

Introduction to Java

Readers-Writer Locks



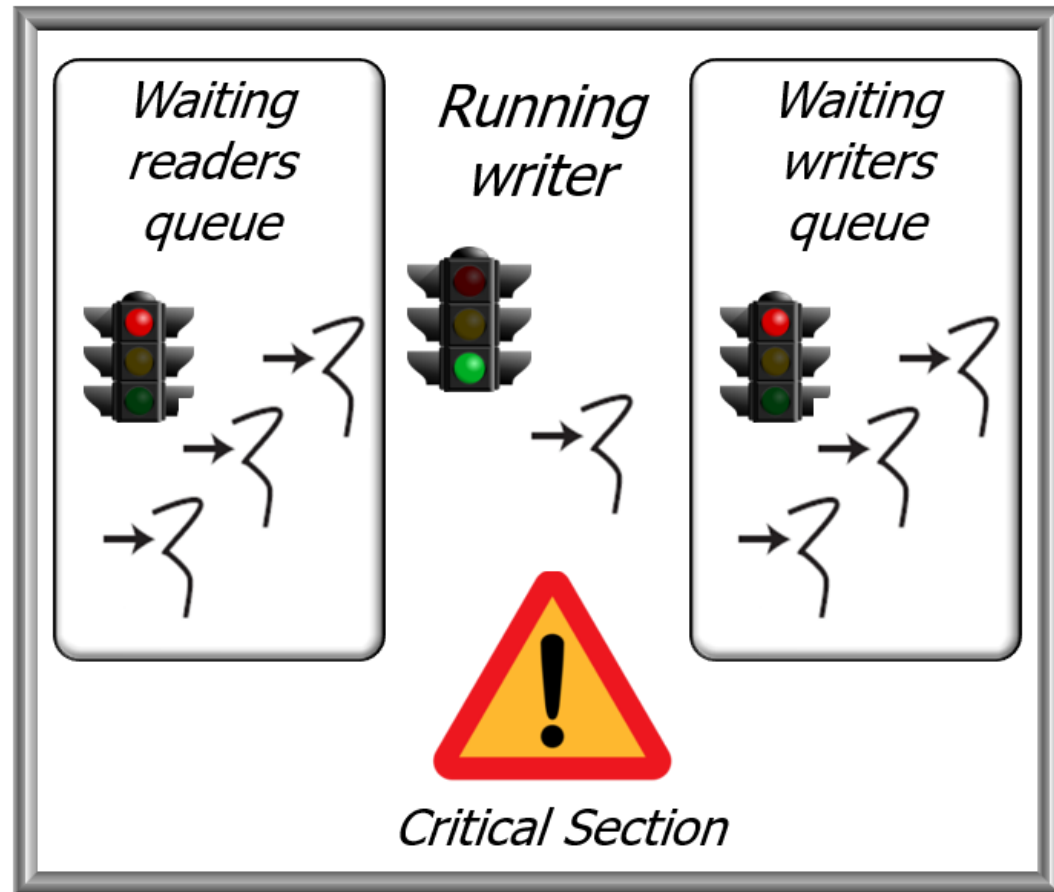
Douglas C. Schmidt
d.schmidt@vanderbilt.edu
www.dre.vanderbilt.edu/~schmidt

**Institute for Software
Integrated Systems
Vanderbilt University
Nashville, Tennessee, USA**



Learning Objectives in this Part of the Lesson

- Recognize the intent of readers-writer locks



Learning Objectives in this Part of the Lesson

- Recognize the intent of readers-writer locks
- Note a human known use of readers-writer locks

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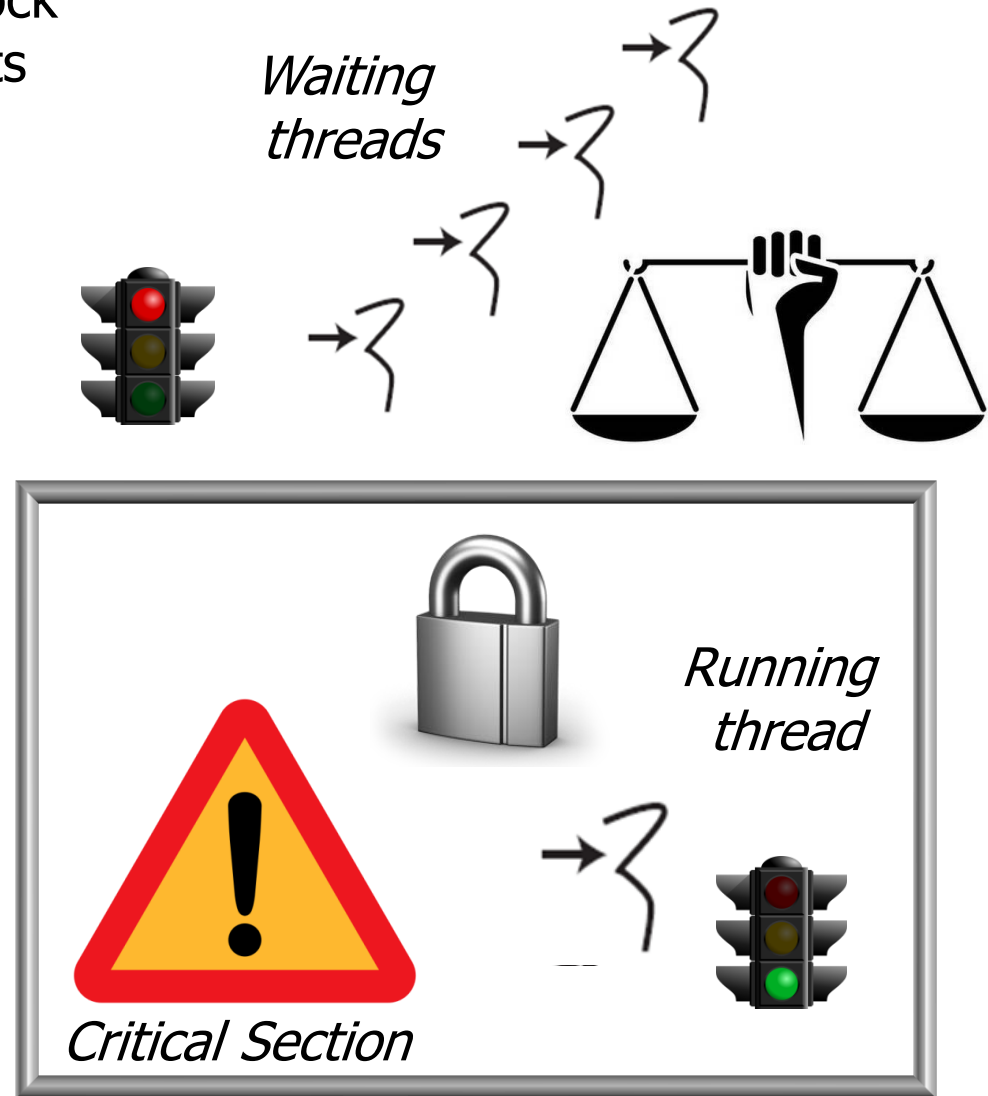
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Overview of Readers-Writer Locks

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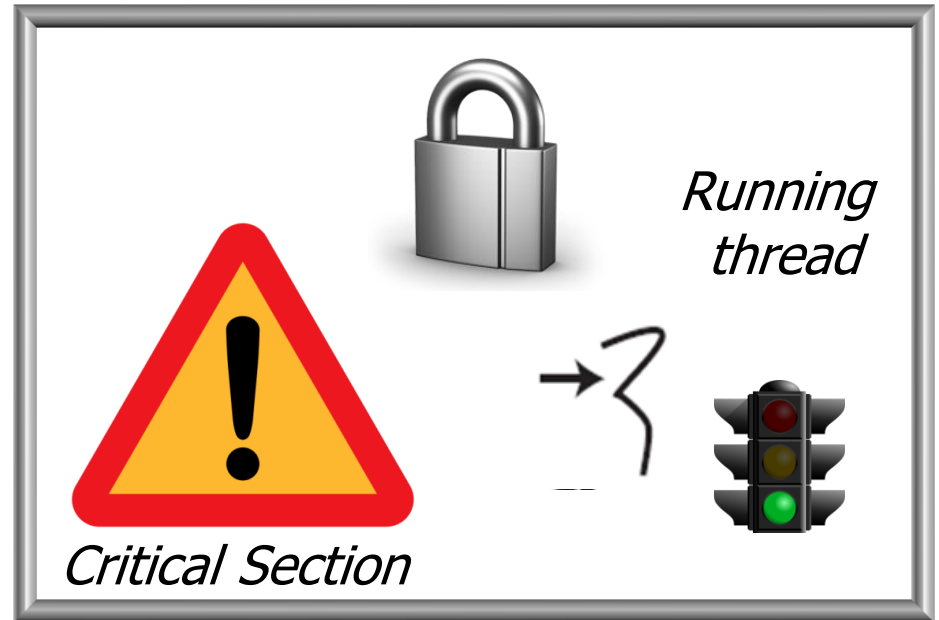
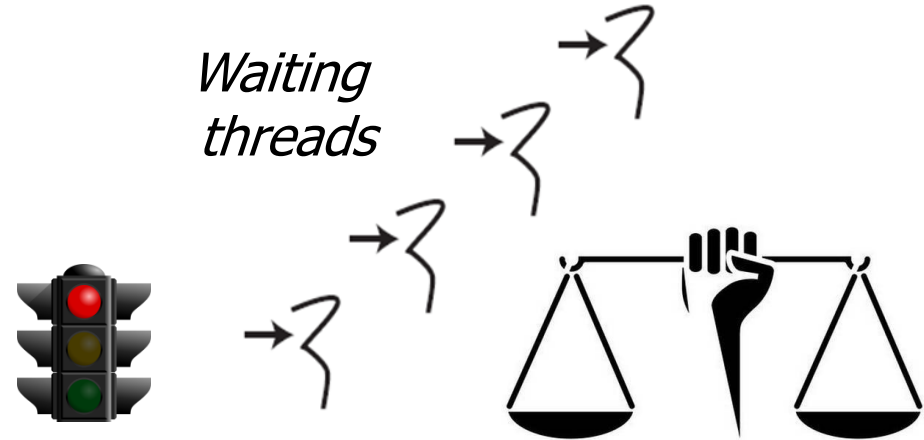
- Java synchronizers like `ReentrantLock` & synchronized methods/statements treat all waiting threads the same



See earlier lessons on "*Java ReentrantLock*" & "*Java Monitor Objects*"

Overview of Readers-Writer Locks

- Java synchronizers like ReentrantLock & synchronized methods/statements treat all waiting threads the same
- This behavior is fine if an object's methods perform a mix of reading & writing to its state



Overview of Readers-Writer Locks

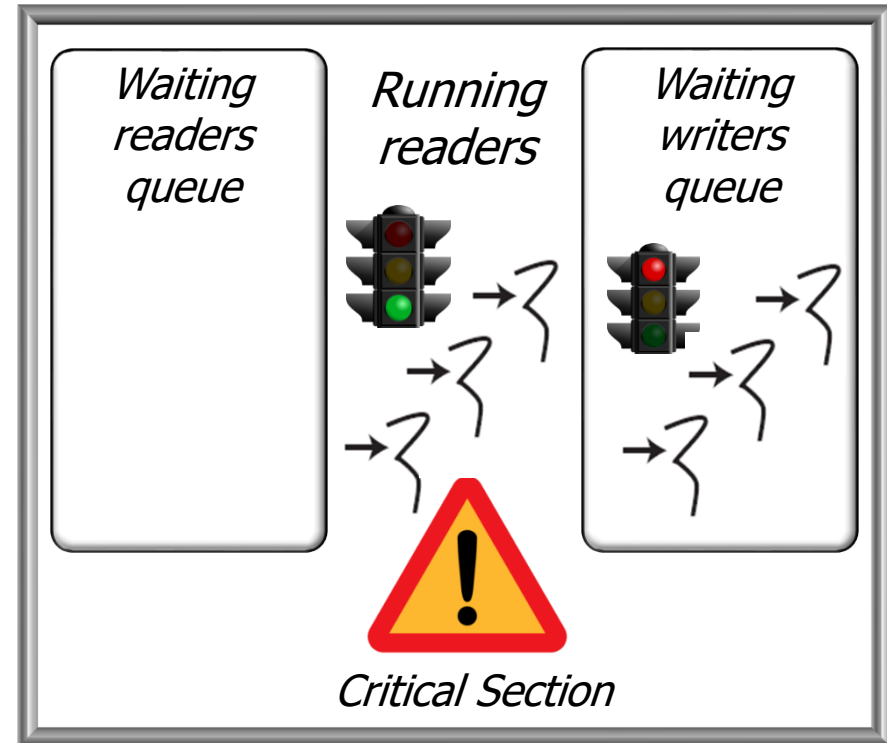
- Conversely, readers-writer locks are used to solve “readers-writer problems”



See en.wikipedia.org/wiki/Readers-writer_lock

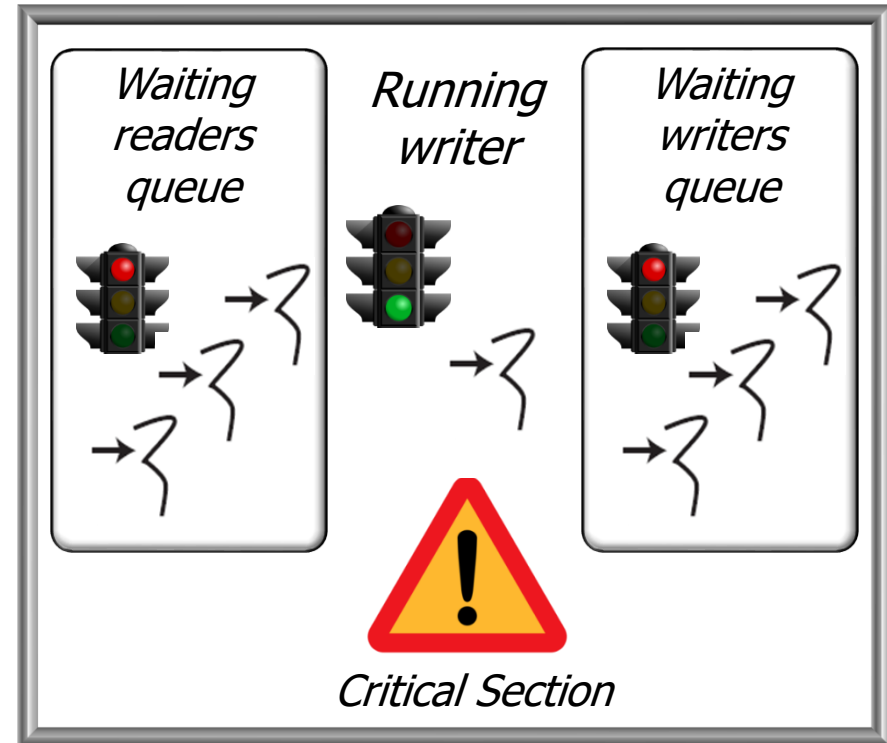
Overview of Readers-Writer Locks

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 - Multiple threads at a time need read access



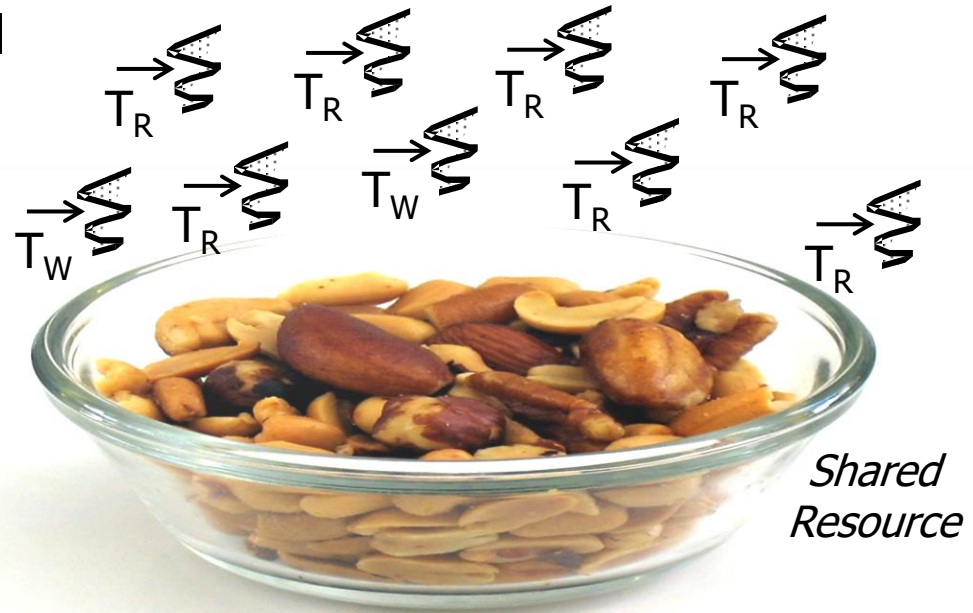
Overview of Readers-Writer Locks

- Conversely, readers-writer locks are used to solve “readers-writer problems”, e.g.
 - Multiple threads at a time need read access
 - Only one thread at a time can have exclusive write access



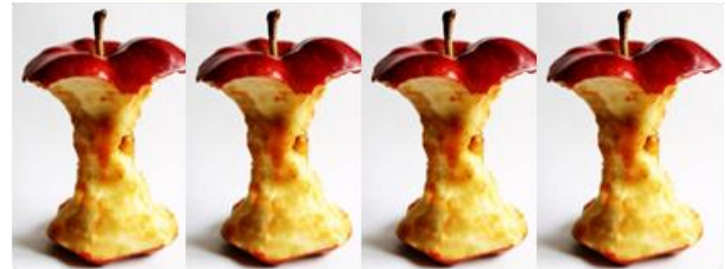
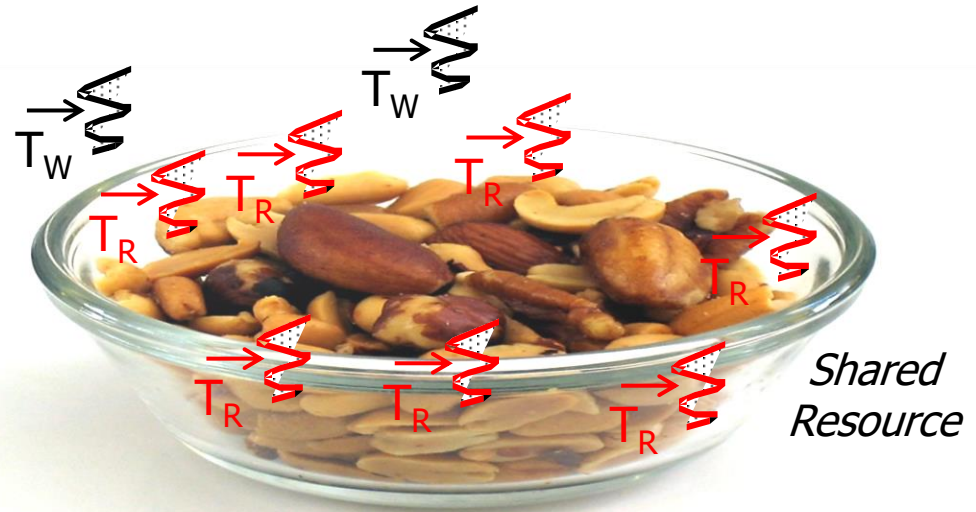
Overview of Readers-Writer Locks

- Readers-writer locks are most useful on multi-core systems where many threads need to access a shared resource at the same time



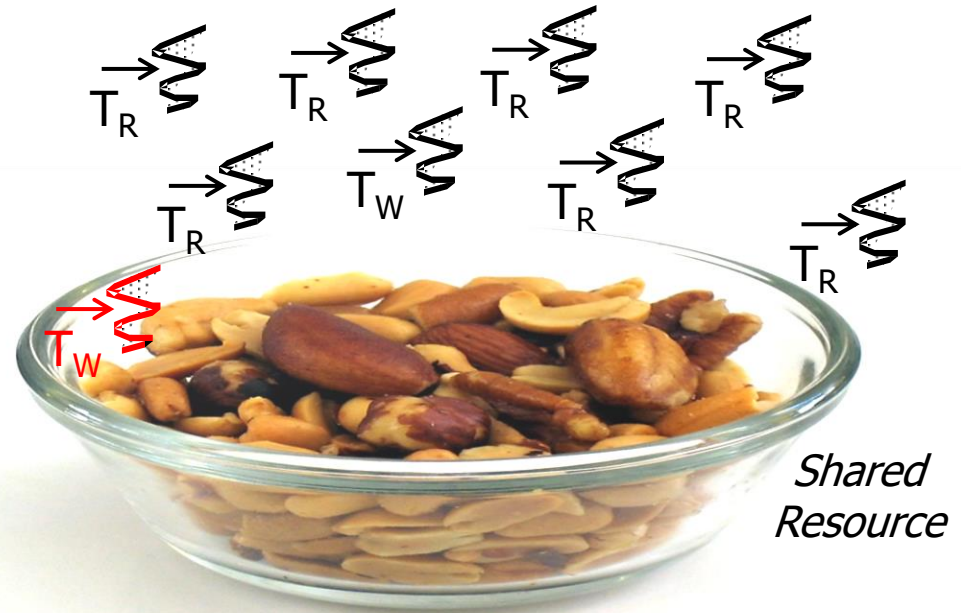
Overview of Readers-Writer Locks

- Readers-writer locks are most useful on multi-core systems where many threads need to access a shared resource at the same time, i.e.
- All threads that require read-only access can run concurrently



Overview of Readers-Writer Locks

- Readers-writer locks are most useful on multi-core systems where many threads need to access a shared resource at the same time, i.e.
 - All threads that require read-only access can run concurrently
 - However, only one thread at a time can have write access



Overview of Readers-Writer Locks

- Java supports two types of readers-writer locks



Overview of Readers-Writer Locks

- Java supports two types of readers-writer locks
 - ReentrantReadWriteLock
 - This is the “classic” way of supporting readers-writer locks in Java



Class ReentrantReadWriteLock

```
java.lang.Object
    java.util.concurrent.locks.ReentrantReadWriteLock
```

All Implemented Interfaces:

```
Serializable, ReadWriteLock
```

```
public class ReentrantReadWriteLock
    extends Object
    implements ReadWriteLock, Serializable
```

An implementation of ReadWriteLock supporting similar semantics to ReentrantLock.

This class has the following properties:

- **Acquisition order**

This class does not impose a reader or writer preference ordering for lock access. However, it does support an optional *fairness* policy.

Non-fair mode (default)

When constructed as non-fair (the default), the order of entry to the read and write lock is unspecified, subject to reentrancy constraints. A nonfair lock that is continuously contended may indefinitely postpone one or more reader or writer threads, but will normally have higher throughput than a fair lock.

Fair mode

When constructed as fair, threads contend for entry using an approximately arrival-order policy. When the currently held lock is released, either the longest-waiting single writer thread will be assigned the write lock, or if there is a group of reader threads waiting longer than all waiting writer threads, that group will be assigned the read lock.

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ReentrantReadWriteLock is “pessimistic”, i.e., it assumes contention may occur

Overview of Readers-Writer Locks

- Java supports two types of readers-writer locks
 - ReentrantReadWriteLock
 - StampedLock
 - This is the newer & better way of supporting readers-writer locks in Java 8+



Class StampedLock

```
java.lang.Object  
    java.util.concurrent.locks.StampedLock
```

All Implemented Interfaces:

```
Serializable
```

```
public class StampedLock  
    extends Object  
    implements Serializable
```

A capability-based lock with three modes for controlling read/write access. The state of a StampedLock consists of a version and mode. Lock acquisition methods return a stamp that represents and controls access with respect to a lock state; "try" versions of these methods may instead return the special value zero to represent failure to acquire access. Lock release and conversion methods require stamps as arguments, and fail if they do not match the state of the lock. The three modes are:

- **Writing.** Method `writeLock()` possibly blocks waiting for exclusive access, returning a stamp that can be used in method `unlockWrite(long)` to release the lock. Untimed and timed versions of `tryWriteLock` are also provided. When the lock is held in write mode, no read locks may be obtained, and all optimistic read validations will fail.
- **Reading.** Method `readLock()` possibly blocks waiting for non-exclusive access, returning a stamp that can be used in method `unlockRead(long)` to release the lock. Untimed and timed versions of `tryReadLock` are also provided.
- **Optimistic Reading.** Method `tryOptimisticRead()` returns a non-zero stamp only if the lock is not currently held in write mode. Method `validate(long)` returns true if the lock has not been acquired in write mode since obtaining a given stamp. This mode can be thought of as an extremely weak version of a read-lock, that can be broken by a writer at any time. The use of optimistic mode for short read-only code segments often reduces contention and improves throughput. However, its use is inherently fragile. Optimistic read sections should only read fields and hold them in local variables for later use after validation. Fields read while in optimistic mode may be wildly inconsistent, so

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

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StampedLock is more "optimistic", i.e., it can assume contention won't occur

Human Known Use of Readers-Writer Locks

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- A human known use of a readers-writer locking protocol is the process for periodic updates of material on websites that change infrequently

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 - But only one writer can access the catalog when it's updated annually

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