The Java Executors Utility Class

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Learning Objectives in this Lesson

- Understand the implementation of key methods in the Executors utility class

Class Executors

java.lang.Object
    java.util.concurrent.Executors

```
public class Executors
extends Object
```

Factory and utility methods for `Executor`, `ExecutorService`, `ScheduledExecutorService`, `ThreadFactory`, and `Callable` classes defined in this package. This class supports the following kinds of methods:

- Methods that create and return an `ExecutorService` set up with commonly useful configuration settings.
- Methods that create and return a `ScheduledExecutorService` set up with commonly useful configuration settings.
- Methods that create and return a "wrapped" ExecutorService, that disables reconfiguration by making implementation-specific methods inaccessible.
- Methods that create and return a `ThreadFactory` that sets newly created threads to a known state.
- Methods that create and return a `Callable` out of other closure-like forms, so they can be used in execution methods requiring `Callable`.

The Java Executors Utility Class

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- Executors is a Java utility class

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- Methods that create and return a `Callable` out of other closure-like forms, so they can be used in execution methods requiring `Callable`.

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

The Java Executors Utility Class

- Executors is a Java utility class
  - A utility class is a final class having only static methods, no non-static state, & a private constructor

Class Executors

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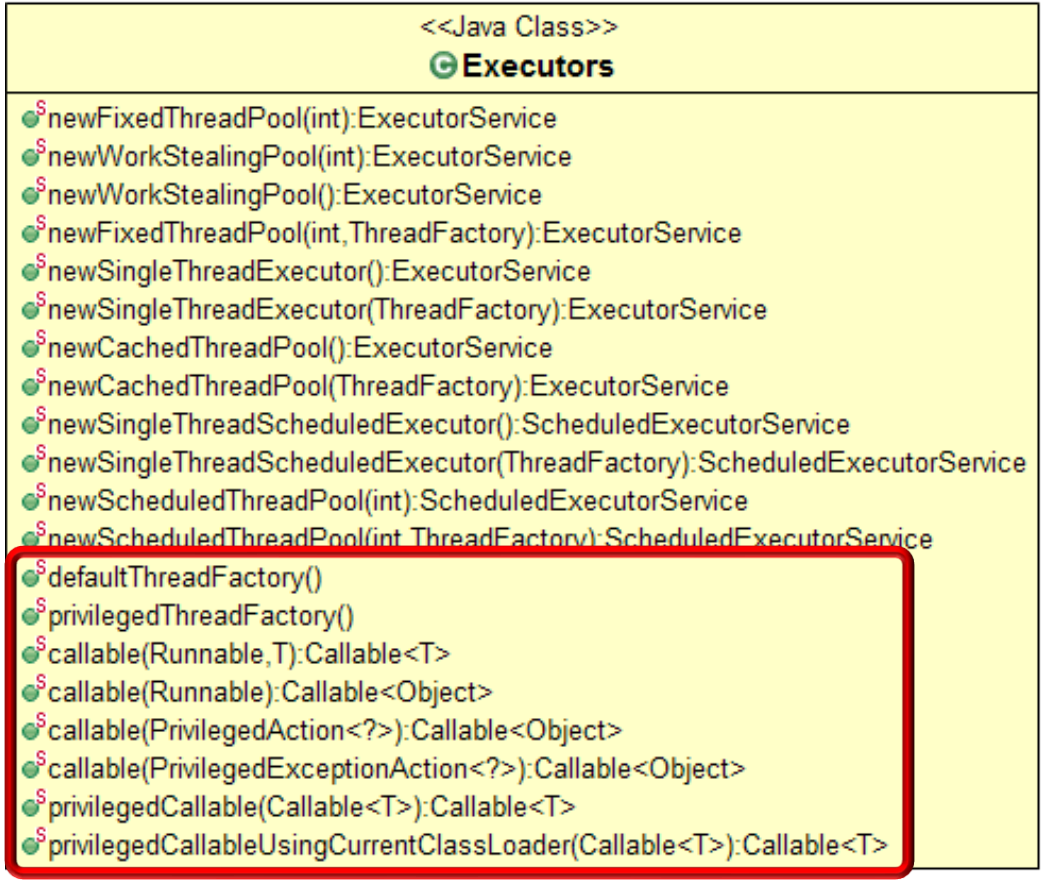
See www.quora.com/What-is-the-best-way-to-write-utility-classes-in-Java/answer/Jon-Harley

The Java Executors Utility Class

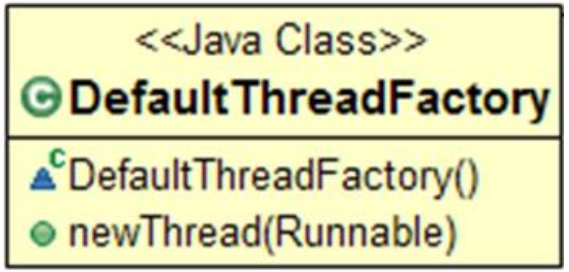
- It defines utility methods used by Executor framework classes



The Java Executors Utility Class

- It defines utility methods used by Executor framework classes, e.g.
  - defaultThreadFactory() sets new threads to a known state

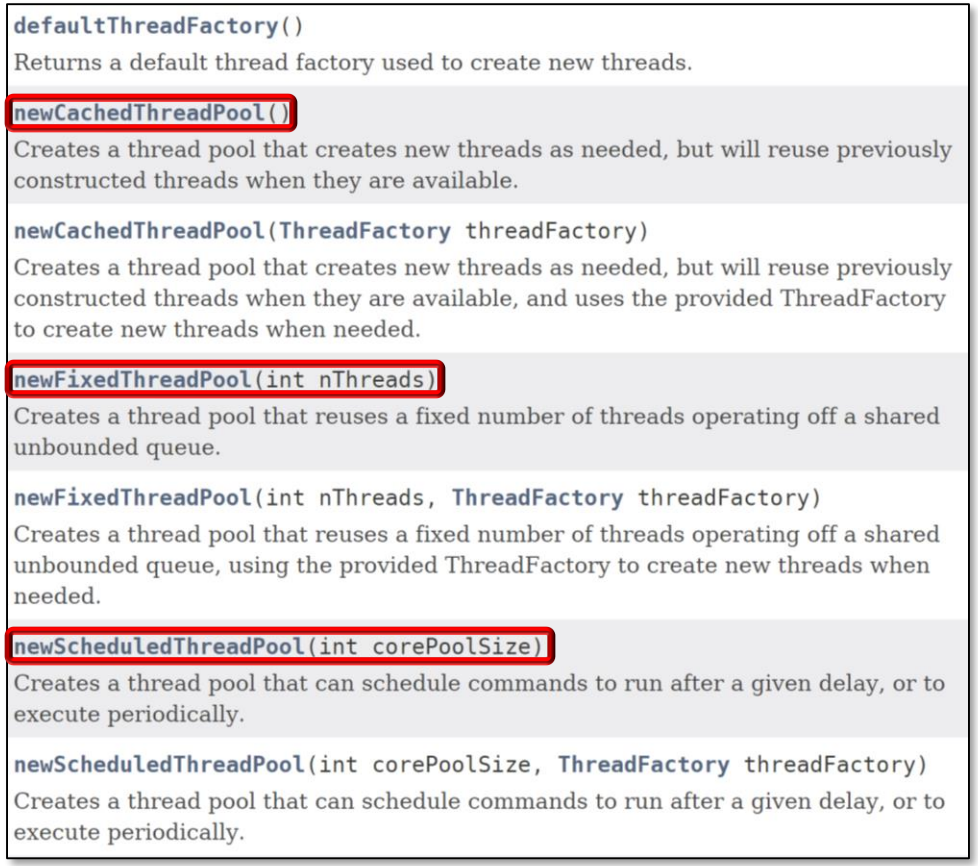
```
public class Executors {
   ...
   public static ThreadFactory
          defaultThreadFactory() {
     return new
       DefaultThreadFactory();
   }
```



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

The Java Executors Utility Class

- It defines utility methods used by Executor framework classes, e.g.
  - defaultThreadFactory() sets new threads to a known state
    - The defaultThreadFactory() is used by these factory methods



`defaultThreadFactory()`

Returns a default thread factory used to create new threads.

`newCachedThreadPool()`

Creates a thread pool that creates new threads as needed, but will reuse previously constructed threads when they are available.

`newCachedThreadPool(ThreadFactory threadFactory)`

Creates a thread pool that creates new threads as needed, but will reuse previously constructed threads when they are available, and uses the provided ThreadFactory to create new threads when needed.

`newFixedThreadPool(int nThreads)`

Creates a thread pool that reuses a fixed number of threads operating off a shared unbounded queue.

`newFixedThreadPool(int nThreads, ThreadFactory threadFactory)`

Creates a thread pool that reuses a fixed number of threads operating off a shared unbounded queue, using the provided ThreadFactory to create new threads when needed.

`newScheduledThreadPool(int corePoolSize)`

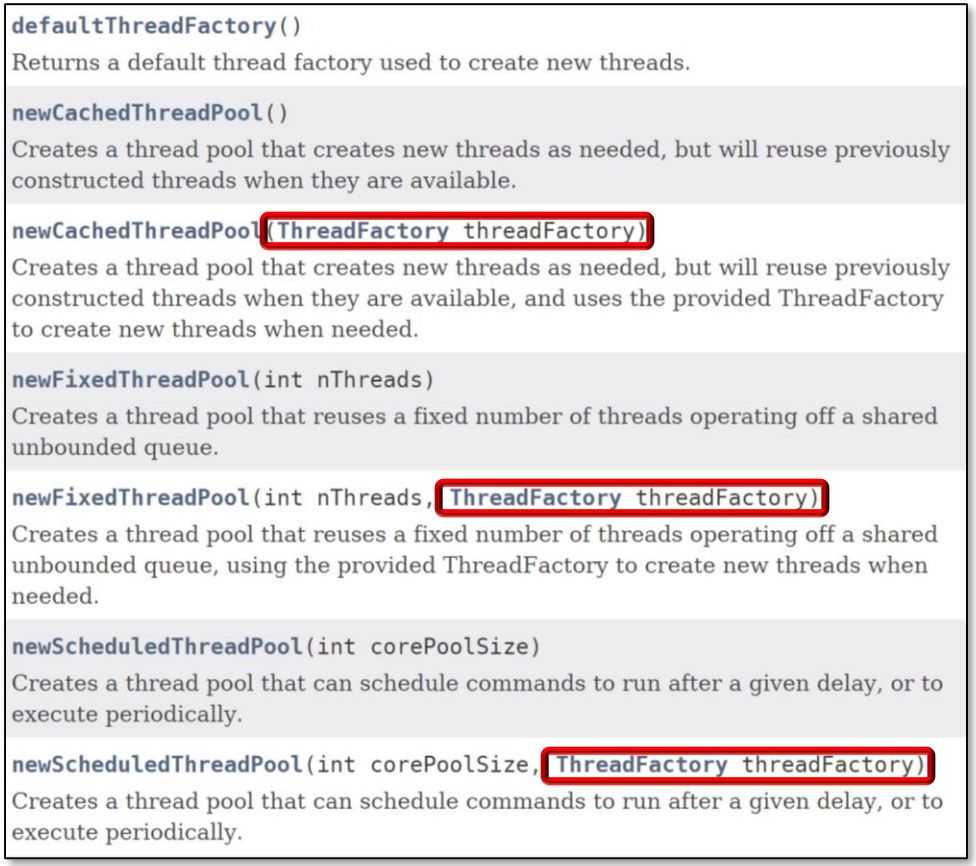
Creates a thread pool that can schedule commands to run after a given delay, or to execute periodically.

`newScheduledThreadPool(int corePoolSize, ThreadFactory threadFactory)`

Creates a thread pool that can schedule commands to run after a given delay, or to execute periodically.

The Java Executors Utility Class

- It defines utility methods used by Executor framework classes, e.g.
  - defaultThreadFactory() sets new threads to a known state
  - User-defined ThreadFactory objects can be passed to other factory methods in Executors



The Java Executors Utility Class

- It defines utility methods used by Executor framework classes, e.g.
  - defaultThreadFactory() sets new threads to a known state
  - User-defined ThreadFactory objects can be passed to other factory methods in Executors
    - e.g., enables apps to create custom thread subclasses, priorities, etc.

`defaultThreadFactory()`
Returns a default thread factory used to create new threads.

`newCachedThreadPool()`
Creates a thread pool that creates new threads as needed, but will reuse previously constructed threads when they are available.

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The Java Executors Utility Class

- It defines utility methods used by Executor framework classes, e.g.
  - defaultThreadFactory() sets new threads to a known state
  - User-defined ThreadFactory objects can be passed to other factory methods in Executors
  - Create a callable from a runnable

```
public class Executors {
   ...
   public static Callable<Object>
            callable(Runnable task){
     ...
     return new RunnableAdapter
               <Object>(task, null);
   }
```

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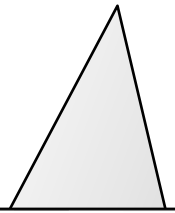


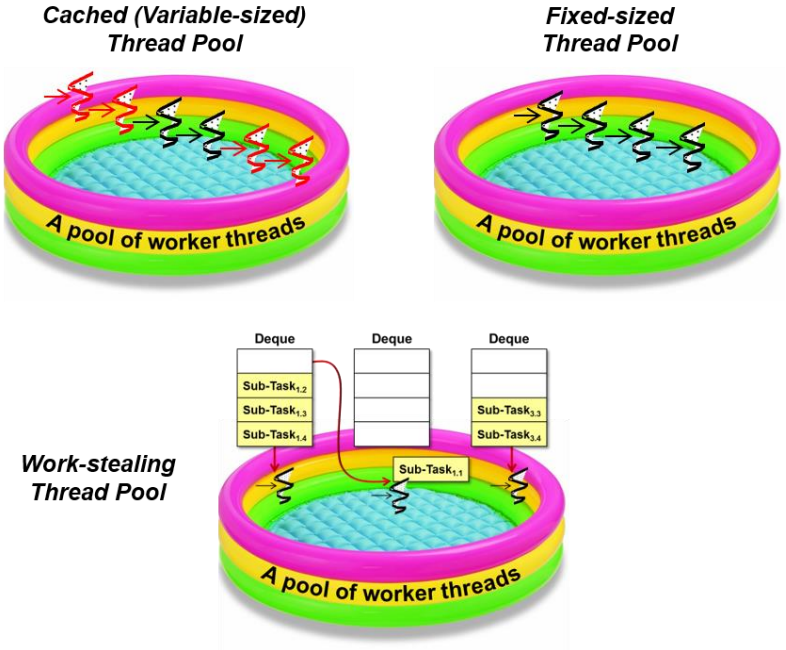
```
class RunnableAdapter<T> implements Callable<T> {
  final Runnable task; final T result;

  RunnableAdapter(Runnable t, T r){ task = t; result = r; }
  public T call() { task.run(); return result; }
}
```

See runtimeverification.com/monitor/annotated-java-8/java/util/concurrent/Executors.RunnableAdapter.html

The Java Executors Utility Class

- It also defines factory methods to make Executor thread pools



<<Java Class>>

Executors

- newFixedThreadPool(int):ExecutorService
- newWorkStealingPool(int):ExecutorService
- newWorkStealingPool():ExecutorService
- newFixedThreadPool(int,ThreadFactory):ExecutorService
- newSingleThreadExecutor():ExecutorService
- newSingleThreadExecutor(ThreadFactory):ExecutorService
- newCachedThreadPool():ExecutorService
- newCachedThreadPool(ThreadFactory):ExecutorService
- newSingleThreadScheduledExecutor():ScheduledExecutorService
- newSingleThreadScheduledExecutor(ThreadFactory):ScheduledExecutorService
- newScheduledThreadPool(int):ScheduledExecutorService
- newScheduledThreadPool(int,ThreadFactory):ScheduledExecutorService
- defaultThreadFactory()
- privilegedThreadFactory()
- callable(Runnable,T):Callable<T>
- callable(Runnable):Callable<Object>
- callable(PrivilegedAction<?>):Callable<Object>
- callable(PrivilegedExceptionAction<?>):Callable<Object>
- privilegedCallable(Callable<T>):Callable<T>
- privilegedCallableUsingCurrentClassLoader(Callable<T>):Callable<T>

The Java Executors Utility Class

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- newCachedThreadPool(ThreadFactory):ExecutorService
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- privilegedCallable(Callable<T>):Callable<T>
- privilegedCallableUsingCurrentClassLoader(Callable<T>):Callable<T>

It can also create a thread pool with just one thread!

The Java Executors Utility Class

- It also defines factory methods to make Executor thread pools, e.g.
  - Create fixed-sized thread pools

```
public class Executors {
   ...
   public static ExecutorService
   newFixedThreadPool(int nThreads,
     ThreadFactory threadFactory){
     return new ThreadPoolExecutor
       (nThreads, nThreads,
        0L, TimeUnit.MILLISECONDS,
        new LinkedBlockingQueue
          <Runnable>(),
        threadFactory);
   }
```

The Java Executors Utility Class

- It also defines factory methods to make Executor thread pools, e.g.
  - Create fixed-sized thread pools
    - Uses ThreadPoolExecutor class

```
public class Executors {
   ...
   public static ExecutorService
   newFixedThreadPool(int nThreads,
     ThreadFactory threadFactory){
     return new ThreadPoolExecutor
        (nThreads, nThreads,
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         new LinkedBlockingQueue
           <Runnable>(),
         threadFactory);
   }
```

See earlier lesson on "*Overview of Java ThreadPoolExecutor*"

The Java Executors Utility Class

- It also defines factory methods to make Executor thread pools, e.g.
  - Create fixed-sized thread pools
    - Uses ThreadPoolExecutor class
    - Core pool size & maximum pool size are the same

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public class Executors {
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The Java Executors Utility Class

- It also defines factory methods to make Executor thread pools, e.g.
  - Create fixed-sized thread pools
    - Uses ThreadPoolExecutor class
    - Core pool size & maximum pool size are the same
  - Idle threads don't timeout

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public class Executors {
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See docs.oracle.com/javase/8/docs/api/java/util/concurrent/LinkedBlockingQueue.html

The Java Executors Utility Class

- It also defines factory methods to make Executor thread pools, e.g.
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  - Threads can be created via a custom ThreadFactory

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public class Executors {
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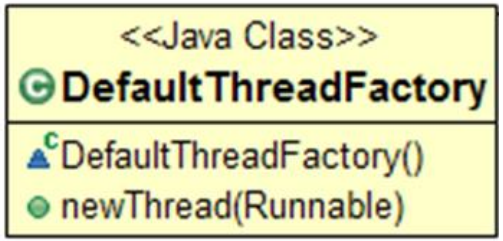
```
public class Executors {
   ...
   public static ExecutorService
   newFixedThreadPool(int
                      nThreads) {
     return new ThreadPoolExecutor
       (nThreads, nThreads,
        0L, TimeUnit.MILLISECONDS,
        new LinkedBlockingQueue
          <Runnable>());
}
```



A variant of newFixedThreadPool() uses DefaultThreadFactory

The Java Executors Utility Class

- It also defines factory methods to make Executor thread pools, e.g.
  - Create fixed-sized thread pools
  - Create variable-sized thread pools

```
public class Executors {
   ...
   public static ExecutorService
   newCachedThreadPool
      (ThreadFactory threadFactory){
      return new ThreadPoolExecutor
         (0, Integer.MAX_VALUE,
          60L, TimeUnit.SECONDS,
          new SynchronousQueue
              <Runnable>(),
          threadFactory);
   }
   ...
```

The Java Executors Utility Class

- It also defines factory methods to make Executor thread pools, e.g.
  - Create fixed-sized thread pools
  - Create variable-sized thread pools
    - Uses ThreadPoolExecutor class

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            <Runnable>(),
        threadFactory);
   }
   ...
```

See earlier lesson on "*Overview of Java ThreadPoolExecutor*"

The Java Executors Utility Class

- It also defines factory methods to make Executor thread pools, e.g.
  - Create fixed-sized thread pools
  - Create variable-sized thread pools
    - Uses ThreadPoolExecutor class
    - New threads started as needed, but existing threads are reused

```
public class Executors {
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   }
   ...
```

The Java Executors Utility Class

- It also defines factory methods to make Executor thread pools, e.g.
  - Create fixed-sized thread pools
  - Create variable-sized thread pools
    - Uses ThreadPoolExecutor class
    - New threads started as needed, but existing threads are reused
    - Terminate & remove threads from cache if unused for 60 seconds

```
public class Executors {
   ...
   public static ExecutorService
   newCachedThreadPool
      (ThreadFactory threadFactory){
      return new ThreadPoolExecutor
         (0, Integer.MAX_VALUE,
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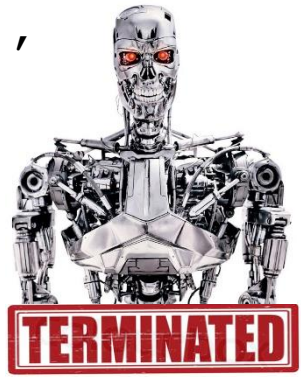

The Java Executors Utility Class

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  - Create fixed-sized thread pools
  - Create variable-sized thread pools
    - Uses ThreadPoolExecutor class
    - New threads started as needed, but existing threads are reused
    - Terminate & remove threads from cache if unused for 60 seconds
    - execute() does a "rendezvous" with a new worker thread

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public class Executors {
   ...
  public static ExecutorService
  newCachedThreadPool
    (ThreadFactory threadFactory){
    return new ThreadPoolExecutor
      (0, Integer.MAX_VALUE,
       60L, TimeUnit.SECONDS,
       new SynchronousQueue
           <Runnable>(),
       threadFactory);
}
...
```

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

The Java Executors Utility Class

- It also defines factory methods to make Executor thread pools, e.g.
  - Create fixed-sized thread pools
  - Create variable-sized thread pools
    - Uses ThreadPoolExecutor class
    - New threads started as needed, but existing threads are reused
    - Terminate & remove threads from cache if unused for 60 seconds
    - execute() does a "rendezvous" with a new worker thread
  - Threads can be created via custom ThreadFactory

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public class Executors {
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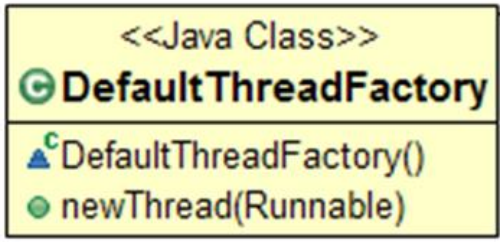

A variant of newCachedThreadPool() uses DefaultThreadFactory

The Java Executors Utility Class

- It also defines factory methods to make Executor thread pools, e.g.
  - Create fixed-sized thread pools
  - Create variable-sized thread pools
  - Create work-stealing thread pools

```
public class Executors {
   ...
   public static ExecutorService
     newWorkStealingPool
        (int parallelism) {
        return new ForkJoinPool
          (parallelism,
           ForkJoinPool
           .defaultForkJoin
            WorkerThreadFactory,
           null,
           true);
   }
   ...
```

The Java Executors Utility Class

- It also defines factory methods to make Executor thread pools, e.g.
  - Create fixed-sized thread pools
  - Create variable-sized thread pools
  - Create work-stealing thread pools
    - Implemented via ForkJoinPool

```
public class Executors {
   ...
  public static ExecutorService
    newWorkStealingPool
      (int parallelism) {
      return new ForkJoinPool
        (parallelism,
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          WorkerThreadFactory,
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         true);
  }
  ...
```

See lessons on "*Java ForkJoinPool*"

The Java Executors Utility Class

- It also defines factory methods to make Executor thread pools, e.g.
  - Create fixed-sized thread pools
  - Create variable-sized thread pools
  - Create work-stealing thread pools
    - Implemented via ForkJoinPool
    - Set the target parallelism level

```
public class Executors {
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      (int parallelism) {
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          WorkerThreadFactory,
         null,
         true);
  }
  ...
```

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- It also defines factory methods to make Executor thread pools, e.g.
  - Create fixed-sized thread pools
  - Create variable-sized thread pools
  - Create work-stealing thread pools
    - Implemented via ForkJoinPool
    - Set the target parallelism level
    - etc.

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See docs.oracle.com/javase/8/docs/api/java/util/concurrent/ForkJoinPool.html#defaultForkJoinWorkerThreadFactory

End of the Java Executors Utility Class