# Understanding Java Streams Aggregate Operations


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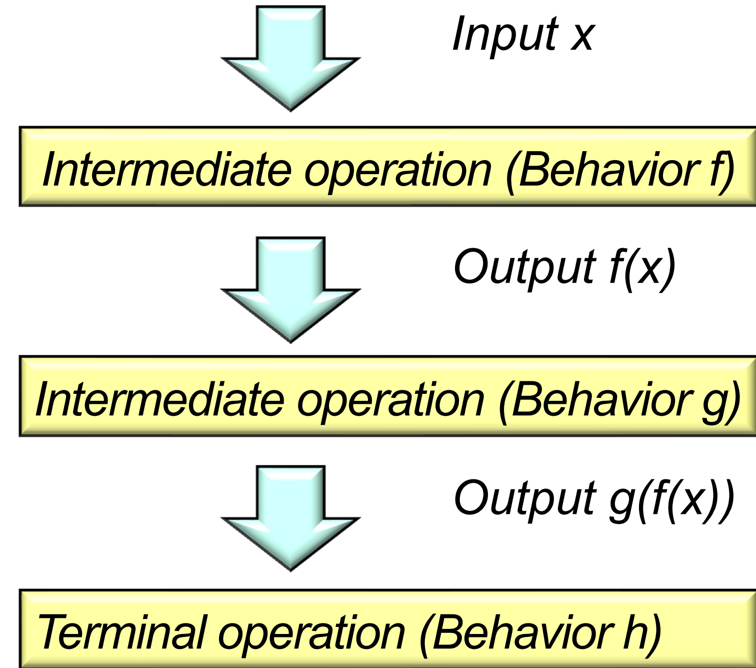
# Learning Objectives in this Part of the Lesson

- Understand the structure & functionality of stream aggregate operations



# Overview of Stream Aggregate Operations

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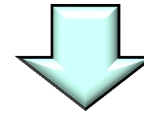
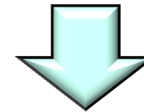
- An aggregate operation is a higher-order function that applies a "behavior" on elements in a stream

*A "higher order function" is a function that is passed a function as a param*



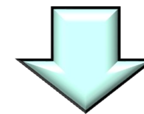
*Input x*

*Aggregate operation (Behavior f)*



*Output f(x)*

*Aggregate operation (Behavior g)*



*Output g(f(x))*

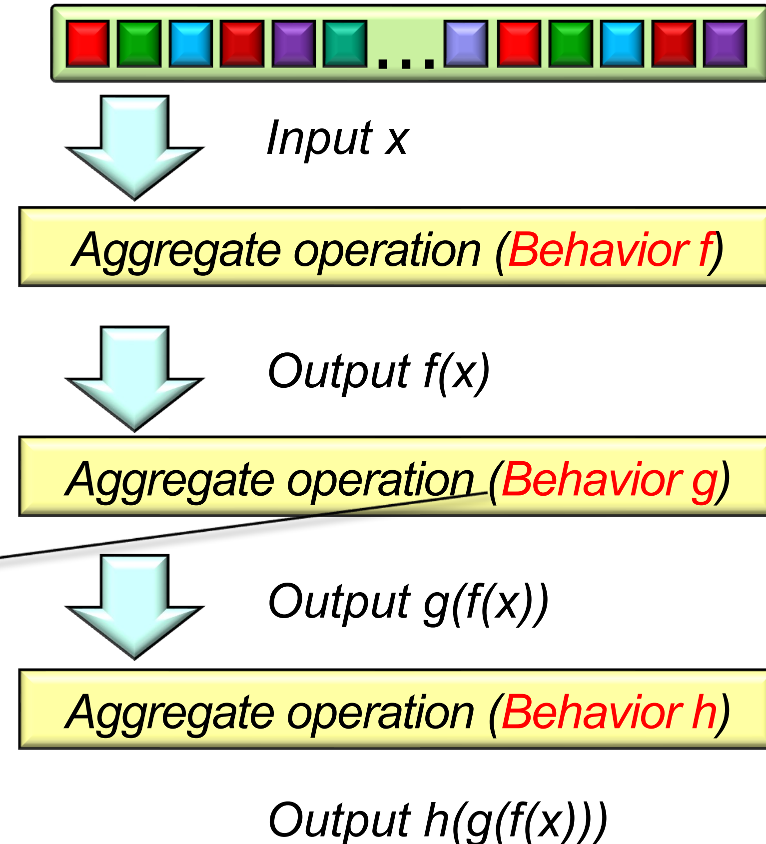
*Aggregate operation (Behavior h)*

*Output h(g(f(x)))*

See en.wikipedia.org/wiki/Higher-order_function

# Overview of Stream Aggregate Operations

- An aggregate operation is a higher-order function that applies a "behavior" on elements in a stream

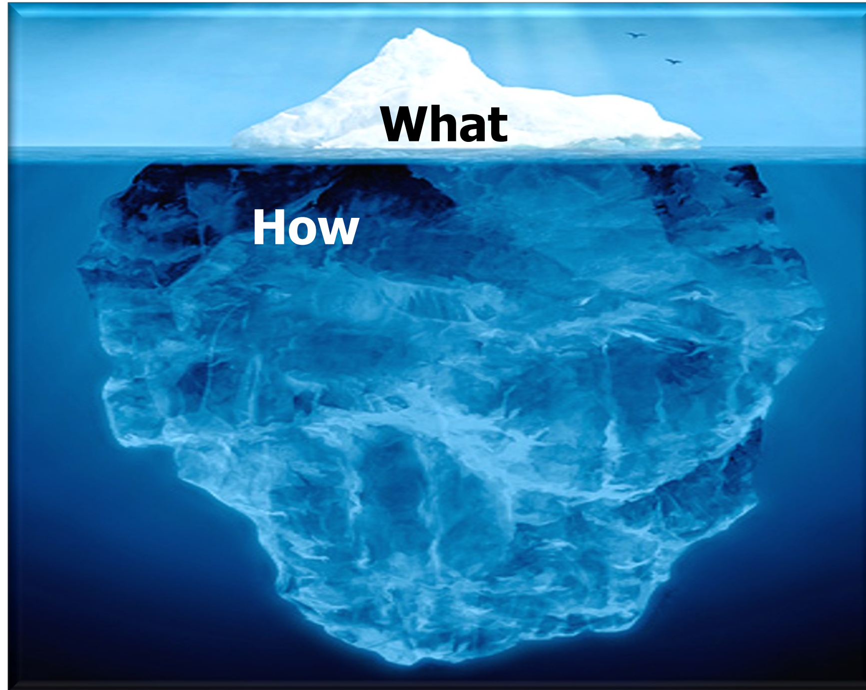


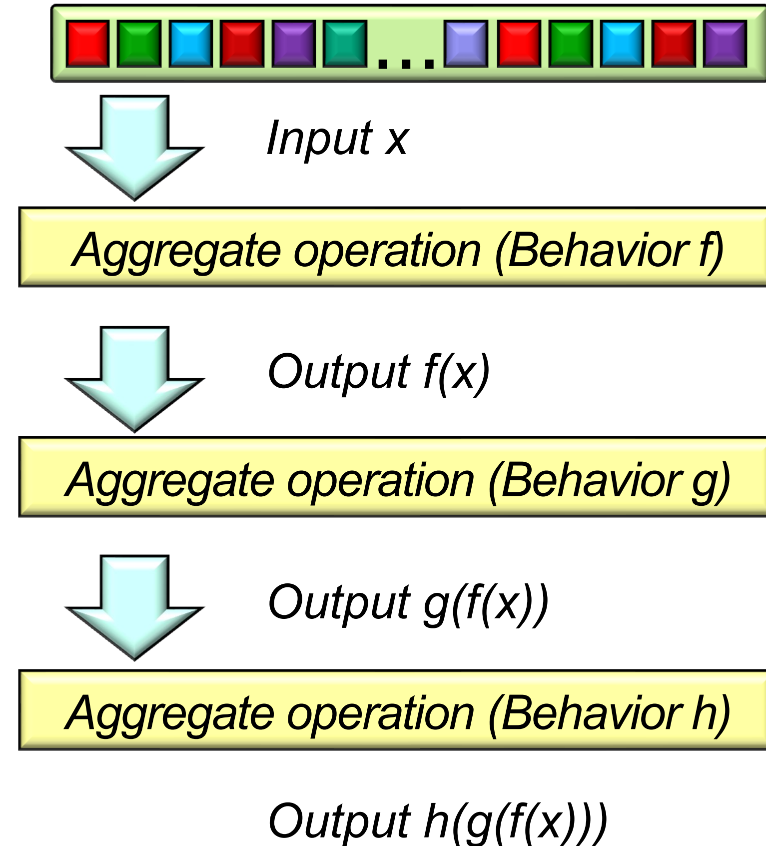

*The behavior can be a lambda or method reference to a Function, Predicate, Consumer, Supplier, etc.*

See www.drdobbs.com/jvm/lambda-expressions-in-java-8/240166764

# Overview of Stream Aggregate Operations

- Aggregate operations form a declarative pipeline that emphasizes the "what" & deemphasizes the "how"

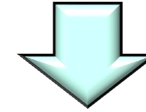



See blog.jooq.org/2015/09/17/comparing-imperative-and-functional-algorithms-in-java-8

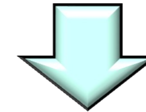
# Overview of Stream Aggregate Operations

- There are two types of aggregate operations



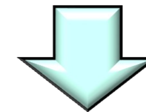
*Input x*

*Intermediate operation (Behavior f)*



*Output f(x)*

*Intermediate operation (Behavior g)*

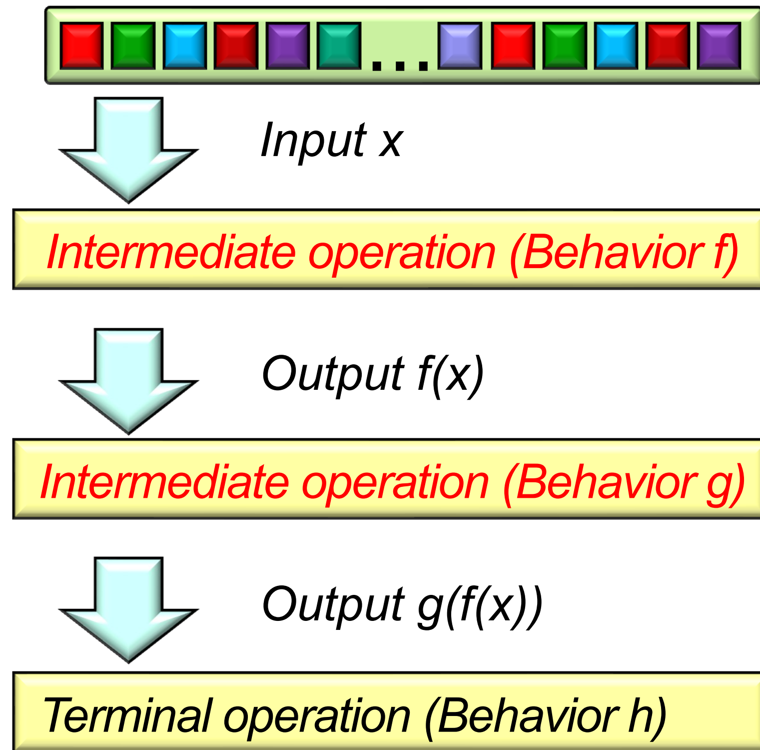


*Output g(f(x))*

*Terminal operation (Behavior h)*

# Overview of Stream Aggregate Operations

- There are two types of aggregate operations
  - **Intermediate operations**
    - Process elements in their input stream & yield an output stream
      - e.g., filter(), map(), flatMap(), takeWhile(), dropWhile(), etc.




See geekylearner.com/java-stream-intermediate-operations-learn-by-examples

# Overview of Stream Aggregate Operations

- There are two types of aggregate operations
  - **Intermediate operations**
    - Process elements in their input stream & yield an output stream
    - Intermediate operations can be further classified via several dimensions

| | Run-to-completion | Shorct-Circuiting |
|---|---|---|
| Stateful | distinct(), skip(), sorted() | limit(), takeWhile(), dropWhile(), etc. |
| Stateless | filter(), map(), flatMap(), etc. | N/A |

# Overview of Stream Aggregate Operations

- There are two types of aggregate operations
  - **Intermediate operations**
    - Process elements in their input stream & yield an output stream
    - Intermediate operations can be further classified via several dimensions, e.g.
      - Stateful
        - Store info from a prior invocation for use in a future invocation

| | Run-to-completion | Short-Circuiting |
|---|---|---|
| Stateful | distinct(), skip(), sorted() | limit(), takeWhile(), dropWhile(), etc. |
| Stateless | filter(), map(), flatMap(), etc. | N/A |

See stuartmarks.wordpress.com/2015/01/09/writing-stateful-stream-operations

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- There are two types of aggregate operations
  - **Intermediate operations**
    - Process elements in their input stream & yield an output stream
    - Intermediate operations can be further classified via several dimensions, e.g.
      - Stateful
      - Stateless
        - Do not store info from any prior invocations

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| Stateless | filter(), map(), flatMap(), etc. | N/A |

See javapapers.com/java/java-stream-api

# Overview of Stream Aggregate Operations

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  - **Intermediate operations**
    - Process elements in their input stream & yield an output stream
    - Intermediate operations can be further classified via several dimensions, e.g.
      - Stateful
      - Stateless
        - Do not store info from any prior invocations

| | Run-to-completion | Short-Circuiting |
|---|---|---|
| Stateful | distinct(), skip(), sorted() | limit(), takeWhile(), dropWhile(), etc. |
| Stateless | filter(), map(), flatMap(), etc. | N/A |

*Stateless operations often require significantly fewer processing & memory resources than stateful operations!*

See automationrhapsody.com/java-8-features-stream-api-explained

# Overview of Stream Aggregate Operations

- There are two types of aggregate operations
  - **Intermediate operations**
    - Process elements in their input stream & yield an output stream
    - Intermediate operations can be further classified via several dimensions, e.g.
      - Stateful
      - Stateless
      - Run-to-completion
        - Process all elements in the input stream

| | Run-to-completion | Short-Circuiting |
|---|---|---|
| Stateful | distinct(), skip(), sorted() | limit(), takeWhile(), dropWhile(), etc. |
| Stateless | filter(), map(), flatMap(), etc. | N/A |

See en.wikipedia.org/wiki/Run_to_completion_scheduling

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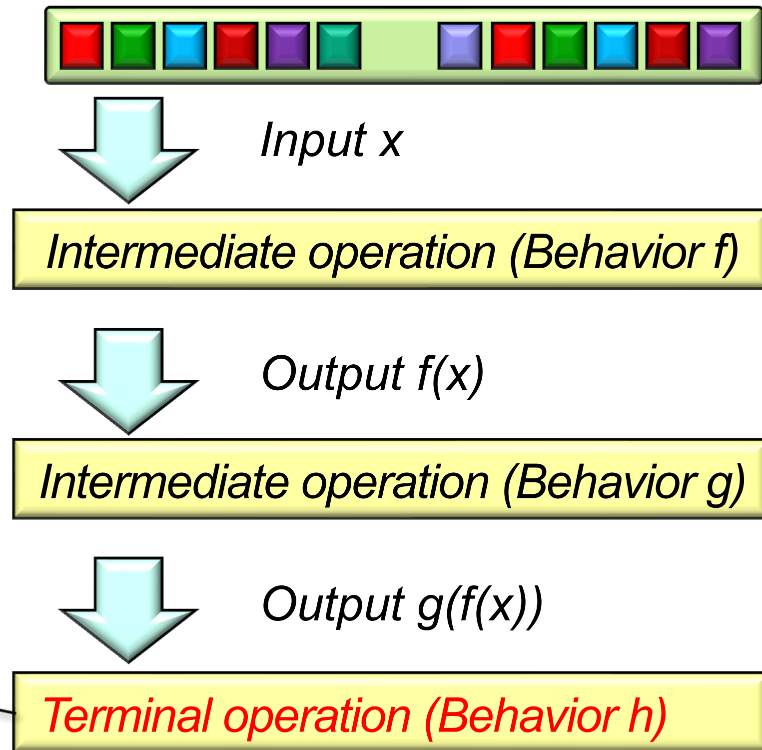
- There are two types of aggregate operations
  - **Intermediate operations**
    - Process elements in their input stream & yield an output stream
    - Intermediate operations can be further classified via several dimensions, e.g.
      - Stateful
      - Stateless
      - Run-to-completion
      - Short-circuiting
        - Make stream operate on a reduced size

| | Run-to-completion | Short-Circuiting |
|---|---|---|
| Stateful | distinct(), skip(), sorted() | limit(), takeWhile(), dropWhile(), etc. |
| Stateless | filter(), map(), flatMap(), etc. | N/A |

See www.logicbig.com/tutorials/core-java-tutorial/java-util-stream/short-circuiting.html

# Overview of Stream Aggregate Operations

- There are two types of aggregate operations
  - Intermediate operations
  - **Terminal operations**
    - Trigger intermediate operations & produce a non-stream result
      - e.g., forEach(), reduce(), collect(), findAny(), etc.



*A stream must have one (& only one) terminal operation*

See www.leveluplunch.com/java/examples/stream-terminal-operations-example

# Overview of Stream Aggregate Operations

- There are two types of aggregate operations
  - **Intermediate operations**
  - **Terminal operations**
    - Trigger intermediate operations & produce a non-stream result
    - Terminal operations can also be classified via several dimensions

| Operation Type | Examples |
|---|---|
| Run-to-completion | reduce(), collect(), forEach(), etc. |
| Short-circuiting | allMatch(), anyMatch(), findAny(), findFirst(), noneMatch() |

# Overview of Stream Aggregate Operations

- There are two types of aggregate operations
  - **Intermediate operations**
  - **Terminal operations**
    - Trigger intermediate operations & produce a non-stream result
    - Terminal operations can also be classified via several dimensions, e.g.
      - Run-to-completion
        - Terminate only after processing all elements in the stream

| Operation Type | Examples |
|---|---|
| Run-to-completion | reduce(), collect(), forEach(), etc. |
| Short-circuiting | allMatch(), anyMatch(), findAny(), findFirst(), noneMatch() |

# Overview of Stream Aggregate Operations

- There are two types of aggregate operations
  - **Intermediate operations**
  - **Terminal operations**
    - Trigger intermediate operations & produce a non-stream result
    - Terminal operations can also be classified via several dimensions, e.g.
      - Run-to-completion
      - Short-circuiting
        - May cause a stream to terminate before processing all values

| Operation Type | Examples |
| --- | --- |
| Run-to-completion | reduce(), collect(), forEach(), etc. |
| Short-circuiting | allMatch(), anyMatch(), findAny(), findFirst(), noneMatch() |

# Interesting Stream Aggregate Operation Interactions

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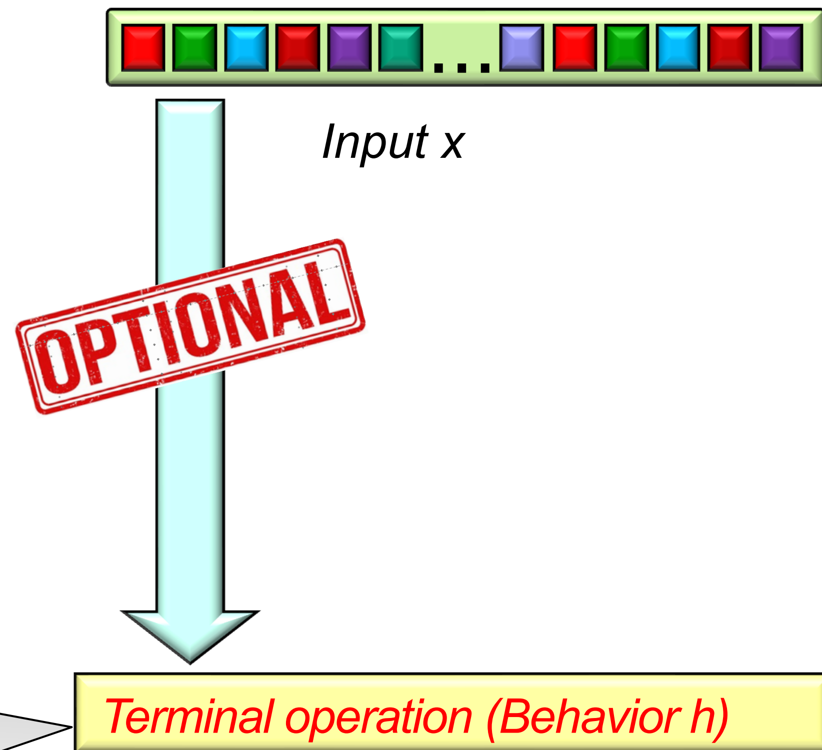
- Intermediate operations are optional in a Java stream



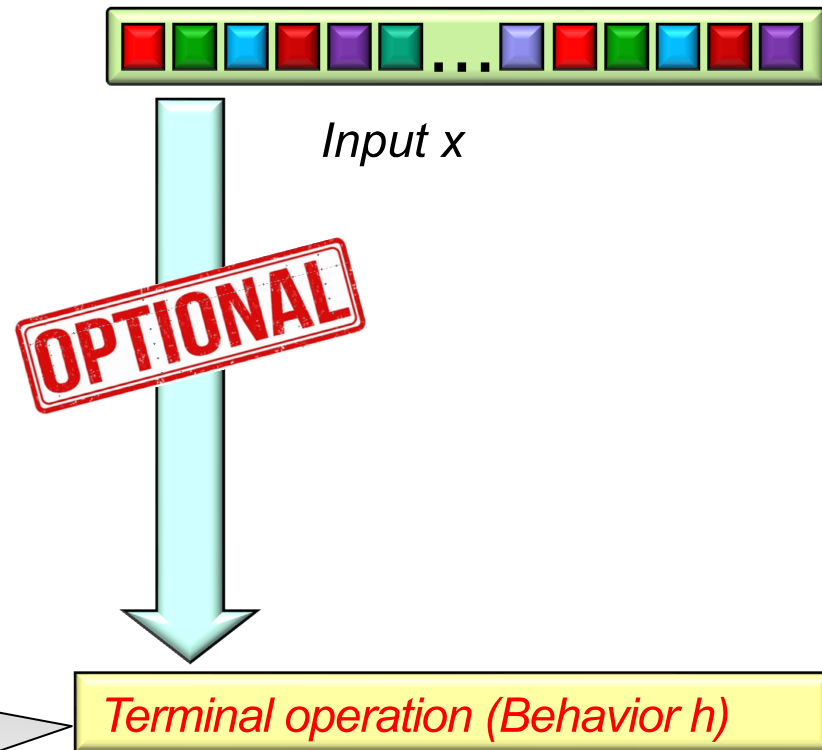

```
long hamletCharacters = Stream
  .of("horatio", "laertes",
      "Hamlet", ...)
  .count();
```

# Interesting Stream Aggregate Operation Interactions

- Intermediate operations are optional in a Java stream
  - However, the semantics of the count() terminal operation may be counter-intuitive

*As of Java 9 peek() prints nothing when combined with count() since the count can be computed directly from the source*

```
long hamletCharacters = Stream
   .of("horatio", "laertes",
       "Hamlet", ...)
   .peek(System.out::print)
   .count();
```



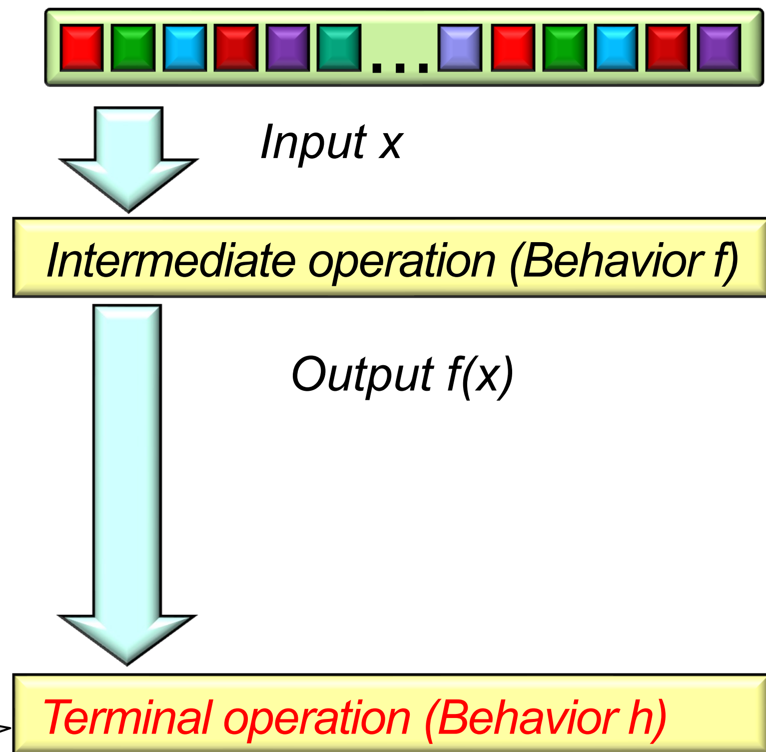

See mkyong.com/java8/java-8-stream-the-peek-is-not-working-with-count

# Interesting Stream Aggregate Operation Interactions

- Intermediate operations are optional in a Java stream
  - However, the semantics of the count() terminal operation may be counter-intuitive

*To force the peek() to run, just appear to access some elements with filter()*

```
long hamletCharacters = Stream
   .of("horatio", "laertes",
       "Hamlet", ...)
   .filter(x -> !x.isEmpty())
   .count();
```



# End of Understanding Java Streams Aggregate Operations