Managing the Java Thread Lifecycle: Stopping a Thread via an Interrupt

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

- Know various ways to stop Java threads
  - Stopping a thread with a volatile flag
  - Stopping a thread with an interrupt request

Stopping Java Threads with an Interrupt Request

Stopping Java Threads with an Interrupt Request

- A thread can be stopped voluntarily by calling its interrupt() method

See docs.oracle.com/javase/8/docs/api/java/lang/Thread.html#interrupt

Stopping Java Threads with an Interrupt Request

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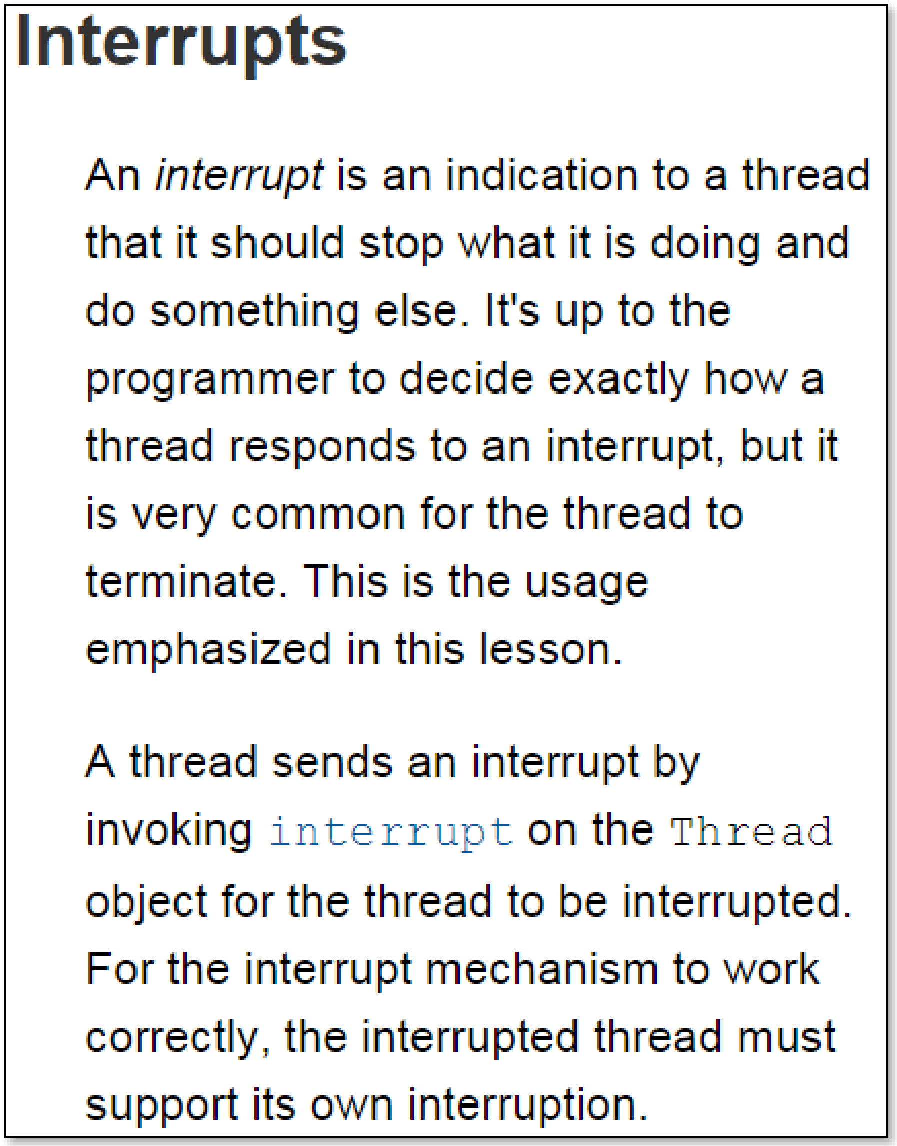
  - Posts an *interrupt request* to a thread



Interrupts

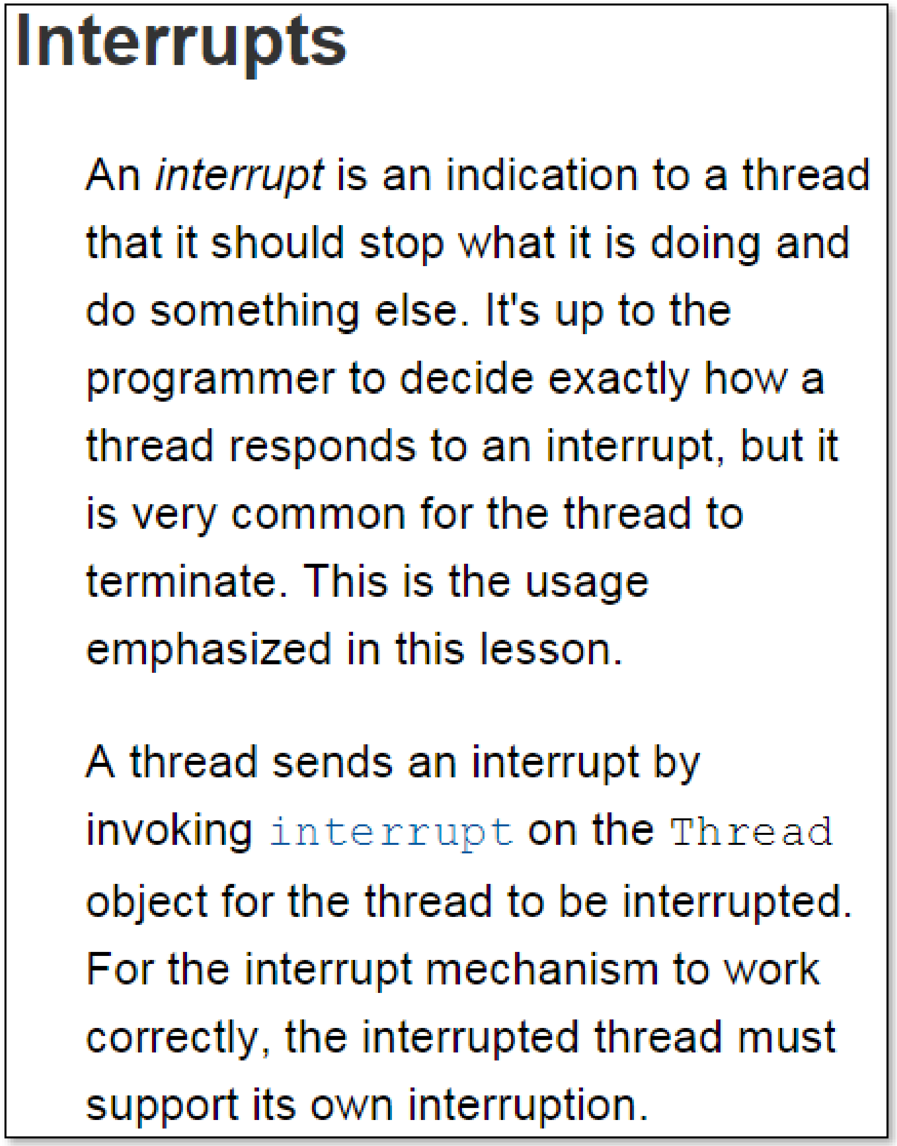
An *interrupt* is an indication to a thread that it should stop what it is doing and do something else. It's up to the programmer to decide exactly how a thread responds to an interrupt, but it is very common for the thread to terminate. This is the usage emphasized in this lesson.

A thread sends an interrupt by invoking `interrupt` on the `Thread` object for the thread to be interrupted. For the interrupt mechanism to work correctly, the interrupted thread must support its own interruption.

See docs.oracle.com/javase/tutorial/essential/concurrency/interrupt.html

Stopping Java Threads with an Interrupt Request

- A thread can be stopped voluntarily by calling its interrupt() method
  - Posts an *interrupt request* to a thread
  - Interrupts are is implemented via an internal *interrupt status* flag



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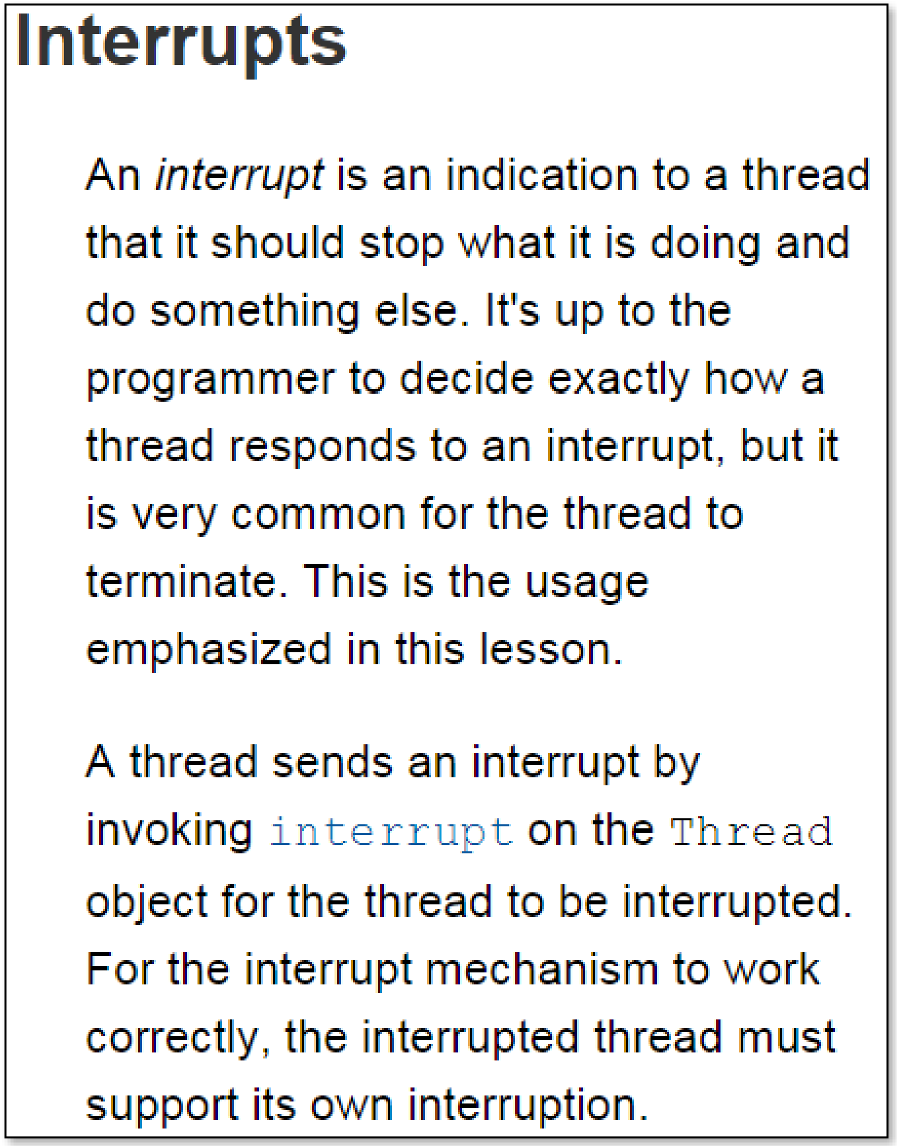
    - Invoking Thread.interrupt() sets this flag



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Stopping Java Threads with an Interrupt Request

- A thread can be stopped voluntarily by calling its interrupt() method
  - Posts an *interrupt request* to a thread
  - Interrupts are is implemented via an internal *interrupt status* flag
    - Invoking Thread.interrupt() sets this flag
    - Programs can check this flag via two thread accessor methods

static boolean	**interrupted**() – Tests whether the current thread has been interrupted (& resets the interrupted flag)
boolean	**isInterrupted**() – Tests whether this thread has been interrupted (& doesn't reset the interrupted flag)

Each method has different side-effects on interrupt status, as discussed shortly

Stopping Java Threads with an Interrupt Request

- Here's a simple Java program that starts, runs, & interrupts a background thread

```
static int main(String args[]) {
  Thread t1 =
    new Thread(() -> {
      for (int i = 0;
               i < args.length; i++) {
          processBlocking(args[i]);
          processNonBlocking(args[i]);
        }
      });

  t1.start();
  ... // Run concurrently for a while
  t1.interrupt();
  ...
```

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```

Create a new thread

Stopping Java Threads with an Interrupt Request

- Here's a simple Java program that starts, runs, & interrupts a background thread

Start the new thread

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static int main(String args[]) {
  Thread t1 =
    new Thread(() -> {
      for (int i = 0;
               i < args.length; i++) {
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Stopping Java Threads with an Interrupt Request

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static int main(String args[]) {
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      for (int i = 0;
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         }
      });

  t1.start();
  ... // Run concurrently for a while
  t1.interrupt();
  ...
```

The main thread continues running

Stopping Java Threads with an Interrupt Request

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      for (int i = 0;
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        processNonBlocking(args[i]);
      }
    });

  t1.start();
  ... // Run concurrently for a while
  t1.interrupt();
  ...
```

After the thread starts, it runs this lambda expression, whose methods perform blocking & non-blocking computations

Stopping Java Threads with an Interrupt Request

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    });

  t1.start();
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  t1.interrupt();
  ...
```

After the main thread performs some computations it interrupts thread t1

Stopping Java Threads with an Interrupt Request

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        }
      });

  t1.start();
  ... // Run concurrently for a while
  t1.interrupt();
  ...
```

Methods running in thread t1 check periodically to see if the thread's been stopped yet

Stopping Java Threads with an Interrupt Request

- Certain blocking operations in the Java language & class libraries return automatically & throw InterruptedException if the thread is interrupted

```
void processBlocking(String args) {
  ...
  while (true) {
    try {
      Thread.currentThread().
        sleep(interval);
      synchronized(this) {
        while (someConditionFalse)
          wait();
      }
    }
    catch (InterruptedException e)
    { ... }
    ...
  }
}
```

e.g., wait(), join(), sleep() & blocking I/O calls on "interruptable channels"

See praveer09.github.io/technology/2015/12/06/understanding-thread-interruption-in-java

Stopping Java Threads with an Interrupt Request

- Methods whose operations do not block must periodically check if Thread.interrupt() has been called

```
void processNonBlocking(String args) {
  ...
  while (true) {
    ... // Long-running computation
    if (Thread.interrupted())
      throw
        new InterruptedException();
    ...
```

interrupted() is a static method that returns true if the calling thread has its interrupt status flag set

interrupted() clears the current thread's interrupt status the first time it's called

Stopping Java Threads with an Interrupt Request

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void processNonBlocking(String args) {
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  while (true) {
    ... // Long-running computation
    if (Thread.interrupted())
      throw
        new InterruptedException();
    ...
```

This example explicitly throws an InterruptedException, which is created/treated like a normal object

See docs.oracle.com/javase/8/docs/api/java/lang/InterruptedException.html

Stopping Java Threads with an Interrupt Request

- Methods whose operations do not block must periodically check if Thread.interrupt() has been called

```
void processNonBlocking(String args) {
  ...
  final myThread =
    Thread.currentThread();

  while (true) {
    ... // Long-running computation
    if (myThread.isInterrupted())
      throw
        new InterruptedException();
    ...
```

isInterrupted() is a non-static method that returns true if the designated thread has its interrupt status flag set

isInterrupted() can be called multiple times w/out affecting its *interrupt status*

Stopping Java Threads with an Interrupt Request

- Programs can override thread interrupt methods since they are virtual
  - e.g., interrupt(), interrupted(), & isInterrupted()

```
public class BeingThread
       extends Thread {
  volatile boolean mInterrupted;

  BeingThread(Runnable runnable) {
    super(runnable);
    mInterrupted = false;
 }

  public void interrupt() {
    mInterrupted = true;
    super.interrupt();
  }

  public boolean isInterrupted() {
    return mInterrupted
      || super.isInterrupted()
  }
}
```

See stackoverflow.com/questions/23369891/overriding-interrupt-isinterrupted-method-in-thread-class

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  public boolean isInterrupted() {
    return mInterrupted
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```

But make sure you know what you're doing…

End of Managing the Java Thread Lifecycle: Stopping a Thread via an Interrupt