# We are all to gather

Rémi Forax
Université Gustave Eiffel – May 2024

# We are all together

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# We are all to **gather**

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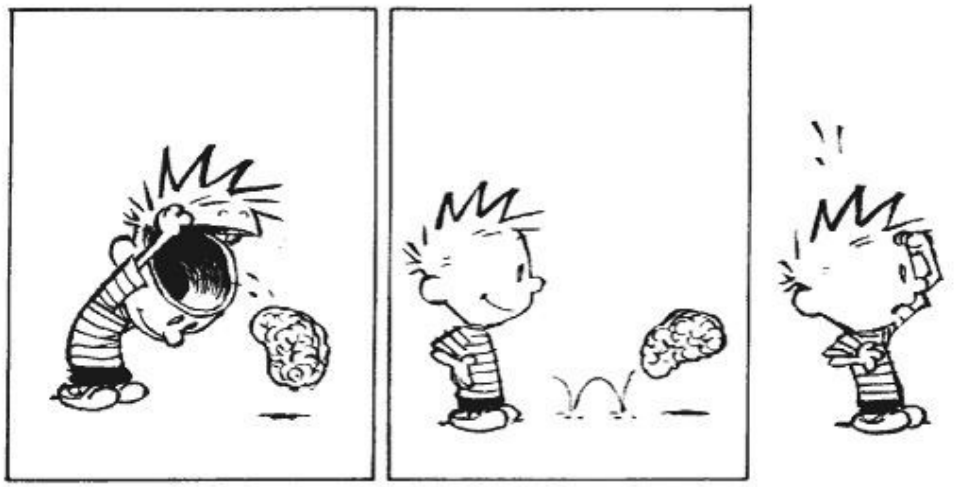



Don’t believe what I’m saying !

# Me, myself and I

Rémi Forax

- Assistant Prof at University Gustave Eiffel
- Expert for lambda, module, record, etc

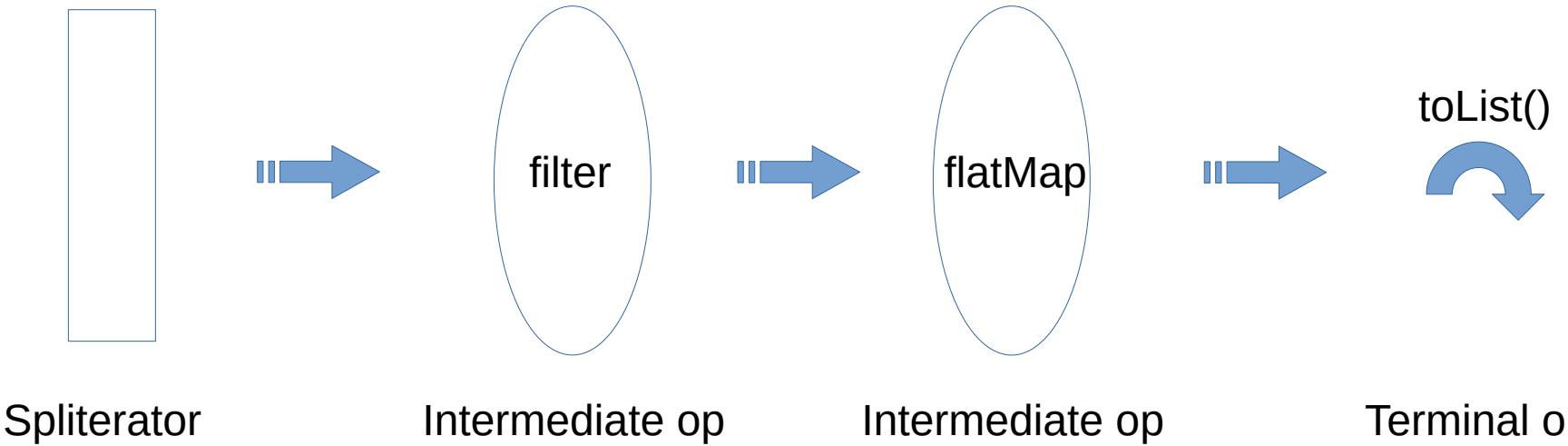
Feel free to google me if you want to know more ...

# Outline

- The Gatherer API
- Performance and limitations

# A stream is defined by ...

- a source, abstracted as a Spliterator
- some intermediate operations
- a terminal operation that drives the pipeline



# A Gatherer

Abstracts any intermediate operation

- Users can define their own

New intermediate method Stream.gather()

- stream.gather(Gatherers.fold(…)).toList()

Modeled like a Collector

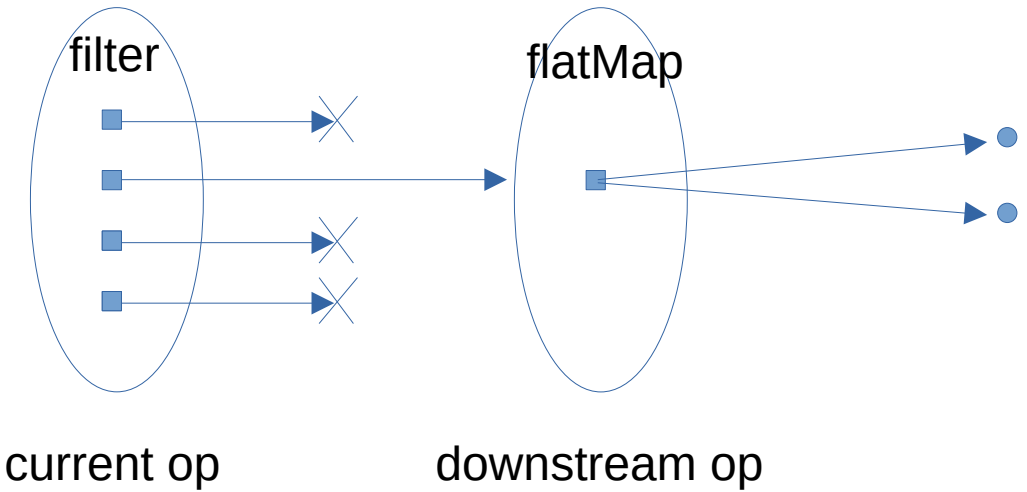
- j.u.s.Gatherers contains predefined Gatherer

# An intermediate operation

Push (or not) transformed elements to the next stage

- Back-propagate “I want more !”

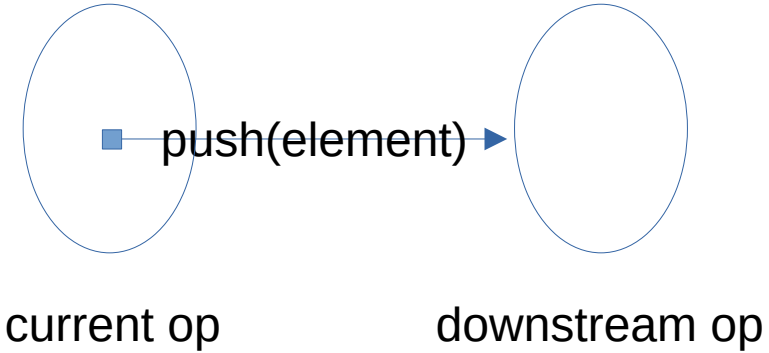
May have state (limit, distinct, sorted, ...)



# Modeling an intermediate op

```
@FunctionalInterface
interface Integrator {
    boolean integrate (???, E element, Downstream<T> downstream)
```

- May push downstream + “I want more”



# Interface Downstream<T>

Conceptually a Consumer<T>

- boolean push(T element)
  - Returns true → “I want more”
- isRejecting()
  - Is the next stage rejecting elements (will return false) ?

# + State management

Gatherer.of() uses 4 functions

**initializer**: Supplier<A>

- Create a state

**integrator**: (A state, E element, Downstream<T> downstream) → boolean

- Modify state and/or push downstream (+ back-propagate return type)

**combiner**: BinaryOperator<A>

- Combine two states, return a new state

**finisher**: BiConsumer<A, Downstream<T>>

- Push downstream at the end

```
interface Downstream<T> {
  boolean push(T element);
  boolean isRejecting();
}
```

# Live Code !

# Gatherer API

# Gatherer<E, A, T>

**initializer**: Supplier<A>

- Create a state

**integrator** (A state, E element, Downstream<T> downstream) → boolean

- Modify state and/or push downstream (+ back-propagate return type)

**combiner**: BinaryOperator<A>

- Combine two states, return a new state

**finisher**: BiConsumer<A, Downstream<T>>

- Push downstream at the end

```
interface Downstream<T> {
  boolean push(T element);
  boolean isRejecting();
}
```

# Creating a Gatherer : 3 axis

Only Sequential vs Parallelizable

- Gatherer.ofSequential() vs Gatherer.of() + combiner?

Stateless vs Stateful

- integrator vs initializer + integrator + finisher?

Short-circuit vs Greedy

- integrator vs Integrator.ofGreedy()

# Greedy vs short-circuit

If a Gatherer does not short-circuit

- It can be merged with a subsequent gatherer
- It can be merged with a subsequent collector

Wraps the Integrator into Greedy.of(integrator)

# Performance ?

# WARNING ! WARNING !

The stream API relies heavily on the VM being able to correctly propagates type profiles

- If that strategy does not work, the VM records type profiles

There is usually no profile pollution in a micro-benchmark so real world scenario performance may differ !

# Performance map + sum

```
public int stream_map_sum() {
  return values.stream().map(String::length).reduce(0, Integer::sum);
}    // 481.222 ±  1.560  us/op

public int stream_mapToInt_sum() {
  return values.stream().mapToInt(String::length).sum();
}    // 102.089 ±  0.672  us/op

public int gatherer_map_sum() {
  return values.stream().gather(map(String::length)).reduce(0, Integer::sum);
}    // 552.384 ±  3.405  us/op
```

No primitive specialization ...

* `values` is a List of 100_000 strings

# Performance map + toList

```
public List<Integer> stream_map_toList() {
  return values.stream().map(String::length).toList();
}    // 332.322 ±  0.512  us/op

public List<Integer> gatherer_map_toList() {
  return values.stream().gather(map(String::length)).toList();
}    // 558.873 ±  6.200  us/op
```

Why using a Gatherer is slower ? ...

# Performance map + count

```
public long stream_map_count() {
  return values.stream().map(String::length).count();
}    // 0.009 ±  0.001  us/op

public long stream_mapToInt_count() {
  return values.stream().mapToInt(String::length).count();
}    // 0.009 ±  0.001  us/op

public long gatherer_map_count() {
  return values.stream().gather(map(String::length)).count();
}    // 101.993 ±  0.105  us/op
```

=> spliterator characteristics are not propagated !

# Performance map + collect(summing)

```
public int stream_map_collect() {
  return integers.stream().map(v -> v + 1).collect(summingInt(v -> v));
}    // 311.241 ± 62.204  us/op

public int gatherer_map_collect() {
  return integers.stream().gather(map(v -> v + 1)).collect(summingInt(v -> v));
}    // 307.455 ±  0.222  us/op
```

gather + collect are fused into one operation, yeah !

* `integers` is a List of 100_000 Integers

# Performance issues

No primitive specialization

- mapToInt/flatMapToInt, etc
  - Same issue with collectors
  - Valhalla generics to the rescue ??

Spliterator characteristics are not propagated

- Same issue with collectors
  - For ex: Stream.toList() can presize, not Collectors.toList()

# Executive Summary

# Gatherer API

User defined intermediary operations

- 4 functions: initializer, integrator, combiner, finisher
- 3 axis: only-sequential / statefulness / short-circuitability

Still in preview in Java 23

- more predefined Gatherers ?
- Spliterator characteristics could be propagated ?

# Questions ?

https://github.com/forax/we_are_all_to_gather