# Java Functional Interface

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https://www.scaler.com/topics/functional-interface-in-java/

# Functional Interface in Java

- Is also called **Single Abstract Method** (SAM) interface.
  - A functional interface can contain only one abstract method and it can contain any number of static and default (non-abstract) methods.
- Enables users to implement functional programming in Java. In functional programming, the function is an independent entity.
  - No function is independently present on its own in java. They are part of classes or interfaces. And to use them we require either the class or the object of the respective class to call that function.

```
// interface
@FunctionalInterface   // annotation
interface interfaceName{
    // abstract method
    abstract returnType methodName( /* parameters */);

    // default or static methods

    int method1(){
        // ....
    }
    String method2(int x, float y){
        // ....
    }
}

// public class
public class className{
    // main method
    public static void main(String[] args){
        interfaceName temp = (/*parameters*/) -> {
            // perform operations
        };

        temp.methodName(); // call abstract method of the interface
    }
}
```

# Ways to Use Functional Interfaces in a Class

- concrete class
- Anonymous class ←→ lambda expression

```java
import java.util.*;
@FunctionalInterface
interface PersonalGreet{
    String greeting(String name);
}
public class MyClass implements PersonalGreet{
    public static void main(String[] args){
        Scanner sc = new Scanner(System.in);
        System.out.println("May I please know your Name?");
        String name = sc.next();
        MyClass obj = new MyClass();
        System.out.println(obj.greeting(name));
    }
    @Override
    public String greeting(String name){
        return "Hello! "+name;
    }
}
```

```java
import java.util.*;
@FunctionalInterface
interface PersonalGreet{
    String greeting(String name);
}
public class MyClass {
    public static void main(String[] args){
        Scanner sc = new Scanner(System.in);
        System.out.println("May I please know your Name?");
        String name = sc.next();
        PersonalGreet hello = (String temp) -> "Hello! "+temp;
        System.out.println(hello.greeting(name));
    }
}
```

# More on Functional Interface

- A Functional Interface Can Have Methods of Object Class

```java
@FunctionalInterface
interface ObjectClassMethods{
    // abstract method
    int abstractMethod(int val);
    // methods of the object class
    int hashCode();
    String toString();
    boolean equals(Object obj);
}
```

- Functional Interface Having Multiple Default and Static methods
- Java has pre-defined or built-in functional interfaces for commonly occurring cases.
  - A few of these interfaces are Runnable, Comparable, ActionListener, Callable

```java
// interface implementation
@FunctionalInterface
interface StaticandDefaultMethods{
    // abstract method
    int square(int x);
    // default methods
    default int add(int a, int b){
        return a+b;
    }
    default int sub(int a, int b){
        return a-b;
    }
    // static methods
    static int multiply(int a, int b){
        return a*b;
    }
    static int divide(int a, int b){
        return a/b;
    }
}

// public class
public class Test implements StaticandDefaultMethods{
    public static void main(String[] args){
```

# Built-in Java Functional Interfaces

- Functional interfaces in Java are mainly of four types:
  - Consumer
  - Predicate
  - Function
  - Supplier

| Function Type | Method Signature | Input parameters | Returns | When to use? |
|---|---|---|---|---|
| Predicate<T> | boolean test(T t) | one | boolean | Use in conditional statements |
| Function<T, R> | R apply(T t) | one | Any type | Use when to perform some operation & get some result |
| Consumer<T> | void accept(T t) | one | Nothing | Use when nothing is to be returned |
| Supplier<R> | R get() | None | Any type | Use when something is to be returned without passing any input |
| BiPredicate<T, U> | boolean test(T t, U u) | two | boolean | Use when Predicate needs two input parameters |
| BiFunction<T, U, R> | R apply(T t, U u) | two | Any type | Use when Function needs two input parameters |
| BiConsumer<T, U> | void accept(T t, U u) | two | Nothing | Use when Consumer needs two input parameters |
| UnaryOperator<T> | public T apply(T t) | one | Any Type | Use this when input type & return type are same instead of Function<T, R> |
| BinaryOperator<T> | public T apply(T t, T t) | two | Any Type | Use this when both input types & return type are same instead of BiFunction<T, U, R> |

https://javatechonline.com/predefined-functional-interfaces

# Consumer

- The Consumer functional interface in Java accepts a single gentrified argument and doesn't return any value.
- void accept(T t);

```java
@FunctionalInterface
public interface Consumer<T> {
    void accept(T t);
}
```

```java
List<String> names = Arrays.asList("John", "Jane", "Bob");

Consumer<String> printName = name -> System.out.println(name);

names.forEach(printName);
```

```java
static void demo1() {
    List<String> names = Arrays.asList(...a:"aba","abi","abo","abe");
    names.forE
}
```

```
forEach(Consumer<? super String> action)  void
```

# Predicate

- The predicate functional interface in Java takes a single argument and returns a boolean value.
- boolean test(T t);

```
public interface Predicate<T>{
    boolean test(T t);
}
```

```
Predicate<Integer> isEven = num -> num % 2 == 0;

boolean result1 = isEven.test(4); // returns true
boolean result2 = isEven.test(7); // returns false

System.out.println("Result1: " + result1);
System.out.println("Result2: " + result2);
```

```
Predicate<String> isLongerThan5 = str -> str.length() > 5;

boolean result3 = isLongerThan5.test("hello"); // returns false
boolean result4 = isLongerThan5.test("goodbye"); // returns true

System.out.println("Result3: " + result3);
System.out.println("Result4: " + result4);
```

# Function

- The function type functional interface receives a single argument, processes it, and returns a value.
- R apply(T t);
- (Remark BiFunction, BinaryOperator)
  - Next slide

```java
@FunctionalInterface
public interface Function<T, R>{
    R apply(T t);
}
```

```java
Function<String, Integer> stringLength = str -> str.length();

int length = stringLength.apply("hello");

System.out.println("Length of string: " + length);
```

```java
Function<String, Integer> stringToInt = str -> Integer.parseInt(str);

int num = stringToInt.apply("42");

System.out.println("Number: " + num);
```

# (More) Function

- BiFunction, BinaryOperator

```java
import java.util.function.BiFunction;

public class Main{
    public static void main(String[] args) {
        // This implementation concats the argument strings passed as parameters
        BiFunction<String, String, String> concatStrings = (s, s2) -> s.concat(s2);
        String s1 = "hello";
        String s2 = "-educative";

        // calling apply method of the BiFunction
        System.out.println(concatStrings.apply(s1, s2));
    }
}
```

```java
import java.util.function.Function;
import java.util.function.BinaryOperator;

public class Main{
    public static void main(String args[]){
        BinaryOperator<Integer> and = (a,b) -> a & b;
        System.out.println(and.apply(12, 4));
    }
}
```

# Supplier

- It doesn't take any arguments. On calling the supplier it simply returns a value.
  - Supplier is a generic interface thus, it takes the type of value in <> (Angular brackets) while implementing to be returned by the get() method.
- T get();

```
@FunctionalInterface
public interface Supplier<T>{
    T get();
}
```

```
Supplier<Integer> randomNumberSupplier = () -> (int) (Math.random() * 100);

int randomNumber = randomNumberSupplier.get();

System.out.println("Random number: " + randomNumber);
```

# More Examples

```
class Product {
  private double price = 0.0;

  public void setPrice(double price) {
    this.price = price;
  }

  public void printPrice() {
    System.out.println(price);
  }
}

public class Test {
  public static void main(String[] args) {
    Consumer<Product> updatePrice = p -> p.setPrice(5.9);
    Product p = new Product();
    updatePrice.accept(p);
    p.printPrice();
  }
}
```

```
Predicate<String> isALongWord = t -> t.length() > 10;
String s = "successfully"
boolean result = isALongWord.test(s);
```

```
Predicate<String> isALongWord = new Predicate<String>() {
    @Override
    public boolean test(String t) {
        return t.length() > 10;
    }
};
String s = "successfully"
boolean result = isALongWord.test(s);
```

# More Examples

```java
public class Test {
  public static void main(String[] args) {
    int n = 5;
    modifyTheValue(n, val-> val + 10);
    modifyTheValue(n, val-> val * 100);
  }

  static void modifyValue(int v, Function<Integer, Integer> function){
    int result = function.apply(v);
    System.out.println(newValue);
  }

}
```

```java
public class Program {
    public static void main(String[] args) {
        int n = 3;
        display(() -> n + 10);
        display(() -> n + 100);
    }

    static void display(Supplier<Integer> arg) {
        System.out.println(arg.get());
    }
}
```

# Method References in Java 8

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# Outlines

- Introduction
- Four types of method references
    1. Method reference to a static method of a class
    2. Method reference to an instance method of an object
    3. Method reference to an instance method of an arbitrary object of a particular type
    4. Method reference to a constructor

There are 4 kinds of method references in Java:

1. `ContainingClass::staticMethodName` - reference to a static method
2. `containingObject::instanceMethodName` - reference to an instance method of a particular object
3. `ContainingType::methodName` - reference to an instance method of an arbitrary object of a particular type
4. `ClassName::new` - reference to a constructor

https://stackoverflow.com/questions/66930573/method-reference-for-static-and-instance-methods

# Recap anonymous class and lambda expression on Functional Interface

```
interface DoubleMe {
  public void timesTwo(int n);
}
```

```
static void main() {
   // anonymous class
   DoubleMe obj1 = new DoubleMe() {
           public void timesTwo(int n) {
             System.out.println(n * 2);
           }
         };
   System.out.println( obj1.timesTwo(6) );

   // lambda expression
   DoubleMe obj2 = n -> System.out.println(n * 2);
   System.out.println( obj2.timesTwo(6) );
}
```

# Introduction

- method reference can be defined as some special form of the lambda expression.
  - It helps reduce the code of the program and aids in supporting the newly developed functionality of the programming language. It is used for referring to a method that serves to be functionally important.
- The following points can be marked while understanding the concept:
  - The method is referred to through the use of "**::**".
  - The arguments for the method type are inferred upon by JRE at the runtime through the context it is defined.

If your lambda expression is like this:

```
str -> System.out.println(str)
```

then you can replace it with a method reference like this:

```
System.out::println
```

# Method reference to a static method of a class

- Sending the context as a parameter to Class's static method
- `ContainingClass::staticMethodName` - reference to a static method

```
import java.util.Arrays;
import java.util.function.Consumer;
public class MRDemo
{
   public static void main(String[] args)
   {
      int[] array = { 10, 2, 19, 5, 17 };
      Consumer<int[]> consumer = Arrays::sort;
      consumer.accept(array);
      for (int i = 0; i < array.length; i++)
         System.out.println(array[i]);
      System.out.println();
      int[] array2 = { 19, 5, 14, 3, 21, 4 };
      Consumer<int[]> consumer2 = (a) -> Arrays.sort(a);
      consumer2.accept(array2);
      for (int i = 0; i < array2.length; i++)
         System.out.println(array2[i]);
   }
}
```

https://www.infoworld.com/article/3453296/get-started-with-method-references-in-java.html

# Method reference to an instance method of an object

- variable s invokes the print() class method with functionality to obtain this string's length as this method's argument.
- `containingObject::instanceMethodName` - reference to an instance method of a particular object

```
import java.util.function.Supplier;
public class MRDemo
{
   public static void main(String[] args)
   {
      String s = "The quick brown fox jumped over the lazy dog";
      print(s::length);
      print(() -> s.length());
      print(new Supplier<Integer>()
      {
         @Override
         public Integer get()
         {
            return s.length(); // closes over s
         }
      });
   }
   public static void print(Supplier<Integer> supplier)
   {
      System.out.println(supplier.get());
   }
}
```

https://www.infoworld.com/article/3453296/get-started-with-method-references-in-java.html

# Method reference to an instance method of an arbitrary object of a particular type

- the print() method with functionality to convert a string to lowercase and the string to be converted as the method's arguments.
  `ContainingType::methodName` - reference to an instance method of an arbitrary object of a particular type

```
ort java.util.function.Function;
lic class MRDemo

public static void main(String[] args)
{
   print(String::toLowerCase, "STRING TO LOWERCASE");
   print(s -> s.toLowerCase(), "STRING TO LOWERCASE");
   print(new Function<String, String>()
   {
      @Override
      public String apply(String s) // receives argument in parameter
      {                             // doesn't need to close over s
         return s.toLowerCase();
      }
   }, "STRING TO LOWERCASE");
}
public static void print(Function<String, String> function, String s)
{
   System.out.println(function.apply(s));
}
```

https://www.infoworld.com/article/3453296/get-started-with-method-references-in-java.html

# Method reference to a constructor

- You can use a method reference to refer to a constructor without instantiating the named class. This kind of method reference is known as a constructor reference
- `ClassName::new` - reference to a constructor

```
//https://www.baeldung.com/java-method-references
//constructor
public Bicycle(String brand) {
    this.brand = brand;
    this.frameSize = 0;
}
...
brands.stream().map(Bicycle::new).toList();
```

# More Examples

```
public class Singer {
    String name;
    Style style;
    Singer(String n, Style s) {
        name = n;
        style = s;
    }
    Singer(String n) {
        name = n;
        style = Style.POP;
    }
    public String getName() { return name; }
    public Style getStyle() { return style; }
    public static void staticSayHi(String n) {
       System.out.println("hi " + n); }
    public void shakeHand(String n) {
       System.out.println(name + " shakes hand with " + n + "."); }
    public void introduce() {
       System.out.println("My name is " + name); };
}
```

```
enum Style {
    POP, ROCK
}
```

# More Examples

```
static void demo1_reference_to_static_method() {
  List<String> test = Arrays.asList("Tom","Jane");
  test.forEach(Singer::staticSayHi);
  // "Hi, Tom" "Hi, Jane"
}

static void demo2_reference_to_instance_method() {
  Singer s = new Singer("aba");
  SayAble say = s::introduce; //My name is aba
  say.say();
}

static void demo3a_reference_to_arbitrary_method() {
  Function<Integer, Integer> fn = new Func()::plus10;
  System.out.println( fn.apply(20) ); // 30
}
```

```
interface SayAble {
    void say();
}
class Func {
    String name;
    public int plus10(int x) {
        return x + 10;
    }
}
```

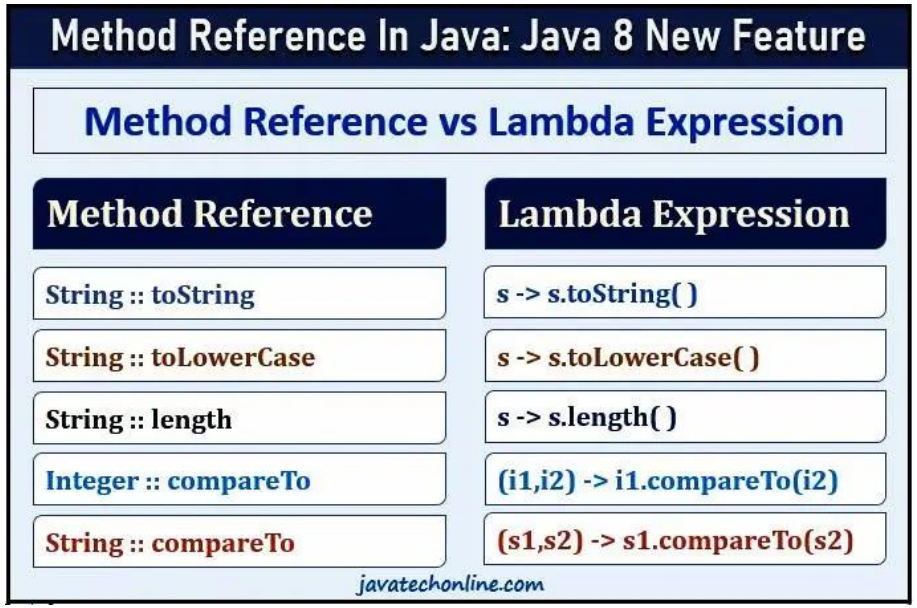
# More Examples

```
static void sub_3b() {
    Singer abi = new Singer("abi");
    List<Singer> lis = Arrays.asList(new Singer("abo"), abi);
    Comparator<Singer> byName = Comparator.comparing(Singer::getName);
    Collections.sort(lis,byName);
    lis.forEach(System.out::println);

    System.out.println("xxx---xxx");
    abi.style = Style.ROCK;
    Collections.sort(lis,
       (s1,s2) -> Integer.compare(s1.style.ordinal(), s2.style.ordinal()));
    lis.forEach(System.out::println);
}

static void demo4_reference_to_constructor() {
  Function<String, Singer> fn = Singer::new;
  Singer s = fn.apply("Tom");
  System.out.println(s.getName() + s.getStyle()
  /* or create toString() */);
}
```

| Nr | Method Reference Type | Method Reference | Lambda expression |
|---|---|---|---|
| 1 | **Static** method | `String::valueOf` | `(int i) -> String.valueOf(i)` |
| 2 | Instance method of a particular object | `s::substring` | `(int beg, int end) -> s.substring(beg, end)` |
| 3 | Instance method of an arbitrary object | `String::equals` | `(String s1, String s2) -> s1.equals(s2)` |
| | | `JLabel::getIcon` | `(JLabel lb) -> lb.getIcon()` |
| 4 | **Constructor** | `String::new` | `() -> new String()` |

https://stackoverflow.com/questions/23023618/how-to-invoke-parameterized-method-with-method-reference

# Recap & Further Readings




https://javatechonline.com/method-reference-java-8/

| Lambda Expressions | Equivalent Method References |
|---|---|
| (String s) -> Integer.parseInt(s) | Integer::parseInt |
| (String s) -> s.toLowerCase() | String::toLowerCase |
| (int i) -> System.out.println(i) | System.out::println |
| (Student s) -> s.getName() | Student::getName |
| () -> s.getName() | s::getName<br>where *'s'* refers to *Student* object which already exist. |
| () -> new Student() | Student::new |

https://javaconceptoftheday.com/java-8-method-references/

- https://www.geeksforgeeks.org/method-references-in-java-with-examples/
- https://examples.javacodegeeks.com/java-development/core-java/java-8-method-reference-example/