**Java 8 tutorial :**

you'll learn how to use default interface methods, lambda expressions, method references and repeatable annotations.

you'll be familiar with the most recent [API](http://download.java.net/jdk8/docs/api/) changes like streams, functional interfaces, map extensions and the new Date API.

**What are new features which got introduced in Java 8?**

There are lots of new features which were added in Java 8. Here is the list of important features:

> Lambda Expression

> Stream API

> Default methods in the interface

> Functional Interface

> Optional

> Method references

> Date API

> Nashorn, JavaScript Engine

**What are main advantages of using Java 8?**

> More compact code

> Less boiler plate code

> More readable and reusable code

> More testable code

> Parallel operations

**Lambda Expressions in Java 8**

Java 8 has introduced a new feature called Lambda expressions. It is considered to be a major change in java. As this change will bring functional programming into Java. Other languages such as Scala already have this feature so this is not new to programming world, it is new to java.

Before understanding Lambda expressions, Lets first understand **Functional Interface.**

**What is Functional Interface?**

Functional interfaces are those interfaces that have only one abstract method in it. It can have more than one default or static method and can override the method from java.lang.object.

Let’s create a functional interface:

@FunctionalInterface

public interface Decorable {

// one abstract method

void decorateWithCurtains();

// default method

default void decorateWithPaints() {

System.out.println("Decorating using paints");

}

// Overriding method of java.lang.Object

@Override

public int hashCode();

}

Java can itself identify Functional Interface but you can also denote interface as Functional Interface by annotating it with @FunctionalInterface.

Some popular Functional Interfaces are:

> java.lang.Runnable

> java.util.concurrent.Callable

> java.awt.event.ActionListener

> java.util.Comparator

**Lambda expression** represents an anonymous function. It comprises of a set of parameters, a lambda operator (->) and a function body . You can call it function without name,

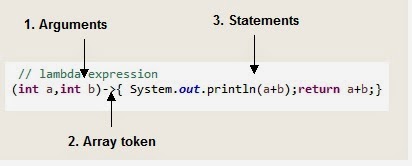
The connection between Lambda Expression and Functional Interface:

You might be thinking I have introduced the functional Interface above but how it is connected to Lambda. So Lambda expression can be applied for the abstract method of functional Interface which is being implemented or being instantiated anonymously.

**Structure of Lambda Expressions**

(Argument List) ->{expression;} or

(Argument List) ->{statements;}



1. **Argument list or parameters**

> Lambda expression can have zero or more arguments.

()->{System.out.println(“Hello”)}; //Without argument, will print hello

(int a)->{System.out.println(a)}; // One argument, will print value of a

(int a,int b)-> {a+b};//two argument, will return sum of these two integers

> You can choose to not declare the type of arguments as it can be inferred from context.

(a,b)->{a+b}; // two argument, will return sum of these two numbers

> you can not declare one argument’s type and do not declare type for other argument.

(int a,b)->{a+b}; // Compilation error

> When there is a single parameter, if its type is inferred, it is not mandatory to use parentheses.

a->{System.out.println(a)}; // Will print value of number a

1. **Array token (->)**
2. **Body**

Body can have expression or statements.

If there is only one statement in body,curly brace is not needed and return type of the anonymous function is same as of body expression

If there are more than one statements, then it should be in curly braces and return type of anonymous function is same as value return from code block, void if nothing is returned.

*// old way*

**new** Thread(**new** Runnable() {

   @Override

   public **void** run() {

    System.out.println("Thread is started");

   }

  }).start();

*// using lambda Expression*

**new** Thread(()->System.out.println("Thread is started")).start();

}

**Code to sort list of movies by name using comparator**

Old way :

List<Movie> listOfMovies = **new** ArrayList<>();

    listOfMovies.add(m1);

    listOfMovies.add(m2);

    listOfMovies.add(m3);

    listOfMovies.add(m4);

    System.out.println("Before Sort by name : ");

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

      Movie movie = (Movie) listOfMovies.get(i);

      System.out.println(movie);

    }

*// Sort by movieName*

*// Anonymous Comparator*

*// old way*

    Collections.sort(listOfMovies, **new** Comparator<Movie>() {

      @Override

      public **int** compare(Movie o1, Movie o2) {

**return** o1.getMovieName().compareTo(o2.getMovieName());

      }

    });

**Lambda way :**

The problem with Anonymous Comparator is of syntax. Each time you want to sort the list using a comparator, you have to remember the bulky syntax.

So generally the main problem with Anonymous classes is syntax. For very simple operation, we need to write complex code. To solve this problem, JDK has introduced a new feature called Lambda Expressions. how lambda expression will reduce this complex code.

*// Sort by movieName*

*// Anonymous Comparator*

*// old way*

    Collections.sort(listOfMovies, **new** Comparator<Movie>() {

      @Override

      public **int** compare(Movie o1, Movie o2) {

**return** o1.getMovieName().compareTo(o2.getMovieName());

      }

    });

*// Using lambda expression*

    Collections.sort(listOfMovies, (o1, o2) -> o1.getMovieName().compareTo(o2.getMovieName()));

    System.out.println("After Sort by name: ");

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

      Movie movie = (Movie) listOfMovies.get(i);

      System.out.println(movie);

    }

  }

for using Comparator. So in spite of writing Anonymous comparator, our expression became very easy.



So we have passed 2 arguments o1 and o2, we didn’t pass type because it can be inferred from context.

We have only one statement here, so no need to put it in curly braces.

**HelloWorld Lambda Expression Example**

   public **interface** HelloWorld {

**void** sayHello();}

public **class** HelloWorldMain {

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

{

*// Lambda Expression*

     HelloWorld helloWorld=()->System.out.println("Hello using Lambda Expression");

    helloWorld.sayHello();

}

}

Java lambda expression is consisted of three components.

**1) Argument-list:** It can be empty or non-empty as well.

**2) Arrow-token:** It is used to link arguments-list and body of expression.

**3) Body:** It contains expressions and statements for lambda expression.

**Without Lambda Expression**

1. **interface** Drawable{
2. **public** **void** draw();
3. }
4. **public** **class** LambdaExpressionExample {
5. **public** **static** **void** main(String[] args) {
6. **int** width=10;
8. //without lambda, Drawable implementation using anonymous class
9. Drawable d=**new** Drawable(){
10. **public** **void** draw(){System.out.println("Drawing "+width);}
11. };
12. d.draw();
13. }
14. }

**With Lambda expression**

1. @FunctionalInterface  //It is optional
2. **interface** Drawable{
3. **public** **void** draw();
4. }
5. **public** **class** LambdaExpressionExample2 {
6. **public** **static** **void** main(String[] args) {
7. **int** width=10;
8. //with lambda
9. Drawable d2=()->{
10. System.out.println("Drawing "+width);
11. };
12. d2.draw();
13. }  }
14. **interface** Sayable{
15. **public** String say();
16. }
17. **public** **class** LambdaExpressionExample3{
18. **public** **static** **void** main(String[] args) {
19. Sayable s=()->{
20. **return** "I have nothing to say.";
21. };
22. System.out.println(s.say());
23. }
24. }
25. **interface** Addable{
26. **int** add(**int** a,**int** b);
27. }
29. **public** **class** LambdaExpressionExample5{
30. **public** **static** **void** main(String[] args) {
32. // Multiple parameters in lambda expression
33. Addable ad1=(a,b)->(a+b);
34. System.out.println(ad1.add(10,20));
36. // Multiple parameters with data type in lambda expression
37. Addable ad2=(**int** a,**int** b)->(a+b);
38. System.out.println(ad2.add(100,200));
39. }
40. }
41. **interface** Addable{
42. **int** add(**int** a,**int** b);
43. }
45. **public** **class** LambdaExpressionExample6 {
46. **public** **static** **void** main(String[] args) {
48. // Lambda expression without return keyword.
49. Addable ad1=(a,b)->(a+b);
50. System.out.println(ad1.add(10,20));
52. // Lambda expression with return keyword.
53. Addable ad2=(**int** a,**int** b)->{
54. **return** (a+b);
55. };
56. System.out.println(ad2.add(100,200));
57. }
58. }

**Java Lambda Expression Example: Foreach Loop**

1. list.forEach(
2. (n)->System.out.println(n)
3. );

**Multiple Statements**

**Creating Thread**

1. //Thread Example with lambda
2. Runnable r2=()->{
3. System.out.println("Thread2 is running...");
4. };

**Comparator**

1. // implementing lambda expression
2. Collections.sort(list,(p1,p2)->{
3. **return** p1.name.compareTo(p2.name);
4. });

**Filter Collection Data**

1. // using lambda to filter data
2. Stream<Product> filtered\_data = list.stream().filter(p -> p.price > 20000);
3. // using lambda to iterate through collection
4. filtered\_data.forEach(
5. product -> System.out.println(product.name+": "+product.price)
6. );

**Event Listener**

  b.addActionListener(e-> {tf.setText("hello swing");});

**Important points:**

> The body of a lambda expression can contain zero, one or more statements.

> When there is a single statement curly brackets are not mandatory and the return type of the anonymous function is the same as that of the body expression.

> When there are more than one statements, then these must be enclosed in curly brackets (a code block) and the return type of the anonymous function is the same as the type of the value returned within the code block, or void if nothing is returned.

**Java 8 functional interface example**

Functional interfaces are those interfaces which have only one abstract method, it can have default methods, static methods and it can also override java.lang.Object class method.  
There are many functional interfaces already present.  
For example: Runnable , Comparable.  
You can implement functional interfaces using [lambda expressions](https://www.java2blog.com/2014/06/lambda-expressions-in-java-8.html" \t "https://java2blog.com/java-8-functional-interface-example/_blank).

*// Using lambda expression*

Thread t1=**new** Thread(

()->System.out.println("In Run method")

);

Example of functional interface,

@FunctionalInterface

public **interface** Decorable {

*// one abstract method*

**void** decorateWithCurtains();

*// default method*

**default** **void** decorateWithPaints()

{

  System.out.println("Decorating using paints");

}

*// Overriding method of java.lang.Object*

@Override

public **int** hashCode();

}

Java can itself identify Functional Interface but you can also denote interface as Functional Interface by annotating it with @FunctionalInterface. If you annotate @FunctionalInterface, you should have only one abstract method otherwise you will get compilation error.

public **class** DecorableMain {

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

*// Using lambada expression*

Decorable dec=()->{System.out.println("Decorating with curtains");};

dec.decorateWithCurtains();

}

}

**How lambda expression and functional interfaces are related?**

Lambda expressions can only be applied to abstract method of functional interface.

Runnable has only one abstract method called run, so it can be used as below:

*// Using lambda expression*

Thread t1=**new** Thread(

()->System.out.println("In Run method")

);

Here we are using Thread constructor which takes Runnable as parameter. As you can see we did not specify any function name here, as Runnable has only one abstract method, java will implicitly create anonymous Runnable and execute run method.  
It will be as good as below code.

Thread t1=**new** Thread(**new** Runnable() {

   @Override

   public **void** run() {

    System.out.println("In Run method");

   }

  });

**Can you create your own functional interface?**

Yes, you can create your own functional interface. Java can implicitly identify functional interface but you can also annotate it with @FunctionalInterface.

**Java Method References**

Java provides a new feature called method reference in Java 8. Method reference is used to refer method of functional interface. It is compact and easy form of lambda expression. Each time when you are using lambda expression to just referring a method, you can replace your lambda expression with method reference.

## **Types of Method References**

There are following types of method references in java:

1. Reference to a static method.
2. Reference to an instance method.
3. Reference to a constructor.

**Example : Reference to a constructor**

1. InstanceMethodReference methodReference = **new** InstanceMethodReference(); // Creating object
2. // Referring non-static method using reference
3. Sayable sayable = methodReference::saySomething;
4. // Calling interface method
5. sayable.say();
6. // Referring non-static method using anonymous object
7. Sayable sayable2 = **new** InstanceMethodReference()::saySomething; // You can use anonymous object also
8. // Calling interface method
9. sayable2.say();

**Reference to a constructor.**

1. Messageable hello = Message::**new**;
2. hello.getMessage("Hello");

**What is Optional? Why and how can you use it?**

Java 8 has introduced new class Called Optional. This class is basically introduced to avoid NullPointerException in java.  
Optional class encapsulates optional value which is either present or not.  
It is a wrapper around object and can be use to avoid NullPointerExceptions.

In Java 8, we have a newly introduced Optional class in java.util package. This class is introduced to avoid NullPointerException that we frequently encounters if we do not perform null checks in our code. Using this class we can easily check whether a variable has null value or not and by doing this we can avoid the NullPointerException. In this guide, we will see how to work with Optional class and the usage of various methods of this class.

public class Example {

public static void main(String[] args) {

  String[] str = new String[10];

Optional<String> isNull = Optional.ofNullable(str[9]);

  if(isNull.isPresent()){

 //Getting the substring

 String str2 = str[9].substring(2, 5);

 //Displaying substring

System.out.print("Substring is: "+ str2);

  }

  else{

  System.out.println("Cannot get the substring from an empty string");

  }

str[9] = "AgraIsCool";

Optional<String> isNull2 = Optional.ofNullable(str[9]);

  if(isNull2.isPresent()){

 //Getting the substring

String str2 = str[9].substring(2, 5);

//Displaying substring

System.out.print("Substring is: "+ str2);

}

else{

System.out.println("Cannot get the substring from an empty string");

}

}  }

public class Example {

public static void main(String[] args) {

//Creating Optional object from a String

Optional<String> GOT = Optional.of("Game of Thrones");

//Optional.empty() creates an empty Optional object

Optional<String> nothing = Optional.empty();

System.out.println(GOT.map(String::toLowerCase));

System.out.println(nothing.map(String::toLowerCase));

Optional<Optional<String>> anotherOptional = Optional.of(Optional.of("BreakingBad"));

System.out.println("Value of Optional object"+anotherOptional);

System.out.println("Optional.map: "

+anotherOptional.map(gender -> gender.map(String::toUpperCase)));

//Optional<Optional<String>>    -> flatMap -> Optional<String>

System.out.println("Optional.flatMap: "

 +anotherOptional.flatMap(gender -> gender.map(String::toUpperCase)));

}}

public class Example {

public static void main(String[] args) {

//Creating Optional object from a String

Optional<String> GOT = Optional.of("Game of Thrones");

  /\* Filter returns an empty Optional instance if the output doesn't

\* contain any value, else it returns the Optional object of the

\* given value.

\*/

System.out.println(GOT.filter(s -> s.equals("GAME OF THRONES")));

System.out.println(GOT.filter(s -> s.equalsIgnoreCase("GAME OF THRONES")));

}}

import java.util.Optional;

  public class Example {

public static void main(String[] args) {

//Creating Optional object from a String

Optional<String> GOT = Optional.of("Game of Thrones");

//Optional.empty() creates an empty Optional object

Optional<String> nothing = Optional.empty();

//orElse() method

System.out.println(GOT.orElse("Default Value"));

System.out.println(nothing.orElse("Default Value"));

//orElseGet() method

System.out.println(GOT.orElseGet(() -> "Default Value"));

System.out.println(nothing.orElseGet(() -> "Default Value"));

}}

import java.util.Optional;

  public class Example {

public static void main(String[] args) {

//Creating Optional object from a String

Optional<String> GOT = Optional.of("Game of Thrones");

//Optional.empty() creates an empty Optional object

Optional<String> nothing = Optional.empty();

/\* isPresent() method: Checks whether the given Optional

\* Object is empty or not.

\*/

if (GOT.isPresent()) {

  System.out.println("Watching Game of Thrones");

}

else {

System.out.println("I am getting Bored");

  }

/\* ifPresent() method: It executes only if the given Optional

\* object is non-empty.

\*/

//This will print as the GOT is non-empty

GOT.ifPresent(s -> System.out.println("Watching GOT is fun!"));

//This will not print as the nothing is empty

nothing.ifPresent(s -> System.out.println("I prefer getting bored"));

}}

public class Example {

public static void main(String[] args) {

  String[] str = new String[10];

Optional<String> isNull = Optional.ofNullable(str[9]);

  if(isNull.isPresent()){

 //Getting the substring

 String str2 = str[9].substring(2, 5);

 //Displaying substring

System.out.print("Substring is: "+ str2);

  }

  else{

  System.out.println("Cannot get the substring from an empty string");

  }

str[9] = "AgraIsCool";

Optional<String> isNull2 = Optional.ofNullable(str[9]);

  if(isNull2.isPresent()){

 //Getting the substring

String str2 = str[9].substring(2, 5);

//Displaying substring

System.out.print("Substring is: "+ str2);

}

else{

System.out.println("Cannot get the substring from an empty string");

}

}  }

**What are defaults methods?**

Default method are those methods in interface which have body and use default keywords.

Default method are introduced in Java 8 mainly because of backward compatibility.

Before Java 8, interfaces could have only abstract methods. The implementation of these methods has to be provided in a separate class. So, if a new method is to be added in an interface, then its implementation code has to be provided in the class implementing the same interface. To overcome this issue, Java 8 has introduced the concept of default methods which allow the interfaces to have methods with implementation without affecting the classes that implement the interface.

**interface** TestInterface

{

    // abstract method

**public** **void** square(**int** a);

    // default method

**default** **void** show()

    {

      System.out.println("Default Method Executed");

    }

}

**class** TestClass **implements** TestInterface

{

    // implementation of square abstract method

**public** **void** square(**int** a)

    {

        System.out.println(a\*a);

    }

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

    {

        TestClass d = **new** TestClass();

        d.square(4);

        // default method executed

        d.show();

    }

}

The default methods were introduced to provide backward compatibility so that existing interfaces can use the lambda expressions without implementing the methods in the implementation class. Default methods are also known as defender methods or virtual extension methods.

**Static Methods:**The interfaces can have static methods as well which is similar to static method of classes.

**interface** TestInterface

{

    // abstract method

**public** **void** square (**int** a);

    // static method

**static** **void** show()

    {

        System.out.println("Static Method Executed");

    }

}

**Default Methods and Multiple Inheritance**In case both the implemented interfaces contain default methods with same method signature, the implementing class should explicitly specify which default method is to be used or it should override the default method.

**interface** TestInterface1

{

    // default method

**default** **void** show()

    {

        System.out.println("Default TestInterface1");

    }

}

**interface** TestInterface2

{

    // Default method

**default** **void** show()

    {

        System.out.println("Default TestInterface2");

    }

}

// Implementation class code

**class** TestClass **implements** TestInterface1, TestInterface2

{

    // Overriding default show method

**public** **void** show()

    {

        // use super keyword to call the show

        // method of TestInterface1 interface

        TestInterface1.**super**.show();

        // use super keyword to call the show

        // method of TestInterface2 interface

        TestInterface2.**super**.show();

    }

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

    {

        TestClass d = **new** TestClass();

        d.show();

    }

}

**Important Points:**

1. Interfaces can have default methods with implementation in Java 8 on later.
2. Interfaces can have static methods as well, similar to static methods in classes.
3. Default methods were introduced to provide backward compatibility for old interfaces so that they can have new methods without affecting existing code.

**What is the difference between Predicate and Function?**

Both are functional interfaces.  
[Predicate](https://www.java2blog.com/java-8-predicate-examples/)<T> is single argument function and either it returns true or false.This can be used as the assignment target for a lambda expression or method reference.

Function<T,R> is also single argument function but it returns an Object.Here T denotes type of input to the function and R denotes type of Result.

This can also be used as the assignment target for a lambda expression or method reference.

A [Functional Interface](https://www.geeksforgeeks.org/functional-interfaces-java/) is an Interface which allows only one Abstract method within the Interface scope. There are some predefined functional interface in Java like Predicate, consumer, supplier etc. The return type of a Lambda function (introduced in JDK 1.8) is a also functional interface.

The Functional Interface PREDICATE is defined in the java.util.Function package. It improves manageability of code, helps in unit-testing them separately, and contain some methods like:

1. **isEqual**(Object targetRef) : Returns a predicate that tests if two arguments are equal according to Objects.equals(Object, Object).

**static Predicate isEqual(Object targetRef)**

Returns a predicate that tests if two arguments are

equal according to Objects.equals(Object, Object).**T :** the type of arguments to the predicate**Parameters:targetRef :** the object reference with which to

compare for equality, which may be null**Returns:** a predicate that tests if two arguments

are equal according to Objects.equals(Object, Object)

1. **and(Predicate other) :**Returns a composed predicate that represents a short-circuiting logical AND of this predicate and another.

**default Predicate and(Predicate other)**

Returns a composed predicate that represents a

short-circuiting logical AND of this predicate and another.**Parameters:**

other: a predicate that will be logically-ANDed with this predicate

Returns : a composed predicate that represents the short-circuiting

logical AND of this predicate and the other predicate

Throws: NullPointerException - if other is null

**negate() :** Returns a predicate that represents the logical negation of this predicate.

**default Predicate negate()**

Returns:a predicate that represents the logical

negation of this predicate

**or(Predicate other) :** Returns a composed predicate that represents a short-circuiting logical OR of this predicate and another.

**default Predicate or(Predicate other)**

Parameters:

other : a predicate that will be logically-ORed with this predicate

Returns:

a composed predicate that represents the short-circuiting

logical OR of this predicate and the other predicate

Throws : NullPointerException - if other is null

**test(T t) :** Evaluates this predicate on the given argument.boolean test(T t)

**test(T t)**

Parameters:

t - the input argument

Returns:

true if the input argument matches the predicate, otherwise false

**import** java.util.function.Predicate;

**public** **class** PredicateInterfaceExample1 {

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

    {

        // Creating predicate

        Predicate<Integer> lesserthan = i -> (i < 18);

        // Calling Predicate method

        System.out.println(lesserthan.test(10));

    }

}

**import** java.util.function.Predicate;

**public** **class** PredicateInterfaceExample2 {

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

    {

        Predicate<Integer> greaterThanTen = (i) -> i > 10;

        // Creating predicate

        Predicate<Integer> lowerThanTwenty = (i) -> i < 20;

**boolean** result = greaterThanTen.and(lowerThanTwenty).test(15);

        System.out.println(result);

        // Calling Predicate method

**boolean** result2 = greaterThanTen.and(lowerThanTwenty).negate().test(15);

        System.out.println(result2);

    }

}

**Predicate in Collection**

// Java program to demonstrate working of predicates

// on collection. The program finds all admins in an

// arrayList of users.

**import** java.util.function.Predicate;

**import** java.util.\*;

**class** User

{

    String name, role;

    User(String a, String b) {

        name = a;

        role = b;

    }

    String getRole() { **return** role; }

    String getName() { **return** name; }

**public** String toString() {

**return** "User Name : " + name + ", Role :" + role;

    }

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

    {

        List<User> users = **new** ArrayList<User>();

        users.add(**new** User("John", "admin"));

        users.add(**new** User("Peter", "member"));

        List admins = process(users, (User u) -> u.getRole().equals("admin"));

        System.out.println(admins);

    }

**public** **static** List<User> process(List<User> users,

                            Predicate<User> predicat)

    {

        List<User> result = **new** ArrayList<User>();

**for** (User user: users)

**if** (predicat.test(user))

                result.add(user);

**return** result;

    }

}

The same functionality can also be achieved by using Stream API and lambda functions offered since JDK 1.8 on top of the Collections API.

The Stream API allows "streaming" of collections for dynamic processing. Streams allow concurrent and parallel computation on data (using internal iterations), to support database-like operations such as grouping and filtering the data (similar to GROUP BY and WHERE clause in SQL). This allows the developers to focus on "what data is needed" instead of "how data is needed" since streaming hides the details of the implementation and provides the result. This is done by providing predicates as inputs to functions operating at runtime upon the streams of collections.

// This line uses Predicates to filter

    // out the list of users with the role "admin".

    // List admins = process(users, (User u) ->

    // u.getRole().equals("admin"));

    // Replacing it with the following line

    // using Stream API and lambda functions

    // produces the same output

    // the input to the filter() is a lambda

    // expression that returns a predicate: a

    // boolean value for each user encountered

    // (true if admin, false otherwise)

    List admins = users.stream()

    .filter((user) -> user.getRole().equals("admin"))

    .collect(Collectors.toList());

**package** java.util.**function**;

import java.util.Objects;

*/\*\**

*\* Represents a predicate (boolean-valued function) of one argument.*

*\**

*\* <p>This is a <a href="package-summary.html">functional interface</a>*

*\* whose functional method is {@link #test(Object)}.*

*\**

*\* @param <T> the type of the input to the predicate*

*\**

*\* @since 1.8*

*\*/*

@FunctionalInterface

public **interface** Predicate<T> {

*/\*\**

*\* Evaluates this predicate on the given argument.*

*\**

*\* @param t the input argument*

*\* @return {@code true} if the input argument matches the predicate,*

*\* otherwise {@code false}*

*\*/*

**boolean** test(T t);

**default** Predicate<T> **and**(Predicate<? **super** T> other) {

        Objects.requireNonNull(other);

**return** (t) -> test(t) && other.test(t);

    }

**default** Predicate<T> negate() {

**return** (t) -> !test(t);

    }

**default** Predicate<T> **or**(Predicate<? **super** T> other) {

        Objects.requireNonNull(other);

**return** (t) -> test(t) || other.test(t);

    }

    static <T> Predicate<T> isEqual(**Object** targetRef) {

**return** (**null** == targetRef)

                ? Objects::isNull

                : **object** -> targetRef.equals(**object**);

    }

}

In Java 8, *[Predicate](https://docs.oracle.com/javase/8/docs/api/java/util/function/Predicate.html)* is a functional interface, which accepts an argument and returns a boolean. Usually, it used to apply in a filter for a collection of objects.

Are you aware of Date and Time API introduced in Java 8? What the issues with Old Date and time API?

Issues with old Date and TIme API:

**Thread Safety:** You might be already aware that java.util.Date is mutable and not thread safe. Even java.text.SimpleDateFormat is also not Thread-Safe. New Java 8 date and time APIs are thread safe.

**Performance**: Java 8 ‘s new APIs are better in performance than old Java APIs.

**More Readable**: Old APIs such Calendar and Date are poorly designed and hard to understand. Java 8 Date and Time APIs are easy to understand and comply with ISO standards.

## Can you provide some APIs of Java 8 Date and TIme?

## **LocalDate**, **LocalTime**, and **LocalDateTime**are the Core API classes for Java 8. As the name suggests, these classes are local to context of observer. It denotes current date and time in context of Observer.

**New Date-Time API in Java 8**

**New date-time API is i**ntroduced in Java 8 to overcome the following drawbacks of old date-time API :

**Not thread safe :** Unlike old java.util.Date which is not thread safe the new date-time API is immutable and doesn’t have setter methods.

**Less operations :** In old API there are only few date operations but the new API provides us with many date operations.

**Java 8 under the package java.time introduced a new date-time API, most important classes among them are :**

**Local :** Simplified date-time API with no complexity of timezone handling.

**Zoned :** Specialized date-time API to deal with various timezones.

// the current date LocalDate date = LocalDate.now();

// the current time

    LocalTime time = LocalTime.now();

// will give us the current time and date

    LocalDateTime current = LocalDateTime.now();

// to print in a particular format

    DateTimeFormatter format =

      DateTimeFormatter.ofPattern("dd-MM-yyyy HH:mm:ss");

    String formatedDateTime = current.format(format);

// printing months days and seconds

    Month month = current.getMonth();

**int** day = current.getDayOfMonth();

**int** seconds = current.getSecond();

 // printing some specified date

    LocalDate date2 = LocalDate.of(1950,1,26);

 // printing date with current time.

    LocalDateTime specificDate =

        current.withDayOfMonth(24).withYear(2016);

// to get the current zone

    ZonedDateTime currentZone = ZonedDateTime.now();

**Period**and **Duration** classes :  
Period : It deals with date based amount of time.  
Duration : It deals with time based amount of time.

**ChronoUnits Enum :** java.time.temporal.ChronoUnit enum is added in Java 8 to replace integer values used in old API to represent day, month etc.

**TemporalAdjuster :**It is used to perform various date related operations.

## **Do we have PermGen in Java 8? Are you aware of MetaSpace?**

Until Java 7, JVM used an area called PermGen to store classes. It got removed in Java 8 and replaced by MetaSpace.  
Major advantage of MetaSpace over permgen:  
PermGen was fixed in term of mazimum size and can not grow dynamically but Metaspace can grow dynamically and do not have any size constraint.

# **Java 8 Stream**

Java provides a new additional package in Java 8 called java.util.stream. This package consists of classes, interfaces and enum to allows functional-style operations on the elements. You can use stream by importing java.util.stream package.

Stream provides following features:

* Stream does not store elements. It simply conveys elements from a source such as a data structure, an array, or an I/O channel, through a pipeline of computational operations.
* Stream is functional in nature. Operations performed on a stream does not modify it's source. For example, filtering a Stream obtained from a collection produces a new Stream without the filtered elements, rather than removing elements from the source collection.
* Stream is lazy and evaluates code only when required.
* The elements of a stream are only visited once during the life of a stream. Like an Iterator, a new stream must be generated to revisit the same elements of the source.

You can use stream to filter, collect, print, and convert from one data structure to other etc. In the following examples, we have apply various operations with the help of stream.

**Java Stream interface method :**

**boolean allMatch(Predicate<? super T> predicate)**  : It returns all elements of this stream which match the provided predicate. If the stream is empty then true is returned and the predicate is not evaluated.

**boolean anyMatch(Predicate<? super T> predicate) :** It returns any element of this stream that matches the provided predicate. If the stream is empty then false is returned and the predicate is not evaluated.

**static <T> Stream.Builder<T> builder() :** It returns a builder for a Stream.

**<R,A> R collect(Collector<? super T,A,R> collector) :** It performs a mutable reduction operation on the elements of this stream using a Collector. A Collector encapsulates the functions used as arguments to collect(Supplier, BiConsumer, BiConsumer), allowing for reuse of collection strategies and composition of collect operations such as multiple-level grouping or partitioning.

**<R> R collect(Supplier<R> supplier, BiConsumer<R,? super T> accumulator, BiConsumer<R,R> combiner) :** It performs a mutable reduction operation on the elements of this stream. A mutable reduction is one in which the reduced value is a mutable result container, such as an ArrayList, and elements are incorporated by updating the state of the result rather than by replacing the result.

**static <T> Stream<T> concat(Stream<? extends T> a, Stream<? extends T> b) :** It creates a lazily concatenated stream whose elements are all the elements of the first stream followed by all the elements of the second stream. The resulting stream is ordered if both of the input streams are ordered, and parallel if either of the input streams is parallel. When the resulting stream is closed, the close handlers for both input streams are invoked.

**long count() :**It returns the count of elements in this stream. This is a special case of a reduction.

**Stream<T> distinct() :** It returns a stream consisting of the distinct elements (according to Object.equals(Object)) of this stream.

**static <T> Stream<T> empty() :** It returns an empty sequential Stream.

**Stream<T> filter(Predicate<? super T> predicate) :** It returns a stream consisting of the elements of this stream that match the given predicate.

**Optional<T> findAny() :** It returns an Optional describing some element of the stream, or an empty Optional if the stream is empty.

**Optional<T> findFirst() :**It returns an Optional describing the first element of this stream, or an empty Optional if the stream is empty. If the stream has no encounter order, then any element may be returned.

**<R> Stream<R> flatMap(Function<? super T,? extends Stream<? extends R>> mapper) :** It returns a stream consisting of the results of replacing each element of this stream with the contents of a mapped stream produced by applying the provided mapping function to each element. Each mapped stream is closed after its contents have been placed into this stream. (If a mapped stream is null an empty stream is used, instead.)

**DoubleStream flatMapToDouble(Function<? super T,? extends DoubleStream> mapper):**  It returns a DoubleStream consisting of the results of replacing each element of this stream with the contents of a mapped stream produced by applying the provided mapping function to each element. Each mapped stream is closed after its contents have placed been into this stream. (If a mapped stream is null an empty stream is used, instead.)

**IntStream flatMapToInt(Function<? super T,? extends IntStream> mapper) :** It returns an IntStream consisting of the results of replacing each element of this stream with the contents of a mapped stream produced by applying the provided mapping function to each element. Each mapped stream is closed after its contents have been placed into this stream. (If a mapped stream is null an empty stream is used, instead.)

**LongStream flatMapToLong(Function<? super T,? extends LongStream> mapper) :** It returns a LongStream consisting of the results of replacing each element of this stream with the contents of a mapped stream produced by applying the provided mapping function to each element. Each mapped stream is closed after its contents have been placed into this stream. (If a mapped stream is null an empty stream is used, instead.)

**void forEach(Consumer<? super T> action) :** It performs an action for each element of this stream.

**void forEachOrdered(Consumer<? super T> action) :**It performs an action for each element of this stream, in the encounter order of the stream if the stream has a defined encounter order.

**static <T> Stream<T> generate(Supplier<T> s) :** It returns an infinite sequential unordered stream where each element is generated by the provided Supplier. This is suitable for generating constant streams, streams of random elements, etc.

**static <T> Stream<T> iterate(T seed,UnaryOperator<T> f) :**It returns an infinite sequential ordered Stream produced by iterative application of a function f to an initial element seed, producing a Stream consisting of seed, f(seed), f(f(seed)), etc.

**Stream<T> limit(long maxSize):** It returns a stream consisting of the elements of this stream, truncated to be no longer than maxSize in length.

**<R> Stream<R> map(Function<? super T,? extends R> mapper) :**It returns a stream consisting of the results of applying the given function to the elements of this stream.

**DoubleStream mapToDouble(ToDoubleFunction<? super T> mapper) :** It returns a DoubleStream consisting of the results of applying the given function to the elements of this stream.

**IntStream mapToInt(ToIntFunction<? super T> mapper) :**It returns an IntStream consisting of the results of applying the given function to the elements of this stream.

**LongStream mapToLong(ToLongFunction<? super T> mapper) :** It returns a LongStream consisting of the results of applying the given function to the elements of this stream.

**Optional<T> max(Comparator<? super T> comparator) :**It returns the maximum element of this stream according to the provided Comparator. This is a special case of a reduction.

**Optional<T> min(Comparator<? super T> comparator):** It returns the minimum element of this stream according to the provided Comparator. This is a special case of a reduction.

**boolean noneMatch(Predicate<? super T> predicate):** It returns elements of this stream match the provided predicate. If the stream is empty then true is returned and the predicate is not evaluated.

**@SafeVarargs static <T> Stream<T> of(T... values) :**It returns a sequential ordered stream whose elements are the specified values.

**static <T> Stream<T> of(T t) :**It returns a sequential Stream containing a single element.

**Stream<T> peek(Consumer<? super T> action) :** It returns a stream consisting of the elements of this stream, additionally performing the provided action on each element as elements are consumed from the resulting stream.

**Optional<T> reduce(BinaryOperator<T> accumulator):** It performs a reduction on the elements of this stream, using an associative accumulation function, and returns an Optional describing the reduced value, if any.

**T reduce(T identity, BinaryOperator<T> accumulator):** It performs a reduction on the elements of this stream, using the provided identity value and an associative accumulation function, and returns the reduced value.

**<U> U reduce(U identity, BiFunction<U,? super T,U> accumulator, BinaryOperator<U> combiner):** It performs a reduction on the elements of this stream, using the provided identity, accumulation and combining functions.

**Stream<T> skip(long n) :** It returns a stream consisting of the remaining elements of this stream after discarding the first n elements of the stream. If this stream contains fewer than n elements then an empty stream will be returned.

**Stream<T> sorted() :**It returns a stream consisting of the elements of this stream, sorted according to natural order. If the elements of this stream are not Comparable, a java.lang.ClassCastException may be thrown when the terminal operation is executed.

**Stream<T> sorted(Comparator<? super T> comparator):** It returns a stream consisting of the elements of this stream, sorted according to the provided Comparator.

**Object[] toArray():** It returns an array containing the elements of this stream.

**<A> A[] toArray(IntFunction<A[]> generator) :**It returns an array containing the elements of this stream, using the provided generator function to allocate the returned array, as well as any additional arrays that might be required for a partitioned execution or for resizing.

1. List<Float> productPriceList2 =productsList.stream()
2. .filter(p -> p.price > 30000)// filtering data
3. .map(p->p.price)        // fetching price
4. .collect(Collectors.toList()); // collecting as list
5. Stream.iterate(1, element->element+1)
6. .filter(element->element%5==0)
7. .limit(5)
8. .forEach(System.out::println);
9. // This is more compact approach for filtering data
10. productsList.stream()
11. .filter(product -> product.price == 30000)
12. .forEach(product -> System.out.println(product.name));
13. // This is more compact approach for filtering data
14. Float totalPrice = productsList.stream()
15. .map(product->product.price)
16. .reduce(0.0f,(sum, price)->sum+price);   // accumulating price
17. System.out.println(totalPrice);
18. // More precise code
19. **float** totalPrice2 = productsList.stream()
20. .map(product->product.price)
21. .reduce(0.0f,Float::sum);   // accumulating price, by referring method of Float class
22. System.out.println(totalPrice2);
23. // Using Collectors's method to sum the prices.
24. **double** totalPrice3 = productsList.stream()
25. .collect(Collectors.summingDouble(product->product.price));
26. // max() method to get max Product price
27. Product productA = productsList.stream()
28. .max((product1, product2)->
29. product1.price > product2.price ? 1: -1).get();
31. System.out.println(productA.price);
32. // min() method to get min Product price
33. Product productB = productsList.stream()
34. .max((product1, product2)->
35. product1.price < product2.price ? 1: -1).get();
36. System.out.println(productB.price);
37. // count number of products based on the filter
38. **long** count = productsList.stream()
39. .filter(product->product.price<30000)
40. .count();
41. System.out.println(count);
42. // Converting product List into Set
43. Set<Float> productPriceList =
44. productsList.stream()
45. .filter(product->product.price < 30000)   // filter product on the base of price
46. .map(product->product.price)
47. .collect(Collectors.toSet());   // collect it as Set(remove duplicate elements)
48. System.out.println(productPriceList);
49. // Converting Product List into a Map
50. Map<Integer,String> productPriceMap =
51. productsList.stream()
52. .collect(Collectors.toMap(p->p.id, p->p.name));
54. System.out.println(productPriceMap);
55. List<Float> productPriceList =
56. productsList.stream()
57. .filter(p -> p.price > 30000) // filtering data
58. .map(Product::getPrice)         // fetching price by referring getPrice method
59. .collect(Collectors.toList());  // collecting as list
60. System.out.println(productPriceList);

Java 8 Streams from creation to parallel execution.

To understand this material, readers need to have a basic knowledge of Java 8 (lambda expressions, Optional, method references) and of the Stream API.

**Stream Creation**

There are many ways to create a stream instance of different sources. Once created, the instance will not modify its source, therefore allowing the creation of multiple instances from a single source.

**2.1. Empty Stream**

The empty() method should be used in case of a creation of an empty stream:

Stream<String> streamEmpty = Stream.empty();

Its often the case that the empty() method is used upon creation to avoid returning null for streams with no element:

public Stream<String> streamOf(List<String> list) {

return list == null || list.isEmpty() ? Stream.empty() : list.stream();

}

**2.2. Stream of Collection**

Stream can also be created of any type of Collection (Collection, List, Set):

Collection<String> collection = Arrays.asList("a", "b", "c");

Stream<String> streamOfCollection = collection.stream();

**2.3. Stream of Array**

Array can also be a source of a Stream:

Stream<String> streamOfArray = Stream.of("a", "b", "c");

They can also be created out of an existing array or of a part of an array:

String[] arr = new String[]{"a", "b", "c"};

Stream<String> streamOfArrayFull = Arrays.stream(arr);

Stream<String> streamOfArrayPart = Arrays.stream(arr, 1, 3);

**2.4. Stream.builder()**

When builder is used the desired type should be additionally specified in the right part of the statement, otherwise the build() method will create an instance of the Stream<Object>:

Stream<String> streamBuilder =

Stream.<String>builder().add("a").add("b").add("c").build();

**2.5. Stream.generate()**

The generate() method accepts a Supplier<T> for element generation. As the resulting stream is infinite, developer should specify the desired size or the generate() method will work until it reaches the memory limit:

Stream<String> streamGenerated =

Stream.generate(() -> "element").limit(10);

The code above creates a sequence of ten strings with the value – “element”.

**2.6. Stream.iterate()**

Another way of creating an infinite stream is by using the iterate() method:

Stream<Integer> streamIterated = Stream.iterate(40, n -> n + 2).limit(20);

The first element of the resulting stream is a first parameter of the iterate() method. For creating every following element the specified function is applied to the previous element. In the example above the second element will be 42.

**2.7. Stream of Primitives**

Java 8 offers a possibility to create streams out of three primitive types: int, long and double. As Stream<T> is a generic interface and there is no way to use primitives as a type parameter with generics, three new special interfaces were created: IntStream, LongStream, DoubleStream.

Using the new interfaces alleviates unnecessary auto-boxing allows increased productivity:

IntStream intStream = IntStream.range(1, 3);

LongStream longStream = LongStream.rangeClosed(1, 3);

The range(int startInclusive, int endExclusive) method creates an ordered stream from the first parameter to the second parameter. It increments the value of subsequent elements with the step equal to 1. The result doesn't include the last parameter, it is just an upper bound of the sequence.

The rangeClosed(int startInclusive, int endInclusive) method does the same with only one difference – the second element is included. These two methods can be used to generate any of the three types of streams of primitives.

Since Java 8 the Random class provides a wide range of methods for generation streams of primitives. For example, the following code creates a DoubleStream, which has three elements:

Random random = new Random();

DoubleStream doubleStream = random.doubles(3);

**2.8. Stream of String**

String can also be used as a source for creating a stream.

With the help of the chars() method of the String class. Since there is no interface CharStream in JDK, the IntStream is used to represent a stream of chars instead.

IntStream streamOfChars = "abc".chars();

The following example breaks a String into sub-strings according to specified RegEx:

Stream<String> streamOfString =

Pattern.compile(", ").splitAsStream("a, b, c");

**2.9. Stream of File**

Java NIO class Files allows to generate a Stream<String> of a text file through the lines() method. Every line of the text becomes an element of the stream:

Path path = Paths.get("C:\\file.txt");

Stream<String> streamOfStrings = Files.lines(path);

Stream<String> streamWithCharset =

Files.lines(path, Charset.forName("UTF-8"));

The Charset can be specified as an argument of the lines() method.