Threads em Java

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Duas Abordagens para Usar Threads

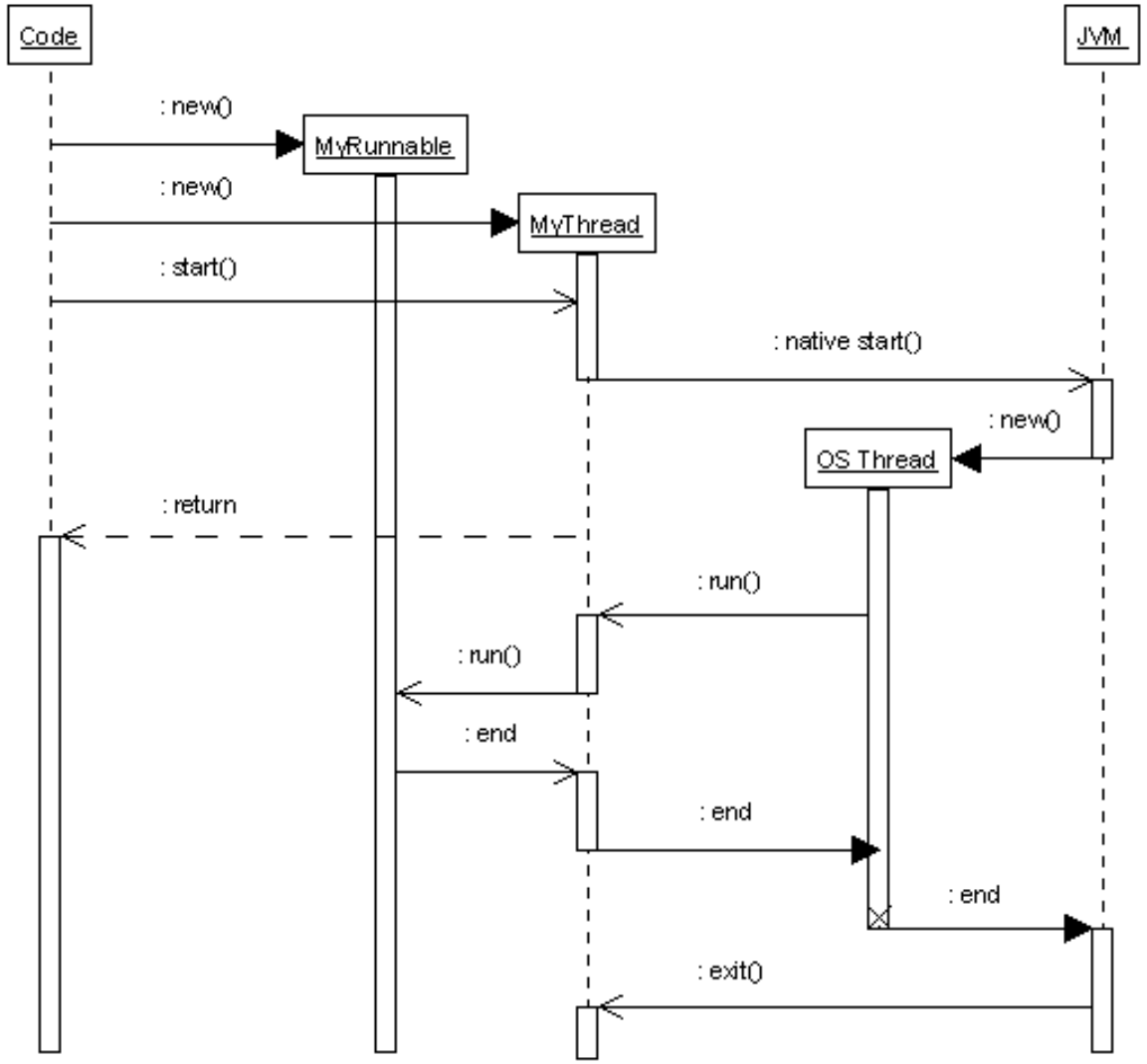
Implementar a interface Runnable

```
public class MyRunnable
  implements Runnable
{
    public void run() { … };
}

(new Thread(new
  MyRunnable(…))).start();
```

Extender a classe thread

```
public class MyThread
     extends Thread
{
    public void run() { … };
}

(new MyThread(…)).start();
```

Gerenciamento de Threads



Thread - Fundamentos

- **Uma *thread* possui um contador de programa separado**

… uma pilha, variáveis locais, etc.

- **Classes, objetos, métodos, etc. não pertencem a uma *thread***

- **Qualquer método pode ser executado por uma *thread*, inclusive simultanemente**

O método Sleep

```
public void run() {
  for(;;) {
    try {
      sleep(1000); // Pause for 1 second
    } catch (InterruptedException e) {
       return;        // caused by thread.interrupt()
    }
    System.out.println("Tick");
  }
}
```

O método Sleep

Este codógo imprime Tick uma vez por segundo? Não.

sleep() ← é um limite inferior

O resto do loop leva um período indeterminado de tempo

```
public void run() {
  for(;;) {
    try {
      sleep(1000); // Pause for 1 second
    } catch (InterruptedException e) {
       return;        // caused by thread.interrupt()
    }
    System.out.println("Tick");
  }
}
```

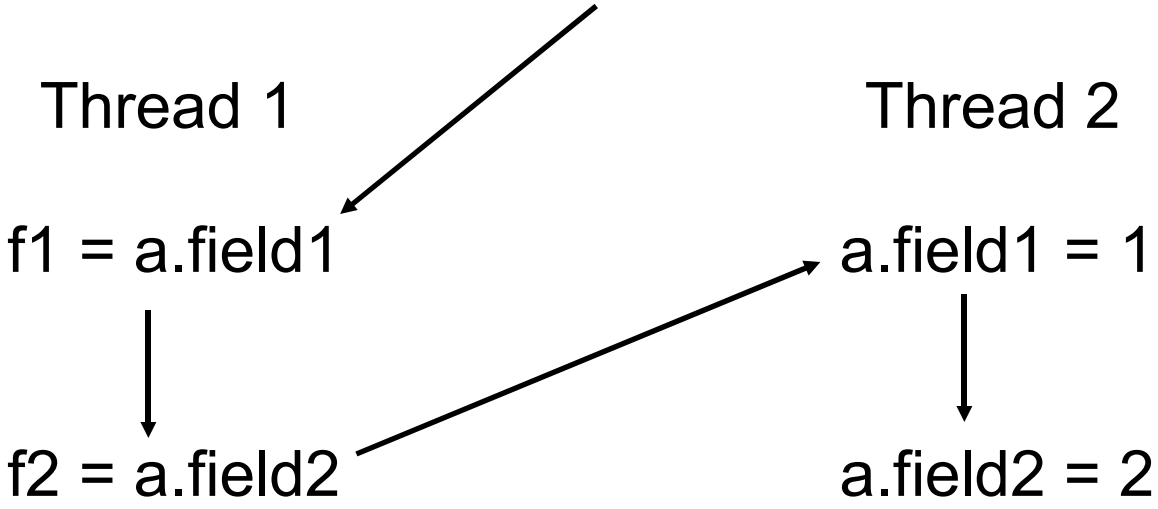
Race Conditions

- In a concurrent world, always assume someone else is accessing your objects
- Other threads are your adversary
- Consider what can happen when simultaneously reading and writing:

Thread 1	Thread 2
f1 = a.field1	a.field1 = 1
f2 = a.field2	a.field2 = 2

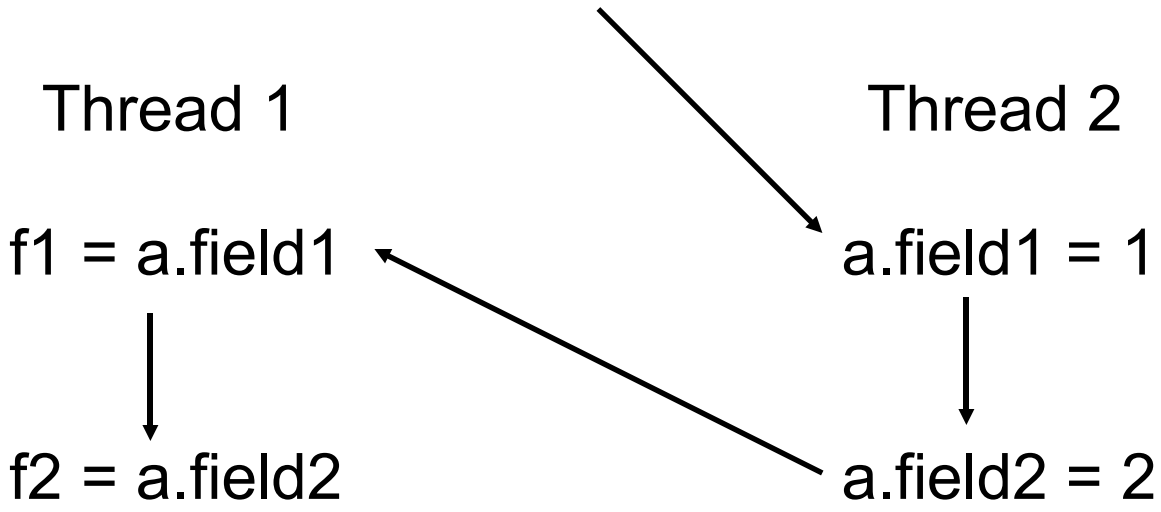
Race Conditions

- Thread 1 goes first
- Thread 1 reads original values



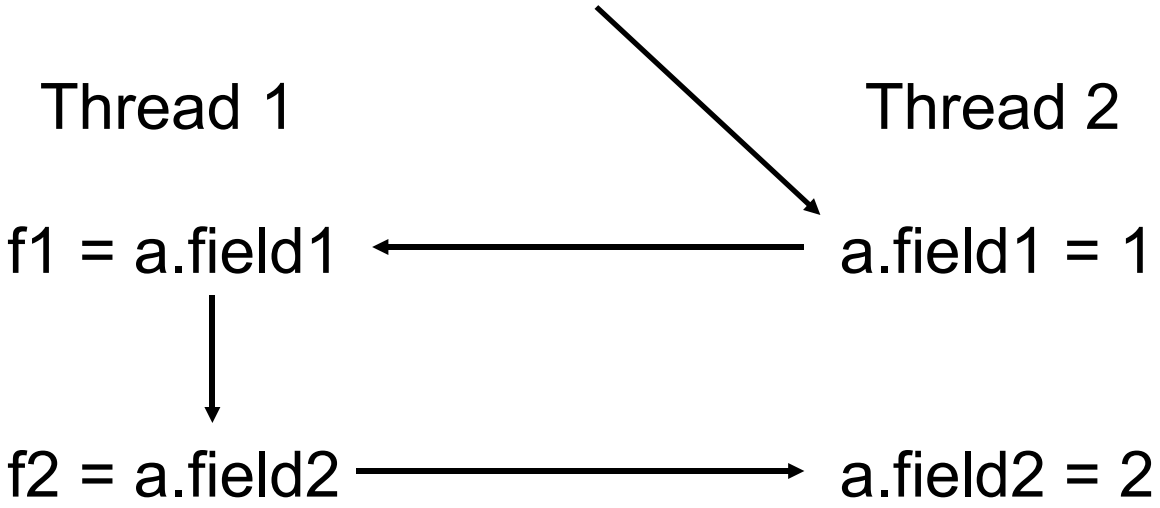
Race Conditions

- Thread 2 goes first
- Thread 1 reads new values



Race Conditions

- Interleaved execution
- Thread 1 sees one new value, one old value



Non-atomic Operations

- 32-bit reads and writes are guaranteed atomic
- 64-bit operations may not be

- Therefore,

int i; double d;

Thread 1	Thread 2	
i = 10;	i = 20;	i will contain 10 or 20
d = 10.0;	d = 20.0;	i might contain garbage

Per-Object Locks

- Each Java object has a lock that may be owned by at least one thread
- A thread waits if it attempts to obtain an already-obtained lock
- The lock is a counter: one thread may lock an object more than once

The Synchronized Statement

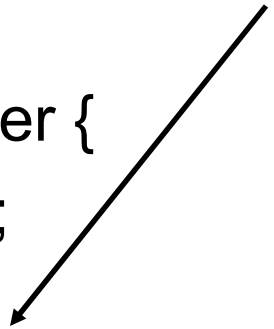
- A synchronized statement gets an object's lock before running its body

```
Counter mycount = new Counter;
synchronized(mycount) {
  mycount.count();
}
```

"get the lock for mycount before calling count()"

- Releases the lock when the body terminates

Synchronized Methods



"get the lock for the AtomicCounter object before running this method"

```
class AtomicCounter {
  private int _count;

  public synchronized void count() {
    _count++;
  }
}
```

This implementation guarantees at most one thread can increment the counter at any time

Deadlock

```
synchronized(Foo) {
  synchronized(Bar) {
    /* Deadlocked */
  }
}
```

```
synchronized(Bar) {
  synchronized(Foo) {
    /* Deadlocked */
  }
}
```

- **Rule: always acquire locks in the same order**

Priorities

- Each thread has a priority from 1 to 10 (5 typical)
- Scheduler's job is to keep highest-priority threads running
- thread.setPriority(5)

What the Language Spec. Says

- From *The Java Language Specification*

> Every thread has a *priority*. When there is competition for processing resources, threads with higher priority are generally executed in preference to threads with lower priority. Such preference is not, however, a guarantee that the highest priority thread will always be running, and thread priorities cannot be used to reliably implement mutual exclusion.

- Vague enough for you?

Multiple threads at same priority?

- Language gives implementer freedom
- Calling yield() suspends current thread to allow other at same priority to run … maybe
- Solaris implementation runs threads until they stop themselves (wait(), yield(), etc.)
- Windows implementation timeslices

Starvation

- Not a fair scheduler
- Higher-priority threads can consume all resources, prevent lower-priority threads from running
- This is called starvation

Waiting for a Condition

- Say you want a thread to wait for a condition before proceeding
- An infinite loop may deadlock the system

```
while (!condition) {}
```

- Yielding avoids deadlock, but is very inefficient

```
while (!condition) yield();
```

Java's Solution: wait() and notify()

- wait() like yield(), but requires other thread to reawaken it

```
while (!condition) wait();
```

- Thread that might affect this condition calls() notify to resume the thread

- Programmer responsible for ensuring each wait() has a matching notify()

wait() and notify()

- Each object has a set of threads that are waiting for its lock (its wait set)

```
synchronized (obj) { // Acquire lock on obj
  obj.wait();                    // suspend
                                 // add thread to obj's wait set
                                 // relinquish locks on obj
In other thread:
obj.notify();            // enable some waiting thread
```

wait() and notify()

1. Thread 1 acquires lock on object
2. Thread 1 calls wait() on object
3. Thread 1 releases lock on object, adds itself to object's wait set

5. Thread 2 calls notify() on object (must own lock)

7. Thread 1 is reawakened: it was in object's wait set
8. Thread 1 reacquires lock on object
9. Thread 1 continues from the wait()

wait() and notify()

- Confusing enough?
- notify() nodeterministically chooses one thread to reawaken (may be many waiting on same object)
  - What happens when there's more than one?
- notifyAll() enables all waiting threads
  - Much safer?

Building a Blocking Buffer

```
class OnePlace {
  El value;

  public synchronized void write(El e) { … }
  public synchronized El read() { … }
}
```

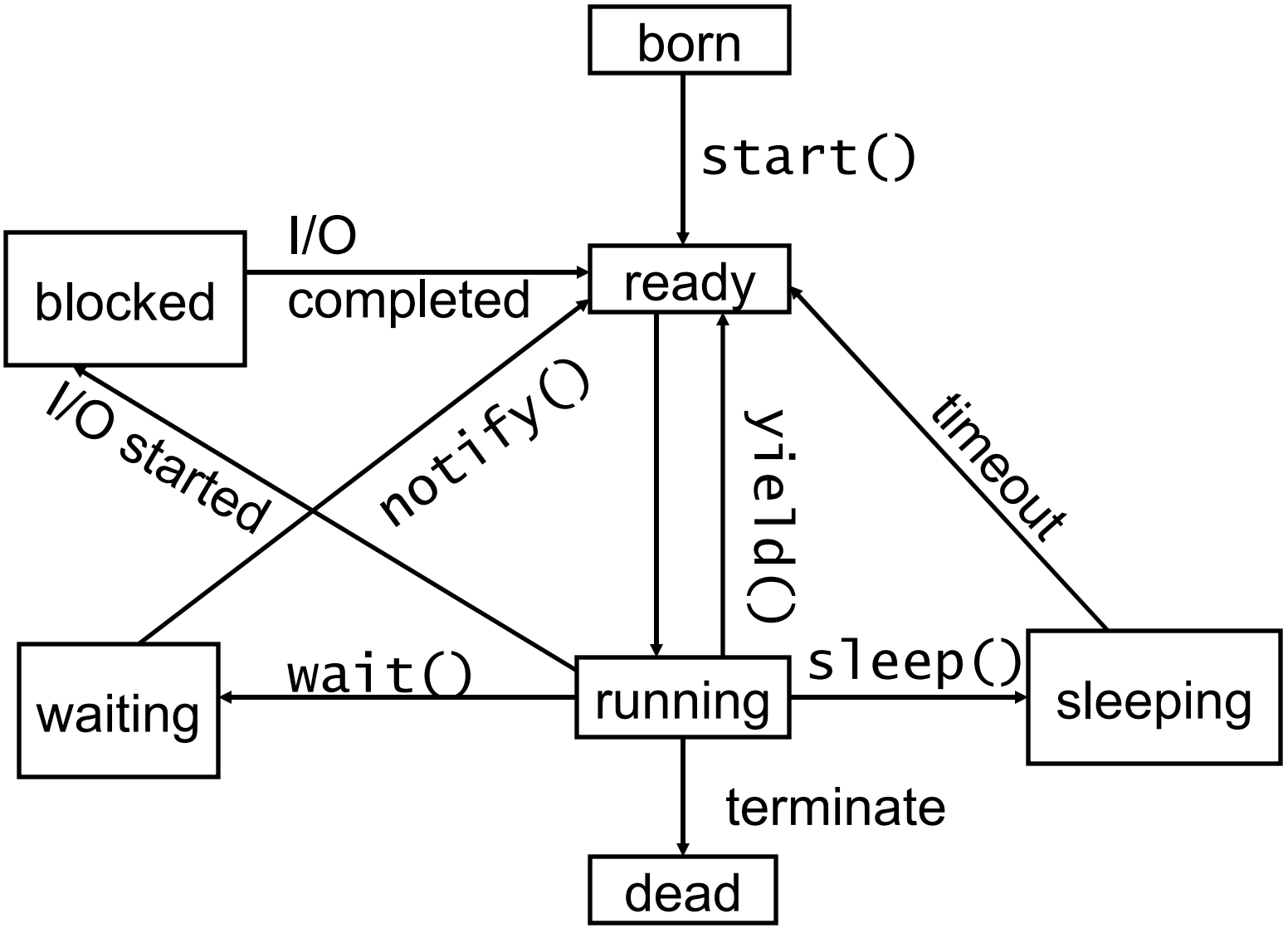
- Idea: One thread at a time can write to or read from the buffer

- Thread will block on read if no data is available
- Thread will block on write if data has not been read

Building a Blocking Buffer

```
synchronized void write(El e) throws InterruptedException
{
  while (value != null) wait();          // Block while full
  value = e;
  notifyAll();                           // Awaken any waiting read
}

public synchronized El read() throws InterruptedException
{
  while (value == null) wait();          // Block while empty
  El e = value; value = null;
  notifyAll();                           // Awaken any waiting write
  return e;
}
```

Thread States



Deprecated Methods

- Do not use the ***stop***() method to terminate a thread, it is deprecated

- Testes:
  - Olá mundo: System.out.flush();
  - Comunicação: sleep() x yield();
  - Sincronização: sleep() x yield() na classe Pessoa; Suporte sem wait() ; Suporte com yield() no lugar de wait();