Java Stream Internals: Construction

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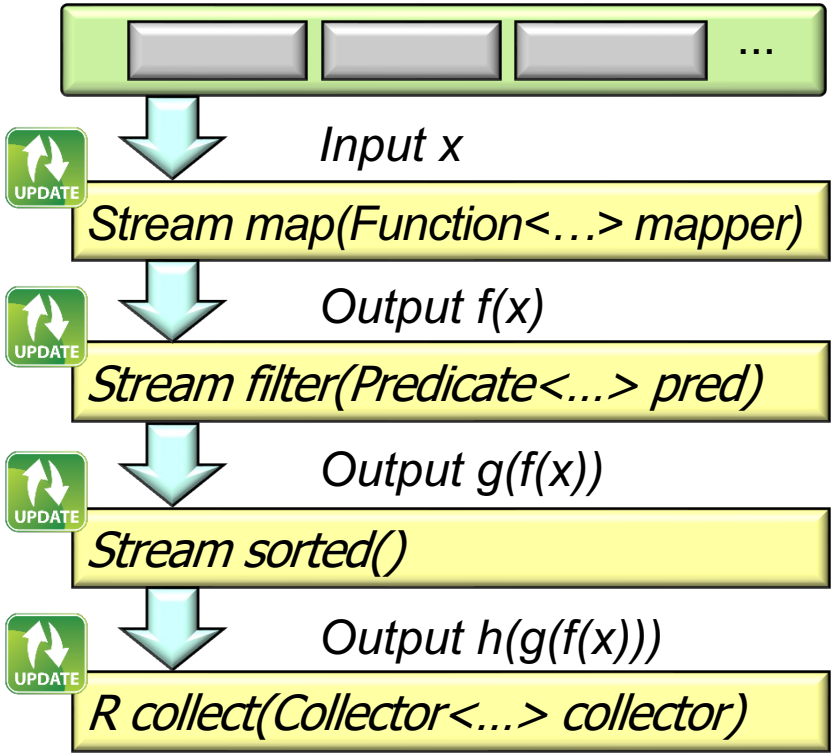
Learning Objectives in this Part of the Lesson

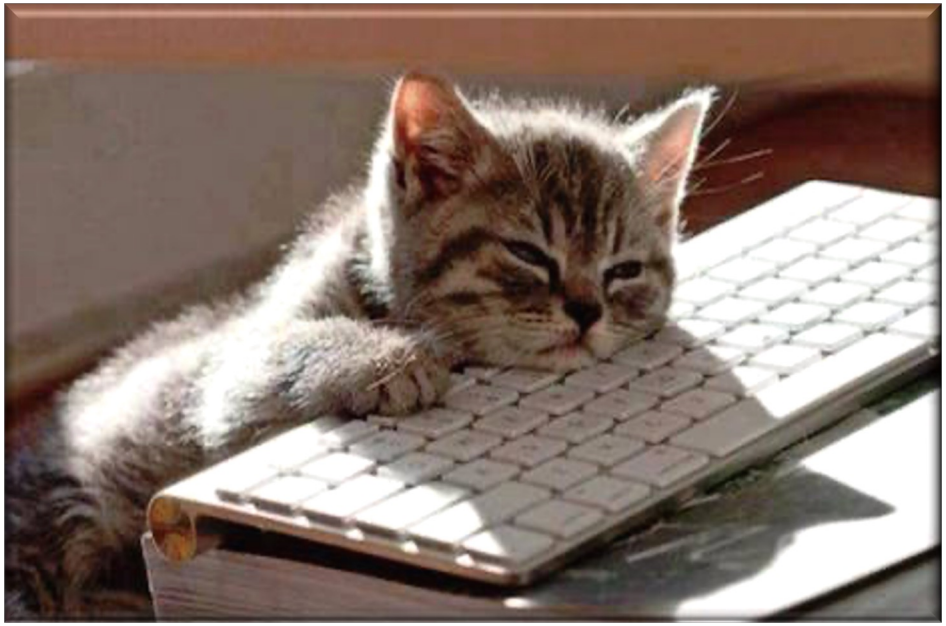
- Understand stream internals, e.g.
  - Know what can change & what can't
  - Recognize how a Java stream is constructed
    - i.e., the data structures & stages used to create & optimize a Java stream at run-time

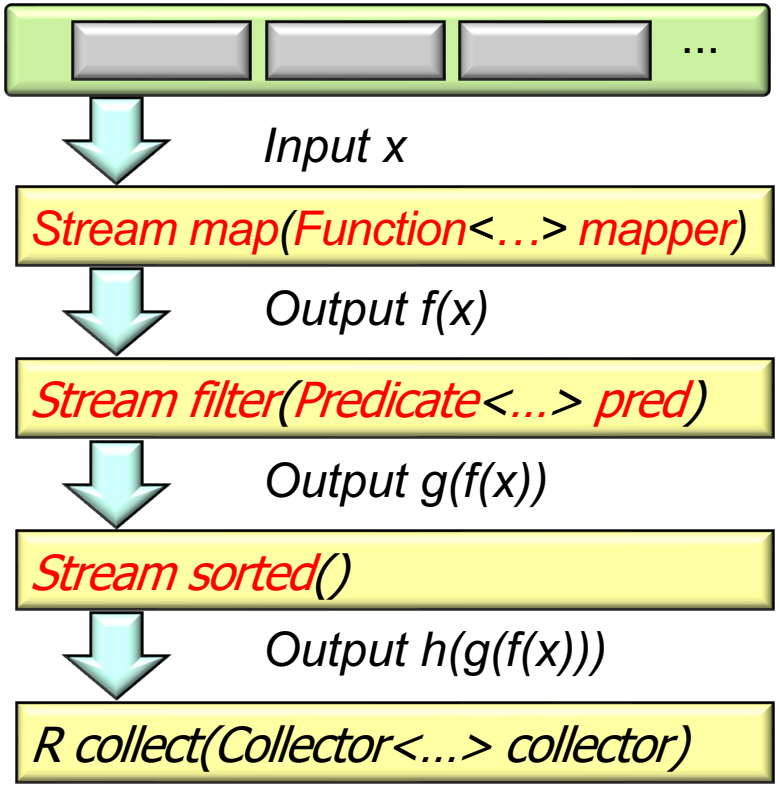


Java Stream Construction

Java Stream Construction

- Recall that intermediate operations are "lazy"

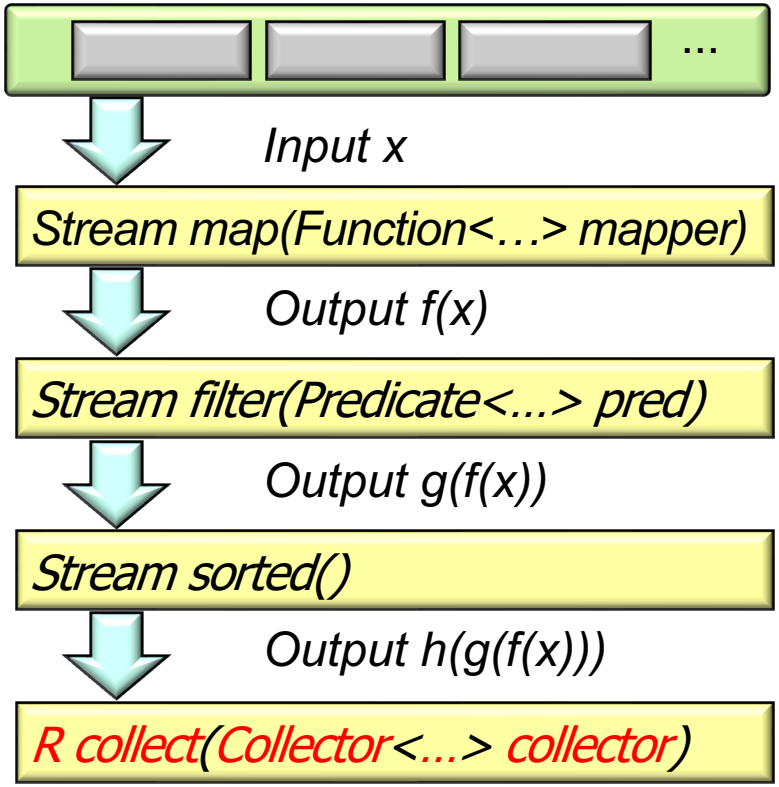




See www.logicbig.com/tutorials/core-java-tutorial/java-util-stream/lazy-evaluation

Java Stream Construction

- Recall that intermediate operations are "lazy"
  - i.e., they don't start to run until a terminal operator is reached



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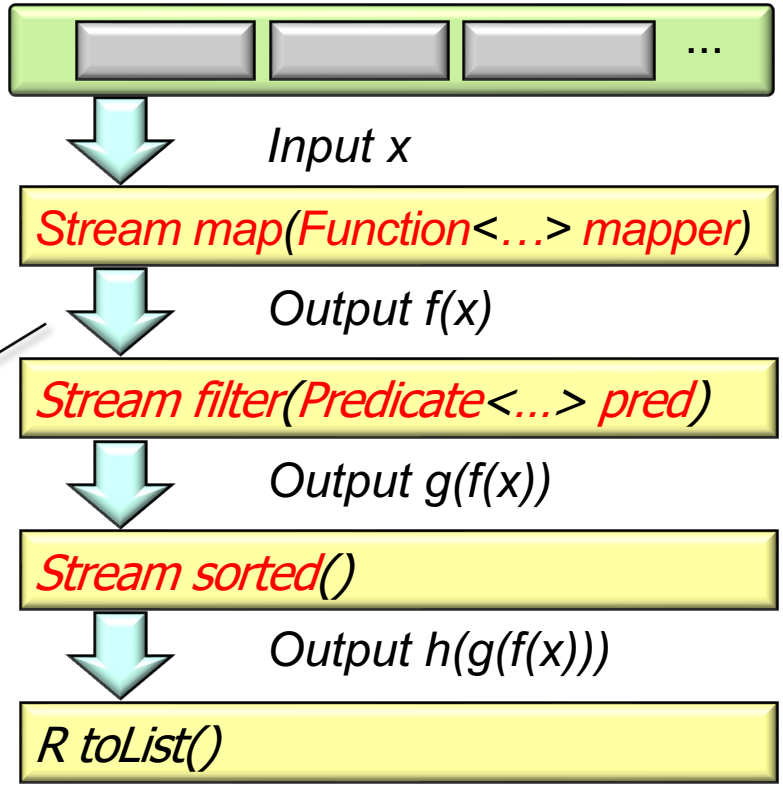
Java Stream Construction

- A stream pipeline is constructed at runtime via an internal representation

```
List<String> ls = ...
List<String> sortedAWords = ls
   .stream()
   .map(String::toUpperCase)
   .filter(s ->
            s.startsWith("A"))
   .sorted()
   .toList();
```

At runtime a linked list of stream source & intermediate operations is built & optimized, one per "stage" in pipeline

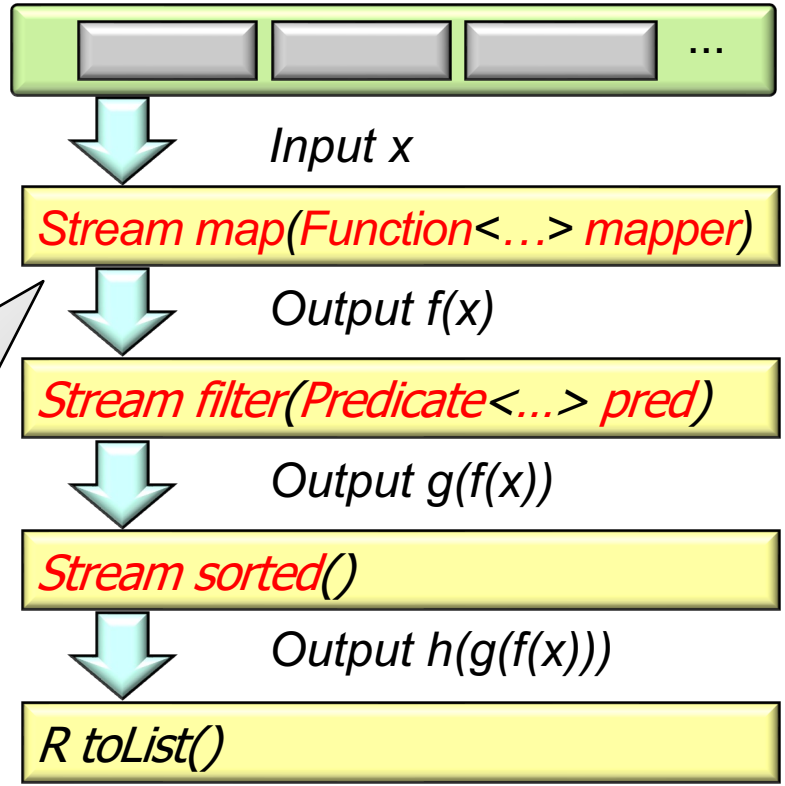


See developer.ibm.com/technologies/java/articles/j-java-streams-3-brian-goetz/#building-a-stream-pipeline

Java Stream Construction

- A stream pipeline is constructed at runtime via an internal representation
  - Each pipeline stage is described by a bitmap of *stream flags* internally

Stream Flag	Interpretation
SIZED	Size of stream is known
DISTINCT	Elements of stream are distinct
SORTED	Elements of the stream are sorted in natural order
ORDERED	Stream has meaningful encounter order



These flags are a subset of the flags that can be defined by a spliterator

Java Stream Construction

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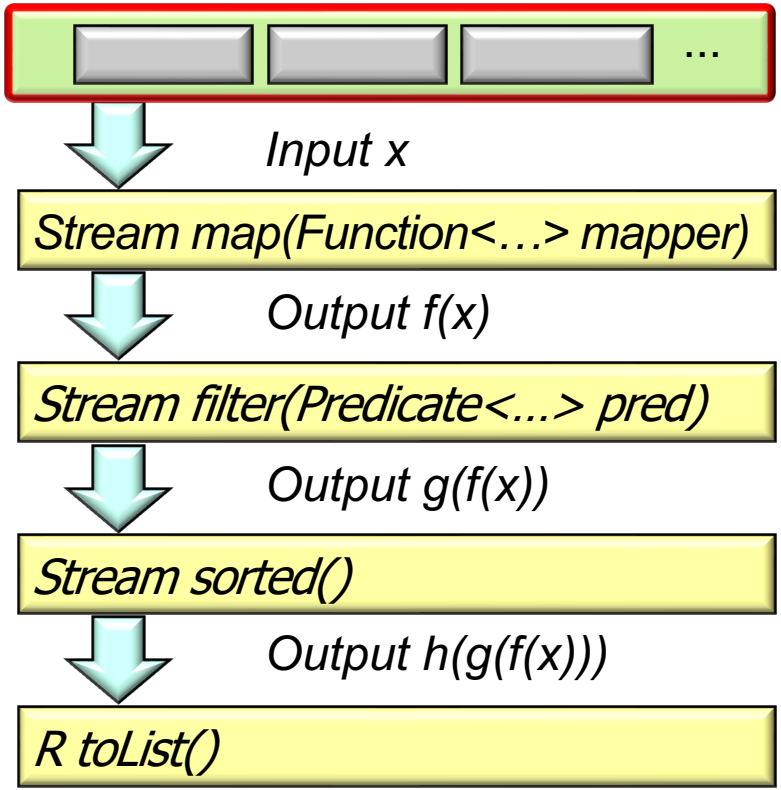
  - Source stage stream flags are derived from spliterator characteristics, e.g.

Collection	Sized	Ordered	Sorted	Distinct
ArrayList	✓	✓		
HashSet	✓			✓
TreeSet	✓	✓	✓	✓



Stream generate() & iterate() methods create streams that are *not* sized!

Java Stream Construction

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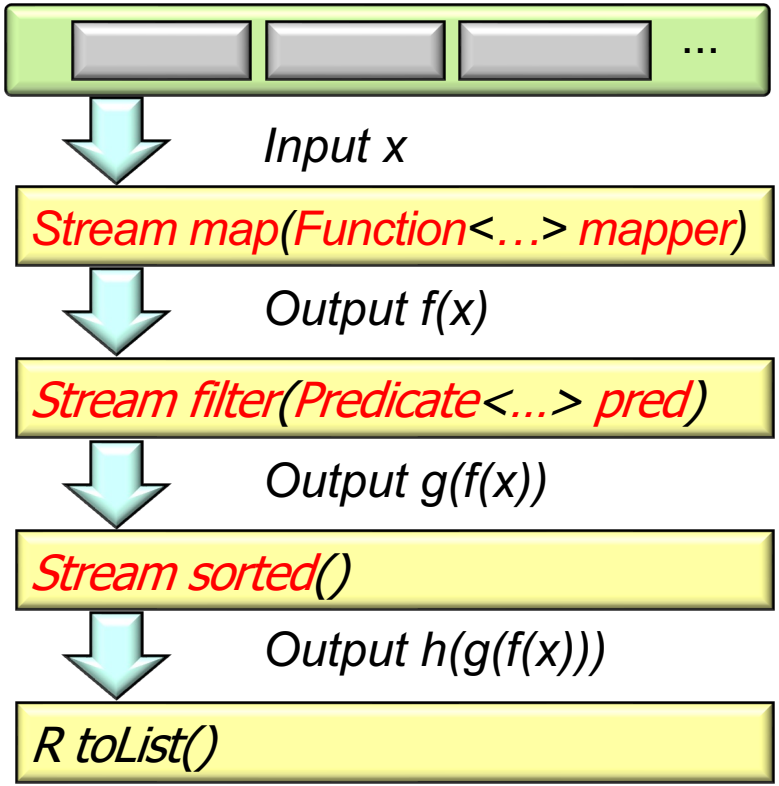
  - Each intermediate operation affects the stream flags



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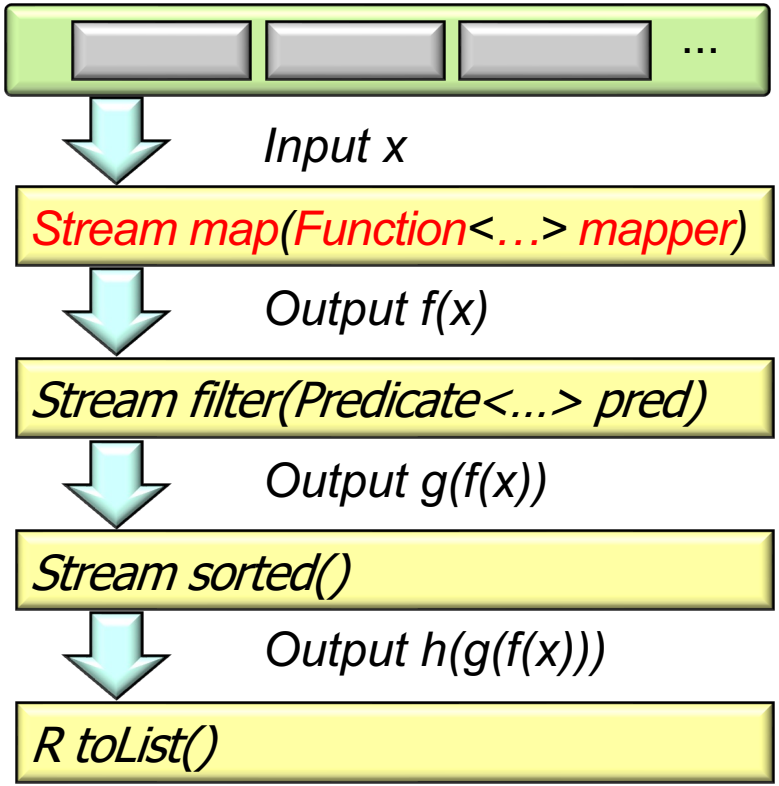
    - map()
      - Clears SORTED & DISTINCT but keeps SIZED



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    - filter()
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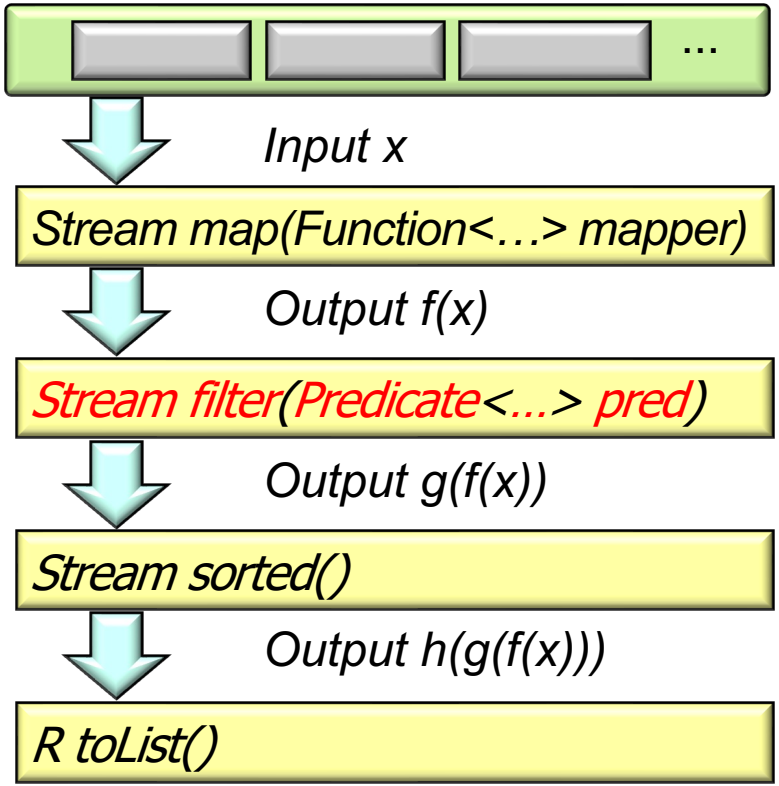

Java Stream Construction

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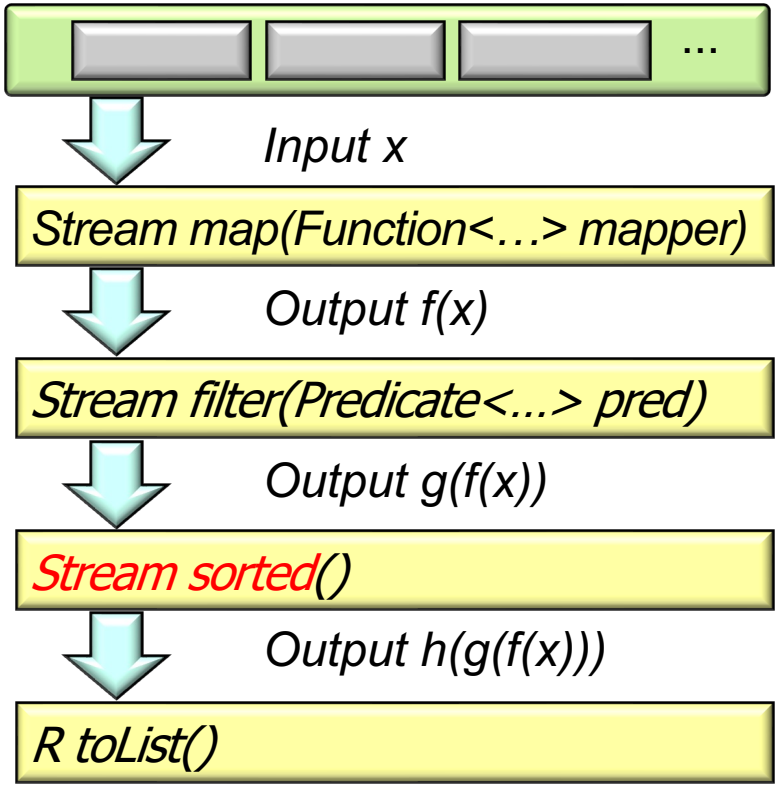
  - Each pipeline stage is described by a bitmap of *stream flags* internally
  - Source stage stream flags are derived from spliterator characteristics
  - Each intermediate operation affects the stream flags, e.g.
    - map()
    - filter()
    - sorted()
      - Keeps SIZED & DISTINCT & adds SORTED



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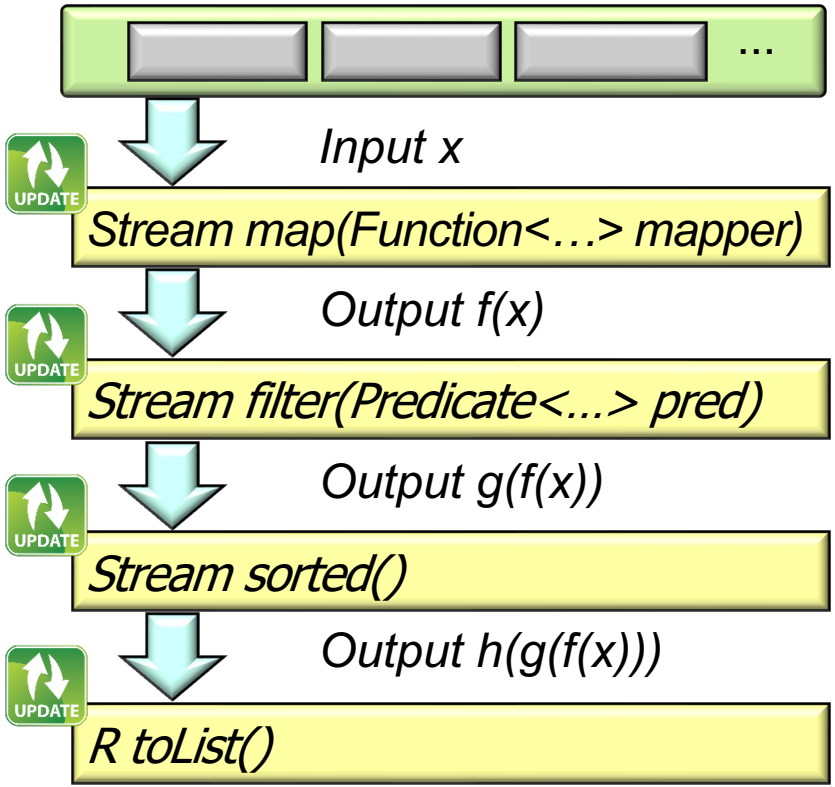

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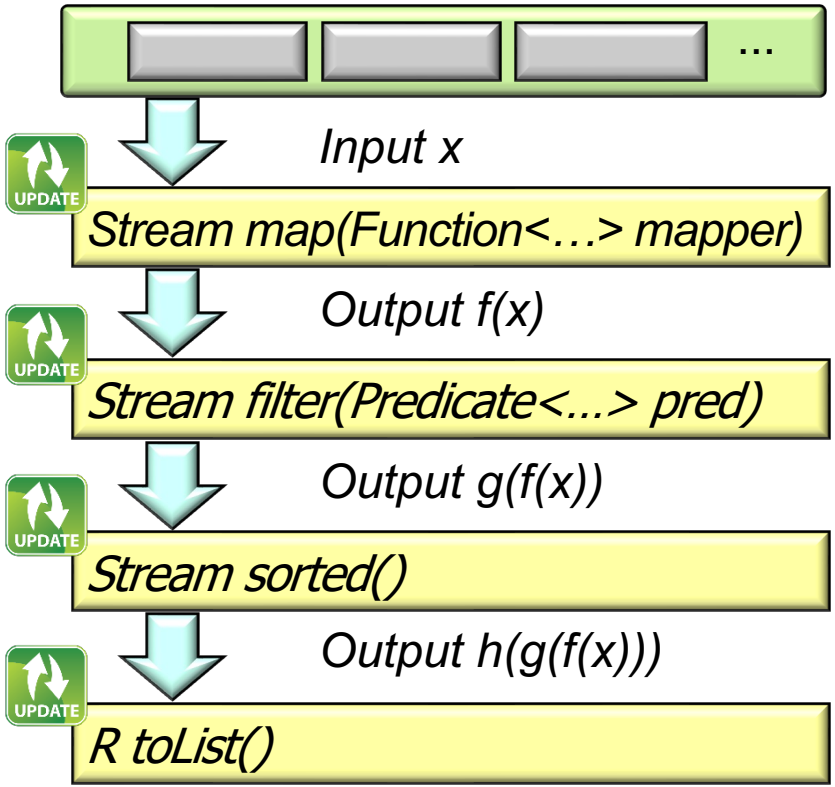
    - e.g., flags for a previous stage are combined with the current stage's behavior to derive a new set of flags



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```
Set<String> ts =
  new TreeSet<>(...);

List<String> sortedAWords =
  ts
    .stream()
    .filter(s ->
              s.startsWith("A"))
    .sorted()
    .toList();
```

SORTED

SORTED

SORTED

The streams framework removes redundant operations since the source is already sorted

End of Java Stream Internals: Construction