The Java Evolution of Eclipse Collections

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Agenda

- **Intro**
- What is Eclipse Collections
- New features in 8.0
- Optional
- Collectors
- Default methods
- Primitive Collections
- Java 9
- Conclusion

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Kristen O'Leary

- Software developer at Goldman Sachs
- Contributor to GS/Eclipse Collections
  - http://www.goldmansachs.com/what-we-do/engineering/see-our-work/growing-with-gs-collections.html
- EC Kata Instructor and Contributor
  - https://www.eclipsecon.org/na2016/session/eclipse-collections-kata-fun-way-learn-feature-rich-collections-framework
- Eclipse Collections Advocate
  - NY Java SIG 2016, JavaOne 2016, EclipseCon 2016, QCon NY 2014

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What is Eclipse Collections?

- Feature rich, memory efficient Java Collections framework
- Open sourced in 2012 as GS Collections
- New – 8.0 compatible with JDK 8+
- eclipse.org/collections
- Eclipse Collections is open for contributions!
  - https://github.com/eclipse/eclipse-collections/blob/master/CONTRIBUTING.md

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Version 8 for Java 8

- Before, EC worked with Java 8
- But did not require or embrace it
- V 8 changes that. Now:
  - If you have JDK 8 code → easy transition to EC
  - If you have EC code → easier to use JDK 8 Collections/Streams features

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What's new in EC 8.0?

- EC **functional interfaces** extend **Java 8 functional interfaces**
- New interop with Java 8 features directly in API
  - reduce, reduceInPlace, summarize, detectOptional and more
- Collectors + Eclipse Collections Types = Collectors2
- Default methods = More Features, Less Code
- Primitive Collections and Java 8

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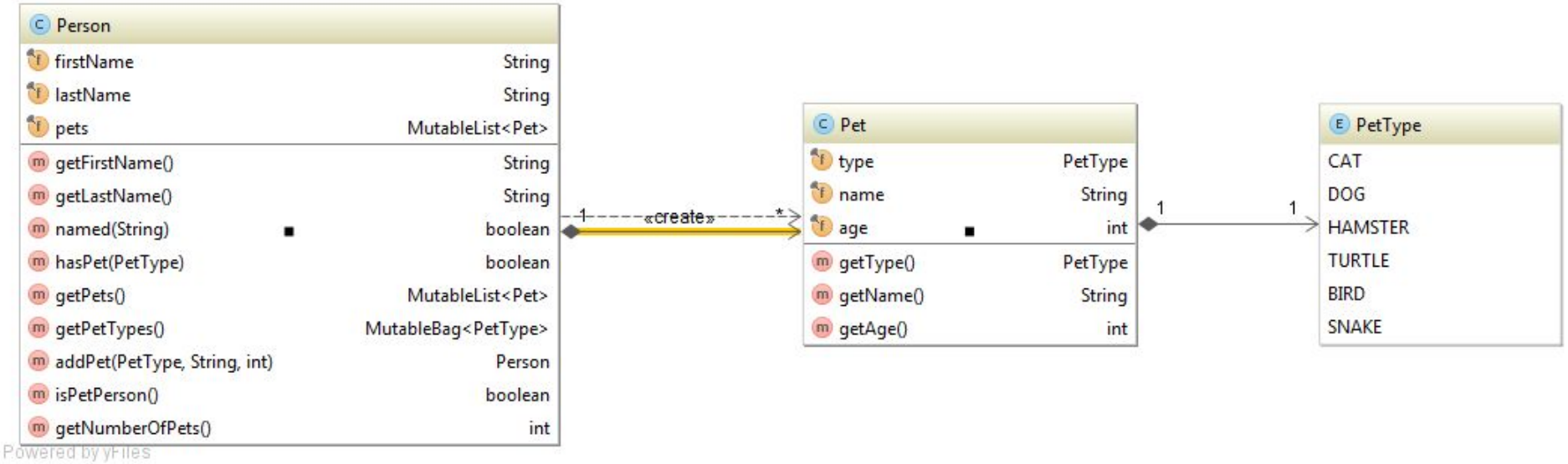
Our Domain



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Optional

- New JDK 8 feature
- From the javadoc:
  - "*A container object which may or may not contain a non-null value. If a value is present, isPresent() will return true and get() will return the value*."

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Where can we use this in EC?

- RichIterable “detectWith” is one example
- From the javadoc:
  - *“Returns the first element that evaluates to true for the specified predicate2 and parameter, or null if none evaluate to true.”*

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So what happens?

Kata exercise - find Mary Smith

```
Person person = this.people
        .detectWith(Person::named, "Mary Smith");

Assert.assertEquals("Mary", person.getFirstName());
Assert.assertEquals("Smith", person.getLastName());
```

java.lang.NullPointerException

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Pre 8.0 – Null check

```
Person person = this.people
        .detectWith(Person::named, "Mary Smith");

if(person == null)
{
    person = new Person("Mary", "Smith");
}

Assert.assertEquals("Mary", person.getFirstName());
Assert.assertEquals("Smith", person.getLastName());
```

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Pre 8.0 – detectWithIfNone

Find Mary Smith, or create her

```
Person person = this.people.detectWithIfNone(
    Person::named, "Mary Smith",
    () -> new Person("Mary", "Smith"));


Assert.assertEquals("Mary", person.getFirstName());
Assert.assertEquals("Smith", person.getLastName());
```

Test passes!

8.0 - Optional

Find Mary Smith, or create her

```
Optional<Person> optional = this.people
        .detectWithOptional(Person::named, "Mary Smith");

Person person = optional.orElseGet(
        () -> new Person("Mary", "Smith"));

Assert.assertEquals("Mary", person.getFirstName());
Assert.assertEquals("Smith", person.getLastName());
```

Test passes!

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What is a Collector?

- New feature in Java 8
- A way to implement a mutable reduction operation
  - Accumulating into a collection
- JDK 8 has several “built in” Collectors

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JDK 8 Collector Examples

```
List<String> names = this.people.stream()
    .map(Person::getFirstName).collect(Collectors.toList());
```

```
// Output:
[Bob, Ted, Jake]
```

```
int total = this.people.stream()
     .collect(Collectors.summingInt(Person::getNumberOfPets));
```

```
// Output:
4
```

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Eclipse Collections and Collectors

- Starting with Eclipse Collections 8.0, we can leverage Collectors
- Also has some “built in” – Collectors2

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Collectors2 Examples

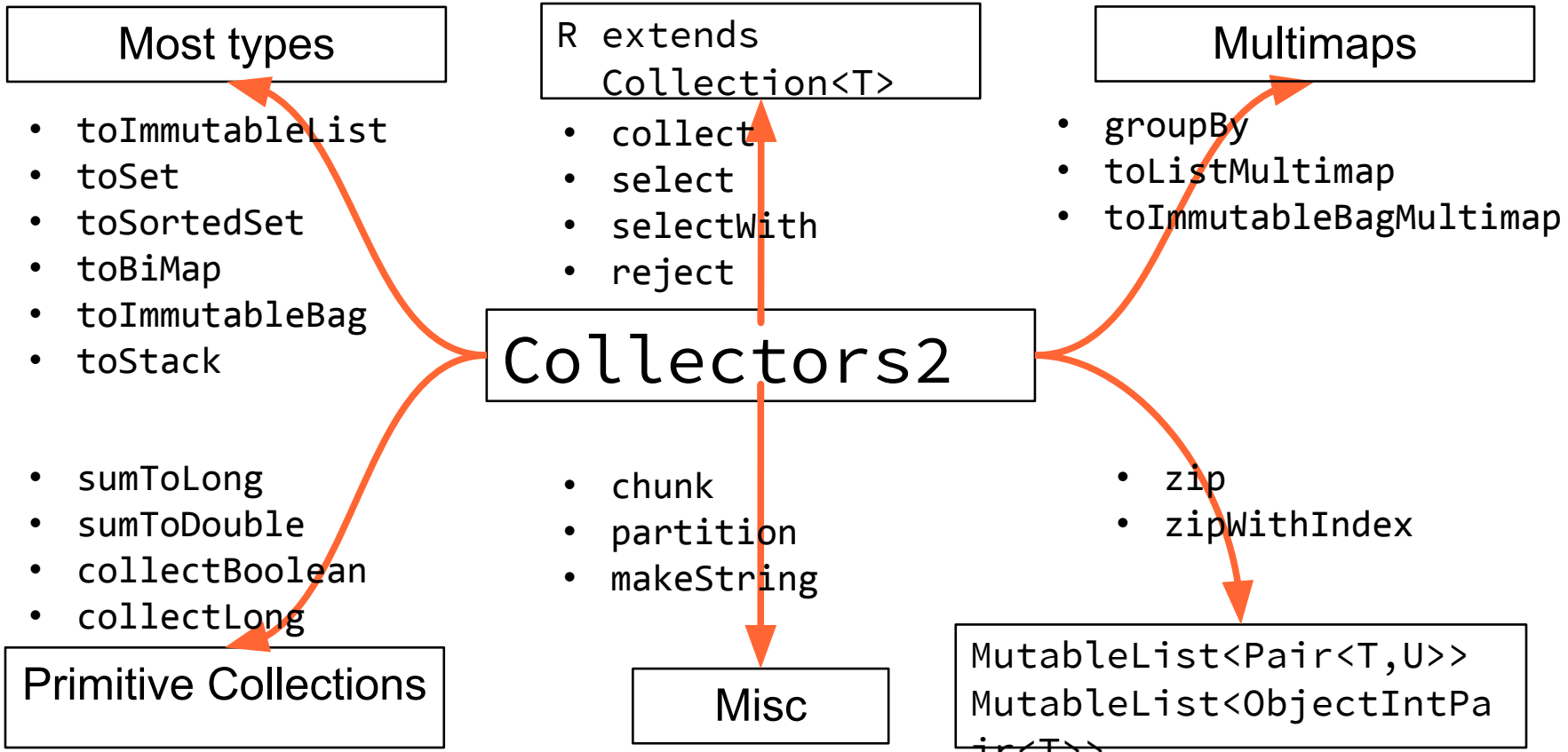
```
MutableBag<Pet> bag = this.people.stream()
        .map(Person::getPets).flatMap(List::stream)
        .collect(Collectors2.toBag());
```

```
// Bag Contents:
Dog   → 2
Cat   → 1
Snake → 1
```

```
ImmutableSet<Person> catPeople = this.people.stream()
        .filter(person -> person.hasPet(PetType.CAT))
        .collect(Collectors2.toImmutableSet());
```

```
// Set Contents:
Bob
```

Collectors2



Interop w/Collectors & Collectors2

```
Map<Integer, String> people = this.people
        .stream()
        .collect(Collectors.groupingBy(
                Person::getNumberOfPets,
                Collectors2.makeString()));
```

```
// Output:
{1=Ted, Jake,
2=Bob}
```

```
Map<Integer, String> collect = this.people
        .stream()
        .collect(Collectors.groupingBy(
                Person::getNumberOfPets,
                Collectors.mapping(
                        Object::toString,
                        Collectors.joining(","))));
```

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RichIterable.reduceInPlace

```
/**
 * This method produces the equivalent result as {@link
Stream#collect(Collector)}.
 *
 * @since 8.0
 */
default <R, A> R reduceInPlace(Collector<? super T, A, R> collector)
{
    A mutableResult = collector.supplier().get();
    BiConsumer<A, ? super T> accumulator = collector.accumulator();
    this.each(each -> accumulator.accept(mutableResult, each));
    return collector.finisher().apply(mutableResult);
}
```

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Example

```
//using Java 8 and Collectors2
ImmutableSet<Person> people = this.people
        .stream()
        .filter(person -> person.hasPet(PetType.DOG))
        .collect(Collectors2.toImmutableSet());

//using Eclipse Collections and Collectors
ImmutableSet<Person> peopleReduce = this.people
        .selectWith(Person::hasPet, PetType.DOG)
        .reduceInPlace(Collectors2.toImmutableSet());
```

```
// Set Contents:
[Bob, Ted]
```

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Lazy and immutable API

```
this.people.toImmutable().stream()


this.people.asLazy().stream()
```

```
Set<Person> peopleReduced = this.people
        .asLazy() // stream() is no longer available
        .selectWith(Person::hasPet, PetType.DOG)
        .reduceInPlace(Collectors.toSet());
```

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Primitive Collections

- Primitive Collections since GS Collections 3.0.
- Memory Optimized Collections for primitive types.
- Similar Interface hierarchy to the Object collections.
- Symmetry among the primitive types.

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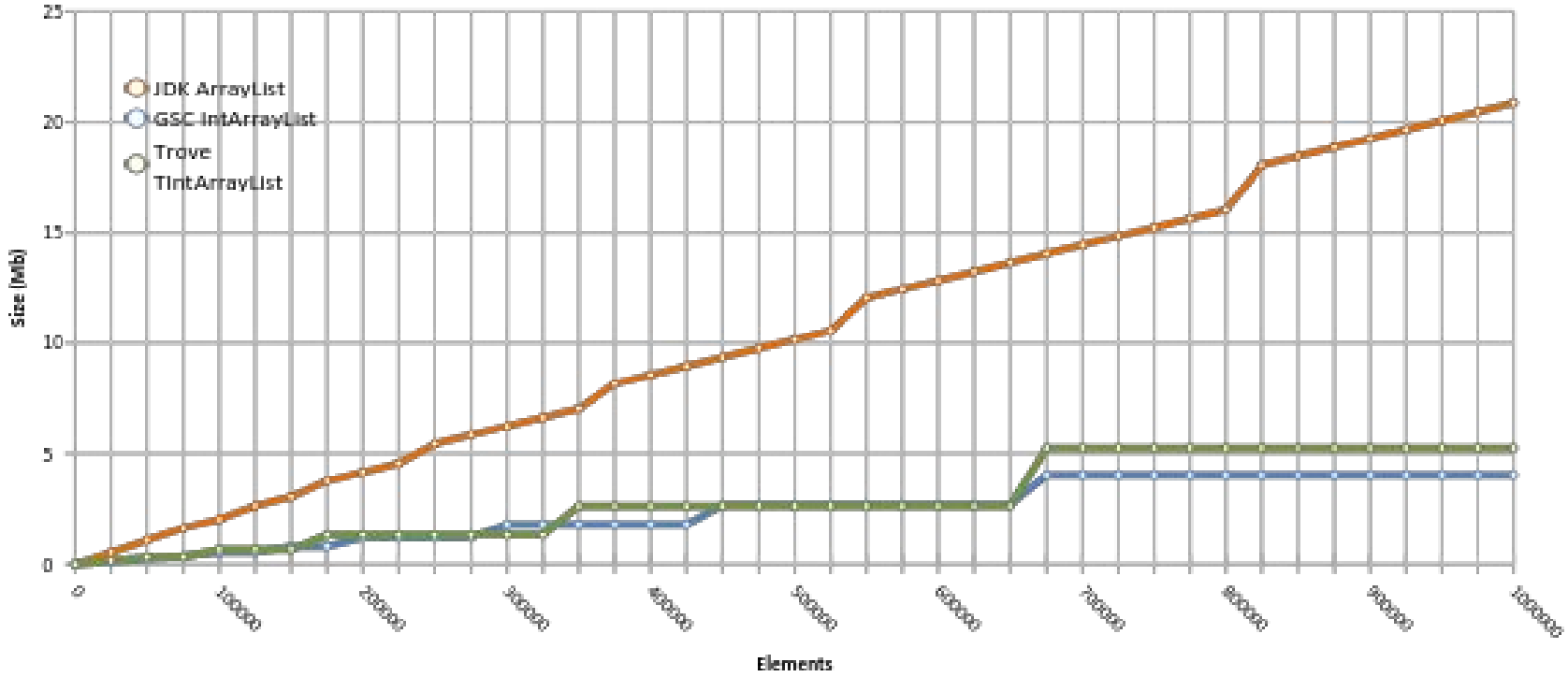
How much should an **int** cost?



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List<Integer> vs. IntList

- Java has object and primitive arrays
  - Primitive arrays have no behaviors
- Java does not have primitive Lists, Sets or Maps
  - Primitives must be boxed
  - Boxing is expensive
    - Reference + Header + alignment

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Primitive vs. JDK Collections

Type	Eclipse Collections	JDK Collections
Primitive List	Yes	Boxed
Primitive Set	Yes	Boxed
Primitive Map	Yes	Boxed
Primitive Stack	Yes	Boxed
Primitive Bag	Yes	Map and Boxed
Primitive Lazy / Stream	Yes (all 8 primitives)	Int, Long, Double only

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IntStream vs. LazyIntIterable

- Java has only 3 primitive stream: Int, Long, Double
  - IntStream.of vs. Stream.of for creation.
  - Specialized lambda expressions
  - Interchangable between Primitive and Obj stream

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IntStream vs. LazyIntIterable cont.

- LazyIterable for all 8 primitive types.
  - AsLazy API for creation
  - Rich APIs both similar to object and type specific.
  - Specialized functional interfaces

  These functional interfaces now can be used in Java 8 streams too!
  - Reusability

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Use or Reuse?

- Streams – like Iterator

```
IntStream stream = IntStream.of(1, 2, 3);
Assert.assertEquals(1, stream.min().getAsInt());
Assert.assertEquals(3, stream.max().getAsInt());          // throws IllegalStateException
```

```
java.lang.IllegalStateException: stream has already been operated upon or closed
      at java.util.stream.AbstractPipeline.evaluate(AbstractPipeline.java:229)
      at java.util.stream.IntPipeline.reduce(IntPipeline.java:461)
      at java.util.stream.IntPipeline.max(IntPipeline.java:424))
```

- LazyIterable – Iterable

```
LazyIntIterable lazy = IntArrayList.newListWith(1, 2, 3).asLazy();
Assert.assertEquals(1, lazy.min());
Assert.assertEquals(3, lazy.max());                       // reuse!
```

Filter Pet Ages Appearing Once

stream

```
List<Map.Entry<Integer, Long>> counts = this.people.stream()
        .flatMap(person -> person.getPets().stream())
        .collect(Collectors.groupingBy(Pet::getAge,
Collectors.counting()))
        .entrySet()
        .stream()
        .filter(e -> e.getValue().equals(Long.valueOf(1)))
        .collect(Collectors.toList());
```

```
// Output:
[3=1, 4=1]
```

asLazy

```
MutableIntBag counts = this.people.asLazy()
     .flatCollect(Person::getPets)
     .collectInt(Pet::getAge)
     .toBag()
     .selectByOccurrences(IntPredicates.equal(1));
```

```
// Output:
[3, 4]
```

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Find the Mode of Pet Age

stream

```
List<Map.Entry<Integer, Long>> topOccurrenceList = this.people.stream()
        .flatMap(person -> person.getPets().stream())
        .collect(Collectors.groupingBy(Pet::getAge, Collectors.counting()))
        .entrySet()
        .stream()
        .sorted(Map.Entry.<Integer, Long>comparingByValue().reversed())
        .limit(1)
        .collect(Collectors.toList());
```

```
// Output:
[2=2]
```

asLazy

```
MutableList<IntIntPair> topOccurrences =
                this.people.asLazy()
                   .flatCollect(Person::getPets)
                   .collectInt(Pet::getAge)
                   .toBag()
                   .topOccurrences(1);
```

```
// Output:
[2:2]
```

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Find the Least Frequent Pet Age

stream

```
List<Map.Entry<Integer, Long>> bottomOccurrenceList = this.people.stream()
        .flatMap(person -> person.getPets().stream())
        .collect(Collectors.groupingBy(Pet::getAge, Collectors.counting()))
        .entrySet()
        .stream()
        .sorted(Map.Entry.<Integer, Long>comparingByValue())
        .limit(1)
        .collect(Collectors.toList());
```

```
// Output:
[3=1]
```

asLazy

```
MutableList<IntIntPair> bottomOccurrences =
                this.people.asLazy()
                    .flatCollect(Person::getPets)
                    .collectInt(Pet::getAge)
                    .toBag()
                    .bottomOccurrences(1);
```

```
// Output:
[3:1]
```

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What's next?

- Java 9 will introduce many interesting changes to the Java ecosystem
  - Module System
  - Internal API Encapsulation
- Eclipse Collections **must** change in order to be compatible

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Methods using reflection

- We need to change our methods that use reflection to build

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What happens?

- *Compile, run tests, deprecate*
- Demo

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ArrayListIterate

```
public final class ArrayListIterate
{
    private static final Field ELEMENT_DATA_FIELD;
    private static final Field SIZE_FIELD;
    private static final int MIN_DIRECT_ARRAY_ACCESS_SIZE = 100;

    static
    {
        Field data = null;
        Field size = null;
        try
        {
            data = ArrayList.class.getDeclaredField("elementData");
            size = ArrayList.class.getDeclaredField("size");
            data.setAccessible(true);
            size.setAccessible(true);
        }
        catch (Exception ignored)
        {
            data = null;
            size = null;
        }
        ELEMENT_DATA_FIELD = data;
        SIZE_FIELD = size;
    }
```

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Workarounds for reflection

- http://mail.openjdk.java.net/pipermail/jigsaw-dev/2017-March/011763.html
- Can avoid via command line arguments
- EC proactively solved the problem

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Resources

- Eclipse Collections 8.2 release

  https://github.com/eclipse/eclipse-collections/releases/tag/8.2.0
- Collectors Fair: Developing and Marketing a New Kind of Component
  https://static.rainfocus.com/oracle/oow16/sess/1462848741026001JnVD/ppt/CollectorsFair_J1_2016_final.pdf
- GS Collections Memory Benchmark
  http://www.goldmansachs.com/gs-collections/presentations/GSC_Memory_Tests.pdf

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