02: ♦ Java 8 Streams, lambdas, intermediate vs terminal ops, and lazy loading with simple examples

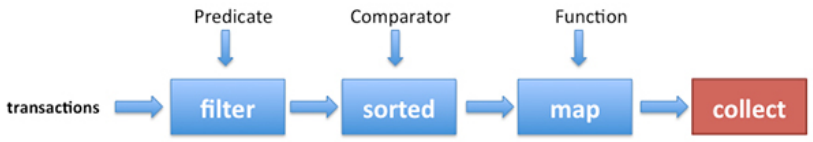
Posted on February 24, 2015 by Arulkumaran Kumaraswamipillai

A **stream** is an infinite sequence of consumable elements (i.e a data structure) for the consumption of an operation or iteration. Any **Collection<T>** can be exposed as a stream. It looks complex, but once you get it, it is very simple. The operations you perform on a stream can either be

1. Intermediate operations like map, filter, sorted, limit, skip, concat, substream, distinct, peek, etc producing another

java.util.stream.Stream<T> or a

2. Terminal operations like forEach, reduce, collect, sum, max, count, matchAny, findFirst, findAny, etc producing an object that is not a stream.



Streams: intermediate(blue) & terminal (red)

Basically, you are building a pipeline as in Unix. In Unix we "pipe" operations, and in Java 8, we stream them.

```
1 ls -l | grep "Dec" | Sort +4n | more
```

The **stream( )** is a default method added to the **Collection<T>**interface in Java 8. The stream( ) returns a java.util.starem.**Stream<T>** interface with multiple abstract methods like filter, map, sorted, collect, etc. The **DelegatingStream<T>** is the implementing class.

Intermediate operations are **lazy operations**, which will be executed only after a terminal operation was executed. So when you call .filter(i -> i % 3 == 0) the lambda body isn't being executed at the moment. It will only be executed after a terminal operation was called (**collect**, in the example shown below). This is essential to understand from the viewpoint of adding break points in your IDE for debugging purpose.

Go through these examples to get a good handle on the stream concepts.

11 numbers 1 to 10 and an extra 6 are **a)** filtered first for multiples of 3 **b)** filtered for values less than 7 **c)** remove duplicates by adding to a Set<T> **d)** print the result.

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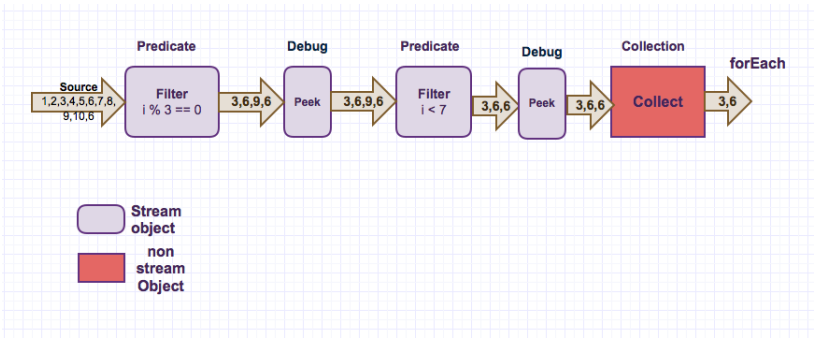
i -> i % 3 == 0 is a **lambda expression** used as a predicate to filter only multiples of 3. So,

Q. what is this "lambda expression"?
A. In OOP or imperative programming, x = x+ 5 makes sense, but in mathematics or **functional programming**, you can't say x = x + 5 because if x were to be 2, you can't say that 2 = 2 + 5. In functional programming you need to say f(x) -> x + 5.



Java 8 Stream

Example 1:

```
1  import java.util.Arrays;
2  import java.util.List;
3  import java.util.stream.Collectors;
4
5  public class Java8LambdaDebug {
6
7      public static void main(String[] args) {
8          List<Integer> list = Arrays.asList(1,2,3
9          list.stream()
10           .filter(i -> i % 3 == 0) //multiples o
11           .peek(i -> System.out.println("Debug p
12           .filter(i -> i < 7)
13           .peek(i -> System.out.println("Debug p
14           .collect(Collectors.toSet()) // remove
15           .forEach(i -> System.out.println("resu
16     }
17
18 }
19
```

In the above example, filter and peek are intermediate operations that return a "Stream<T>" object. The "peek" is used for **debugging**. The "collect(…)" is a terminal operation that returns a "Collection<T>" object, which extends

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"Iterable<T>"interface which has the "forEach(…)" method. Don't confuse this with the "forEach()" method in the "java.util.stream.Stream<T>".

Output:

```
Debug pt1: 3
Debug pt2: 3
Debug pt1: 6
Debug pt2: 6
Debug pt1: 9
Debug pt1: 6
Debug pt2: 6
result: 3
result: 6
```

Example 2:

Same as above, let's introduce another terminal operation **sum()**.

```
import java.util.Arrays;
import java.util.List;

public class Java8LambdaDebug {

    public static void main(String[] args) {
        List<Integer> list = Arrays.asList(1,2,3

        final int sum  = list.stream()
          .filter(i -> i % 3 == 0) //multiples o
          .peek(i -> System.out.println("Debug p
          .filter(i -> i < 7)
          .peek(i -> System.out.println("Debug p
          .mapToInt(Integer::intValue)
          .sum(); //duplicate 6 is included 3+6+

        System.out.println("sum=" + sum);
    }
}
```

In the above example, filter, peek, and mapToInt are intermediate operations that return a "Stream" object. "sum" is terminal operation that returns a result.

Output:

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```
1 Debug pt1: 3
2 Debug pt2: 3
3 Debug pt1: 6
4 Debug pt2: 6
5 Debug pt1: 9
6 Debug pt1: 6
7 Debug pt2: 6
8 sum=15
9
```

Example 3:

Let's mix "intermediate" and "terminal" operations up.

```
1  import java.util.Arrays;
2  import java.util.List;
3  import java.util.stream.Collectors;
4
5  public class Java8LambdaDebug {
6
7      public static void main(String[] args) {
8          List<Integer> list = Arrays.asList(1,2,3
9
10         final int sum  = list.stream()
11           .filter(i -> i % 3 == 0) //multiples o
12           .peek(i -> System.out.println("Debug p
13           .filter(i -> i < 7)
14           .peek(i -> System.out.println("Debug p
15           .collect(Collectors.toSet()) //remove
16           .stream()
17           .mapToInt(Integer::intValue)
18           .sum(); //duplicate is removed 3+6=12
19
20         System.out.println("sum=" + sum);
21     }
22 }
23
24
```

In the above example, filter(..), peek(..), stream(..), and mapToInt(..) are intermediate operations that return a "Stream<T>" object. "collect(…)" and "sum()" are terminal operations. Since, "collect" returns a "Collection&lt';T>" terminal object after removing the duplicate value of 6 with the help of *toSet()*, we need to call the stream() again to get the "Stream<T>" object back. Finally, "sum()" is a terminal operation.

Output:

```
1 Debug pt1: 3
2 Debug pt2: 3
```

```
3 Debug pt1: 6
4 Debug pt2: 6
5 Debug pt1: 9
6 Debug pt1: 6
7 Debug pt2: 6
8 sum=9
9
```

So, if still having trouble grasping this, have a look at the **Java 8 API docos** for Interfaces Stream<T>, Iterable<T> and Interface Collection<E>. Pay attention to default methods and return objects.

So, now with a little bit of help from the Java 8 API docs, you can perform different combination of operations on a collection of data. You can also debug by placing break points in your IDE like eclipse by keeping in mind that **intermediate ops are lazily evaluated** after a terminal operation. The **peek()** intermediate operation is very handy for debugging as well.

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