Overview of Java FutureTask

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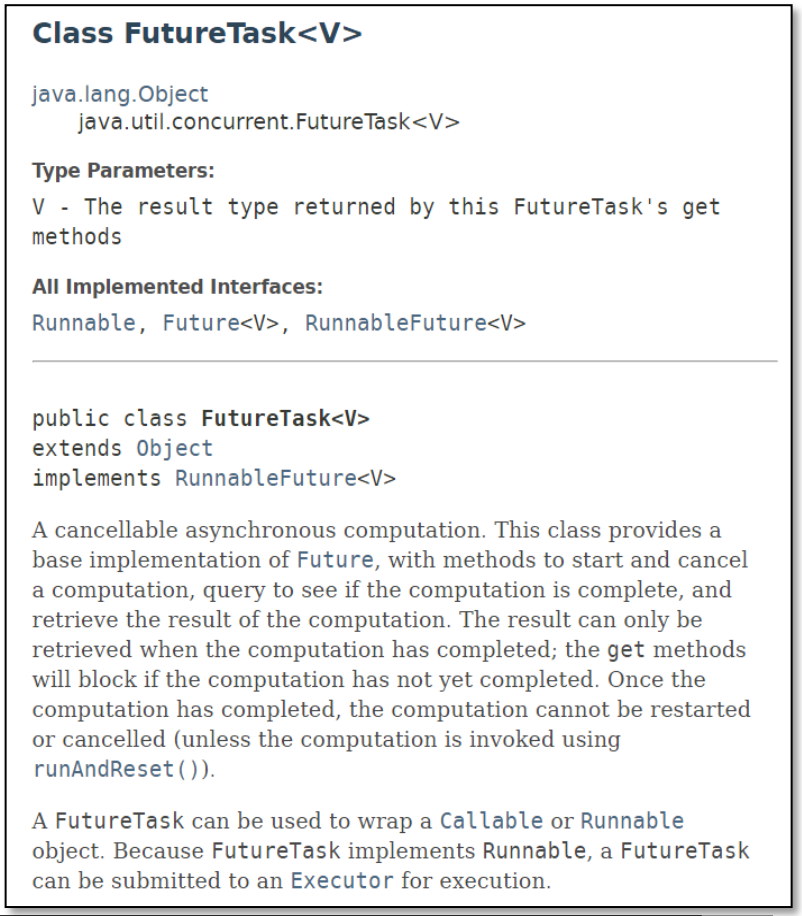
Learning Objectives in this Part of the Lesson

- Understand the need for the *Future* pattern & Java Future interface
- Recognize the lifecycle of a Future & human known uses of the *Future* pattern
- Know the key methods in the modern Java Future interface
- Learn how to implement a Future via the FutureTask class
  - FutureTask conveys the result from a Thread running an async computation to a Thread that wants to process the result



Class FutureTask<V>

java.lang.Object
    java.util.concurrent.FutureTask<V>

Type Parameters:

`V - The result type returned by this FutureTask's get methods`

All Implemented Interfaces:

`Runnable, Future<V>, RunnableFuture<V>`

```
public class FutureTask<V>
extends Object
implements RunnableFuture<V>
```

A cancellable asynchronous computation. This class provides a base implementation of `Future`, with methods to start and cancel a computation, query to see if the computation is complete, and retrieve the result of the computation. The result can only be retrieved when the computation has completed; the `get` methods will block if the computation has not yet completed. Once the computation has completed, the computation cannot be restarted or cancelled (unless the computation is invoked using `runAndReset()`).

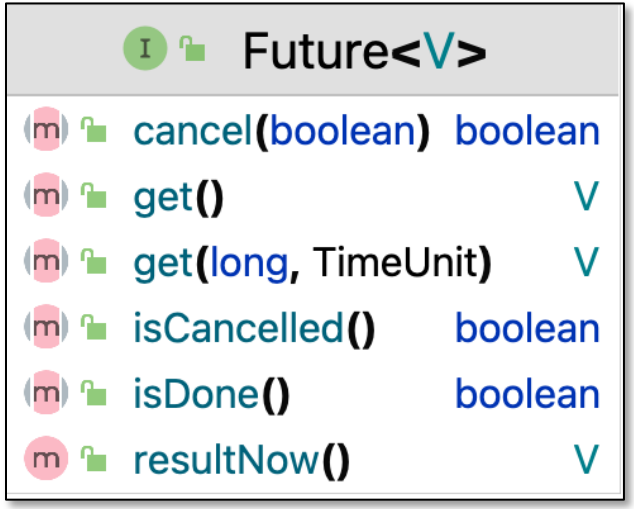
A `FutureTask` can be used to wrap a `Callable` or `Runnable` object. Because `FutureTask` implements `Runnable`, a `FutureTask` can be submitted to an `Executor` for execution.

See javase/20/docs/api/java.base/java/util/concurrent/FutureTask.html

Overview of Java FutureTask

Overview of Java FutureTask

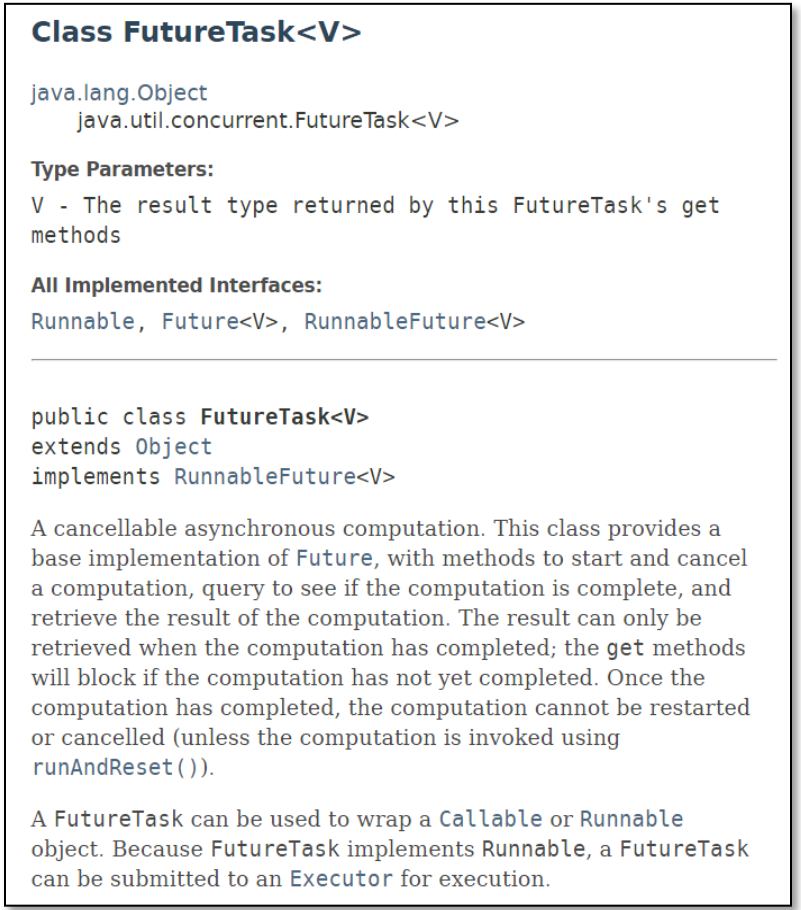
- The Java Future is an interface, so it must be implemented by a class before it can be used



See 20/docs/api/java.base/java/util/concurrent/Future.html

Overview of Java FutureTask

- The Java FutureTask class implements Future (indirectly) & provides a cancelable async computation



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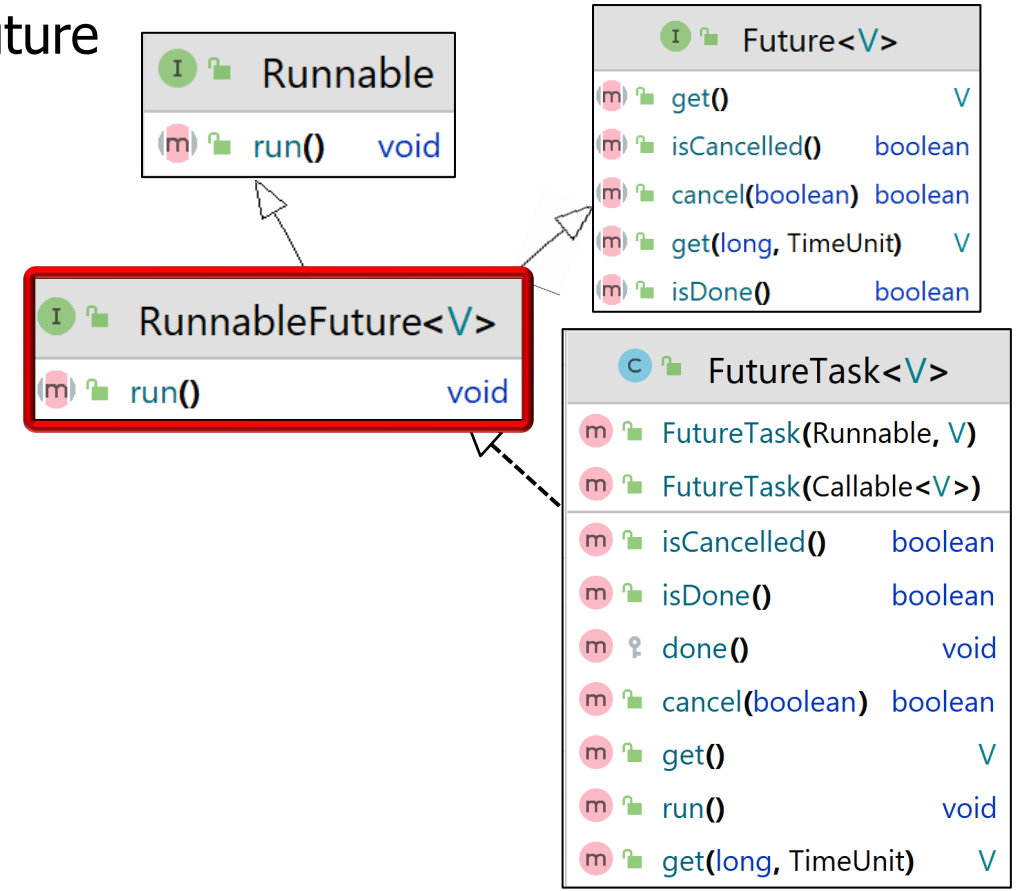
A FutureTask can be used to wrap a Callable or Runnable object. Because FutureTask implements Runnable, a FutureTask can be submitted to an Executor for execution.

See javase/20/docs/api/java.base/java/util/concurrent/FutureTask.html

Overview of Java FutureTask

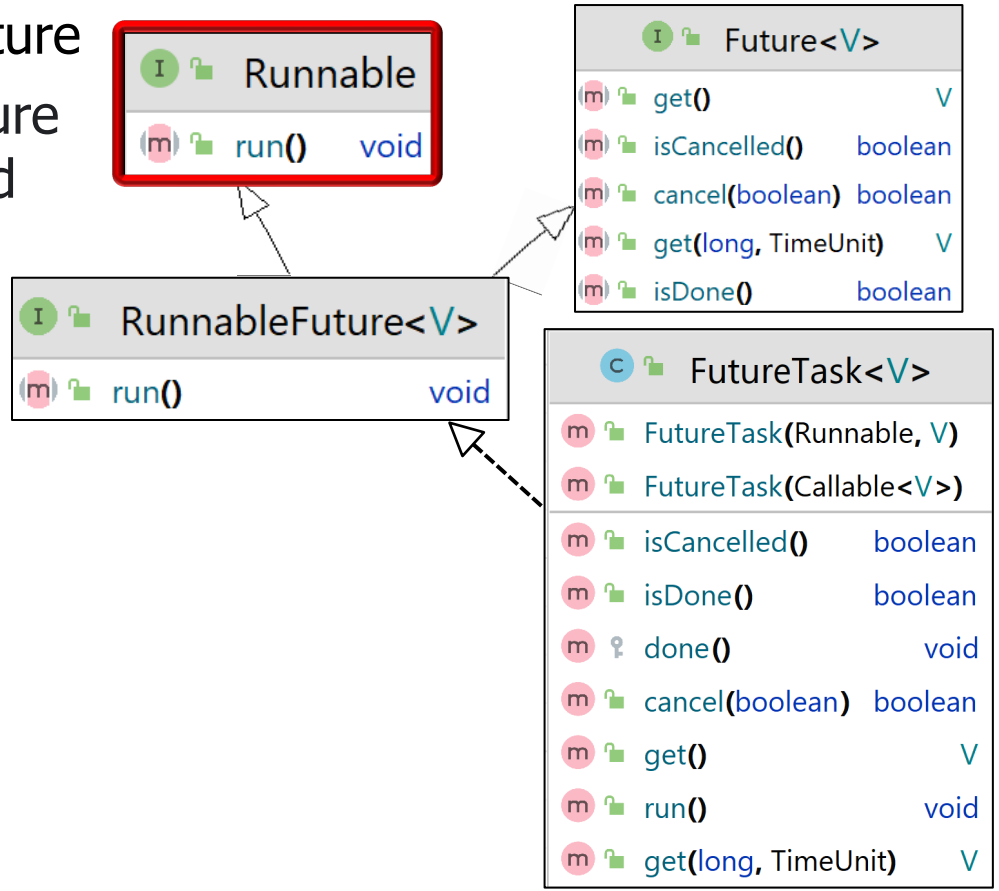
- FutureTask implements RunnableFuture



See javase/20/docs/api/java.base/java/util/concurrent/RunnableFuture.html

Overview of Java FutureTask

- FutureTask implements RunnableFuture
  - By implementing Runnable, a Future Task can be submitted to a Thread or Executor for execution



See javase/20/docs/api/java.base/java/lang/Runnable.html

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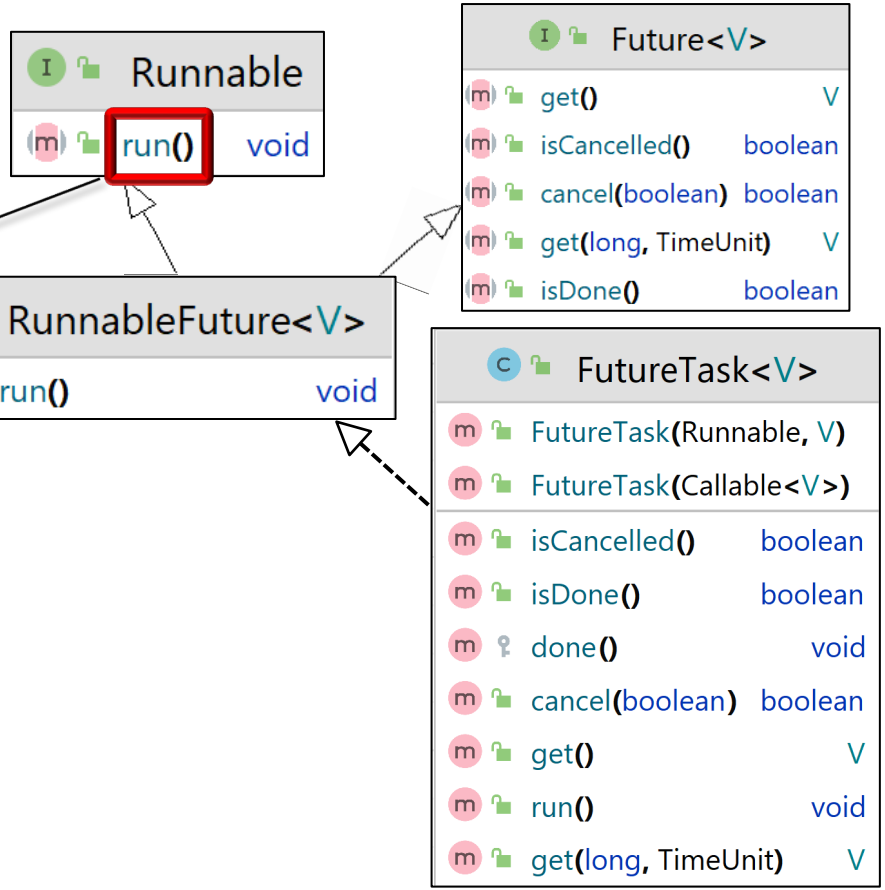
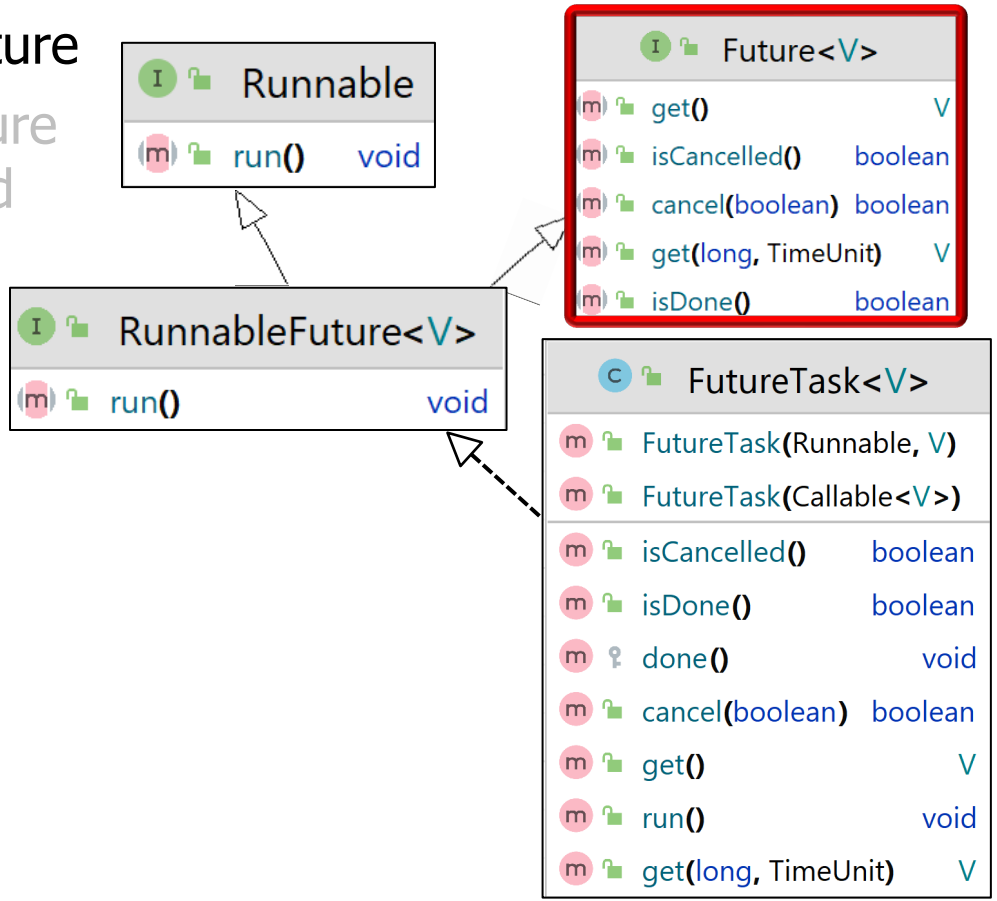


The run() hook method is called back in the right concurrency context

See javase/20/docs/api/java.base/java/lang/Runnable.html#run

Overview of Java FutureTask

- FutureTask implements RunnableFuture
  - By implementing Runnable, a Future Task can be submitted to a Thread or Executor for execution
  - By implementing Future, a Future Task can process the results of an asynchronous computation



See 20/docs/api/java.base/java/util/concurrent/Future.html

Overview of Java FutureTask

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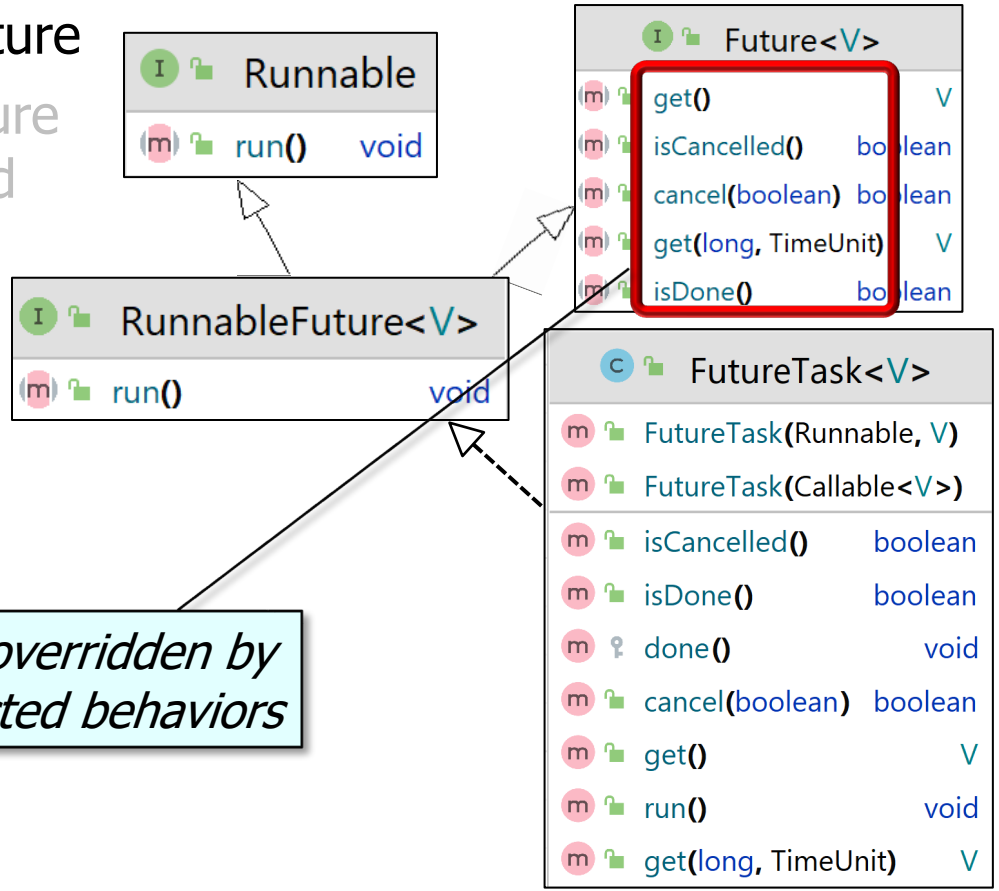
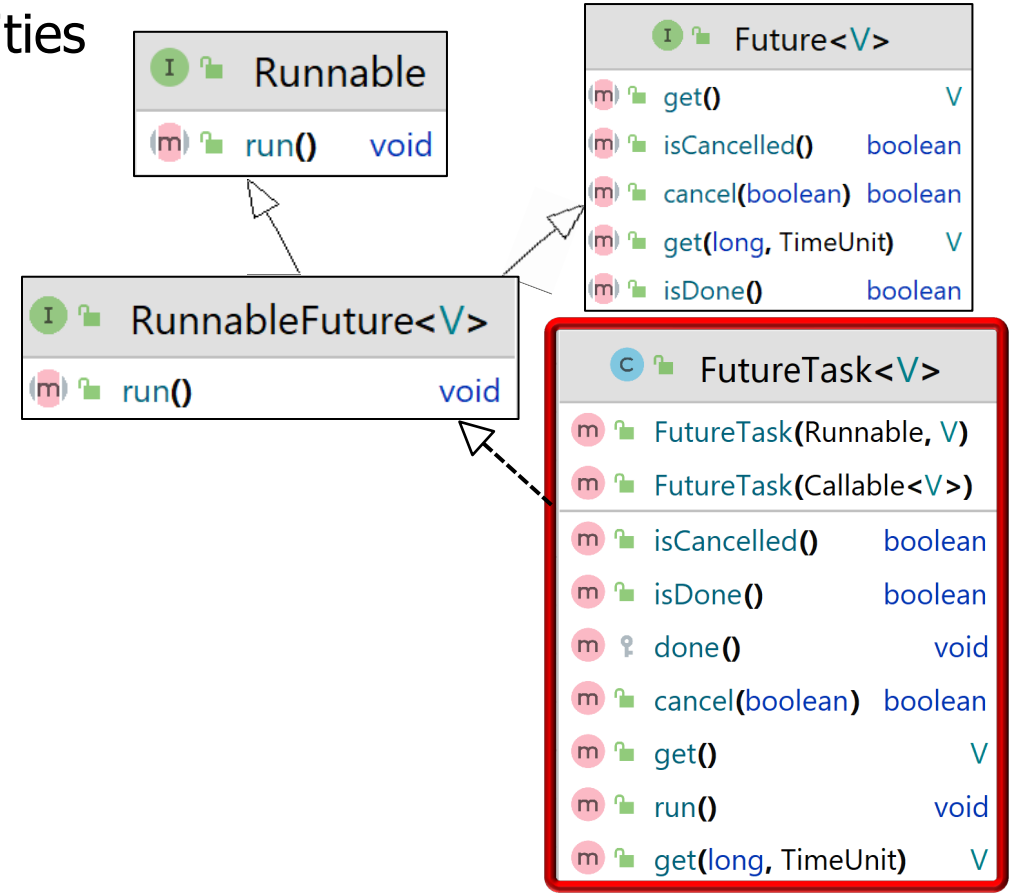


All the Future methods are overridden by FutureTask to do their expected behaviors

Overview of Java FutureTask

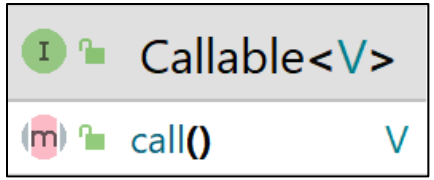
- FutureTask provides several capabilities

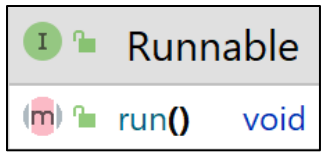


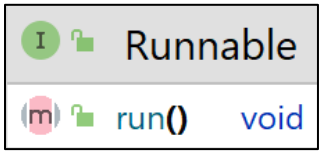
See www.geeksforgeeks.org/future-and-futuretask-in-java

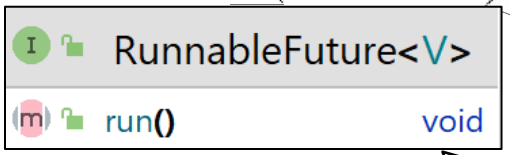
Overview of Java FutureTask

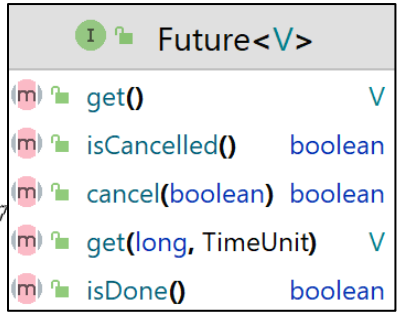
- FutureTask provides several capabilities, e.g.
  - It wraps Callable or Runnable
    - i.e., these computations can now run asynchronously

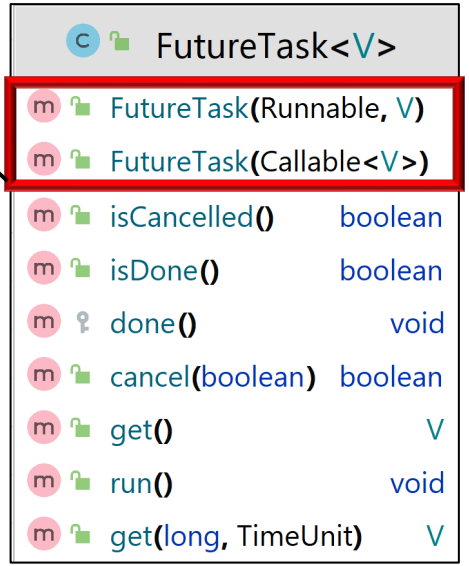








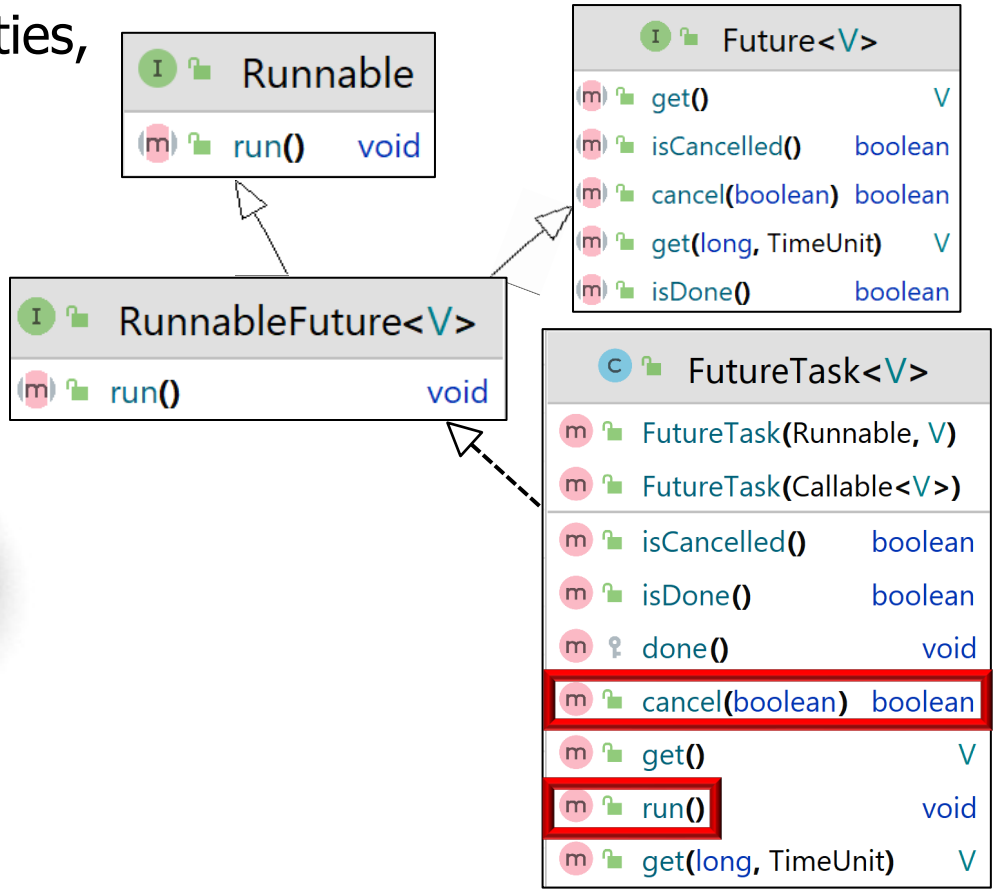




See javase/20/docs/api/java.base/java/util/concurrent/Callable.html

Overview of Java FutureTask

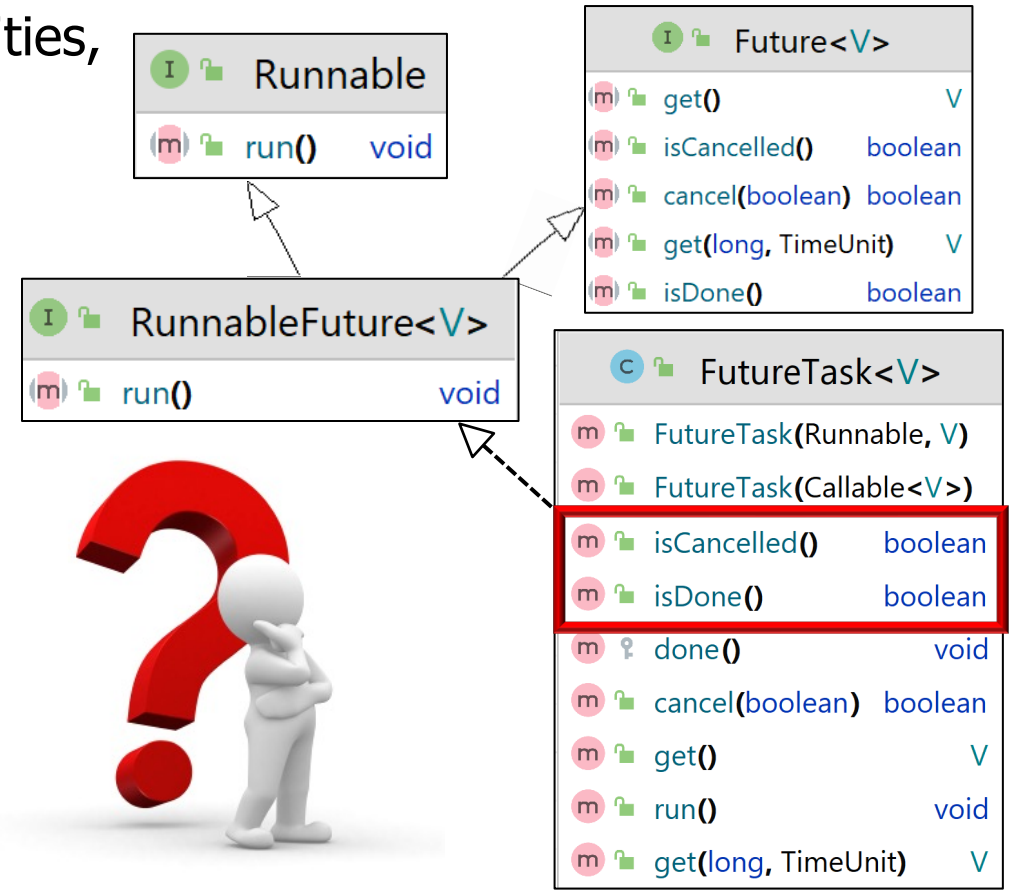
- FutureTask provides several capabilities, e.g.
  - It wraps Callable or Runnable
  - Start & cancel a computation that can run asynchronously



Async FutureTask computations can run via a Java Thread or some Executor

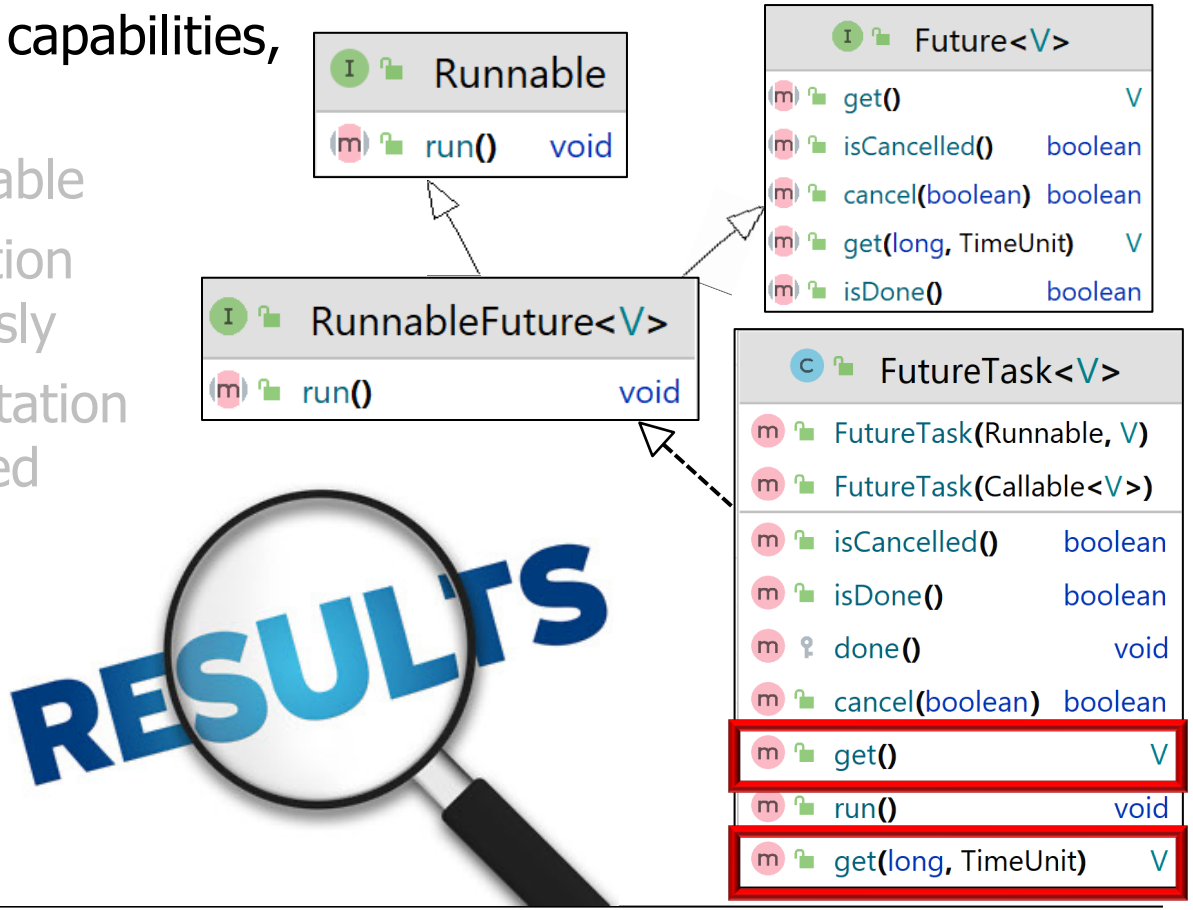
Overview of Java FutureTask

- FutureTask provides several capabilities, e.g.
  - It wraps Callable or Runnable
  - Start & cancel a computation that can run asynchronously
  - Query if the async computation completed or was cancelled



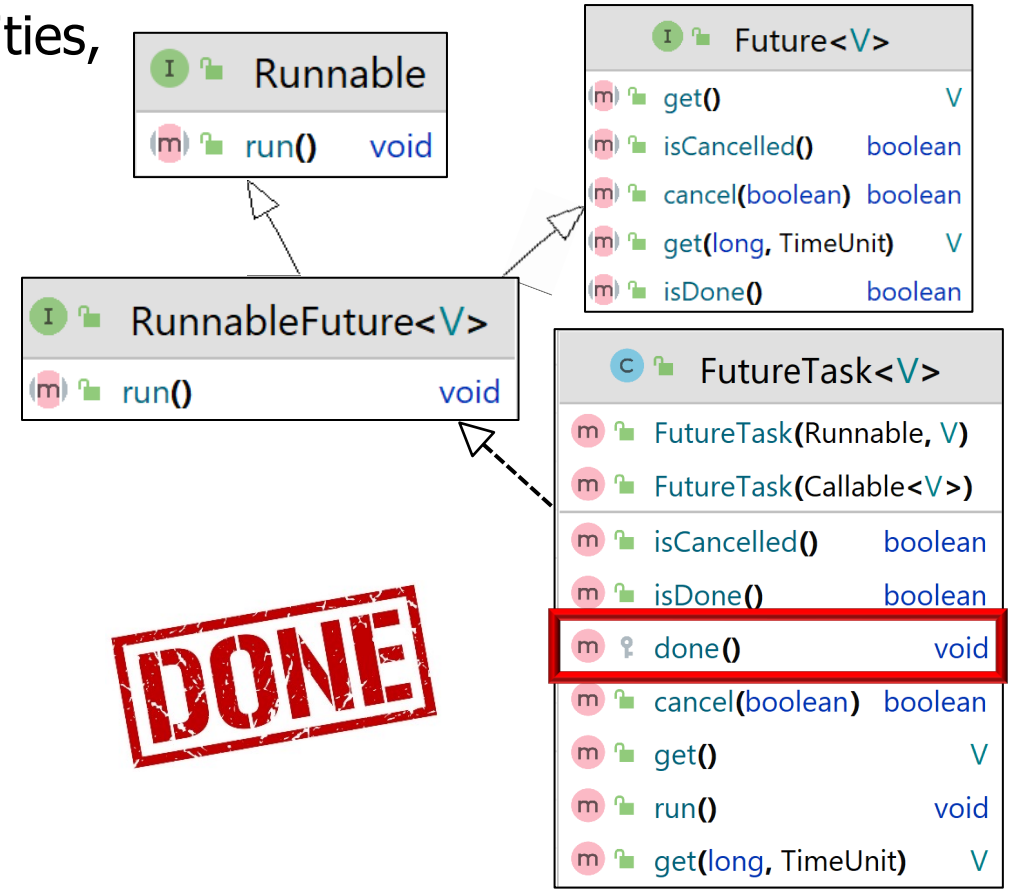
Overview of Java FutureTask

- FutureTask provides several capabilities, e.g.
  - It wraps Callable or Runnable
  - Start & cancel a computation that can run asynchronously
  - Query if the async computation completed or was cancelled
  - Get the result of an async computation



Overview of Java FutureTask

- FutureTask provides several capabilities, e.g.
  - It wraps Callable or Runnable
  - Start & cancel a computation that can run asynchronously
  - Query if the async computation completed or was cancelled
  - Get the result of an async computation
  - Hook method invoked when task transitions to isDone state



Subclasses may override this hook method, e.g., to invoke completion callbacks

Applying Java FutureTask

Applying Java FutureTask

- The ActiveObject class uses FutureTask to define a closure that applies a Function param within a virtual Thread object

```
RunnableFuture<R> makeThreadClosure
          (Function<T, R> function,
           T n) {

  var runnableFuture = new
      FutureTask<R>(() -> {
        return mResult = function
                  .apply(n);
  });

  mThread = Thread
     .startVirtualThread
        (runnableFuture);

  return runnableFuture;
}
```

See ModernJava/blob/main/FP/ex16/src/main/java/utils/ActiveObject.java

Applying Java FutureTask

- The ActiveObject class uses FutureTask to define a closure that applies a Function param within a virtual Thread object

This factory method is passed a 'function' & a parameter to apply this 'function' to

```
RunnableFuture<R> makeThreadClosure
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         T n) {

  var runnableFuture = new
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  mThread = Thread
     .startVirtualThread
        (runnableFuture);

  return runnableFuture;
}
```

See javase/20/docs/api/java.base/java/util/function/Function.html

Applying Java FutureTask

- The ActiveObject class uses FutureTask to define a closure that applies a Function param within a virtual Thread object

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  mThread = Thread
     .startVirtualThread
        (runnableFuture);

  return runnableFuture;
}
```

Create a FutureTask that defines a Callable closure that applies the function' param to the param 'n'

See javase/20/docs/api/java.base/java/util/concurrent/FutureTask.html#FutureTask

Applying Java FutureTask

- The ActiveObject class uses FutureTask to define a closure that applies a Function param within a virtual Thread object

Create & return a new virtual Thread whose Runnable param is the Future Task that executes asynchronously

```
RunnableFuture<R> makeThreadClosure
          (Function<T, R> function,
           T n) {

  var runnableFuture = new
      FutureTask<R>(() -> {
        return mResult = function
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  mThread = Thread
     .startVirtualThread
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  return runnableFuture;
}
```

See javase/20/docs/api/java.base/java/lang/Thread.html#startVirtualThread

Applying Java FutureTask

- The ActiveObject class uses FutureTask to define a closure that applies a Function param within a virtual Thread object

Return the RunnableFuture, which is stored in the mRunnableField by the ActiveObject constructor

```
RunnableFuture<R> makeThreadClosure
          (Function<T, R> function,
           T n) {

  var runnableFuture = new
      FutureTask<R>(() -> {
        return mResult = function
                  .apply(n);
  });

  mThread = Thread
     .startVirtualThread
        (runnableFuture);

  return runnableFuture;
}
```

Applying Java FutureTask

- The ActiveObject class overrides all the Future methods it inherits

```
public boolean cancel
   (boolean mayInterruptIfRunning) {
   return mRunnableFuture
    .cancel(mayInterruptIfRunning);
}

public boolean isCancelled() {
   return mRunnableFuture
     .isCancelled();
}

public R get() ... {
   return mRunnableFuture.get();
} ...
```

Applying Java FutureTask

- The ActiveObject class overrides all the Future methods it inherits
  - & forwards them all to the mRunnableFuture field

```
public boolean cancel
   (boolean mayInterruptIfRunning) {
   return mRunnableFuture
    .cancel(mayInterruptIfRunning);
}

public boolean isCancelled() {
   return mRunnableFuture
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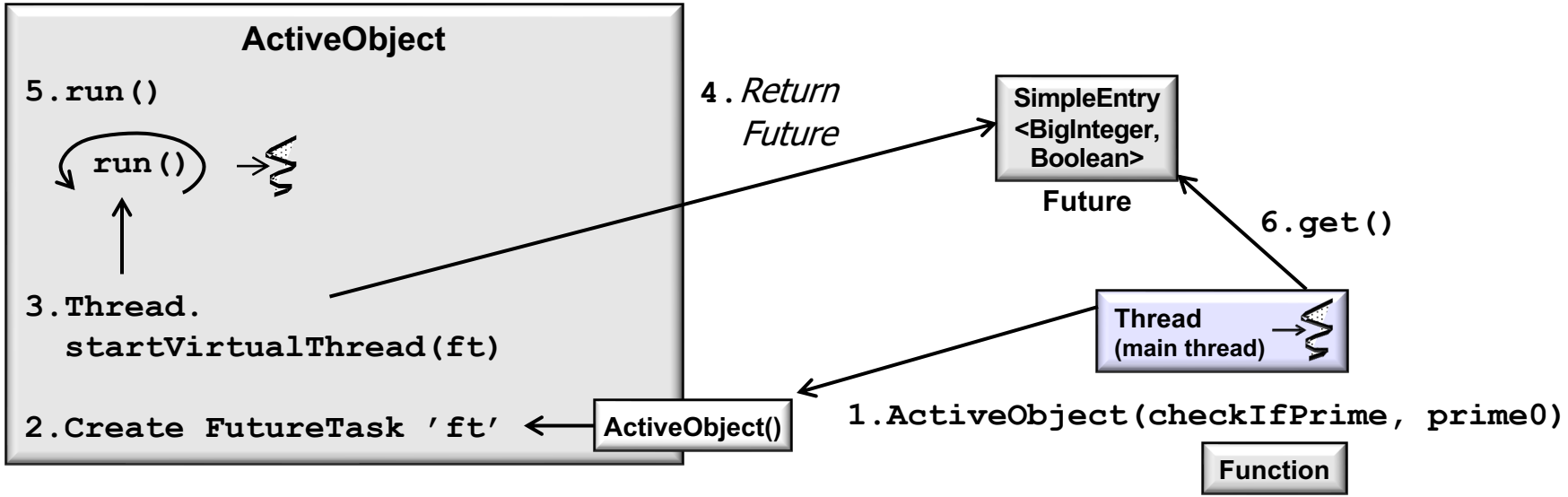
public R get() ... {
   return mRunnableFuture.get();
} ...
```

Applying Java FutureTask

- The next part of this lesson shows how the Java FutureTask class can be combined with the Java Future interface & the *Active Object* pattern



See github.com/douglascraigschmidt/ModernJava/tree/main/FP/ex16

End of Overview of Java FutureTask