Java ReentrantLock Usage Considerations

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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 ReentrantLock
- Be aware of reentrant mutex semantics
- Know the key methods defined by the Java ReentrantLock class
- Master how to use ReentrantLock in practice
- Appreciate Java ReentrantLock usage considerations

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ReentrantLock Usage Considerations

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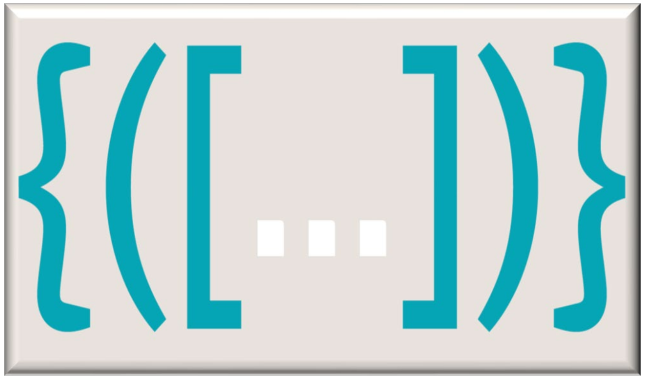
- ReentrantLock must be used via a "fully bracketed" protocol

```
void someMethod() {
  ReentrantLock lock
    = this.lock;
  lock.lock();
  try { ...
  } finally {
    lock.unlock();
  }
}
```

The thread that acquires the lock ***must*** *be the one to release it*

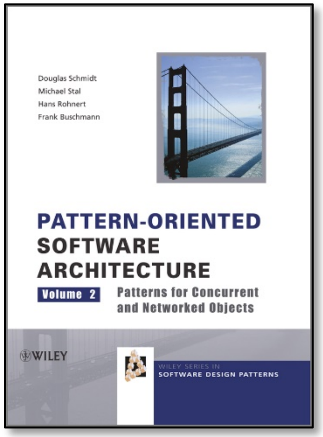


ReentrantLock Usage Considerations

- ReentrantLock must be used via a “fully bracketed” protocol
  - This design is known as the “*Scoped Locking*” pattern

```
void someMethod() {
  ReentrantLock lock
    = this.lock;
  lock.lock();
  try { ...
  } finally {
    lock.unlock();
  }
}
```

The finally clause ensures that the lock is released on all paths out the try clause


Douglas Schmidt
Michael Stal
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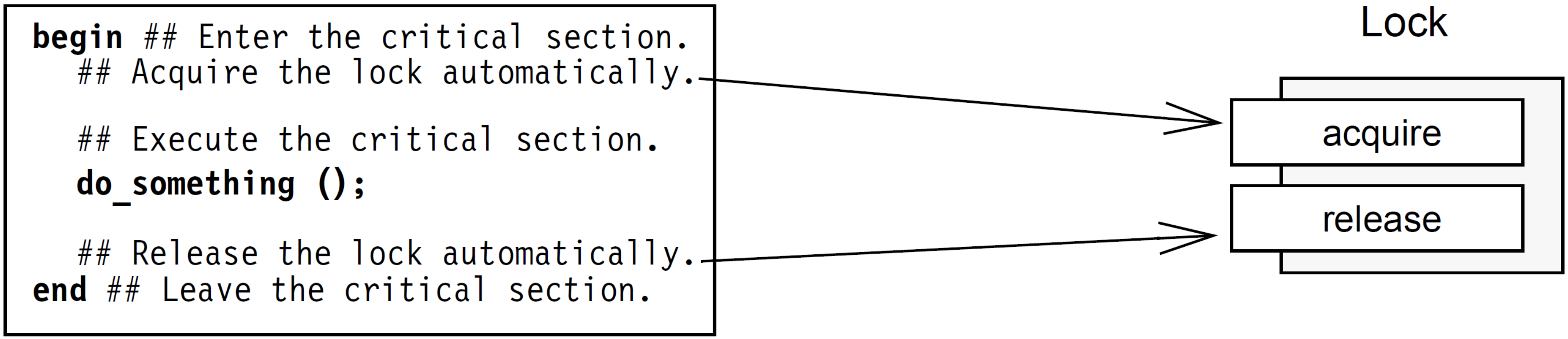


```
begin ## Enter the critical section.
   ## Acquire the lock automatically.

   ## Execute the critical section.
   do_something ();

   ## Release the lock automatically.
end ## Leave the critical section.
```

See www.dre.vanderbilt.edu/~schmidt/PDF/locking-patterns.pdf

ReentrantLock Usage Considerations

- ReentrantLock must be used via a "fully bracketed" protocol
  - This design is known as the "*Scoped Locking*" pattern
  - Implemented implicitly via Java synchronized methods & statements

```
void someMethod() {
   synchronized (this) {
      ...
   }
}

synchronized void anotherMethod()
{
   ...
}
```

See lesson on "*Java Built-in Monitor Object*"

ReentrantLock Usage Considerations

- ReentrantLock must be used via a "fully bracketed" protocol
  - This design is known as the "*Scoped Locking*" pattern
  - Implemented implicitly via Java synchronized methods & statements
  - This pattern is commonly used in C++ (& C#) via constructors & destructors

```
void write_to_file
    (std::ofstream &file,
     const std::string &msg)
{
  static std::mutex mutex;

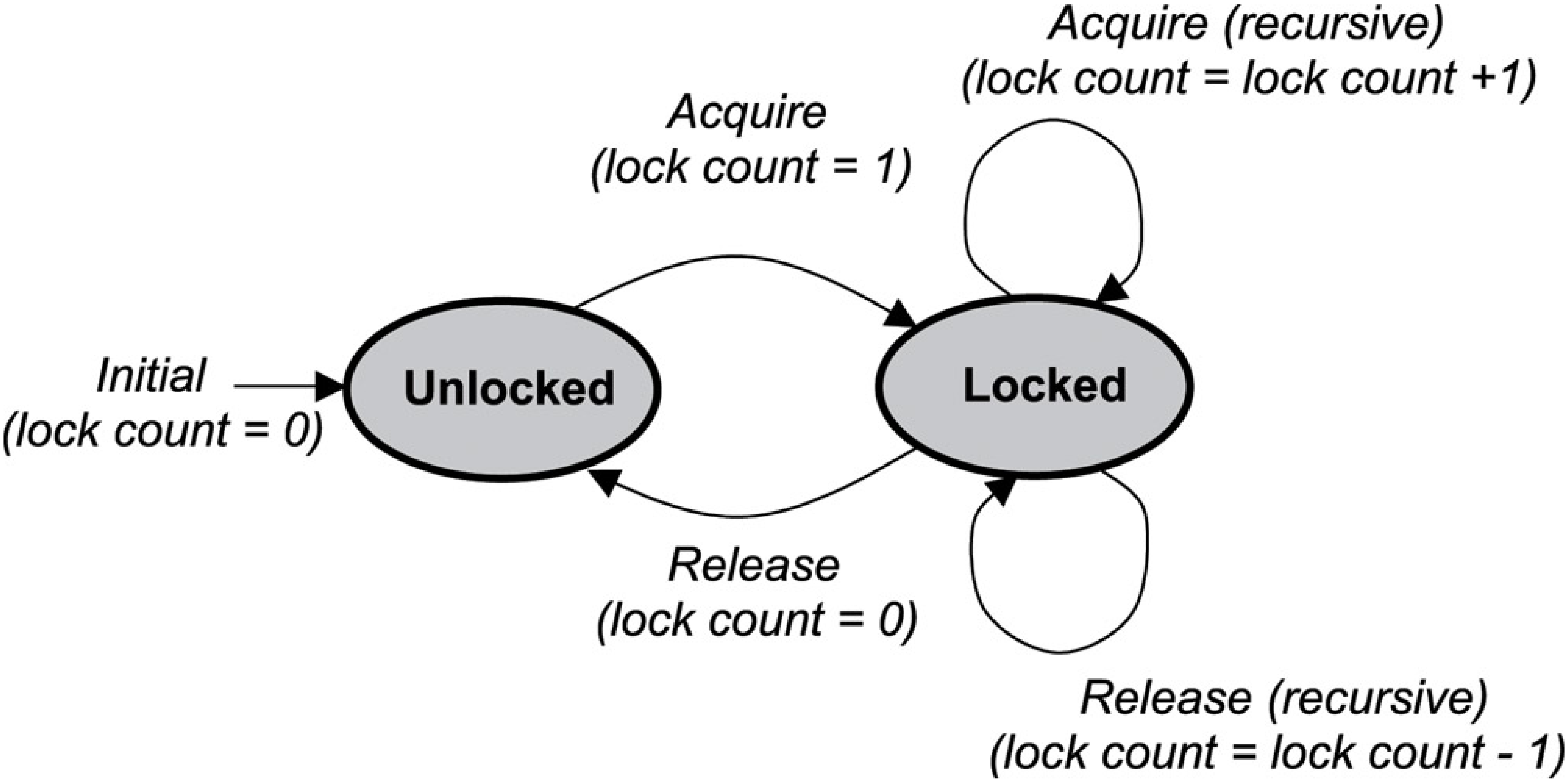
  std::lock_guard<std::mutex>
    lock(mutex);

  file << msg << std::endl;
}
```

See en.wikipedia.org/wiki/Resource_Acquisition_Is_Initialization

ReentrantLock Usage Considerations

- ReentrantLock supports "recursive mutex" semantics where a lock may be acquired multiple times by the same thread, without causing self-deadlock



See en.wikipedia.org/wiki/Reentrant_mutex

ReentrantLock Usage Considerations

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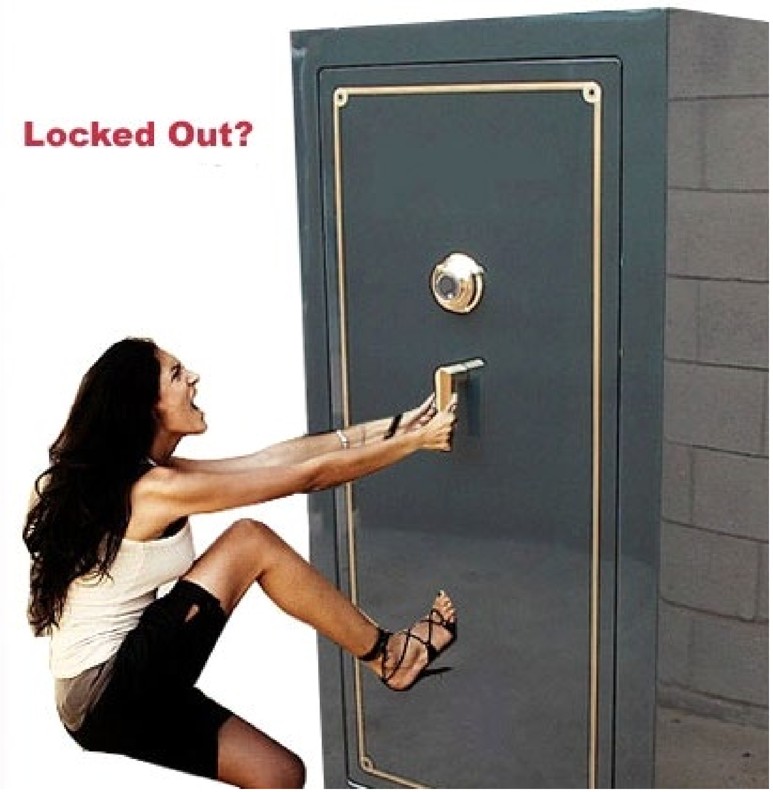

```
void someMethod() {
  ReentrantLock lock
    = this.lock;
  lock.lock();
  try {
    for (;;) {
      // Do something that
      // doesn't involve lock
    }
  } finally {
    lock.unlock();
  }
}
```

ReentrantLock Usage Considerations

- ReentrantLocks can be tedious & error-prone to program due to common traps & pitfalls, e.g.
  - Holding a lock for a long time without needing it
  - Acquiring a lock & forgetting to release it

```
void someMethod() {
  ReentrantLock lock
    = this.lock;
  lock.lock();
  ... // Critical section
  return;
}
```

This lock may be locked indefinitely!

ReentrantLock Usage Considerations

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```
void someMethod() {
  ReentrantLock lock
    = this.lock;
  lock.lock();
  try {
    ... // Critical section
    return;
  } finally {
    lock.unlock();
  }
}
```

Use the try/finally idiom to ensure a fully-bracketed semaphore is always released, even if exceptions occur

See docs.oracle.com/javase/tutorial/essential/exceptions/finally.html

ReentrantLock Usage Considerations

- ReentrantLocks can be tedious & error-prone to program due to common traps & pitfalls, e.g.
  - Holding a lock for a long time without needing it
  - Acquiring a lock & forgetting to release it
  - Releasing a lock that was never acquired
    - or has already been released

```
void someMethod() {
  ReentrantLock lock
    = this.lock;
  // lock.lock();
  try {
    ... // Critical section
  } finally {
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}
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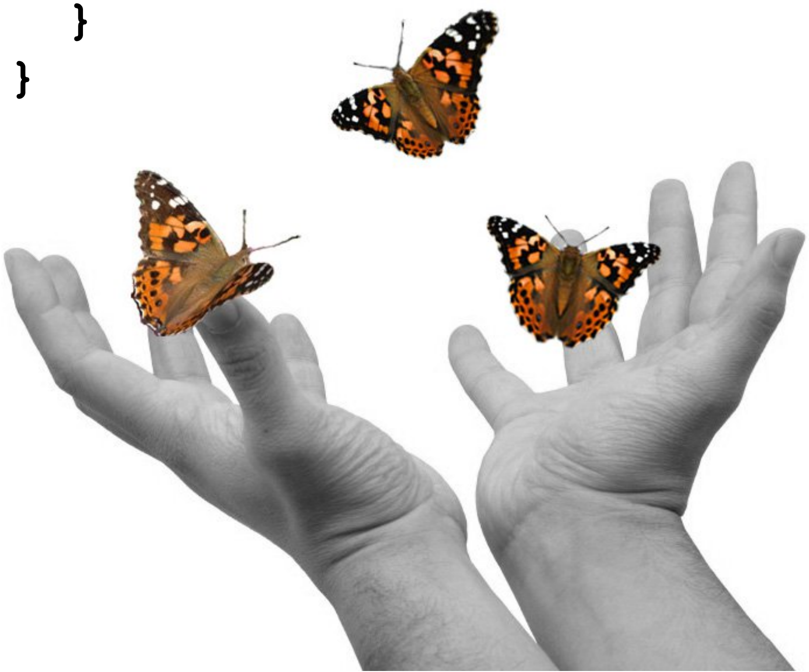

ReentrantLock Usage Considerations

- ReentrantLocks can be tedious & error-prone to program due to common traps & pitfalls, e.g.
  - Holding a lock for a long time without needing it
  - Acquiring a lock & forgetting to release it
  - Releasing a lock that was never acquired
  - Accessing a resource without acquiring a lock for it first
    - or after releasing it

```
void someMethod() {
  ReentrantLock lock
    = this.lock;
  // lock.lock();
  try {
    ... // Critical section
  } finally {
    // lock.unlock();
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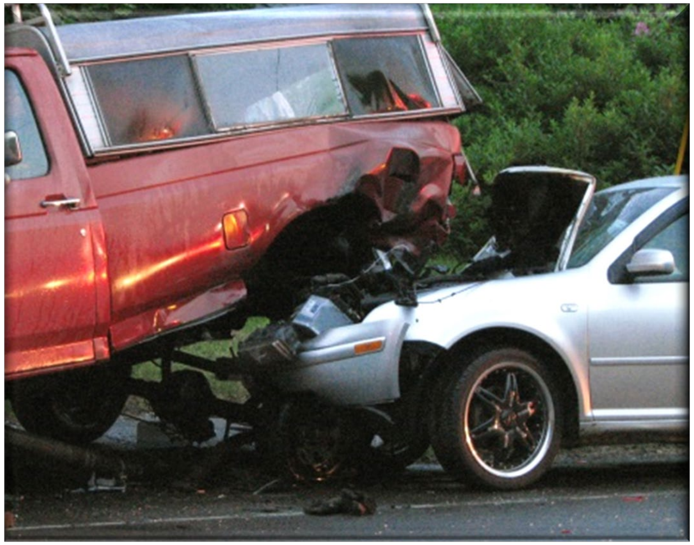
}
```



Compare with lesson on "*Java Built-in Monitor Objects*"

ReentrantLock Usage Considerations

- ReentrantLocks can be tedious & error-prone to program due to common traps & pitfalls, e.g.
  - Holding a lock for a long time without needing it
  - Acquiring a lock & forgetting to release it
  - Releasing a lock that was never acquired
  - Accessing a resource without acquiring a lock for it first
  - Calling lock() within the try block

```
void someMethod() {
  ReentrantLock lock
    = this.lock;

  try {
    lock.lock();
    ... // Critical section
  } finally {
    lock.unlock();
  }
}
```

Chaos & insanity will result if lock() throws an exception!

End of Java ReentrantLock Usage Considerations