Motivating the Need for Java Futures

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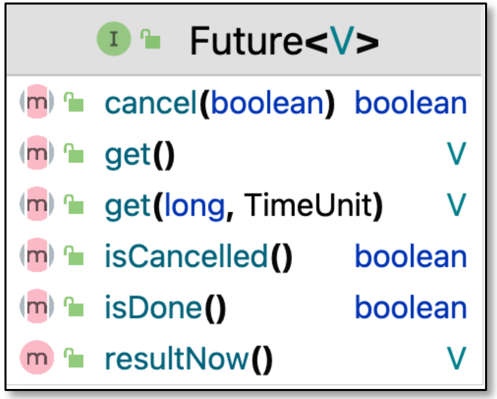
Learning Objectives in this Lesson

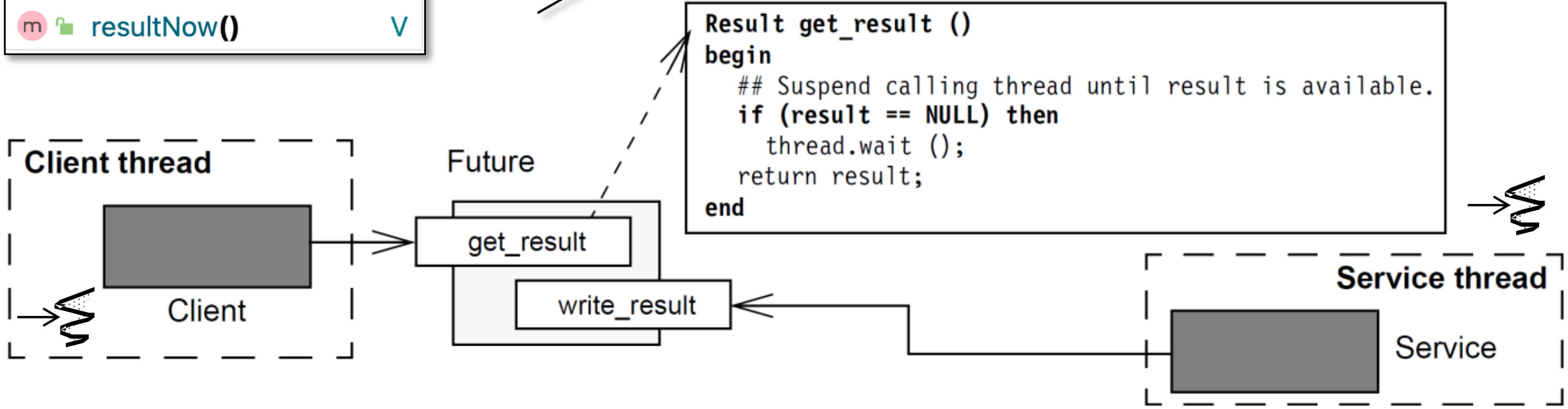
- Understand the need for the *Future* pattern & Java Future interface



Future<V>

cancel(boolean)	boolean
get()	V
get(long, TimeUnit)	V
isCancelled()	boolean
isDone()	boolean
resultNow()	V

A future provides a means to retrieve the result of a computation being executed asynchronously, without indefinitely blocking the client thread



```
Result get_result ()
begin
  ## Suspend calling thread until result is available.
  if (result == NULL) then
    thread.wait ();
  return result;
end
```

See en.wikipedia.org/wiki/Futures_and_promises

Motivating the Need for Java Futures

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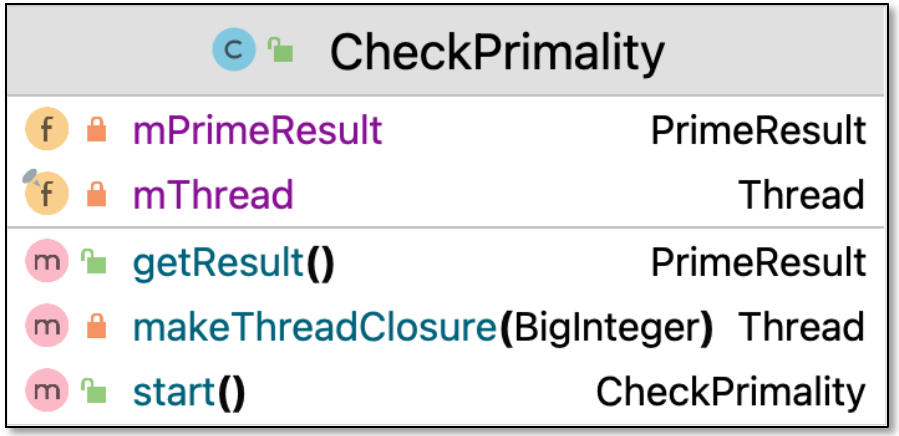
- The CheckPrimality class showed how a closure could store the results of a computation running in a Java Thread

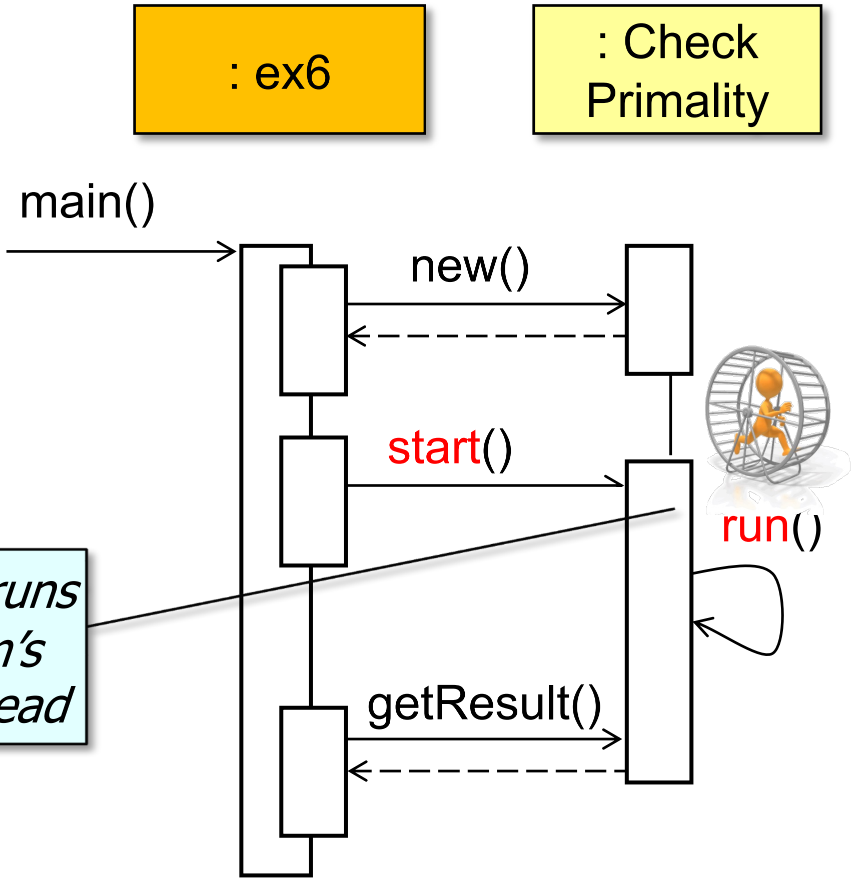


```
CheckPrimality
mPrimeResult                         PrimeResult
mThread                              Thread
getResult()                          PrimeResult
makeThreadClosure(BigInteger)        Thread
start()                              CheckPrimality
```

See earlier lessons on "*Implementing Closures with Java Lambda Expressions*"

Motivating the Need for Java Futures

- The CheckPrimality class showed how a closure could store the results of a computation running in a Java Thread



The computation for primality checking runs asynchronously after the main program's client Thread starts the background Thread

See ModernJava/blob/main/FP/ex6/src/main/java/CheckPrimality.java

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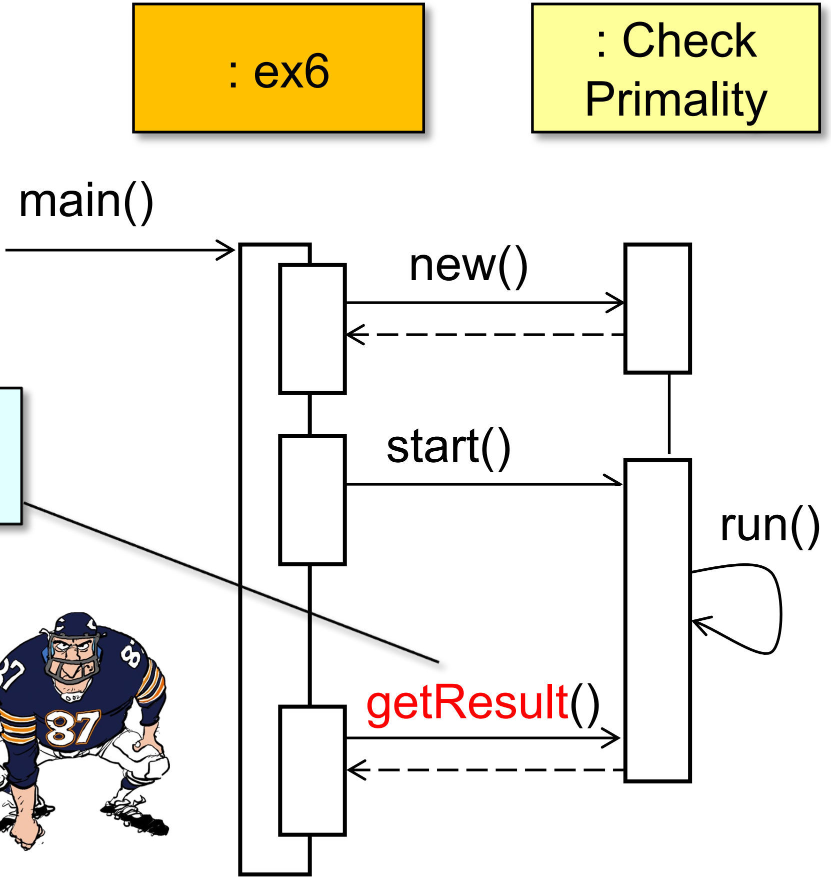
- The CheckPrimality class showed how a closure could store the results of a computation running in a Java Thread

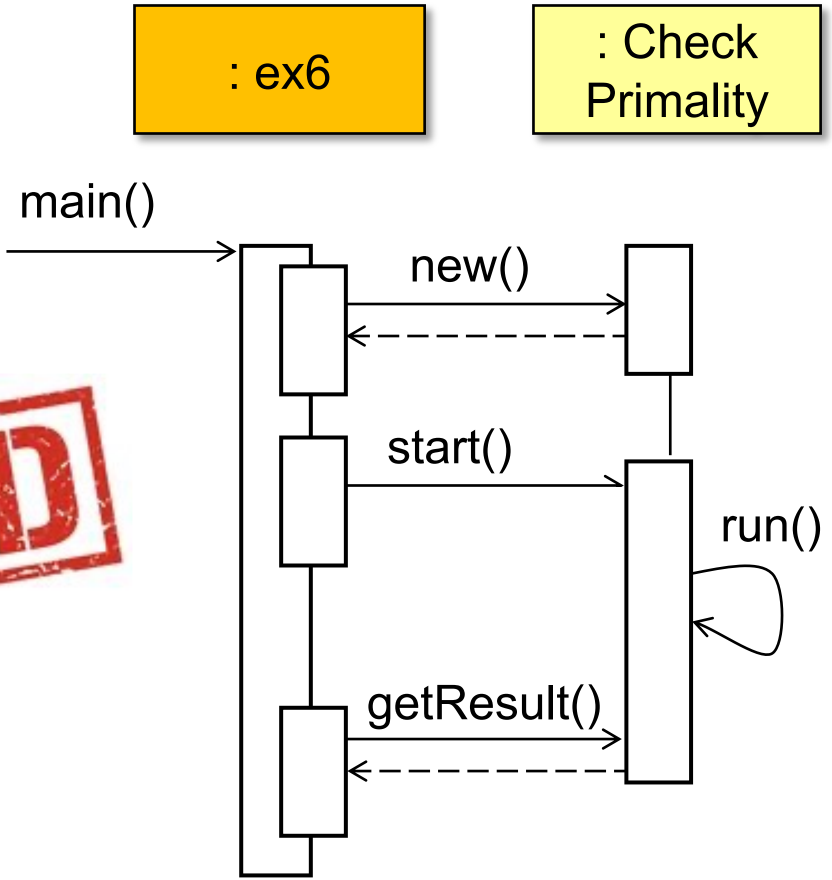


The client Thread blocks until the result is available

See www.geeksforgeeks.org/blocking-methods-in-java

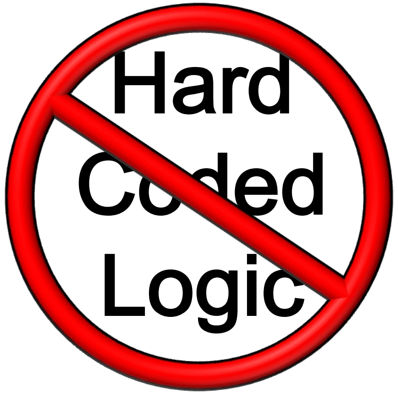
Motivating the Need for Java Futures

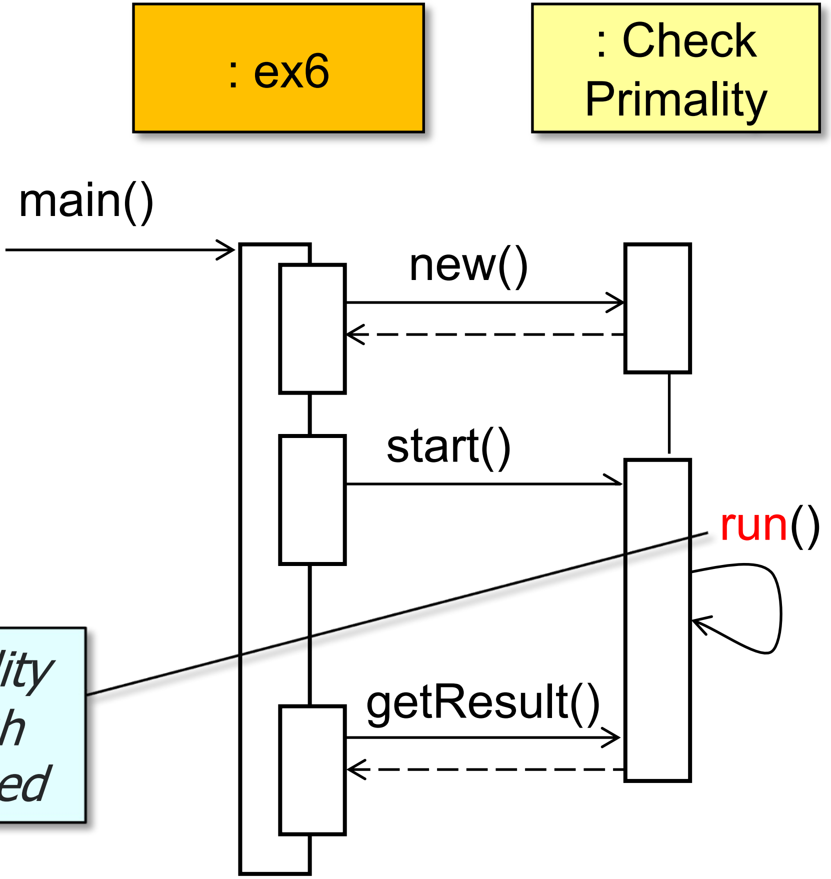
- Although CheckPrimality provides some useful features, there are two limitations



Motivating the Need for Java Futures

- Although CheckPrimality provides some useful features, there are two limitations
  - Its behavior is "hard-coded"





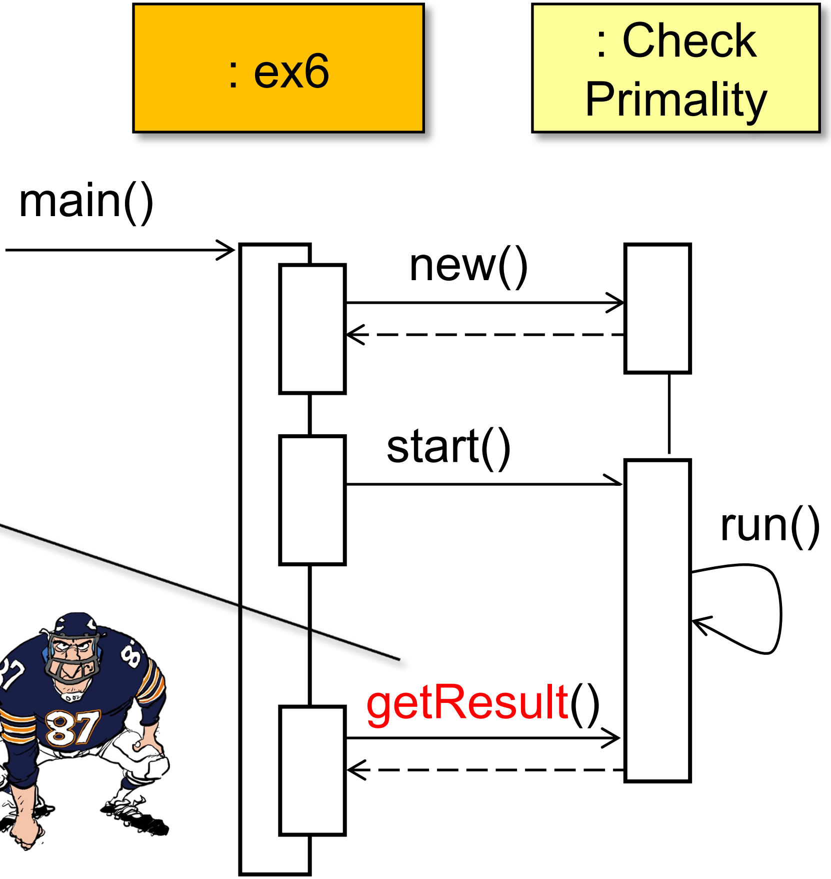
i.e., it only checks the primality of a BigInteger, even though its design could be generalized

See en.wikipedia.org/wiki/Hard_coding

Motivating the Need for Java Futures

- Although CheckPrimality provides some useful features, there are two limitations
  - Its behavior is "hard-coded"
  - getResult() blocks indefinitely

i.e., waiting for the completion of the primality computation



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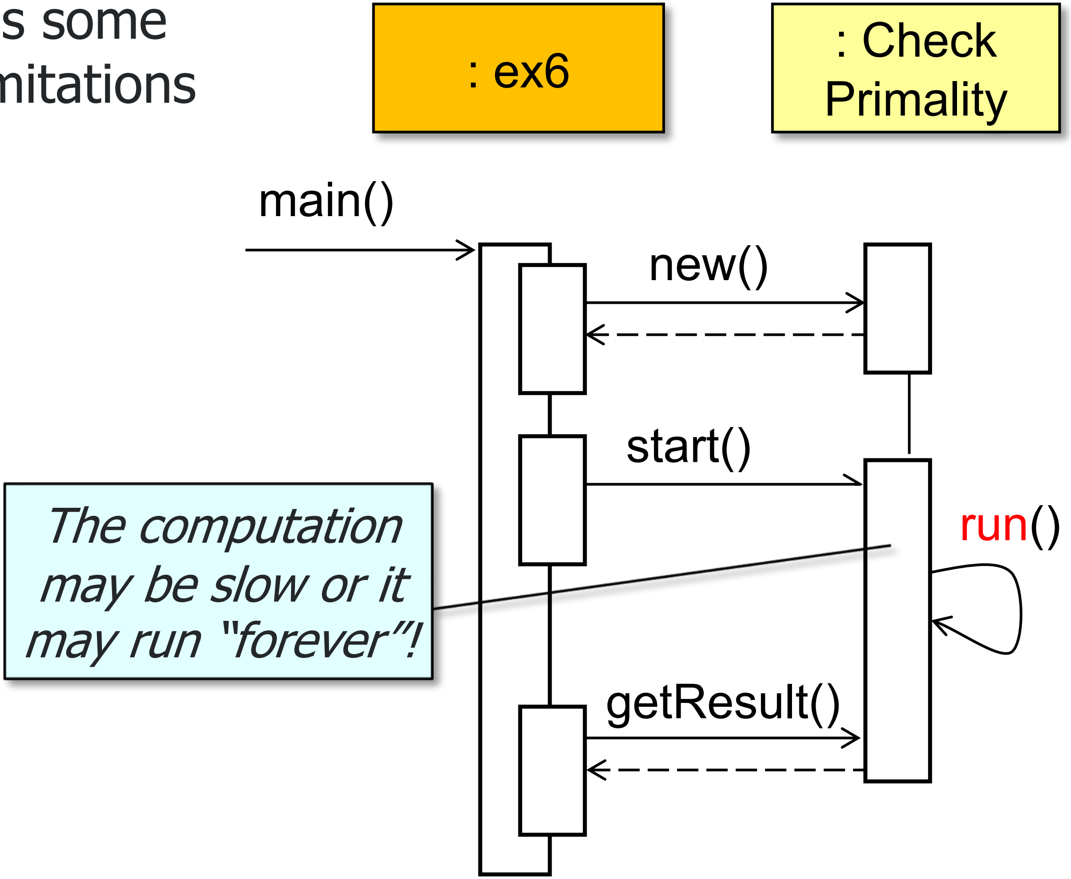
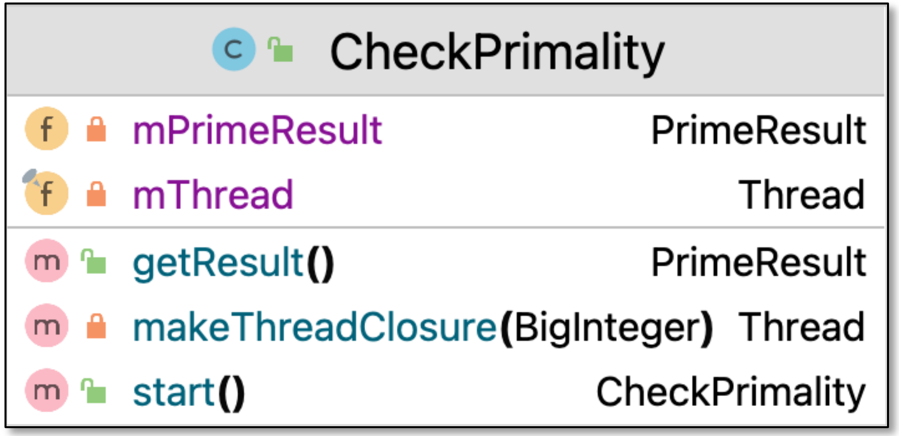


Applying Java Futures to Address These Limitations

Applying Java Futures to Address These Limitations

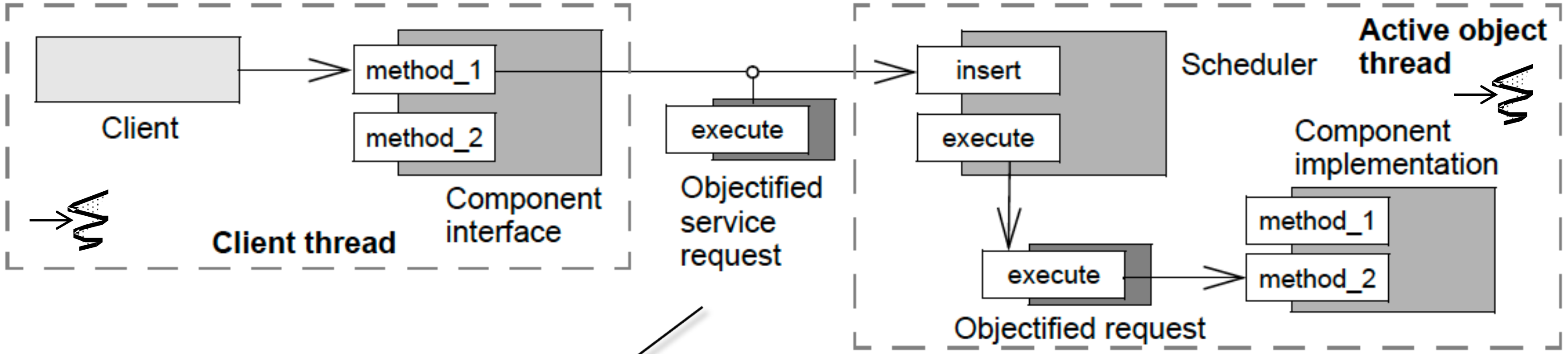
- We address these limitations in 2 ways



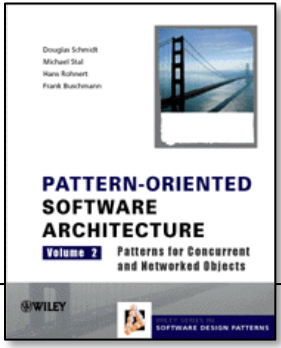
CheckPrimality	
mPrimeResult	PrimeResult
mThread	Thread
getResult()	PrimeResult
makeThreadClosure(BigInteger)	Thread
start()	CheckPrimality

Applying Java Futures to Address These Limitations

- We address these limitations in 2 ways
  - Apply the *Active Object* pattern to create generic concurrent objects



This pattern decouples method execution from method invocation for objects residing in their own thread of control



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Volume 2
Patterns for Concurrent and Networked Objects
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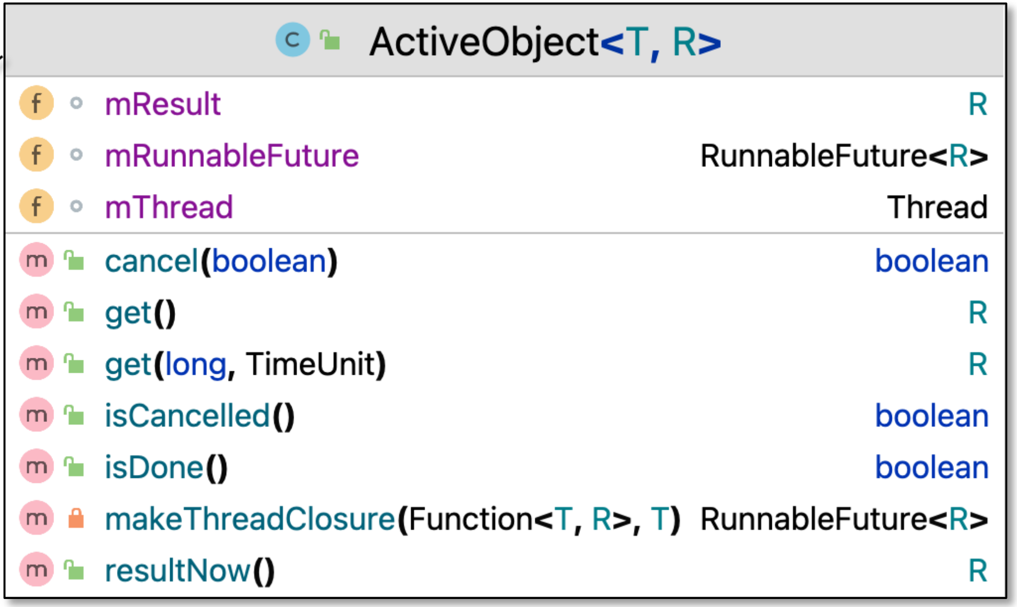
See en.wikipedia.org/wiki/Active_object

Applying Java Futures to Address These Limitations

- We address these limitations in 2 ways
  - Apply the *Active Object* pattern to create generic concurrent objects



ActiveObject<T, R>

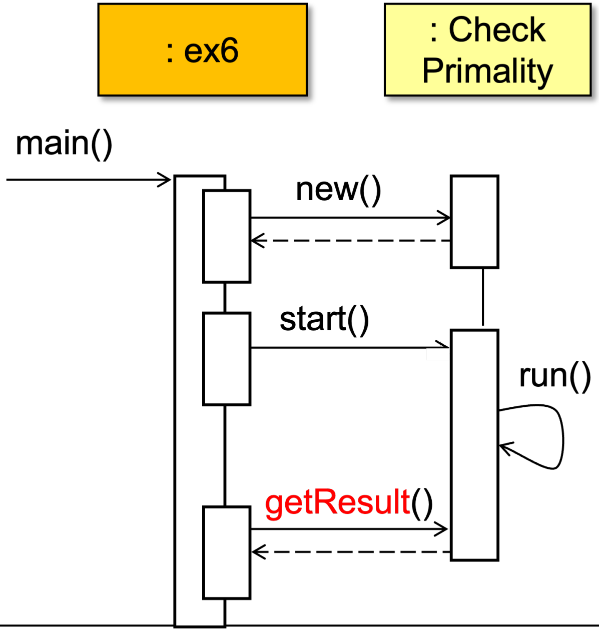
mResult	R
mRunnableFuture	RunnableFuture<R>
mThread	Thread
cancel(boolean)	boolean
get()	R
get(long, TimeUnit)	R
isCancelled()	boolean
isDone()	boolean
makeThreadClosure(Function<T, R>, T)	RunnableFuture<R>
resultNow()	R

This class implements a variant of the Active Object pattern using modern Java features (e.g., a virtual Thread & the Function functional interface)

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

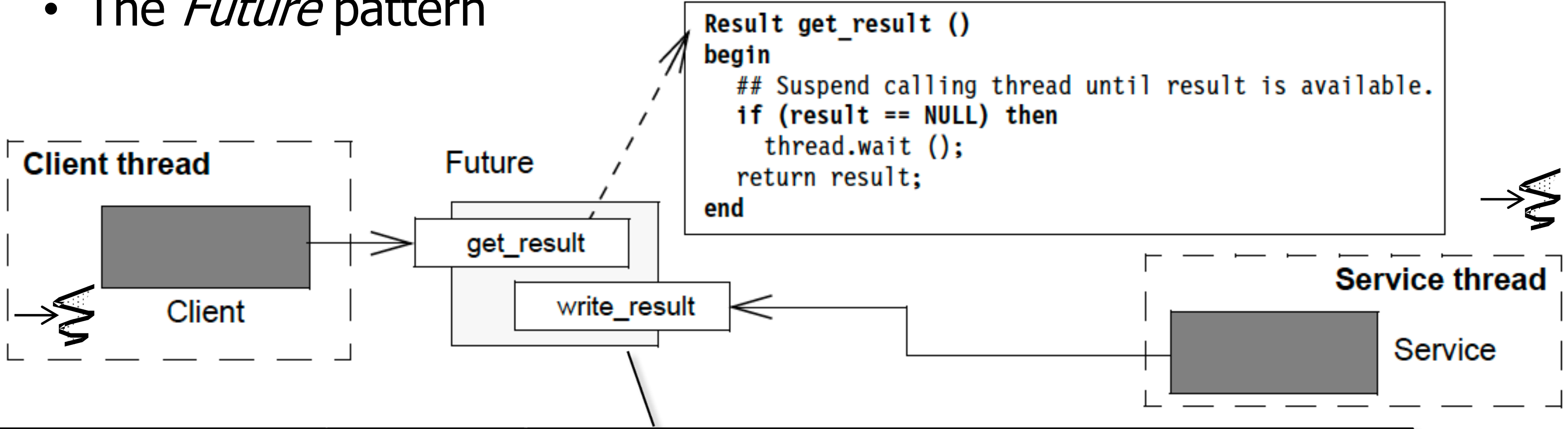
Applying Java Futures to Address These Limitations

- We address these limitations in 2 ways
  - Apply the *Active Object* pattern to create generic concurrent objects
  - Apply the *Future* pattern & Java Future interface to avoid indefinite blocking



Applying Java Futures to Address These Limitations

- We address these limitations in 2 ways
  - Apply the *Active Object* pattern to create generic concurrent objects
  - Apply the *Future* pattern & Java Future interface to avoid indefinite blocking
    - The *Future* pattern



```
Result get_result ()
begin
   ## Suspend calling thread until result is available.
   if (result == NULL) then
     thread.wait ();
   return result;
end
```

Provides a 'virtual' data object that blocks (or do not block) clients when they try to get its contents before its concurrent computation completes

See en.wikipedia.org/wiki/Futures_and_promises

Applying Java Futures to Address These Limitations

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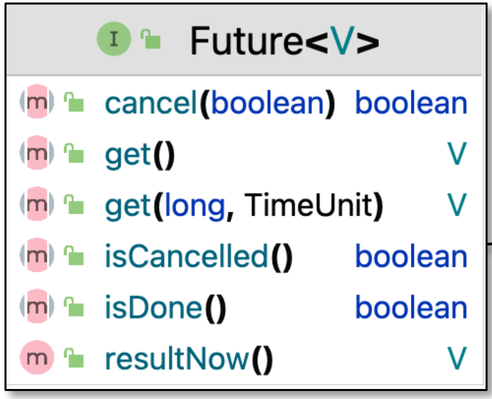
    - The *Future* pattern
    - The Future interface



```
Future<V>
cancel(boolean)       boolean
get()                 V
get(long, TimeUnit)   V
isCancelled()         boolean
isDone()              boolean
resultNow()           V
```

A proxy that represents the result of an asynchronous computation

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

Applying Java Futures to Address These Limitations

- We address these limitations in 2 ways
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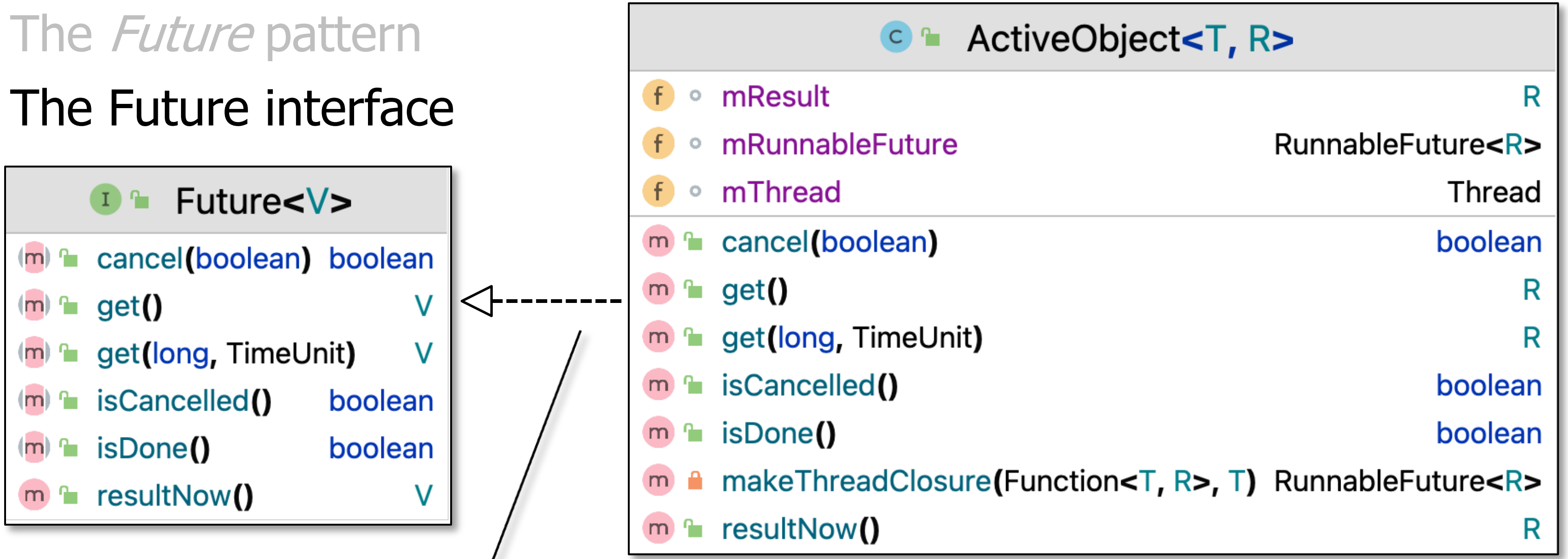
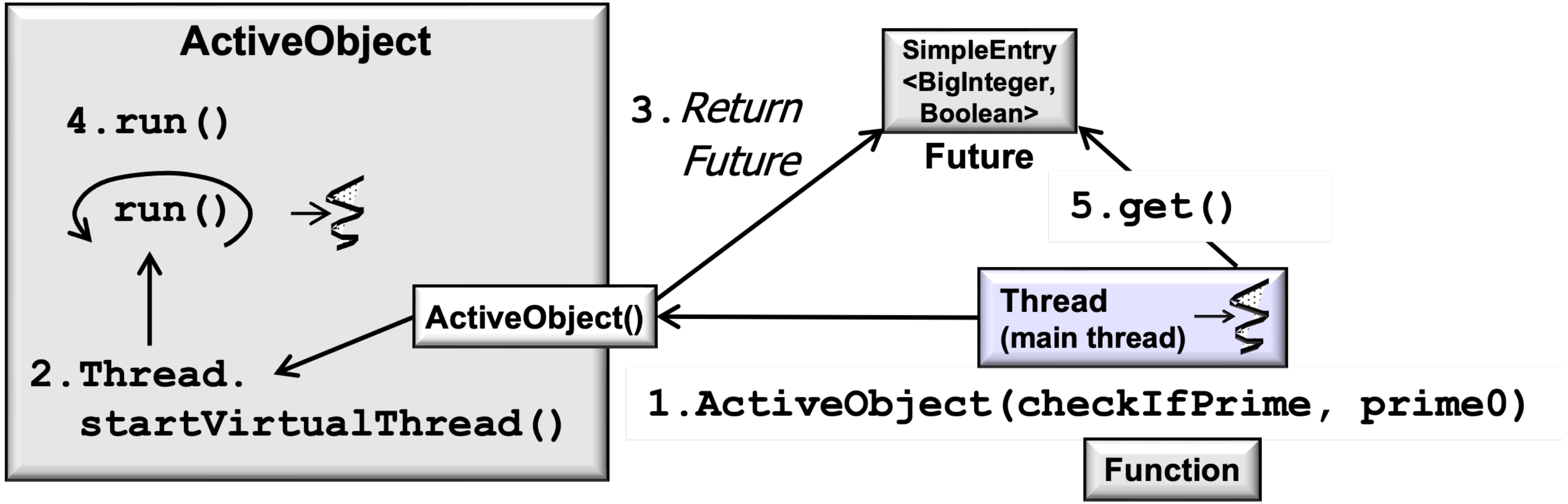


The ActiveObject class implements the Java Future interface, so a caller can obtain its results without blocking indefinitely

Applying Java Futures to Address These Limitations

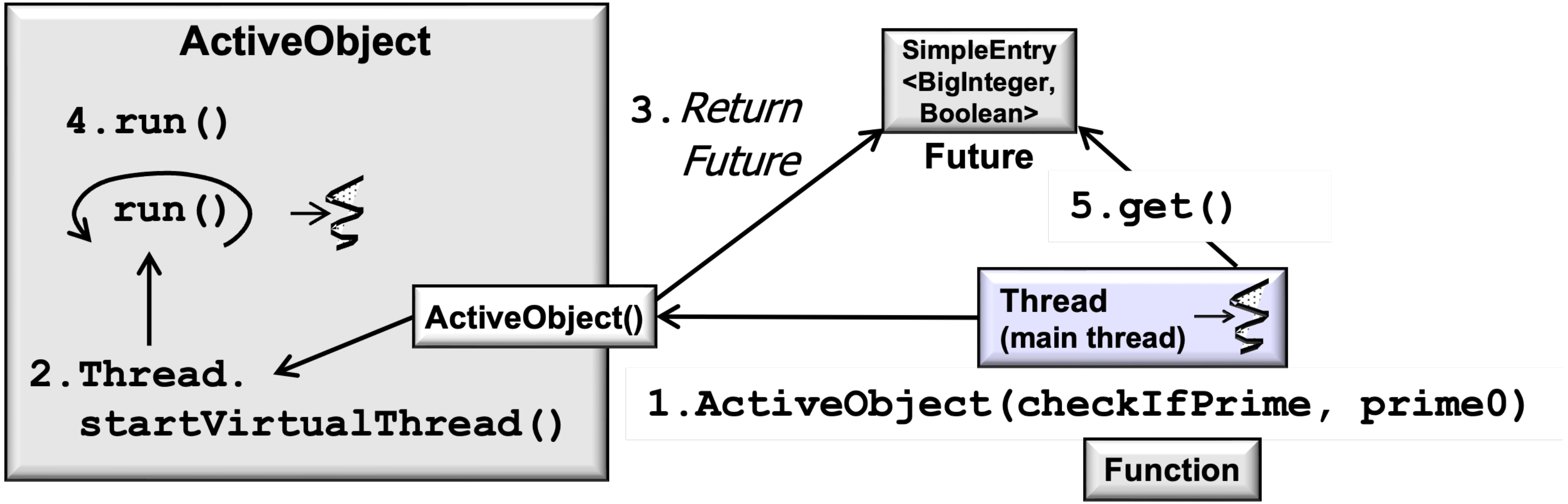
- We demonstrate the *Active Object* & *Future* patterns in conjunction with the Java Future interface in an upcoming case study



See upcoming lesson on "*Applying Java Futures in Case Study ex16*"

Applying Java Futures to Address These Limitations

- We demonstrate the *Active Object* & *Future* patterns in conjunction with the Java Future interface in an upcoming case study



  - This case study generalizes case study ex6 that checked the primality of BigInteger objects when computing RSA public & private keys

See earlier lessons on "*Implementing Closures with Java Lambda Expressions*"

End of Motivating the Need for Java Futures