Java Threads : An Introduction

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Itinerary

(1) What are threads?

(2) How to create and control a thread.

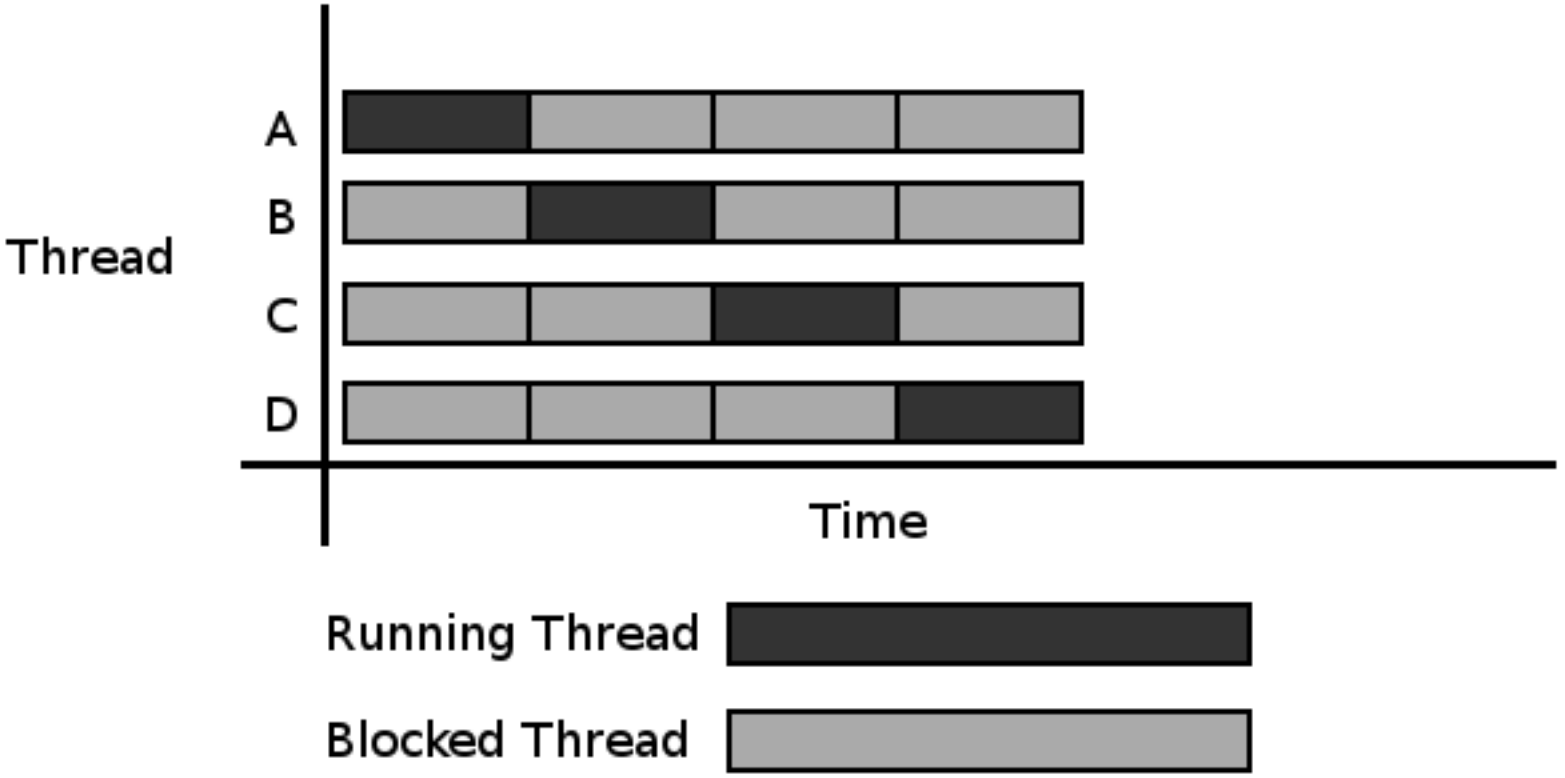
(3) Synchronization and signals.

(4) Example

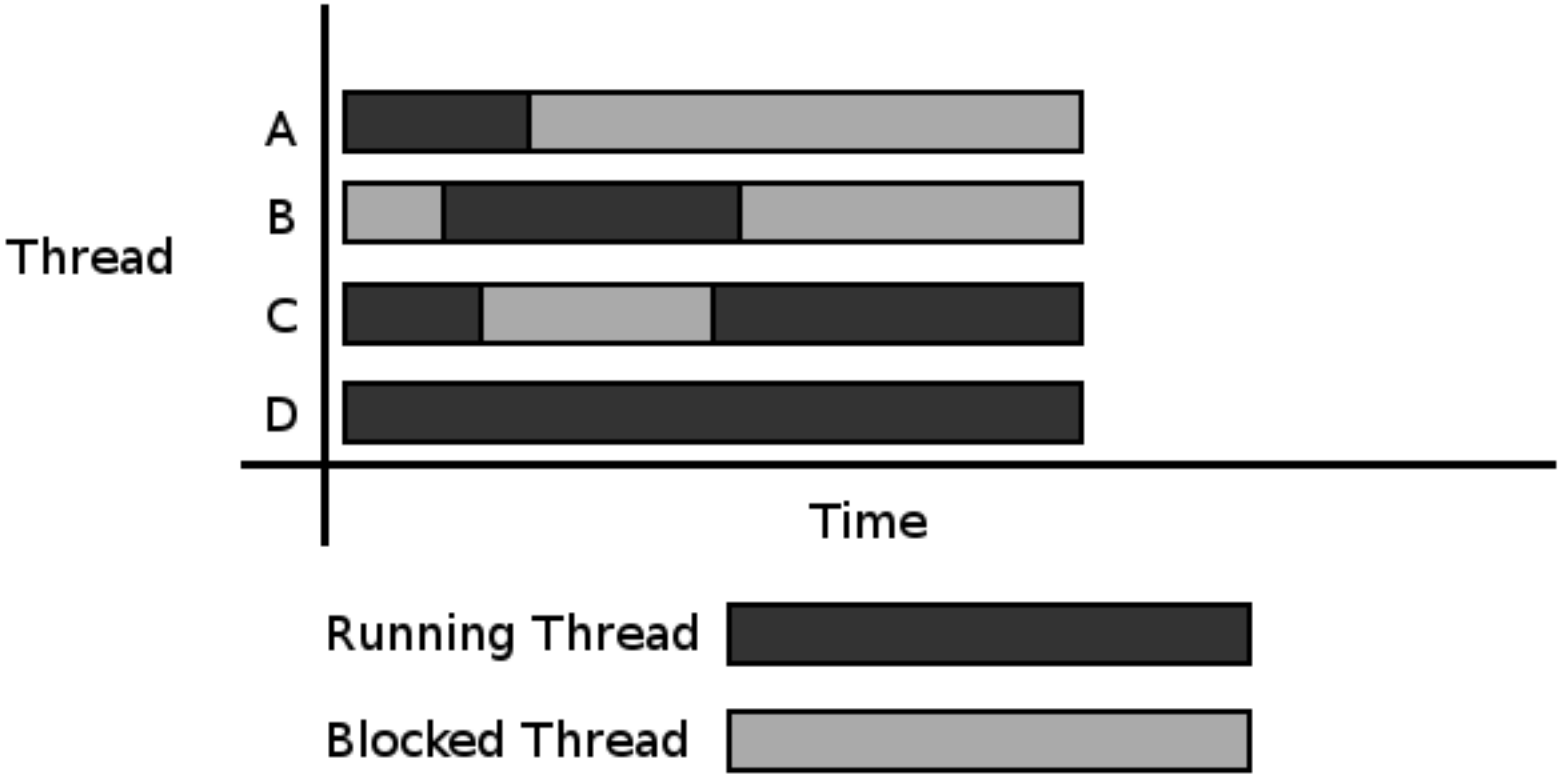
What is a Thread?

- Light-weight process that can run concurrently with other threads.
- All Threads share a node, sharing memory.
- Main() is a thread.
- Java garbage collection is a thread.

Single Core



Multi-Core (4 Core)



How to create and control threads.

- Thread class and runnable interface
- thread.start()
- thread.join()
- thread.sleep()
- Keyword : 'volatile'

Creating a thread

There are 2 ways to create a thread in Java

(1) Extend the 'Thread' class.

(2) Implement the 'Runnable' interface.

Method #1
Extend the 'Thread' class

```
public class Example1 extends Thread{

    public static void main(String[] args){
        Example1 thread = new Example1();
        thread.start();
    }

    public void run(){
        ...
    }
}
```

Method #2
Implement 'Runnable'

```
public class Example1 implements Runnable{

    public static void main(String[] args)   {
        Example1 example = new Example1();
        Thread thread = new Thread(example);
        thread.start();
    }

    public void run() {
        .... do something ....
    }
}
```

Common Methods

start() : Causes a thread to begin execution; the Java Virtual Machine calls the 'run' method of the interface.

join() : Blocks while waiting for a particular thread to terminate.

sleep(long msec) : Causes the currently executing thread to temporarily cease execution.

Example : starting one thread

```
public class Example1 extends Thread{

   public static void main(String[] args){
      new Example1().start();
   }

   public void run() {
      System.out.println("I am an independent thread!");
      System.out.println("My Thread ID is " + this.getId());
      System.out.println("My Name is " + this.getName());
   }
}
```

```
I am an independent thread!

My Thread ID is 9

My Name is Thread-0

>_
```

Example : starting two threads

```
public class Example2 extends Thread{

    public Example2()          { super(); }
    public Example2(String s) { super(s); }

    public static void main(String[] args){
        new Example2().start();
        new Example2("Albert Threadington").start();
    }

    @Override
    public void run() {
        System.out.println("I am an independent thread!");
        System.out.println("My Thread ID is " + this.getId());
        System.out.println("My Name is " + this.getName());
    }
}
```

```
I am an independent thread!

I am an independent thread!

My Thread ID is 11

My Thread ID is 10

My Name is Albert Threadington

My Name is Thread-0

>_
```

Race Condition

A race condition occurs when where some event (in this case the output) is dependent on the sequence or timing of other uncontrollable events; the order in which threads access I/O.

thread.join()

```
void    join()
```

Waits for this thread to terminate.

```
void    join(long millis)
```

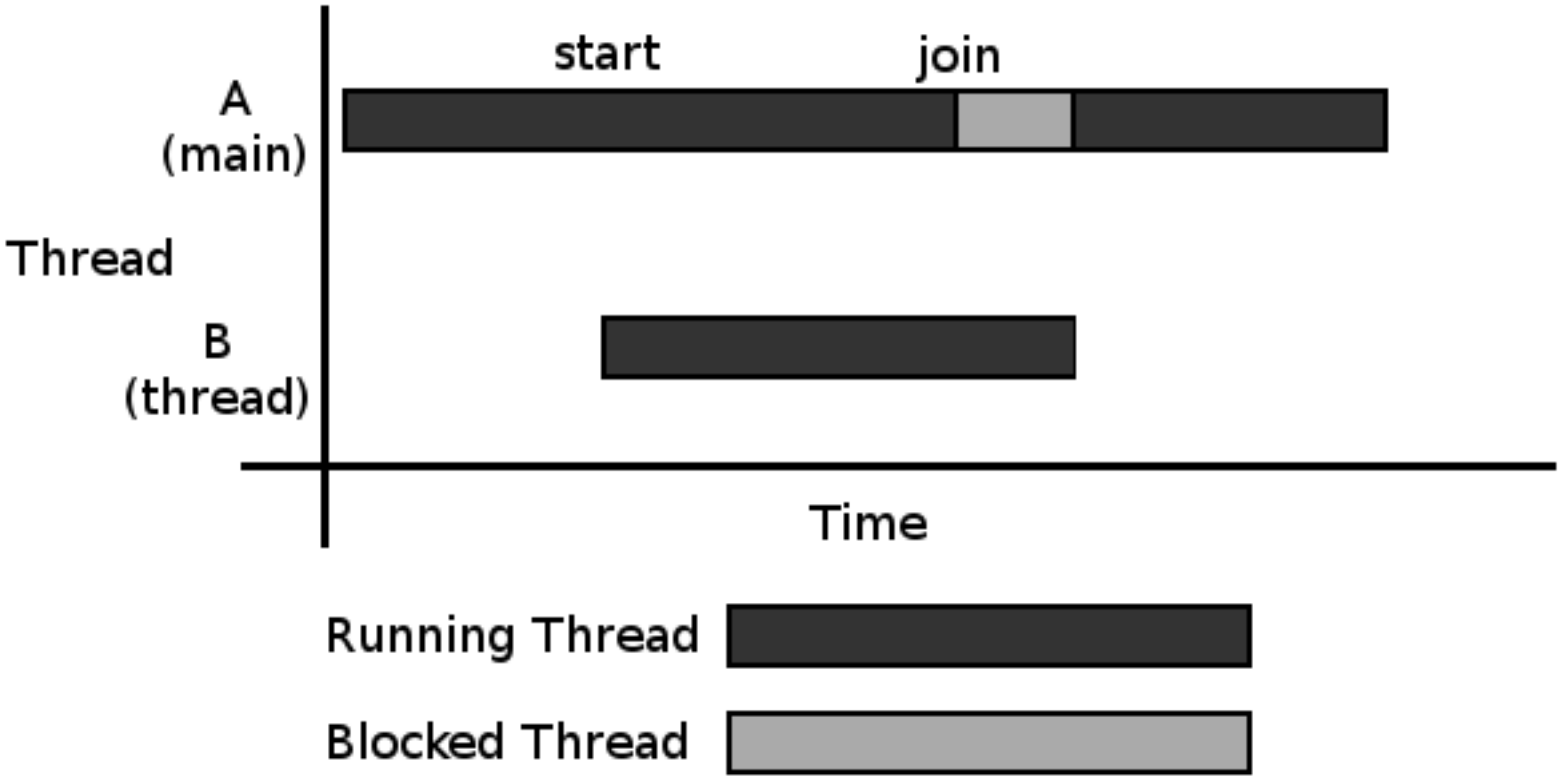
Waits at most millis milliseconds for this thread to terminate.

```
void    join(long millis, int nanos)
```

Waits at most millis milliseconds plus nanos nanoseconds for this thread to terminate.

These definitions from the java api
http://docs.oracle.com/javase/7/docs/api/java/lang/Thread.html

start - join


start
join
A
(main)
Thread
B
(thread)
Time
Running Thread
Blocked Thread

Example : thread.join

```
public class Example3 extends Thread{

    public Example3()          { super(); }
    public Example3(String s){ super(s); }

    public static void main(String[] args) throws InterruptedException{
        Thread t1 = new Thread(new Example3());
        Thread t2 = new Thread(new Example3("Albert Threadington"));
        t1.start();
        t1.join();
        t2.start();
    }

    @Override
    public void run() {
        System.out.println("I am an independent thread!");
        System.out.println("My Thread ID is " + this.getId());
        System.out.println("My Name is " + this.getName());
    }
}
```

```
I am an independent thread!

I am an independent thread!

My Thread ID is 9

My Thread ID is 10

My Name is Albert Threadington

My Name is Thread-0

>_
```

Stopping a thread.

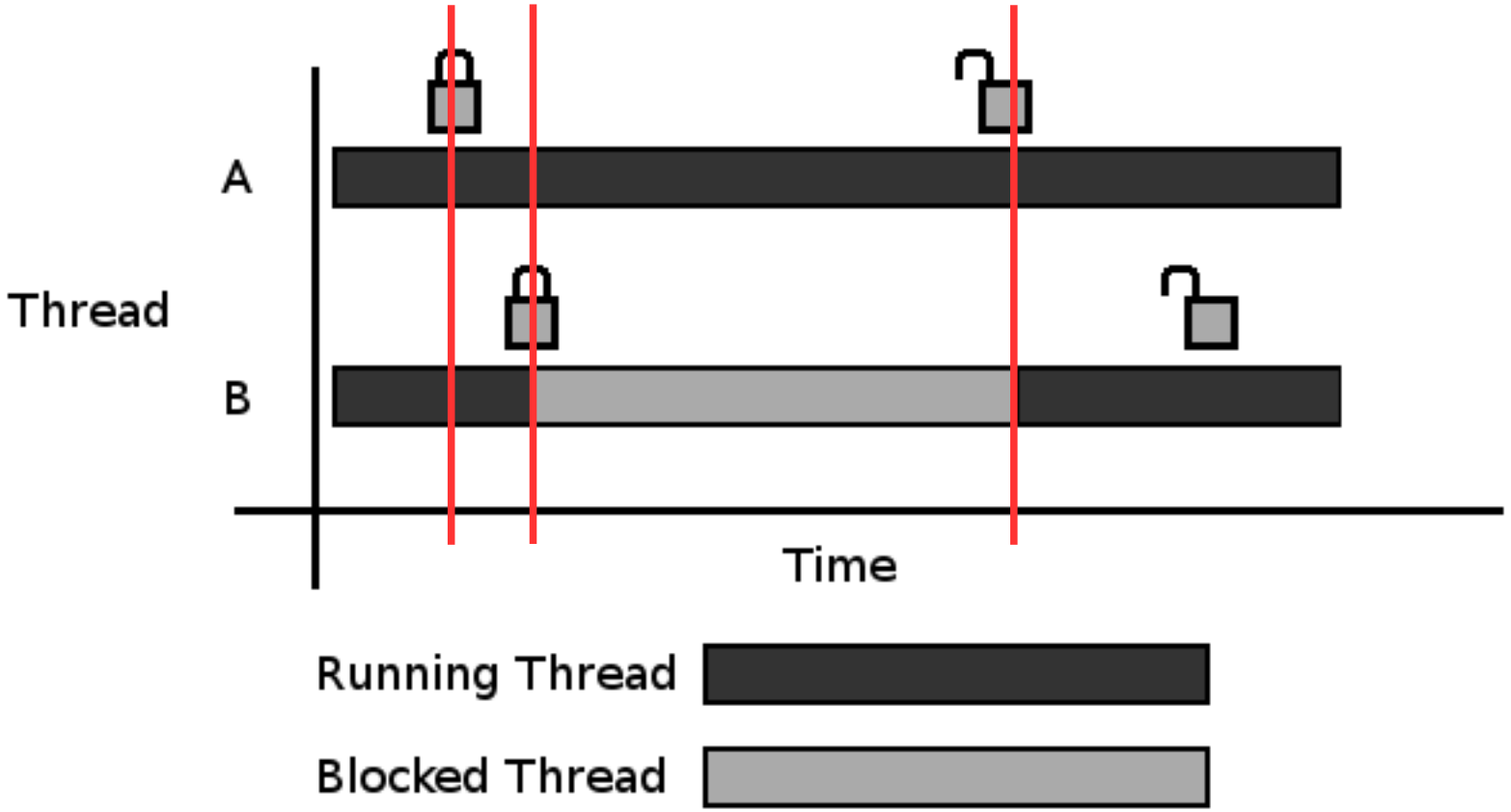
```
public class Example3 extends Thread{

   private volatile boolean isRunning = true;

   public static void main(String[] args) throws InterruptedException{
      ... stuff ...
   }

   public void run() {
      while(isRunning){
         ... do something ...
      }
   }

   public void flagStop(){
      isRunning = false;
   }
}
```

Volatile

```
public class Example3 extends Thread{

    private volatile boolean isRunning = true;

    public static void main(String[] args) throws InterruptedException{
        ... stuff ...
    }

    @Override
    public void run() {
        while(isRunning){
            ... do something
        }
    }

    public void flagStop(){
        isRunning = false;
    }

}
```

- 'isRunning' is actually accessed by 2 (or more) threads, and may be kept locally in machine registers.
- Loading and storing of some variables are atomic.
- Their value may be in cache memory or registers.
- Volatile ensures the variable is kept in main memory.
- More elegant than sync'd getters/setters.

Synchronization locks.



Keyword: Synchronized

- object's method
- class's static method
- locking an object
  - instance level code block
  - class level code block

Keyword: Synchronized

- instance method
- static method
- instance code block
- static code block

```
public class Example {

    public synchronized void doSomething(){
        ....
        /* code goes here */
        ....
    }

}
```

Keyword: Synchronized

- instance method
- static method
- instance code block
- static code block

```
public class Example {

    public synchronized static void doSomething(){
        ....
        /* code goes here */
        ....
    }

}
```

Keyword: Synchronized

- instance method
- static method
- instance code block
- static code block

```
public class Example {
    public void doSomething(Object obj){
        synchronized(obj){
            ....
        }
    }
}
```

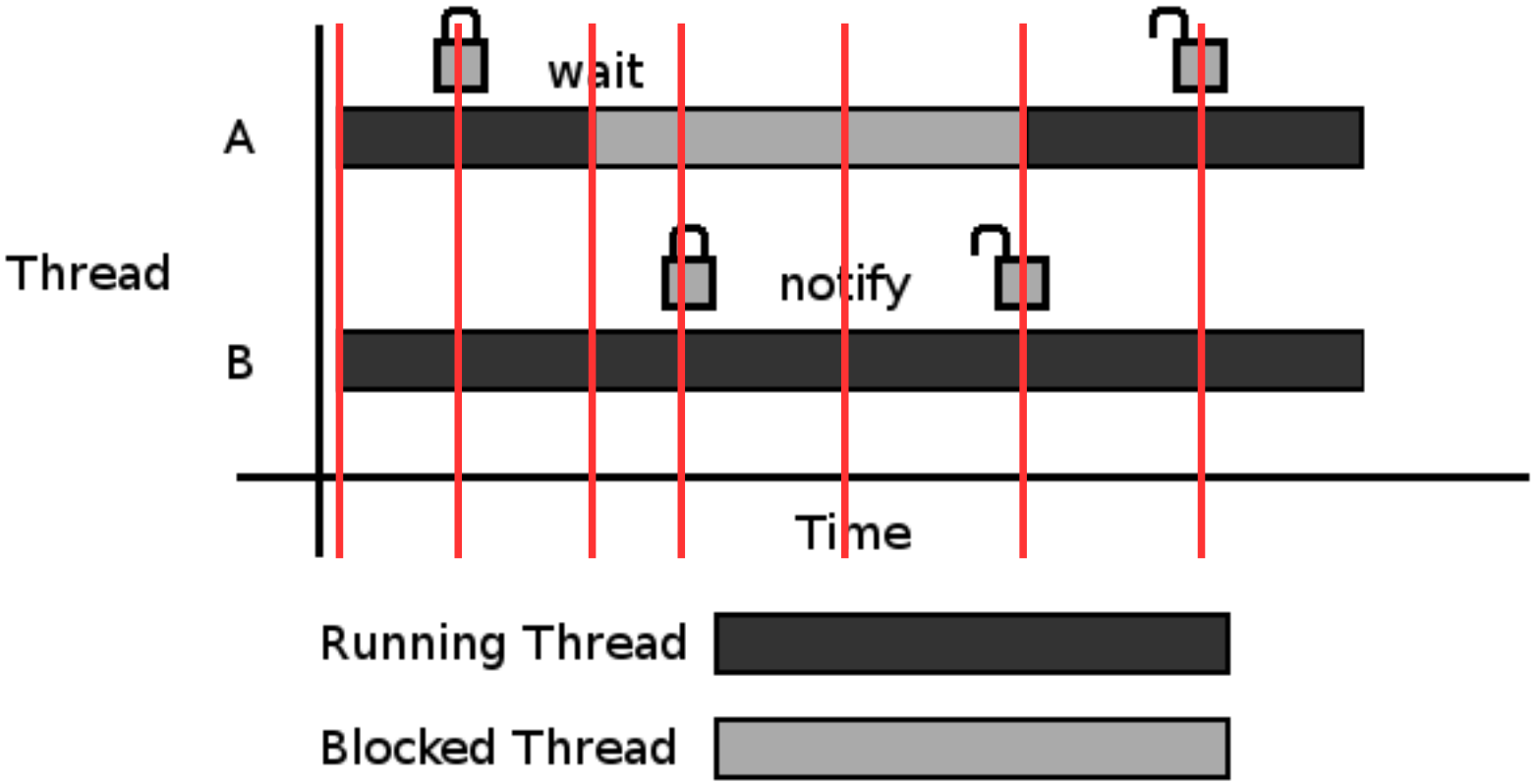
```
public class Example {
    public void doSomething(){
        -- not synch'd --
        synchronized(this){
            ....
        }
        -- not synch'd --
    }
}
```

Keyword: Synchronized

- instance method
- static method
- instance code block
- static code block

```
public class Example {
    public void doSomething(){
        -- not synch'd --
        synchronized(SomeClass.class){
            ....
        }
        -- not synch'd --
    }
}
```

wait - notify



wait-notify

```
public class ThreadA extends Thread{
  public void run(){
    synchronized(WaitNotify.class){
      try {
        System.out.println("Thread A - Before");
        WaitNotify.class.wait();
        System.out.println("Thread A - After");
      } catch (InterruptedException ex) {}
    }
  }
}
```

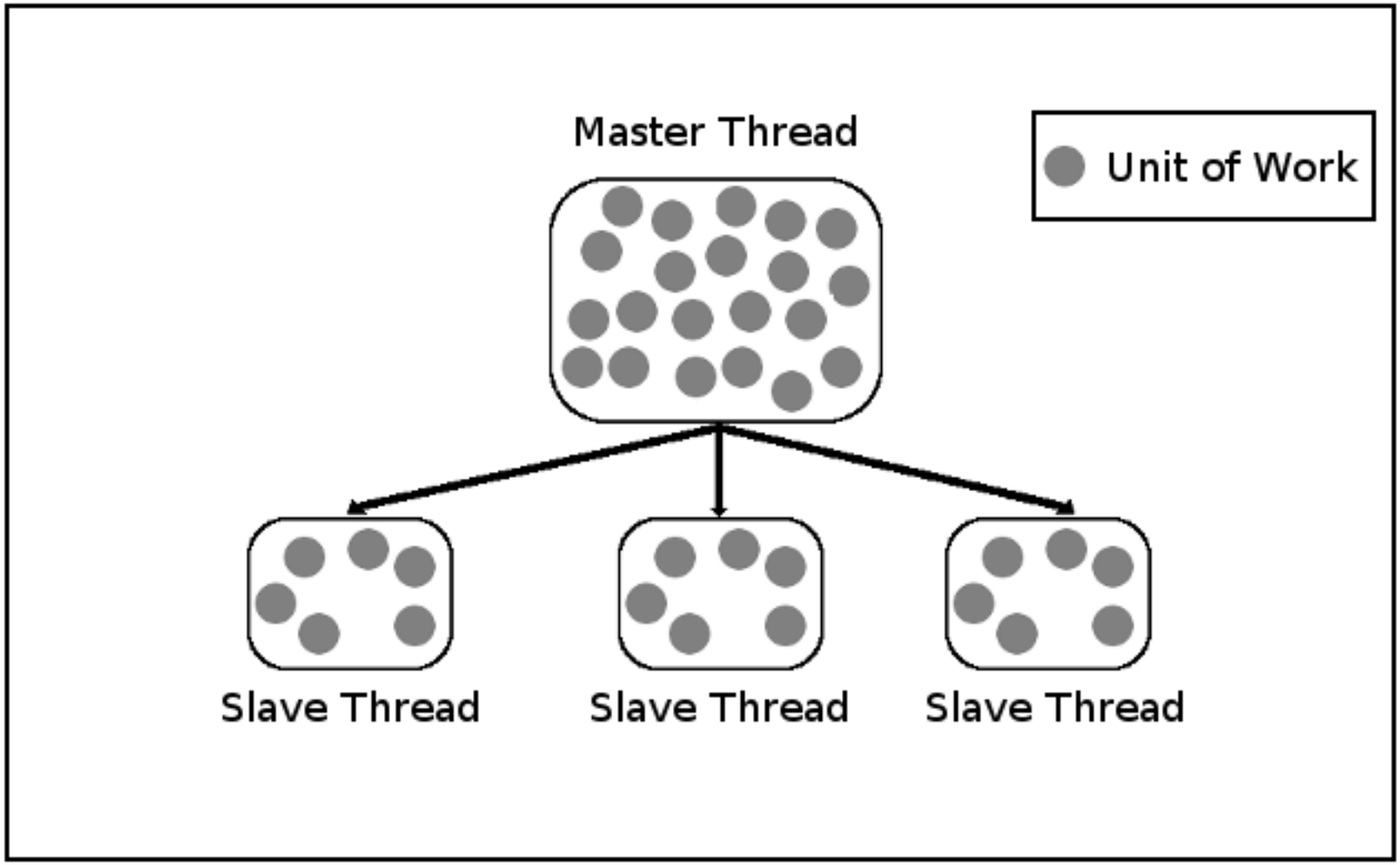
```
public class ThreadB extends Thread{
  public void run(){
    synchronized(WaitNotify.class){
        System.out.println("Thread B - Before");
        WaitNotify.someCondition = true;
        WaitNotify.class.notify();
        System.out.println("Thread B - After");
    }
  }
}
```

wait-notify (fixed)

```
public class ThreadA extends Thread{
  public void run(){
    synchronized(WaitNotify.class){
      try {
        System.out.println("Thread A - Before");
        while (WaitNotify.someCondition == false) WaitNotify.class.wait();
        System.out.println("Thread A - After");
      } catch (InterruptedException ex) {}
    }
  }
}
```

```
public class ThreadB extends Thread{
  public void run(){
    synchronized(WaitNotify.class){
        System.out.println("Thread B - Before");
        WaitNotify.someCondition = true;
        WaitNotify.class.notify();
        System.out.println("Thread B - After");
    }
  }
}
```

Master-Slave Example



Final Example

/work/edward/Examples/Farmer-Worker/

Thank You,
Questions?