Key Methods in Java
ReentrantLock

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Learning Objectives in this Part of the Lesson

• Understand the concept of mutual exclusion in concurrent programs
• Note a human-known use of mutual exclusion
• Recognize the structure & functionality of Java ReentrantLocks
• Be aware of reentrant mutex semantics
• Know the key methods defined by the Java ReentrantLock class
Overview of Key ReentrantLock Methods
Overview of Key ReentrantLock Methods

- It key methods acquire & release the lock

```java
public class ReentrantLock
    implements Lock,
    java.io.Serializable {

    ...

    public void lock() { sync.lock(); }

    public void lockInterruptibly() 
        throws InterruptedException {
        sync.acquireInterruptibly(1);
    }

    public boolean tryLock() {
        return sync.nonfairTryAcquire(1);
    }

    public void unlock() {
        sync.release(1);
    }

    ...

See src/share/classes/java/util/concurrent/locks/ReentrantLock.java
```
Overview of Key ReentrantLock Methods

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    }

    public void unlock() {
        sync.release(1);
    }
    ...
```

These methods are defined in the Java Lock interface

See docs.oracle.com/javase/8/docs/api/java/util/concurrent/locks/Lock.html
Overview of Key ReentrantLock Methods

- It key methods acquire & release the lock

```java
public class ReentrantLock
    implements Lock,
    java.io.Serializable {
    ... public void lock() { sync.lock(); }
    ...
    public void lockInterruptibly() throws InterruptedException {
        sync.acquireInterruptibly(1);
    }
    ...
    public boolean tryLock() {
        return sync.nonfairTryAcquire(1);
    }
    ...
    public void unlock() {
        sync.release(1);
    }
    ...
```

**These methods simply forward to their implementor methods, which largely inherit from AbstractQueuedSynchronizer**

See docs.oracle.com/javase/8/docs/api/java/util/concurrent/locks/AbstractQueuedSynchronizer.html
Overview of Key ReentrantLock Methods

- It key methods acquire & release the lock
- lock() acquires the lock if it’s available

```java
public class ReentrantLock
    implements Lock,
    java.io.Serializable {

    ... 

    public void lock() {
        sync.lock();
    }

    ... 
```
Overview of Key ReentrantLock Methods

- It key methods acquire & release the lock
- lock() acquires the lock if it’s available
- If lock isn’t available its implementation depends on the “fairness” policy

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public class ReentrantLock
    implements Lock,
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    public void lock() {
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Overview of Key ReentrantLock Methods

• It key methods acquire & release the lock
  • lock() acquires the lock if it’s available
  • If lock isn’t available its implementation depends on the “fairness” policy
    • Non-fair implementations are optimized in hardware

```java
public class ReentrantLock
    implements Lock,
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    public void lock() {
        sync.lock();
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See en.wikipedia.org/wiki/Spinlock
Overview of Key ReentrantLock Methods

- It key methods acquire & release the lock
- lock() acquires the lock if it’s available
- If lock isn’t available its implementation depends on the “fairness” policy
  - Non-fair implementations are optimized in hardware
  - Fair implementations “park” themselves on a wait queue in FIFO order

```java
public class ReentrantLock
    implements Lock,
    java.io.Serializable {
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    public void lock() {
        sync.lock();
    }
...
```
Overview of Key ReentrantLock Methods

- It key methods acquire & release the lock
- lock() acquires the lock if it’s available
  - If lock isn’t available its implementation depends on the “fairness” policy
- lock() is not interruptible

```java
public class ReentrantLock
    implements Lock,
    java.io.Serializable {

    ... 

    public void lock() {
        sync.lock();
    }

    ... 

Java built-in monitor objects have the same semantics..

See upcoming lesson on “Java Built-in Monitor Objects"
Overview of Key ReentrantLock Methods

- It key methods acquire & release the lock
  - lock() acquires the lock if it’s available
  - lockInterruptibly() acquires lock unless interrupted

```java
public class ReentrantLock implements Lock, java.io.Serializable {
    ...
    public void lockInterruptibly() throws InterruptedException {
        sync.acquireInterruptibly(1);
    }
    ...

    These semantics differ wrt built-in monitor objects..
}
```

See upcoming lesson on “Managing the Java Thread Lifecycle'
Overview of Key ReentrantLock Methods

- It key methods acquire & release the lock
  - lock() acquires the lock if it’s available
  - lockInterruptibly() acquires lock unless interrupted
  - tryLock() acquires lock only if it’s not held by another thread at invocation time

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public class ReentrantLock
    implements Lock,
    java.io.Serializable {

    ...

    public boolean tryLock() {
        sync.nonfairTryAcquire(1);
    }

    ...

```

Untimed tryLock() doesn’t honor fairness setting & can “barge”
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- It key methods acquire & release the lock
  - lock() acquires the lock if it’s available
  - lockInterruptibly() acquires lock unless interrupted
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  - unlock() attempts to release the lock

```java
public class ReentrantLock implements Lock, java.io.Serializable {

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    - IllegalMonitorStateException is thrown if calling thread doesn’t hold lock

```java
public class ReentrantLock implements Lock, java.io.Serializable {
    ...
    public void unlock() {
        sync.release(1);
    }
    ...

    Class IllegalMonitorStateException
    java.lang.Object
    java.lang.Throwable
    java.lang.Exception
    java.lang.RuntimeException
    java.lang.IllegalMonitorStateException

    All Implemented Interfaces:
    Serializable

    public class IllegalMonitorStateException extends RuntimeException

    Thrown to indicate that a thread has attempted to wait on an object's monitor or to notify other threads waiting on an object's monitor without owning the specified monitor.
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```
public class ReentrantLock implements Lock, java.io.Serializable {

  ...  
  public void unlock() {
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  }

  ...  

```

i.e., a ReentrantLock is “fully bracketed”!
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    - IllegalMonitorStateException is thrown if calling thread doesn’t hold lock
    - If hold count > 1 then lock is not released

```java
public class ReentrantLock implements Lock, java.io.Serializable {

    ... public void unlock() {
        sync.release(1);
    }
    ...
```

![Diagram showing lock acquisition and release](image)

See en.wikipedia.org/wiki/Reentrant_mutex
Overview of Other ReentrantLock Methods
Overview of Other ReentrantLock Methods

- There are many other ReentrantLock methods

<table>
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<tr>
<th>Method</th>
<th>Description</th>
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<td>tryLock(long timeout, TimeUnit unit)</td>
<td>Acquires the lock if it is not held by another thread within the given waiting time and the current thread has not been interrupted</td>
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<td>isFair()</td>
<td>Returns true if this lock has fairness set true</td>
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<td>isLocked()</td>
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<td>newCondition()</td>
<td>Returns a Condition instance for use with this Lock instance</td>
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These methods go above & beyond what’s available from Java’s synchronized statements/methods
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Timed `tryLock()` *does* honor fairness setting & can’t “barge”
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Not very useful due to non-determinism of concurrency..
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See upcoming lesson on “Java ConditionObject”
End of Key Methods in Java ReentrantLock