Lambdas: Myths and Mistakes

by Richard Warburton

the critical design tool for software development is a mind well educated in design principles. It is not ... technology.

Craig Larman

Talk Structure

- Why am I talking about this?
- Intro to Lambda Expressions
- Beyond the Myths
- Functional Thinking

Why am I talking about this?

Lambda Expressions are coming in Java 8!

lots of discussion/debate

How can we help?

Adopt-a-JSR

Adopt-a-JSR?

- More community driven standards
- Hackdays
- Serve on Expert Groups

Some discussion unimportant

Concrete Examples focus discussion

Intro to Lambda Expressions

Overview of Lambdas

- Goal: Better Libraries
- Example: Collections with Data Parallelism
- Approach: Allow Code as Data

Action Listener

```
button.addActionListener(new ActionListener() {
    public void actionPerformed(ActionEvent event) {
        System.out.println("button clicked");
    }
});
```

Code as Data

```
button.addActionListener(
    ?
);
```

Need a parameter

```
button.addActionListener(event

);
```

Lambda Example

```
button.addActionListener(event ->
    System.out.println("button clicked")
);
```

No parameters

```
Runnable helloWorld =
    () -> System.out.println("Hello World");
```

Variable Capture

```
String name = getUserName();
button.addActionListener(event ->
    System.out.println("hi " + name)
);
```

Functional Interfaces

- Everything in Java has a type
- Problem: Need types to represent Functions
- Solution: Use interfaces

Functional Interfaces

```
public interface ActionListener extends EventListener {
    public void actionPerformed(ActionEvent event);
}
```

Streams

- Support automated data parallelism
- Build computation pipelines
- Iterator with inversion of control

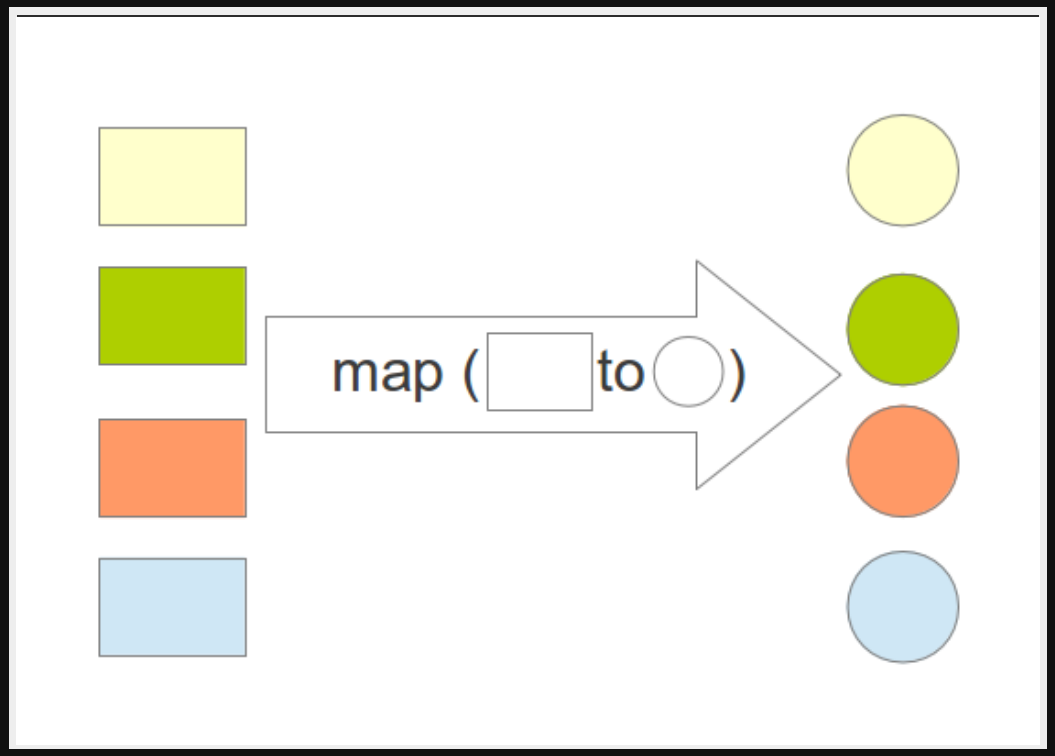
External Iteration

```
int count = 0;
for (Artist artist : artists) {
    if (artist.isFrom("London")) {
        count++;
    }
}
```

Internal Iteration

```
artists.stream()
       .filter(artist -> artist.isFrom("London"))
       .count();
```

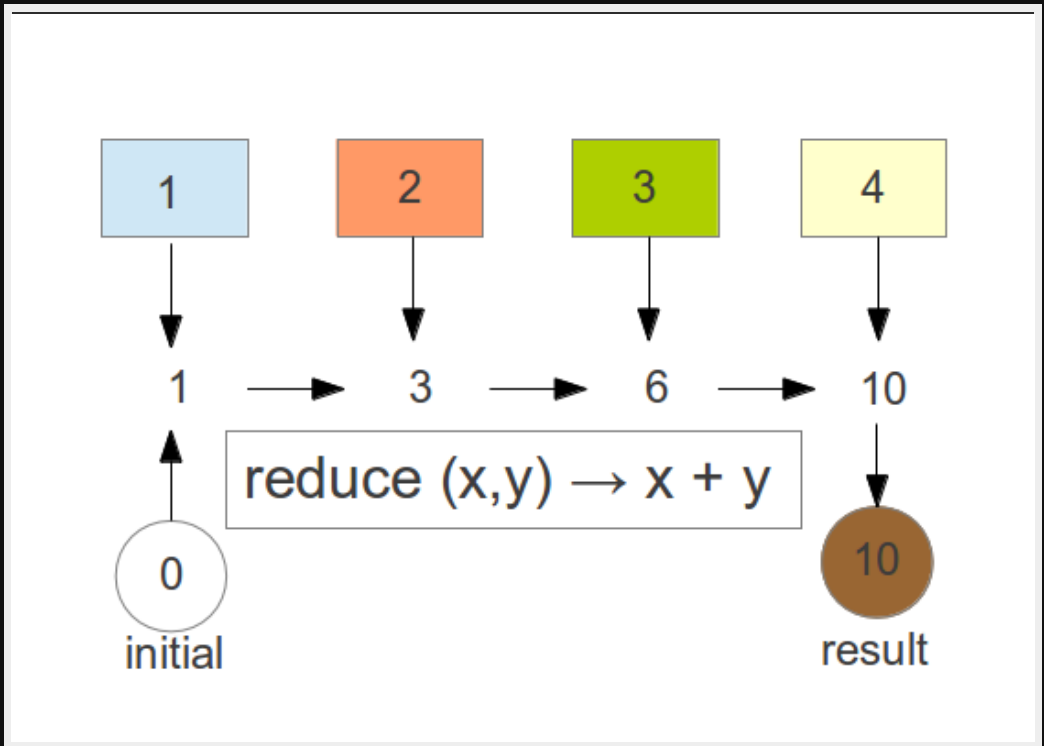
map



map

```
List<String> collected = Stream.of("a", "b", "hello")
                               .map(string -> string.toUpperCase())
                               .collect(toList());

assertEquals(asList("A", "B", "HELLO"), collected);
```

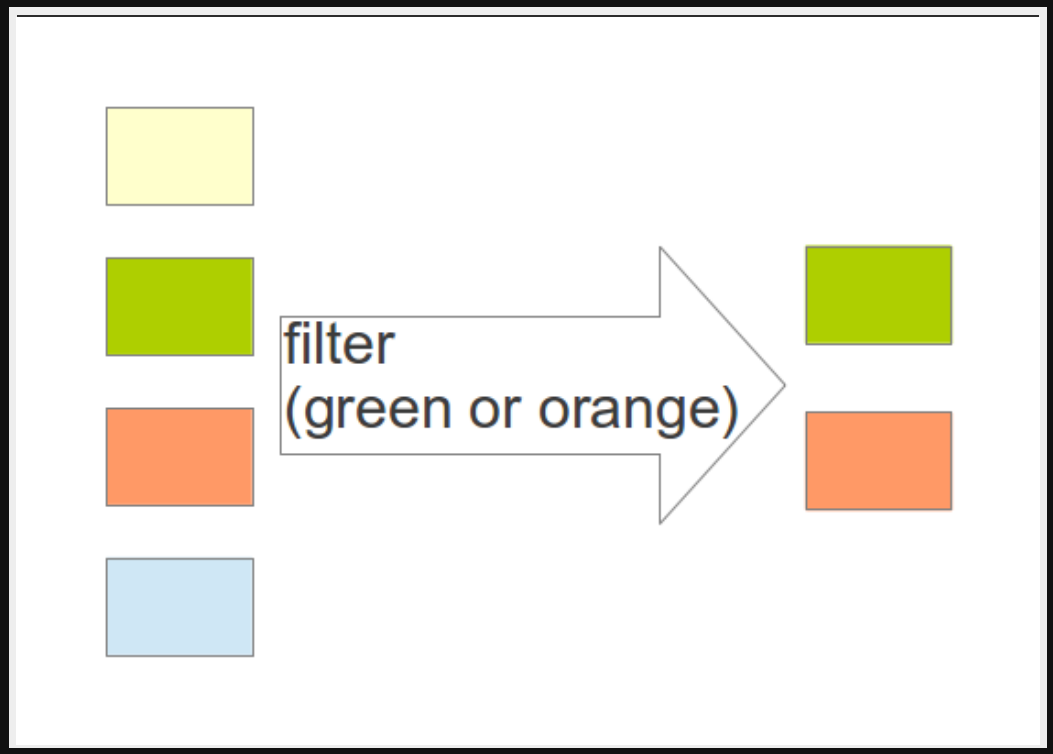
reduce



reduce

```
int sum = Stream.of(1, 2, 3, 4)
                .reduce(0, (acc, x) -> acc + x);

assertEquals(10, sum);
```

filter



filter

```
List<String> beginningWithNumbers =
    Stream.of("a", "1abc", "abc1")
          .filter(value -> isDigit(value.charAt(0)))
          .collect(toList());

assertEquals(asList("1abc"), beginningWithNumbers);
```

Putting it all together

for a given an album, find the nationality of every band playing on that album

Putting it all together (2)

1. transform an album into its artists
2. figure out which artists are bands
3. find the nationalities of each band

Putting it all together (3)

```
List<String> origins =
  album.getMusicians()
       .filter(artist -> artist.getName().startsWith("The"))
       .map(artist -> artist.getNationality())
       .collect(toList());
```

Method References

```
str -> str.length
String::length

x -> foo.bar(x)
foo::bar

str -> new Name(str)
Name::new
```

Beyond the Myths

Claim: Syntax is the most important thing about Lambda Expressions

Yeah, I liked the # syntax proposal better, too. One less character to type! :)

Have you considered 'default null'? It will save a keyword

How about a single punctuation mark, currently unused, as syntax sugar for "()->".

```
(_, _) -> _ + _
```

This is starting to look like risque ASCII art :)

Its a Myth!

Claim: Syntax is irrelevant

```java
// Originally invalid
Stream.of(1, 2, 3)
      .forEach(x -> System.out.println(x));

// Required extra ;
Stream.of(1, 2, 3)
      .forEach(x -> System.out.println(x););
```

Difference between expectations

- Many language features ~~stolen!~~ adapted
- Missing Features
  - Stronger Type System
  - Tuples
  - List construction syntax

Framing Effect

Different reactions depending on whether something is presented as a loss or a gain.

Recall our earlier example

```
List<String> origins =
  album.getMusicians()
       .filter(artist -> artist.getName().startsWith("The"))
       .map(artist -> artist.getNationality())
       .collect(toList());
```

Eager vs Lazy (2)

```
  album.getMusicians()
       .filter(artist -> artist.getName().startsWith("The"))
       .map(artist -> artist.getNationality())

// What's happened?
       .collect(toList());
```

Very little Testing

Maybe ...

- a reflection on popularity of TDD
- spikes are good for learning
- unfamiliarity with testing lambdas

How do I test this?

```
list.stream()
    .map(x -> 1.0 / Math.ceil(1 + Math.pow(x) + Math.atan2(y, x)))
    .collect(toList());
```

Approach 1: Test surrounding method

- Don't test the lambda
- Test the method its surrounded by
- Works well for simple lambdas

Approach 2: Extract Method

```
double complexFunction(double x) {
    return 1.0 / Math.ceil(1 + Math.pow(x) + Math.atan2(0, x));
}

list.stream()
    .map(this::complexFunction)
    .collect(toList());
```

Mistake: debugging

```
// Streams
list.stream()
    .filter(filteringFunction)
    .map(mappingFunction)
    .collect(toList());

// Ye olde for loop
List<Bar> bars = new ArrayList<>();
for (Foo element : list) {
    if (filteringFunction(element) {
        Bar result = mappingFunction(element);
        bars.add(result);
    }
}
```

peek

```
list.stream()
    .filter(filteringFunction)
    .peek(e -> System.out.println("Filtered value: " + e));
    .map(mappingFunction)
    .map(e -> e);
    .collect(toList());
```

Compiler Error Messages

Comparators

```
Comparator<String> comparator = comparing(String::length);

Comparator<String> comparator = comparing(str -> str.length);
```

Compiler Error

```
java: reference to comparing is ambiguous both
method
<T>comparing(java.util.function.ToIntFunction< ? super T>)
in java.util.Comparator and method
<T,U>comparing(java.util.function.Function< ? super T,? extends U>)
in java.util.Comparator match
```

What happened?

```
// Generic object variant
public static <T, U extends Comparable< ? super U>>
    Comparator<T>
        comparing(Function< ? super T, ? extends U> keyExtractor)

// Specialised primitive variant
public static <T>
    Comparator<T>
        comparing(ToIntFunction< ? super T> keyExtractor)
```

Summary

- Syntax important, but not in the way people think
- New approaches for debugging and testing
- Take care of overloads and compiler error messages

Functional Thinking

Functional Thinking?

Thinking in terms of the input to output relationship and not a sequence of steps

First code that people write

```
List<Integer> numbers = Arrays.asList(1, 2, 3);
numbers.forEach(x -> {
    System.out.println(x);
});
```

Non-idiomatic Proposals

Eg: capture non-final local variables

Example Problem

Count the number of instances of each word in a document.

Ideal Solution

```
reader.lines()
      .flatMap(s -> s.splitAsStream(" "))
      .collect(groupingBy(s -> s,
               counting()));
```

Ideal Solution (then)

```
reader.lines()
      .flatMap(s -> Stream.of(s.split(" ")))
      .collect(groupingBy(s -> s,
               reducing(s -> 1, Integer::sum)));

// Map entries for "dad"
// [ "dad", "dad", "dad" ] => [1, 1, 1] => 3
```

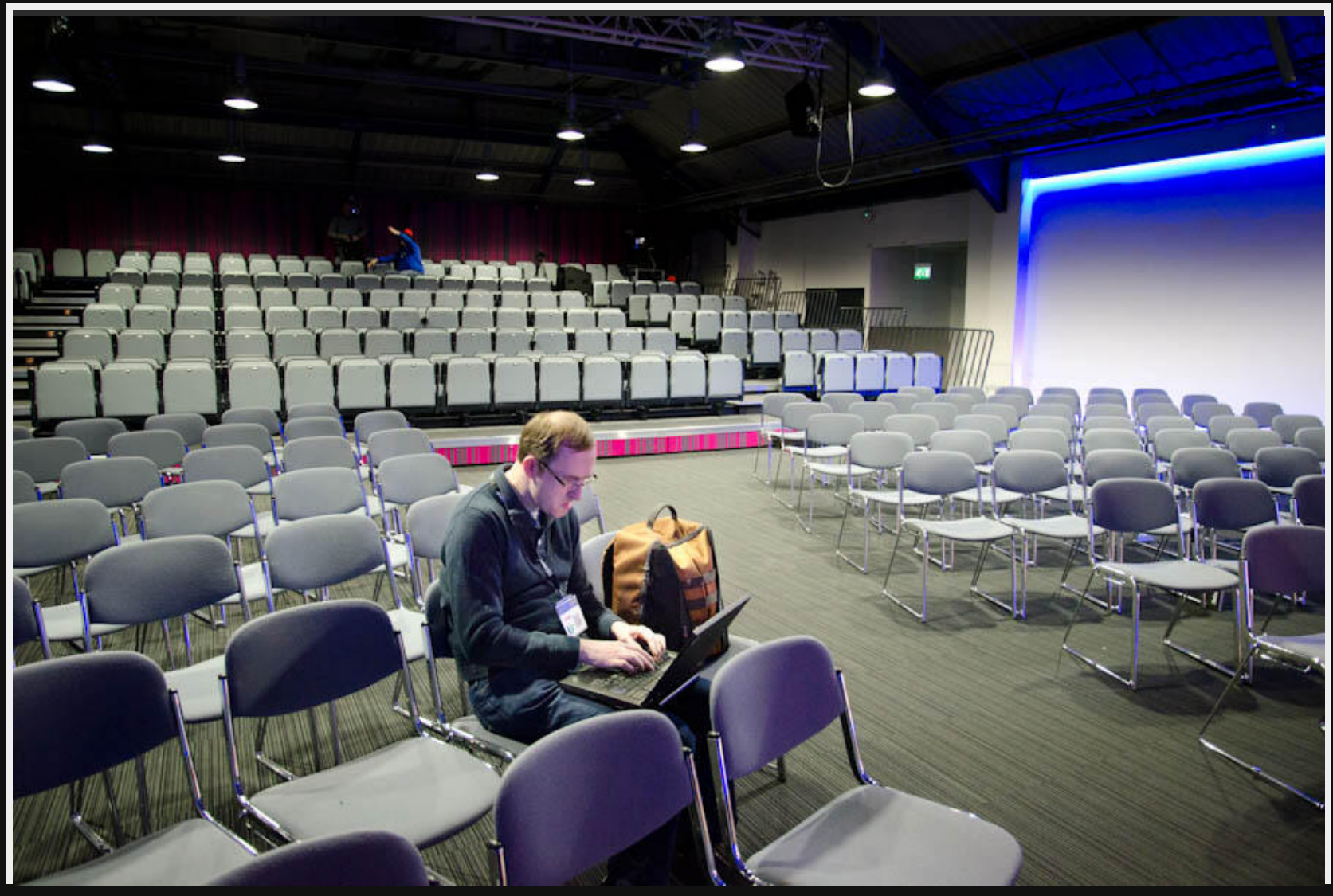
Bad Solution (Part 1)

```
Map<String, List<String>> initial
      = br.lines()
          .flatMap(s -> Arrays.stream(s.split(" ")))
          .collect(groupingBy(s -> s));

  Map<Map.Entry<String, Integer>, Integer> freq1 = initial
    .entrySet().stream()
    .map(entry -> new AbstractMap.SimpleImmutableEntry<String,
Integer>(entry.getKey(), entry.getValue().size()))
    .collect(Collectors.toMap(entry -> entry.getValue()));
```

Bad Solution (Part 2)

```
  Supplier<HashMap<String, Integer>> supplier = () -> new
HashMap<String, Integer>();
  BiConsumer<HashMap<String, Integer>, Map.Entry<String, Integer>> accum =
    (HashMap<String, Integer> result, Map.Entry<String, Integer>
entry) -> result.put(entry.getKey(), entry.getValue());
  BiConsumer<HashMap<String, Integer>, HashMap<String, Integer>>
merger = HashMap::putAll;

  Map<String, Integer> freq2 = initial.entrySet().stream()
    .map(entry -> new AbstractMap.SimpleImmutableEntry<String,
Integer>(entry.getKey(), entry.getValue().size()))
    .collect(supplier, accum, merger);
```

This takes thought



Summary

- Idioms are vital
- Not Java specific at all
- Requires Practise

Conclusions

- Gone through a bunch of examples of specific issues
- ‘Functional Thinking’: Not necessary to start learning.
- Try before you buy

Q & A

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