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Cloud-Ready: Introduction to Distributed Lambdas

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Live for
the Code

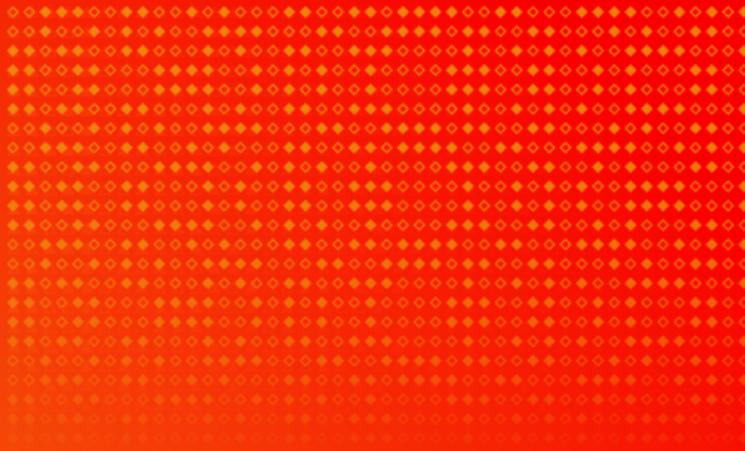


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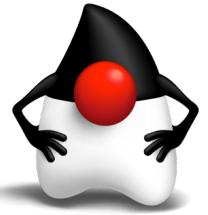
Program Agenda

- 1 ➤ Lambdas
- 2 ➤ Remote Functional Interfaces & Lambdas
- 3 ➤ Demonstrations!
- 4 ➤ The Challenges and Limitations
- 5 ➤ Next Steps



Introduction to Lambdas



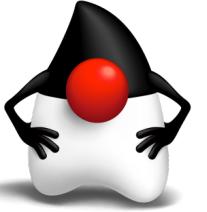


Introduction to Lambdas

A defining new feature of the Java 8 Platform

- Enable hybrid, object-oriented / functional programming in Java
- Allow you to pass code-as-data
 - Both as arguments and as return values
- Extensive enhancement of existing Java libraries to support them

```
Map<Integer, String> champs = new HashMap<>();  
  
champs.put(2016, "Nico Rosberg");  
champs.put(2015, "Lewis Hamilton");  
champs.put(2014, "Lewis Hamilton");  
  
champs.forEach((k, v) -> System.out.printf("key: %s, value: %s\n", k, v));
```



Introduction to Lambdas

Automatically Capture Surrounding “effectively final” Context = Closures!

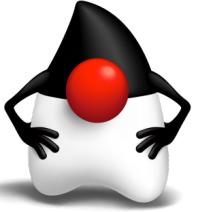
- Closures = function + environment

```
int nLast = 2016;

Map<Integer, String> champs = new HashMap<>();

champs.put(2016, "Nico Rosberg");
champs.put(2015, "Lewis Hamilton");
champs.put(2014, "Lewis Hamilton");

champs.forEach((k, v) -> System.out.printf("%s is the latest champ? %s\n", v, k == nLast));
```



Introduction to Lambdas

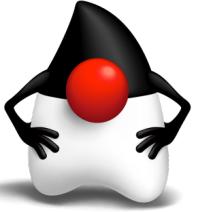
Replace anonymous “functional interface” inner-classes with lambdas

- Before:

```
executor.submit(new Runnable()
{
    public void run()
    {
        System.out.println("Hello from anonymous class!");
    }
});
```

- After:

```
executor.submit(() -> System.out.println("Hello from lambda!")); // Beautiful ☺
```



Introduction to Lambdas

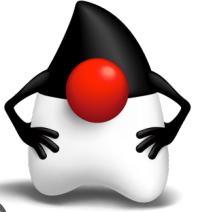
What qualifies as a @FunctionalInterface?

- Runnable Interface in Java 8:

```
@FunctionalInterface  
public interface Runnable {  
    /**  
     * When an object implementing interface <code>Runnable</code> is used  
     * to create a thread, starting the thread causes the object's  
     * <code>run</code> method to be called in that separately executing  
     * thread.  
     * <p>  
     * The general contract of the method <code>run</code> is that it may  
     * take any action whatsoever.  
     */  
    public void run();  
}
```

But...

...Can they be distributed and
invoked across devices, machines,
data-centers... clouds?



Introduction to Lambdas

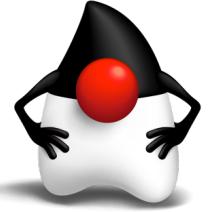
Standard Functional Interfaces and thus Lambdas are not serializable by default ☹

- We can cast them though...

```
Runnable r = (Runnable & Serializable)  
    () -> System.out.println("Hello from lambda!");
```

- Output*:

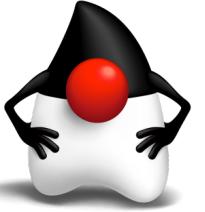
```
SerializedLambda[capturingClass=class JavaExamples,  
functionalInterfaceMethod=java/lang/Runnable.run:()V,  
implementation=invokeStatic JavaExamples.lambda$serialization$2feeadd5$1:()V,  
instantiatedMethodType=()V, numCaptured=0]
```



Introduction to Lambdas

None of the new functional interfaces are **Serializable** ☹

- There are many new *functional interfaces* in Java 8:
 - `java.util.function.Function<T, R>`
 - `java.util.function.Predicate<T>`
 - `java.util.function.Supplier<T>`
 - `java.util.function.Consumer<T>`
 - `java.util.function.BiConsumer<T, U>`
 - `java.util.function.UnaryOperator<T>`
 - `java.util.function.BinaryOperator<T>`
 - ... and their primitive variants



Introduction to Lambdas

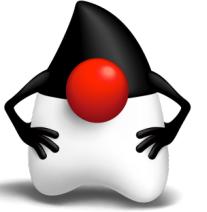
None of the existing functional interfaces are Serializable ☹

- And some of our old friends are also *functional interfaces*:
 - `java.lang.Runnable`
 - `java.util.concurrent.Callable<V>`
 - `java.util.Comparator<T>`
- Perhaps all unusable in a distributed environment?



Remote Functional Interfaces





Remote Functional Interfaces

Extensions of existing functional interfaces to support Serialization 😊

- Eg: The Coherence Remote Class defines serializable functional interfaces

```
public class Remote
{
    @FunctionalInterface
    public interface Function<T, R>
        extends java.util.function.Function<T, R>, Serializable {}

    @FunctionalInterface
    public interface Runnable
        extends java.lang.Runnable, Serializable {}

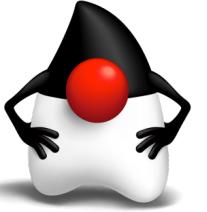
    ...
}
```



Where's the Cloud?

Introduction to Coherence





Remote Functional Interfaces

Most specific methods win!

- In addition to the standard Map method:

```
V computeIfAbsent(K key, Function<? super K, ? extends V> mappingFunction);
```

- Coherence NamedCache also defines:

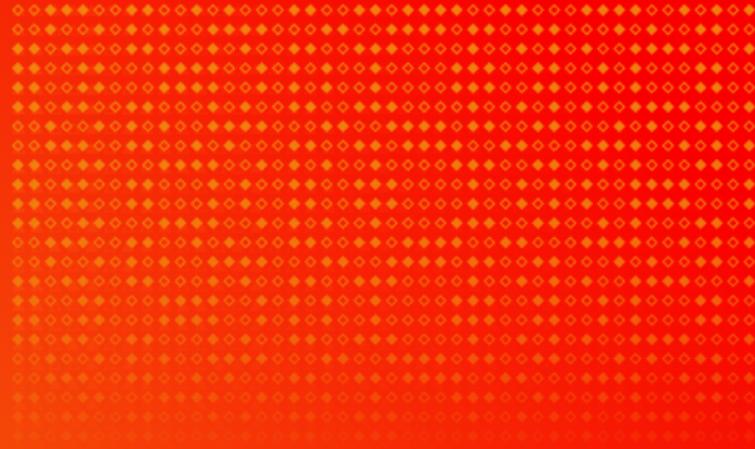
```
V computeIfAbsent(K key, Remote.Function<? super K, ? extends V> mappingFunction);
```

- Java Compiler resolves to use the “most specific overloaded method”... so we’re ready to do some distributed lambdas!



Demo time!

Also available here: <https://github.com/harveyraja/coh-lambda-demo>



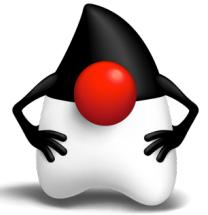
Challenges and Limitations



Oh!

*“Serialization: The gift that keeps
on giving”*

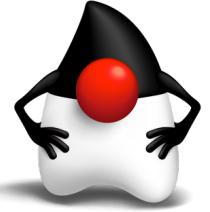
Brian Goetz
Java Language Architect



Challenge: Lambda Serialization

Java provides the bare minimum... in a distributed environment we need a lot more

- Developers use multiple types of serialization
 - Java only provides one
- Lambdas need to be stable across application versions
 - Java does not provide any such guarantees; it's weak at best
- Developers want to introduce new lambdas without restarting
 - Java expects the same version of the capturing class to exist everywhere
- Coherence provides a custom and yet completely compatible remoting framework to solve these challenges

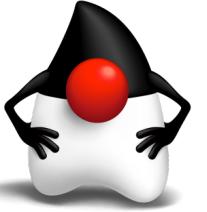


Limitation: Closure Serialization

Lambdas need to be self contained and serializable

- Should not reference fields or methods of the capturing class
- Should not reference anything that isn't certain to exist both on the client and on the server
- Should only capture local serializable variables (use a static factory!)

```
public static Remote.BiFunction<String, String, String> changeName(String name)
{
    return (key, value) ->
    {
        return name;
    };
}
```



Limitation: Closure Serialization

Lambdas need to be self contained and serializable

- Should not nest other non-serializable lambdas
- Don't do this:

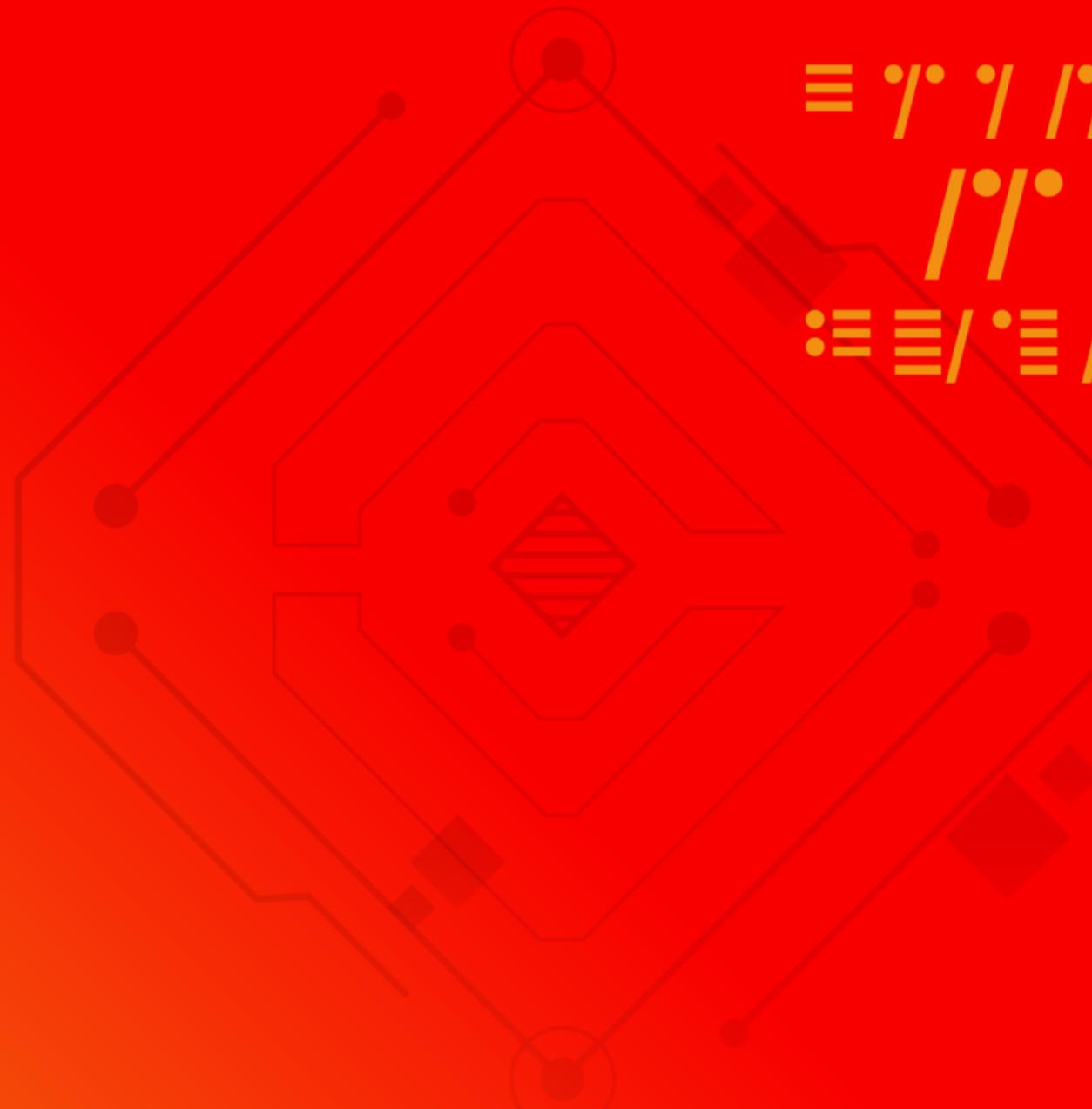
```
Map<Integer, String> names = champs.invokeAll((entry) -> entry.extract(Champ::getName));
```

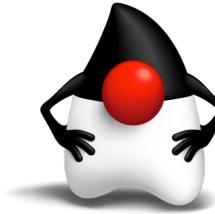
- Instead do this:

```
ValueExtractor<Champ, String> extractor = Champ::getName;  
Map<Integer, String> names = champs.invokeAll((entry) -> entry.extract(extractor));
```



Summary

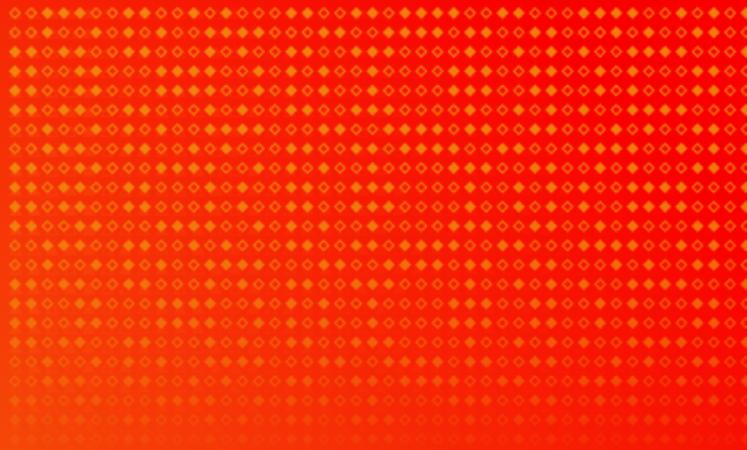




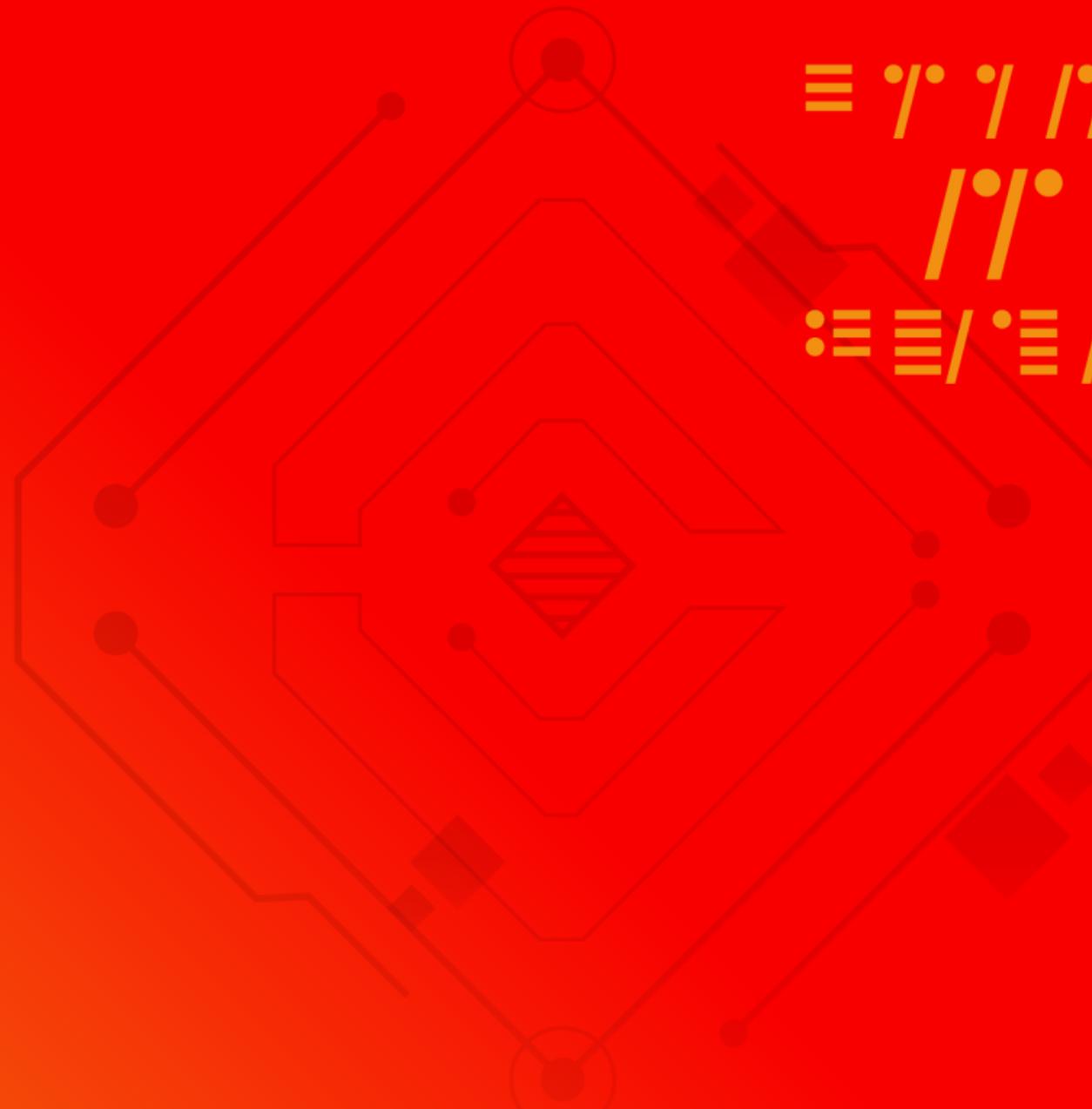
Summary

Distributed Lambdas Rock! Imagine the possibilities!

- Lambdas are a defining feature of Java 8
- Coherence 12.2.1 allows you to use lambdas
 - Like standard Java, but both locally & in a distributed manner
 - Allows in-place update without locking / synchronization
 - With existing Coherence features (like Entry Processors, Listeners...)
 - To perform stream-based operations
- Coherence adds support for serialization of standard functional interfaces
- Coherence handles distributed stream & lambdas in a dynamic way
 - Supports multiple versions of clients seamlessly running side-by-side without restart



Next Steps



Start Playing!

Coherence for Developers!



- <https://www.oracle.com/goto/coherence>
- <http://coherence.me>



<https://twitter.com/OracleCoherence>



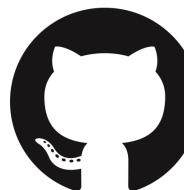
<http://www.youtube.com/OracleCoherence>



<https://www.linkedin.com/grp/home?gid=1782166>



<https://blogs.oracle.com/OracleCoherence>



<https://github.com/harveyraja/coh-lambda-demo>

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