Java 8 Lambda Expression: Functional Interface

"Code with Passion!"

Topics

- Java 8 provided Functional Interface definitions
  - Simply typed functional interfaces
  - Generically typed functional interfaces
- Usage example of *Predicate*
- Usage example of *Function*
- Composition

Java 8 Provided Functional Interfaces

Functional Interfaces defined in Java 8

- Java 8 comes with a set of commonly used functional interfaces in *java.util.function* package - so you don't have to define your own anymore

- There are two kinds of Java 8 provided functional interfaces
  - Simply typed
  - Generically typed

Simply Typed Functional Interfaces

Simply Typed Functional Interfaces

- Use simply typed functional interfaces when the types of arguments and return type can be pre-determined
- Simply typed functional interfaces
  - IntPredicate — int -> boolean — test()
  - LongPredicate — long -> boolean — test()
  - LongUnaryOperator — long ->long — applyAsLong()
  - DoubleBinaryOperator — (double, double) -> double — applyAsDouble()
  - …

```
// Implementation of the functional interface is provided
LongUnaryOperator  operator = x -> x * 10;

// You are going to call the method of the functional interface
Long resultLong = operator.applyAsLong(20L);
```

IntPredicate int->boolean test()

- Represents a predicate (boolean-valued function) of one int-valued argument
  - This is the int-consuming primitive type specialization of Predicate

```
// Definition
@FunctionalInterface
public interface IntPredicate {
    boolean test(int value);
}

// Usage
IntPredicate predicate = x -> x > 10;
boolean resultBoolean = predicate.test(5);
```

Generically Typed Functional Interfaces

Generically Types Functional Interfaces

- Supplier<T> () -> T get()
- Consumer<T> T -> void accept()
- BiConsumer<T,U> (T,U) -> void accept()
- Function<T,R> T -> R apply()
- BiFunction<T,U,R> (T,U) -> R apply()
- Predicate<T> T -> boolean test()
- BiPredicate<T,U> (T,U) -> boolean test()
- UnaryOperator<T> T -> T apply()
- BinaryOperator<T> (T,T) -> T apply()

Supplier<T> ()->T get()

- Represents a supplier of results
  - This is a functional interface whose functional method is get()
  - <T> the type of result supplied by this supplier

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

// Usage examples
Supplier<String>    supplier1 = () -> "String1";
Supplier<Integer>  supplier2 = () -> "String1".length();
```

Consumer<T> T->void accept()

- Represents an operation that accepts a single input argument and returns no result
  - This is a functional interface whose functional method is *accept(Object)*
  - <T> the type of the input to the operation
- Variation: BiConsumer<T,U> (T,U) -> void accept()

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

// Usage examples
Consumer<String>    consumer1 = x -> System.out.println(x);
Consumer<Integer>   consumer2 = y -> System.out.println(y*y);
```

Function<T,R> T->R apply()

- Represents a function that accepts one argument and produces a result
  - The lambda expression is the body of the *apply()* method
  - <T> the type of the input to the function
  - <R> the type of the result of the function
- Variation: BiFunction<T,U,R> (T,U) -> R apply()

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

// Usage examples
Function<String, String>   function1 = x -> x.toUpperCase();
Function<String, Integer>  function2 = x -> x.length();
```

Predicate<T> T->boolean test()

- Represents a predicate (boolean-valued function) of one argument.
  - <T> the type of the input to the predicate
- BiPredicate<T,U> (T,U) -> boolean test()

```
// Definition
@FunctionalInterface
public interface Predicate<T> {
   boolean test(T t);
}

// Usage examples
Predicate<Double> predicate1 = x -> x > 10;
Predicate<String>  predicate2 = s -> s.length() > 10;
```

UnaryOperator<T> T->T apply()

- UnaryOperator is a java 8 functional interface that extends Function
- UnaryOperator is used to work on a single operand. It returns the same type as an operand
- BinaryOperator<T> (T,T) -> T apply()

```
// Definition
@FunctionalInterface
public interface UnaryOperator<T> extends Function<T, T> {
    static <T> UnaryOperator<T> identity() {
        return t -> t;
    }
}

// Usage example
UnaryOperator<String>  unaryOperator1 = x -> x.toUpperCase();
```

Usage Example of Predicate

Example Usage of Predicate

- Example scenario
  - From a list, find all items that meet a test criteria - use predicate to filter out unqualified items

- There are several options to write this code (in the order of least desirable to most desirable option)
  - #1: Embed test code in a for loop (In Java 7) - least desirable
  - #2: Use predicate with specific type (Java 8)
  - #3: Use predicate with generic type (Java 8)
  - #4: Use a stream (Java 8) - most desirable

#1: Embed test code in a for loop (Java 7)

- Find all people who has name “Jon”

```
public static List<Person> findPeopleByName(List<Person> people, String name) {
   List<Person> result = new ArrayList<Person>();
   for (Person p : people) {
      if (p.getName().equals(name)) {  result.add(p); }
    }
    return result;
}
```

(Bad) Every time you need to perform a search using a new test criteria, you have to write new code. Here, we had to write 3 different code.

- Find all people whose age is greater than 10

```
public static List<Person> findPeopleByAge(List<Person> people, int age){  // Code …
}
```

- Find all people who has name “Jon” and whose age is greater than 10

```
public static List<Person> findPeopleByNameAndAge(List<Person> people, String name,  int age){ //  …
}
```

#2 Use Predicate for specific type (Java 8)

- Find all people who has name “Jon”

```
public static List<Person> finePeople(List<Person> people, Predicate<Person> aPredicate) {
    List<Person> result = new ArrayList<Person>();
    for (Person p : people) {
        if (aPredicate.test(p)) { result.add(p);}
    }
    return result;
}
peopleResult = finePeople(people, person -> person.getName().equals("Jon"));
```

(Good) Every time you need to perform a search with a new test criteria, you just write new predicate.

(Bad) The code works only with Person type and cannot be used other types

- Find all people whose age is greater than 10

```
peopleResult = finePeople(people, person -> person.getAge() > 10);
```

- Find all people who has name “Jon” and whose age is greater than 10

```
peopleResult = finePeople(people, person -> person.getName().equals("Jon") &&
                                  person.getAge() > 10);
```

#3 Use Predicate for Generic type (Java 8)

- Find people using test criteria

```
public static <T> List<T> find(List<T> myList, Predicate<T> aPredicate) {
    List<T> result = new ArrayList<T>();
    for (T item : myList) {
        if (aPredicate.test(item)) {result.add(item);}
    }
    return result;
}
List<Person> peopleResult = peopleResult = find(people, person -> person.getName().equals("Jon"));
peopleResult = find(people, person -> person.getAge() > 10);
peopleResult = find(people, person -> person.getName().startsWith("J") &&person.getAge() > 10);
```

(Good) The same code can be used with different types - Person and Fruit

.

(Bad) The code still uses for loop

- Find fruits using test criteria

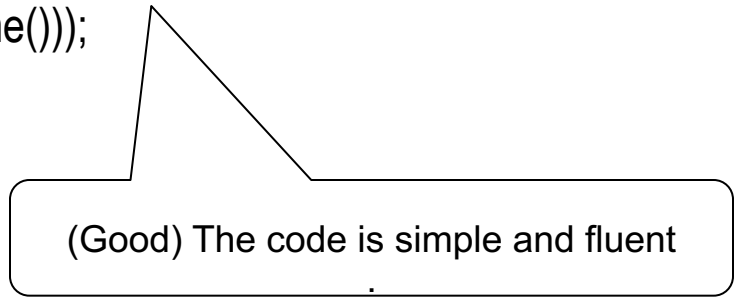
```
List<Fruit> fruitResult = find(fruits, fruit -> fruit.getName().equals("Apple"));
fruitResult = find(fruits, fruit -> fruit.getQuantity() > 10);
fruitResult = find(fruits, fruit -> fruit.getName().startsWith("J") && fruit.getQuantity() > 10);
```

#4 Use Stream's filter (Java 8)

- <We are going to cover Streams in another presentation in detail. It is mentioned here for the sake of completeness>

```
Stream<Person> resultPeople = people.stream().filter(person -> person.getName().equals("Jon"));
resultPeople.forEach(person -> System.out.println(person.getName()));

Stream<Fruit> resultFruits = fruits.stream().filter(fruit -> fruit.getName().equals("Apple"));
resultFruits.forEach(fruit -> System.out.println(fruit.getName()));
```



Usage Example of Function

Example Usage of Function

- Example scenario
  - From a list, convert each item using conversion logic - use Function to perform conversion of each item

- There are several options to write this code (in the order of least desirable to most desirable)
  - #1: Embed conversion code in a for loop (In Java 7) - least desirable
  - #2: Use Function with specific type (Java 8)
  - #3: Use Function with generic type (Java 8)
  - #4: Use a stream (Java 8) - most desirable

#1: Embed conversion code in a for loop (Java 7)

- Convert name of each person to uppercase

```
public static void convertPeopleUppercase(List<Person> people) {
    for (Person p : people) {
        p.setName(p.getName().toUpperCase());
    }
}
```

(Bad) Every time you need to perform a new conversion, you have to write new code.

- Convert name of each person to lowercase

```
public static void convertPeopleLowercase(List<Person> people) {
    for (Person p : people) {
        p.setName(p.getName().toLowerCase());
    }
}
```

- Convert name of each person to camelcase

```
public static void convertPeopleCamelcase(List<Person> people) {
}
```

#2: Use Function for specific type (Java 8)

- Convert name of each person to uppercase

```
public static void convertPeople(List<Person> people, Function<Person, Person>aFunction) {
    for (Person p : people) {
        aFunction.apply(p);
    }
}
```

(Good) Every time you need to perform a new conversion, you just write new Function.

(Bad) The code works only with Person type and cannot be used other types

```
Function<Person, Person> aFunction1 =
  person -> {person.setName(person.getName().toUpperCase()); return person;};
convertPeople(people, aFunction1);
```

- Convert name of each person to lowercase

```
Function<Person, Person> aFunction2 =
  person -> {person.setName(person.getName().toLowerCase()); return person;};
convertPeople(people, aFunction2);
```

- Convert name of each person to camelcase

#3: Use Function for Generic type (Java 8)

- Convert name of each person to uppercase

```
public static <T,R> void convert(List<T> myList, Function<T, R> aFunction) {
    for (T t : myList) {
        aFunction.apply(t);
    }
}
Function<Person, Person> aFunction1 =
   person -> {person.setName(person.getName().toUpperCase()); return person;};
convert(people, aFunction1);
```

(Good) The same code can be used with different types - Person and Fruit

.

(Bad) The code still uses for loop

- Convert name of each person to lowercase

```
Function<Person, Person> aFunction2 =
   person -> {person.setName(person.getName().toLowerCase()); return person;};
convert(people, aFunction2);
```

- Convert name of each fruit to camelCase

```
Function<Fruit, Fruit> aFunction3 = ...
```

#4 Use Stream's map (Java 8)

- <We are going to cover Streams in another presentation in detail. It is mentioned here for the sake of completeness>

```
// Use stream
Stream<Person> resultPeople =
                people
                .stream()
               .map(person -> {person.setName(person.getName().toUpperCase()); return person;});
resultPeople.forEach(person -> System.out.print(person.getName() + " "));
```

(Good) The code is simple and fluent

.

Composition of Lambda Expressions

Composition of Lambda Expressions

- Composition allows applying lambda expressions one after another

- There are two methods:
  - *Function compose(Function before)* - The before function is applied first and then the calling function
  - *Function andThen(Function after)* - The after function is applied after the calling function

andThen and compose

```
// Functions without composition
Function<Person, Address> personToAddressFunction =(person) -> person.getAddress();
Function<Address, String> addressToCountryFunction = (address) -> address.getCountry();
Address address = personToAddressFunction.apply(new Person("Sang", new Address("Korea")));
String country = addressToCountryFunction.apply(address);

// Functions with "andThen" composition
Function<Person, String> personToCountryFunction1 =
   personToAddressFunction.andThen(addressToCountryFunction);
country = personToCountryFunction1.apply(new Person("Jon",new Address("USA")));

// Functions with "compose" composition
Function<Person, String> personToCountryFunction2 =
    addressToCountryFunction.compose(personToAddressFunction);
country = personToCountryFunction2.apply(new Person("Jon",new Address("China")));
```

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