Java ExecutorCompletionService: Implementation Internals

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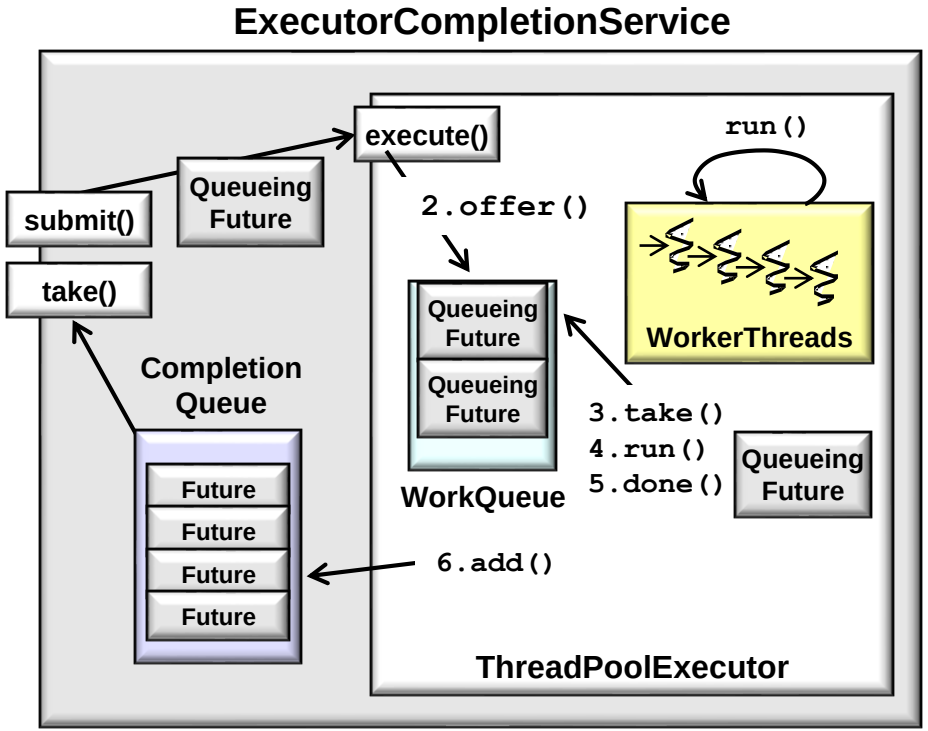
Learning Objectives in this Part of the Lesson

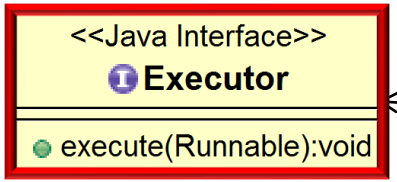
- Understand how the Java CompletionService interface defines a framework for handling the completion of asynchronous tasks
- Know how to instantiate the Java ExecutorCompletionService
- Recognize the key methods in the Java CompletionService interface
- Visualize the ExecutorCompletion Service in action
- Be aware of how the Java Executor CompletionService implements the CompletionService interface



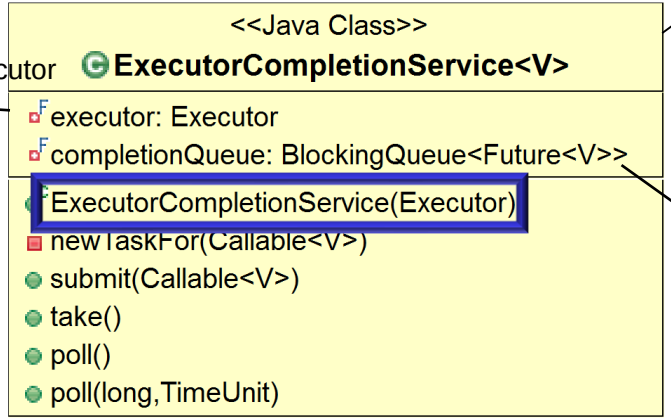
Implementation of the Java ExecutorCompletionService

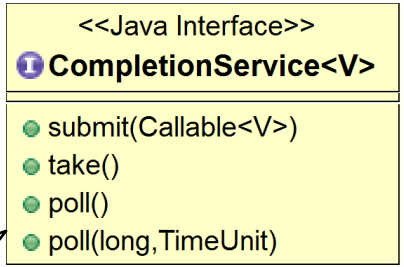
Implementation of the ExecutorCompletionService

- Uses an Executor to run tasks asynchronously

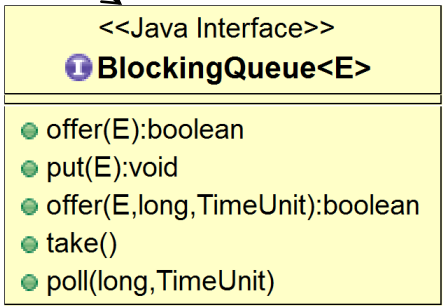


-executor





-completion Queue



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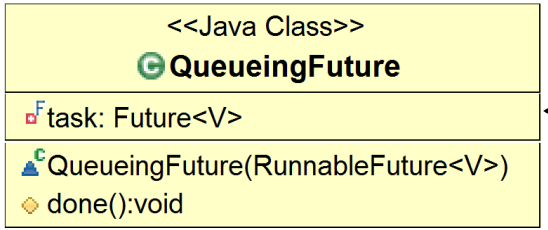
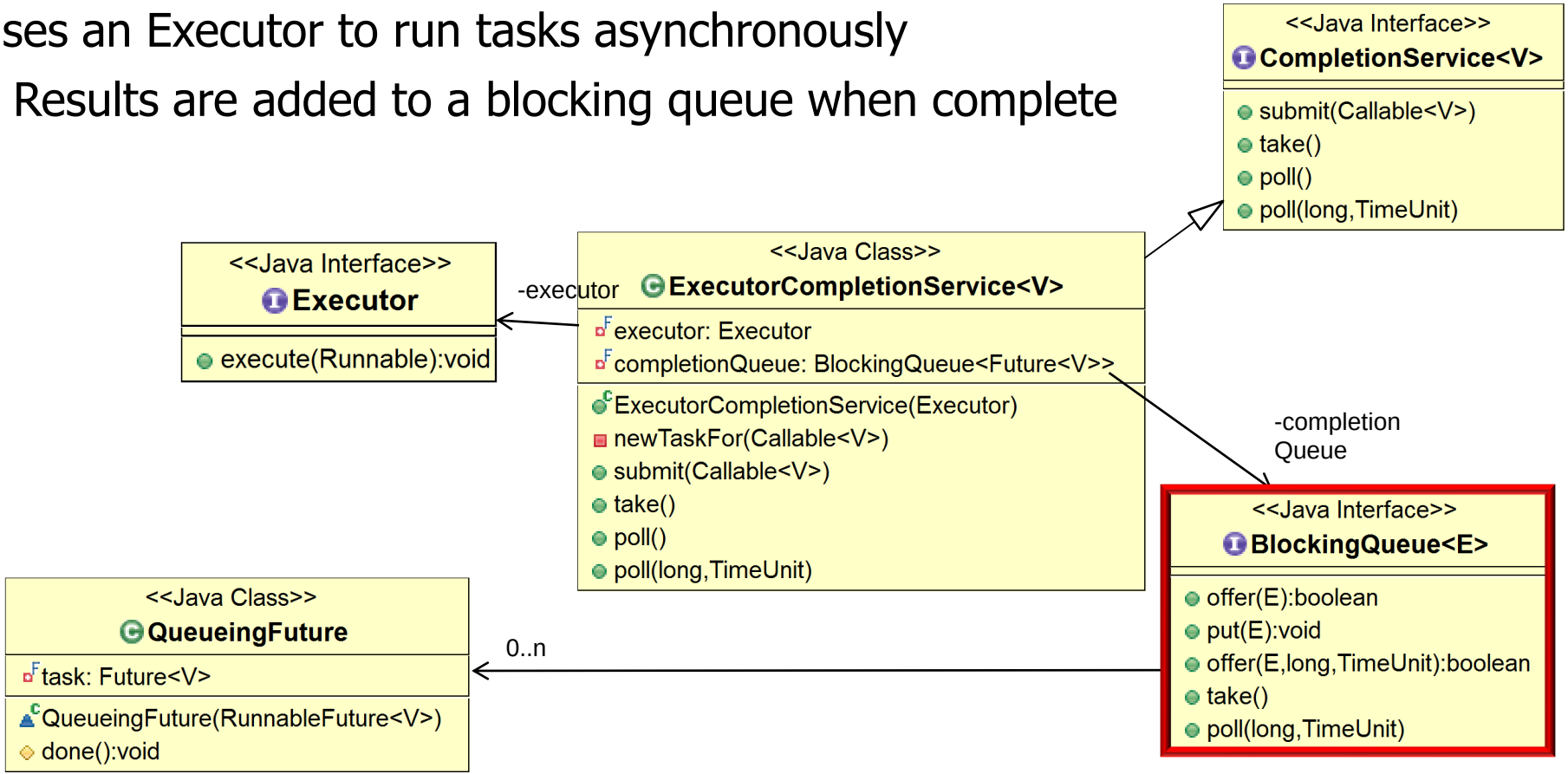


See docs.oracle.com/javase/8/docs/api/java/util/concurrent/ExecutorCompletionService.html

Implementation of the ExecutorCompletionService

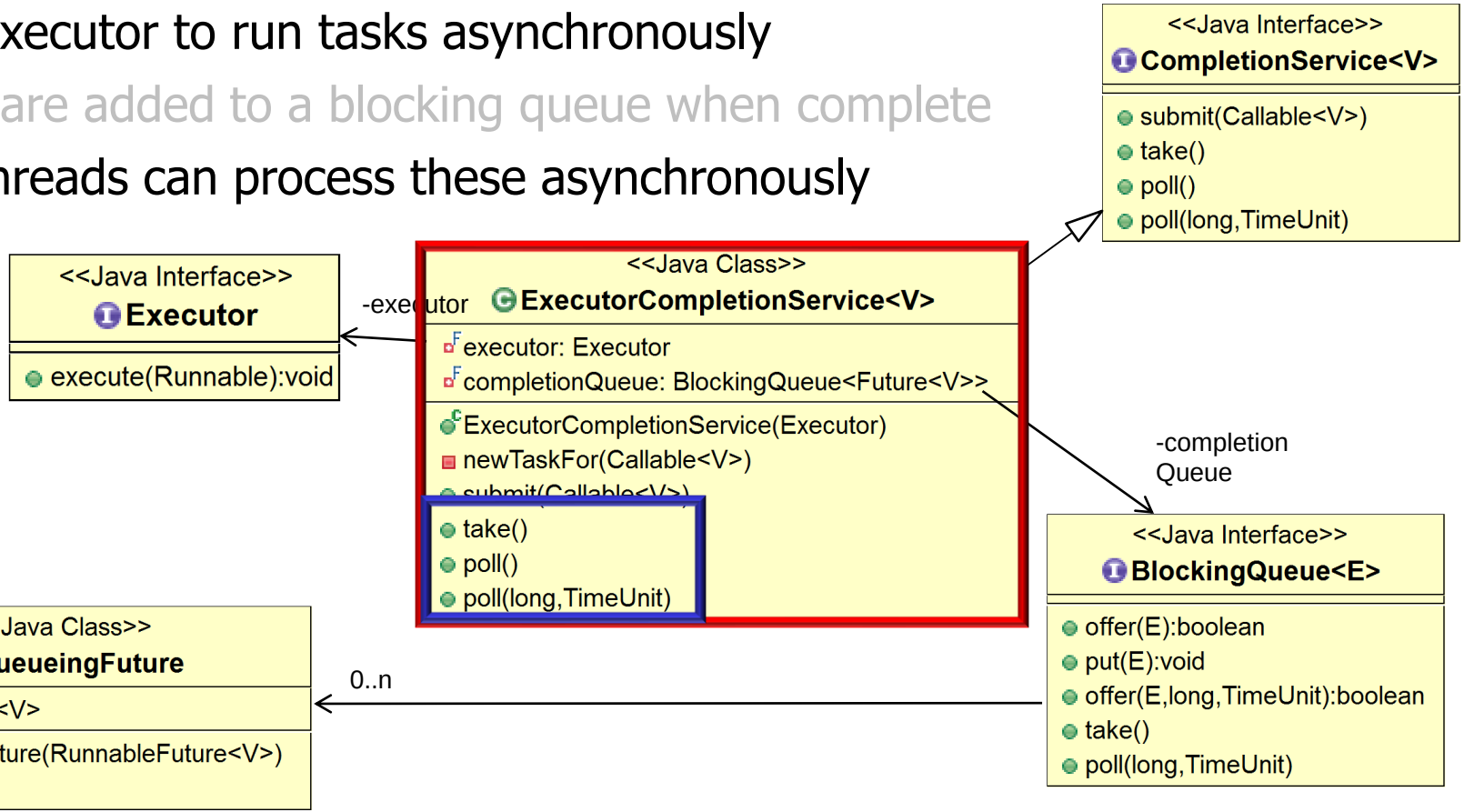
- Uses an Executor to run tasks asynchronously
  - Results are added to a blocking queue when complete



See [openjdk/6-b14/java/util/concurrent/ExecutorCompletionService.java]

Implementation of the ExecutorCompletionService

- Uses an Executor to run tasks asynchronously
  - Results are added to a blocking queue when complete
  - Client threads can process these asynchronously



Implementation of the ExecutorCompletionService

- There are five key methods
  - Submit a task for execution

```
class ExecutorCompletionService<V>
  implements CompletionService<V> {
  ...
  public Future<V> submit
                  (Callable<V> task) {
     RunnableFuture<V> f =
       newtaskFor(task);
     executor.execute(new
              QueueingFuture(f));
     return f;
  }

  public Future<V> submit
            (Runnable task, V result)
  { /* ... */ } ...
```

Implementation of the ExecutorCompletionService

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            QueueingFuture(f));
    return f;
  }

  public Future<V> submit
           (Runnable task, V result)
  { /* ... */ } ...
```

Remember, the futures that are returned from these submit() methods are typically ignored!

Implementation of the ExecutorCompletionService

- There are five key methods
  - Submit a task for execution
    - Submit a two-way task


```
class ExecutorCompletionService<V>
  implements CompletionService<V> {
  ...
  public Future<V> submit
                  (Callable<V> task) {
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     executor.execute(new
              QueueingFuture(f));
     return f;
  }

  ...
```

Implementation of the ExecutorCompletionService

- There are five key methods
  - Submit a task for execution
    - Submit a two-way task

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    RunnableFuture<V> f =
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    executor.execute(new
            QueueingFuture(f));
    return f;
  }

  ...
```

Provides an "async future" processing model, where clients don't block waiting on the future

Implementation of the ExecutorCompletionService

- There are five key methods
  - Submit a task for execution
    - Submit a two-way task

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  implements CompletionService<V> {
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  public Future<V> submit
                  (Callable<V> task) {
    RunnableFuture<V> f =
      newtaskFor(task);
    executor.execute(new
            QueueingFuture(f));
    return f;
  }
  ...
```

```
public interface Callable<V> {
  V call() throws Exception;
}
```

See docs.oracle.com/javase/8/docs/api/java/util/concurrent/Callable.html

Implementation of the ExecutorCompletionService

- There are five key methods
  - Submit a task for execution
    - Submit a two-way task

```
RunnableFuture<V> newtaskFor
          (Callable<V> task) {
  ...
  return new FutureTask<V>(task);
  ...
}
```

```
class ExecutorCompletionService<V>
  implements CompletionService<V> {
  ...
  public Future<V> submit
                (Callable<V> task) {
    RunnableFuture<V> f =
      newtaskFor(task);
    executor.execute(new
            QueueingFuture(f));
    return f;
  }
...
```

Implementation of the ExecutorCompletionService

- There are five key methods
  - Submit a task for execution
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class ExecutorCompletionService<V>
  implements CompletionService<V> {
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                (Callable<V> task) {
    RunnableFuture<V> f =
      newtaskFor(task);
    executor.execute(new
            QueueingFuture(f));
    return f;
  }
...
```

```
RunnableFuture<V> newtaskFor
          (Callable<V> task) {
  ...
  return new FutureTask<V>(task);
  ...
}
```

The callable task is encapsulated in a FutureTask

Implementation of the ExecutorCompletionService

- There are five key methods
  - Submit a task for execution
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                  (Callable<V> task) {
    RunnableFuture<V> f =
      newtaskFor(task);
    executor.execute(new
            QueueingFuture(f));
    return f;
  }

  ...
```

```
class FutureTask<V>
  implements RunnableFuture<V> {
  public void run() {
    ...
    V result = callable.call();
    ...
    done(); ...
  }
```

FutureTask's run() hook method invokes the task's call() method

See docs.oracle.com/javase/8/docs/api/java/util/concurrent/FutureTask.html

Implementation of the ExecutorCompletionService

- There are five key methods
  - Submit a task for execution
    - Submit a two-way task

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                  (Callable<V> task) {
    RunnableFuture<V> f =
      newtaskFor(task);
    executor.execute(new
            QueueingFuture(f));
    return f;
  }

  ...
```

```
class FutureTask<V>
  implements RunnableFuture<V> {
  public void run() {
    ...
    V result = callable.call();
    ...
    done(); ...
  }
```

FutureTask's run() hook method also calls the done() hook method if all goes well

See docs.oracle.com/javase/8/docs/api/java/util/concurrent/FutureTask.html

Implementation of the ExecutorCompletionService

- There are five key methods
  - Submit a task for execution
    - Submit a two-way task

```
class ExecutorCompletionService<V>
  implements CompletionService<V> {
  ...
  public Future<V> submit
                  (Callable<V> task) {
    RunnableFuture<V> f =
      newtaskFor(task);
    executor.execute(new
            QueueingFuture(f));
    return f;
  }
  ...
```

```
interface RunnableFuture<V>
          extends Runnable,
                  Future<V> {
  void run();
}
```

RunnableFuture's run() hook method must be overridden by a subclass

See docs.oracle.com/javase/8/docs/api/java/util/concurrent/RunnableFuture.html

Implementation of the ExecutorCompletionService

- There are five key methods
  - Submit a task for execution
    - Submit a two-way task

```
class ExecutorCompletionService<V>
  implements CompletionService<V> {
  ...
  public Future<V> submit
                (Callable<V> task) {
    RunnableFuture<V> f =
      newtaskFor(task);
    executor.execute(new
                QueueingFuture(f));
    return f;
  }

  ...
```

```
class QueueingFuture
      extends FutureTask<Void> {
  private final Future<V> task;
  QueueingFuture
    (RunnableFuture<V> task) {
    super(task, null);
    this.task = task;
  }
  protected void done()
  { completionQueue.add(task); }
}
```

This constructor passes the task to the FutureTask constructor & stores the task in a future field

See src/share/classes/java/util/concurrent/ExecutorCompletionService.java

Implementation of the ExecutorCompletionService

- There are five key methods
  - Submit a task for execution
    - Submit a two-way task

```
class ExecutorCompletionService<V>
  implements CompletionService<V> {
  ...
  public Future<V> submit
                (Callable<V> task) {
    RunnableFuture<V> f =
      newtaskFor(task);
    executor.execute(new
                QueueingFuture(f));
    return f;
  }

  ...
```

```
class QueueingFuture
      extends FutureTask<Void> {
  private final Future<V> task;
  QueueingFuture
    (RunnableFuture<V> task) {
    super(task, null);
    this.task = task;
  }
  protected void done()
  { completionQueue.add(task); }
}
```

This done() hook method adds the future to the queue upon completion

See src/share/classes/java/util/concurrent/ExecutorCompletionService.java

Implementation of the ExecutorCompletionService

- There are five key methods
  - Submit a task for execution
    - Submit a two-way task
    - Submit a one-way task


```
class ExecutorCompletionService<V>
  implements CompletionService<V> {
  ...
  public Future<V> submit
                  (Callable<V> task) {
    ...
  }

  public Future<V> submit
            (Runnable task, V result)
  { /* ... */ }
  ...
```

Implementation of the ExecutorCompletionService

- There are five key methods
  - Submit a task for execution
  - Retrieve results

```
class ExecutorCompletionService<V>
  implements CompletionService<V> {
...
 public Future<V> take() ...
 { return completionQueue.take(); }

 public Future<V> poll()
 { return completionQueue.poll(); }

 public Future<V> poll(long
   timeout, TimeUnit unit) ... {
   return completionQueue.poll
     (timeout, unit);
 }
 ...
```

Implementation of the ExecutorCompletionService

- There are five key methods
  - Submit a task for execution
  - Retrieve results
    - Block until a future for next completed task is available
      - Then retrieve/remove it

```
class ExecutorCompletionService<V>
  implements CompletionService<V> {
...
 public Future<V> take() ...
 { return completionQueue.take(); }

 public Future<V> poll()
 { return completionQueue.poll(); }

 public Future<V> poll(long
   timeout, TimeUnit unit) ... {
   return completionQueue.poll
     (timeout, unit);
 }
 ...
```

Implementation of the ExecutorCompletionService

- There are five key methods
  - Submit a task for execution
  - Retrieve results
    - Block until a future for next completed task is available
    - Retrieve/remove a future for the next completed task
      - Returns null if no future is available

```
class ExecutorCompletionService<V>
  implements CompletionService<V> {
...
 public Future<V> take() ...
 { return completionQueue.take(); }

 public Future<V> poll()
 { return completionQueue.poll(); }

 public Future<V> poll(long
   timeout, TimeUnit unit) ... {
   return completionQueue.poll
     (timeout, unit);
 }
 ...
```

Implementation of the ExecutorCompletionService

- There are five key methods
  - Submit a task for execution
  - Retrieve results
    - Block until a future for next completed task is available
    - Retrieve/remove a future for the next completed task
    - Wait up to specified time if future isn't available
      - Returns null if timeout occurs

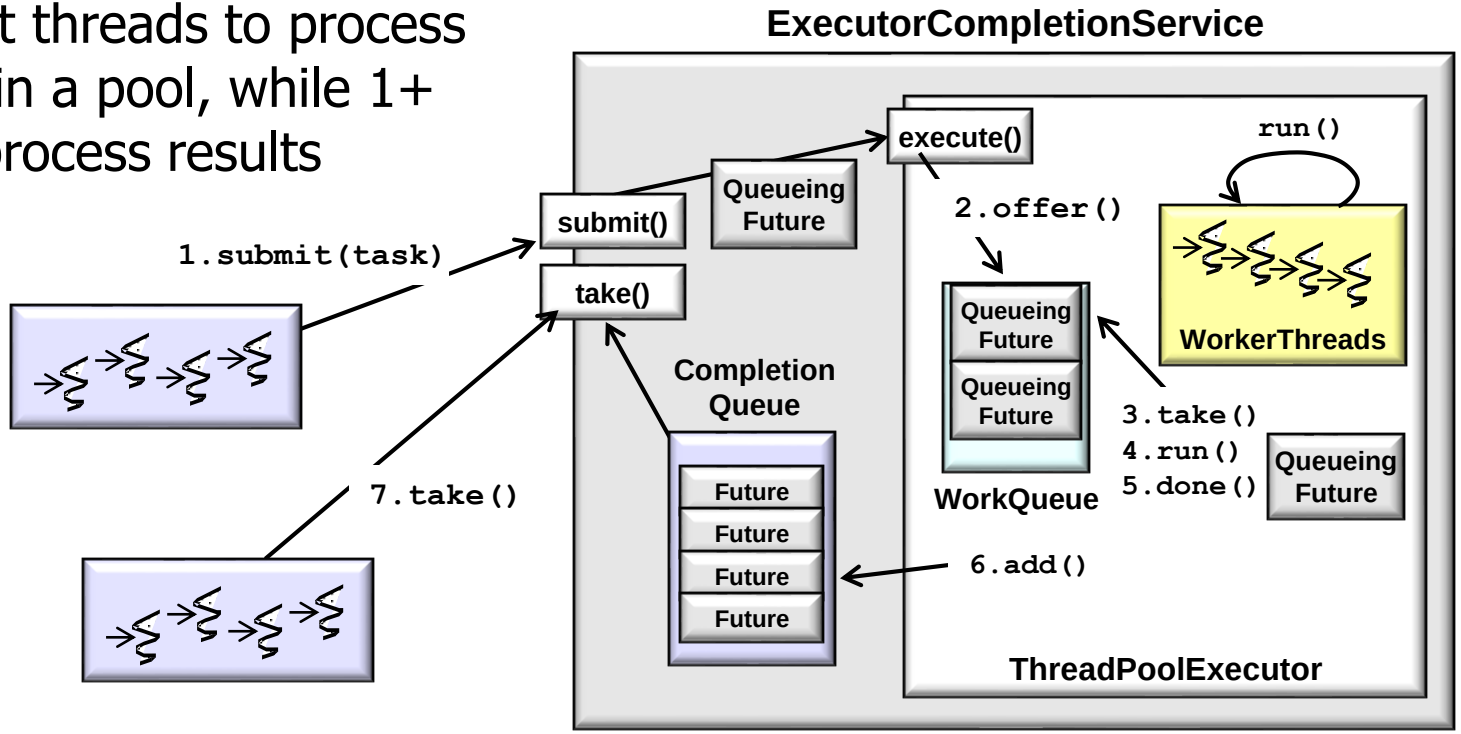
```
class ExecutorCompletionService<V>
  implements CompletionService<V> {
...
 public Future<V> take() ...
 { return completionQueue.take(); }

 public Future<V> poll()
 { return completionQueue.poll(); }

 public Future<V> poll(long
   timeout, TimeUnit unit) ... {
   return completionQueue.poll
     (timeout, unit);
 }
 ...
```

Implementation of the ExecutorCompletionService

- Allows 1+ client threads to process two-way tasks in a pool, while 1+ other threads process results



End of Java Executor CompletionService: Implementation Internals