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JSR for Java Collections 2.0

Enhancing the Java Core Libraries for the next 25 years

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JCP Executive Committee Meeting

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Information Classification: Public

Agenda

Some background on the past decade in the Java collections space

Proposal: Create a JSR for Java Collections 2.0

The Great News

A Glimpse of the Future

Recommendations

Appendix

– Serial / Eager Algorithms

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Some background on the past decade in the Java collections space

- A Java collections framework design – JVM Language Summit – July 2012
- GS Collections and Java 8 – **JCP Executive Committee F2F Meeting** – London – May 2014
- Large HashMap overview: JDK, FastUtil, Goldman Sachs, HPPC, Koloboke, Trove – Jan. 2015
- GS Collections moves to the Eclipse Foundation – InfoQ – Jan. 2016
- Java Collections Cheat Sheet – JRebel – April 2016
- Energy Profiles of Java Collections Classes – May 2016
- Collections.Compare(() -> {JDK; Apache; Eclipse; Guava…}); – Devoxx US (March) & JavaOne 2017
- Vavr, Collections, and Java Stream API Collectors – Aug. 2017
- New Collection Types Explained – Nov. 2017
- Optimization Strategies with Eclipse Collections – April 2018
- Java Collections are Evolving – June 2018
- Recommending Energy-Efficient Java Collections – ACM – May 2019
- The Best of Java Collections [Tutorials] – Dec. 2019
- Java Streams are great but it's time for better Java Collections – Feb. 2020

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Proposal: Create a JSR for Java Collections 2.0

Who will support a JSR for Java Collections 2.0?

- What are our plans for adding a new collections framework in Java 17 (September 2021)?

Determining the scope of Collections 2.0. This is some of what is missing today…

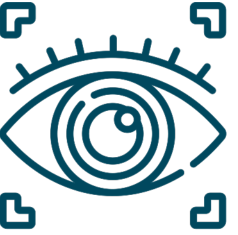
- Functional and optimized eager APIs directly on the collections
- Missing types: Multimaps, Bags, BiMaps, Tree/Trie, Table
- Memory Efficient Containers
- Separate Mutable and Immutable Hierarchies and Factories
- Primitive Collections
- 64-bit collections (size is long, arrays are 64-bit)
- Persistent Collections
- Off-heap Collections
- Lazy *Iterable* APIs for object and primitive collections
- A *distinct* Parallel *Iterable* Hierarchy

Some features may be out of scope. Some features could be delivered in follow on minor releases.

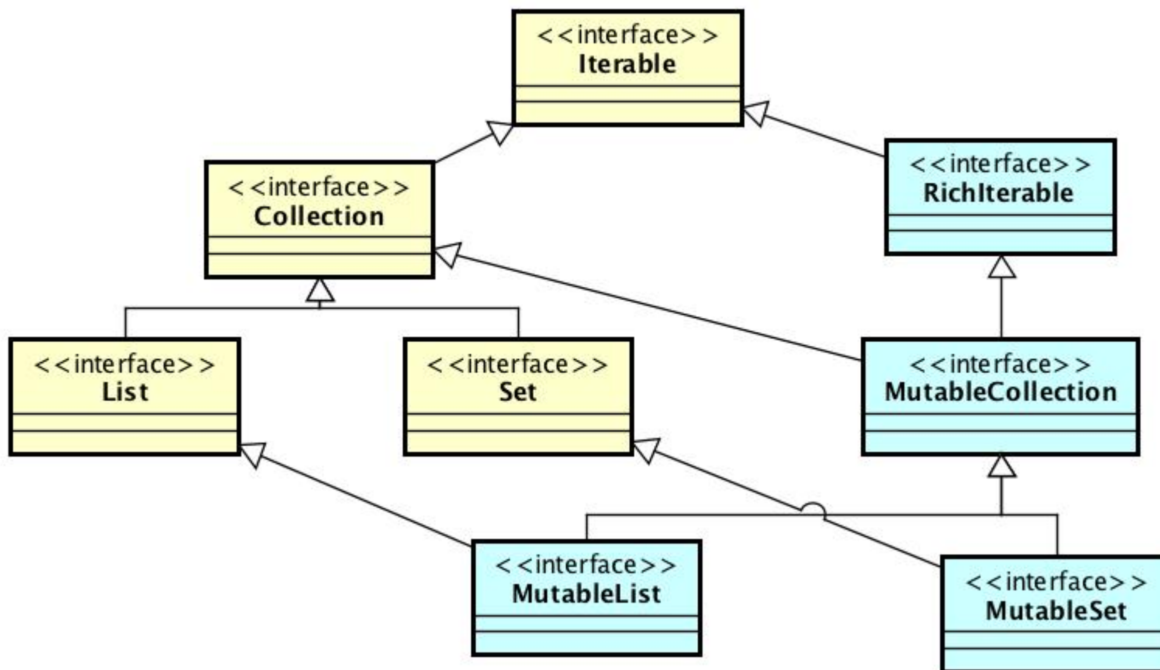
The Great News

- Java 8 with Lambdas, Methods References, Default Methods and Streams is an amazing success!
- There is an enormous body of work to learn and borrow from for a JSR for Java Collections 2.0
  - OSS Java Collections Frameworks
    - Apache Commons Collections
    - Eclipse Collections
    - FastUtil
    - Functional Java
    - Google Guava
    - Vavr
  - Languages
    - Lisp, Smalltalk, Python, Ruby
    - Groovy, Kotlin, Scala, Clojure
    - Haskell, F#, C#
    - Others

A Glimpse of the Future

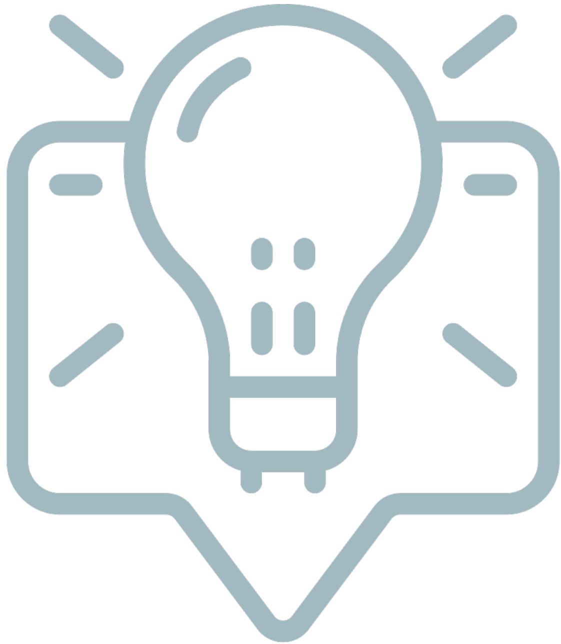


- Demo – Deck of Cards Kata from https://github.com/BNYMellon/CodeKatas
  - Kata for comparing Java Collections Frameworks
  - New Custom Collections Framework
    - Implements sampling of methods available on Java Streams



- **Eager Iteration Protocols**
  - `filter / filterNot`
  - `map / flatMap`
  - `reduce / collect`
  - `anyMatch / allMatch / noneMatch`
  - `groupBy / countBy`
  - `findFirst`
  - `count`
- **Converter Methods**
  - `toCollection, toList, toSet`
  - `asUnmodifiable`
- **Factory Methods**
  - `empty / of`
  - `fromIterable / fromStream`

Recommendations



- Java needs a new collections framework to help motivate developers to upgrade to newer releases.
  – A new framework should provide adaptation/transition from the existing framework
- Implement serial/eager iteration protocols directly on collections to make Java easier to teach and learn.
- Identify a JSR Spec Lead and form an Expert Group for a Java Collections 2.0 JSR
  – Leverage talent in OSS Collections talent for the Expert Group and Reference Implementation.

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Appendix

Information Classification: Public

Serial / Eager Algorithms

- filter
- map
- collect
- groupBy (using Map)
- groupBy (using Multimap)
- countBy (using Map)
- countBy (using Bag)
- anyMatch
- allMatch
- noneMatch
- count
- findFirst

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Make Java Easier to Learn – Serial / Eager – Filter

MutableList.filter(Predicate)

```
default MutableList<T> filter(Predicate<? super T> predicate) {
    var mutableList = MutableList.<T>empty();
    for (T each : this) {
        if (predicate.test(each)) {
            mutableList.add(each);
        }
    }
    return mutableList;
}
```


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Make Java Easier to Learn – Serial / Eager – Map

MutableList.map(Function)

```
default <V> MutableList<V> map(Function<? super T, ? extends V> function) {
    var mutableList = MutableList.<V>empty();
    for (T each : this) {
        mutableList.add(function.apply(each));
    }
    return mutableList;
}
```


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Make Java Easier to Learn – Serial / Eager – Collect

RichIterable.collect(Collector)

```
default <R, A> R collect(Collector<? super T, A, R> collector) {
    A mutableResult = collector.supplier().get();
    // BiConsumer<A, ? super T> accumulator = collector.accumulator();
    var accumulator = collector.accumulator();
    for (T each : this) {
        accumulator.accept(mutableResult, each);
    }
    return collector.finisher().apply(mutableResult);
}
```


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Make Java Easier to Learn – Serial / Eager – GroupBy (using Map)

MutableList.groupBy(Function)

```
default <K, V> MutableMap<K, MutableList<T>> groupBy(Function<? super T, ? extends K> function) {
    var mutableMap = MutableMap.<K, MutableList<T>>empty();
    for (T each : this) {
        K key = function.apply(each);
        mutableMap.getIfAbsentPut(key, MutableList::empty)
                .add(each);
    }
    return mutableMap;
}
```


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Make Java Easier to Learn – Serial / Eager – GroupBy (using Multimap)

MutableList.groupBy(Function)

```java
default <K> MutableListMultimap<K, T> groupBy(Function<? super T, ? extends K> function) {
    var multimap = MutableListMultimap.<K, T>empty();
    for (T each : this) {
        K key = function.apply(each);
        multimap.put(key, each);
    }
    return multimap;
}
```


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Make Java Easier to Learn – Serial / Eager – CountBy (using Map)

RichIterable.countBy(Function)

```
default <K> MutableMap<K, Long> countBy(Function<? super T, ? extends K> function) {
    MutableMap<K, Long> counts = MutableMap.empty();
    for (T each : this) {
        K key = function.apply(each);
        Long value = counts.get(key);
        if (value == null) {
            value = 0L;
        }
        counts.put(key, value + 1L);
    }
    return counts;
}
```


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Make Java Easier to Learn – Serial / Eager – CountBy (using Bag)

RichIterable.countBy(Function)

```java
default <K> MutableBag<K> countBy(Function<? super T, ? extends K> function) {
    MutableBag<K> counts = MutableBag.empty();
    for (T each : this) {
        K key = function.apply(each);
        counts.add(key);
    }
    return counts;
}
```


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Make Java Easier to Learn – Serial / Eager – AnyMatch

RichIterable.anyMatch(Predicate)

```java
default boolean anyMatch(Predicate<? super T> predicate) {
    for (T each : this) {
        if (predicate.test(each)) {
            return true;
        }
    }
    return false;
}
```


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Make Java Easier to Learn – Serial / Eager –AllMatch

RichIterable.allMatch(Predicate)

```java
default boolean allMatch(Predicate<? super T> predicate) {
    for (T each : this) {
        if (!predicate.test(each)) {
            return false;
        }
    }
    return true;
}
```


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Make Java Easier to Learn – Serial / Eager – NoneMatch

RichIterable.noneMatch(Predicate)

```
default boolean noneMatch(Predicate<? super T> predicate) {
    for (T each : this) {
        if (predicate.test(each)) {
            return false;
        }
    }
    return true;
}
```


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Make Java Easier to Learn – Serial / Eager – Count

RichIterable.count(Predicate)

```
default int count(Predicate<? super T> predicate) {
    int count = 0;
    for (T each : this) {
        if (predicate.test(each)) {
            count++;
        }
    }
    return count;
}
```


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Make Java Easier to Learn – Serial / Eager – FindFirst

RichIterable.findFirst(Predicate)

```
default Optional<T> findFirst(Predicate<? super T> predicate) {
    for (T each : this) {
        if (predicate.test(each)) {
            return Optional.of(each);
        }
    }
    return Optional.empty();
}
```


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