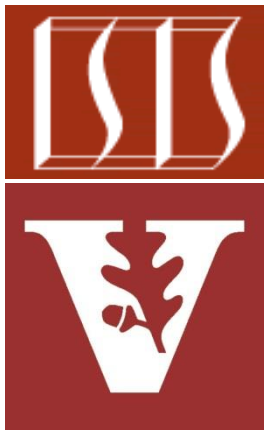
Java ConditionObject (Part 1)



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Institute for Software
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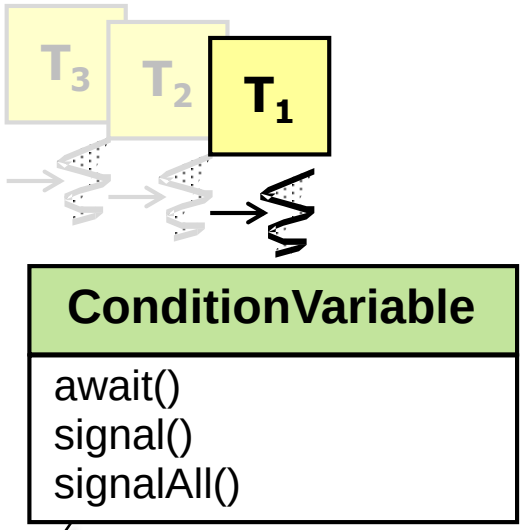
Learning Objectives in this Part of the Lesson

- Understand what condition variables are

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Condition cond = l.newCondition()
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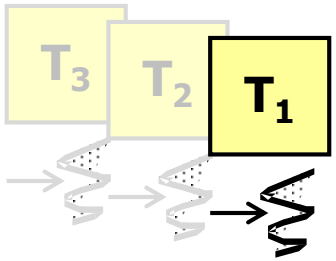
l.lock()
while (conditionNotSatisfied())
  cond.await()
doOperationProcessing()
```

Learning Objectives in this Part of the Lesson

- Understand what condition variables are
- Know what pattern they implement



ConditionVariable

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signal()
signalAll()

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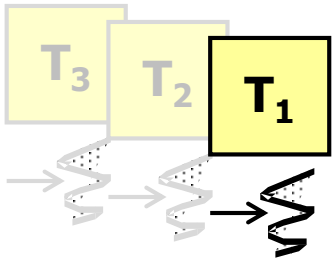

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Condition variables can be tricky, so I recommend you rewatch this lesson & read the links carefully

Overview of Condition Variables

Overview of Condition Variables

- A CV is a synchronizer that allows a thread to (repeatedly) suspend its execution until a condition is satisfied

Wheel of Pain – Conan the Barbarian

See blog.dcoles.net/2012/02/understanding-how-to-use-condition.html

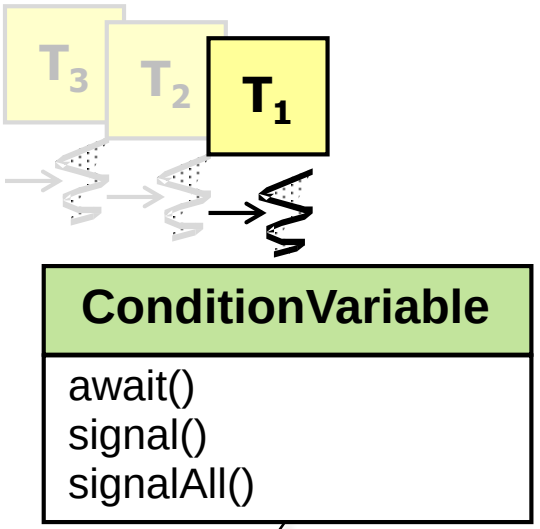
Overview of Condition Variables

- A CV is a synchronizer that allows a thread to (repeatedly) suspend its execution until a condition is satisfied
  - A thread whose execution is suspended on a CV is said to be "blocked" on the CV

Tree of Woe – Conan the Barbarian

Overview of Condition Variables

- A CV is implemented as a queue of threads that wait for certain condition(s) to be satisfied

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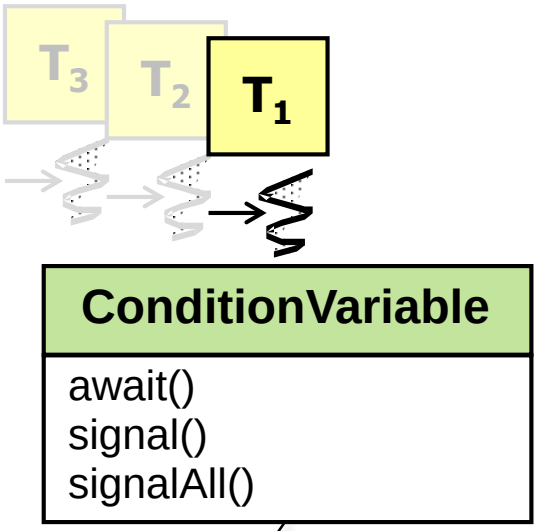
See en.wikipedia.org/wiki/Monitor_(synchronization)#Condition_variables

Overview of Condition Variables

- A CV is implemented as a queue of threads that wait for certain condition(s) to be satisfied
  - This queue of threads is known as the "wait set"

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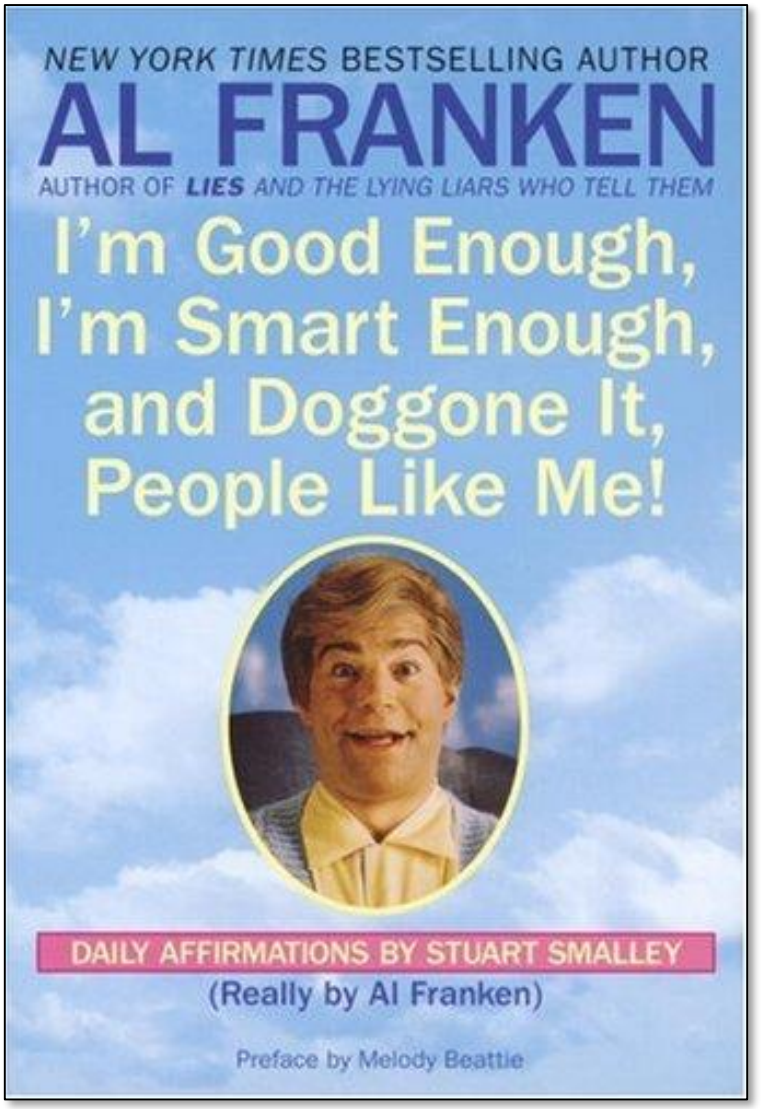
Overview of Condition Variables

- CVs are often used when *mutual exclusion* alone is inadequate



Overview of Condition Variables

- CVs are often used when *mutual exclusion* alone is inadequate, e.g.
  - Inefficient use of resources
    - e.g., due to excessive "busy waiting"

See en.wikipedia.org/wiki/Busy_waiting

Overview of Condition Variables

- CVs are often used when *mutual exclusion* alone is inadequate, e.g.
  - Inefficient use of resources
  - Insufficient to ensure *coordination*
    - e.g., what to do when a thread encounters shared state that it can't do any work upon (yet)

Overview of Condition Variables

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  - Inefficient use of resources
  - Insufficient to ensure *coordination*
    - e.g., what to do when a thread encounters shared state that it can't do any work upon (yet)

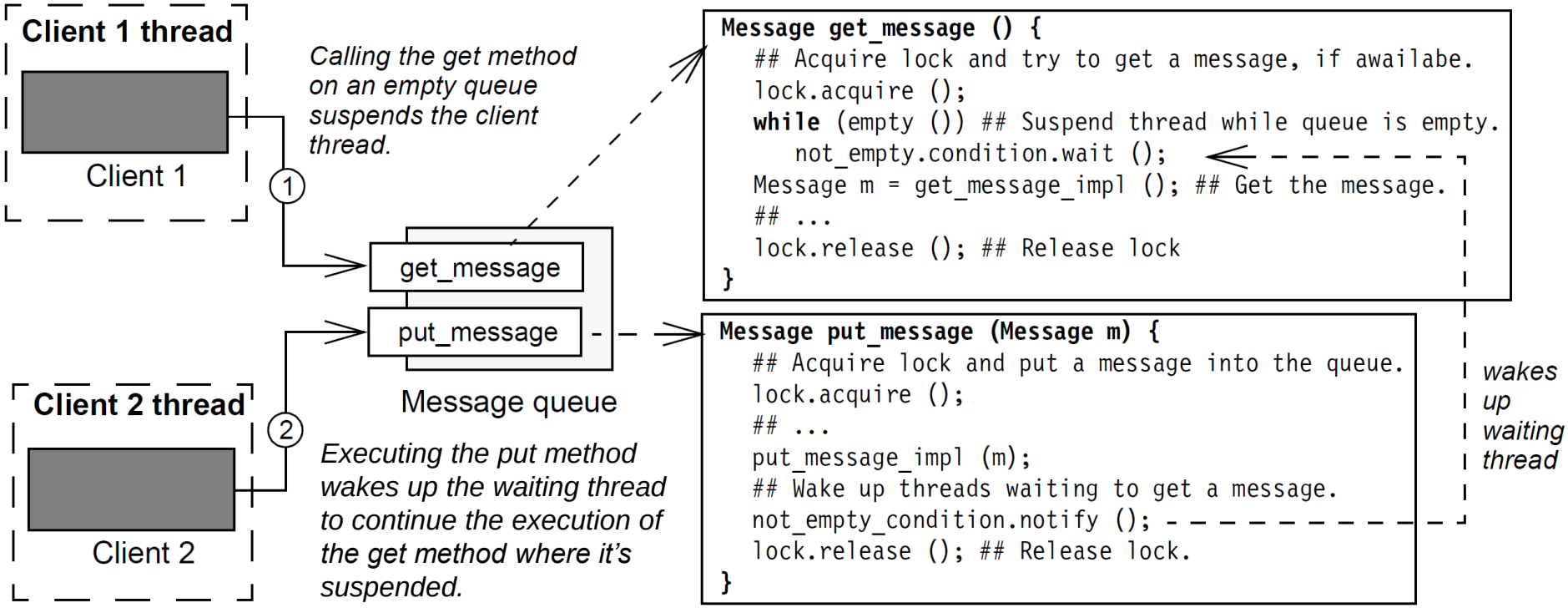
Waiting on an empty list

See en.wikipedia.org/wiki/Waiting_for_Godot

Implementing Guarded Suspension with CVs

Implementing Guarded Suspension with CVs

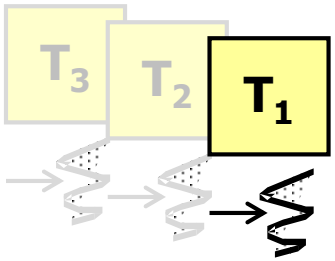
- CVs are most often used to implement the *Guarded Suspension* pattern



See en.wikipedia.org/wiki/Guarded_suspension

Implementing Guarded Suspension with CVs

- This pattern is applied to operations that can run only when a condition is satisfied



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Implementing Guarded Suspension with CVs

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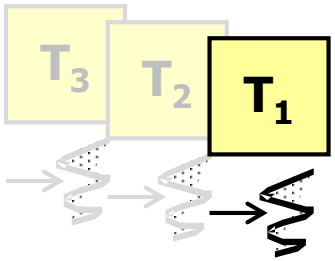
  - a lock is acquired



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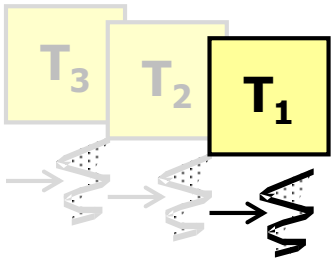
Implementing Guarded Suspension with CVs

- This pattern is applied to operations that can run only when a condition is satisfied, e.g.,
  - a lock is acquired
  - a precondition holds



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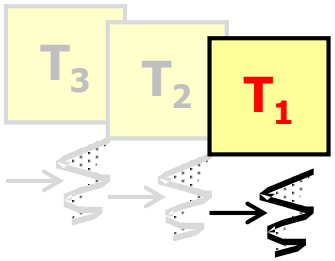
Implementing Guarded Suspension with CVs

- In this example thread T_1 uses a CV to suspend its execution until thread T_n notifies it that shared state it's waiting on *may* now be satisfied



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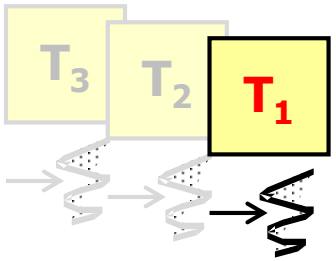

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```

Note the tentative nature of "may"..

Implementing Guarded Suspension with CVs

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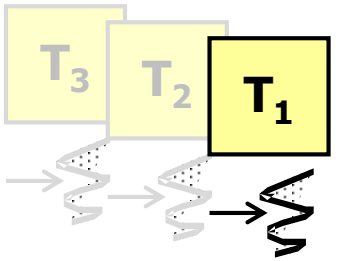

ConditionVariable

await()
signal()
signalAll()

First, a lock must be acquired..

```
Lock l = new Lock()
Condition cond =
l.newCondition()
...
l.lock()
while (conditionNotSatisfied())
  cond.await()
doOperationProcessing()
```

Implementing Guarded Suspension with CVs

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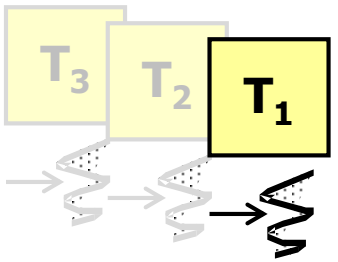

ConditionVariable

await()
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Second, a condition is checked (in a loop) with the lock held..

```
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l.lock()
while (conditionNotSatisfied())
  cond.await()
doOperationProcessing()
```
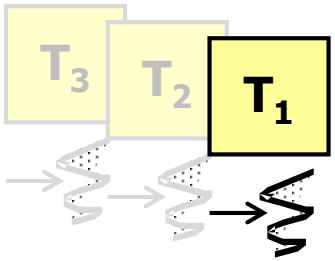

Implementing Guarded Suspension with CVs

- In this example thread T_1 uses a CV to suspend its execution until thread T_n notifies it that shared state it's waiting on *may* now be satisfied
  - A condition can be arbitrarily complex



ConditionVariable

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e.g., a method call, an expression involving shared state, etc.

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while (conditionNotSatisfied())
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doOperationProcessing()
```

Any state shared between threads must be protected by a lock associated with the CV

Implementing Guarded Suspension with CVs

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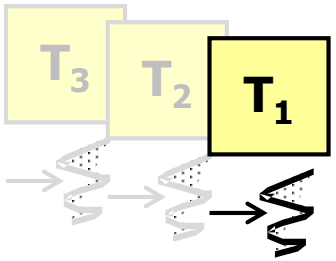

ConditionVariable

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signalAll()

The calling thread will block (possibly repeatedly) while the condition is not satisfied (await() atomically releases the lock)

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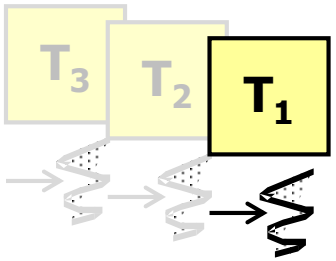

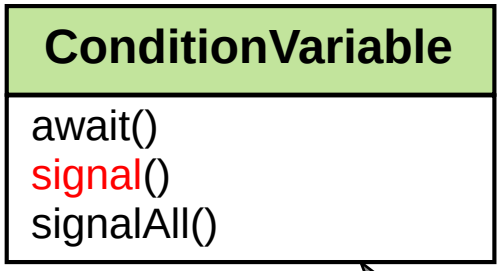

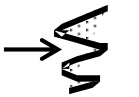

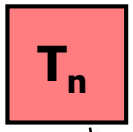


```
cond.signal()
```

Another thread can signal the condition when shared state may now be true

```
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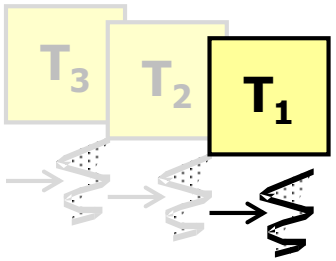

ConditionVariable

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await() reacquires the lock & the condition is rechecked in the loop

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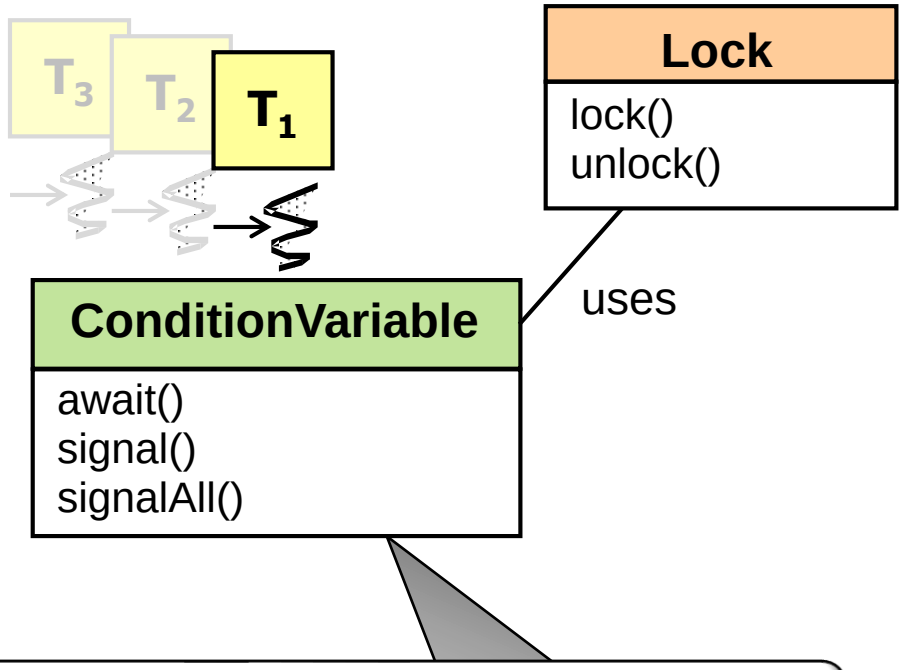


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- In this example thread T_1 uses a CV to suspend its execution until thread T_n notifies it that shared state it's waiting on *may* now be satisfied
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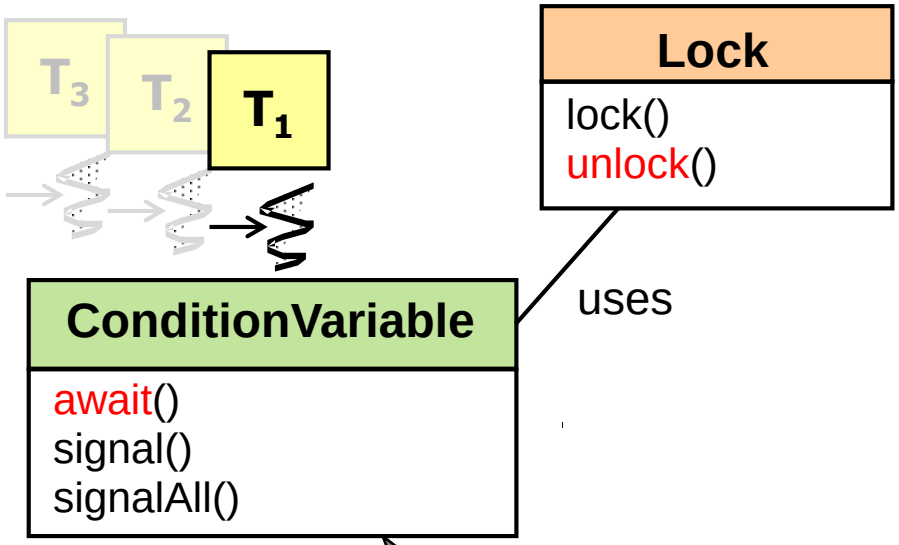
  - Waiting on a CV releases the lock & suspends the thread *atomically*

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The lock is released when the thread is suspended on the CV

Implementing Guarded Suspension with CVs

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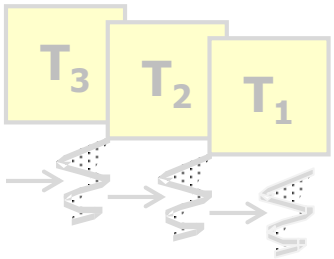
    - Thread T_1 is suspended until thread T_n signals the CV

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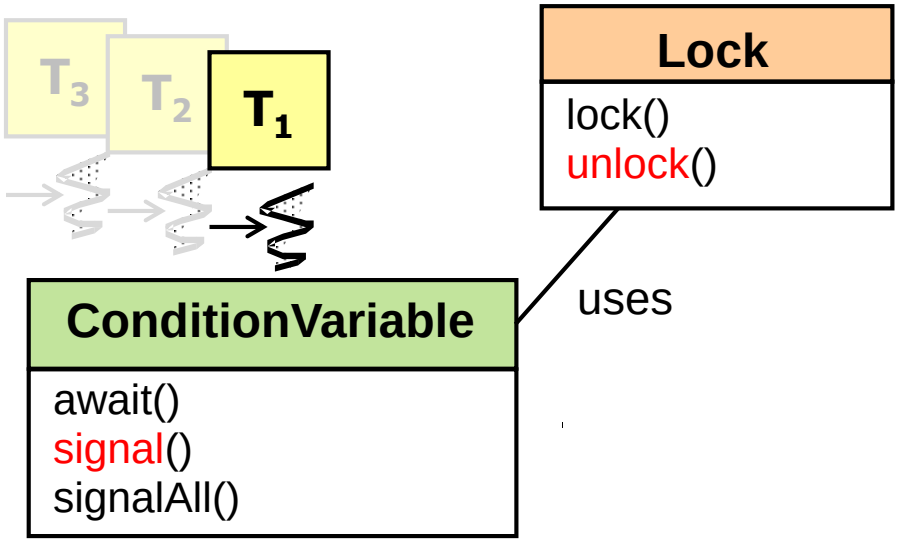

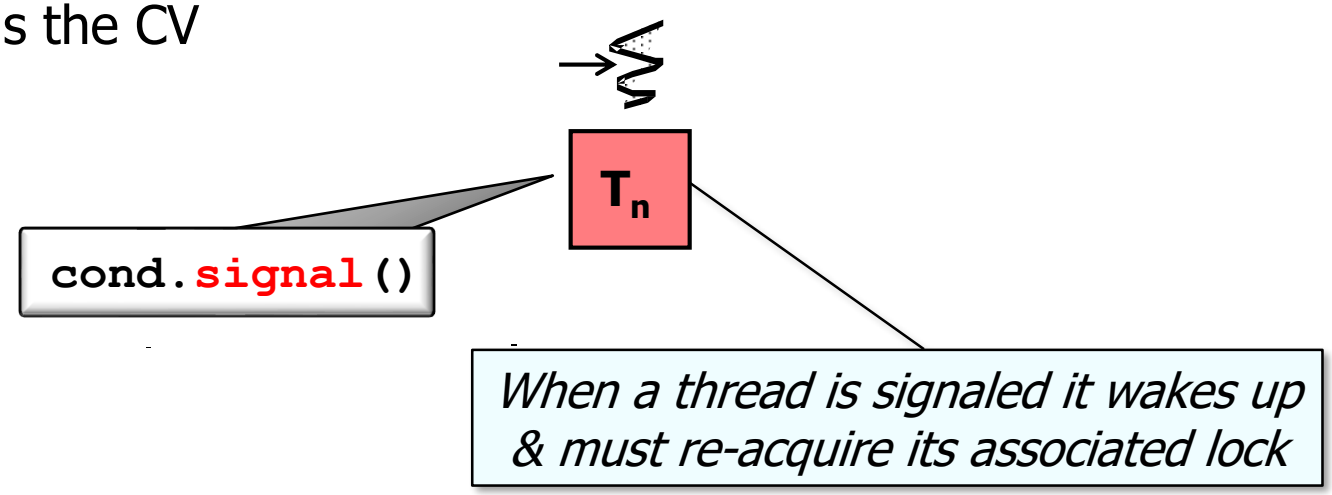

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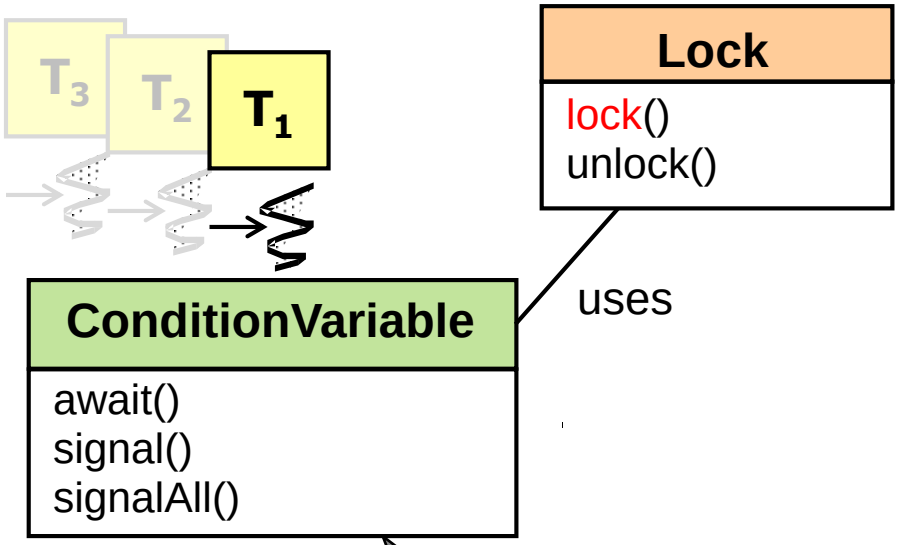


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After lock is re-acquired the thread can reevaluate its condition to see if it's satisfied

Implementing Guarded Suspension with CVs

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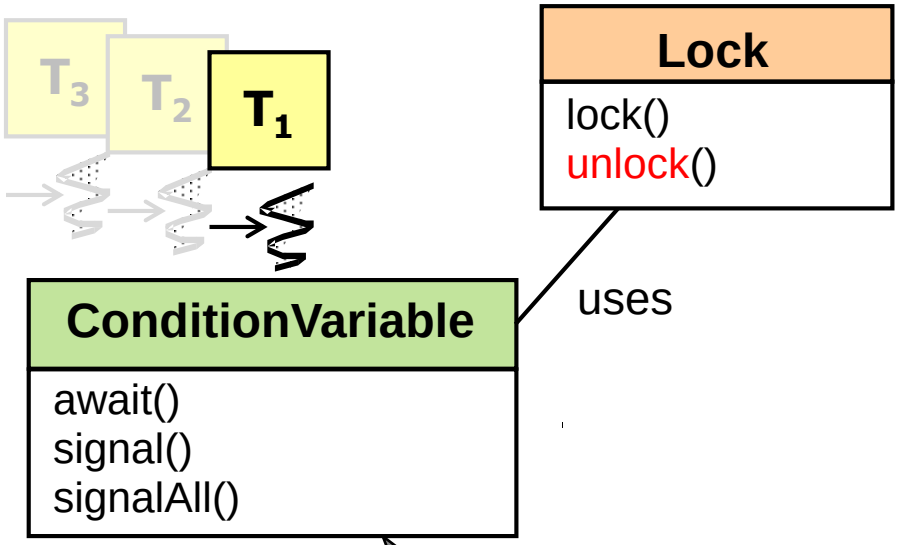


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If condition is not satisfied the thread must wait (which releases the lock atomically)

Implementing Guarded Suspension with CVs

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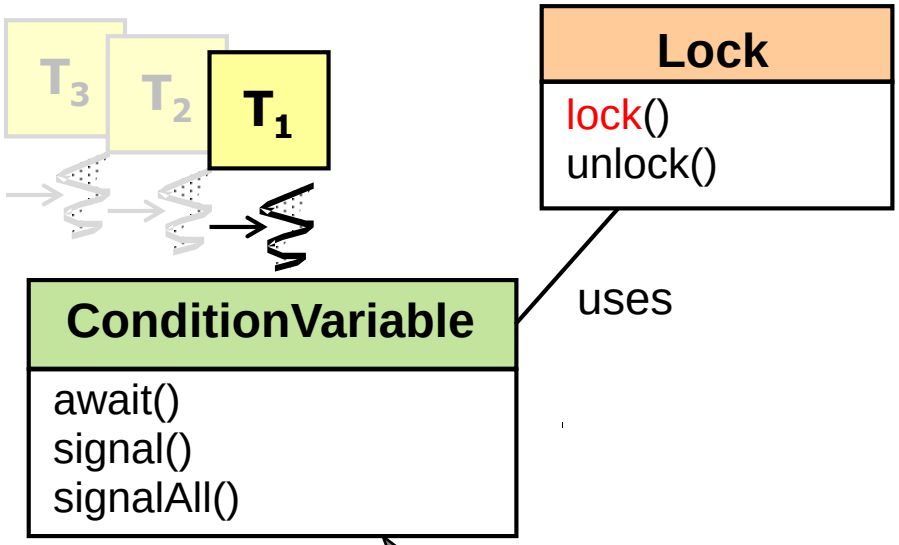


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After the lock is re-acquired & the condition is satisfied the operation can proceed (with lock held)

End of Java ConditionObject (Part 1)