have the opportunity to override the method**(unless, as you learned earlier, the method is final)**

The key benefit of overriding is to define the ability to define behaviour that’s specific to a particular subclass type.

For abstract methods you inherit from a superclass, you have no choice: but to implement the method in the subclass unless the subclass is also abstract. **(unlike c++, here in case of abstract class, abstract keyword is to be mentioned explicitly)**

**However, polymorphism, in which a base class reference holds the object of a subclass (it can be done based on the reference rule) is a tricky one.**

**In that case, the base class reference, cannot call the functions which are only specific to the subclass , whose object it is currently holding.**

Consider the following example:

**class Animal**

**{**

**public void eat()**

**{**

**System.out.println("Generic animal eating generically");**

**}**

**}**

**class Horse extends Animal**

**{**

**public void eat()**

**{**

**System.out.println("Horse eating hay, oats and horse treats");**

**}**

**public void buck()**

**{**

**}**

**}**

**public class PolymorphismTrial**

**{**

**public static void main(String args[])**

**{**

**Animal c=new Horse();**

**c.buck();**

**}**

**}**

This will generate a compilation error.

**Another important point** is overriding method cannot have a more restrictive access modifier than the method being overridden.

For instance, the following code will throw compilation error:

**class Animal**

**{**

**public void eat()**

**{**

**System.out.println("Generic animal eating generically");**

**}**

**}**

**class Horse extends Animal**

**{**

**private void eat()**

**{**

**System.out.println("Horse eating hay, oats and horse treats");**

**}**

**}**

**public class TestAnimals**

**{**

**public static void main(String args[])**

**{**

**Animal a=new Animal();**

**Animal b=new Horse();**

**a.eat();**

**b.eat();**

**}**

**}**

TestAnimals.java:10: error: eat() in Horse cannot override eat() in Animal

private void eat()

^

attempting to assign weaker access privileges; was public

1 error

**The basic overriding rules are the following:**

* The argument list must exactly match that of the overridden method, If they don’t match, you can end up with an overloaded method you did not intend.
* The return type must be same as, or a subtype of, the return type declared in in the original method in the superclass
* The access level of a overridden function cannot be more restricted than the original method.
* Instance methods can only be overridden only if they are inherited by the subclass.
* The overriding method can throw any unchecked exception, regardless of whether the original method declares the exception
* The overriding method must not throw any checked exception that are new or broader than those declared by the original method. For example, a method which declares a FileNotFoundException, cannot be overridden by a method which throws SQLException, Exception or any other runtime exception unless it is subclass of **FileNotFoundException**
* The overriding method can throw narrower and/or fewer exceptions.
* You cannot override a method marked as final.
* You cannot override a method that is a static. (because, static methods are class specific, not instance specific. Static methods can not be overridden. But can be overloaded since they are resolved using static binding by compiler at compile time.)

**Some More Conceptual Examples:**

**Example 1:**

class Animal

{

public void eat()

{

System.out.println("Animal's version of eat called");

}

}

class Dog extends Animal

{

public void eat()

{

System.out.println("Dog's version of eat called");

}

}

public class PolymorphismExample1

{

public static void main(String args[])

{

Dog labrador=new Dog();

labrador.eat();

}

}

Here Dog’s version of eat will be called. Though, in compile time, it will actually check if a function with no argument exists or not in Animal class. And, that function which is found in base class, it’s signature is kind of stored. So, in runtime, a function definition with the same function signature will be searched in derived class. If the definition is not found in derived class, it will invoke the function of base class.

**Example 2:**

class Animal

{

public void eat()throws Exception

{

throw new Exception("Animal's eat function was called");

}

}

class Dog extends Animal

{

public void eat()

{

System.out.println("Dog's eat function was called");

}

}

public class PolymorphismExample2

{

public static void main(String args[])

{

Animal a=new Dog();

Dog d=new Dog();

d.eat();

//it will generate no compilation error as d is a reference of Class Dog and is initialized with Dog object

a.eat();

//it will generate compilation error

}

}

If a method is overridden but you use a polymorphic (supertype) reference to refer to the subtype object with the overriding method, the compiler assumes that you are calling the supertype version of the method. If the supertype version declares a checked exception, but the overriding method does not, the compiler still thinks you are calling a method that declares an exception.

**Overloaded Methods:**

* overloaded method must change the argument list.
* Overloaded method can change the return type. (if you know either prototype concept or function signature concept, you will know, function signature depends upon the number of arguments, argument type,
* Overloaded method can change the access modifier.
* Overloaded methods can declare new or broader checked exception.
* A method can be overloaded in the same class or subclass. (however,the first rule is to be followed. Overloaded method must change the argument list)

Invoking overloaded methods that take object references rather than primitive type is a little more interesting. Say you have the overloaded method such that one version takes an animal and another version takes a horse (horse extends animal). If you pass a Horse object in the method invocation, you will invoke the overloaded version that takes Horse.

**class Animal**

**{**

**}**

**class Horse extends Animal**

**{**

**}**

**class UseAnimals**

**{**

**public void doStuff(Animal s)**

**{**

**System.out.println("In the animal version");**

**}**

**public void doStuff(Horse h)**

**{**

**System.out.println("In the horse version");**

**}**

**public static void main(String args[])**

**{**

**UseAnimals ua=new UseAnimals();**

**Animal animalObj=new Animal();**

**Horse horseObj=new Horse();**

**ua.doStuff(animalObj);**

**ua.doStuff(horseObj);**

**}**

**}**

Now, here, the output is what you expect

In the animal version

In the horse version

**But, what if you use an Animal reference to a horse object?**

**Animal animalRefToHorse=new Horse();**

**ua.doStuff(animalRefToHorse);**

Which of the overloaded versions is invoked? You might want to answer, “The want that takes a Horse, since, the reference to the Animal class **animalRefToHorse** is ultimately initialized with an object of Horse class.

Even though the actual object at runtime is a Horse and not an Animal. The choice of which overloaded method to call (in other words, the signature of the method) is not dynamically decided at runtime. It is decided at compile time. Hence, the upper example will print

In the animal version

**(in case of overloading)**

**Which overridden version of the method to call is decided at runtime based on the object type.**

**Animal animalRefToHorse=new Horse();**

Here, Animal is the reference type.

**new Horse(),** this Horse is the object type.

**class Animal**

**{**

**public void eat()**

**{**

**System.out.println("Generic animal eating generically"):**

**}**

**}**

**public class Horse extends Animal**

**{**

**public void eat()**

**{**

**System.out.println("Horse eating hay");**

**}**

**public void eat(String s)**

**{**

**System.out.println("Horse eating "+s);**

**}**

**}**

Notice that, the Horse class has both overloaded and overridden the eat() method.

**Combination Of Method Overloading and Overriding:**class Animal

{

public void eat()

{

System.out.println("Generic animal eating generically"):

}

}

public class Horse extends Animal

{

public void eat()

{

System.out.println("Horse eating hay");

}

public void eat(String s)

{

System.out.println("Horse eating "+s);

}

}

**Difference Between Overloaded Methods And Overriding Methods:**

|  |  |  |
| --- | --- | --- |
|  | **Overloaded Method** | **Overridden Method** |
| Argument(s) | Must change. | Must not change |
| Return Type | Can change | In most cases cannot change until the return type was an object to some superclass in the original method and object to the subclass in the overridden methods |
| Exceptions | Can change | Can reduce or eliminate. Can not throw new or broader checked exceptions |
| Access | Can change | Must not make more restrictive access |
| Invocation | Reference type determines which overloaded version is selected. Happens at compile time. | Object type (in other words, the type of the actual instance on the heap) determines which method is selected. Happens at runtime. |

**Polymorphism and Method Overloading and Method Overriding:**

|  |  |
| --- | --- |
| **Method Invocation Code** | **Result** |
| Animal a=new Animal();  a.eat(); | Generic animal eating generically |
| Horse h=new Horse(); h.eat(); | Horse eating hay |
| Animal ah=new Horse(); ah.eat(); | Horse eating Hay. Polymorphism works: The actual object type (Horse), not the reference type (Animal), is used to determine which eat() is called |
| Horse he=new Horse();  He.eat(“Apples”); | Horse eating Apples  The overloaded eat(String s) method is invoked |
| Animal a2=new Animal();  A2.eat(“treats”) | Compiler error!. Compiler does not see that the animal class does not have an eat() method that takes a string |
| Animal ah2=new Horse();  ah2.eat(“Carrots”); | Compiler error. Compiler will look only at the reference (compile time) and sees that Animal does not have an eat() method that takes a string. Compiler does not care the type of actual object. |

**Casting:**

You have seen how it’s both possible and common to use generic reference variable types to refer to more specific object types. (we could use a superclass reference to refer to subclass object types) It’s the heart of the polymorphism. For example, this line of code second nature by now:

**Animal animal=new Dog();**

But what happens when you want to use that animal reference variable to invoke a method which is specific to Dog. (and that method is not defined as a generic method is Animal)

In the following code, we have got an array of Animals, and whenever we find a Dog in the array, we want to do a special Dog thing.

class Animal

{

void makeNoise();

}

class Dog extends Animal

{

void makeNoise()

{

System.out.println("Bark");

}

void playDead()

{

System.out.println("Roll over");

}

}

public class CastTest

{

public static void main(String args[])

{

Animal []a={new Animal(), new Dog(), new Animal()};

for(Animal animal: a)

{

animal.makeNoise();

if(animal instanceof Dog)

//it will check the specific class Type of an object

{

animal.playDead();

}

}

}

}

It will necessarily generate compilation error.

However, if we change the following code block:

**if(animal instanceof Dog)**

**//it will check the specific class Type of an object**

**{**

**animal.playDead();**

**}**

To

**if(animal instanceof Dog)**

**//it will check the specific class Type of an object**

**{**

**Dog d=(dog) animal;**

**animal.playDead();**

**}**

It will work fine.

The new and improved code block contains a cast, which in this case is sometimes called a downcast, because, we are casting down the inheritance tree to a more specific class.

**Important Things About Casting:**

It’s important to know about that the compiler is forced to trust us when we do a downcast, even when we screw up:

**Class Animal**

**{**

**}**

**Class Dog extends Animal**

**{**

**}**

**Class DogTest**

**{**

**public static void main(String args[])**

**{**

**Animal animal=new Animal();**

**Dog d=(Dog)animal;**

**}**

**}**

The code will be compiled but it will fail later.

It will generate the ClassCastException at runtime.

java.lang.ClassCastException

Why cannot we trust the compiler to help use out here? Can’t it see that animal is of type Animal? All the compiler can do is to verify that the two types are in the same inheritance tree. So that depending upon whatever code might have come before the downcast, it’s possible that animal is of type Dog. The compiler must allow things that might possibly works at runtime. However, if compiler knows with certainty that the cast would not possibly work, compilation will fail. The following replacement code block will not compile:

**Animal animal=new Animal();**

**Dog d=(Dog) animal;**

**String a=(string) animal;**

In this case, you will get an error something like this: Inconvertible types.

Since, String and Animal do not belong to the same instance tree.

Now, unlike downcasting, upcasting (casting up the inheritance tree) works implicitly. Because, when you upcast you are implicitly restricting the number of methods you can invoke, as opposed to downcasting, which is implied that later on, you might want to invoke a more specific method.

The implicit typecast is always legal for assigning an object of a subtype to a reference of one of its supertype classes (or interfaces). If Dog implements pet **(even interface and class can be part of same inheritance tree? I understand that superclass and subclass are part of same inheritance tree)** and Pet defined beFriendly(), then a dog can be implicitly typecast to a pet, but the only Dog method you can invoke is beFriendly()

One more thing..If Dog implements Pet, then if Beagle extends Dog, but beagle does not declare that implements Pet, **it is completely Legal and Beagle is still a Pet. Beagle is a pet simply because it extends Dog, and Dog’s already taken care of the pet parts for itself, and for all its children. The Beagle class can always override any method it inherits from Dog, including methods that Dog implemented to fulfill its interface contract.**

**So, what do you learn?**

* When two objects belong to the same inheritance tree, the compiler will trust the developer though under some condition, it will generate run time error later.
* When two objects do not belong to the same inheritance tree, the casting is prevented by the compiler itself.

**Upcasting and Downcasting:**

Although there's no need to for programmer to upcast manually, it's allowed to do.

Consider the following example:

**Code:**

Mammal m = (Mammal)new Cat();

is equal to

**Code:**

Mammal m = new Cat();

But downcasting must always be done manually:

**Code:**

Cat c1 = new Cat();

Animal a = c1; //automatic upcasting to Animal

Cat c2 = (Cat) a; //manual downcasting back to a Cat

Why is that so, that upcasting is automatical, but downcasting must be manual? Well, you see, upcasting can never fail. But if you have a group of different Animals and want to downcast them all to a Cat, then there's a chance, that some of these Animals are actually Dogs, and process fails, by throwing ClassCastException.

This is where is should introduce an useful feature called "instanceof", which tests if an object is instance of some Class.

**Consider the following example:**

**Code:**

Cat c1 = new Cat();

Animal a = c1; //upcasting to Animal

if(a instanceof Cat){ // testing if the Animal is a Cat

System.out.println("It's a Cat! Now i can safely downcast it to a Cat, without a fear of failure.");

Cat c2 = (Cat)a;

}

Note, that casting can't always be done in both ways. If you are creating a Mammal, by calling "new Mammal()", you a creating a Object that is a Mammal, but it cannot be downcasted to Dog or Cat, because it's neither of them.

**For example:**

**Code:**

Mammal m = new Mammal();

Cat c = (Cat)m;

Such code passes compiling, but throws "java.lang.ClassCastException: Mammal cannot be cast to Cat" exception during running, because im trying to cast a Mammal, which is not a Cat, to a Cat.

**Java Memory Layout:**

**Java Heap Space**

**Java Heap space is used by java runtime to allocate memory to Objects and JRE classes. Whenever we create any object, it’s always created in the Heap space.**

**Garbage Collection runs on the heap memory to free the memory used by objects that doesn’t have any reference. Any object created in the heap space has global access and can be referenced from anywhere of the application.**

**Java Stack Memory**

Java Stack memory is used for execution of a thread. They contain method specific values that are short-lived and references to other objects in the heap that are getting referred from the method.

**Difference between Java Heap Space and Stack Memory**

Based on the above explanations, we can easily conclude following differences between Heap and Stack memory.

Heap memory is used by all the parts of the application whereas stack memory is used only by one thread of execution.

Whenever an object is created, it’s always stored in the Heap space and stack memory contains the reference to it. Stack memory only contains local primitive variables and reference variables to objects in heap space.

Objects stored in the heap are globally accessible whereas stack memory can’t be accessed by other threads.

Memory management in stack is done in LIFO manner whereas it’s more complex in Heap memory because it’s used globally. Heap memory is divided into Young-Generation, Old-Generation etc, more details at Java Garbage Collection.

Stack memory is short-lived whereas heap memory lives from the start till the end of application execution.

We can use -Xms and -Xmx JVM option to define the startup size and maximum size of heap memory. We can use -Xss to define the stack memory size.

When stack memory is full, Java runtime throws java.lang.StackOverFlowError whereas if heap memory is full, it throws java.lang.OutOfMemoryError: Java Heap Space error.

Stack memory size is very less when compared to Heap memory. Because of simplicity in memory allocation (LIFO), stack memory is very fast when compared to heap memory.

That’s all for Java Heap Space vs Stack Memory in terms of java application, I hope it will clear your doubts regarding memory allocation when any java program is executed.

**Some Deep Analyzing:**

**Consider the following example:**

class Collar

{

}

public class Dog

{

Collar c;

String name;

public static void main(String []args)

{

Dog d;

d=new Dog();

d.go(d);

}

void go(Dog dog)

{

c=new Collar();

dog.setName("aiko");

}

void setName(String dogName)

{

name=dogName;

//do more stuff

}

}

**Now, this is not the best example to learn java. But, it is a good example of learning stack and heap memory allocation.  
  
Line 7:** main() is placed on the stack

**Line 9:** Reference variable is created on the stack. But, there’s no Dog object yet.

**Line 10:** A new Dog object is created from heap and is assigned to the d reference variable (d reference variable is in the stack)

**Line 11:** A copy of the reference variable is passed to the go() method.

**Line 13:** the go method is placed on the stack, with the dog parameter as a local stack variable

**Line 14:** A new collar object is created to the heap and is assigned to Dog’s instance reference variable Collar c.

**Line 17:** setName() is addded to the stack, with the dogName parameter as it’s local variable

**Line 18:** The name instance variable now also refers to the String object.

**Now, note the following things:**

Notice that two different local variables refer to the same Dog object.

(d from main and dog from go)

Notice that one local variable and one instance variable both refer to the same String Aiko.

**After line 19th completes,** setName() completes and is removed from the stack. At this point, the local reference variable dogName disappears, too, although the String object is referred to is still on the top.

**Literals, Assignments And Variables:**

**Literal Values For All Primitive Types:**

'b': char literal

42: int literal

false: boolean literal

245789.343: double literal

**Integer Literal:**

**Numeric Literals with underscores:**you can define, but, don’t use underscore at the beginning or ending of the literal.

**Decimal Literals:  
  
Binary Literals:**

int b1=0B101010;//set b1 to binary 101010

int b2=0b0011;//set b2 to binary 11

**Octal Literals:**

**Hexadecimal Literals:**

**Floating Point Literals:**

Now, floating point literals are defined as a double by default. So, if you want to assign a floating point literal to a variable type of type float (32 bits), you must attach the suffix F or f.

**Boolean Literals:**

**Character literals:**

A char literal is represented by a single character in single question:

**char a= 'a';**

You can also assign a unicode value of the character. Using the Unicode notation of prefixing the value with '\u’ as follows:

**char letterN='\u004E';**

**Literal Values For Strings:**

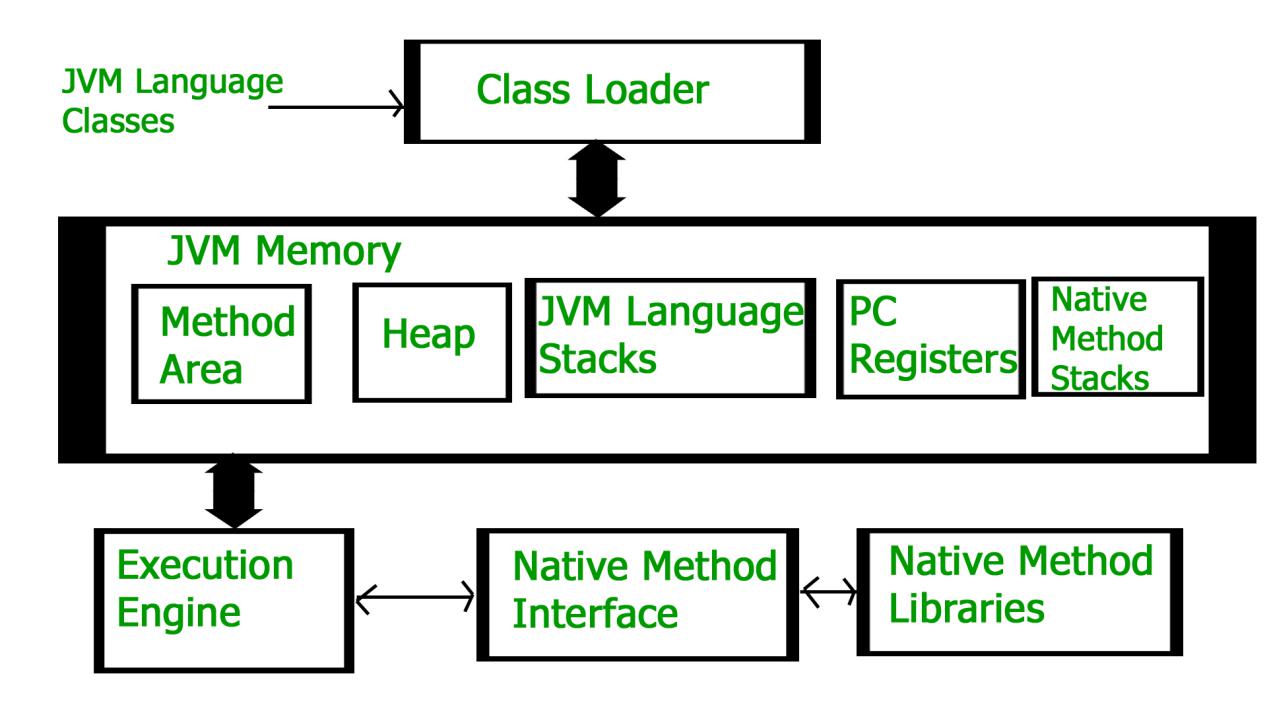
**Java Virtual Machine:**

**How JVM Works – JVM Architecture?**

JVM(Java Virtual Machine) acts as a run-time engine to run Java applications. JVM is the one that actually calls the main method present in a java code. JVM is a part of JRE(Java Run Environment).

Java applications are called WORA (Write Once Run Everywhere). This means a programmer can develop Java code on one system and can expect it to run on any other Java enabled system without any adjustment. This is all possible because of JVM.

When we compile a .java file, a .class file(contains byte-code) with the same filename is generated by the Java compiler. This .class file goes into various steps when we run it. These steps together describe the whole JVM.



Now, as you can see (the lop layer is) class loader is on top.

**Class Loader SubSystem:**

It is mainly responsible for three activities.

Loading

Linking

Initialization

**Loading :**

The Class loader reads the .class file, generate the corresponding binary data and save it in method area. For each .class file, JVM stores following information in method area.

Fully qualified name of the loaded class and its immediate parent class.

Whether .class file is related to Class or Interface or Enum Modifier, Variables and Method information etc.

After loading .class file, JVM creates an object of type Class to represent this file in the heap memory. Please note that this object is of type Class predefined in java.lang package. This Class object can be used by the programmer for getting class level information like name of class, parent name, methods and variable information etc. To get this object reference we can use getClass() method of Object class.

**getClass() method example and obtaining Information Example:**

// A Java program to demonstrate working of a Class type

// object created by JVM to represent .class file in

// memory.

import java.lang.reflect.Field;

import java.lang.reflect.Method;

// Java code to demonstrate use of Class object

// created by JVM

public class Test

{

public static void main(String[] args)

{

Student s1 = new Student();

// Getting hold of Class object created

// by JVM.

Class c1 = s1.getClass();

// Printing type of object using c1.

System.out.println(c1.getName());

// getting all methods in an array

Method m[] = c1.getDeclaredMethods();

for (Method method : m)

System.out.println(method.getName());

// getting all fields in an array

Field f[] = c1.getDeclaredFields();

for (Field field : f)

System.out.println(field.getName());

}

}

// A sample class whose information is fetched above using

// its Class object.

class Student

{

private String name;

private int roll\_No;

public String getName() { return name; }

public void setName(String name) { this.name = name; }

public int getRoll\_no() { return roll\_No; }

public void setRoll\_no(int roll\_no) {

this.roll\_No = roll\_no;

}

}

**Linking:**

Performs verification, preparation, and (optionally) resolution.

**Verification :** It ensures the correctness of .class file i.e. it check whether this file is properly formatted and generated by valid compiler or not. If verification fails, we get run-time exception java.lang.VerifyError.

**Preparation :** JVM allocates memory for class variables and initializing the memory to default values. (class variables: that means the static variables of a class)

**Resolution :** It is the process of replacing symbolic references from the type with direct references. It is done by searching into method area to locate the referenced entity.

**Initialization :**

In this phase, all static variables are assigned with their values defined in the code and static block(if any). This is executed executed from top to bottom in a class and from parent to child in class hierarchy.

In general there are three class loaders :

Bootstrap class loader : Every JVM implementation must have a bootstrap class loader, capable of loading trusted classes. It loads core java API classes present in JAVA\_HOME/jre/lib directory. This path is popularly known as bootstrap path. It is implemented in native languages like C, C++.

Extension class loader : It is child of bootstrap class loader. It loads the classes present in the extensions directories JAVA\_HOME/jre/lib/ext(Extension path) or any other directory specified by the java.ext.dirs system property. It is implemented in java by the sun.misc.Launcher$ExtClassLoader class.

System/Application class loader : It is child of extension class loader. It is responsible to load classes from application class path. It internally uses Environment Variable which mapped to java.class.path. It is also implemented in Java by the sun.misc.Launcher$AppClassLoader class.