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

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

Posts an *interrupt request* to a thread.

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](https://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 implemented via an internal interrupt status flag

Interrupts

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- Interrupts are implemented via an internal *interrupt status* flag
- 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 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

```java
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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        });

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

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static int main(String args[]) {
    Thread t1 =
        new Thread(() -> {
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            }
        });
    t1.start();
    ... // Run concurrently for a while
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Here's a simple Java program that starts, runs, & interrupts a background thread:

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                processNonBlocking(args[i]);
            }
        });

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

The main thread continues running.
Here’s a simple Java program that starts, runs, & interrupts a background thread

```java
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();
...}
```

After the thread starts, it runs this lambda expression, whose methods perform blocking & non-blocking computations.
Stopping Java Threads with an Interrupt Request

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

```java
static int main(String args[]) {
    Thread t1 =
        new Thread(() -> {
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                processNonBlocking(args[i]);
            }
        });
    t1.start();
    ... // Run concurrently for a while
    t1.interrupt();
    ...
```

After the main thread performs some computations it interrupts thread t1
Here’s a simple Java program that starts, runs, & interrupts a background thread.

```java
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();
    ...
}
```

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

```java
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.

```java
void processNonBlocking(String args) {
    ... // Long-running computation
    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

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

```java
void processNonBlocking(String args) {
    ...
    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
Stops Java Threads with an Interrupt Request

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

```java
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 without 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()

```java
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()
    }
}
```

Stopping Java Threads with an Interrupt Request

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  - e.g., `interrupt()`, `interrupted()`, & `isInterrupted()`

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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();
    }
}
```

But make sure you know what you’re doing...
End of Managing the Java Thread Lifecycle: Stopping a Thread via an Interrupt