Java CyclicBarrier: Example Application

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Learning Objectives in this Part of the Lesson

- Understand the structure & functionality of Java CyclicBarrier
- Recognize the key methods in the Java CyclicBarrier
- Know how to program with Java CyclicBarrier in practice

```
class GCDCyclicBarrierWorker implements Runnable {
  private final CyclicBarrier mEntryBarrier;
  private final CyclicBarrier mExitBarrier; ...

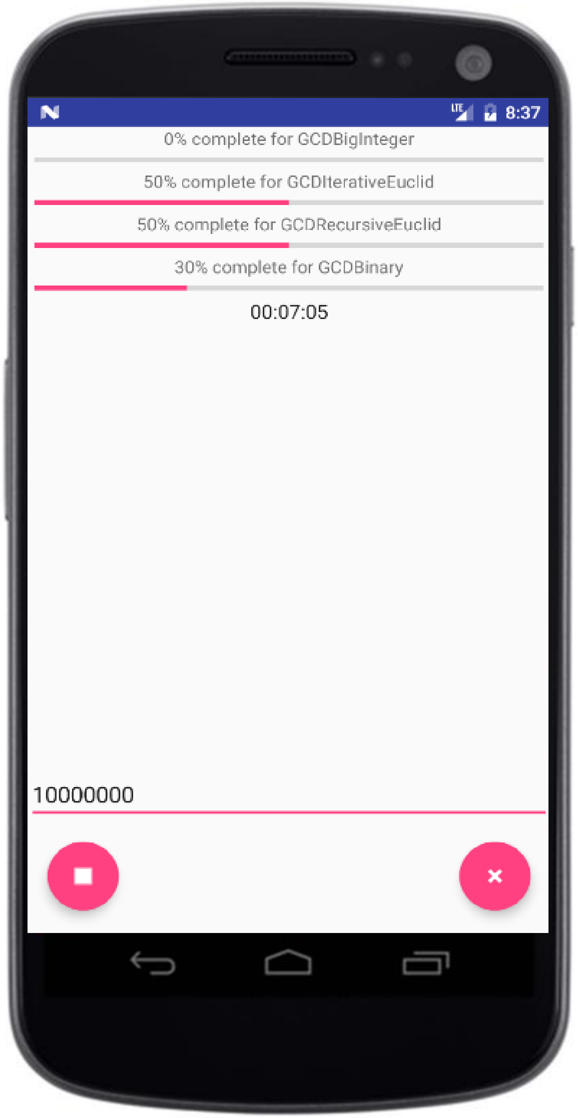
  GCDCyclicBarrierWorker(CyclicBarrier entryBarrier,
                          CyclicBarrier exitBarrier, ...) {
    mEntryBarrier = entryBarrier; mExitBarrier = exitBarrier;
    ...
  }

  public void run() {
    ...
    mEntryBarrier.await();
    runTest();
    mExitBarrier.await();
    ...
```

Overview of the GCD App

Overview of the GCD App

- This Android app uses CyclicBarrier objects to coordinate the concurrent benchmarking of four Greatest Common Divisor (GCD) algorithms



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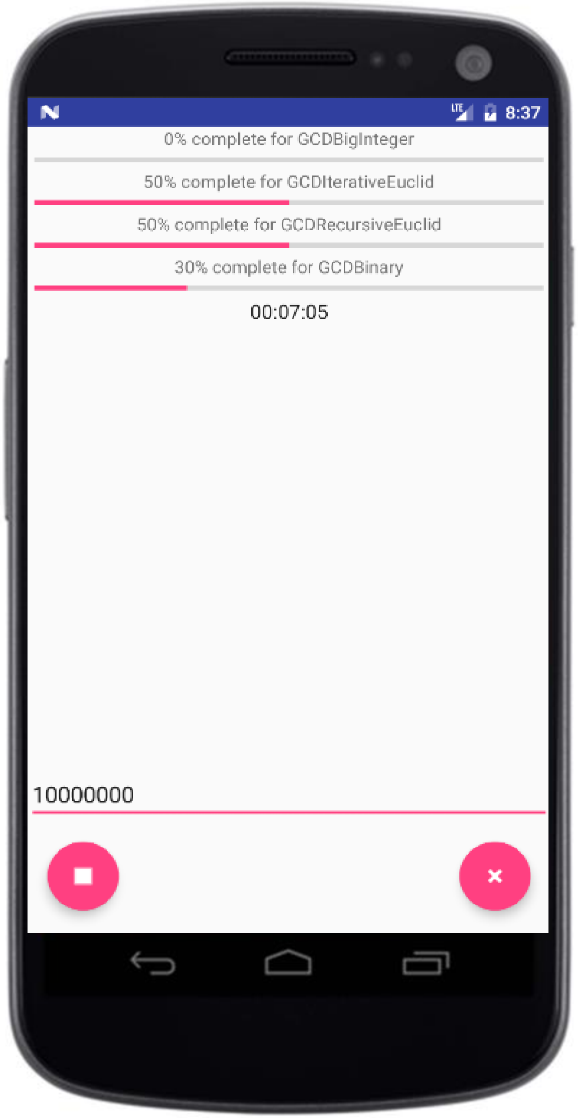
See github.com/douglascraigschmidt/POSA/tree/master/ex/M3/GCD/CyclicBarrier

Overview of the GCD App

- This Android app uses CyclicBarrier objects to coordinate the concurrent benchmarking of four Greatest Common Divisor (GCD) algorithms
  - GCD computes the largest positive integer that is a divisor of two numbers
    - e.g., the GCD of 80 & 120 = 40



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See en.wikipedia.org/wiki/Greatest_common_divisor

Overview of the GCD App

- This Android app uses CyclicBarrier objects to coordinate the concurrent benchmarking of four Greatest Common Divisor (GCD) algorithms
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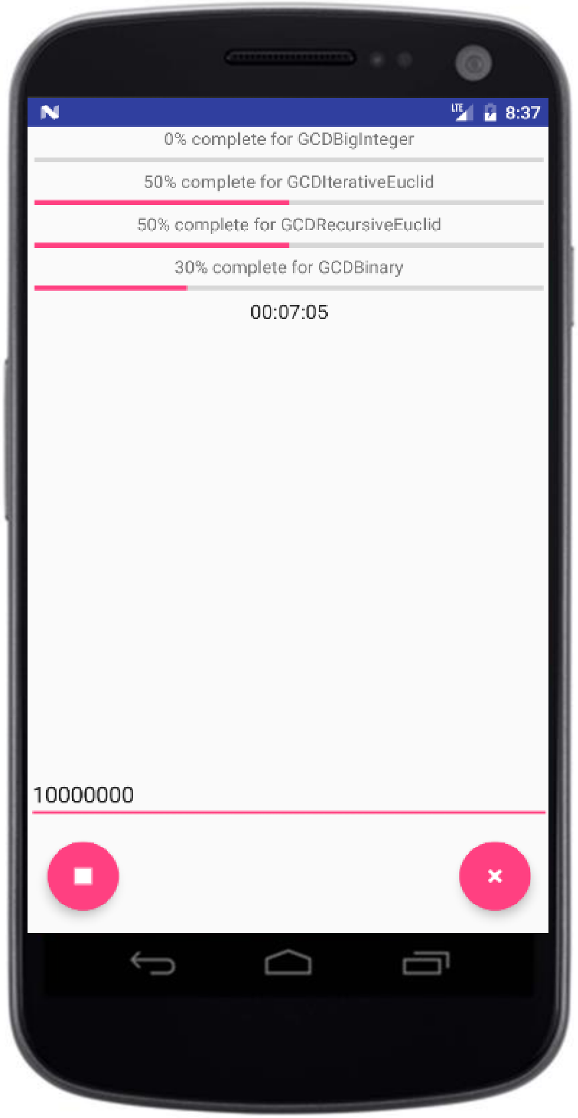
  - Four GCD algorithms are tested



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  - GCD computes the largest positive integer that is a divisor of two numbers
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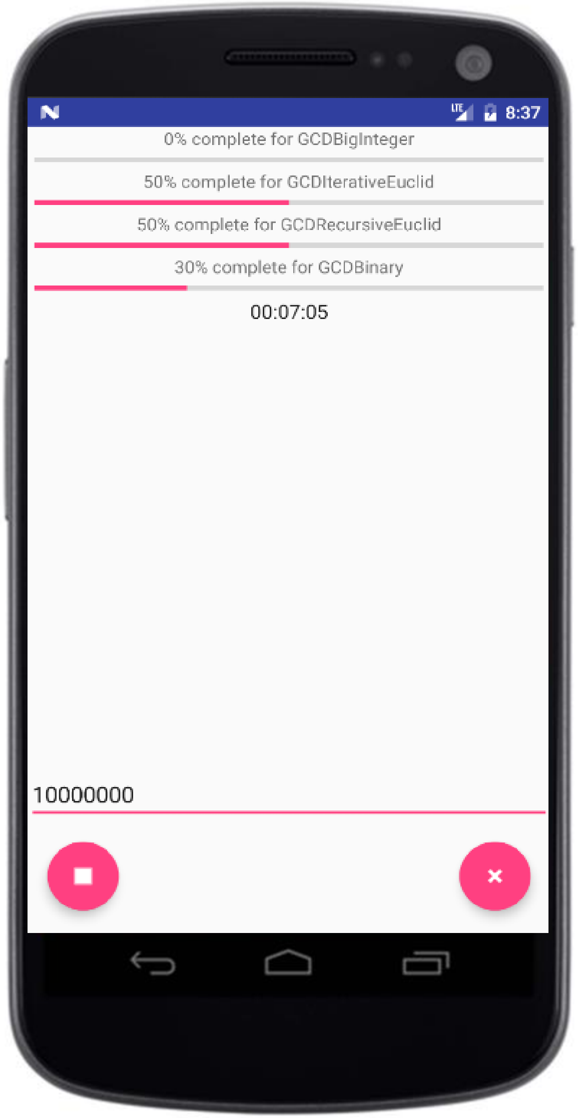
    - The gcd() method defined by BigInteger



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See docs.oracle.com/javase/8/docs/api/java/math/BigInteger.html#gcd

Overview of the GCD App

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  - GCD computes the largest positive integer that is a divisor of two numbers
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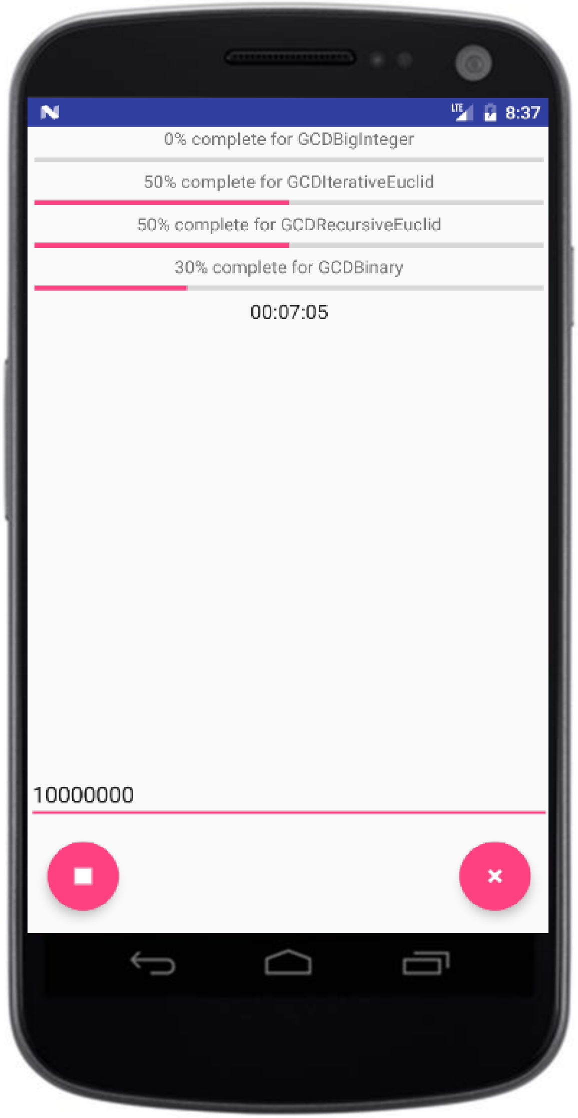
    - The gcd() method defined by BigInteger
    - An iterative Euclid algorithm



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See en.wikipedia.org/wiki/Euclidean_algorithm

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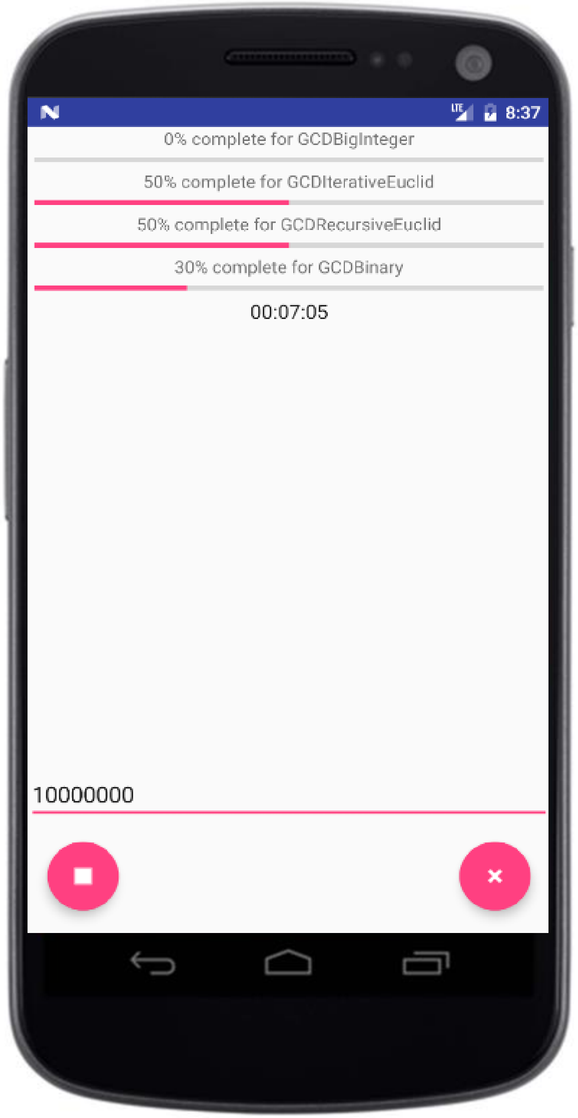

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See codedost.com/java/methods-and-recursion-in-java/java-program-to-find-gcd-hcf-using-euclidean-algorithm-using-recursion

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- This Android app uses CyclicBarrier objects to coordinate the concurrent benchmarking of four Greatest Common Divisor (GCD) algorithms
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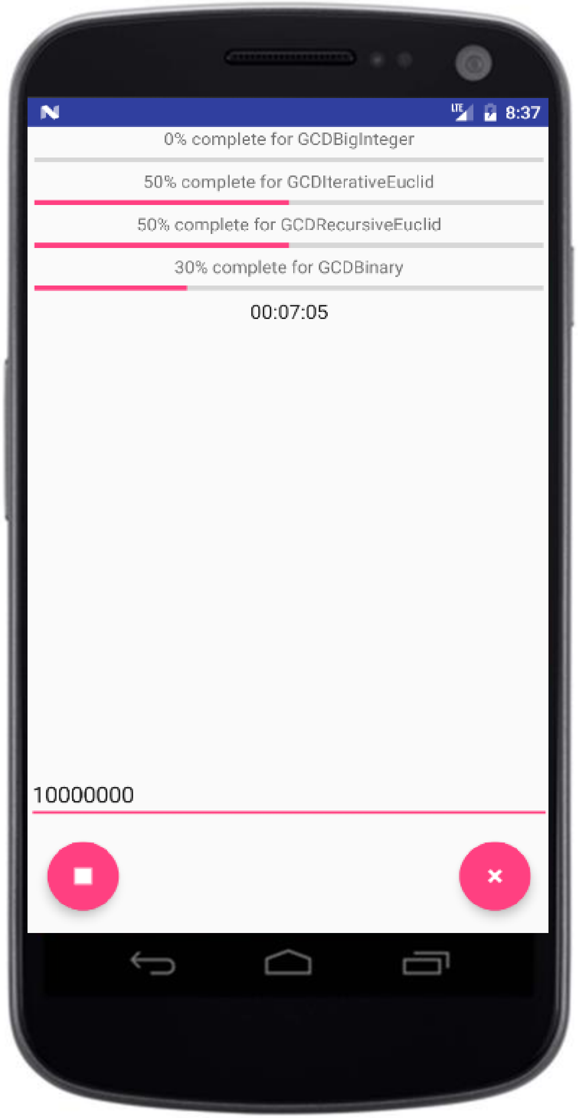
    - The gcd() method defined by BigInteger
    - An iterative Euclid algorithm
    - A recursive Euclid algorithm
    - A complex GCD algorithm that uses binary arithmetic



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See en.wikipedia.org/wiki/Binary_GCD_algorithm

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    - A re
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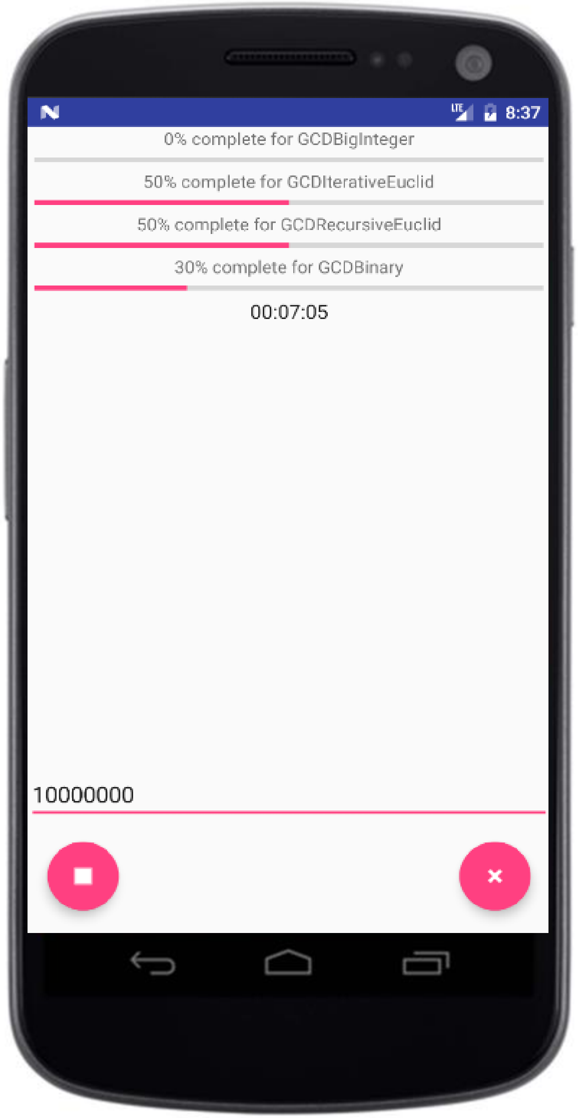

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However, the details of these algorithms are not important for our discussion

GCDCyclicBarrierTest Class Walkthrough

GCDCyclicBarrierTest Class Walkthrough

- Create worker threads that use exit & entry barrier CyclicBarrier objects

```
class GCDCyclicBarrierTest {
  @Test public void testGCDCyclicBarrierTester() {
    List<GCDTuple> gcdTests = makeGCDTuples();

    CyclicBarrier entryBarrier =
      new CyclicBarrier(gcdTests.size() + 1, () ->
           GCDCyclicBarrierWorker.initializeInput(sITERATIONS));
    CyclicBarrier exitBarrier =
      new CyclicBarrier(gcdTests.size() + 1);

    for (int cycle = 1; cycle <= sCYCLES; cycle++) {
      gcdTests.forEach(gcdTuple -> new Thread(new
        GCDCyclicBarrierWorker(entryBarrier, exitBarrier,
                               gcdTuple, this)).start());
      System.out.println("Starting tests");
      entryBarrier.await();
      System.out.println("Waiting for results");
      exitBarrier.await();
      System.out.println("All tests done"); ...
```

See GCD/CyclicBarrier/app/src/test/java/edu/vandy/gcdtesttask/GCDCyclicBarrierTest.java

GCDCyclicBarrierTest Class Walkthrough

- Create worker threads that use exit & entry barrier CyclicBarrier objects

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Entry point into the unit test

GCDCyclicBarrierTest Class Walkthrough

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```

Initialize all the GCD algorithms

GCDCyclicBarrierTest Class Walkthrough

- Create worker threads that use exit & entry barrier CyclicBarrier objects

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      entryBarrier.await();
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```

Create entry barrier

We add a "+ 1" for the thread that initializes the tests

GCDCyclicBarrierTest Class Walkthrough

- Create worker threads that use exit & entry barrier CyclicBarrier objects

Barrier action allocates each cycle's input

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      System.out.println("Starting tests");
      entryBarrier.await();
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```

Create exit barrier

We add a "+ 1" for the thread that initializes the tests

GCDCyclicBarrierTest Class Walkthrough

- Create worker threads that use exit & entry barrier CyclicBarrier objects

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```

Iterate through each cycle

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      exitBarrier.await();
      System.out.println("All tests done"); ...
```

Create & start threads w/barriers

GCDCyclicBarrierTest Class Walkthrough

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```

Don't start just yet

GCDCyclicBarrierTest Class Walkthrough

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      entryBarrier.await();
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      exitBarrier.await();
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```

Let all worker threads proceed at the same time, fixing limitation with CountDownLatch

See previous lesson on "*Java CountDownLatch*"

GCDCyclicBarrierTest Class Walkthrough

- Create worker threads that use exit & entry barrier CyclicBarrier objects

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      System.out.println("Starting tests");
      entryBarrier.await();
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      exitBarrier.await();
      System.out.println("All tests done"); ...
```

Exit barrier waits for all threads to finish this cycle

After await() returns for a CyclicBarrier it will be reset (& is thus reusable) *without* needing to create a new CyclicBarrier instance

GCDCyclicBarrierWorker Class Walkthrough

GCDCyclicBarrierWorker Class Walkthrough

- This class applies two entry & exit barrier CyclicBarrier objects to coordinate the benchmarking of a given GCD algorithm implementation

```
class GCDCyclicBarrierWorker implements Runnable {
  private final CyclicBarrier mEntryBarrier;
  private final CyclicBarrier mExitBarrier;
  ...

  GCDCyclicBarrierWorker(CyclicBarrier entryBarrier,
                         CyclicBarrier exitBarrier, ...) {
    mEntryBarrier = entryBarrier; mExitBarrier = exitBarrier;
    ...
  }

  public void run() {
    ...
    mEntryBarrier.await();
    runTest();
    mExitBarrier.await();
    ...
```

Define a worker that runs in a thread

See GCD/CyclicBarrier/app/src/main/java/edu/vandy/gcdtesttask/presenter/GCDCyclicBarrierWorker.java

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    mEntryBarrier = entryBarrier; mExitBarrier = exitBarrier;
    ...
  }

  public void run() {
    ...
    mEntryBarrier.await();
    runTest();
    mExitBarrier.await();
    ...
```

Initialize barrier fields

GCDCyclicBarrierWorker Class Walkthrough

- This class applies two entry & exit barrier CyclicBarrier objects to coordinate the benchmarking of a given GCD algorithm implementation

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  GCDCyclicBarrierWorker(CyclicBarrier entryBarrier,
                         CyclicBarrier exitBarrier, ...) {
    mEntryBarrier = entryBarrier; mExitBarrier = exitBarrier;
    ...
  }
```

This hook method executes after the thread is started

```
  public void run() {
    ...
    mEntryBarrier.await();
    runTest();
    mExitBarrier.await();
    ...
```

GCDCyclicBarrierWorker Class Walkthrough

- This class applies two entry & exit barrier CyclicBarrier objects to coordinate the benchmarking of a given GCD algorithm implementation

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    ...
  }

  public void run() {
    ...
    mEntryBarrier.await();
    runTest();
    mExitBarrier.await();
    ...
```

This entry barrier causes all worker threads to wait until they are all ready, thus fixing the earlier limitation with CountDownLatch

See previous lesson on "*Java CountDownLatch*"

GCDCyclicBarrierWorker Class Walkthrough

- This class applies two entry & exit barrier CyclicBarrier objects to coordinate the benchmarking of a given GCD algorithm implementation

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  }

  public void run() {
    ...
    mEntryBarrier.await();
    runTest();
    mExitBarrier.await();
    ...
```

Run the GCD algorithm associated with this object

GCDCyclicBarrierWorker Class Walkthrough

- This class applies two entry & exit barrier CyclicBarrier objects to coordinate the benchmarking of a given GCD algorithm implementation

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  }

  public void run() {
    ...
    mEntryBarrier.await();
    runTest();
    mExitBarrier.await();
    ...
```

Exit barrier waits until all threads are done before returning

End of Java CyclicBarrier: Example Application