Java Executor:

Application to the PrimeChecker App

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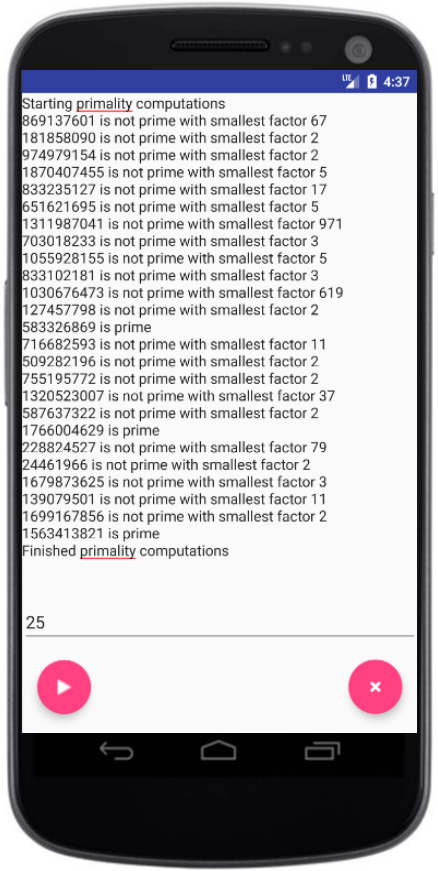
Learning Objectives in this Part of the Lesson

- Recognize the simple/single feature provided by the Java Executor interface
- Understand various implementation choices for the Executor interface
- Learn how to program a simple "prime checker" app using the Java Executor interface



Overview of the PrimeChecker App

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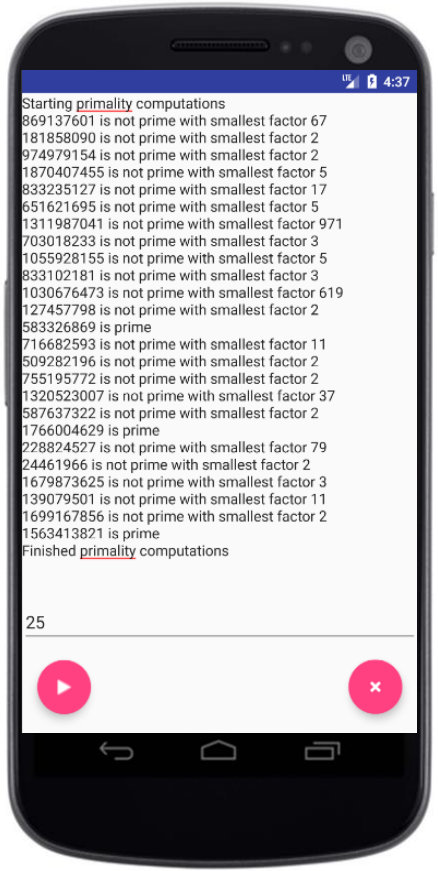
- This app shows how to use the Java Executor framework to check if *N* random #'s are prime

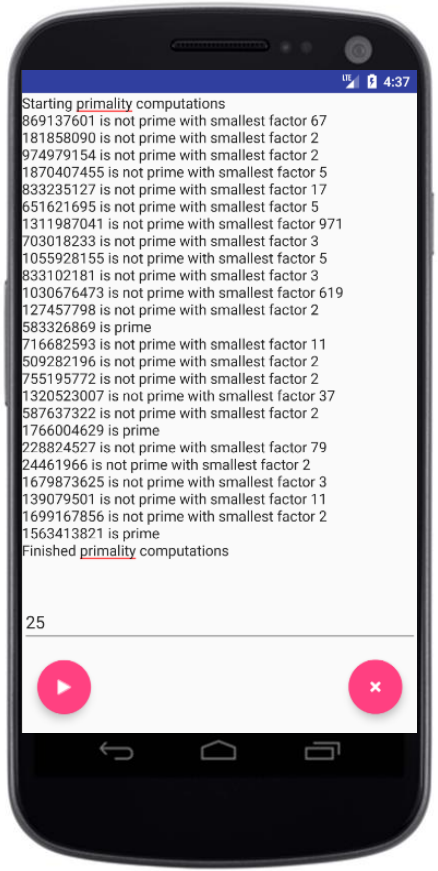


See github.com/douglascraigschmidt/POSA/tree/master/ex/M4/Primes/PrimeExecutor

Overview of the PrimeChecker App

- This app shows how to use the Java Executor framework to check if *N* random #'s are prime
  - Each natural # divisible only by 1 & itself is prime

2	3	5	7	11
13	17	19	23	29
31	37	41	43	47
53	59	61	67	71
73	79	83	89	97



See en.wikipedia.org/wiki/Prime_number

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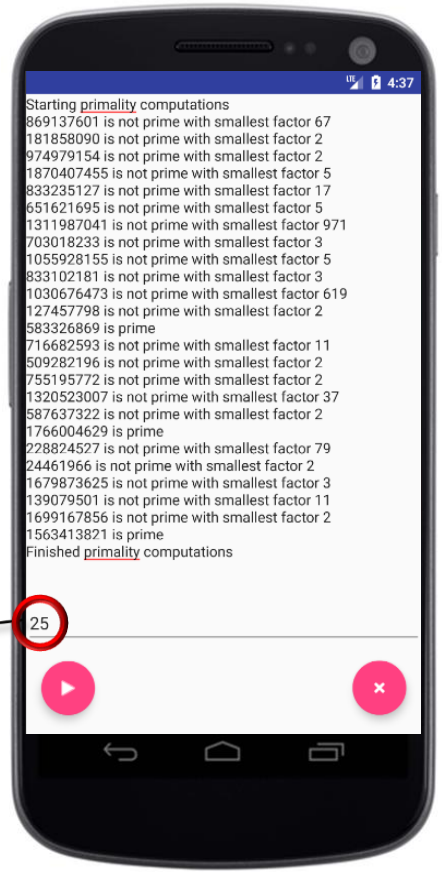

The user can select the # 'N'

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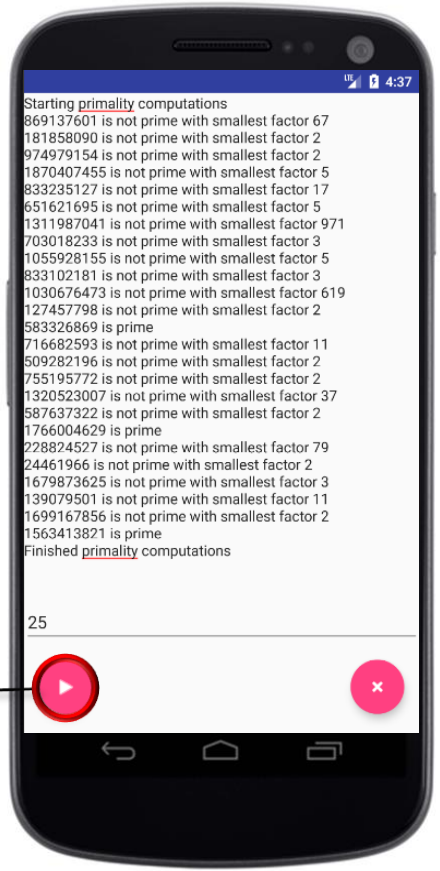
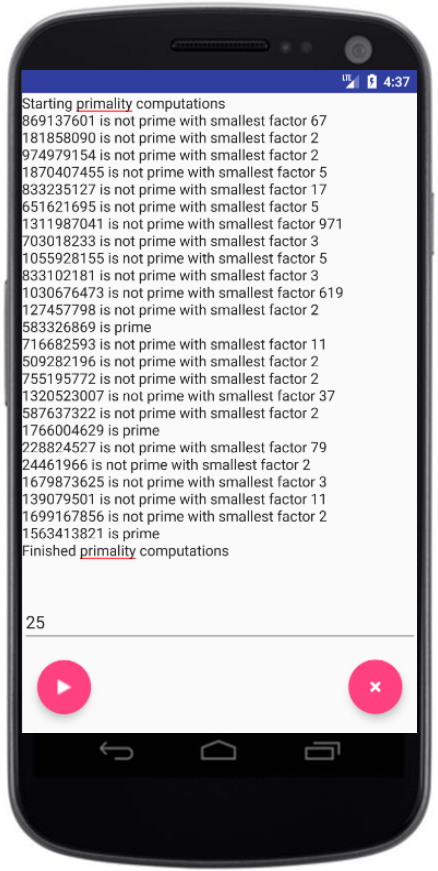


The user can also start running the app

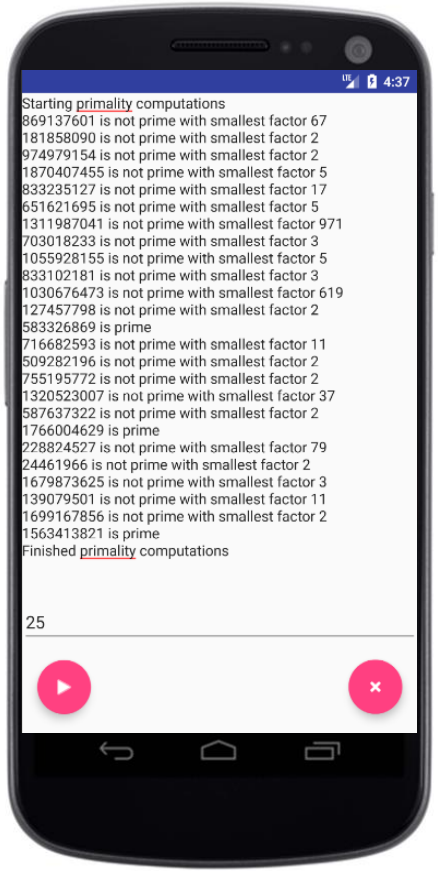
Overview of the PrimeChecker App

- This app has several notable properties



Overview of the PrimeChecker App

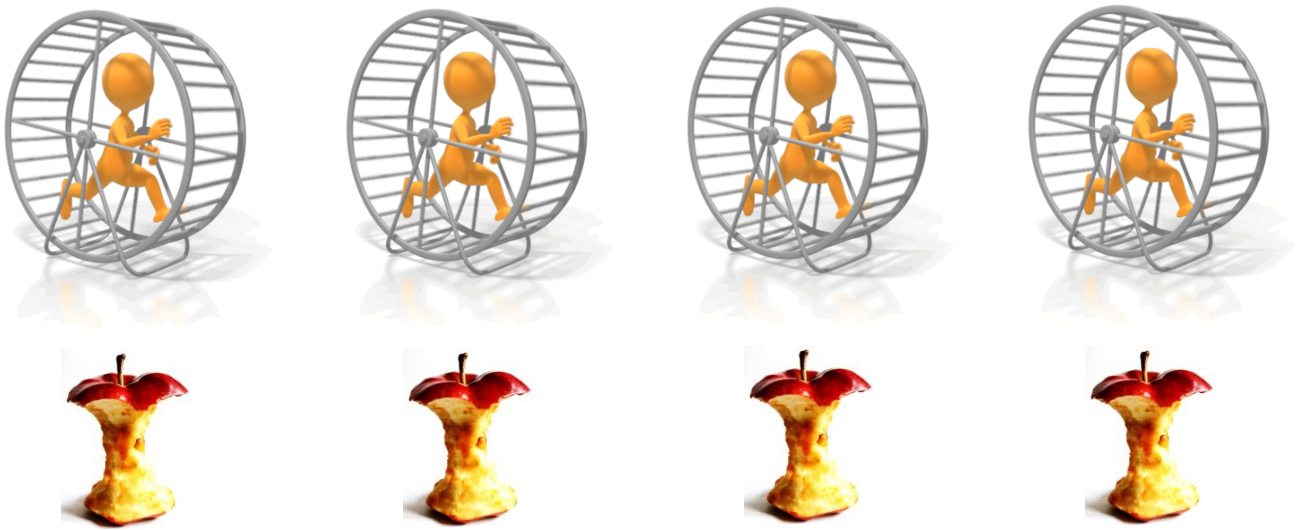
- This app has several notable properties
  - It is "embarrassingly parallel"
    - i.e., no data dependencies between running tasks

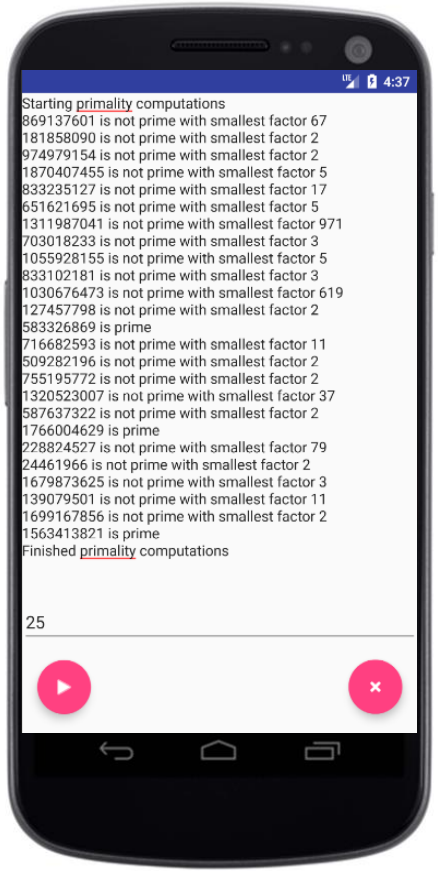


See en.wikipedia.org/wiki/Embarrassingly_parallel

Overview of the PrimeChecker App

- This app has several notable properties
  - It is "embarrassingly parallel"
  - It is compute-bound
    - i.e., time to complete a task is dictated by CPU speed





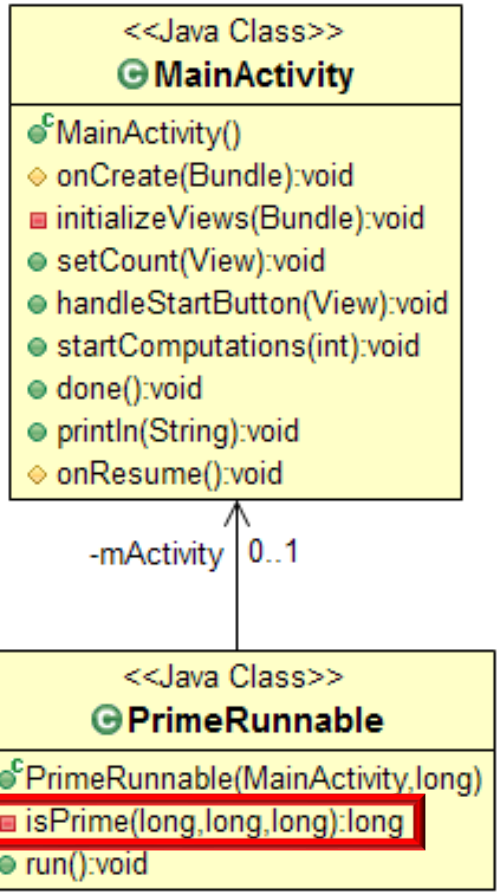
See en.wikipedia.org/wiki/CPU-bound

Overview of the PrimeChecker App

- PrimeRunnable defines a brute-force means to check if a # is prime

```
long isPrime(long n) {
  if (n > 3)
    for (long factor = 2;
         factor <= n / 2;
         ++factor)
      if (n / factor * factor
          == n)
        return factor;

  return 0;
}
```



See www.mkyong.com/java/how-to-determine-a-prime-number-in-java

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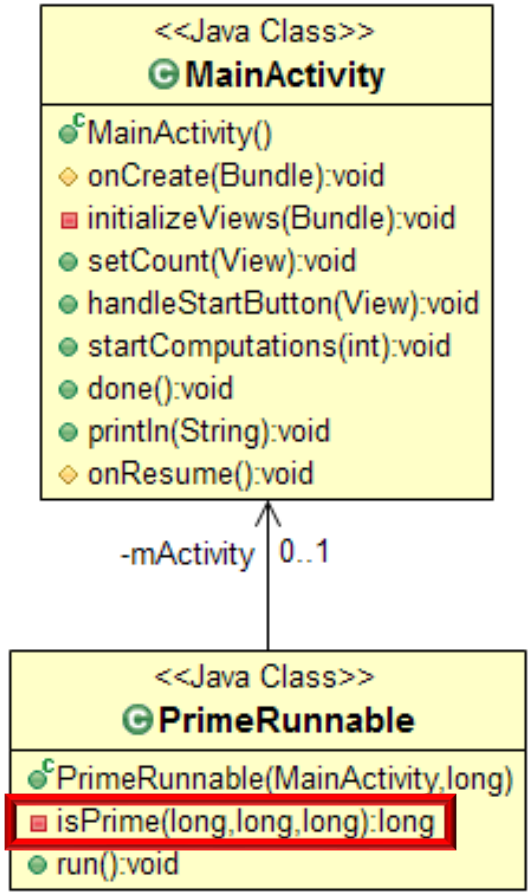
Note how this algorithm is "compute-bound"



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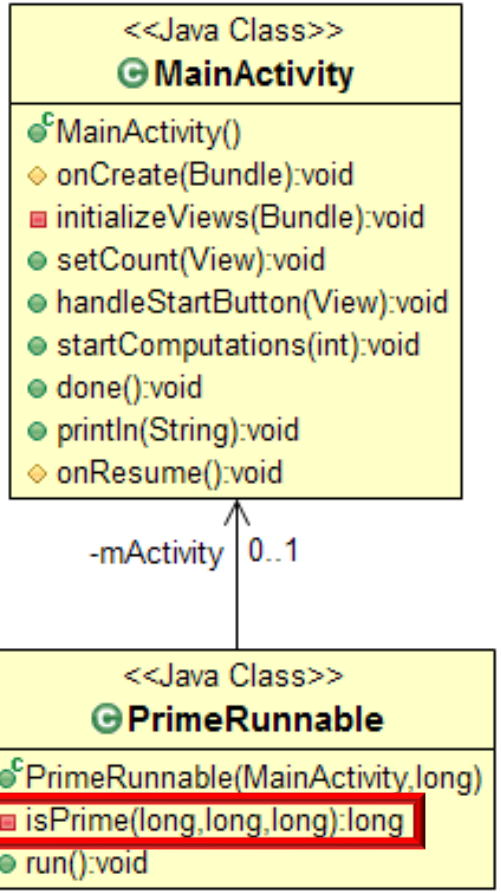
Return 0 if # is prime or smallest factor if not



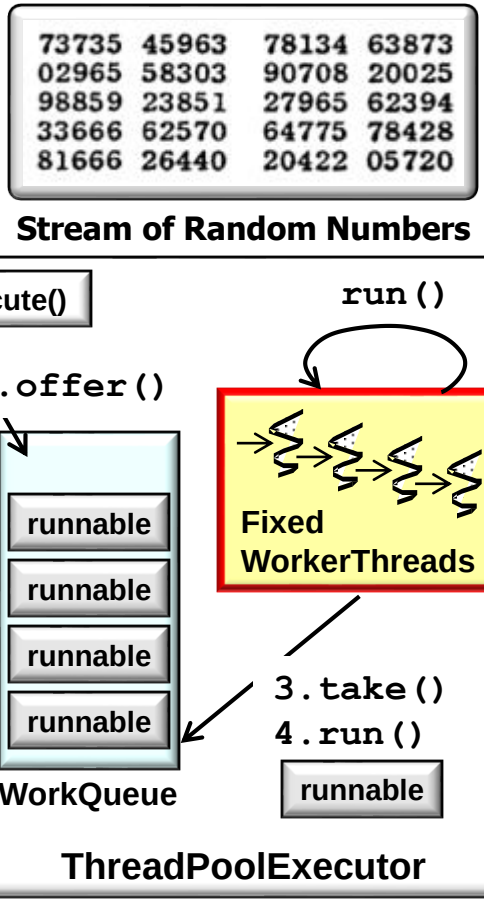
The goal is to burn non-trivial CPU time!!

Overview of the PrimeChecker App

- This app uses a fixed-sized Executor implementation

```
mExecutor = Executors
   .newFixedThreadPool
      (Runtime.getRuntime().
       availableProcessors());
```

Create fixed-sized thread pool



See docs.oracle.com/javase/8/docs/api/java/util/concurrent/Executors.html#newFixedThreadPool

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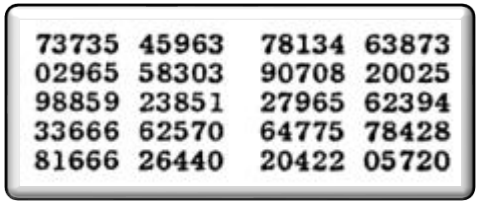
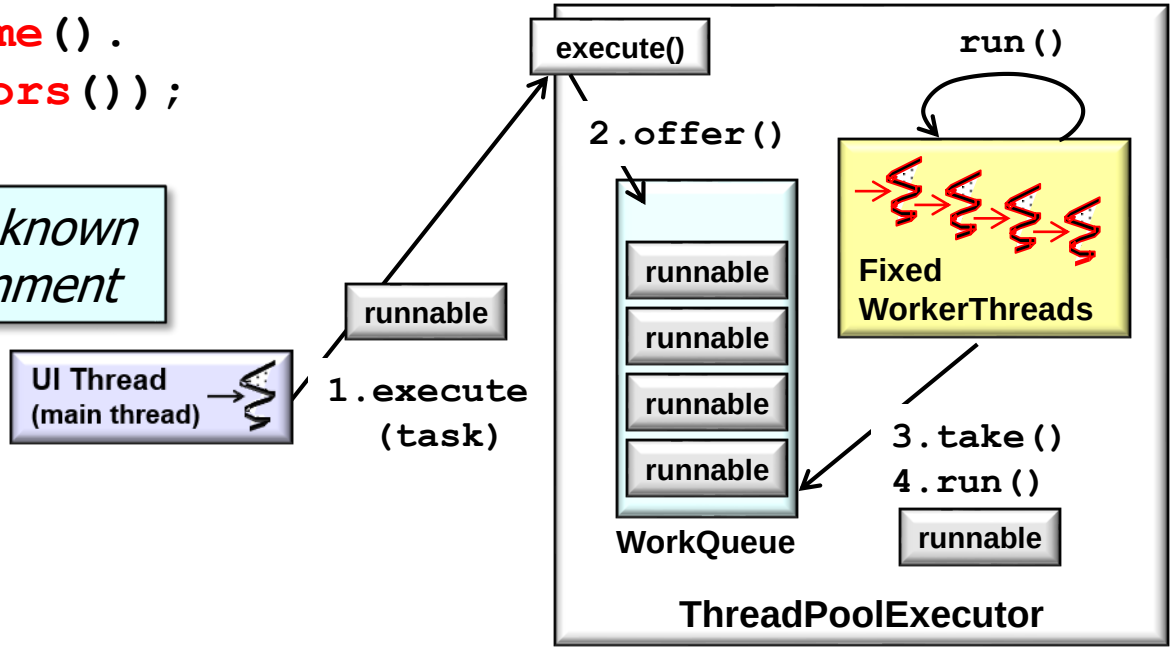
Returns # of processor cores known to the Java execution environment





See docs.oracle.com/javase/8/docs/api/java/lang/Runtime.html#availableProcessors

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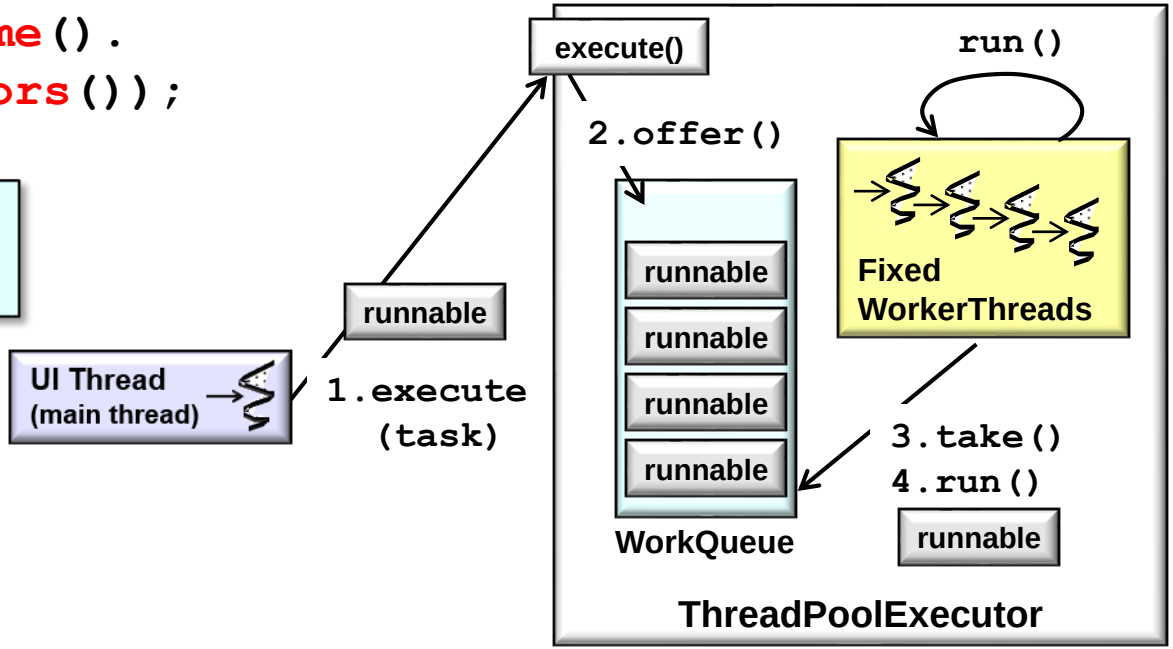
Use this value since isPrime() is a "compute-bound" task

73735	45963	78134	63873
02965	58303	90708	20025
98859	23851	27965	62394
33666	62570	64775	78428
81666	26440	20422	05720

Stream of Random Numbers



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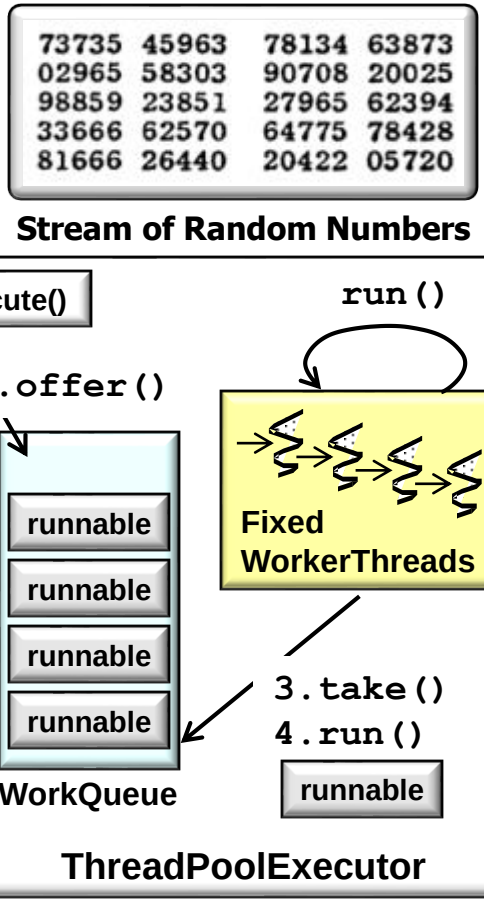

The UI thread generates random #'s that are processed via the thread pool

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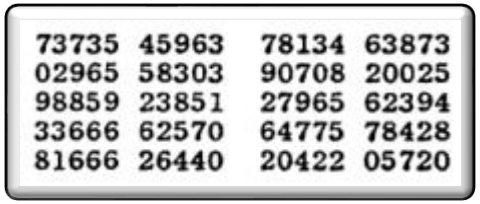
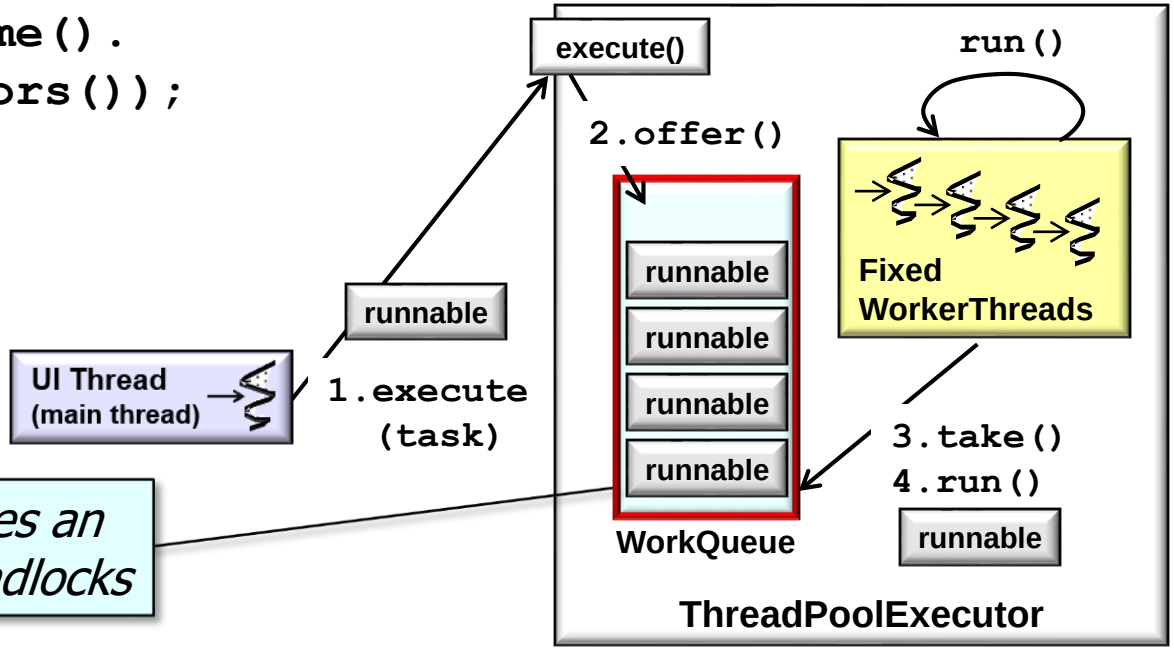




This fixed-size thread pool uses an unbounded queue to avoid deadlocks

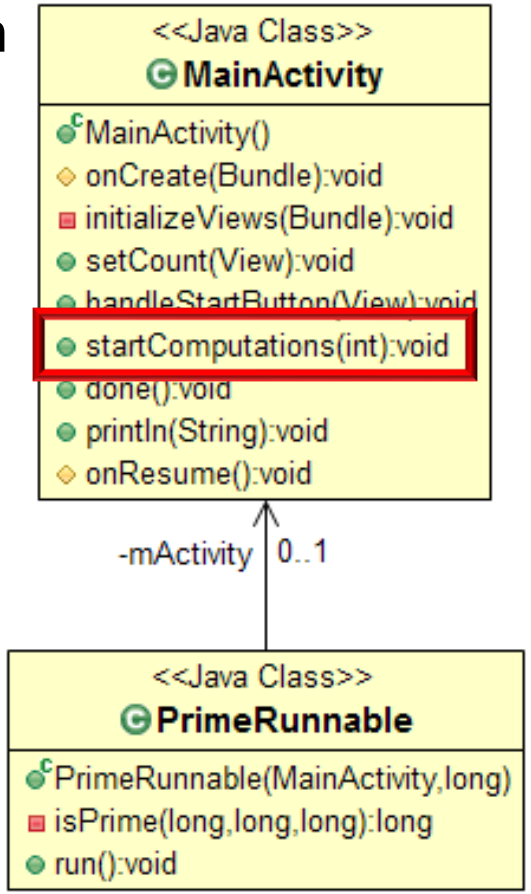
See asznajder.github.io/thread-pool-induced-deadlocks

Overview of the PrimeChecker App

- MainActivity creates/executes a PrimeRunnable for each of the "count" random #

```
new Random()
   .longs(count,
          sMAX_VALUE - count, sMAX_VALUE)

   .forEach(randomNumber ->
            mExecutor.execute
               (new PrimeRunnable
                     (this, randomNumber)));
```



Overview of the PrimeChecker App

- MainActivity creates/executes a PrimeRunnable for each of the "count" random #

These random longs are in the range sMAX_VALUE – count & sMAX_VALUE

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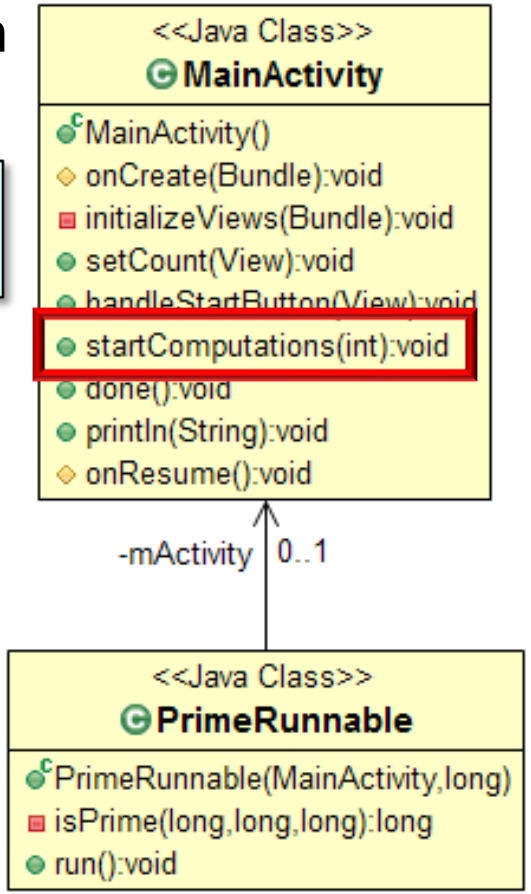

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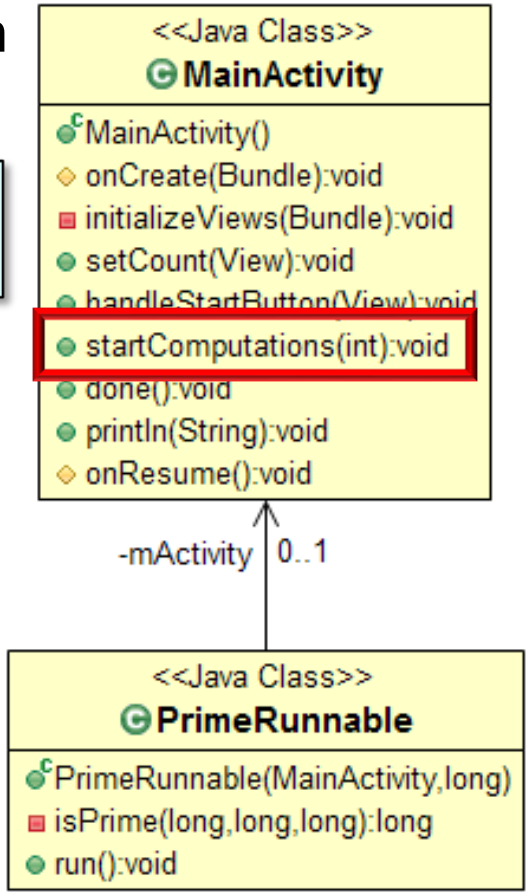

sMAX_VALUE is set to a large #, e.g., 1,000,000,000

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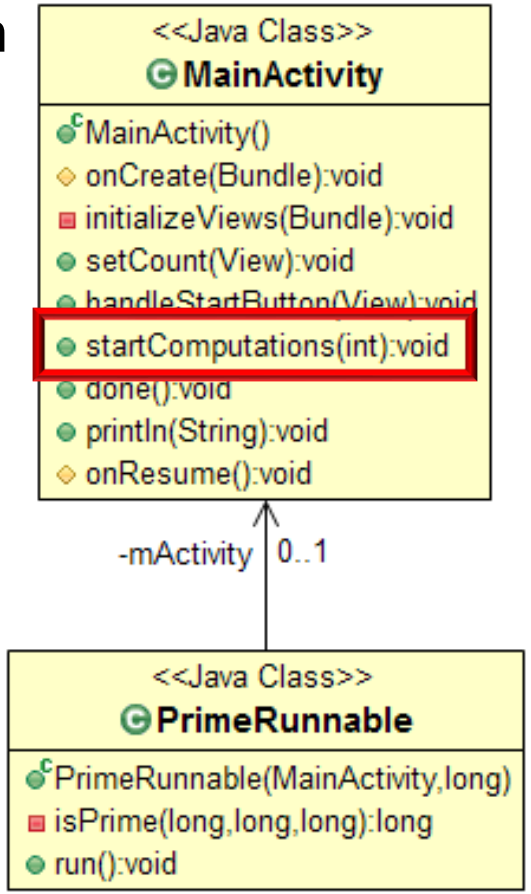
Each random long is queued for execution by a thread in the pool



See docs.oracle.com/javase/8/docs/api/java/util/concurrent/Executor.html#execute

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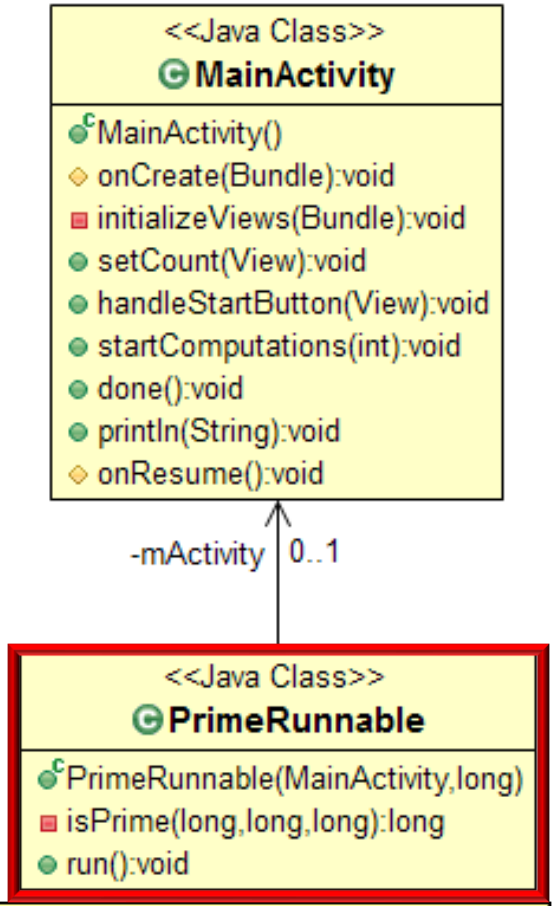
- PrimeRunnable determines if a # is prime

```
class PrimeRunnable implements Runnable {
  long mPrimeCandidate;
  private final MainActivity mActivity;
  ...

  PrimeRunnable(MainActivity a, Long pc)
  { mActivity = a; mPrimeCandidate = pc; }

  long isPrime(long n) { ... }

  void run() {
    long smallestFactor =
      isPrime(mPrimeCandidate);
    ...
```



See PrimeExecutor/app/src/main/java/vandy/mooc/prime/activities/PrimeRunnable.java

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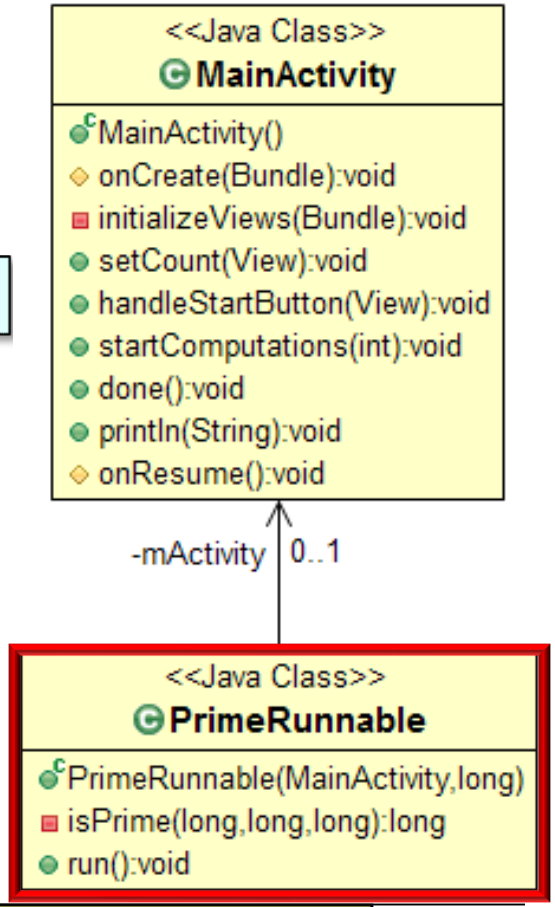
Implements Runnable



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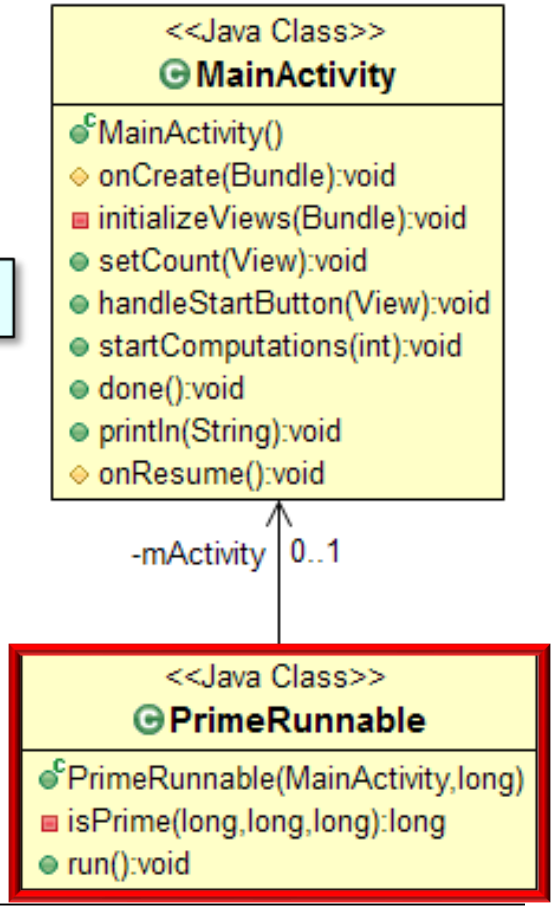
Constructor stores prime # candidate & activity



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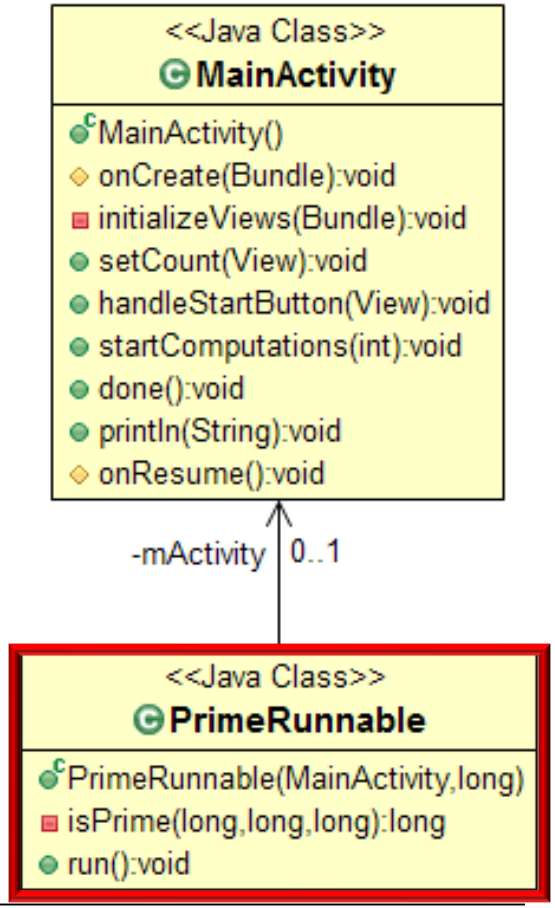

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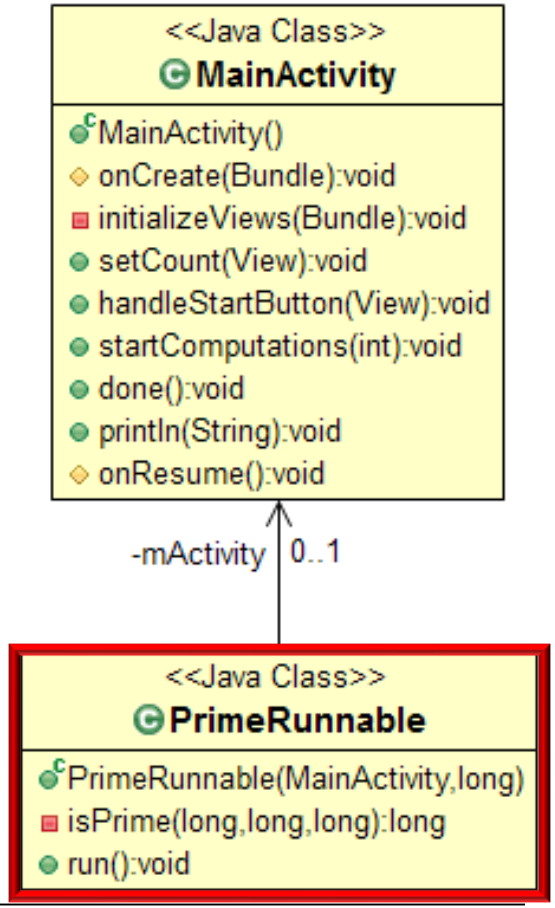
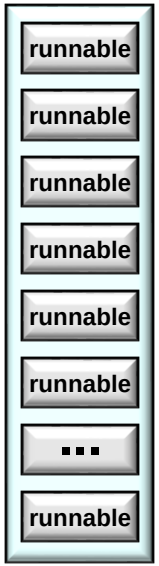
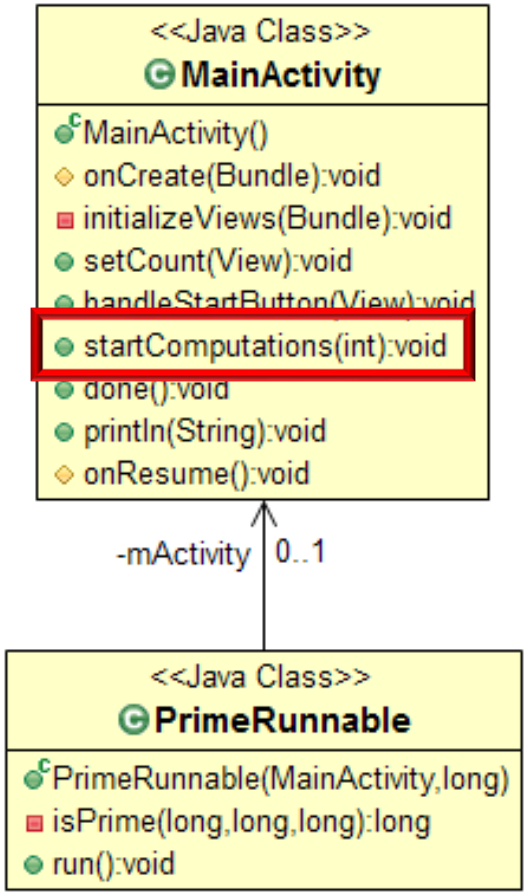


run() hook method invokes isPrime() in a pool thread

Overview of the PrimeChecker App

- Although there may be many PrimeRunnable instances, they will run on a (much) smaller # of threads, which can be tuned transparently





End of Java Executor: Application to PrimeChecker App