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Completable Future

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Program Agenda

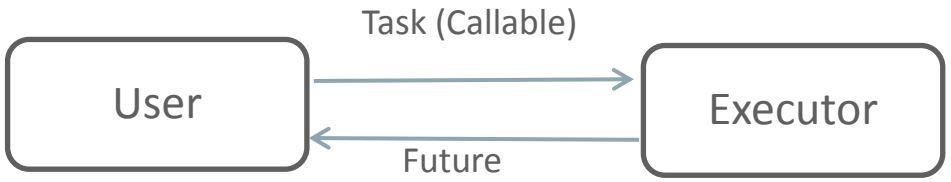
1. java.util.Future Introduction
2. Cloud Services Design and the fight for Performance
3. CompletableFuture and power of parallelism
4. Building powerful libraries with Completable Future

java.util.Future Introduction

- Before jdk1.5 , no java.util.concurrent.*, only threads ,synchronized primitives
- “Write once , run anywhere ?” – great success , “But run it a million times , work the same ?“ big question
- In came java.util.concurrent.* with executor service and future tasks and many other concurrency constructs
- A java.util.Future is a construct which holds a result available at a later time
- Future is asynchronous , but its not non-blocking

The Executor Service and Future Task

- Executors contains pool of threads which accepts tasks and supplies to the Future
- When a task is submitted to the executor it returns a future and future.get() would block the computation until it ends




```
ExecutorService executorService =
Executors.newFixedThreadPool(20);

Future<Integer> future =
executorService.submit(new Callable<Integer>()
{
@Override
public Integer call() throws Exception {
return 42;
}
});

System.out.println(future.get());

executorService.shutdown();
```

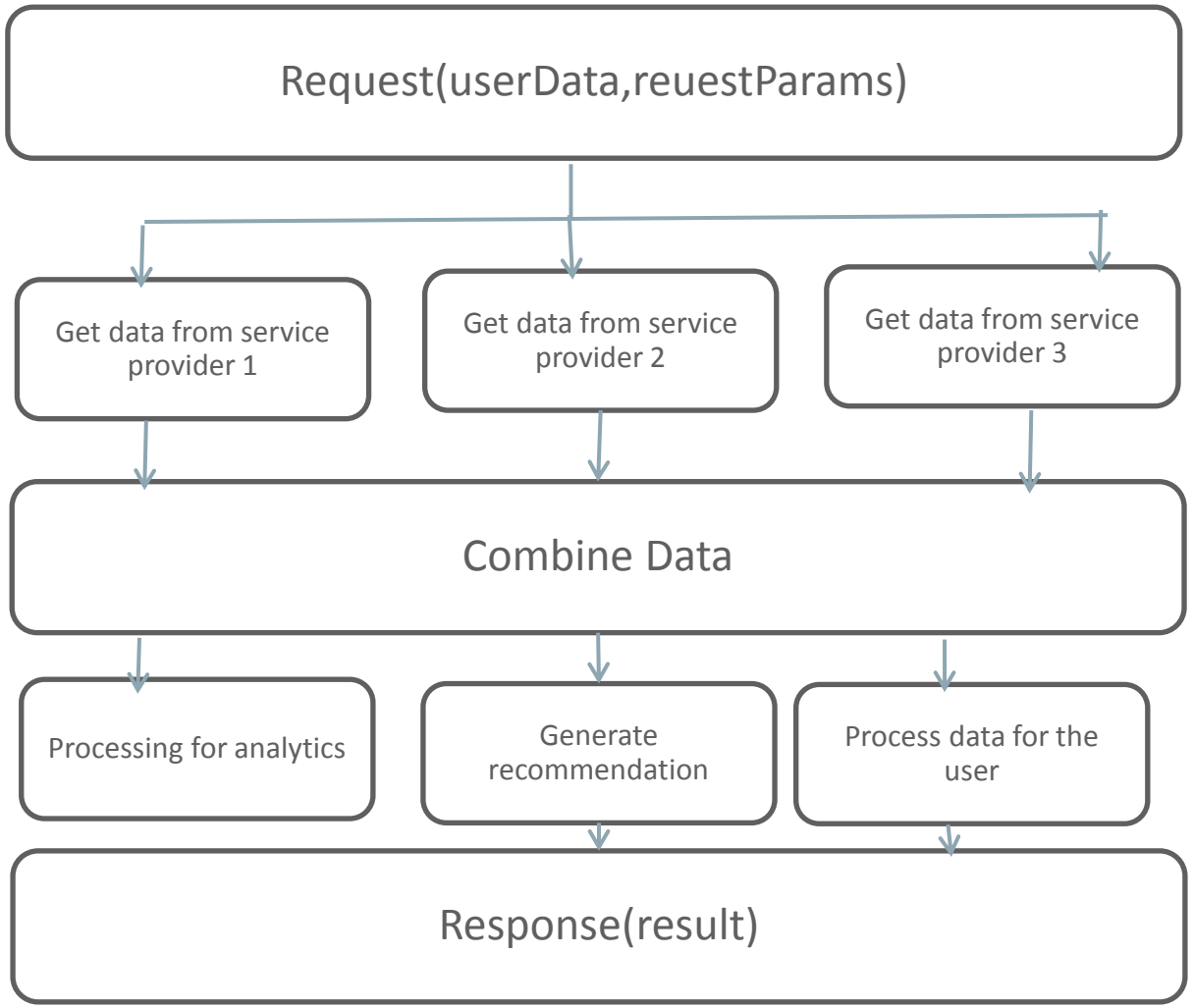
What can be done ?

- Future can allow computation in the background so improving performance
- Future.get() would block the thread and wait till the computation is complete and get the result
- Can get an exception if there is a failure
- future.cancel() cancels the computation
- future.isDone() checks the computation is complete
- And that's it /////

```
ExecutorService executorService =
Executors.newFixedThreadPool(20);

Future<Integer> future =
executorService.submit(new Callable<Integer>()
{
@Override
public Integer call() throws Exception {
//Some complex work
return 42;
}
});

System.out.println(future.get());

executorService.shutdown();
```

Distributed Cloud Services Design and the fight for Performance

A Typical distributed cloud service



Performance Bottlenecks and impacts

- Java.util.Future can help in parallelism
- But it cannot help with pipeline the tasks and managing the thread pool for you
- Future does not supports call backs and chaining of operations
- Building libraries with future can be complictaed
- Performing in a serial way can impact the latency big time
- It can destroy all benefits of having distributed services
- No amount of horizontal and vertical scaling can help
- Without dynamic services offerings business can be affected

CompletableFuture and power of parallelism

What is Completable future ?

- Its new addition to java 8
- Asynchronous, allows registering asyc callbacks just like java scripts, event-driven programming model
- Support for depending functions to be triggered on completion
- Each stage can be executed with different executor pool
- Also comes with a built in thread pool for executing tasks
- Built in lambda support ,super flexible and scalable api

Basics

```
 CompletableFuture<String> future =
CompletableFuture.supplyAsync(new Supplier<String>()
{
        @Override
        public String get() {
        // ...long running...
           return "42";
        }
        }, executor1);

future.get();
```

```
//Come on ...  we are in JDK 8 !!!

 CompletableFuture<String> future =
         CompletableFuture
             .supplyAsync(() -> "42",executor1);
future.get();
```

Lambdas , Crash Recap

Lambdas

- Function definition that is not bound to an identifier

```
/**
 *
 * This is a piece of code that illustrate how lambdas work in
Java 8
 *
 * Given an example
 *
 * f(x) = 2x+5;
 *
 * given x= 2 ; f(x) = 9 ;
 *
 * z(x)= f(g(x)) where g(x) =3x+5
 *
 * z(x) = 2(3x+5) +5 = 6x+15 12+15 = 27
 * *
 */
```

```
public class LambdaUnderStanding2 {
	@FunctionalInterface
	static interface Funct {

		int apply(int x);

		default Funct compose(Funct before) {
			return (x) -> apply(before.apply(x));
		}
	}

	public static void main(String[] args) {

		Funct annoymous = new Funct() {

			@Override
			public int apply(int x) {
				return 2 * x + 5;;
			}
		};


		Funct funct = (x) -> 2 * x + 5;

		System.out.println(funct.apply(2));


		Funct composed = funct.compose((x) -> 3 * x + 5);

		System.out.println(composed.apply(2));
	}
}
```

Java 8 Functional Interface

```
Predicate<Integer> test = (x) -> x> 10;

Function<Integer, Integer> function = (x) -> 3 * x + 5;

Consumer<Integer> print = (x) -> System.out.println(x);

BiFunction<Integer, Integer, Integer> biFunction = (x, y) -> 3 * x + 4* y + 2;

Supplier<Integer> supplier = () -> Integer.MAX_VALUE;
```

thenApply() -transformations

```
 /**
 *  Classic call back present in javascript or scala .
 *  theApply is like run this function when the result
*arrives  from previous stages
 */

final CompletableFuture<Integer> future1 =
CompletableFuture
            .supplyAsync(() -> "42", executor1).thenApply(
                        (x) -> Integer.parseInt(x));
```

```
/**
 * thenApply is trasformative changing
CompletableFuture<Integer> to
 * CompletableFuture<Double>
 */
CompletableFuture<Double> future2 = CompletableFuture
            .supplyAsync(() -> "42", executor1)
            .thenApply((x) -> Integer.parseInt(x))
            .thenApply(r -> r * r * Math.PI);
```

```
/**
 * U can supply a differnt  executor pool for
thenApply
 */

CompletableFuture<Double> future = CompletableFuture
.supplyAsync(() -> "42", executor1)
.thenApplyAsync((x) -> Integer.parseInt(x),
executor2)
.thenApplyAsync(r -> r * r * Math.PI, executor2);
```

thenCombine() , whenComplete() –completion

```
final CompletableFuture<Integer> future = CompletableFuture
.supplyAsync(() -> "32", executor1).thenApply(
(x) -> Integer.parseInt(x));

CompletableFuture.supplyAsync(() -> "42", executor2)
.thenApply((x) -> Integer.parseInt(x))
.thenCombine(future, (x, y) -> x + y)
.thenAccept((result) -> System.out.println(result));
```

```
/**
 * When complete is final stage where it can check
the execpetions
 * propagated and pass results through it
 */
final CompletableFuture<Integer> future =
CompletableFuture
.supplyAsync(() -> "42", executor1)
.thenApply((x) -> Integer.parseInt(x))
.whenComplete(
(x, throwable) -> {
if (throwable != null) {
Logger.getAnonymousLogger().log(Level.SEVERE,
"Logging" + throwable);

} else {
Logger.getAnonymousLogger().log(Level.FINE,
" Passed " + x);
}
});
```

thenCombine() allOf() - combining futures

```
/**
 * Combining two dependent futures
 */
final CompletableFuture<Integer> future =
CompletableFuture
.supplyAsync(() -> "32", executor1).thenApply(
(x) -> Integer.parseInt(x));

CompletableFuture.supplyAsync(() -> "42", executor2)
.thenApply((x) -> Integer.parseInt(x))
.thenCombine(future, (x, y) -> x + y)
.thenAccept((result) -> System.out.println(result));
```

```
/**
 * Combining n  futures unrelated
 */

CompletableFuture<Void> future2 = CompletableFuture
.supplyAsync(() -> "42", executor1)
.thenApplyAsync((x) -> Integer.parseInt(x),
executor2)
.thenAcceptAsync(
(x) -> Logger.getAnonymousLogger().log(Level.FINE,
"Logging" + x), executor2);

CompletableFuture<Void> future1 = CompletableFuture
.supplyAsync(() -> "32", executor1)
.thenApplyAsync((x) -> Integer.parseInt(x),
executor2)
.thenAcceptAsync(
(x) -> Logger.getAnonymousLogger().log(Level.FINE,
"Logging" + x), executor2);

CompletableFuture.allOf(future1,future2).join();
```

Building powerful libraries with Completable Future

Building powerful libraries with completable futures

- Building scalable service orchestrator
- Building dynamic http client framework
- Improve parallelism in existing services with are done serial
- Building libraries tuned for vertical scalability

References

- https://docs.oracle.com/javase/tutorial/
- https://docs.oracle.com/javase/8/docs/api/java/util/concurrent/CompletableFuture.html
- http://cs.oswego.edu/mailman/listinfo/concurrency-interest
- https://github.com/srinivasanraghavan/functional

Questions ?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