Java Semaphore

Usage Considerations

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Learning Objectives in this Part of the Module

• Understand the concept of semaphores
• Be aware of the two types of semaphores
• Note a human known use of semaphores
• Recognize the structure & functionality of Java Semaphore
• Know the key methods defined by the Java Semaphore class
• Learn how Java semaphores enable multiple threads to
  • Mediate access to a limited number of shared resources
  • Coordinate the order in which operations occur
• Appreciate Java Semaphore usage considerations
Java Semaphore
Usage Considerations
Java Semaphore Usage Considerations

• Semaphore is more flexible than the more simple Java synchronizers

Synchronized Statements

Another way to create synchronized code is with synchronized statements. Unlike synchronized methods, synchronized statements must specify the object that provides the intrinsic lock:

```java
public void addName(String name) {
    synchronized(this) {
        lastName = name;
        nameCount++;
    }
    nameList.add(name);
}
```

Class ReentrantLock

java.lang.Object
    java.util.concurrent.locks.ReentrantLock

All Implemented Interfaces:
    Serializable, Lock
Java Semaphore Usage Considerations

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• Can atomically acquire & release multiple permits with 1 operation
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- Its acquire() & release() methods need not be fully bracketed

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  - Can atomically acquire & release multiple permits with 1 operation
  - Its acquire() & release() methods need not be fully bracketed

Naturally, this flexibility comes at some additional cost in performance
When a semaphore is used for a resource pool, it tracks the # of free resources
Java Semaphore Usage Considerations

• When a semaphore is used for a resource pool, it tracks the # of free resources
• However, it does not track *which* resources are free
When a semaphore is used for a resource pool, it tracks the number of free resources. However, it does not track which resources are free. Other mechanisms may be needed to select a particular free resource. For example, a List, HashMap, etc. 

See docs.oracle.com/javase/8/docs/technote guides/collections
When a semaphore is used for a resource pool, it tracks the number of free resources.

- However, it does not track which resources are free.
- Other mechanisms may be needed to select a particular free resource.
  - e.g., a List, HashMap, etc.

These mechanisms require synchronizers to ensure thread-safety.
Java Semaphore Usage Considerations

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Java Semaphore Usage Considerations

• Semaphores can be tedious & error-prone to program due to common traps & pitfalls, e.g.
  • Holding a semaphore for a long time without needing it

Semaphore semaphore =
    new Semaphore(1);

void someMethod()
{
    semaphore.acquire();

    try {
        for (;;)
        {
            // Do something not involving semaphore
        }
    } finally {
        semaphore.release();
    }
}

Other thread(s) won’t be able to acquire the semaphore in a timely manner
Semaphores can be tedious & error-prone to program due to common traps & pitfalls, e.g.

- Holding a semaphore for a long time without needing it
- Releasing the semaphore more times than needed

Java Semaphore Usage Considerations

```java
Semaphore semaphore = new Semaphore(1);

void someMethod() {
    semaphore.acquire();  // 0
    ...
    semaphore.release();
    semaphore.release();
    semaphore.release();
}
```

These extra calls to release() will allow too many threads to acquire the semaphore.
Java Semaphore Usage Considerations

- Semaphores can be tedious & error-prone to program due to common traps & pitfalls, e.g.
  - Holding a semaphore for a long time without needing it
  - Releasing the semaphore more times than needed
  - Acquiring a semaphore & forgetting to release it

```
Semaphore semaphore = new Semaphore(1);

void someMethod() {
    semaphore.acquire();

    ... // Critical section
    return;
}
```

*The semaphore may be locked indefinitely!*
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```java
Semaphore semaphore = new Semaphore(1);

void someMethod() {
    semaphore.acquire();
    try {
        ... // Critical section
        return;
    } finally {
        semaphore.release();
    }
}
```

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
Java Semaphore Usage Considerations

- Semaphores are rather limited synchronizers that don’t scale to complex coordination use cases
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Java ConditionObjects may be a better choice for complex coordination use-cases.

See upcoming lessons on "Java ConditionObject"
End of Java Semaphore
Usage Considerations