What is Unicode ?

The Unicode-characters are universal characters encoding standard. It represents way different characters can be represented in different documents like text file, web pages etc.

It is the industry standard designed to consistently and uniquely encode characters used in written languages throughout the world.

The **Unicode standard uses hexadecimal to express a character.**

For example the value 0x0041 represents A.

The ASCII character set contained limited number of characters. It doesn't have Japanese characters , can't support Devnagari scripts.

The idea behind Unicode was to create a single character set that included every reasonable character in all writing systems in the world.

The Unicode standard was initially designed using 16 bits to encode characters because the primary machines were 16-bit PCs. When the specification for the Java language was created, the Unicode standard was accepted and the char primitive was defined as a 16-bit data type, with characters in the hexadecimal range from 0x0000 to 0xFFFF.

Java Vs C++

Development wise differences

1. Java is platform independent language but c++ is dependent upon operating system.

At compilation time Java Source code(.java) converts into byte code(.class) .The interpreter translates this byte code at run time into native code and gives output.

2. Java uses both a compiler and interpreter, while C++ only uses a compiler

Syntactical differences

1. There is no final semi-colon at the end of the class definition.

2. Functions are called as methods.

3. main method is a member of class & has a fixed form

public static void main(String[] args) -- argument is an array of String. This array contains the command-line arguments.

4. main method must be inside some class (there can be more than one main function -- there can even be one in every class)

5. Like the C++ << operator,

To write to standard output, you can use either of the following:

```
System.out.println( ... )
System.out.print( ... )
```

The former prints the given expression followed by a newline, while the latter just prints the given expression.

These functions can be used to print values of any type. eg :

```
System.out.print("hello");   // print a String
System.out.print(16);       // print an integer
System.out.print(5.5 * .2);  // print a floating-point number
```

The + operator can be useful when printing. It is overloaded to work on Strings as follows:

If either operand is a String, it

converts the other operand to a String (if necessary)

creates a new String by concatenating both operands .

Features wise differences.

1. C++ supports pointers whereas Java does not support pointer arithmetic. It supports Restricted pointers.

Java references (Restricted pointers) can't be arithmatically modified.

2. C++ supports operator overloading , multiple inheritance but java does not.

3. C++ is nearer to hardware than Java.

4. Everything (except fundamental or primitive types) is an object in Java (Single root hierarchy as everything gets derived from java.lang.Object).

Java is similar to C++ but it doesn't have the complicated aspects of C++, such as pointers, templates, unions, operator overloading, structures, etc. Java also does not support conditional compilation (#ifdef/#ifndef type).

Thread support is built into Java but not in C++. C++11, the most recent iteration of the C++ programming language, does have Thread support though.

Internet support is built into Java, but not in C++. On the other hand, C++ has support for socket programming which can be used.

Java does not support header files and library files. Java uses import to include different classes and methods.

Java does not support default arguments.

There is no scope resolution operator :: in Java. It has . using which we can qualify classes with the namespace they came from.

There is no goto statement in Java.

Because of the lack of destructors in Java, exception and auto garbage collector handling is different than C++.

Java has method overloading, but no operator overloading unlike C++.

The String class does use the + and += operators to concatenate strings and String expressions use automatic type conversion,

Java is pass-by-value.

Java does not support unsigned integers.

Why java doesn't support c++ copy constructor?

Java does. They're just not called implicitly like they are in C++ .

Firstly, a copy constructor is nothing more than:

```
public class Blah {
  private int foo;

  public Blah() { } // public no-args constructor
  public Blah(Blah b) { foo = b.foo; }  // copy constructor
}
```

Now C++ will implicitly call the copy constructor with a statement like this:

```
Blah b2 = b1;
```

Cloning/copying in that instance simply makes no sense in Java because all b1 and b2 are references and not value objects like they are in C++. In C++ that statement makes a copy of the object's state. In Java it simply copies the reference. The object's state is not copied so implicitly calling the copy constructor makes no sense.

All stand-alone C++ programs require a function named main and can have numerous other functions. Java does not have stand alone functions, all functions (called methods) are members of a class. All classes in Java ultimately inherit from the Object class, while it is possible to create inheritance trees that are completely unrelated to one another in C++. In this sense , Java is a pure Object oriented language, while C++ is a mixture of Object oriented and structure language.

The interface keyword in Java is used to create the equivalence of an abstract base class containing only method declarations and constants. No variable data members or method definitions are allowed(true till Java 8) . C++ does not support interface concept. Java does not support multiple

inheritance. To some extent, the interface feature provides the desirable features of multiple inheritance to a Java program without some of the underlying problems.(death of a diamond)

Java is running on a Virtual Machine, which can recollect unused memory to the operating system, so Java does not destructor. Unlike C++, Java cannot access pointers to do memory operation directly. This leads to a whole host of subtle and extremely important differences between Java and C++.

Furthermore, the C++ compiler does not check whether all local variables are initialized before they are read. It is quite easy to forget initializing a variable in C++. The value of the variable is then the random bit pattern that happened to be in the memory location that the local variable occupies.

Java does not have global functions and global data. Static in Java is just like global in C++, can be accessed through class name directly, and shared by all instances of the class. For C++, static data members must be defined out side of class definition, because they don't belong to any specific instance of the class.

Generally Java is more robust than C++ because:

Object handles (references) are automatically initialized to null.

Handles are checked before accessing, and exceptions are thrown in the event of problems.

You cannot access an array out of bounds.

Memory leaks are prevented by automatic garbage collection.

While C++ programmer clearly has more flexibility to create high efficient program, also more chance to encounter error.

Operators in Java

Arithmetic Operators

Unary Operators

Assignment Operator

Relational Operators

Logical Operators

Ternary Operator

Bitwise Operators

Shift Operators

Arithmetic Operators: They are used to perform simple arithmetic operations on primitive data types.

* : Multiplication

/ : Division

% : Modulo

+ : Addition

– : Subtraction

Unary Operators: Unary operators need only one operand. They are used to increment, decrement or negate a value.

– : Unary minus, used for negating the values.

eg : int a=20;

int b=-a;

++ :Increment operator, used for incrementing the value by 1. There are two varieties of increment operator.

Post-Increment : Value is first used for computing the result and then incremented.

Pre-Increment : Value is incremented first and then result is computed.

eg : int n1=10;

int n2=n1++;

System.out.println(n2+" "+n1);

What will be output ?

— : Decrement operator, used for decrementing the value by 1. There are two varieties of decrement operator.

Post-decrement : Value is first used for computing the result and then decremented.

Pre-Decrement : Value is decremented first and then result is computed.

! : Logical not operator, used for inverting a boolean value.

eg :

```
boolean jobDone=true;

boolean flag=!jobDone;

System.out.println(flag);
```

Assignment Operator : '=' Assignment operator is used to assign a value to any variable. It has a right to left associativity.

eg : int a=200;

In many cases assignment operator can be combined with other operators to build a shorter version of statement called Compound Statement.

eg : int a=100;

```
a += 10;

System.out.println(a);
```

+=, for adding left operand with right operand and then assigning it to variable on the left.

-=, for subtracting left operand with right operand and then assigning it to variable on the left.

*=, for multiplying left operand with right operand and then assigning it to variable on the left.

/=, for dividing left operand with right operand and then assigning it to variable on the left.

%=, for assigning modulo of left operand with right operand and then assigning it to variable on the left.

Relational Operators : These operators are used to check for relations like equality, greater than, less than. They return boolean result after the comparison and are used in looping statements and conditional if else statements.

==, Equal to : returns true if left hand side is equal to right hand side.

!=, Not Equal to : returns true if left hand side is not equal to right hand side.

<, less than : returns true if left hand side is less than right hand side.

<=, less than or equal to : returns true if left hand side is less than or equal to right hand side.

>, Greater than : returns true if left hand side is greater than right hand side.

>=, Greater than or equal to: returns true if left hand side is greater than or equal to right hand side.

Logical Operators : These operators are used to perform “logical AND” and “logical OR” operation, i.e. the function similar to AND gate and OR gate in digital electronics. One thing to keep in mind is the second condition is not evaluated if the first one is false, i.e. it has a short-circuiting effect. Used extensively to test for several conditions for making a decision.

Conditional operators are-

&&, Logical AND : returns true when both conditions are true.

||, Logical OR : returns true if at least one condition is true.

eg :

```
int data=100;
int data2=50;
if(data > 60 && data2 < 100)
 System.out.println("test performed...");
else
 System.out.println("test not performed...");
```

Ternary operator : Ternary operator is a shorthand version of if-else statement. It has three operands and hence the name ternary. General format is-

condition ? if true : if false

The above statement means that if the condition evaluates to true, then execute the statements after the ‘?’ else execute the statements after the ‘:’.

eg :

```
int data=100;

System.out.println(data>100?"Yes":"No");
```

Bitwise Operators : These operators are used to perform manipulation of individual bits of a number. They can be used with any of the integer types. They are used when performing update and query operations of Binary indexed tree.

&, Bitwise AND operator: returns bit by bit AND of input values.

|, Bitwise OR operator: returns bit by bit OR of input values.

^, Bitwise XOR operator: returns bit by bit XOR of input values.

~, Bitwise Complement Operator: This is a unary operator which returns the one's compliment representation of the input value, i.e. with all bits inversed.

eg :

```
String binary[] = {
                    "0000", "0001", "0010", "0011", "0100", "0101", "0110", "0111",
                    "1000", "1001", "1010", "1011", "1100", "1101", "1110", "1111"
                   };
                   int a = 3; // 0 + 2 + 1 or 0011 in binary
                   int b = 6; // 4 + 2 + 0 or 0110 in binary
                   int c = a | b;
                   int d = a & b;
                   int e = a ^ b;



                   System.out.println("      a = " + binary[a]);
                   System.out.println("      b = " + binary[b]);
                   System.out.println("    a|b = " + binary[c]);
                   System.out.println("    a&b = " + binary[d]);
                   System.out.println("    a^b = " + binary[e]);


                  }
```

Shift Operators : These operators are used to shift the bits of a number left or right thereby multiplying or dividing the number by two respectively. They can be used when we have to multiply or divide a number by two.

<<, Left shift operator: shifts the bits of the number to the left and fills 0 on voids left as a result. Similar effect as of multiplying the number with some power of two.

eg :

int a = 25;

System.out.println(a<<4); //25 * 16 = 400

a=-25;

System.out.println(a<<4);//-25 * 16 = -400

Signed right shift operator

The signed right shift operator '>>' uses the sign bit to fill the trailing positions. For example, if the number is positive then 0 will be used to fill the trailing positions and if the number is negative then 1 will be used to fill the trailing positions.

Assume if a = 60 and b = -60; now in binary format, they will be as follows −

a = 0000 0000 0000 0000 0000 0000 0011 1100

b = 1111 1111 1111 1111 1111 1111 1100 0100

In Java, negative numbers are stored as 2's complement.

Thus a >> 1 = 0000 0000 0000 0000 0000 0000 0001 1110

And b >> 1 = 1111 1111 1111 1111 1111 1111 1110 0010

Unsigned right shift operator

The unsigned right shift operator '>>' do not use the sign bit to fill the trailing positions. It always fills the trailing positions by 0s.

Thus a >>> 1 = 0000 0000 0000 0000 0000 0000 0001 1110

And b >>> 1 = 0111 1111 1111 1111 1111 1111 1110 0010

eg : D:\ACTS-2020\java11\test2\src\operators\Tester.java

Data Type Ranges:-

Byte(1 byte), Short(2 byte), int (4 byte), long (8 byte), float(4), double(8),char(2)

1. byte: The byte data type is an 8-bit signed two's complement integer. It has a minimum value of -128 and a maximum value of 127 (inclusive). --- -2^7 ---- 2^7-1

2. short: The short data type is a 16-bit signed two's complement integer. It has a minimum value of -32,768 and a maximum value of 32,767 (inclusive).

-2^15 ---- 2^15-1

3.int: The int data type is a 32-bit signed two's complement integer. It has a minimum value of -2,147,483,648 and a maximum value of 2,147,483,647 (inclusive).

4. long: The long data type is a 64-bit signed two's complement integer. It has a minimum value of -9,223,372,036,854,775,808 and a maximum value of 9,223,372,036,854,775,807 (inclusive).

5.float: The float data type is a single-precision 32-bit IEEE 754 floating point.

Covers a range from 1.4012984643248170e-45 to 3.4028234663852886e+38 (positive or negative).

BE careful -- in assigning integer to float & vice versa.

6. double : 8 bytes IEEE 754. Covers a range from 4.94065645841246544e-324d to 1.79769313486231570e+308d (positive or negative).

7. boolean

Typically 1-bit(as per underlying JVM specification) May take on the values true and false only.

true and false are defined constants of the language. Booleans may not be cast into any other type of variable nor may any other variable be cast into a boolean.

8. char -- unsigned char. --- UTF 16

range 0----65535

What are the rules for naming variables in java?

Answer:

All variable names must begin with a letter of the alphabet, an underscore (_), or a dollar sign ($). Can't begin with a digit. The rest of the characters may be any of those previously mentioned plus the digits 0-9.

The convention is to always use a (lower case) letter of the alphabet. The dollar sign and the underscore are discouraged.

What is JIT Compiler?

The Just In Time Compiler (JIT) concept and more generally adaptive optimization is well known concept in many languages besides Java (.Net, Lua, JRuby).

In order to explain what is JIT Compiler I want to start with a definition of compiler concept. According to wikipedia compiler is "a computer program that transforms the source language into another computer language (the target language)".

We are all familiar with static java compiler (javac) that compiles human readable .java files to a byte code that can be interpreted by JVM - .class files. Then what does JIT compile? The answer will given a moment later after explanation of what is "Just in Time".

According to most researches, 80% of execution time is spent in executing 20% of code. That would be great if there was a way to determine those 20% of code and to optimize them. That's exactly what JIT does - during runtime it gathers statistics, finds the "hot" code compiles it from JVM interpreted bytecode (that is stored in .class files) to a native code that is executed directly by Operating System and heavily optimizes it. Smallest compilation unit is single method. Compilation and statistics gathering is done in parallel to program execution by special threads. During statistics gathering the compiler makes hypotheses about code function and as the time passes tries to prove or to disprove them. If the hypothesis is dis-proven the code is deoptimized and recompiled again.

The name "Hotspot" of Sun (Oracle) JVM is chosen because of the ability of this Virtual Machine to find "hot" spots in code.

What optimizations does JIT?

Let's look closely at more optimizations done by JIT.

Inline methods - instead of calling method on an instance of the object it copies the method to caller code. The hot methods should be located as close to the caller as possible to prevent any overhead.

Eliminate locks if monitor is not reachable from other threads

Replace interface with direct method calls for method implemented only once to eliminate calling of virtual functions overhead

Join adjacent synchronized blocks on the same object

Eliminate dead code

Drop memory write for non-volatile variables

Remove prechecking NullPointerException and IndexOutOfBoundsException

When the Java VM invokes a Java method, it uses an invoker method as specified in the method block of the loaded class object. The Java VM has several invoker methods, for example, a different invoker is used if the method is synchronized or if it is a native method. The JIT compiler uses its own invoker. Sun production releases check the method access bit for value ACC_MACHINE_COMPILED to notify the interpreter that the code for this method has already been compiled and stored in the loaded class. JIT compiler compiles the method block into native code for this method and stores that in the code block for that method. Once the code has been compiled the ACC_MACHINE_COMPILED bit, which is used on the Sun platform, is set.

Class & Object

Classes and Objects are basic concepts of Object Oriented Programming which revolve around the real life entities.

Class

A class is a user defined blueprint or prototype or template : from which objects are created.

It represents the set of properties or methods that are common to all objects of one type.

Class declaration includes

1. Access specifiers : A class can be public or has default access

2. Class name: The name should begin with a capital letter & then follow camel case convention

3. Superclass(if any): The name of the class's parent (superclass), if any, preceded by the keyword extends. (Implicit super class of all java classes is java.lang.Object)

4. Interfaces(if any): A comma-separated list of interfaces implemented by the class, if any, preceded by the keyword implements.

A class can implement more than one interface.

eg : public class Emp extends Person implements Artist,Player{...}

5. Body: The class body surrounded by braces, { }.

6. Constructors are used for initializing new objects.

7. Fields are variables that provides the state of the class and its objects

8. Methods are used to implement the behavior of the class and its objects.

eg : Student,Employee,Flight,PurchaseOrder, Shape ,BankAccount.....

Object

It is a basic unit of Object Oriented Programming and represents the real life entities.

A typical Java program creates many objects, which interact by invoking methods.

An object consists of :

State : It is represented by attributes of an object. (properties of an object) / instance variables (non static)

Behavior : It is represented by methods of an object (actions upon data)

Identity : It gives a unique identity to an object and enables one object to interact with other objects.
eg : Emp id / Student PRN / Invoice No

Creating an object

The new operator instantiates a class by allocating memory for a new object and returning a reference to that memory.

The new operator also invokes the class constructor.

Constructor -- is a special method having

same name as the class name

no explicit return type

may be parameterized or parameter less.

Parameterized constructor is used initialize state of the object.

If a class does not explicitly declare any constr , the Java compiler automatically provides a no-argument constructor, called the default constructor.

This default constructor implicitly calls the super class's no-argument constructor

Revise "this" keyword

this => current object reference

Usages of this

1. To unhide , instance variables from method local variables.(to resolve the conflict)

eg : this.name=name;

2. To invoke the constructor , from another overloaded constructor in the same class.(constructor chaining , to avoid duplication)

Encapsulation in Java

Encapsulation is defined as the wrapping up of data & code under a single unit. It is the mechanism that binds together code and the data it manipulates.

It's is a protective shield that prevents the data from being accessed by the code outside this shield.

The variables or data of a class is hidden from any other class and can be accessed only through any member function/method of own class in which they are declared.

As in encapsulation, the data in a class is hidden from other classes, so it is also known as data-hiding.

Tight Encapsulation can be achieved by: Declaring all the variables in the class as private and writing public methods as its accessors.

Advantages of Encapsulation:

1. Data Hiding (security)

2. Increased Flexibility: We can make the variables of the class as read-only or write only or r/w.

3. Reusability: Encapsulation also improves the re-usability and easy to change with new requirements.

4. Testing code is easy

Summary

Encapsulation -- consists of Data hiding + Abstraction

Information hiding -- achieved by private data members & supplying public accessors.

Abstraction -- achieved by supplying an interface to the Client (customer) .Highlighting only WHAT is to be done & not highlighting HOW it's internally implemented.

Regarding Garbage Collection

Garbage Collection is a process to identify and delete the objects from Heap memory which are not in use. GC frees the space after removing unreferenced objects.

Garbage= un -referencable object.

Automatic Gargabe Collection --- to avoid memory. leaks/holes

JVM creates 2 system thrds --- main thrd(to exec main() sequentially) -- foreground thrd

G.C --- daemon thrd ---background thrd --- JVM activates it periodically(only if required)

--- GC releases the memory occupied by un-referenced objects allocated on the heap(the object whose no. of ref=0)

How to request for GC ?

API of System class

public static void gc()

eg : System.gc(); //it's simply a REQUEST to JVM , for running GC thread.

Object class API

protected void finalize() throws Throwable

Automatically called by the garbage collector on an object before garbage collection of the object takes place.

----------1st half over----------

Releasing of non- Java resources(eg - closing of DB connection, closing file handles, closing socket connections) is NOT done automatically by GC

Triggers for marking the object for GC(candidate for GC)

1. Nullifying all valid refs.

    eg : Box b1=new Box(1,2,3);

    Box b2=b1;

    b1=b2=null;//Box obj is marked for GC

2. re-assigning the reference to another object

    eg : Box b1=new Box(10,20,30);

    b1=new Box(2,3,4);

3. Object created within a method & its ref NOT returned to the caller.

4. Island of isolation

More Details

Garbage Collection is a process to identify and delete the objects from Heap memory which are not in use. GC frees the space after removing unreferenced objects.

The event in which Garbage Collectors are doing their job is called “Stop the world” event which means all of your application threads are put on hold until the garbage is collected.

How Garbage Collector works

The basic process of Hotspot JVM Garbage collector completes in two phases:

1. Marking

This phase is called marking phase in which GC identifies which objects are in use or which are not.

All objects are scanned in the marking phase to make this determination.

2. Deletion

In Deletion phase, the marked object is deleted and the memory is released. Deletion of the unreferenced objects can be done in two ways:

2.1 Normal Deletion: In this phase, all unused objects will be removed and memory allocator has pointers to free space where a new object can be allocated.

OR

2.2 Deletion and Compaction: As you see in normal deletion there are free blocks between referenced objects.

To further improve performance, in addition to deleting unreferenced objects, remaining referenced object will be compact.

Why Heap divided into Generations ?

It is a time consuming process to scan all of the objects from a whole heap and further mark and compact them.

The list of the object grows gradually which leads to longer garbage collection time as more and more objects are allocated with time.

In General Applications most of the objects are short-lived. Fewer and fewer objects remain allocated over time.

That's why to enhance the performance of the JVM, Heap is broken up into smaller parts called generations and JVM performs GC in these generations when the memory is about to fill up.

Generational Process of Garbage Collection

1. New objects are allocated in Eden Space of Young Generation. Both Survivor Spaces are empty in starting.

2. A minor garbage collection will trigger once the Eden space fills up.

Referenced objects are moved to the S0 survivor space and Eden Space will be cleared and all unreferenced objects will be deleted.

3. It will happen again to Eden space when next time GC will be triggered. But, in this case, all referenced objects are moved to S1 survivor space. In addition, objects from the last minor GC on the S0 survivor space have their age incremented and get moved to S1. Now both Eden and S0 will be cleared, and this process will repeat every time when GC is triggered. On every GC triggered, survivor spaces will be switched and object's age will be incremented.

4. Once the objects reach a certain age threshold, they are promoted from young generation to old generation. So, this is how objects promotion takes place.

5. The major GC will be triggered once the old generation completely fills up.

Available Garbage collectors in Hotspot JVM

1. Serial Garbage Collector: Serial GC designed for the single-threaded environments. It uses just a single thread to collect garbage.

It is best suited for simple command-line programs. Though it can be used on multiprocessors for applications with small data sets.

2. Parallel Garbage Collector: Unlike Serial GC it uses multiple threads for garbage collection.

It is a default collector of JVM and it is also called the Throughput garbage collector.

3. CMS(concurrent mark & sweep) Garbage Collector: CMS uses multiple threads at the same time to scan the heap memory and mark in the available for eviction and then sweep the marked instances.

4. G1 Garbage Collector: G1 Garbage collector is also called the Garbage First. It is available since Java 7 and its long-term goal is to replace the CMS collector. The G1 collector is a parallel, concurrent, and incrementally compacting low-pause garbage collector.

static --- keyword in java

Usages

1. static data members --- Memory allocated only once at the class loading time --- not saved on object heap --- but in special memory area -- method area (meta space) . -- shared across all objects of the same class.

Initialized to their default values(eg --double --0.0,char -0, boolean -false,ref -null)

How to refer ? -- className.memberName

eg -- class Emp {

public static int idCounter;

private String name;

}

2. static methods --- Can be accessed w/o instantiation. (ClassName.methodName(....))

Can't access 'this' or 'super' from within static method.

Rules –

1. Can static methods access other static members directly(w/o instance) -- YES

2. Can static methods access other non-static members directly(w/o instance) -- NO

eg : class A

```
{
  private int i;
  private static int j;
  public static void show()
  {

    sop(i);//javac err
    sop(j);//no err
  }
}
```

3. Can non-static methods access other static members directly(w/o instance) -- YES

eg :

In Test class

void test1() {test2();}//no error

OR

static void test2(){test1();//javac error}

3. static import --- Can directly use all static members from the specified class.

eg --

//can access directly , ALL static members of the System class

```
import static java.lang.System.*;
import static java.lang.Math.sqrt;
import java.util.Scanner;
main(...)
{
  out.println(.....);
  Scanner sc=new Scanner(in);
  sqrt(12.34);
  gc();
  exit(0);

}
```

4. static initializer block

syntax --

```
static {
// block gets called only once at the class loading time , by JVM's classloader
// usage --1.  to init all static data members
//& can add functionality -which HAS to be called precisely once.
Use case : singleton pattern , J2EE for loading hibernate/spring... framework.
}
```

They appear -- within class definition & can access only static members directly.(w/o instance)

A class can have multiple static init blocks(legal BUT not recommended)

Regarding non-static initilizer blocks(instance initilizer block)

syntax

{

//will be called per instantiation --- before matching constructor

//Better alternative --- parameterized constructor.

}

5. static nested classes ---

eg --

```
class Outer {
// static & non-static members
  static class Nested
  {
     //can access ONLY static members of the outer class DIRECTLY(w/o inst)
  }
}
```

Why static methods can't be overridden in java ?

Method overriding is a way to achieve dynamic method dispatch(i.e run time polymorphism)

Meaning which behaviour to choose or which method to choose for execution --this decision is taken at the run time depending upon type of the object by the JVM(late binding). Since it depends upon the type of the object , for static methods this concept is not applicable. (since they are not associated with any object)

Overriding depends on having an instance of a class. The point of polymorphism is that you can subclass a class and the objects implementing those subclasses will have different behaviours for the same methods defined in the superclass (and overridden in the subclasses). A static method is not associated with any instance of a class so the concept is not applicable.

Regarding Packages

What is a package ?

Collection of functionally similar classes & interfaces.

Creating user defined packages

Need ?

1. To group functionally similar classes together.

2. Avoids name space collision (allows duplicate class names in different packages)

3. Finer control over access specifiers.

About Packages

1. Creation : package statement has to be placed as the 1st statement in Java source.

eg : package p1; => the classes will be part of package p1.

2.Package names are mapped to folder names.

eg : package p1; class A{....}

A.class must exist in folder p1.

3. For simplicity --- create folder p1 -- under <src> & compile from <src>

From <src>

javac -d ..\bin p1\A.java

-> javac will auto. create the sub-folder <p1> under the <bin> folder & place A.class within <p1>

NOTE : Its not mandatory to create java sources(.java) under package named folder. BUT its mandatory to store packaged compiled classes(.class) under package named folders

Earlier half is just maintained as convenience (eg --- javac can then detect auto. dependencies & compile classes).

3.5 How to launch / run packaged java classes?

cd <bin>

java FullyQualifiedClassName

java p1.A

4. To run the pkged classes from any folder : you must set Java specific environment variable : classpath

set classpath=g:\dac1\day2\bin;

classpath= Java only environment variable

Used mainly by JRE's classloader : to locate & load the classes.

Classloader will try to locate the classes from current folder, if not found --- will refer to classpath entries : to resolve & load Java classes.

What should be value of classpath ---Must be set to top of packged class hierarchy(eg : bin)

set classpath=d:\dac\day2\bin;.;(cmd line invocation)

OR better still

set it from environment variables.

Rules

1. If the class is part of a package, the package statement must be the first line in the source code file, before any import statements that may be present.

2. If there are import statements, they must go between the package statement

(if there is one) and the class declaration. If there isn't a package statement,

then the import statement(s) must be the first line(s) in the source code file.

If there are no package or import statements, the class declaration must be

the first line in the source code file.

3. import and package statements apply to all classes within a source code file.

In other words, there's no way to declare multiple classes in a file and have

them in different packages, or use different imports.

NOTE : Setting classpath on all platforms

Refer :

https://www.javacodestuffs.com/2020/09/how-to-set-classpath-in-java-windows.html#:~:text=%20How%20to%20set%20classpath%20in%20Java%20-,is%20one%20way%20to%20tell%20applications%2C...%20More%20

OR

https://www.edureka.co/blog/set-Java-classpath/

What is enum in java ? : Keyword in java

Enumerations (in general) are generally a set of related constants.

They have been in other programming languages like C++ from beginning. BUT more powerful in Java.

Supported in Java since JDK 1.5 release.

Enumeration in java is supported by keyword enum. enums are a special type of class that always extends java.lang.Enum.

It's a combination of class & interface features.

Why ?

1. Helps to define constants.

2. Adds type safety to constants.

```
Eg. interface MovieConstants
{
int AGE_MINOR=16;
int AGE_MIN = 10;
int AGE_MAX=70;
```

int TKT_COST_SILVER =100;

int TKT_COST_GOLD =200;

int TKT_COST_PLATINUM =300;

}

If by programer's mistake application uses TKT_COST to compare ages of user , what will happen ?

Both being int type neither javac or jvm can realise err , but you will get wrong results.

It should not be allowed --as they represent different types ---AGE type & TKT_COST type.

3. You can't iterate over all constant values from i/f but with enums you can.

4 . Consider this

eg interface Menu

{

String SOUP="Tomato soup";

String DOSA="Mysore Dosa";

String RICE="Fried rice";

}

Can you assign any price along with menu? ---Not easily !

But with enums you can.

A simple usage will look like this:

public/default enum Direction {

EAST,

WEST,

NORTH,

SOUTH //optionally can end with ";"

}

Here EAST, WEST, NORTH and SOUTH are implicitly of type

public final static Direction EAST=new Direction("EAST",0) ---super("EAST",0);

public final static Direction WEST=new Direction("WEST",1) ---super("WEST",1);

Super class of all enums

public abstract class Enum<E extends Enum<E>>

extends Object

implements Comparable<E>, Serializable

ie. they are comparable and serializable implicitly.

All enum types in java are singleton by default.

So, you can compare enum types using '==' operator also.

Since enums extends java.lang.Enum, so they can not extend any other class because java does not support multiple inheritance . But, enums can implement any number of interfaces.

enum can be declared within a class or separately.

eg of enum within a class

When declared inside a class, enums are always static by default

eg public class TestOuter

```
{
  enum Direction
  {
    EAST,
    WEST,
    NORTH,
    SOUTH
  }
}
```

To access a direction -- use TestOuter.Direction.NORTH.

Constructors of enum

By default, you don't have to supply constructor definition.

Javac implicitely calls super class constructor , Enum(String name,int ordinal)

Important Methods of Enum (implicitly added by javac)

1. public static Enum[] values() --rets array of enum type of refs.--pointing to singleton objs

2. public static Enum valueOf(String name) throws IllegalArgumentException -- string to enum type converter

values & valueOf methods generated by compiler --so not part of javadocs.

If you pass a different name (eg -- ABC) to valueOf ---throws IllegalArgumentException

Inherited from Suerpclass Enum

String name() --rets name of constant in string form

int ordinal() --rets index of the const as it appears in enum.--starts with 0

public String toString() : overridden to return name of the enum constant.

You can supply your own constructor/s to initialize the state(data member of enum types.

```
enum Direction {
 // Enum types
 EAST(0), WEST(180), NORTH(90), SOUTH(270);

 // Constructor
 private Direction(final int angle) {
  this.angle = angle;
 }
```

```
  // Internal state
  private int angle;

  public int getAngle() {
    return angle;
  }
}
```

BUT u can't instantiate enums using these constructors , since they are implicitely private.

You can override toString BUT you can't override equals since it's declared as final method in enum.

Inheritance

In OOP, we often organize classes in hierarchy to avoid duplication and reduce redundancy. The classes in the lower hierarchy inherit all the variables (attributes) and methods (dynamic behaviours) from the higher hierarchies.

A class in the lower hierarchy is called a subclass (or derived, child, extended class). A class in the upper hierarchy is called a superclass (or base, parent class).

By pulling out all the common variables and methods into the superclasses, and leave the specialized variables and methods in the subclasses, redundancy can be greatly reduced or eliminated as these common variables and methods do not need to be repeated in all the subclasses. Re usability is maximum.

A subclass inherits all the member variables and methods from its superclasses (the immediate parent and all its ancestors). It can use the inherited methods and variables as they are. It may also override an inherited method by providing its own version, or hide an inherited variable by defining a variable of the same name.

Summary : Sub class IS-A super class , and something more (additional state + additional methods) and something modified(behaviour --- method overriding)

eg :

Person,Student,Faculty

Emp,Manager,SalesManager,HRManager,Worker,TempWorker

Shape, Circle,Rectangle,Cyllinder,Cuboid

BankAccount ,LoanAccount,HomeLoanAccount,VehicleLoanAccount

Student,GradStudent,PostGradStudent

Fruit -- Apple -- FujiApple

A subclass inherits all the variables and methods from its superclasses, including its immediate parent as well as all the ancestors.

It is important to note that a subclass is not a "subset" of a superclass. In contrast, subclass is a "superset" of a superclass. It is because a subclass inherits all the variables and methods of the superclass; in addition, it extends the superclass by providing more variables and methods.

Inheritance --- generalization ----> specialization.

IS A Relationship.

Why -- code/state re-usability.

super class ---base class

sub class --derived class

keyword --extends

Types of inheritance

1. single inheritance ---Supported in Java

class A{...} class B extends A{...}

2. multi level inhertance

class A{...}

class B extends A{...}

class C extends B{...}

Supported in java

3. multiple inhertiance --- NOT supported

class A extends B,C{...} -- compiler err

Why --For simplicity.

(Diamond problem)

We have two classes B and C inheriting from A. Assume that B and C are overriding an inherited method and they provide their own implementation. Now D inherits from both B and C doing multiple inheritance. D should inherit that overridden method. BUT which overridden method will be used? Will it be from B or C? Here we have an ambiguity.

Constructor invocations in inheritance hierarchy -- single & multi level.

eg -- Based on class A -- super class & B its sub class.

Further extend it by class C as a sub-class of B.

super keyword usage

1. To access super class's visible members(data members n methods)

eg : p1 : package

class A { void show(){sop("in A's show");}}

package p1 :

class B extends A {

  //overriding form /sub class version

```
 void show(){sop("in B's show");
   super.show();
}
}
```

eg : B b1=new B();

b1.show();

2. To invoke immediate super class's matching constructor --- accessible only from sub class constructor.(super(...))

eg : Organize following in suitable class hierarchy(under "inheritance" package) : tight encapsulation

Person -- firstName,lastName

Student --firstName,lastName,grad year,course,fees,marks

Faculty -- firstName,lastName,yrs of experience , sme

Confirm invocation of constructors & super.

Regarding this & super :

1. Only a constr can use this(...) or super(..)

2. Has to be 1st statement in the constructor

3. Any constructor can never have both ie. this() & super()

4. super & this (w/o brackets) are used to access (visible) members of super class or the same class.

eg :

1.Simple example to understand inheritance n polymorphism

1.1 Fruit : name

Add a parametrized constr , to accept name of the fruit.

Add taste() method to display its taste.

eg : public void taste() : "no specific taste"

1.2 Apple : extends Fruit

parametrized constr ---super(name);

override : taste

method definition : sweet n sour in taste

1.3 Similarly : add Orange n Mango

parametrized constr ---super(name);

Add taste() method to display its taste.

Orange : Sour in taste

Mango : sweet in taste

1.5 Write a simple tester : to understand upcasting n run time polymorphism.

2. Another example

Write a Tester to create basket of fruits.

(populate basket based on user choice)

1. Fruit,Apple,Orange,Cherry

Add taste() method to display its taste.

2. Create FruitUtils class.

Add static method , addFruit to add a fruit to the Fruit Basket.

3. Write a Tester to create basket of fruits.

(populate basket based upon user's choice)

Menu

1. Add Apple

2. Add Orange

3. Add Cherry

4. Display taste of all fruits in the basket.

5. Exit : terminate the application.

Menu

1. Add Apple

2. Add Orange

3. Add Mango

4. Display taste of all fruits in the basket (for-each)

5 : Exit : terminate the application.

2. Create FruitUtils class.(later)

Add static method , addFruit to add a fruit to the Fruit Basket.

Polymorphism

---one functionality

--multiple (changing) forms

1. **static -- compile time** --early binding ---resolved by javac.

Achieved via method overloading

rules -- can be in same class or in sub classes.

same method name

signature -- different (number/type/both)

ret type --- ignored by compiler.

eg --- void test(int i,int j){...}

void test(int i) {..}

void test(double i){..}

void test(int i,double j,boolean flag){..}

int test(int a,int b){...}

RULE -- when javac doesn't find exact match --tries to resolve it by the closest arg type(just wider than the specified arg)

solve --- EasyOver.java

(More interesting examples after boxing & var-args)

2. **Dynamic polymorphism** (run time polymorphism) --- late binding --- dynamic method dispatch --- resolved by JRE.

Dynamic method dispatch -- which form of method to send for execution ---This decision can't be taken by javac --- BUT taken by JRE

Achieved via -- method overriding

Method Overriding --- Means of achieving run-time polymorphism

NO "virtual" keyword in java.

All java methods can be overridden : if they are not marked as private,static,final

Super-class form of method - --- overridden method

sub-class form --- overriding form of the method

Rules : to be followed by overriding method in a sub-class

1. **same method name, same signature, ret type must be same or its sub-type**(co-variance)

eg of co-variance

class A {

```
    A getInstance()
            {
                return new A();
            }
}

class B extends A
{
    B getInstance()
            {
                return new B();
            }
}
```

2. scope---must be same or wider.

3. Will be discussed in exception handling.

Can not add in its throws clause any new or broader checked exceptions.

BUT can add any new unchecked excs.

Can add any subset or sub-class of checked excs.

```
class A
{
  void show() throws IOExc
  {...}
}
class B extends A
{
  void show() throws Exc
  {...}
}
```

Can't add super class of the checked excs.

example of run time polymorphism -- Car & its sub classes.

From JDK 1.5 onwards : Annoations are available --- metadata meant for Compiler or JRE.(Java tools)

Java Annotation is a tag that represents the metadata i.e. attached with class, interface, methods or fields to indicate some additional information which can be used by java compiler and JVM.

Annotations in java are used to provide additional information, so it is an alternative option for XML.

Eg. @Override,@Deprecated,@SuppressWarnings,@FunctionalInterface

@Override --

Annotation meant for javac.

Method level annotation

Optional BUT recommended.

eg : Fruit <----- Orange

public class Orange extends Fruit {

@Override

 public void taste() {....}

}

While overriding the method in a sub class -- if you want to inform the compiler that : following is the overriding form of the method use :

@Override

method declaration {...}

Run time polymorphism or Dynamic method dispatch in detail

Super -class ref. can directly refer to sub-class object(direct=w/o type casting) as its the example of up-casting(similar to widening auto. conversion) .

When such a super class ref is used to invoke the overriding method: which form of the method to send for execution : this decision is taken by JRE & not by compiler. In such case --- overriding form of the method(sub-class version) will be dispatched for exec.

Super -class ref. can directly refer to sub-class inst BUT it can only access the members declared in super-class -- directly.

eg : A ref=new B(); ref.show() ---> this will invoke the sub-class: overriding form of the show () method

---

Applying inheritance & polymorphism

java.lang.Object --- Universal super class of all java classes including arrays.

Object class method

public String toString() ---Rets string representation of object.

Returns --- Fully qualified class Name @ hash code

hash code --internal memory representation.(hash code is mainly used in hashing based data structures -- will be done in Collection framework)

Why override toString?

To replace hash code version by actual details of any object.

Objective -- Use it in sub classes. (override toString to display Account or Point2D or Emp details or Student / Faculty)

Object class method

public boolean equals(Object o)

Returns true --- If 'this' (invoker ref) & o ---refers to the same object(i.e reference equality) i.e this==o , otherwise returns false.

Need of overriding equals method ?

To replace reference equality by content identity equality , based upon prim key criteria.

eg : In Car scenario

(Primary key -- int registration no)

Objective : use it for understanding downcasting n instanceof keyword

---

instanceof -- keyword in java --used for testing run time type information.

refer : regarding instanceof

Solve

```
Fruit f=new Fruit();
f.taste();
f.pulp();
((Mango)f).pulp();
f=new Orange();
f.taste();
((Mango)f).pulp();
if(f instanceof Mango)
 ((Mango)f).pulp();
else
 sop("Invalid fruit....");
if(f instanceof Object)
 ((Mango)f).pulp();
else
 sop("Invalid fruit....");
```

---

abstract : keyword in Java

abstract methods ---methods only with declaration & no definition

eg : public abstract double calNetsalry();

private abstract double calNetsalry();//**javac error**

Any time a class has one or multiple abstract methods ---- class must be declared as abstract class.

eg. public abstract class Emp {....}

Abstract classes can't be instantiated BUT can create the ref. of abstract class type to refer to concrete sub-class instances.

Emp e1=new Emp(...);//illegal : RHS

Emp e1=new Mgr(....);//legal : provided Mgr class is concrete

Abstract classes CAN HAVE concrete(non-abstract) methods.

Abstract classes MUST provide constructor/s to init its own private data members.(to create concrete sub class instance)

eg : Emp : empId, dept...: private

Mgr extends Emp : to init empId, dept ... : MUST supply a constr in Emp class.

Can a class be declared as abstract & final ? NO

Can an abstract class be created with 100% concrete functionality?----------Yes

eg --- Event adapter classes / HttpServlet

Use "abstract" keyword in Emp , Mgr ,Worker hierarchy & test it

final -- keyword in java

Usages

1 final data member(primitive types) - constant.

eg -- public final int data=123;

2. final methods ---can't be overridden.

usage eg public final void show{.....}

eg -- Object class -- wait , notify ,notifyAll

3. final class --- can't be sub-classed(or extended) -- i.e stopping inheritance hierarchy.

eg -- String ,StringBuffer,StringBuilder

eg : public class MyString extends String {...} //javac err

4. final reference -- references can't be re-assigned.

eg --final Emp e=new Mgr(.....);//up casting

e=new Worker(.....);//compiler err

Special note on protected

Protected members act as default scope within the same package.

BUT outside pkg -- a sub-class can access it through inheritance(i.e just inherits it directly) & CAN'T be accessed by creating super class instance.

Upcasting

The most important aspect of inheritance is the relationship expressed between the new class and the base class. This relationship can be summarized by saying,

The new class "IS A" type of the existing class.

eg : Student is of Person type or Faculty is of Person type.

This description is not just a fancy way of explaining inheritance—it's supported directly by the language.

Meaning :

Can we say ?

Person p=new Student(....);//YES --upcasting

sop(p);//dynamic method dispatch

As another example, consider a base class called Fruit that represents any fruit, and a derived class called Mango.

Because inheritance means that all of the methods in the base class are also available in the derived class,

any message you can send to the base class can also be sent to the derived class. If the Fruit class has a taste( ) method, so will Mango.

This means we can accurately say that a Mango object is also a type of Fruit.

Instanceof

-- keyword in java --used for testing run time type information.(RTTI)

It is used to test whether the object is an instance of the specified type (class or subclass or interface).

Meaning

In "a instanceof B", the expression returns true if the reference to which a points is an instance of class B, a subclass of B (directly or indirectly), or a class that implements the B interface (directly or indirectly).

The instanceof in java is also known as type comparison operator because it compares the instance with type. It returns either true or false.

For null --instanceof returns false.

For sub-class object --instanceof super class -- rets true

For super-class object --instanceof sub class -- rets false

eg ---Object <----Emp <---Mgr <---SalesMgr

Object <---- Emp <--- Worker

What will be o/p ?

Emp e =new Mgr(...);//no java err : up casting!

e instanceof Mgr - true

e instanceof Emp - true

e instanceof Object - true

e instanceof SalesMgr - false

e instanceof Worker - false

e=null;

e instanceof Emp/Mgr/SalesMgr/Worker/Object -false

Interface in Java

What is interface ?

An interface in java is a blueprint of a class. Typically it has public static final data members and public n abstract methods only.

The interface in java is a mechanism to achieve fully abstraction. There can be only abstract methods in the java interface (not method body)(true till JDK 1.7) . It is used to achieve full abstraction and multiple inheritance in Java.

Java Interface also represents IS-A relationship.

It cannot be instantiated just like abstract class.

Why java interfaces?

1. It is used to achieve full abstraction.

2. By interface, we can support the functionality of multiple inheritance.

3. It can be used to achieve loose coupling.

(Interfaces allow complete separation between WHAT(specification or a contract) is to be done Vs HOW (implementation details) it's to be done

The java compiler adds public and abstract keywords before the interface method and public, static and final keywords before data members.

---

syntax of interface

default(no modifier)/public interface NameOfInterface extends comma separated list of super interfaces

{

```
  //data members --- public static final : added implicitly by javac
  int DATA=100;
  //methods -- public abstract : added implicitly by javac
  double calc(double d1,double d2);
```

}

Implementing class syntax

default(no modifier)/public class NameOfClass extends SuperCls implements comma separated list of interfaces {

```
  //Mandatory for implementation class to be non-abstract(concrete): MUST define/implement all abstract methods inherited from all i/fs.
```

}

eg : public class Circle extends Shape implements Computable,Runnable {...}

1. Relationship between classes and interfaces

A class inherits from another class(extends), an interface extends another interfaces(extends) but a class implements an interface.

2. Multiple inheritance in Java by interface

If a class implements multiple interfaces, or an interface extends multiple interfaces i.e. known as multiple inheritance.

eg :

Multiple inheritance in java

```
interface Printable{
void print();
}

interface Showable{
void show();
}

class A implements Printable,Showable{

public void print(){System.out.println("Hello");}
public void show(){System.out.println("Welcome");}

public static void main(String args[]){
A obj = new A();
obj.print();
obj.show();
 }
}
```

Question

Multiple inheritance is not supported through class in java but it is possible by interface, why?

Multiple inheritance is not supported in case of class, since it can create an ambiguity. But it is supported in case of interface because there is no ambiguity as implementation is provided by the implementation class.

For example:

```
interface Printable{
void print();
}
interface Showable{
void print();
}

class TestTnterface1 implements Printable,Showable{
public void print(){System.out.println("Hello");}
public static void main(String args[]){
TestTnterface1 obj = new TestTnterface1();
obj.print();
 }
}
```

As you can see in the above example, Printable and Showable interface have same methods but its implementation is provided by class TestTnterface1, so there is no ambiguity.

Interface inheritance

A class implements interface but one interface extends another interface .

```
interface Printable{
void print();
}
interface Showable extends Printable{
void show();
```

```
}
class Testinterface2 implements Showable{

public void print(){System.out.println("Hello");}
public void show(){System.out.println("Welcome");}

public static void main(String args[]){
Testinterface2 obj = new Testinterface2();
obj.print();
obj.show();
 }
}
```

Q) **What is marker or tagged interface**?

An interface that has no member is known as marker or tagged interface. For example: Serializable, Cloneable, Remote etc. They are used to provide some essential information to the JVM(Run time marker) so that JVM may perform some useful operation.

```
//How Serializable interface is written?
public interface Serializable{
}
```

Nested Interface in Java

Note: An interface can have another interface i.e. known as nested interface.

```
eg :
interface printable{
 void print();
 interface MessagePrintable{
```

```
  void msg();
 }
}
```

Q . What is a **functional i/f**

An interface containing **sing abstract methods (SAM)**

eg : Comparator , Runnable , Consumer...

Abstract Class vs. Interface

Java provides and supports the creation of abstract classes and interfaces. Both implementations share some common features, but they differ in the following features:

1. All methods in an interface are implicitly abstract. On the other hand, an abstract class may contain both abstract and non-abstract methods.

2.A class may implement a number of Interfaces, but can extend only one abstract class.

3.

In order for a class to implement an interface, it must implement all its declared methods. However, a class may not implement all declared methods of an abstract class. Though, in this case, the sub-class must also be declared as abstract.

Abstract classes can implement interfaces without even providing the implementation of interface methods.

4.

Variables declared in a Java interface is by default final. An abstract class may contain non-final variables.

5. Members of a Java interface are public by default. A member of an abstract class can either be private, protected or public.

6.

An interface is absolutely abstract and cannot be instantiated, doesn't support a constructor. An abstract class also cannot be instantiated BUT can contain a constructor to be used while creating concrete(non abstract) sub class instance.

Why static methods can't be overridden in java ?

Method overriding is a way to achieve dynamic method dispatch(i.e run time polymorphism)

Meaning which behaviour to choose or which method to choose for execution --this decision is taken at the run time depending upon type of the object by the JVM(late binding). Since it depends upon the type of the object , for static methods this concept is not applicable. (since they are not associated with any object)

Overriding depends on having an instance of a class. The point of polymorphism is that you can subclass a class and the objects implementing those subclasses will have different behaviours for the same methods defined in the superclass (and overridden in the subclasses). A static method is not associated with any instance of a class so the concept is not applicable.

Exception Handling

Regarding Exception Handling in java.....

Any run time exc occurs(eg file not found,accessing out of array size,accessing func from null ref, divide by 0)

---JRE(main thrd) --- creates matching exc class instance(java.io.FileNotFoundException,java.lang.ArrayOutOfBoundsExc,NullPointerExc,ArithmeticExc)

--- JRE checks -- if prog has proivided exc handling code ?

--- NO -- JRE aborts java code(by supplying def handler) & prints details --F.Q exc class name,reason behind failure & location details(err stack trace

--- YES (try---catch) JRE execs exc handling block & continues with the rest of the code.

syntax(key words) --- try,catch,finally,throw,throws

Inheritance hierarchy of exc classes

unchecked vs checked excs.

Creating custom excs

JDK 1.7 syntax --- try-with-resources(in I/O or device prog)

Checked & UnChecked exception are detected or occur only in run-time.

JRE/JVM DOES NOT distinguish between them (un handled : w/o try-catch chked or un checked exc will cause aborting of code)

Compiler(javac) differentiates between them

Javac forces handling of the checked exc. upon the prog.(Handling by supplying matching try-catch block or including it in the throws clause.)

Legal syntax

1. try {...} catch (exc1 e){...}

2. try {...} catch (exc1 e){...} catch (exc2 e) {..} ....

3. try {...} catch (NPE e){} catch (AE e) {}catch(Exception e){catch-all}

3. try {...} catch (AE e){...} catch (NPE | AOB e) {...}catch(Exception e){catch-all}

4. **throws** syntax ---

method declaration throws comma separated list of exc classes.

eg : Integer class API

public static int parseInt(String s) throws NumberFormatException

Thread class API

public static void sleep(long ms) throws InterruptedException

FileReader API

public FileReader(String fileName) throws FileNotFoundException

throws --- keyword meant for javac

Meaning -- Method MAY raise specified exc.

Current method is NOT handling it , BUT its caller should handle.

Mandatory--- only in case of un handled(no try-catch) checked excs(not extended from RuntimeException).

Use case --used in delegating the exception to caller.

4.5 Throwable class API

1. public String toString() --	rets Name of exc class & reason.(detailed err mesg)
2. public String getMessage() --	rets error mesg of exception
3. public void printStackTrace() ---	Displays name of exc class, reason, location dtls.

5. finally --- keyword in exc handling

finally -- block -- finally block ALWAYS survives(except System.exit(0) i.e terminating JVM)

i.e in the presence or absence of excs.

5.1 try{...} catch (Exception e){....} finally {....}

5.2 try{...} catch (NullPointerException e){....} finally {....}

5.3 try {...} finally {....}

try-with-resources

From Java SE 7 onwards --- Java has introduced java.lang.AutoCloseable -- i/f

It represents --- resources that must be closed -- when no longer required.

Autocloesable i/f method

public void close() throws Exception-- closing resources.

Java I/O classes(eg : BufferedReader,PrintWriter.....),Scanner -- have already implemented this i/f -- to automatically close resource when no longer required.

syntax of try-with-resources

try (//can open one or multiple AutoCloseable resources)

{ .....

} catch(Exception e)

{

}

eg :

try(Scanner sc=new Scanner(System.in);

FileReader fr=new FR(....))

{

.....

} catch -all

Creating Custom Exc(User defined exception or application exc)

Need :

1. Validations : In case of validation failures : Prog will have to throw custom exc class instance

2. B.L failures (eg : funds transfer : insufficient finds) : Prog will have to throw custom exc class instance

1. Create a packaged public class which extends Throwable(not reco but legal)/Exception(recommended)/Error(not reco but legal)/RuntimeExc(not reco but legal)

eg : public class MyException extends Exception{

public MyException(String mesg)

{

super(mesg);

}

}

public class MyException2 extends RunTimeException{....}

2.CustExc(String msg) : overload the constr : to invoke the super-class constr. of the form

Exception (String msg)

OR

CustExc(String msg, Throwable rootCause)

public Exception(String message, Throwable cause)

Objective :

Check the speed of vehicle on a freeway

Accept the speed using Scanner : can be speed too low(exc) or too high(exc) or in range

keyword -- throw --for throwing exception.

JVM uses it to throw built-in exceptions(eg : NullPointerExc , IOException etc) & prog uses it throw custom exception(user defined excs) in case of B.L or validation failures.

syntax :

throw Throwable instance;

eg :

throw new NullPointerExc();// no javac err

throw new InterruptedExc();// no javac err

throw new Throwable("abc");// no javac err

throw new Account(...);//javac err (provided it doesn't extend from Throwable hierarchy)

throw new AccountOverdrawnException("funds too low...");//proper usage

---

String class API

Important String class constructors

1.String(byte[] bytes) --- byte[] ----> String converter

2.String(char[] chars) --- char[] ---> String converter

3.String (byte[] bytes,int offset,int len) ---byte[] ----> String converter from the specified offset , specified length no of bytes will be converted.

eg . String s=new String(bytes,3,4); --- String will contain bytes[3]----bytes[6]

4. String(char[] ch,int offset,int len)

5. String(String s)

String class methods --- to go through

charAt,compareTo,contains,copyValueOf,format,valueOf,getBytes,toCharArray,toLowerCase,indexOf,lastIndexOf,split,replace,startsWith,endsWith,length,intern

1. boolean equals(Object o) ---- ret true if 2 strings are having same contents (case sensitive)

About equals()

super class def. --- java.lang.Object

public boolean equals(Object o)

Rets true if both refs(this & o) are equal i.e referring to the same object.

Sub-class developers MUST override equals for content-wise(depending on Object's state) comparison.

2. concat,charAt,indexOf,lastIndexOf,toUpperCase,toLowerCase,format,split

printf & Formatter class

Refer to java.util.Formatter class for formatting conversion details.

Imp ---

Formatting details

%c -- character

%b -- boolean

%h -- hex value of hashcode of obj ref.

%s -- string

%d -- int

%f, %g -- float/double

%x -- hex value

%n -- line separator

%tD -- Date

%tT -- Time

%tc -- Time stamp(date & Time)

%td-%1$tb-%1$tY -- can be applied to GC or Date.

Date/Time Handling in Java

API

1. java.util.Date--- represents system date.

Constructor

1.Date() --- creates Date class instance representing system date.

2.Date(long msec) --- creates Date class instance representing date for msec elapsed after epoch(=1st Jan 1970)

For parsing & formatting

1. Create an instance of java.text.SimpleDateFormat

Constr : SimpleDateFormat(String pattern)

pre defined pattern

y --yr

MM -- month in digit(1-12)

MMM -- month in abbreviation

MMMM ---complete month name

h- Hour

m --minute

s -- second

eg : SDF sdf=new SimpleDateFormat("dd-MM-yyyy");

2. Parsing (use inherited API) string ----> Date

public Date parse(String s) throws ParseException

3. Formatting

public String format(Date d)

2. java.util.GregorianCalendar

month range --- 0-11

GregorianCalendar(int yr,int mon,int date);

GregorianCalendar(int yr,int mon,int date,int hr,int min,int sec);

2.5 How to find out current year ?

GregorianCalendar class API (inherited from Calendar class)

public int get(String fieldName)

eg : gc.get(Calendar.YEAR);

3. Date/Time formatting via printf

%tc -- for complete timestamp(date & time)

%tD -- for date

%tT -- time

Arguments --- Date, GregorianCalendar

static import syntax ---

eg -- import static java.util.Calendar.*;

or import static java.lang.System.*;

in such src - u can access directly static members of Calendar class or from 2nd statement u can directly use out.println("testing static imports!");

---

var-args

variable args syntax.--- Must be last arg in the method args.

Can use primitive type or ref types.

Legal ---

```
void doStuff(int... x) {


 } // expects from 0 to many ints
```

Usage : ref.doStuff();

```
int[] ints={1,2,3,4};

ref.doStuff(ints);

ref.doStuff(20,34,56);


System.out.printf("%n");

// as parameters

void doStuff2(char c, int... x) { } // expects first a char,

// then 0 to many ints

void doStuff3(Animal... animal) { } // 0 to many Animals
```

invocations ---

```
ref.doStuff3();

Animal[] animals={new Cat(),new Dog(),new Horse()};

ref.doStuff3(animals);

ref.doStuff3(a1,a2,a3);
```

Illegal:

void doStuff4(int x...) { } // bad syntax

void doStuff5(int... x, char... y) { } // too many var-args

void doStuff6(String... s, byte b) { } // var-arg must be last

---

wrapper classes

1. What's need of wrapper classes?

    ---1. to be able to add primitive types to growable collection(growable data structure eg -- LinkedList)

    --- 2. wrapper classes contain useful api(eg --- parseInt,parseFloat....,isDigit,isWhiteSpace...)

2. What are wrappers? --- Class equivalent for primitive types

    -- Inheritance hierarchy

    java.lang.Object --- Character (char)

    java.lang.Object --- Boolean

    Object -- Number -- Byte,Short,Integer,Long,Float,Double

3. Constrs & methods --- for boxing & unboxing

boxing= conversion from prim type to the wrapper type(class type)

un-boxing = conversion from wrapper type to the prim type

eg

Integer(int data) --- boxing

```
Integer i1=new Integer(100);
//un-boxing
int data=i1.intValue();
```

```
Integer i1=100;//no err from JDK 1.5
sop(i1);
int data=1234;
i1++;//Integer--->int(auto unboxing), inc ,auto box
Object o=123.45;//auto-boxing(double--->Double)--up casted to Object
Number n1=true;//auto-box----X(up casted) to Number
Object o2=false;//auto box -- up casting
```

Double d1=1234;//auto boxing (int --->Integer) ---X--Double

4. JDK 1.5 onwards --- boxing &unboxing performed automatically by java compiler,when required. --- auto-boxing , auto-unboxing,

---

Association

Association is relationship between two separate classes ,typically using object references.

Represents HAS-A

Why : Code reusability

Association can be one-to-one, one-to-many, many-to-one, many-to-many.

Composition and Aggregation are the two forms of association.

eg : refer to association-aggregation-composition.png

Association :

Owner HAS-A Pet -- Owner feeds a Pet & Pet plays with Owner.

Aggregation implies a HAS-A relationship where the child can exist independently of the parent.

eg : Class & Student / Bank HAS-A Customer

```
class Bank
{
  private String name;
  private String ifsc;
  private String address;
 //one to many
  private Customer[] customers;

}
class Customer {...
```

+

//many to one

private Bank myBank;

}

Composition (Part Of or Belongs To)

Pet HAS-A Tail

It implies a relationship where the child cannot exist independent of the parent.

eg : Human HAS-A Lungs / Car HAS-A Engine / Person HAS-A Address

(when parent is deleted , typically child can't exist on its own)

eg :

```
class Person
{
  private String firstName,lastName;
  private Date dob;
  private String uid;
  private Address adr;
  class Address
  {
    private String street,city,state,country;
    ....
  }

//setter / method
}
```

Aggregation is a weaker form of HAS-A relationship than Composition

Generic Syntax

Available from Java SE 5 onwards.

Represents Parameterized Types.

Can Create Generic classes, interfaces, methods and constructors.

In Pre-generics world , similar achieved via Object class reference.

Syntax -- similar to c++ templates (angle brackets)

eg : ArrayList<Emp> , HashMap<Integer,Account> .....

1. Syntax is different than C++ --for nested collections only.

2. NO code bloat issues unlike c++

Advantages

Adds Type Safety to the code @ compile time

Meaning :

1. Can add type safe code where type-mismatch errors(i.e ClassCastExceptions) are detected at compile time.

2. No need of explicit type casting, as all casts are automatic and implicit.

A generic class means that the class declaration includes a type parameter.

eg --- class MyGeneric<T>

{

private T ref;

}

class MyGeneric<T,U> {...}

T ,U ---type --- ref type

eg : ArrayList<Emp>

Understand why generics with example.

eg : Create a Holder class , that can hold ANY data type (primitive/ref type)

Nested Classes :-

Non-Static Nested Class :-

1. The inner class(non-static nested) has access to all of the outer class's members, including those marked private , directly(without inst.)

BUT Outer class MUST make an instance of the inner class , to access it's members.

2. To instantiate an inner class, you must have a reference to an instance of the outer class.

syntax :

Instantiating a non-static nested class requires using both the outer inst and nested class names as follows:

BigOuter.Nested n = new BigOuter().new Nested();

3. Such Inner classes can't have static members.(Java SE 8 --allows static final data members)

About method-local inner classes

1.A method-local inner class is defined within a method of the enclosing class.

2.For the inner class to be used, you must instantiate it, and that instantiation must happen within the same method, but after the class definition code.

3. A method-local inner class cannot use variables declared within the method

(including parameters) unless those variables are marked final or effectively final.

static nested classes :-

1.A static nested class is not an inner class, it's a top-level nested class.

2. You don't need an instance of the outer class to instantiate a static nested class.

4.It cannot access non-static members of the outer class directly BUT can access static members of the outer class.

5. It can contain both static & non-static members.

6. JVM will not load any class's static init block -- until u actually refer to something from that class.

(Lazy loading) This is true for static nested classes too.

7. Instantiating a static nested class requires using Outer class name and instance of nested class names as follows:

Outer.Nested n = new Outer.new Nested();

Collections :-

List<E> features

1. List represents ordered collection --- order is significant(It remembers the order of insertion)

2. Allows null references

3. Allows duplicates

4. Supports index based operation

java.util.ArrayList<E> -- E -- type of ref.

1. ArrayList<E> -- constructor

API

ArrayList() -- default constructor. -- creates EMPTY array list object , with init capacity=10,size=0;

eg ---ArrayList<Integer> l1=new ArrayList<>();

1.5 1. ArrayList<E> -- constructor

API

public ArrayList(int capacity) -- -- creates EMPTY array list object , with init capacity=capacity,size=0;

eg ---ArrayList<Integer> l1=new ArrayList<>(100);

l1.add(1);.....l1.add(100);

l1.add(101);//capa=150 --as per JVM spec.

2. add methods

boolean add(E e) --- append

void add(int index,E e) --- insert

void addAll(Collection<E> e) -- bulk append operation

eg : l1 --- AL<Emp>

l1.addAll(.....);

AL,LL,Vector --- legal

HS,TS,LHS --legal

HM,LHM,TM --illegal --javac error

2.5 Retrieve elem from list

E get(int index)

index ranges from ---0 ---(size-1)

java.lang.IndexOutOfBoundsException

3. display list contents using --- toString

4. Attaching Iterator

Collection<E> interface method -- implemented by ArrayList

Iterator<E> iterator()

---places iterator BEFORE 1st element ref.

Iterator<E> i/f methods

boolean hasNext() -- rets true if there exists next element, false otherwise.

E next() --- returns the element next to iterator position

void remove() -- removes last returned element from iterator.

Limitation --- type forward only & can start from 1st elem only.

Regarding exceptions with Iterator/List

1. java.util.NoSuchElementException -- thrown whenever trying to access the elem beyond the size of list via Iterator/ListIterator

2. java.lang.IllegalStateException --- thrown whenever trying to remove elem before calling next().

3. java.util.ConcurrentModificationException-- thrown typically --- when trying to use same iterator/list iterator --after structrually modifying list(eg add/remove methods of list)

Above describes fail-fast behaviour of the Iterator/ListIterator

Exception while accessing element by index.

4. java.lang.IndexOutOfBoundsException -- thrown typically -- while trying to access elem beyond size(0---size-1) --via get

6. Attaching for-each = attaching implicit iterator.

Attaching ListIterator ---scrollable iterator or to begin iteration from a specific element -- List ONLY or list specific iterator.

ListIterator<E> listItearator() --places LI before 1st element

ListIterator<E> listItearator(int index) --places LI before specified index.

4. search for a particular element in list

boolean contains(Object o)

5. searching for 1st occurrence

use -- indexOf

int indexOf(Object o)

rets index of 1st occurrence of specified elem. Rets -1 if elem not found.

searching for last occurrence

use -- lastIndexOf

int lastIndexOf(Object o)

rets index of last occurrence of specified elem. Rets -1 if elem not found.

5.5

E set(int index,E e)

Replaces old elem at spepcified index by new elem.

Returns old elem

6. remove methods

E remove(int index) ---removes elem at specified index & returns removed elem.

boolean remove(Object o) --- removes element specified by argument , rets true -- if elem is removed or false if elem cant be removed.

Objectives in Integer list

0. Create ArrayList of integers & populate it.

1. check if element exists in the list.

2. disp index of 1st occurance of the elem

3. double values in the list --if elem val > 20

4. remove elem at the specified index

5. remove by elem. -- rets true /false.

NOTE :

For searching or removing based upon primary key , in List Implementation classes --- All search/remove methods (contains,indexOf,lastIndexOf,remove(Object o)) -- based upon equals method(of type of List eg --Account/Customer/Emp....)

For correct working

1. Identify prim key & create overloaded constr using PK.

eg : public Emp(int id) { this.id=id;}

2. Using PK , override equals for content equality.

Usage eg : ArrayList<Emp> emps=new AL<>();

emps.add(e1);//id=10

emps.add(e2);//id=20

emps.add(e3);//id=30

int index=emps.indexOf(20);//int ---> Integer --> Object (Integer)

Integer i=new Integer(20); // javac

//internally invokes equals : whose equals --Object | Integer | Emp | NOA

invokes equals on Integer class

i.equals(e1) ---since it's incompatible types --rets false

i.equals(e2) ---since it's incompatible types --rets false

i.equals(e3) ---since it's incompatible types --rets false

Thus : indexOf rets -1

sop(index);// -1

Solution :

Emp e=new Emp(20);

int index=emps.indexOf(e);

//internally invokes equals : whose equals --Object | Integer | Emp | NOA

invokes equals on Emp class

e.equals(e1) ---it's compatible types BUT ids are different --rets false

e.equals(e2) --- it's compatible types --ids are SAME --rets true

Thus : indexOf rets 1

sop(index);// 1

Sorting --- For sorting elements as per Natural(implicit i.e criteria defined within UDT class definition) ordering or Custom(explicit i.e criteria defined outside UDT , in a separate class or anonymus iner class)

Steps for Natural ordering

Natural Ordering is specified in generic i/f

java.lang.Comparable<T>

T -- UDT , class type of the object to be compared.

eg -- Emp,Account , Customer

I/f method

int compareTo(T o)

Steps

1. UDT must implement Comparable<T>

eg : public class Account implements Comparable<Account>

2. Must override method

public int compareTo(T o)

{

use sorting criteria to ret

< 0 if this < o,

=0 if this = o

> 0 if this > o

}

3.Use java.util.Collections class API

Method

public static void sort(List<T> l1)

l1 -- List of type T.

sort method internally invokes compareTo method(prog supplied) of UDT & using advanced sorting algorithm , sort the list elems.

Limitation of natural Ordering

Can supply only 1 criteria at given time & that too is embedded within UDT class definition

Instead keep sorting criteria external --using Custom ordering

Typically use -- Natural ordering in consistence with equals method.

Alternative is Custom Ordering(external ordering)

I/f used is --- java.util.Comparator<T>

T -- type of object to be compared.

Steps

1. Create a separate class (eg. AccountBalComparator) which implements Comparator<T>

eg

public class AccountBalComparator implements Comparator<Account>

2.Implement(override) i/f method -- to supply comparison criteria.

int compare(T o1,T o2)

Must return

< 0 if o1<o2

=0 if o1=o2

> 0 if o1 > o2

3. Invoke Collections class method for actual sorting.

public static void sort(List<T> l1,Comparator<T> c)

parameters

l1 --- List to be sorted(since List is i/f --- any of its implementation class inst. can be passed)

c - instance of the class which has implemented compare method.(or implemented Comparator)

Internally sort method invokes compare method from the supplied Comparator class instance.

More on generic syntax

Constructor of ArrayList(Collection<? extends E> c)

? -- wild card in generic syntax (denotes any unknown type)

--Added for supporting inheritance in generics.

extends -- keyword in generics, to specify upper bound

? extends E -- E or sub type

Complete meaning --- Can create new populated ArrayList of type E , from ANY Collection(ArrayList,LinkedList,Vector,HashSet,LinkedhashSet,TreeSet) of type E or its sub type.

```
ArrayList<Emp> l1=new ArrayList<>();
l1.add(new Emp(1,"aa",1000);
l1.add(new Emp(2,"ab",2000);
ArrayList<Emp> l2=new ArrayList<>(l1);
sop(l2.size());
----------
 HashSet<Emp> hs=new HashSet<>();
hs.add(new Emp(1,"aa",1000);
hs.add(new Emp(2,"ab",2000);
l2=new ArrayList<>(hs);
----
Vector<Mgr> v1=new Vector<>();
v1.add(new Mgr(....));
v1.add(new Mgr(....));
ArrayList<Emp> l2=new ArrayList<Mgr>(v1);
AL<Mgr> mgrs=new AL<>(hs);
```

Map API

HashMap<K,V> --

1. un-sorted(not sorted as per Natural ordering or custom ordering based criteria) & un-ordered(doesn't remember order of insertion) map implementation class.

2. No duplicate keys.

3. Guarantees constant time performance --- via 2 attributes --initial capacity & load factor.

4. Allows null key reference(once).

5. Inherently thrd unsafe.

HashMap constrs

1. HashMap<K,V>() --- creates empty map , init capa = 16 & load factor .75

2. HashMap<K,V>(int capa) --- creates empty map , init capa specified & load factor .75

3.HashMap<K,V>(int capa,float loadFactor) --- creates empty map , init capa & load factor specified

4. HashMap constructor for creating populated map

HashMap(Map <? extends K,? extends V> m)

? -- wild card in generics, represents unknown type

extends -- represents upper bound

? extends K --- K or its sub type

? extends V -- V or its sub type.

Complete meaning -- Creates populated HM<K,V> from ANY map(ie. any Map imple class)

of type K or its sub type & V or its sub type.

eg : Suppose Emp <---- Mgr

```
HM<Integer,Emp> hm=new HM<>();
hm.put(1,e1);
hm.put(2,m1);
HM<Integer,Emp> hm2=new HM<>(hm);
sop(hm2);
LHM<Integer,Emp> lhm=new LHM<>(hm);//legal
HM<Integer,Mgr> hm3=new HM<Integer,Emp>(hm);//javac error
```

TM<Integer,Mgr> hm4=new TM<>();

hm4.put.....

HM<Integer,Emp> hm5=new HM<>(hm4);

HM(Map<? extends K,? extends V>map)

put,get,size,isEmpty,containsKey,containValue,remove

Objective : Create AccountMap

Identify key & value type

create empty unsorted map(HashMap<K,V>) & populate the same

Disp all entries of HM ---can use only toString

1.get acct summary --- i/p --id o/p --- err / dtls

2.Withdraw --- specify Account id & Amt ---- o/p : update acct dtls if acct exists o.w err msg or exc

3.funds transfer ---

i/p sid,dest id, amt

4.remove --- account

i/p id

5.Apply interest on on saving type of a/cs.

or

display all accts created after date.

Attach for-each to map & observe.

Sort the map as per : asc order of accts Ids.

Sort the map as per : desc order of accts Ids

Sort the accts as per : balance

If map sorting involves key based sorting criteria --- can be sorted by converting into TreeMap

Constructors of TreeMap

1. TreeMap() -- Creates empty map , based upon natural ordering of keys

2. TreeMap(Map<? extends K,? extends V> map)

Creates populated map , based upon natural ordering of keys

3. TreeMap(Comparator<? super K> c)

Regarding generic syntax & its usage in TreeMap constructor.

<? super K>

? --- wild card --- any unknown type

super --- gives lower bound

K --- key type

? super K --- Any type which is either K or its super type.

TreeMap(Comparator<? super K> c) --- creates new empty TreeMap, which will sort its element as per custom ordering(i.e will invoke compare(...) of Key type)

disp acct ids of all accounts ---impossible directly....(will be done by Collection view of map @ the end)

Apply interest to all saving type a/cs

difficult directly ---so get a collection view of the map & sort the same.

Limitations on Maps

1. Maps can be sorted as per key's criteria alone.

2. can't attach iterators/for-each(till JDK 1.7)/for

3 Maps can be searched as per key's criteria alone.

To fix --- get a collection view of a map (i.e convert map to collection)

API of Map i/f

1. To get set of keys asso. with a Map

    Set<K> keySet();

2. To get collection of values from a map

    Collection<V> values();

3. To get set of Entries(key & val pair) ---

    entrySet

    Set<Map.Entry> entrySet()

    Methods of Map.Entry

    K getKey()

    V getValue()

7. conversion from collection to array

Object[] toArray() -- non generic version --- rets array of objects

T[] toArray(T[] type)

T = type of collection .

Rets array of actual type.

8. sorting lists --- Natural ordering criteria

Using java.util.Collections --- collection utility class.

static void sort(List<E> l1) ---sorts specified list as per natural sorting criteria.

Difference between ArrayList and LinkedList in Java

Underlying data structure

ArrayList and LinkedList both implements List interface and their methods and results are almost identical.

But ArrayList is a resizable array implementation , where as LinkedList is doubly-linked list implementation of List i/f. LinkedList also implements Deque i/f.

ArrayList Vs LinkedList

1) Search: ArrayList search operation is pretty fast compared to the LinkedList search operation.

get(int index) in ArrayList gives the performance of O(1) while LinkedList performance is O(n).

Reason: ArrayList maintains index based system for its elements as it uses array data structure implicitly

which makes it faster for searching an element in the list. On the other side LinkedList implements doubly linked list which requires the traversal through all the elements for searching an element.

2) Deletion: LinkedList remove operation gives O(1) performance while ArrayList gives variable performance: O(n) in worst case (while removing first element) and O(1) in best case (While removing last element).

Conclusion: LinkedList element **deletion** is faster compared to ArrayList.

Reason: LinkedList's each element maintains two pointers (addresses) which points to the both neighbour elements in the list.

Hence removal only requires change in the pointer location in the two neighbour nodes (elements) of the node which is going to be removed.

While In ArrayList all the elements need to be shifted to fill out the space created by removed element.

3) Inserts Performance: LinkedList add method gives O(1) performance while ArrayList gives O(n) in worst case. Reason is same as explained for remove.

4) Memory Overhead: ArrayList maintains indexes and element data while LinkedList maintains element data and two pointers for neighbour nodes hence the memory consumption is high in LinkedList comparatively.

There are few similarities between these classes which are as follows:

Both ArrayList and LinkedList are implementation of List interface.

They both maintain the elements insertion order which means while displaying ArrayList and LinkedList elements the result set would be having the same order

in which the elements got inserted into the List.

Both these classes are non-synchronized and can be made synchronized explicitly by using Collections.synchronizedList method.

The iterator and listIterator returned by these classes are fail-fast (if list is structurally modified at any time after the iterator is created, in any way except through the iterator's own remove or add methods, the iterator will throw a ConcurrentModificationException).

When to use LinkedList and when to use ArrayList?

1) As explained above the insert and remove operations give good performance (O(1)) in LinkedList compared to ArrayList(O(n)).

Hence if there is a requirement of frequent addition and deletion in application then LinkedList is a best choice.

2) Search (get(index) method) operations are fast in Arraylist (O(1)) but not in LinkedList (O(n)) so If there are less add and remove operations and more search operations requirement, ArrayList would be your best bet.

Hashing based Data structures....(eg : HashSet,HashTable,HashMap)

Steps for Creating HashSet

1. Type class in HashSet must override : hashCode & equals method both in consistent manner.

Object class API

public int hashCode() --- rets int : which represents internal addr where obj is sitting on the heap(typically -- specific to JVM internals)

public boolean equals(Object ref) -- Object class rets true : if 2 refs are referring to the same copy.

2. Rule to observe while overriding these methods

If 2 refs are equal via equals method then their hashCode values must be same.

eg : If ref1.equals(ref2) ---> true then ref1.hashCode() = ref2.hashCode()

Converse may not be mandatory.(i.e if ref1.equals(ref2) = false then its not mandatory that ref1.hashCode() != ref2.hashCode() : but recommended for better working of hashing based D.S)

String class , Wrapper classes , Date related classes have already followed this contract.

Questions :

1. How does hashing based data structure ensure constant time performance?

If no of elements(size) > capacity * load factor --- re-hashing takes place ---

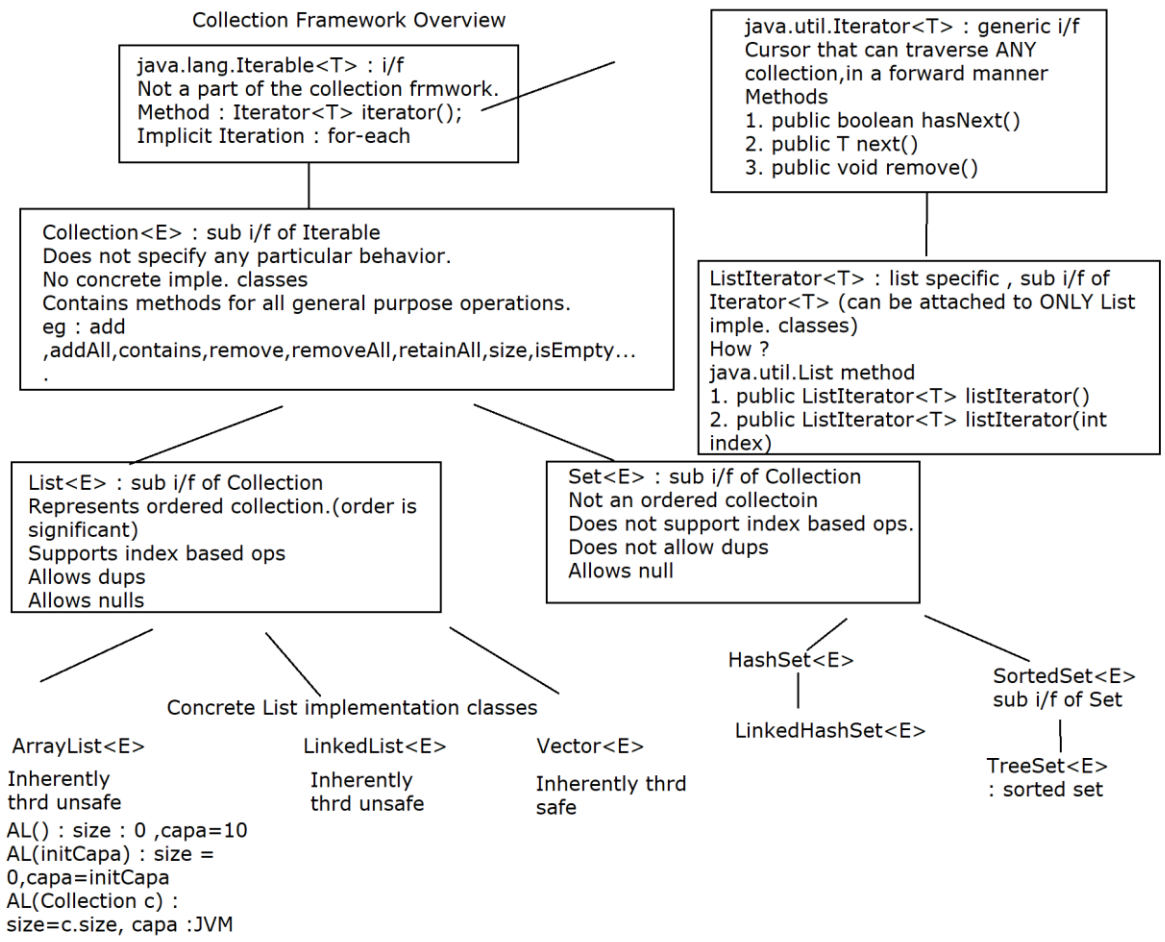
New data structure is created --(hashtable) -- with approx double the original capacity --- HS takes all earlier entries from orig set & places them in newly created D.S -- using hashCode & equals. -- ensures lesser hash collisions.

2. Why there is a guarantee that a duplicate ref can't exist in yet another bucket ?

Answer is thanks to the contract between overriding of hashCode & equals methods

If two elements are the same (via equals() returns true when you compare them), their hashCode() method must return the same number. If element type violate this, then elements that are equal might be stored in different buckets, and the hashset would not be able to find elements (because it's going to look in the same bucket).

If two elements are different(i.e equals method rets false) , then it doesn't matter if their hash codes are the same or not. They will be stored in the same bucket if their hash codes are the same, and in this case, the hashset will use equals() to tell them apart.


Collection Framework Overview
java.lang.Iterable<T> : i/f
Not a part of the collection frmwork.
Method : Iterator<T> iterator();
Implicit Iteration : for-each
java.util.Iterator<T> : generic i/f
Cursor that can traverse ANY collection,in a forward manner
Methods
1. public boolean hasNext()
2. public T next()
3. public void remove()
Collection<E> : sub i/f of Iterable
Does not specify any particular behavior.
No concrete imple. classes
Contains methods for all general purpose operations.
eg : add ,addAll,contains,remove,removeAll,retainAll,size,isEmpty... .
ListIterator<T> : list specific , sub i/f of Iterator<T> (can be attached to ONLY List imple. classes)
How ?
java.util.List method
1. public ListIterator<T> listIterator()
2. public ListIterator<T> listIterator(int index)
List<E> : sub i/f of Collection
Represents ordered collection.(order is significant)
Supports index based ops
Allows dups
Allows nulls
Set<E> : sub i/f of Collection
Not an ordered collectoin
Does not support index based ops.
Does not allow dups
Allows null
HashSet<E>
LinkedHashSet<E>
SortedSet<E>
sub i/f of Set
TreeSet<E>
: sorted set
Concrete List implementation classes
ArrayList<E>
Inherently thrd unsafe
AL() : size : 0 ,capa=10
AL(initCapa) : size = 0,capa=initCapa
AL(Collection c) : size=c.size, capa :JVM
LinkedList<E>
Inherently thrd unsafe
Vector<E>
Inherently thrd safe

	ArrayList	LinkedList
Structure	ArrayList is an index based data structure where each element is associated with an index.	Elements in the LinkedList are called as nodes, where each node consists of three things – Reference to previous element, Actual value of the element and Reference to next element.
Insertion And Removal	Insertions and Removals in the middle of the ArrayList are very slow. Because after each insertion and removal, elements need to be shifted.	Insertions and Removals from any position in the LinkedList are faster than the ArrayList. Because there is no need to shift the elements after every insertion and removal. Only references of previous and next elements are to be changed.
Retrieval (Searching or getting an element)	Insertion and removal operations in ArrayList are of order O(n). Retrieval of elements in the ArrayList is faster than the LinkedList . Because all elements in ArrayList are index based.	Insertion and removal in LinkedList are of order O(1). Retrieval of elements in LinkedList is very slow compared to ArrayList. Because to retrieve an element, you have to traverse from beginning or end (Whichever is closer to that element) to reach that element.
Random Access	Retrieval operation in ArrayList is of order of O(1). ArrayList is of type Random Access. i.e elements can be accessed randomly.	Retrieval operation in LinkedList is of order of O(n). LinkedList is not of type Random Access. i.e elements can not be accessed randomly. you have to traverse from beginning or end to reach a particular element.
Usage	ArrayList can not be used as a Stack or Queue.	LinkedList, once defined, can be used as ArrayList, Stack, Queue, Singly Linked List and Doubly Linked List.
Memory Occupation	ArrayList requires less memory compared to LinkedList. Because ArrayList holds only actual data and it's index.	LinkedList requires more memory compared to ArrayList. Because, each node in LinkedList holds data and reference to next and previous elements.
When To Use	If your application does more retrieval than the insertions and deletions, then use ArrayList.	If your application does more insertions and deletions than the retrieval, then use LinkedList.

Map Overview (refer to the diagram "regarding Maps")

Map Implementation class

1. HashMap<K,V>

1.1 Constructors

1. HashMap()

2. HashMap(int initCapa)

3. HashMap(int initCapa,float loadFactor)

4. public HashMap(Map<? extends K,? extends V> m)

Meaning : Creates populated HashMap of type K,V from any Map (AL/LL/Vector : javac err

HS/LHS/TS : javac err

HM/LHM/TM : no error) having generic type of K or its sub type & V or its sub type

Steps n API

0. Create new empy map to store account details

HashMap<Integer,BankAccount> hm=new HM<>();//size=0,capa=16,L.F=0.75

0.5 Create new account

Map i/f API

1. public V put(K key,V value)

Meaning : It will insert the new entry into map.If key already exists : it will replace old value by new value.

Rets : null in case of new entry or old value ref. in case of existing entry.

eg : sop(map.put(k1,v1));//null

sop(map.put(k2,v2));//null

sop(map.put(k3,v3));//null

sop(map.put(k1,v4));//v1

//which entries : k1:v4,k2:v2 ,k3:v3

2. public V putIfAbsent(K key,V value)

eg : sop(map.putIfAbsent(k1,v1));//null

sop(map.putIfAbsent(k2,v2));//null

sop(map.putIfAbsent(k3,v3));//null

sop(map.putIfAbsent(k1,v4));//v1

//which values(entries) : k1:v1 k2:v2 k3:v3

3. public void putAll(Map<? extends K,? extends V> m)

eg : map1.putAll(map2);

Meaning : It will copy all entries from map2 ----> map1

(put : replace)

4. public V get(Object key)

Rets value type of ref if key is found else rets null.

eg : map.get(k2) : v2

map.get(k10) : null

5. boolean containsKey(Object key)

Returns true if this map contains a mapping for the specified key , otherwise false;

eg : map.containsKey(k1) ---true

6. boolean containsValue(Object value)

Returns true if this map maps one or more keys to the specified value.

eg : map : k1:v1 k2:v2 k3:v3

map.containsValue(v3) ---- true

containsKey : O(1)

containsValue : O(n)

7. public V remove(Object K)

Tries to remove the entry(=mapping=key n value pair) if key is found --rets existing value ref.

Rets null if key is not found.;

eg : map : k1:v1 k2:v2 k3:v3

sop(map.remove(k2));//v2

sop(map);//k1:v1 k3:v3

sop(map.remove(k20));//null

sop(map);//k1:v1 k3:v3

How to overcome limitations of Map (can't iterate over map , can't search/sort/remove by any value based criteria)

Solution : Convert the map into its Collection view

1. How to extract key type refs from a Map ?

public Set<K> keySet()

eg : HM<Integer,BankAccount> hm=new HM<>();

add some a/cs

Set<Integer> keys =hm.keySet();//O(n)

2. How to get value type of references from a Map ?

public Collection<V> values();

eg : HM<Integer,BankAccount> hm=new HM<>();

added some a/cs ....

Collection<BankAccount> accts =hm.values();//O(n)

3. How to get key-value pair(entry) of references from a Map ?

Map : i/f

Nested i/f : Map.Entry<K,V> : Entry in a Map

public Set<Map.Entry<K,V>> entrySet();

4. Method of Map.Entry i/f

public K getKey()

public V getValue();

How HashMap internally works in Java

Hash Map is one of the most used collection. It doesn't extend from Collection i/f.

BUT collection view of a map can be obtained using keySet,values or entrySet()

Internal Implementation

HashMap works on the principal of hashing.

What is hashing ?

Hashing means using some function or algorithm to map object data to some representative integer value.

Map.Entry interface ---static nested interface of Map i/f

This interface represents a map entry (key-value pair).

HashMap in Java stores both key and value object ref , in bucket, as an object of Entry class which implements this nested interface Map.Entry.

hashCode() -HashMap provides put(key, value) for storing and get(key) method for retrieving Values from HashMap.

When put() method is used to store (Key, Value) pair, HashMap implementation calls hashcode on Key object to calculate a hash that is used to

find a bucket where Entry object will be stored.

When get() method is used to retrieve value, again key object is used to calculate a hash which is used then to find a bucket where that particular key is stored.

equals() - equals() method is used to compare objects for equality. In case of HashMap key object is used for comparison, also using equals()

method Map knows how to handle hashing collision (hashing collision means more than one key having the same hash value, thus assigned to the same bucket.

In that case objects are stored in a linked list (growable --singly linked)

Bucket term used here is actually an index of array, that array is called table in HashMap implementation. Thus table[0] is referred as bucket0, table[1] as bucket1 and so on.

HashMap uses equals() method to see if the key is equal to any of the already inserted keys (Recall that there may be more than one entry in the same bucket).

Note that, with in a bucket key-value pair entries (Entry objects) are stored in a linked-list . In case hash is same, but equals() returns false (which essentially means more than one key having the same hash or hash collision) Entry objects are stored, with in the same bucket, in a linked-list.

In short , there are three scenarios in case of put() -

Using hashCode() method, hash value will be calculated. Using that hash it will be ascertained, in which bucket particular entry will be stored.

equals() method is used to find if such a key already exists in that bucket, if no then a new node is created with the map entry and stored within the same bucket.

A linked-list is used to store those nodes.

If equals() method returns true, which means that the key already exists in the bucket. In that case, the new value will overwrite the old value for the matched key.

How get() methods works internally

As we already know how Entry objects are stored in a bucket and what happens in the case of Hash Collision it is easy to understand what happens when key object is passed in the get method of the HashMap to retrieve a value.

Using the key again hash value will be calculated to determine the bucket where that Entry object is stored, in case there are more than one Entry object with in the same bucket stored as a linked-list equals() method will be used to find out the correct key. As soon as the matching key is found get() method will return the value object stored in the Entry object.

In case of null Key

Since HashMap also allows null, though there can only be one null key in HashMap. While storing the Entry object HashMap implementation checks if the key is null, in case key is null, it always map to bucket 0 as hash is not calculated for null keys.

HashMap changes in Java 8

Though HashMap implementation provides constant time performance O(1) for get() and put() method but that is in the ideal case when the Hash function distributes the objects evenly among the buckets.

But the performance may worsen in the case hashCode() used is not proper and there are lots of hash collisions. In case of hash collision entry objects are stored

as a node in a linked-list and equals() method is used to compare keys. That comparison to find the correct key with in a linked-list is a linear operation so in a

worst case scenario the complexity becomes O(n).

To address this issue in Java 8 hash elements use balanced trees instead of linked lists after a certain threshold is reached. Which means HashMap starts with storing Entry objects in linked list but after the number of items in a bucket becomes larger than a certain threshold, the bucket will change from using a linked list to a balanced tree, this will improve the worst case performance from O(n) to O(log n).

Lambda expressions

It's derived from lambda caculus.

It was a big change in calculus world , which gave tremendous ease in maths

Now the same concept is being used in programming languages.

1st language to use lambda

LISP

c , c++ , c# , scala , javascript , python

Finally in java also(Java SE 8 onwards)

Why lamda expressions?

Java is an object-oriented language. With the exception of primitive data types, everything in Java is an object. Even an array is an Object. Every class creates instances that are objects. There is no way of defining just a function / method which stays in Java all by itself. There is no way of passing a method as argument or returning a method body for that instance.

i.e passing /returning the behaviour was not possible till java 8.

It was slightly possible using anonymous inner classes --but that still required us to write a class !

What is lambda expression ?

Concise anonymous function which can be passed around

It has

1. list of params

2. body

3. return type.(optional)

Lambda expressions in Java is usually written using syntax (argument) -> (body). For example:

(type1 arg1, type2 arg2...) -> { body }

Following are some examples of Lambda expressions.

1.(int a, int b) -> { return a + b; }

OR can be reduced to

(int a, int b) -> a + b

OR further can be reduced to

(a,b) -> a+b

2. () -> System.out.println("Hello World");

3. s -> System.out.println(s)

4. () -> 42

5. () -> 3.1415

Above is just a syntax of lambda . But how to use them ?

Answer is ---You can use lambda expressions as targets of functional i/f reference.

Why lambdas --

Easy way of passing a behaviour.

Till Java SE 7 , there was no way of passing a method as argument or returning a method body for that instance.

To enable this style of functional programming , lambdas are introduced.

How to pass a behaviour ? : Using lambda expression

What is a functional programming paradigm ?

A language where below features are supported.

Functions are treated as a first class citizens.

Meaning : You can

1.1 define anonymous functions

1.2 assign a function to a variable (function literal)

1.3 pass function as a parameter

1.4 return function as a return value

Why FP ?

1. To write more readable , maintainable , clean & concise code.

2. To use APIs easily n effectively.

3. To enable parallel processing

OOP uses imperative style of programming (where you will have to specify what's to be done & how --both) .

FP uses declarative style of programming (where you will just have to specify what's to be done

eg :

Find out the average salary of emp from the specified dept.

How will you do it in imperative manner?

eg : List<Emp> l1=new AL<>();

l1.add(..);.....

String dept=sc.next();

double total=0;

int num=0;

for(Emp e : l1)

```
 if(e.getDept().equals(dept)) {
  total += e.getSal();
  num++;
 }
sop(total/num);
```

Vs

How to do it in declarative style ?

eg : List<Emp> l1=new AL<>();

l1.add(..);.....

```
l1.stream().filter(e->e.getDept().equals(dept)).mapToDouble(Emp::getSal).average().getAsDouble()
```

Immediate Objectives

1. Create your own functional interface n use it in lambda expression

eg : Perform ANY arithmetic operation on 2 double values & return the result

eg --add/multiply/subtract/divide....

Explore Existing higher order functions

2. Iterable : forEach

3. Collection : removeIf(Predicate<? super T> filter)

func method : public boolean test(T o)

Objective : remove details of accts having balance < specified bal

eg : list.removeIf(new Predicate()

```
{
  public boolean test(BankAccount a)
  {
```

```
    return a.getBalance() < specifiedBalance;
  }
}
);
```

OR

```
list.removeIf(a -> a.getBalance() < specifiedBalance );
```

4. Map : forEach

5. Sorting : custom ordering

Objective : sort list of account as per creation date n balance

```
Collections.sort(list,(a1,a2) -> {.....});
```

Objective --

1. Perform ANY operation on 2 double values & return the result

eg --add/multiply/subtract/divide....

2. Convert from ANY src type to ANY dest type

eg : String ---> length

String ----> upper case string

celcius ---> fahrenheit (f=c*1.8+32)

Student ---> GPA

number ---> square root

1. Create generic interface Converter<F,T> to specify single abstract method --convert , from F ---> T

2. Create a Tester class (with main method)

Add a static method to test the converter.

I/P -- 1. conversion source type(From)

2. conversion behaviour

O/P -- conversion result.(To)

```
public static <F,T> testConverter(F from, Converter<F,T> c)
{
  return c.convert(from);
}
```

3. main(..) invokes this static method for testing Converter.

But what will be 2nd argument ?

Exam objective :

Main Differences between Lambda Expression and Anonymous class

1. One key difference between using Anonymous class and Lambda expression is the use of "this" keyword.

For anonymous class ‘this’ keyword resolves to anonymous class, whereas for lambda expression ‘this’ keyword resolves to enclosing class where lambda is written.

2. Another difference between lambda expression and anonymous class is in the way these two are compiled.

Java compiler compiles lambda expressions and convert them into private method of the class.

Functional Programming

What is functional programming ?

Functional programming is the way of writing s/w applications that uses only pure functions & immutable values.

Main concepts of FP are

1. Pure functions & side effects
2. Referential transparency
3. First class functions & higher order funcs.
4. Anonymous functions
5. Immutability
6. Recursion & tail recursion
7. Statements
8. Strict & Lazy evaluations
9. Pattern Matching
10. Closures

Why Functional Programming paradigm

- Elegance and simplicity
- Easier decomposition of problems
- Code more closely tied to the problem domain

Through these , one can achieve :

- Straightforward unit testing
- Easier debugging
- Simple concurrency

Functional programming In java

Functional Programming (FP) is one of the type of programming pattern that helps the process of building application by using of higher order functions, avoiding shared state, mutable data

Functional programming vs OOP

Declarative vs Imperative :

Functional programming is a declarative pattern, meaning that the program logic is expressed without explicitly describing the flow control.Imperative programs spend lines of code describing the specific steps used to achieve the desired results — the flow control

Declarative programs remove the flow control process, and instead spend lines of code describing the data flow.

In Functional programming

Functions are treated as a first class citizens.

Meaning : You can

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1.3 pass function as a parameter

1.4 return function as a return value

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OOP uses imperative style of programming (where you will have to specify what's to be done & how --both) .

FP uses declarative style of programming (where you will just have to specify what's to be done

2. Functional interfaces

An interface which has exactly single abstract method(SAM) is called functional interface.

eg Runnable,Comparable,Comparator,Iterable,Consumer,Predicate,Supplier,Function...

Java SE 8 has introduced a new package for functional i/f

java.util.function

New annotation introduced -- @FunctionalInterface

(since Java SE 8)

Functional i/f references can be substituted by lambda expressions, method references, or constructor references.

Solve -- Is following valid functional interface ?

public interface A { double calc(int a,int b);} :

public interface B extends A {} :

public interface C extends A { void show();} :

public interface D {} -- Marker / empty / tag i/f :

public interface E extends A {default void show(){}} --

13. Addition of "default" keyword to add default method implementation , in interfaces.

Java 8 enables us to add non-abstract method implementations to interfaces by using the default keyword. This feature is also known as Extension Methods.

Why default keyword ?

1. To maintain backward compatibility with earlier Java SE versions

2. To avoid implementing new functionality in all implementation classes.

eg : Java added in Iterable<T> interface

default void forEach(Consumer<? super T> action) -- as a default method implementation

eg :

```
interface Formula {
   double calculate(double a);//javac adds implicit keywords : public n abstract
           //javac adds implicit keyword public
   default double sqrt(double a,double b) {
      return Math.sqrt(a+b);
   }
}
```

Q : If you write an implementation class MyFormula

```
public class MyFormula imple Formula
{
 .....
}
```

Which methods have to be implemented to avoid javac err?

1. calculate
2. sqrt
3. both
4. neither

Q : Can MyFormula class override the def. of sqrt ?

1 Display all elements of ArrayList

forEach

2. Create AL of integers

remove all odd numbers.

3. Create AL of emps

Remove underperforming employees (performance index < 7)

Dsiplay the list

4. Enter Java 8 Streams

1.Create int[] ---> IntStream & display its contents.

2. Create AL<Integer> , populate it.

Convert it to seq stream & display elems

Convert it to parallel stream & display elems

3. Create stream of ints between 1-100 & display all even elements.

(Hint : IntStream methods --range,filter,forEach)

4. Display all emp names from a particular dept , joined after specific date

(stream,filter,forEach)

5. Display sum of all even nos between 1-100 .

(stream , filter ,sum)

6. Display sum of salaries of all emps from a specific dept

7. Create a supplier of random numbers

eg :

```
Supplier<Double> randomValue = () -> Math.random();

// Print the random value using get()
System.out.println(randomValue.get());
```

8. Create a supplier of LocalDate & Time

eg :

```
Supplier<LocalDateTime> s = () -> LocalDateTime.now();
LocalDateTime time = s.get();
```

```
System.out.println(time);


Supplier<String> s1 = () -> dtf.format(LocalDateTime.now());
String time2 = s1.get();


System.out.println(time2);
```

---

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eg :

```
interface Formula {
   double calculate(double a);//public n abstract
         //public
   default double sqrt(double a,double b) {
      return Math.sqrt(a+b);
   }
}
```

In case of ambiguity or to refer to def imple. from i/f -- use InterfaceName.super.methodName(...) syntax

2 Can add static methods in java interfaces --- It's a better alternative to writing static library methods in helper class(eg --Arrays or Collections)

Such static methods can't be overridden in implementation class.

BUT can be re-declared.

They have to be invoked using interface name , even in implementation or non implementation classes.(otherwise compiler error)

3. Functional interfaces ---An interface which has exactly single abstract method(SAM) is called functional interface. (were present earlier)

eg Runnable,Comparable,Comparator,Iterable,Consumer,Predicate...

New annotation introduced -- @FunctionalInterface

(since Java SE 8 : a new package --java.util.function --functional interfaces)

Functional i/f references can be substituted by lambda expressions, method references, or constructor references.

Solve -- Is following valid functional interface ?

public interface A { double calc(int a,int b);} : YES (contains SAM)

public interface B extends A {} : YES (inherits SAM)

public interface C extends A { void show();} : NO (2 abstract methods)

public interface D {} --NO (marker / tag i/f)

public interface E extends A {default void show(){}

static boolean test(int data) {...}

} --YES (SAM)

4. Refer to readme of lambda expressions.

5. Date/Time APIs

Java 8 Date/Time related APIs

Java 8 New Features

java.time : new package is introduced

LocalDate : Date (immutable)(yr-mon-day) : inherently thrd safe.

API

1. public static LocalDate now()

Obtains the current date from the system clock in the default time-zone.

eg :

LocalTime : Time (immutable)(hr-min-sec) : inherently thrd safe.

LocalDateTime : Date n Time : inherently thrd safe.

eg : sop("curnt date "+now());

2. public static LocalDate of(int year,int month,int dayOfMonth)

Obtains an instance of LocalDate from a year, month and day.

eg : ?????

3. public static LocalDate parse(CharSequence text)

Obtains an instance of LocalDate from a text string such as 2007-12-03.

eg : LocalDate dt=parse(sc.next());//0 based dates

4. Methods :

isBefore,isAfter,isEqual

5. Can you change default DateTime format ? : YES

How : use java.time.format.DateTimeFormatter

What is a Stream?

A sequence of elements from a source that supports data processing operations.

• Sequence of elements - Like a collection, a stream provides an interface to a sequenced set of values of a specific type.

• Source - Streams refer to collections, arrays, or I/O resources.

• Data processing operations - Supports common operations from functional programming languages.

• e.g. filter, map, reduce, find, match, sort etc

They have nothing to do with java.io -- InputStream or outputstream

The Streams also support Pipelining and Internal Iterations. The Java 8 Streams are designed in such a way that most of its stream operations returns Streams only. This help us creating chain of various stream operations. This is called as pipelining. The pipelined operations looks similar to a sql query.(or Hibernate Query API)

Concurrency is IMPORTANT. But it comes with a learning curve.

So , Java 8 goes one more step ahead and has developed a Streams API which allows us to use multi cores easily.

Parallel processing = divide a larger task into smaller sub tasks (forking), then processing the sub tasks in parallel and then combining the results together to get the final output (joining).

Java 8 Streams API provides a similar mechanism to work with Java Collections.

The Java 8 Streams concept is based on converting Collections to a Stream (or arrays to a stream) , processing the elements in parallel and then gathering the resulting elements into a Collection.

Most stream operations accept some kind of lambda expression parameter, a functional interface specifying the exact behaviour of the operation. Most of those operations must be both non-interfering and stateless. What does that mean?

A function is non-interfering when it does not modify the underlying data source of the stream, e.g.

```
List<String> myList =Arrays.asList("a1", "a2", "b1", "c2", "c1");

myList.stream().filter(s -> s.startsWith("c")).map(String::toUpperCase) .sorted()

  .forEach(System.out::println);
```

In the above example no lambda expression does modify myList by adding or removing elements from the collection.

A function is stateless when the execution of the operation is deterministic,

e.g. in the above example no lambda expression depends on any mutable variables or states from the outer scope which might change during execution.

API

The starting point is java.util.stream.Stream i/f

Different ways of creating streams

1. Can be created of any type of Collection (Collection, List, Set):

java.util.Collection<E> API

1.1 default Stream<E> stream()

1.2 public default Stream<E> parallelStream()

NOTE that Java 8 streams can't be reused, will raise IllegalStateException

2. Stream of Array

How to create stream from an array?

Arrays class API

public static <T> Stream<T> stream(T[] array)

Returns a sequential Stream with the specified array as its source.

3. Can be attached to Map ,via entrySet method.

Refer to CreateStreams.java

4. To create streams out of three primitive types: int, long and double.

As Stream<T> is a generic interface , can't support primitives.

So IntStream, LongStream, DoubleStream are added.

API of java.util.stream.IntStream

4.1 static IntStream of(int... values)

Returns a sequential ordered stream whose elements are the specified values.

4.2 static IntStream **range**(int startInclusive,int endExclusive)

Returns a sequential ordered IntStream from startInclusive (inclusive) to endExclusive (exclusive) by an incremental step of 1.

4.3 static IntStream rangeClosed(int startInclusive,int endInclusive)

Returns a sequential ordered IntStream from startInclusive (inclusive) to endInclusive (inclusive) by an incremental step of 1.

5. To perform a sequence of operations over the elements of the data source and aggregate their results, three parts are needed – the source, intermediate operation(s) and a terminal operation.

6.java.util.stream.Stream<T> i/f API

6.1 Stream<T> skip(long n)

Returns a stream consisting of the remaining elements of this stream after discarding the first n elements of the stream(stateful intermediate operation)

6.2 map

<R> Stream<R> map(Function<? super T,? extends R> mapper)

Returns a stream consisting of the results of applying the given function to the elements of this stream(intermediate stateless operation)

mapToInt

IntStream mapToInt(ToIntFunction<? super T> mapper)

Returns an IntStream consisting of the results of applying the given function to the elements of this stream.

6.3 filter

Stream<T> filter(Predicate<? super T> predicate)

Returns a stream consisting of the elements of this stream that match the given predicate.(intermediate stateless operation)

ref : StreamAPI1.java

---

7. Confirm lazyness of streams.

Intermediate operations are lazy. This means that they will be invoked only if it is necessary for the terminal operation execution.

ref : LazyStreams.java

8. Reduce operation

Readymade methods of IntStream

count(), max(), min(), sum(),average()

9. Customized reduce operation

ref : ReduceStream.java

10 collect

Reduction of a stream can also be executed by another terminal operation – the collect() method.

eg : StreamCollect.java

Good examples in java.util.stream.Collectors -api docs.

Details ---

1. Streams are functional programming design pattern for processing sequence of elements sequentially or in parallel.(a.k.a Monad in functional programming)

2. Stream represents a sequence of elements and supports different kind of operations to perform computations upon those elements

3. Stream operations are either intermediate or terminal. Intermediate operations return a stream so we can chain multiple intermediate operations .

Terminal operations are either void or return a non-stream result.

4. They can't be reused.

5. Collections vs Streams:

Collections are in-memory data structures which hold elements within it. Each element in the collection is computed before it actually becomes a part of that collection. On the other hand Streams are fixed data structures which computes the elements on-demand basis.

The Java 8 Streams -- lazily constructed Collections, where the values are computed when user demands for it.

Actual Collections behave absolutely opposite to it and they are set of eagerly computed values (no matter if the user demands for a particular value or not).

Method References

Method reference is a shorthand notation of a lambda expression to call a method.

Can all lambda expressions be concised into method reference ? NO

eg :

If your lambda expression is like this:

s -> System.out.println(s)

then you can replace it with a method reference like this:

(since we are directly calling an existing method in a lambda expression , we can refer to the method itself)

System.out::println

The :: operator is used in method reference to separate the class or object from the method name

Four types of method references

1. Method reference to an instance method of an object – object::instanceMethod

2. Method reference to a static method of a class – Class::staticMethod

3. Method reference to an instance method of an arbitrary object of a particular type – Class::instanceMethod

4. Method reference to a constructor – Class::new

1. Method reference to an instance method of an object

```
@FunctionalInterface
interface MyInterface{
   void display();
}
public class Example {
   public void myMethod(){
         System.out.println("Instance Method");
   }
   public static void main(String[] args) {
         Example obj = new Example();
         // Method reference using the object of the class
         MyInterface ref = obj::myMethod;
```

```
        // Calling the method of functional interface
        ref.display();
    }
}
```

2. Method reference to a static method of a class

```
import java.util.function.BiFunction;
class Multiplication{
  public static int multiply(int a, int b){
        return a*b;
  }
}
public class Example {
  public static void main(String[] args) {
        BiFunction<Integer, Integer, Integer> product = Multiplication::multiply;
        int pr = product.apply(11, 5);
        System.out.println("Product of given number is: "+pr);
  }
}
```

3. Method reference to an instance method of an arbitrary object of a particular type

```
import java.util.Arrays;
public class Example {

  public static void main(String[] args) {
        String[] stringArray = { "aa", "bb", "cc", "dd", "ee"};
        /* Method reference to an instance method of an arbitrary
         * object of a particular type
         */
//Arrays.sort(stringArray, (s1,s2)->s1.compareTo(s2));
```

```
        Arrays.sort(stringArray, String::compareTo);
        Arrays.stream(stringArray).forEach(System.out::println);
  }
}
```

4. Method reference to a constructor

```
@FunctionalInterface
interface MyInterface{
   Hello display(String say);
}
class Hello{
   public Hello(String say){
      System.out.print(say);
   }
}
public class Example {
   public static void main(String[] args) {
         //Method reference to a constructor
      MyInterface ref = Hello::new;
      ref.display("Hello World!");
   }
}
```

4.1

```
@FunctionalInterface
interface MyFunctionalInterface {

   Student getStudent();
}
class Student {
```

```
    private String name;

    public String getName() {
        return name;
    }

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

Following example uses constructor reference.

```
public class ConstructorReferenceDemo {

    public static void main(String[] args) {

        MyFunctionalInterface ref = Student::new;

        Supplier<Student> s1 = Student::new;// Supplier Example
        Supplier<Student> s2 = () -> new Student();// equals to above line

        System.out.println(ref.getStudent());//Student class toString() call
        System.out.println(s1.get());//Student class toString() call
    }
}
```

I/O handling

Desc of FileInputStream --- java.io.FileInputStream

bin i/p stream connected to file device(bin/char) -- to read data.

Desc of FileOutputStream --- java.io.FileOutputStream

bin o/p stream connected to file device(bin/char) -- to write data.

Desc of FileReader--- java.io.FileReader

char i/p stream connected to file device(char) -- to read data.

Desc of FileWriter--- java.io.FileWriter

char o/p stream connected to file device(char) -- to write data.

Objective --- Read data from text file in buffered manner.

1. java.io.FileReader(String fileName) throws FileNotFoundException

--- Stream class to represent unbuffered char data reading from a text file.

Has methods -- to read data using char/char[]

eg -- public int read() throws IOException

public int read(char[] data) throws IOException

Usage eg-- char[] data=new char[100];

int no= fin.read(data);

public int read(char[] data,int offset,int noOfChars) throws IOException

Usage eg-- char[] data=new char[100];

int no= fin.read(data,10,15);

eg -- 12 chars available

no=12;data[10]----data[21]

1.5 FileReader(File f) throws FileNotFoundException

java.io.File -- class represents path to file or a folder.

2. Improved version -- Buffered data read .

For char oriented streams--- java.io.BufferedReader(Reader r)

API of BR ---

String readLine() --- reads data from a buffer in line by line manner-- & rets null at end of Stream condition.

Objective -- Replace JDK 1.6 try-catch-finally BY JDK 1.7 try-with-resources syntax.

Meaning --- From Java SE 7 onwards --- Introduced java.lang.AutoCloseable -- i/f

It represents --- resources that must be closed -- when no longer required.

i/f method

public void close() throws Exception-- closing resources.

java.io --- classes -- have implemented this i/f -- to auto close resource when no longer required.

syntax of try-with-resources

try (//open one or multiple AutoCloseable resources)

{ .....

} catch(Exception e)

{

}

Objective ---To confirm device independence of Java I/O --- replace File device by Console

i.e --- Read data from console i/p --- in buffered manner till 'stop' & echo back it on the console.

required stream classes --- BR(ISR(System.in))

Alternative is --- use Scanner class.

Adv. of Scanner over above chain ----- contains ready-made parsing methods(eg --- nextInt,nextDouble.....)

But Scanner is not Buffered Stream

Can combine both approaches.(new Scanner(br.readLine())

Objective --- Combine scanner & buffered reader api --- to avail buffering + parsing api. ---

BufferedReader provides buffering BUT no simple parsing API. -- supplies br.readLine only

Scanner -- Can be attached to file directly

Constr -- Scanner(File f)

BUT no buffering .

How to use both?

Create BR br=new BR(new FR(...));

```
while ((s=br.readLine())!=null)
 {
   //scanner can be attached to string ---Scanner(String s)
Scanner sc=new Scanner(s);
// parse data using Scanner API --next,nextInt,nextBoolean
}
```

Overloaded constructor of FileReader(File f)

java.io.File ---- class represents path to file / folder

Regarding java.io.File -----

Does not follow stream class hierarchy, extends Object directly.

File class --- represents abstract path which can refer to file or folder.

Usage --- 1. To access/check file/folder attributes(exists,file or folder,read/w/exec permisssions,path,parent folder,create new empty file,create tmp files & delete them auto upon termination,mkdir,mkdirs,rename,move,size,last modified ,if folder---list entries from folder,filter entries)

Constructor ---

File (String path) ---

eg --- File f1=new File("abc.dat");

if (f1.exists() && f1.isFile() && f1.canRead())

...attach FileInputStream or FileReader

File (String path) ---

File class API --- boolean exists(),boolean isFile() , boolean canRead()

Objective --- Text File copy operation --- in buffered manner.

For writing data to text file using Buffered streams

java.io.PrintWriter --- char oriented buffered o/p stream --- which can wrap any device.(Binary o/p stream or Char o/p stream)

Constructors---

PrintWriter(Writer w) --- no auto flushing,no conversion, only buffering

PrintWriter(Writer w, boolean flushOnNewLine)--- automatically flush buffer contents on to the writer stream --upon new line

PrintWriter(OutputStream w) --- can wrap binary o/p stream -- buffering +conversion

(char-->binary),no auto-flush option

PrintWriter(OutputStream w , boolean flushOnNewLine) ---

API Methods----print/println/printf same as in PrintStream class(same type as System.out)

Stream class which represents --- Char o/p stream connected to Text file. --- java.io.FileWriter

Constructor

FileWriter(String fileName) throws IOException -- new file will be created & data will be written in char format.

FileWriter(String fileName,boolean append) --- if append is true , data will be appended to existing text file.

Collection & I/O

Objective ---

Items Inventory

Item -- code(String-Prim key),desc,category,quantity,price,shipmentDate

constr,toString.

Create suitable collection of Items(HashMap) --- sort map as per desc item code ,& store sorted item dtls in 1 text file .

NOTE : individual item rec MUST be written on separate line.

Sort items as shipment Date & store sorted dtls in another file . Before exiting ensure closing of data strms .

(buffered manner)

Objective -- Restore collection of items created in above requirement ---in form of HashMap . -- buffering is optional.

Objective --- using Binary file streams.

Classes --- FileInputStream -- unbuffered bin i/p stream connected to bin file device.

FileOutputStream --unbuffered bin o/p stream connected to bin file device.

But these classes --- dont provide buffering & have only read() write() methods in units of bytes/byte[]

API of InputStream class

1. int read() throws IOException

    Will try to read 1 byte from the stream.

    Data un-available method blocks.

    Returns byte--->int to caller.

    eg -- int data=System.in.read();

2. int read(byte[] bytes) throws IOException

    Will try to read data from underlying stream.

    Data un-available -- method blocks.

    Rets actual no of bytes read.

    eg :

    byte[] bytes=new byte[100];

    int no=System.in.read(bytes);

    no data --method blocks.

    10 bytes available -no =10;bytes[0]-----bytes[9]

    110 bytes available -- no=100;bytes[0]....bytes[99]

3. int read(byte[] bytes,int offset,int maxNoOfBytes) throws IOException

    Will try to read data from underlying stream.

    Data un-available -- method blocks.

    Rets actual no of bytes read.

    eg :

    byte[] bytes=new byte[100];

    int no=System.in.read(bytes,10,15);

    no data --BLOCKS

5 bytes available --no=5;bytes[10].....bytes[14]

110 bytes available -- no=15;bytes[10]..bytes[24]

4. int available() throws IOException

Returns no of available bytes in the stream

no data ---DOESN't block -- rets 0.

Important API of OutputStream

1. public void write(int byte) throws IOException

2. public void write(byte[] bytes) throws IOException

3. public void write(byte[] bytes,int offset,int maxNo) throws IOException

bytes[offset].....bytes[offset+maxNo-1] -- written out to stream

4. void flush() throws IOException

5. void close() throws IOException

Using BIS(BufferedInputStream) -- enables buffering BUT doesn't provide any advanced API(ie. read(), read(byte[]), read(byte[] b,int off,int len) . Same is true with BOS.(BufferedOutputStream)

Objective ---

Create Customer/Account based collection. Sort if reqd.

Store Sorted collection to bin file in buffered manner --

& re-store the same.

Use advanced streams in such cases ---

Mixed Data streams

java.io.DataOutputStream ---implements DataOutput i/f

(converter stream)   prim types / string ---> binary

Constructor -- DataOutputStream (OutputStream out)

API ---

public void writeInt(int i) throws IOExc

public void writeChar(char i) throws IOExc

public void writeFloat,writeDouble.....

For Strings

public void writeUTF(String s) throws IOExc ---uses Modified UTF 8 convention

or

public void writeChars(String s) throws IOExc --- uses UTF16 convention

eg : Items Inventory

Item -- code(String-Prim key),desc,category,quantity,price,shipmentDate

constr,toString.

Objective ---

Customer data is already stored in bin file.

Read customer data from Bin file --- in buffered manner & upload the same in HM .display customer details.

Stream class --- java.io.DataInputStream -- implements DataInput

Conversion stream(converts from bin ---> prim type or String)

Constructor

DataInputStream(InputStream in)

API Methods

public int readInt() throws IOException

public double readDouble() throws IOException

public char readChar() throws IOException

public String readUTF() throws IOException(must be used with writeUTF)

public String readChars() throws IOException(must be used with writeChars)

Most Advanced streams ---

Binary streams which can read/write data from/to binary stream in units of Object/Collection of Object refs (i.e Data Transfer Unit = Object/Collection of Objects)

Stream Class for writing Objects to bin. stream

java.io.ObjectOutputStream implements DataOutput,ObjectOutput

Description --- ObjectOutputStream class performs serialization.

serialization= extracting state of object & converting it in binary form.

state of object = non-static & non-transient data members

Constructor

ObjectOutputStream(OutputStream out)

out--- dest Binary o/p stream --- where serialized data stream has to be sent.

API methods ---

public void writeInt(int i) throws IOExc

public void writeChar(char i) throws IOExc

public void writeFloat,writeDouble.....

For Strings

public void writeUTF(String s) throws IOExc ---uses Modified UTF 8 convention

public void writeObject(Object o) throws IOException,NotSerializableException

De-serialization---- conversion or re-construction of Java objs from bin stream.

java.io.ObjectInputStream --- performs de-serialization.--- implements DataInput,ObjectInput

Constructor --- ObjectInputStream(InputStream in)

API methods ---

readInt,readShort,readUTF,readChars..... +

public Object readObject() throws IOException

Objective --- attach OIS to the bin file using FIS & display customer data.

Objective :

Confirming concepts of serialization & de-serialization

Emp -- int id, String name,double salary,Address adr;

Address -- String state,city,street.

Objective -- Understanding Set & its implementation classes

HashSet -- based upon hashing algorithm

More involved scenario.

(store customer info & Items to be purchased)

Data members - int no,Customer info, AL<Item>, Date creationDate

Refer to **Thread** state transitions figure

A -- transition from rdy to run -----> Running

Triggered by --- in time slice based scheduling --- time slot of earlier thrd over OR in pre-emptive multitasking -- higher prio thrd pre-empts lower prio thrd.

B --- transition from running ---> ready to run

Reverse of earlier transition OR

public static void yield()----

Requests underlying scheduler to swap out current thrd SO THAT some other lower priority thrd MAY get a chance to run. (to avoid thrd starvation -- i.e co-operative multi-tasking.)

C --running state --- Only in this state --- run() method gets executed.

running --->dead --- Triggers -- run() method returns in healthy manner . OR run() aborts due to un-handled , un-checked excs.

D -- blocked ---> rdy to run --- when any of blocking condition is removed --- blocked thrd enters rdy pool & resumes competition among other thrds.

API Involved

1. Thread class constructor to be used in extends Thread scenario

1.1 Thread() --- A new thrd is created BUT with JVM supplied name.

1.2 Thread(String nm) -- creates named thread.

2. Thread class constructor to be used in implements scenario

2.1 Thread (Runnable target/inst) --- Creates a new thrd --- by passing instance of the class which implements Runnable i/f.

Run time significance -- Whenever this thrd gets a chance to run --- underlying task scheduler -- will invoke(via JVM) this class's run() method.

2.2 Thread (Runnable inst,String name)

public class Myclass extends Thread --- start()

Vs

public class Myclass implements Runnable --- This class simply represents a runnable task. Prog MUST create a thrd class inst BY attaching Runnable task to it.

Thread class API

1.public String getName()

2. public void setName(String nm)

3. public static Thread currentThread() -- rets ref of the invoker thrd.

4. public int getPriority() -- rets current prio.

Prio scale -- 1---10(MIN_PRIORITY,MAX_PRIORITY)

NORM_PRIORITY ---- 5

4.5 public void setPriority(int prio) --- must be invoked before start()

DO NOT rely on priority factor -- since it is ultimately specific to underlying OS prio range.-- may cause loss of portability.

t1 --- max-prio ---run() --- begin up-counter -- obs val after 10 secs

t1 --- min-prio ---run() --- begin up-counter -- obs val after 10 secs

t1 --- max-prio & t2 -- min prio

5. public String toString() --- to ret -- name,prio & thrd grp name

6. public static void sleep(long ms) throws InterruptedException

Objective -1. to test concurrency of thrd : in extends thrd scenario.

Create a Thrd class, add simple loop with dly in run method to display the exec. sequence.

Write main method : which will instantiate threads(multi-threaded system) & test the concurrent exec. of main thrd along with other thrds.

To ensure that main thrd terminates last : no orphan thrds in the system.

Thread class Method :

1. public void join() throws InterruptedExc.

The invoker thrd gets blocked until the specified thrd joins it(i.e specified thrd becomes dead)

eg : 2 thrds t1 & t2 are running concurrently.

If u invoke : in run() method of t1 :

t2.join() ----> t1 gets blocked until t2 is over.

t3 -- t1.interrupt()

t1 : Blocked on join

Unblcking triggers -- t2 over,getting interrupt signal.

2. public void join(long ms) throws InterruptedExc

waits max for specified tmout .

Unblocking triggers -- t2 over,getting interrupt signal, tmout exceeded.

Objective -- Ensure no orphans , w/o touching child thread class.

Objective

Replace for loop from thrds, by indefinite loop (while true) & still ensure -- no orphans.

Start --- main + 3 child thrds. --- main(parent thrd waits patiently for 5 secs. & then somehow forces termination of child thrds & then terminates last.

API ---

public void interrupt() -- sends interrupt signal to the specified thread. If specified thrd has invoked any method (sleep,join,wait)-- having throws clause of InterruptedExc --- then only thrd gets UNBLOCKED due to InterruptedExc.

NOTE -- Thread which is blocked on I/O -- CANT be un-blocked by interrupt signal.

Threads blocked by invoking any method -- having InterruptedException (sleep,join,wait) can be unblocked by interrupt signal.

2. Objective - to test concurrency of thrds : in implements Runnable scenario.

2.5 implements scenario

3.

Objective : create 3 thrds with 3 random sleep durations(range is 500ms-5sec)

& start them conc. & ensure that main terminates last.

For random nos--- java.util.Random() , nextInt,nextInt(int upperLim)

Objective : create 3 thrds & start them conc. & ensure that main terminates last.

2nd thrd should accept data from console, dont supply data & observe .

How to unblock a thread , which is blocked on I/O?

Objective : Apply multi threading to Swing application.

Create Swing application -- with start & stop buttons, in south region.

Create JPanel in center region , with some default color.

When start button is clicked, center panel should start changing color(random color) periodically.

When stop button is clicked, stop changing color.

Objective -- To store emp details , dept wise in SAME data file.(text buffered manner--- PrintWriter)

Design :

0. Emp class --- id,deptid,name,sal

1. Write Utils class

d.m --- pw

constr --pw inst ---

void writeData(Emp e) {...}

void cleanUp() {...}

constr ---create PW inst --

PW pw=new PW(new FW("emps.data"),true);

---add writeData(....) : instance method to write Emp dtls (first name, last name ,deptId of the emp)

to the file with small dly in between.(why dly ? --- for simulating practical scenario & also to add randomness to code)

do u need clean up method- -- yes -- close pw.

2. Write Dept Handler runnable task class --- implements

Override run() method which will invoke writeData method till 'exit' condition is encountered.

Add stop/exit method to enable 'exit' flag.

....

{

Emp e;

Utils u;

constr(u,e)

{this.e=e;

//u=new Utils(); ------

```
public void run()
{
   while(!exit)
      u.writeData(e);
}
```

3. Write Tester class : accept some emp dtls . Create depthandler task per dept ,attach thrds & start them.

Wait for key stroke ---

System.in.read();

stop all child thrds

ensure no orphans

clean up -- pw

Wait for the key stroke : upon key stroke --- stop all child thrds & then finally terminate main.

Observed o/p ------garbled display or garbled data written in file.

Reason : multiple thrds trying to access the shared resource concurrently.

eg of shared resource : Console or file device,socket,DB table

Solution : Any time when asynch thrds need to access the SHARED resource : LOCK the shared resource --- so that after locking -- only single thread will be able to access the resource concurrently

When is synchronization(=applying thread safety=locking shared resource) required?

In multi-threaded java applns -- iff multiple thrds trying to access SAME copy of the shared resource(eg -- reservation tkt,db table,file or socket or any shared device) & some of the threads are reading n others updating the resource

How to lock the resource?

Using synchronized methods or synchronized blocks.

In either approach : the java code is executed from within the monitor & thus protects the concurrent access.

Note : sleeping thrd sleeps inside the monitor(i.e Thread invoking sleep(...) , DOESn't release the ownership of the monitor)

eg classes :

StringBuilder : thrd-unsafe.--- unsynchronized --- if multiple thrds try to access the same copy of the SB, SB may fail(wrong data)

StringBuffer --- thrd -safe ----synchronized internally--- if multiple thrds try to access the same copy of the SB, only 1 thrd can access the SB at any parti. instance.

which is reco class in single threaded appln? --- StringBuilder

multiple thrds -- having individual copies -- StingBuilder

multiple thrds -- sharing same copy -- StringBuilder --

identify code to be guarded -- sb 's api -- invoke thrd unsafe API -- from inside synched block.

ArrayList(inherently thrd un-safe) Vs Vector(inherently thrd safe)

HashMap(un-safe) Vs Hashtable(thrd safe)

synchronized block syntax --- to apply synchro. externally.

synchronized (Object to be locked--- shared resource)

{

//code to be synchronized --methods of shared res. -- thrd safe manner(from within monitor)

}

1. If any thrd is accessing any synched method of 1 obj, then same thrd or any other thrd CANT concurrently access same method of the same obj.(Tester1.java)

2. If any thrd is accessing any synched method of 1 obj, then same thrd or any other thrd CANT concurrently access same method or any other synchronized method of the same obj.(Tester2.java)

2. If thrds have their own independent copies of resources, synch IS NOT required.(Tester2.java)

3.If u are using any thrd un-safe code(ie. ready code without source) --& want to apply thrd safety externally --- then just wrap the code within synched block to use locking.(Tester3.java)

Objective : Create Producer & Consumer thrds .

Producer produces data samples & consumer reads the same.

For simplicity : let the data be represented by : single Emp record

Producer produces emp rec sequentially & consumer reads the same.

Rules : 1 when producer is producing data , consumer thrd concurrently should not be allowed to read data & vice versa.

Any more rules?????????????

Yes --- correct sequencing is also necessary in such cases.

Rule 2 : Producer must 1st produce data sample ---consumer reads data sample & then producer can produce next data sample. Similarly consumer should not be able to read stale(same) data samples .

ITC --- API level

Object class API

1. public void wait() throws IE ---thrd MUST be owner of the monitor(i.e invoke wait/notify/notifyAll from within synched block or method) --- othewise MAY get IllegalMontitorStateExc

---causes blocking of the thrd outside montitor.

UnBlocking triggers --- interrupt(not reco --- since it may cause death of thrd) , notify/notifyAll --- reco.

2. 1. public void wait(long ms) throws IE

UnBlocking triggers --- interrupt(not reco --- since it may cause death of thrd) , notify/notifyAll --- reco.,tmout exceeded

2.2 public void notify() -- MUST be invoked from within monitor , ow may get IllegalMonitorStateExc

Un-blocks ANY waiting thread , blocked on SAME MONITOR

2.3 public void notifyAll() -- Un-blocks ALL waiting threads , blocked on SAME MONITOR

notify/notifyAll--- DOESN't BLOCK the thread & Doesn't release lock on monitor. --- send wake up signal -- to thrd/s waiting on same monitor.

wait --- Blocks the thread --- Releases lock on the monitor.

volatile --- java keyword, applicable at data member.

typically used in multi-threaded scenario only when multiple thrds are accessing the same data member.

Use --- to specify-- that data var. is being used by multiple thrds concurrently -- so dont apply any optimizations(OR the value of the variable can get modified outside the current thrd) . With volatile keyword -- its guaranteed to give most recent value.

The volatile modifier tells the JVM that a thread accessing the variable must always get its own private copy of the variable with the main copy in memory

---

Thread related API

Starting point

1. java.lang.**Runnable** --functional i/f

SAM (single abstract method) -- public void run()

Prog MUST override run() -- to supply thread exec. logic.

2. java.lang.Thread --class -- imple . Runnable

It has imple. run() -- blank manner.

3. Constrs of Thread class in "extends" scenario

3.1 Thread() -- Creates a new un-named thrd.

3.2 Thread(String name) -- Creates a new named thrd.

4. Constrs of Thread class in "implements" scenario

4.1 Thread(Runnable instance) -- Creates a new un-named thrd.

4.2 Thread(Runnable instance, String name) -- Creates a new named thrd.

Methods of Thread class

1. public void start() -- To cause transition from NEW -- RUNNABLE

throws IllegalThreadStateException -- if thrd is already runnable or dead.

2. public static void yield() -- Requests the underlying native scheduler to release CPU & enters rdy pool.

Use case -- co operative multi tasking(to allow lesser prio thrds to access processor)

3. public void setName(String nm)

4. public String getName()

5. Priority scale -- 1---10

Thread class consts --MIN_PRIO=1 , MAX_PRIO=10 , NORM_PRIO =5

public void setPriority(int prio)

6. public static Thread currentThread() -- rets invoker(current) thrd ref.

7. public String toString() -- Overrides Object class method , to ret

Thread name,priority,name of thrd grp.

8.public static void sleep(long ms) throws InterruptedException

Blocks invoker thread till specified msecs.

9. public void join() throws InterruptedException

Blocking method(API)

--Causes the invoker thread to block till specified thread gets over.

eg : t1 & t2

t1's run()

{

 .....

 t2.join();//who is waiting for whom for which purpose ? : t1 is waiting for t2 : to complete exec

....

}

t2's run()

{

  //some B.L :read data from file

}

join method can be used effectively to avoid orphan threads

main has to wait for child thrds to complete exec

How ?

In main(..)

t1.join();

t2.join();

10 public void join(long ms) throws InterruptedException

eg : In main method

t1.join(10000);//main is waiting for t1 to finish exec: upto max 10 sec

//t1 gets over after 2 secs : main un blocks

//If t1 doesn't get over within 10 secs : main will be blocked for 10 sec n auto un block.

--Causes the invoker thread to block till specified thread gets over OR tmout elapsed

11. public void interrupt() -- interrupts(un blocks) the threads blocked on ---sleep/join/wait

Methods of Object class (Use Case : Inter thread communication)

1. public final void wait() throws InterruptedException,IllegalMonitorStateException

Meaning -- Forces the invoker thread to release processor & monitor & wait outside .

Trigger for InterruptedException

Some other thread sends interrupt signal to the waiting thread.

Trigger for IllegalMonitorStateException

If the invoker thread is not an owner of the monitor

(i.e if its invoking neither a synched method nor a block)

2. public final void notify() throws IllegalMonitorStateException

Meaning -- Un blocks (wakes up) exactly 1 thread , which has invoked wait on the same object's monitor.

May raise IllegalMonitorStateException --if the current thread is not the owner of a lock.

3. public final void notifyAll() throws IllegalMonitorStateException

Un blocks ALL waiting threads , on the same object's monitor.

Singleton

In object-oriented programming, a singleton class is a class that can have only one object (an instance of the class) at a time, in a particular JVM.

It is a creational design pattern which talks about the creation of an object.

After first time, if we try to instantiate the Singleton class, the new variable also points to the first instance created. So whatever modifications we do to any variable inside the class through any instance, it affects the variable of the single instance created and is visible if we access that variable through any variable of that class type defined.

eg : Device drivers, Cache , DB connection

How To design a singleton class?

Private constructor to restrict instantiation of the class from other classes.

Private static variable of the same class that is the only instance of the class.

Public static method that returns the instance of the class, this is the global access point for outer world to get the instance of the singleton class.

Lazy initialization

Mark constructor as private.

Write a static method that has return type object of this singleton class.

Eager initialization

In eager initialization, the instance of Singleton Class is created at the time of class loading, this is the easiest method to create a singleton class but it has a drawback that instance is created even though client application might not be using it.

Mark constructor as private.

Create static init block to instantiate a singleton

Factory design pattern

It is a creational design pattern which talks about the creation of an object. The factory design pattern says that define an interface (A java interface or an abstract class) and let the subclasses decide which object to instantiate. The factory method in the interface lets a class defer the instantiation to one or more concrete subclasses. It is one of the best ways to create an object where object creation logic is hidden to the client.

Implementation:

1. Define a factory method inside an interface.

2. Let the subclass implements the above factory method and decide which object to create.

In Java constructors are not polymorphic, but by allowing subclass to create an object, we are adding polymorphic behavior to the instantiation. i.e we are trying to achieve Pseudo polymorphism by letting the subclass to decide what to create, and so this Factory method is also called as Virtual constructor.

eg : Shape Scenario