Structure & Functionality of Java ConditionObject

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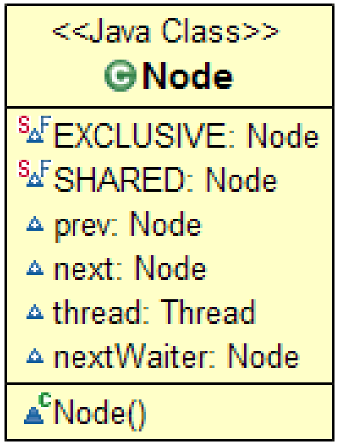
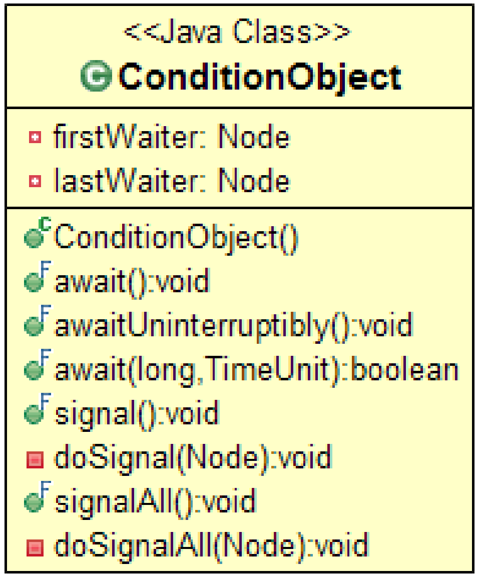
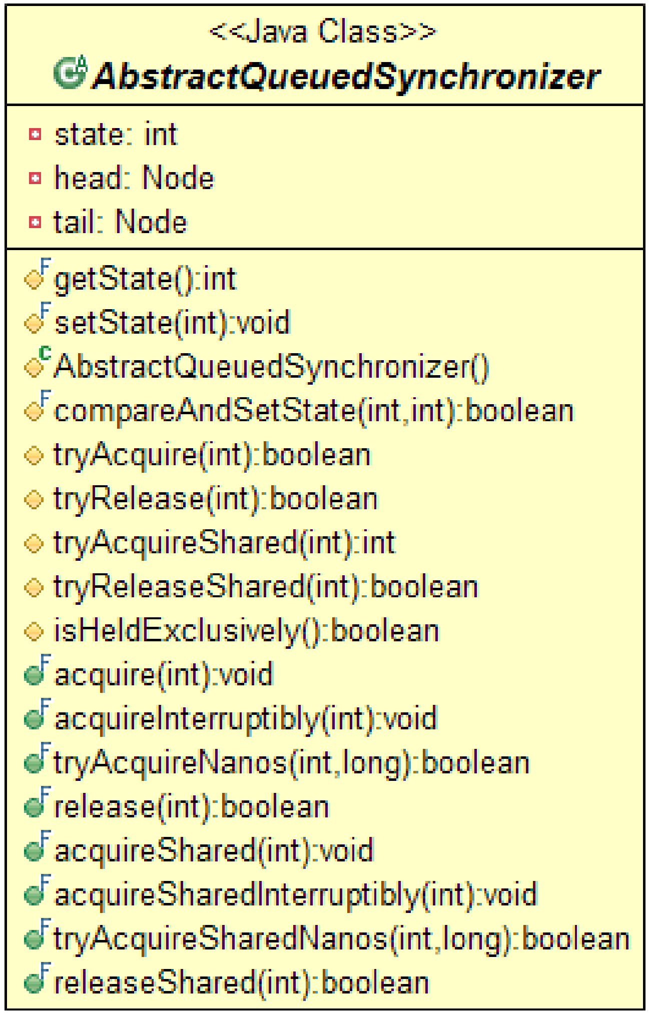
Learning Objectives in this Part of the Lesson

- Understand what condition variables are
- Note a human known use of condition variables
- Know what pattern they implement
- Recognize common use cases where condition variables are applied
- Recognize the structure & functionality of Java ConditionObject







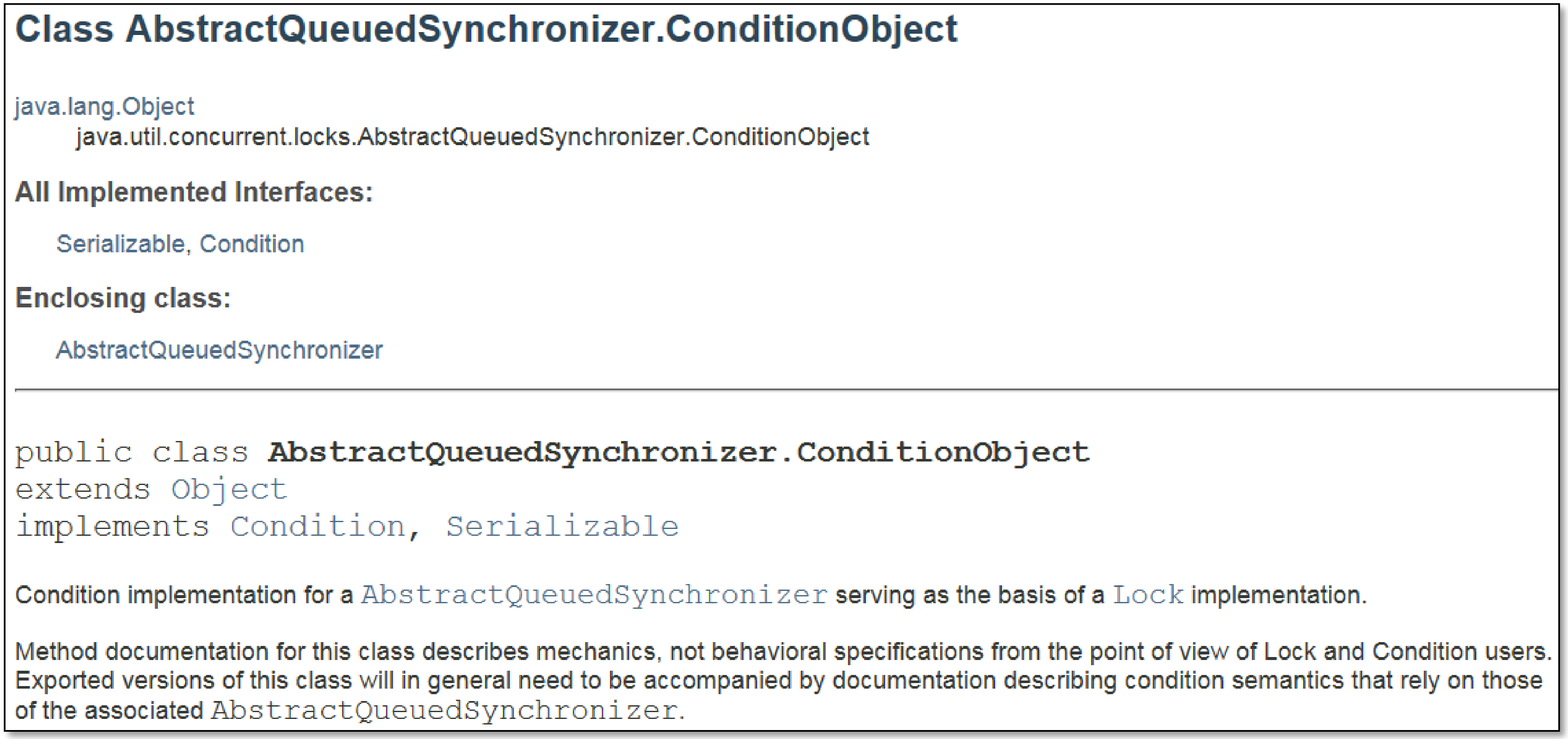
<<Java Class>>
AbstractQueuedSynchronizer
state: int
head: Node
tail: Node
getState():int
setState(int):void
AbstractQueuedSynchronizer()
compareAndSetState(int,int):boolean
tryAcquire(int):boolean
tryRelease(int):boolean
tryAcquireShared(int):int
tryReleaseShared(int):boolean
isHeldExclusively():boolean
acquire(int):void
acquireInterruptibly(int):void
tryAcquireNanos(int,long):boolean
release(int):boolean
acquireShared(int):void
acquireSharedInterruptibly(int):void
tryAcquireSharedNanos(int,long):boolean
releaseShared(int):boolean

Overview of Java ConditionObject

Overview of Java ConditionObject

- ConditionObject provides the condition variable abstraction

```
public class ConditionObject
             implements Condition,
             java.io.Serializable {
  ...
```



Class AbstractQueuedSynchronizer.ConditionObject

java.lang.Object
    java.util.concurrent.locks.AbstractQueuedSynchronizer.ConditionObject

All Implemented Interfaces:

Serializable, Condition

Enclosing class:

AbstractQueuedSynchronizer

```
public class AbstractQueuedSynchronizer.ConditionObject
extends Object
implements Condition, Serializable
```

Condition implementation for a `AbstractQueuedSynchronizer` serving as the basis of a `Lock` implementation.

Method documentation for this class describes mechanics, not behavioral specifications from the point of view of Lock and Condition users. Exported versions of this class will in general need to be accompanied by documentation describing condition semantics that rely on those of the associated `AbstractQueuedSynchronizer`.

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

Overview of Java ConditionObject

- ConditionObject provides the condition variable abstraction
  - Implements Condition interface

```
public class ConditionObject
                 implements Condition,
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  ...
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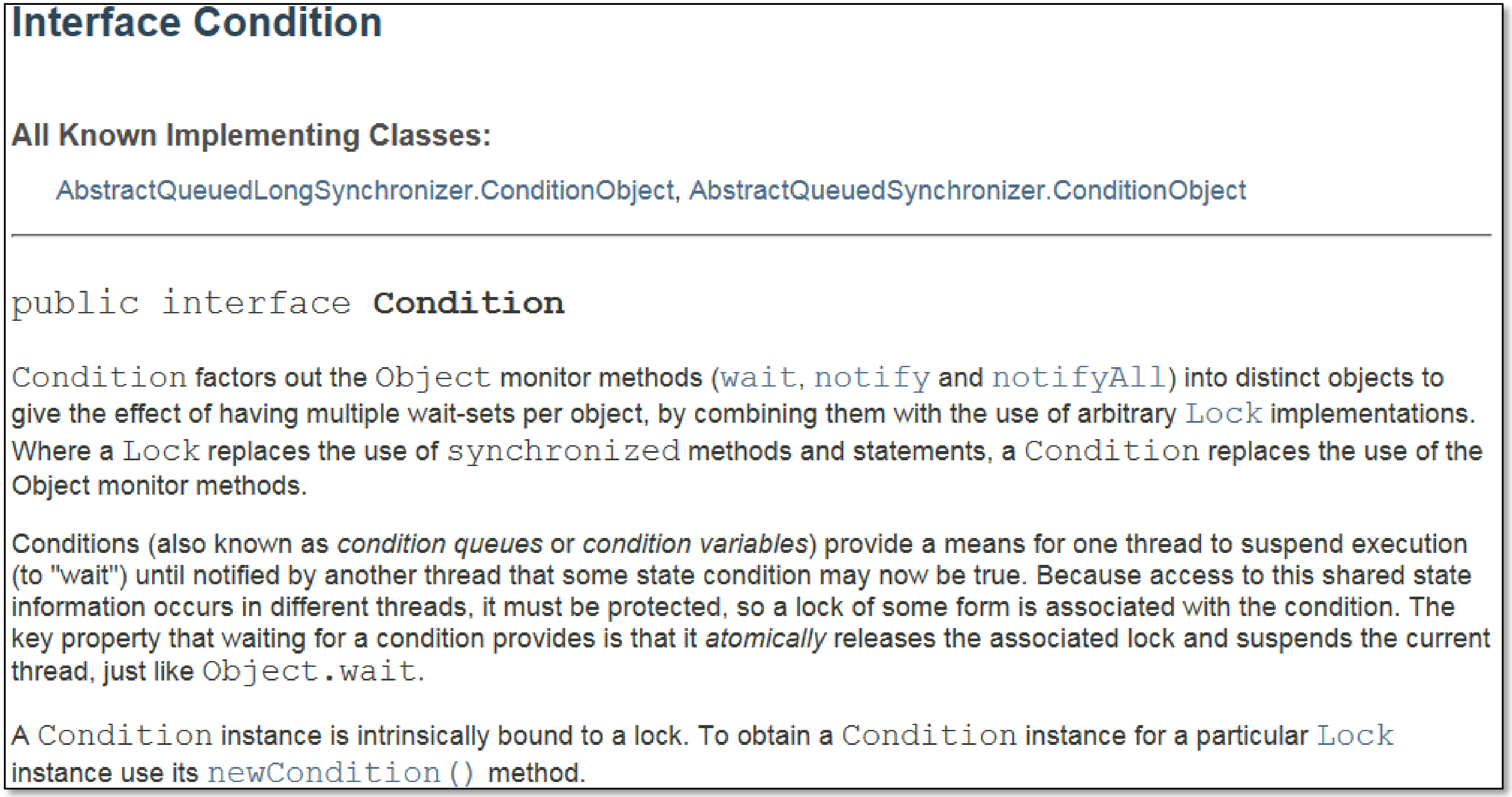


Interface Condition

All Known Implementing Classes:

AbstractQueuedLongSynchronizer.ConditionObject, AbstractQueuedSynchronizer.ConditionObject

public interface **Condition**

`Condition` factors out the `Object` monitor methods (`wait`, `notify` and `notifyAll`) into distinct objects to give the effect of having multiple wait-sets per object, by combining them with the use of arbitrary `Lock` implementations. Where a `Lock` replaces the use of `synchronized` methods and statements, a `Condition` replaces the use of the Object monitor methods.

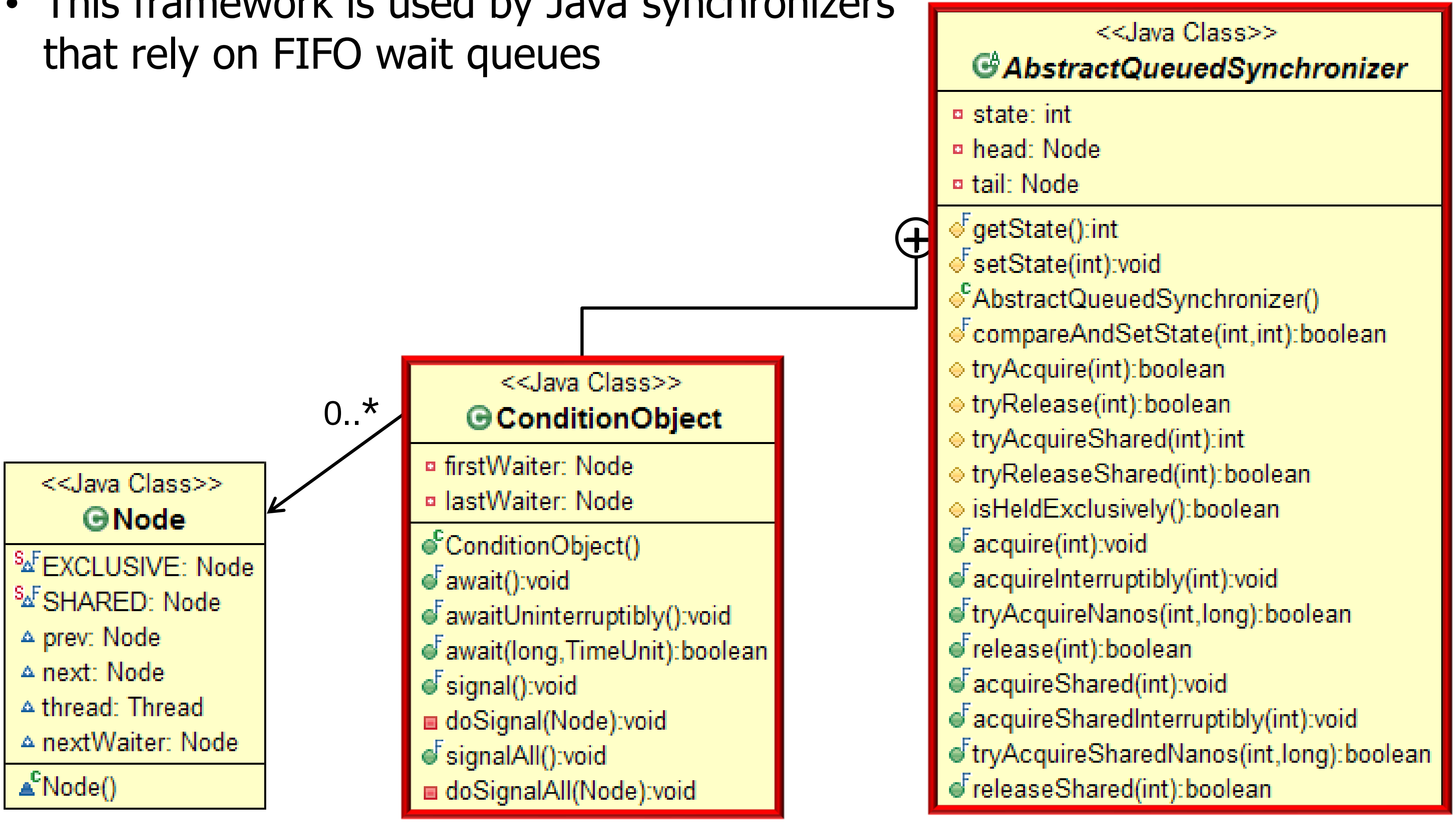
Conditions (also known as *condition queues* or *condition variables*) provide a means for one thread to suspend execution (to "wait") until notified by another thread that some state condition may now be true. Because access to this shared state information occurs in different threads, it must be protected, so a lock of some form is associated with the condition. The key property that waiting for a condition provides is that it *atomically* releases the associated lock and suspends the current thread, just like `Object.wait`.

A `Condition` instance is intrinsically bound to a lock. To obtain a `Condition` instance for a particular `Lock` instance use its `newCondition()` method.

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

Overview of Java ConditionObject

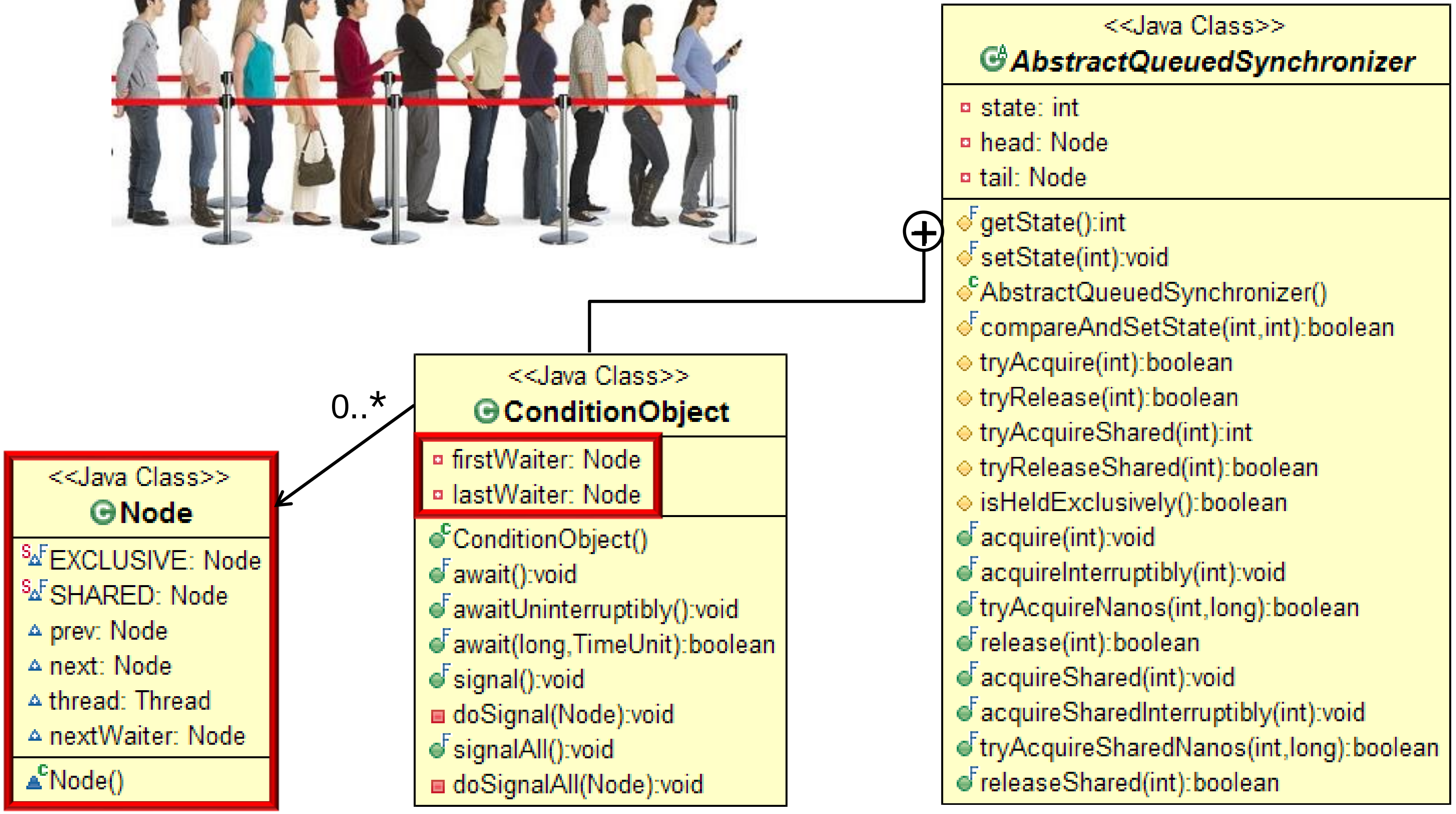
- ConditionObject is nested within the AbstractQueuedSynchronizer class
  - This framework is used by Java synchronizers that rely on FIFO wait queues



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

Overview of Java ConditionObject

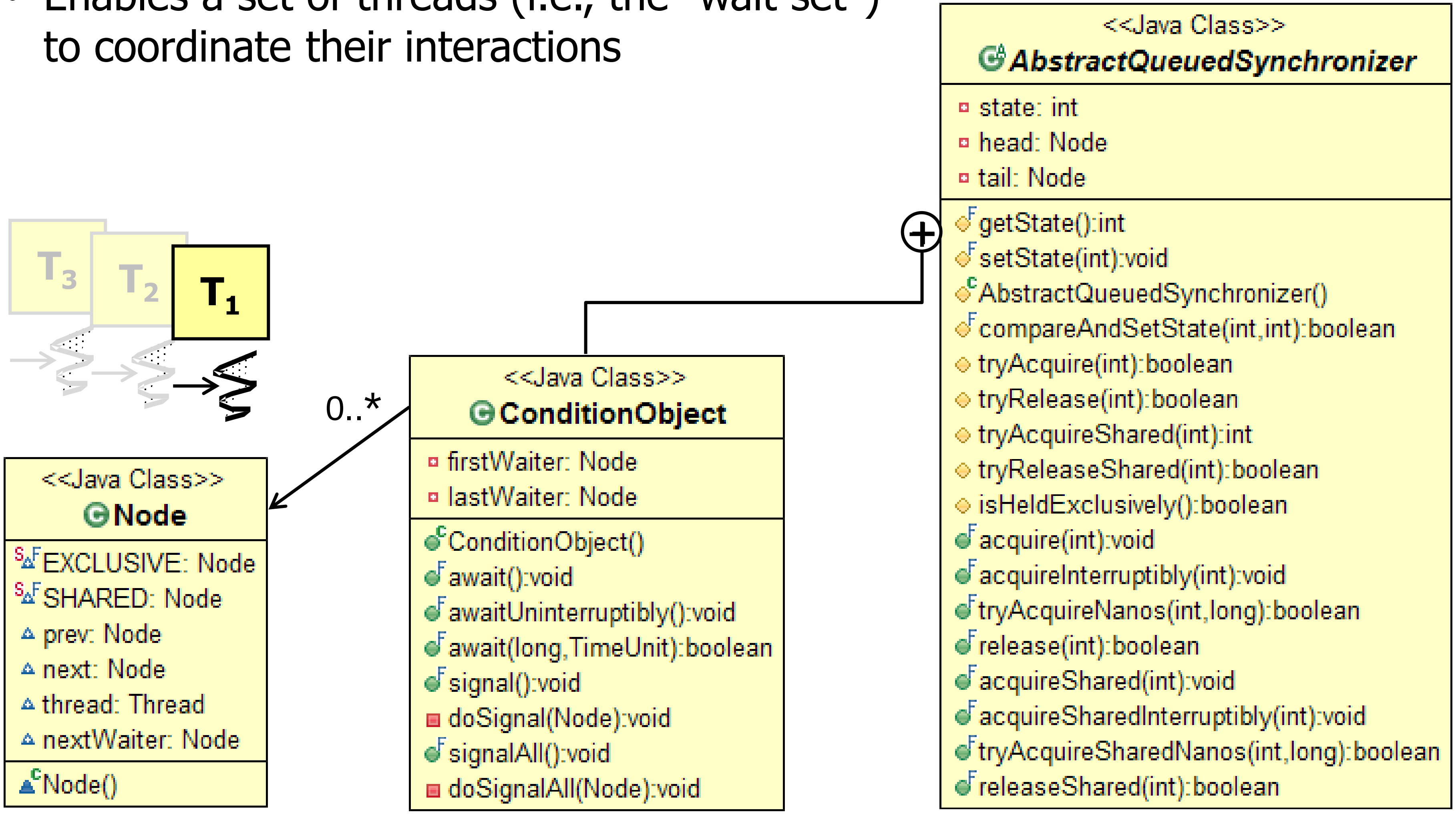
- A ConditionObject provides a "wait queue" of nodes



See gee.cs.oswego.edu/dl/papers/aqs.pdf

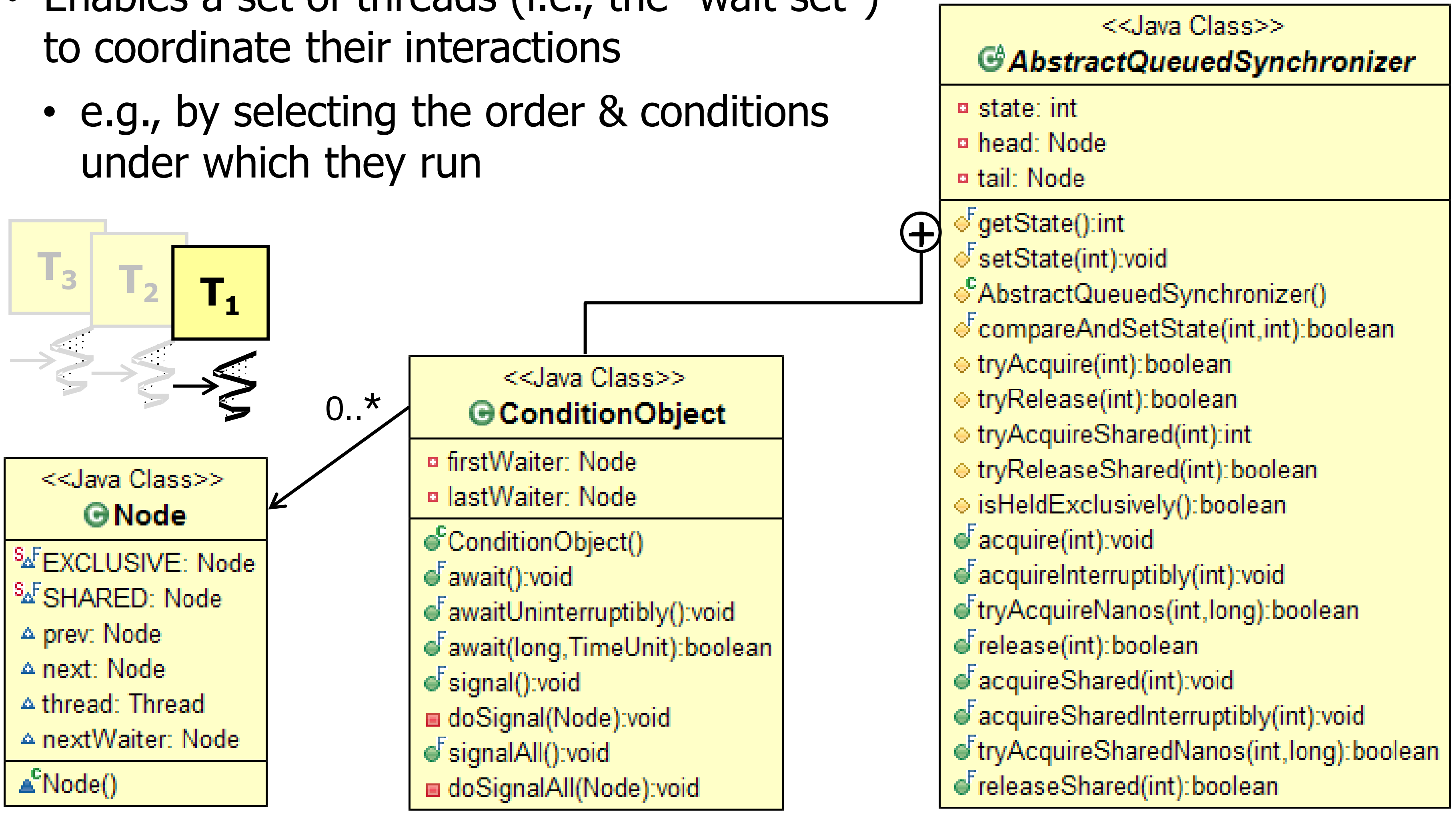
Overview of Java ConditionObject

- A ConditionObject provides a "wait queue" of nodes
  - Enables a set of threads (i.e., the "wait set") to coordinate their interactions



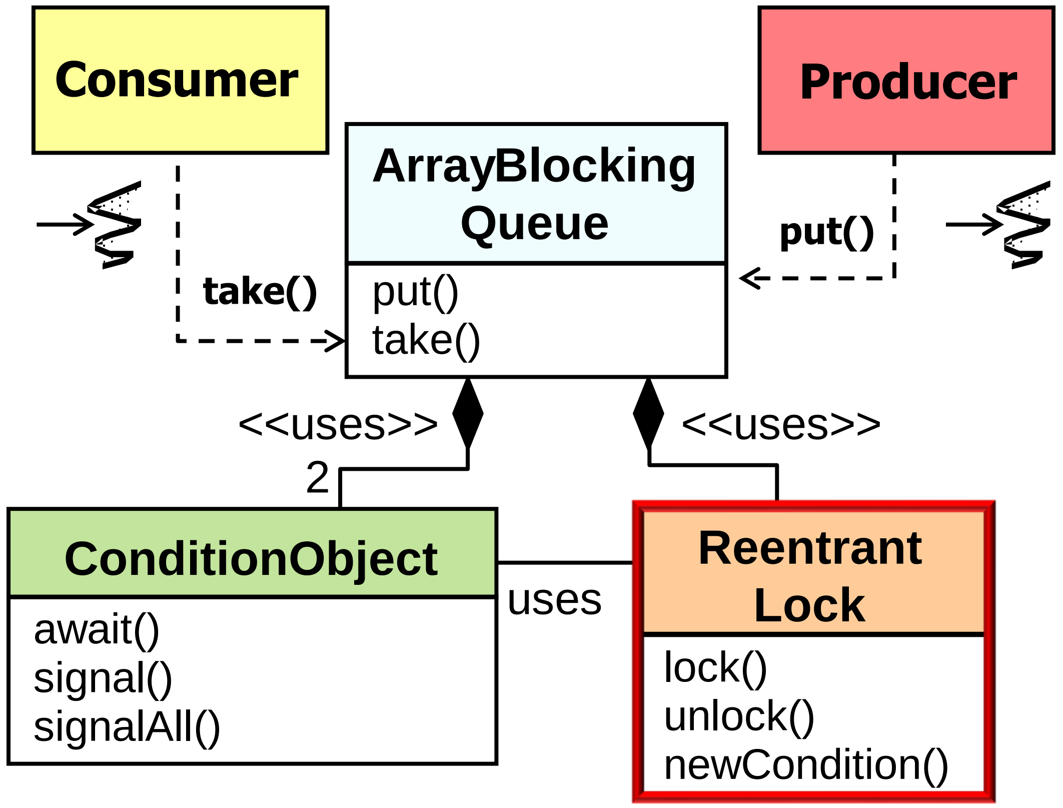
Overview of Java ConditionObject

- A ConditionObject provides a "wait queue" of nodes
  - Enables a set of threads (i.e., the "wait set") to coordinate their interactions
    - e.g., by selecting the order & conditions under which they run



Overview of Java ConditionObject

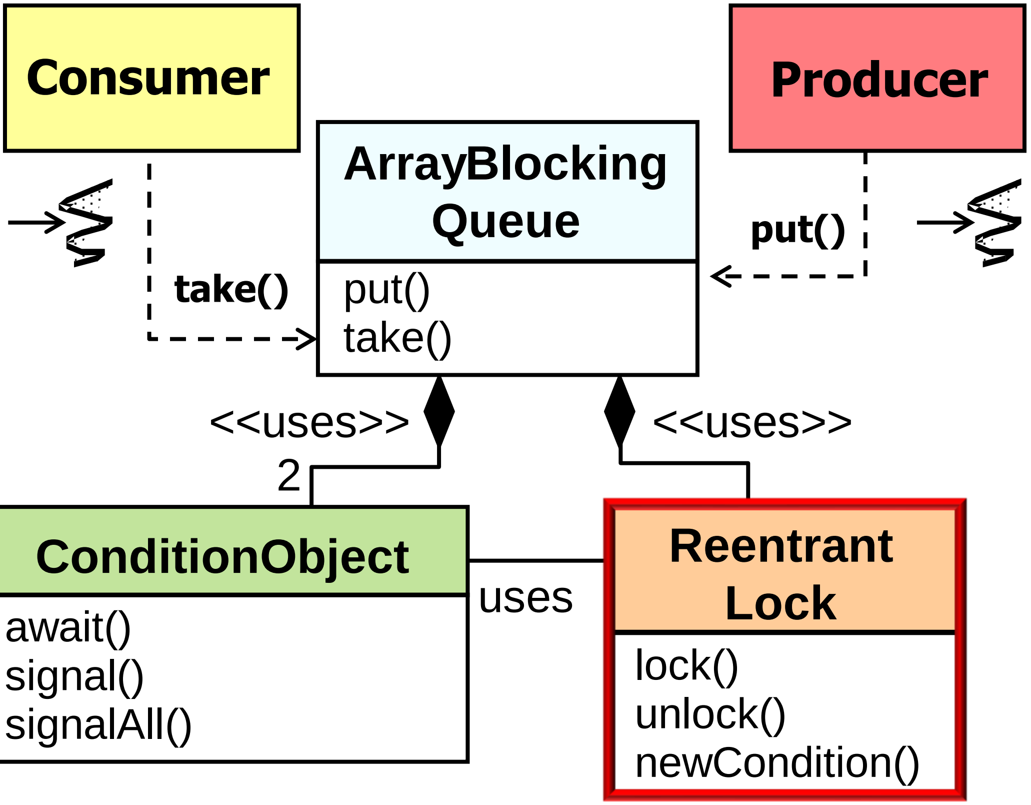
- A ConditionObject is *always* used with a lock



See earlier lessons on "*Java ReentrantLock*"

Overview of Java ConditionObject

- A ConditionObject is *always* used with a lock
  - This lock protects shared state in a condition expression from concurrent manipulation



See screenrant.com/lord-rings-eowyn-witch-king-kill-reason-merry

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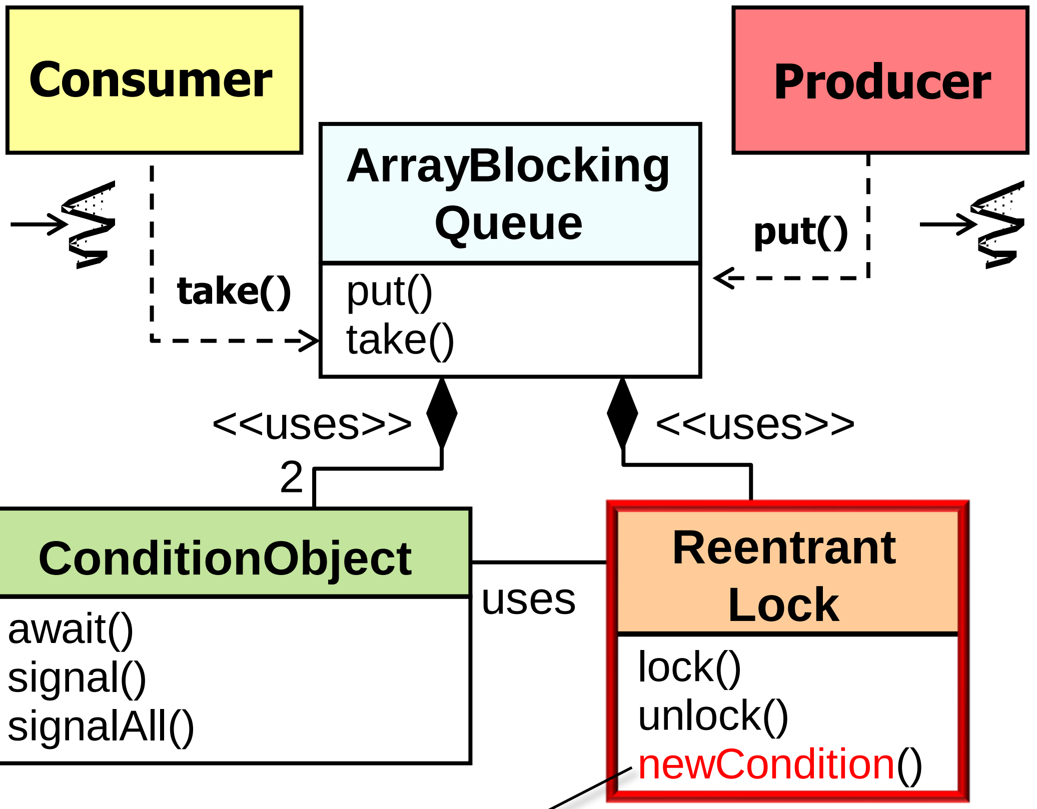
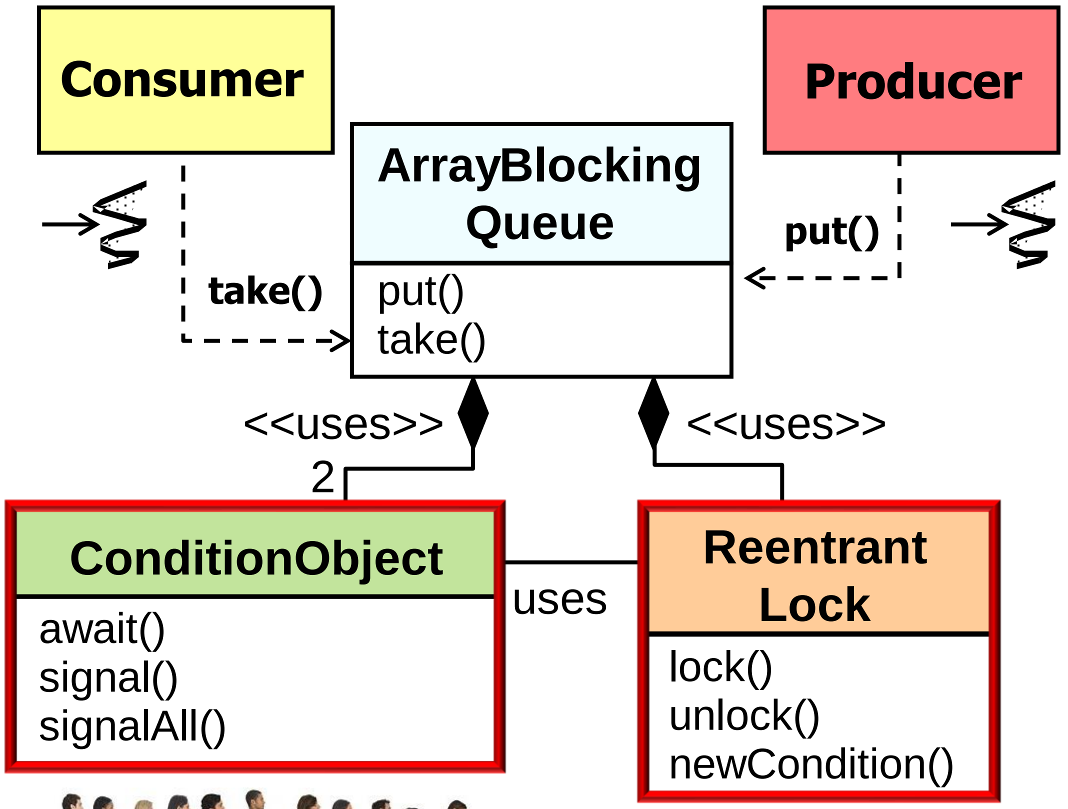


newCondition() is a factory method that returns a ConditionObject that can be used with this lock

See docs.oracle.com/javase/8/docs/api/java/util/concurrent/locks/ReentrantLock.html#newCondition

Overview of Java ConditionObject

- Both ReentrantLock & ConditionObject have internal queues



Overview of Java ConditionObject

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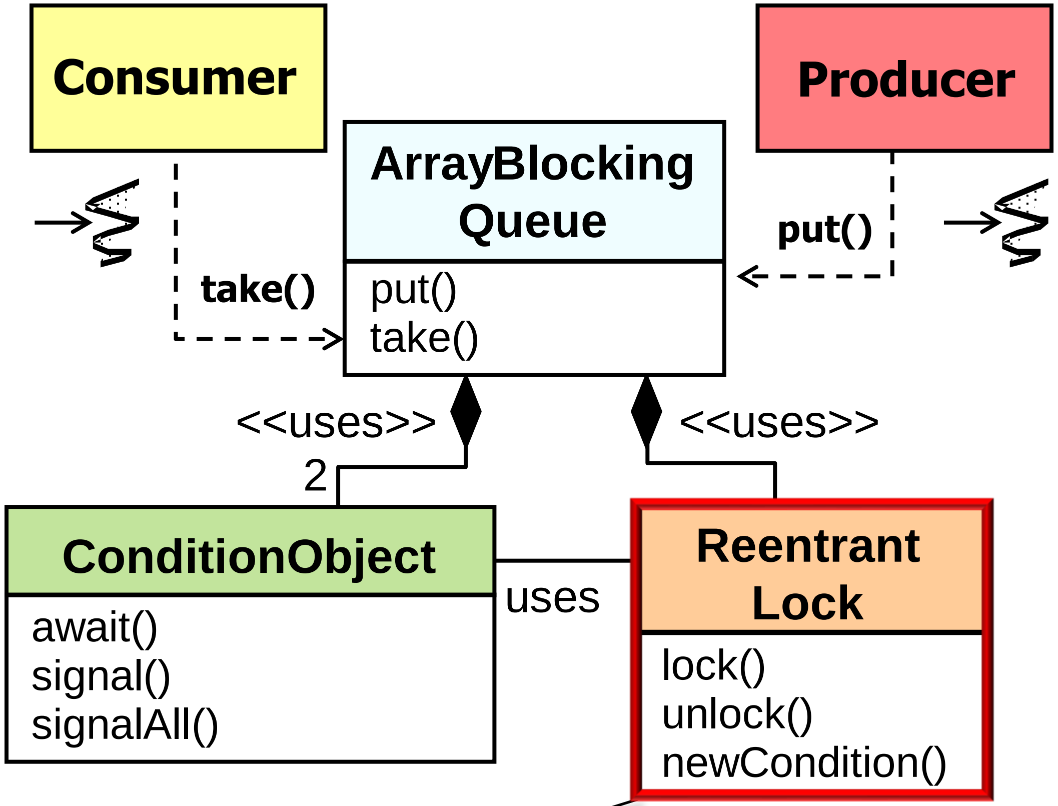
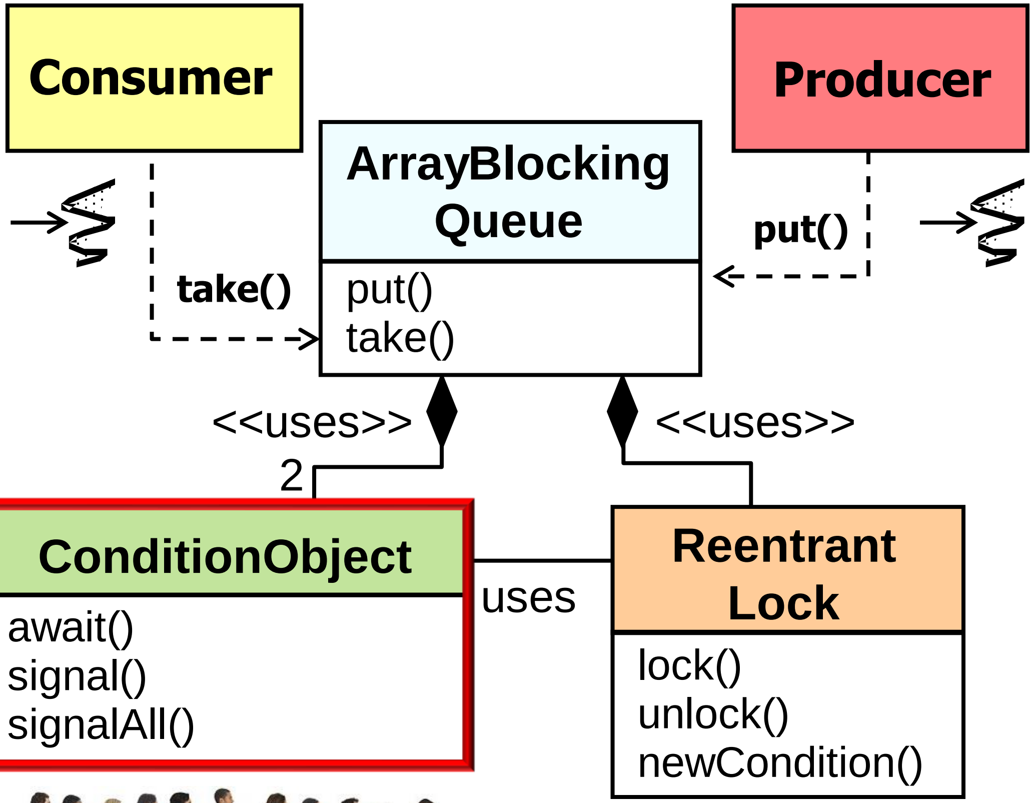


Queues up threads that are waiting to acquire the lock

Overview of Java ConditionObject

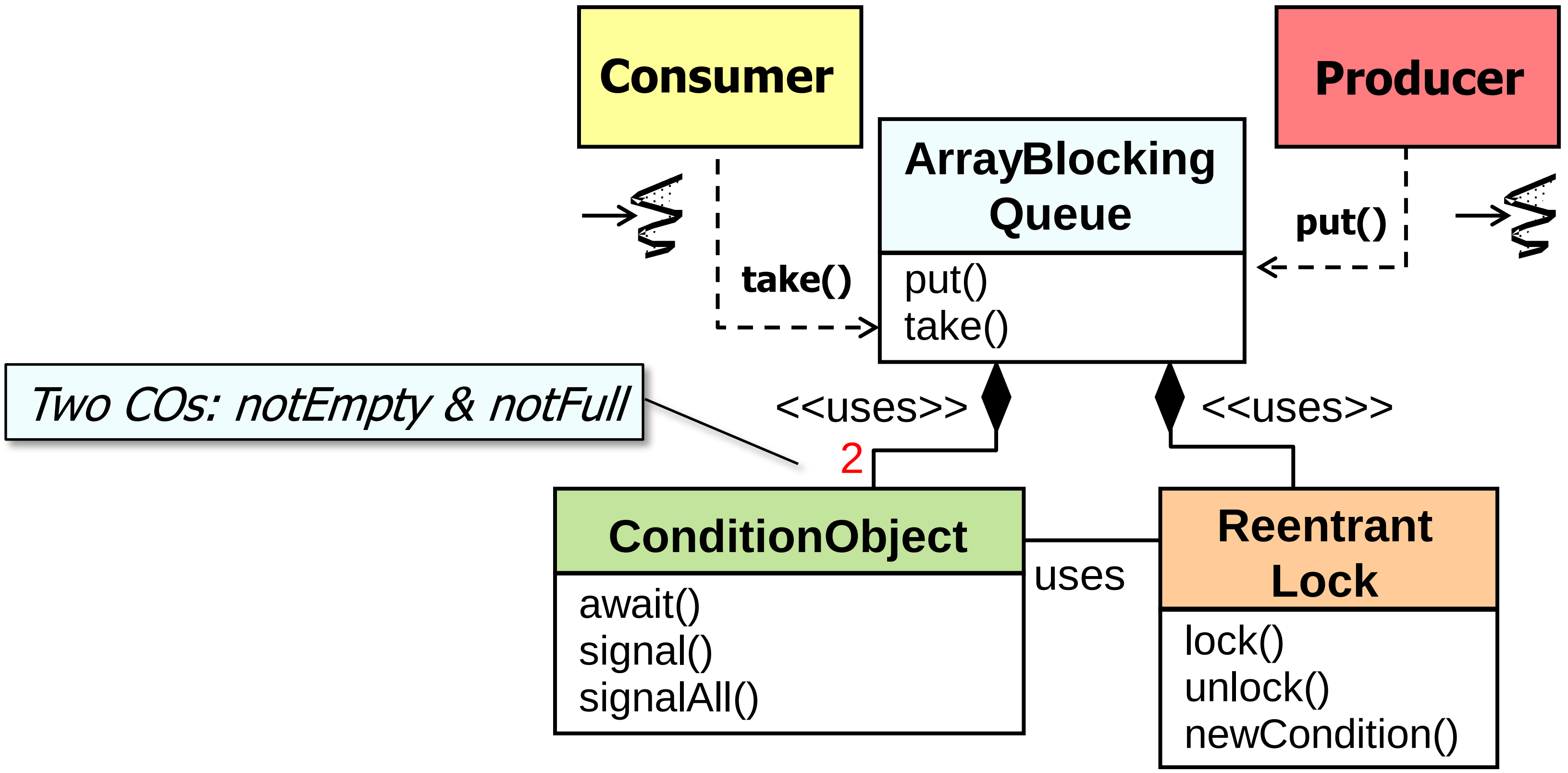
- Both ReentrantLock & ConditionObject have internal queues



Queues up threads waiting for some condition(s) to become true

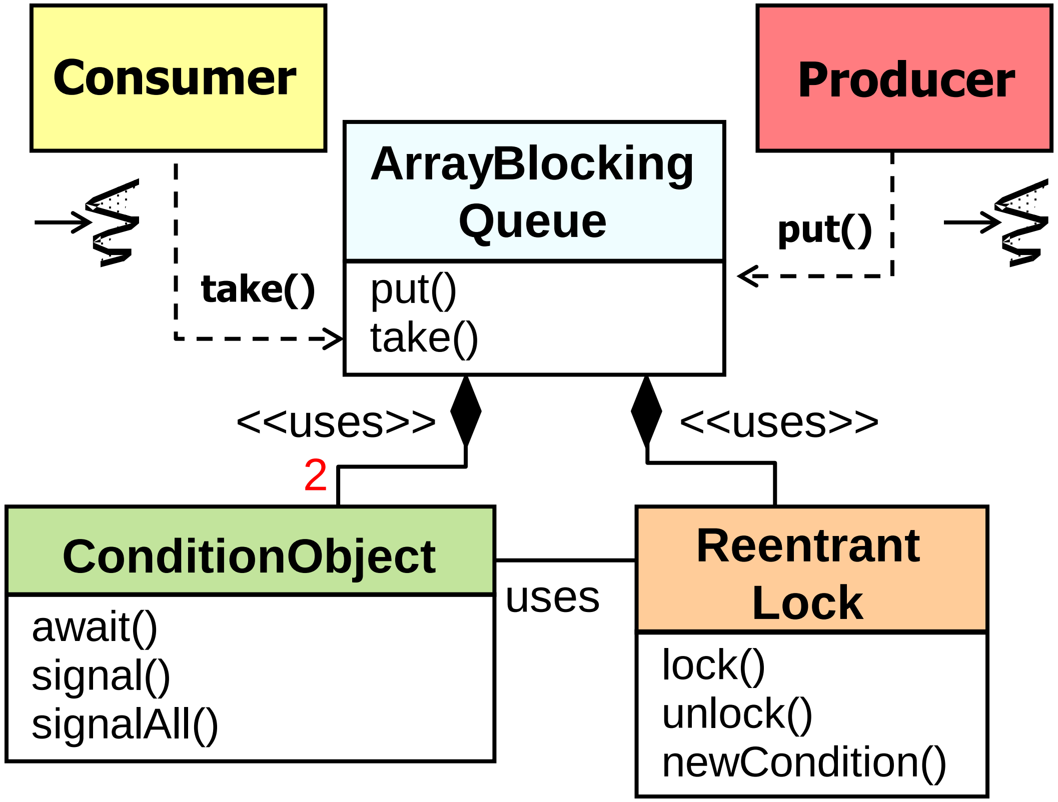
Overview of Java ConditionObject

- User-defined Java objects can have multiple ConditionObjects (COs)



Overview of Java ConditionObject

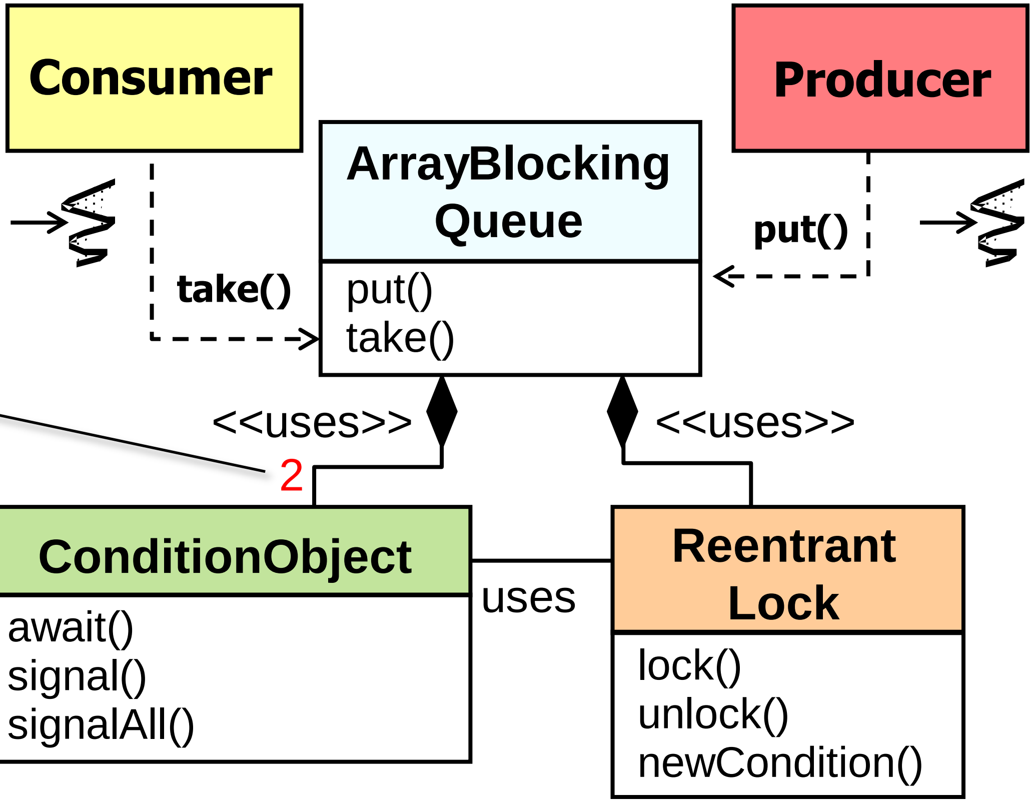
- User-defined Java objects can have multiple ConditionObjects (COs)
  - Multiple COs enable more sophisticated & efficient ways to coordinate multiple threads



Overview of Java ConditionObject

- User-defined Java objects can have multiple ConditionObjects (COs)
  - Multiple COs enable more sophisticated & efficient ways to coordinate multiple threads

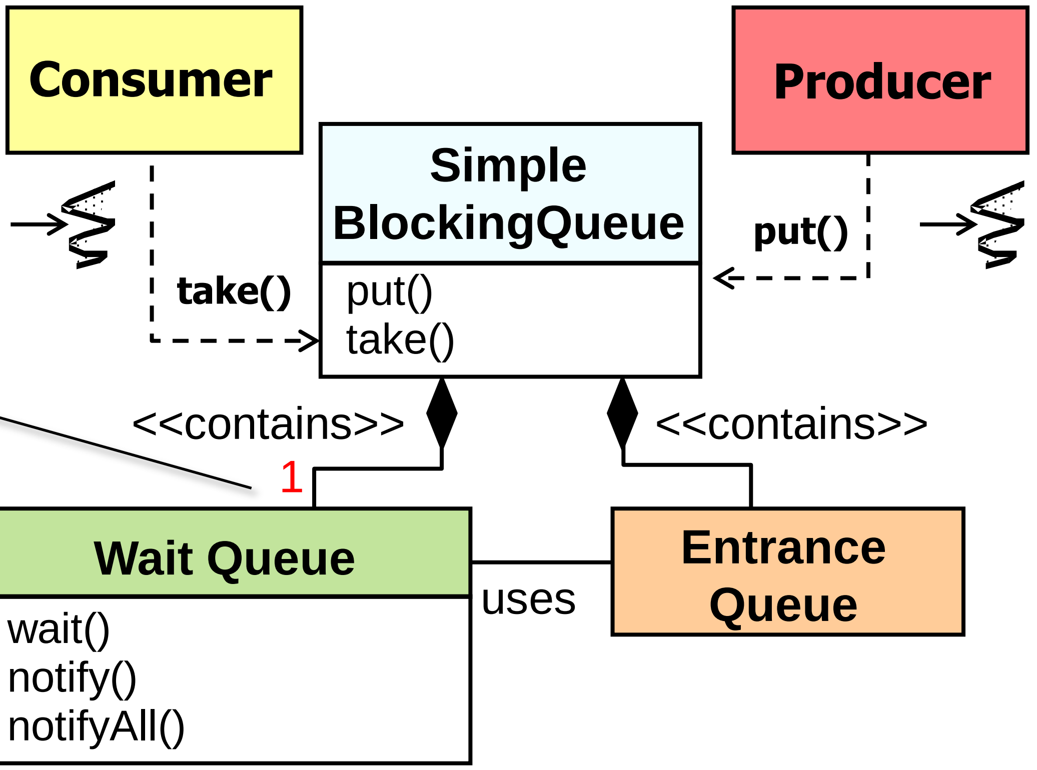
e.g., multiple wait-sets per app object can share a lock & are notified on different conditions



See stackoverflow.com/questions/18490636/condition-give-the-effect-of-having-multiple-wait-sets-per-object

Overview of Java ConditionObject

- In contrast, Java's built-in monitor objects only support *one* monitor condition

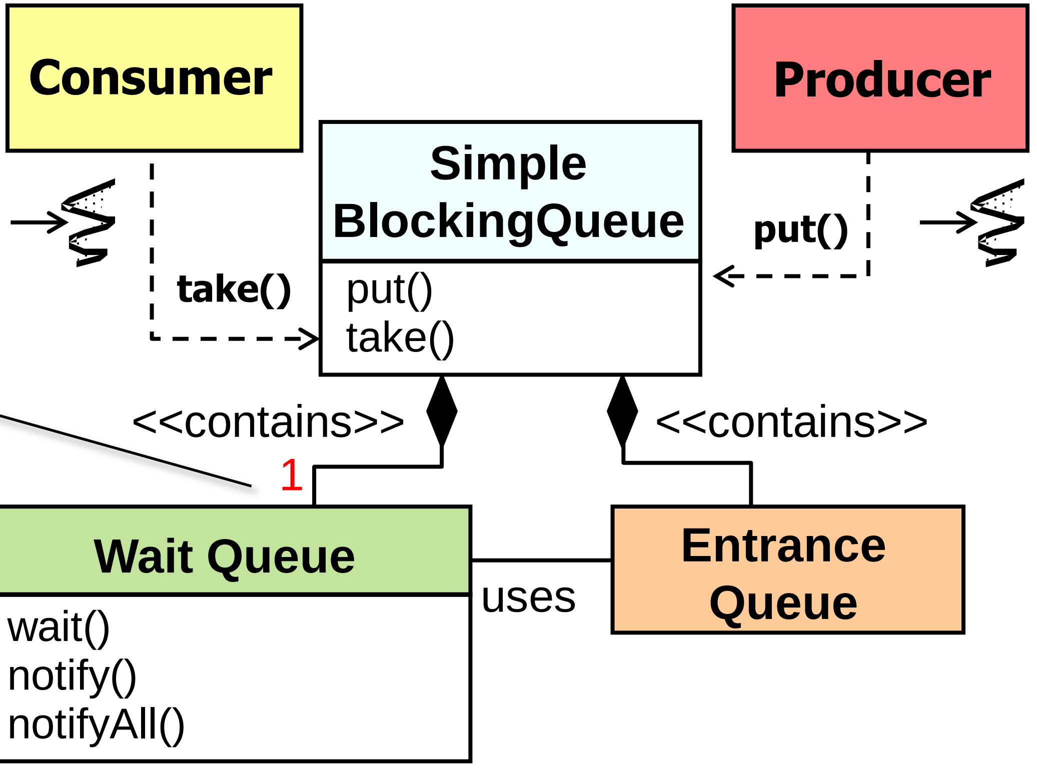


i.e., there's just a single "wait queue"

See github.com/douglascraigschmidt/LiveLessons/tree/master/SimpleBlockingQueue

Overview of Java ConditionObject

- In contrast, Java's built-in monitor objects only support *one* monitor condition

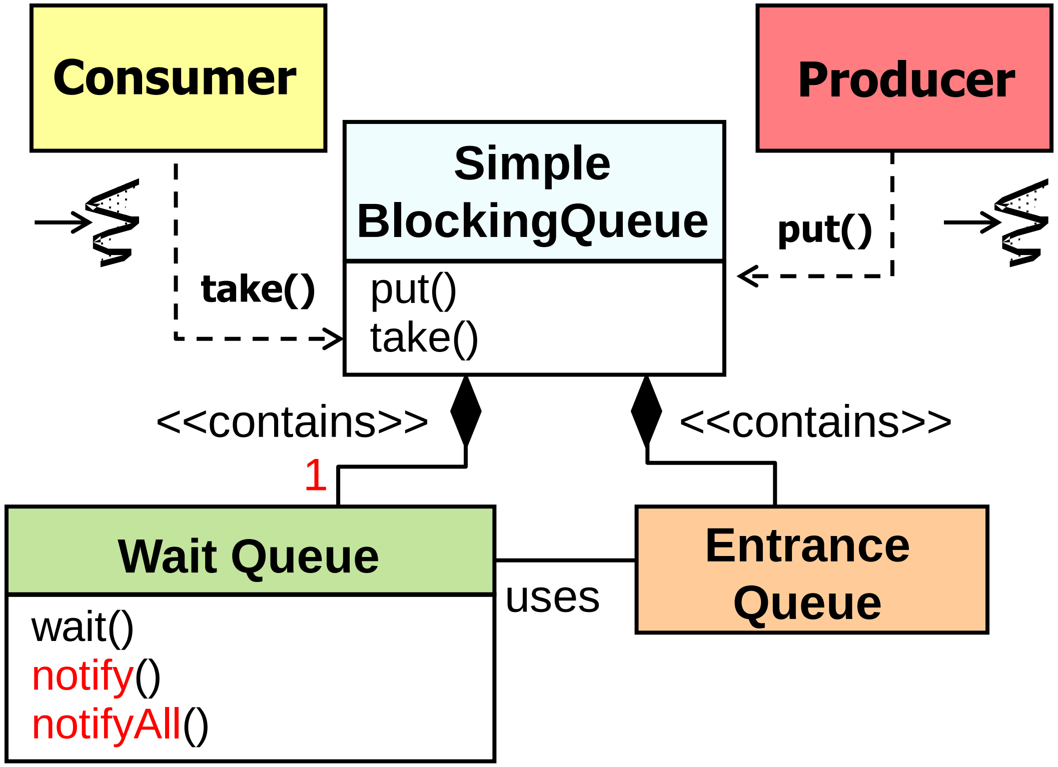


i.e., there's just a single "wait queue"

See upcoming lesson on "*Java Built-in Monitor Objects*"

Overview of Java ConditionObject

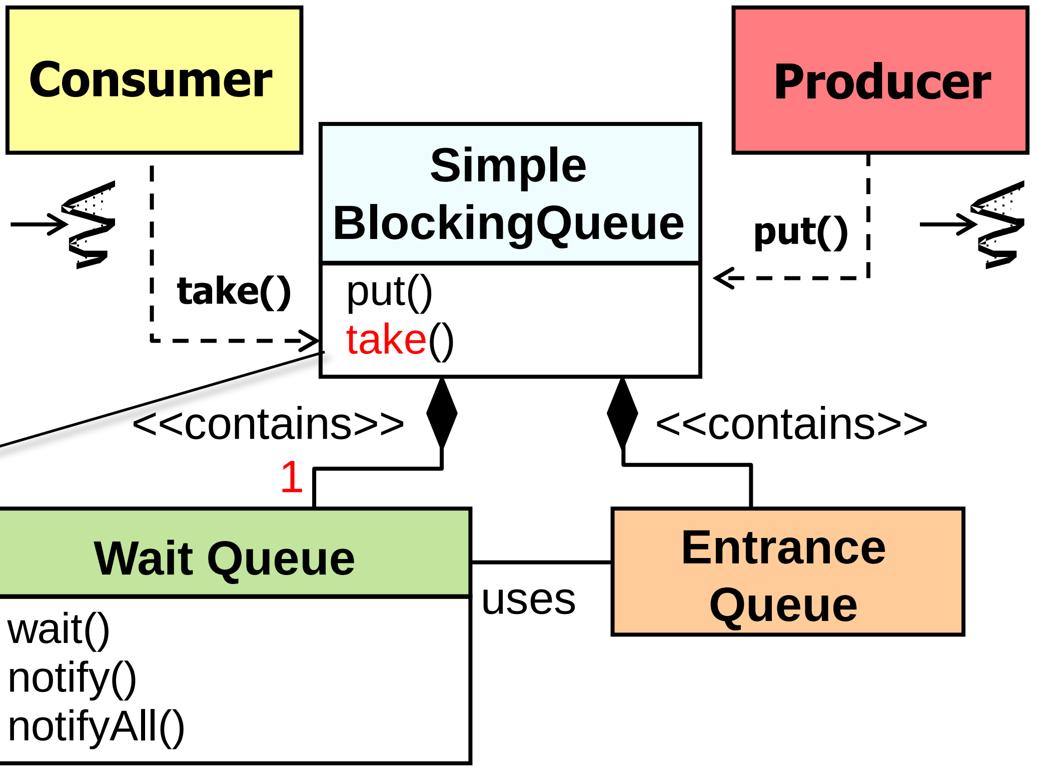
- In contrast, Java's built-in monitor objects only support *one* monitor condition
  - Yields inefficient programs that require excessive notifications & use of notifyAll()



See www.dre.vanderbilt.edu/~schmidt/C++2Java.html#concurrency

Overview of Java ConditionObject

- In contrast, Java's built-in monitor objects only support *one* monitor condition
  - Yields inefficient programs that require excessive notifications & use of notifyAll()
    - e.g., producers & consumers must both wake up on every change to the queue, even if a given thread can't proceed



```
synchronized(this) {
  while (mList.isEmpty())
    wait();
  notifyAll();
  return mList.poll();
}
```

See stackoverflow.com/questions/18490636/condition-give-the-effect-of-having-multiple-wait-sets-per-object

End of Structure & Functionality of Java ConditionObject