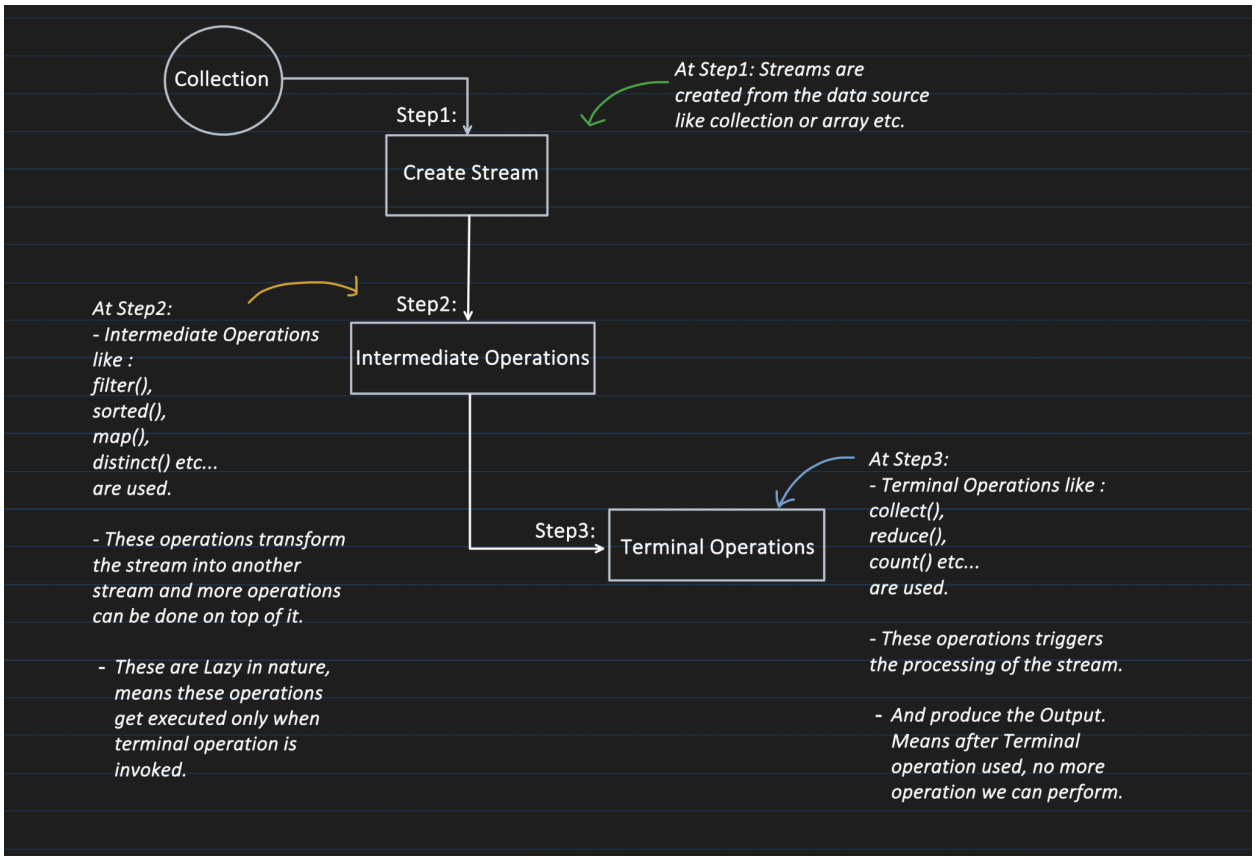
Java streams in Java8

Stream (Java8)

Sunday, 1 October 2023 12:33 PM

What is Stream?

- We can consider Stream as a pipeline, through which our collection elements passes through.
- While elements passes through pipelines, it perform various operations like sorting, filtering etc.
- Useful when deals with bulk processing. (can do parallel processing)



For Example:

```java
public class StreamExample {

    public static void main(String args[]){

        List<Integer> salaryList = new ArrayList<>();
        salaryList.add(3000);
        salaryList.add(4100);
        salaryList.add(9000);
        salaryList.add(1000);
        salaryList.add(3500);

        int count = 0;
        for(Integer salary : salaryList){
            if(salary > 3000){
                count++;
            }
        }

        System.out.println("Total Employee with salary > 3000: " + count);
    }
}
```

using Stream

```java
public class StreamExample {

    public static void main(String args[]){

        List<Integer> salaryList = new ArrayList<>();
        salaryList.add(3000);
        salaryList.add(4100);
        salaryList.add(9000);
        salaryList.add(1000);
        salaryList.add(3500);

        long output = salaryList.stream().filter((Integer sal) -> sal>3000).count();
        System.out.println("Total Employee with salary > 3000: " + output);
    }
}
```

Output:

```
Total Employee with salary > 3000: 3
```

Different ways to create a stream:

1. From Collection:

```java
List<Integer> salaryList = Arrays.asList(3000, 4100, 9000, 1000, 3500);
Stream<Integer> streamFromIntegerList = salaryList.stream();
```

2. From Array:

```java
Integer[] salaryArray = {3000, 4100, 9000, 1000, 3500};
Stream<Integer> streamFromIntegerArray = Arrays.stream(salaryArray);
```

3. From Static Method:

```java
Stream<Integer> streamFromStaticMethod= Stream.of( ...values: 1000, 3500, 4000, 9000);
```

4. From Stream Builder:

```
Stream.Builder<Integer> streamBuilder = Stream.builder();
streamBuilder.add(1000).add(9000).add(3500);

Stream<Integer> streamFromStreamBuilder =  streamBuilder.build();
```

5. From Stream Iterate:

```
Stream<Integer> streamFromIterate = Stream.iterate( seed: 1000, (Integer n) -> n + 5000).limit( maxSize: 5);
```

Different Intermediate Operations:

We can chain multiple Intermediate operations together to perform more complex processing before applying terminal operation to produce the result.

No.	Intermediate Operation	Description

1.	filter(Predicate<T> predicate)
	`Stream<String> nameStream = Stream.of( ...values: "HELLO", "EVERYBODY", "HOW", "ARE", "YOU", "DOING");`
	`Stream<String> filteredStream = nameStream.filter((String name) -> name.length() <= 3);`
	`List<String> filteredNameList = filteredStream.collect(Collectors.toList());`
	`//OUTPUT: HOW, ARE, YOU`
		Filters the element.

2.	map(Function<T, R> mapper)
	`Stream<String> nameStream = Stream.of( ...values: "HELLO", "EVERYBODY", "HOW", "ARE", "YOU", "DOING");`
	`Stream<String> filteredNames = nameStream.map((String name) -> name.toLowerCase());`
	`//OUTPUT: hello, everybody, how, are, you, doing`
		Used to transform each element

3. flatMap(Function<T, Stream<R>> mapper)

```
List<List<String>>  sentenceList = Arrays.asList(
        Arrays.asList("I", "LOVE", "JAVA"),
        Arrays.asList("CONCEPTS", "ARE", "CLEAR"),
        Arrays.asList("ITS", "VERY", "EASY")
);

Stream<String> wordsStream1 = sentenceList.stream()
        .flatMap((List<String> sentence)-> sentence.stream());
//Output: I, LOVE, JAVA, CONCEPTS, ARE, CLEAR, ITS, VERY, EASY

Stream<String> wordsStream2 = sentenceList.stream()
        .flatMap((List<String> sentence)-> sentence.stream().map((String value) -> value.toLowerCase()));
//Output: i, love, java, concepts, are, clear, its, very, easy
```

Used to iterate over each element of the complex collection, and helps to flatten it.

4. distinct()

```
Integer[] arr = {1,5,2,7,4,4,2,0,9};

Stream<Integer> arrStream = Arrays.stream(arr).distinct();
//Output: 1, 5, 2, 7, 4, 0, 9
```

Removes duplicate from the stream.

5. sorted()

```
Integer[] arr = {1,5,2,7,4,4,2,0,9};

Stream<Integer> arrStream = Arrays.stream(arr).sorted();
//Output: 0, 1, 2, 2, 4, 4, 5, 7, 9
```

Sorts the elements.

```
Integer[] arr = {1,5,2,7,4,4,2,0,9};

Stream<Integer> arrStream = Arrays.stream(arr).sorted((Integer val1, Integer val2) -> val2-val1);
//Output: 9, 7, 5, 4, 4, 2, 2, 1, 0
```

6.	peek(Consumer<T> action)
	`List<Integer> numbers = Arrays.asList(2,1,3,4,6);`
	`Stream<Integer> numberStream = numbers.stream()`
	`.filter((Integer val)-> val>2)`
	`.peek((Integer val) -> System.out.println(val)) //it will print 3, 4, 6`
	`.map((Integer val) -> -1*val);`
	`List<Integer> numberList = numberStream.collect(Collectors.toList());`
		Helps you to see the intermediate result of the stream which is getting processed.

7.	limit(long maxSize)
	`List<Integer> numbers = Arrays.asList(2,1,3,4,6);`
	`Stream<Integer> numberStream = numbers.stream().limit( maxSize: 3);`
	`List<Integer> numberList = numberStream.collect(Collectors.toList());`
	`//Output: 2, 1, 3`
		Truncate the stream, to have no longer than given maxSize

8.	skip(long n)
	`List<Integer> numbers = Arrays.asList(2,1,3,4,6);`
	`Stream<Integer> numberStream = numbers.stream().skip( n: 3);`
	`List<Integer> numberList = numberStream.collect(Collectors.toList());`
	`//Output: 4, 6`
		Skip the first n elements of the stream.

9.	mapToInt(ToIntFunction<T> mapper)
	`List<String> numbers = Arrays.asList("2", "1", "4", "7");`
	`IntStream numberStream = numbers.stream().mapToInt((String val) -> Integer.parseInt(val));`
	`int[] numberArray = numberStream.toArray();`
	`//Output: 2, 1, 4, 7`
	`int[] numbersArray = {2, 1, 4, 7};`
	`IntStream numbersStream = Arrays.stream(numbersArray);`
	`numbersStream.filter((int val) -> val > 2);`
	`int[] filteredArray = numbersStream.toArray();`
	`//Output: 4, 7`
		helps to work with primitive "int" data types

10.	mapToLong(ToLongFunction<T> mapper) (pls try it out....)	helps to work with primitive "long" data types
11.	mapToDouble(ToDoubleFunction<T> mapper) (pls try it out....)	helps to work with primitive "double" data types

Why we call Intermediate operation "Lazy":

```java
public class StreamExample {

    public static void main(String args[]){

        List<Integer> numbers = Arrays.asList(2, 1, 4, 7, 10);
       Stream<Integer> numbersStream = numbers.stream().filter((Integer val) -> val >=3).peek((Integer val) -> System.out.println(val));
    }
}
```

Output:
Nothing would be printed in the Output

```java
public class StreamExample {

    public static void main(String args[]){

        List<Integer> numbers = Arrays.asList(2, 1, 4, 7, 10);
      Stream<Integer> numbersStream = numbers.stream().filter((Integer val) -> val >=3).peek((Integer val) -> System.out.println(val));

      numbersStream.count(); //count is one of the terminal operation
    }
}
```

Output:

```
4
7
10
```

Sequence of Stream Operations:

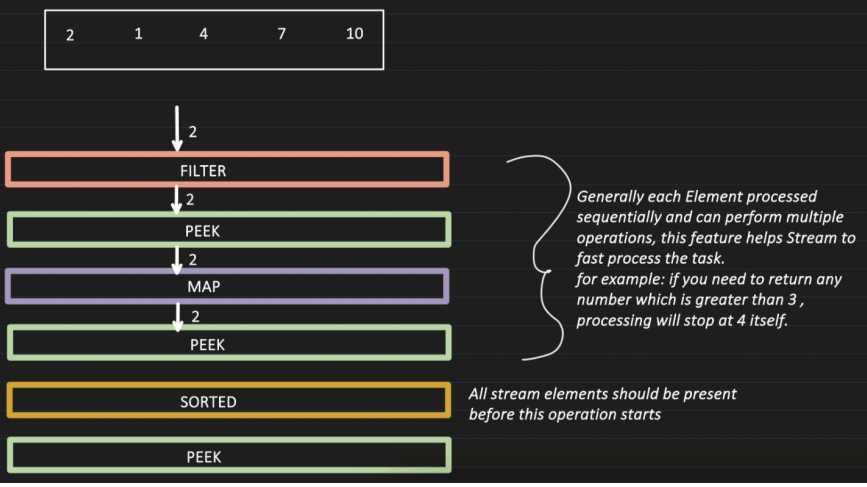
```java
public class StreamExample {

    public static void main(String args[]){

        List<Integer> numbers = Arrays.asList(2, 1, 4, 7, 10);
      Stream<Integer> numbersStream = numbers.stream()
              .filter((Integer val) -> val >=3)
              .peek((Integer val)-> System.out.println("after filter:" + val))
              .map((Integer val) -> (val * -1))
              .peek((Integer val)-> System.out.println("after negating:" + val))
              .sorted()
              .peek((Integer val)-> System.out.println("after Sorted:" + val));

      List<Integer> filteredNumberStream = numbersStream.collect(Collectors.toList());
    }
}
```

Expected Output:

```
after filter: 4
after filter: 7
after filter: 10

after negating: -4
after negating: -7
after negating: -10

after Sorted: -10
after Sorted: -7
after Sorted: -4
```

Actual Output:

```
after filter:4
after negating:-4
after filter:7
after negating:-7
after filter:10
after negating:-10
after Sorted:-10
after Sorted:-7
after Sorted:-4
```



Generally each Element processed sequentially and can perform multiple operations, this feature helps Stream to fast process the task.
for example: if you need to return any number which is greater than 3 , processing will stop at 4 itself.

All stream elements should be present before this operation starts

Different Terminal Operations:

Terminal operations are the ones that produces the result. It triggers the processing of the stream.

No.	Terminal Operations	Description

1.	forEach(Consumer<T> action)
	`List<Integer> numbers = Arrays.asList(2, 1, 4, 7, 10);`
	`numbers.stream()`
	`.filter((Integer val) -> val >=3)`
	`.forEach((Integer val)-> System.out.println(val));`
	`//OUTPUT: 4, 7, 10`
		Perform action on each element of the Stream.
		DO NOT Returns any value.

2.	toArray()
	`List<Integer> numbers = Arrays.asList(2, 1, 4, 7, 10);`
	`Object[] filteredNumberArrType1 = numbers.stream()`
	`.filter((Integer val) -> val >=3)`
	`.toArray();`
	`Integer[] filteredNumberArrType2 = numbers.stream()`
	`.filter((Integer val) -> val >=3)`
	`.toArray((int size) -> new Integer[size]);`
		Collects the elements of the stream into an Array.

3.	reduce(BinaryOperator<T> accumulator)
	`List<Integer> numbers = Arrays.asList(2, 1, 4, 7, 10);`
	`Optional<Integer> reducedValue = numbers.stream()`
	`.reduce((Integer val1, Integer val2) -> val1+val2);`
	`System.out.println(reducedValue.get());`
	`//output: 24`
		does reduction on the elements of the stream. Perform associative aggregation function.

4.	collect(Collector<T, A, R> collector)
	`List<Integer> numbers = Arrays.asList(2, 1, 4, 7, 10);`
	`List<Integer> filteredNumber = numbers.stream()`
	`.filter((Integer val) -> val >=3)`
	`.collect(Collectors.toList());`
		can be used to collects the elements of the stream into an List.

5.

min(Comparator<T> comparator) and max(Comparator<T> comparator)

```
List<Integer> numbers = Arrays.asList(2, 1, 4, 7, 10);

Optional<Integer> minimumValueType1 = numbers.stream()
        .filter((Integer val) -> val>=3)
          .min((Integer val1, Integer val2) -> val1-val2);

System.out.println(minimumValueType1.get());
//output: 4

  Optional<Integer> minimumValueType2 = numbers.stream()
          .filter((Integer val) -> val>=3)
          .min((Integer val1, Integer val2) -> val2-val1);

  System.out.println(minimumValueType2.get());
  //output: 10
```

Finds the minimum or maximum element from the stream based on the comparator provided.

*Can you pls comment the output for **max** for both the types*

6.

count()

```
List<Integer> numbers = Arrays.asList(2, 1, 4, 7, 10);


long noOfValuesPresent = numbers.stream()
        .filter((Integer val1) -> val1>=3)
        .count();

System.out.println(noOfValuesPresent);
//output: 3
```

returns the count of element present in the stream

7.	anyMatch(Predicate<T> predicate)
	`List<Integer> numbers = Arrays.asList(2, 1, 4, 7, 10);`
	`boolean hasValueGreaterThanThree = numbers.stream()`
	`.anyMatch((Integer val) -> val>3);`
	`System.out.println(hasValueGreaterThanThree);`
	`//output: true`
		Checks if any value in the stream match the given predicate and return the boolean.

8.	allMatch(Predicate<T> predicate) *Can you pls try it out...*	Checks if all value in the stream match the given predicate and return the boolean.
9.	noneMatch(Predicate<T> predicate) *Can you pls try it out...*	Checks if no value in the stream match the given predicate and return the boolean.

10.	findFirst()
	`List<Integer> numbers = Arrays.asList(2, 1, 4, 7, 10);`
	`Optional<Integer> firstValue = numbers.stream()`
	`.filter((Integer val) -> val >= 3)`
	`.findFirst();`
	`System.out.println(firstValue.get());`
	`//output: 4`
		finds the first element of the stream.

11.	findAny() *Can you pls try it out...*	finds any random element of the stream.

How many times we can use a single stream:

- One Terminal Operation is used on a Stream, it is closed/consumed and can not be used again for another terminal operation.

```java
List<Integer> numbers = Arrays.asList(2, 1, 4, 7, 10);

Stream<Integer> filteredNumbers = numbers.stream()
        .filter((Integer val) -> val >= 3);

filteredNumbers.forEach((Integer val) -> System.out.println(val)); // consumed the filteredNumbers stream

//trying to use the closed stream again
List<Integer> listFromStream = filteredNumbers.collect(Collectors.toList());
```

Output:

```
4
7
10
Exception in thread "main" java.lang.IllegalStateException Create breakpoint : stream has already been operated upon or closed
    at StreamExample.main(StreamExample.java:19)
```

Parallel Stream:

Helps to perform operation on stream concurrently, taking advantage of multi core CPU.
ParallelStream() method is used instead of regular stream() method.
Internally it does:

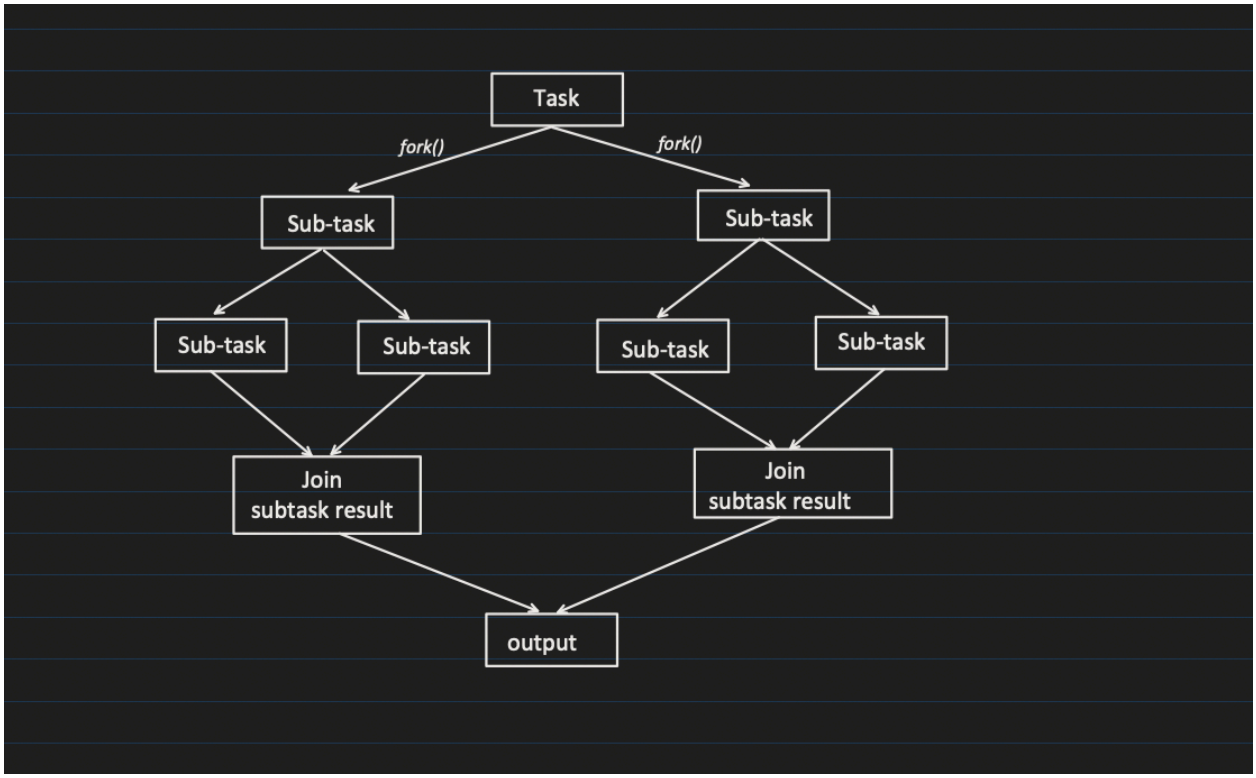
- Task splitting : it uses "spliterator" function to split the data into multiple chunks.
- Task submission and parallel processing : Uses Fork-Join pool technique.

Note: i will cover Fork-Join pool implementation in Multithreading topic

```java
public class StreamExample {

    public static void main(String args[]) {

        List<Integer> numbers = Arrays.asList(11, 22, 33, 44, 55, 66, 77, 88, 99, 110);

        // Sequential processing
        long sequentialProcessingStartTime = System.currentTimeMillis();
        numbers.stream()
                .map((Integer val) -> val * val)
                .forEach((Integer val) -> System.out.println(val));
        System.out.println("Sequential processing Time Taken: " + (System.currentTimeMillis() - sequentialProcessingStartTime) + " millisecond");

        // Parallel processing
        long parallelProcessingStartTime = System.currentTimeMillis();
        numbers.parallelStream()
                .map((Integer val) -> val * val)
                .forEach((Integer val) -> System.out.println(val));
        System.out.println("Parallel processing Time Taken: " + (System.currentTimeMillis() - parallelProcessingStartTime) + " millisecond");
    }
}
```

Output:

```
121
484
1089
1936
3025
4356
5929
7744
9801
12100
Sequential processing Time Taken: 64 millisecond
7744
121
5929
4356
1936
484
12100
1089
9801
3025
Parallel processing Time Taken: 5 millisecond
```


Task
fork()
fork()
Sub-task
Sub-task
Sub-task
Sub-task
Sub-task
Sub-task
Join
subtask result
Join
subtask result
output