Turbo Charge CPU Utilization in Fork/Join Using the ManagedBlocker

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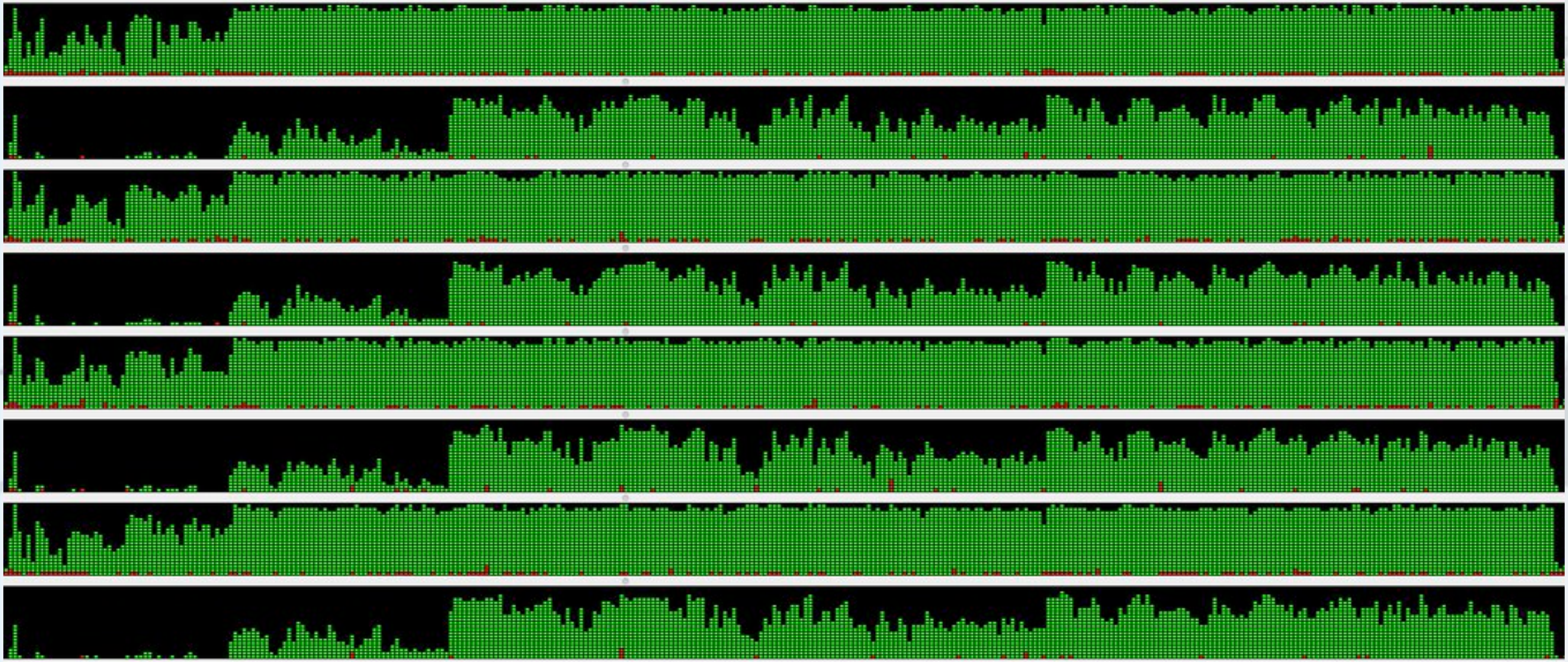
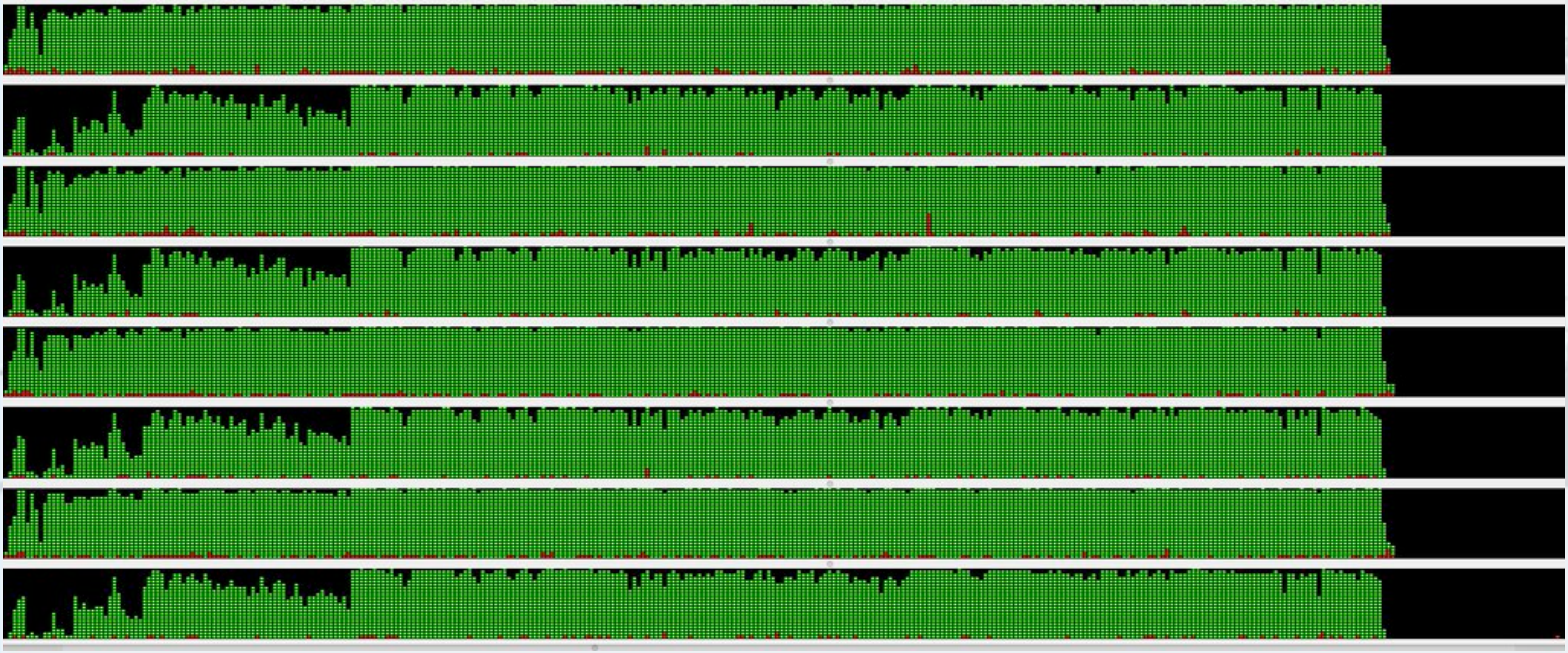
java training

Regular

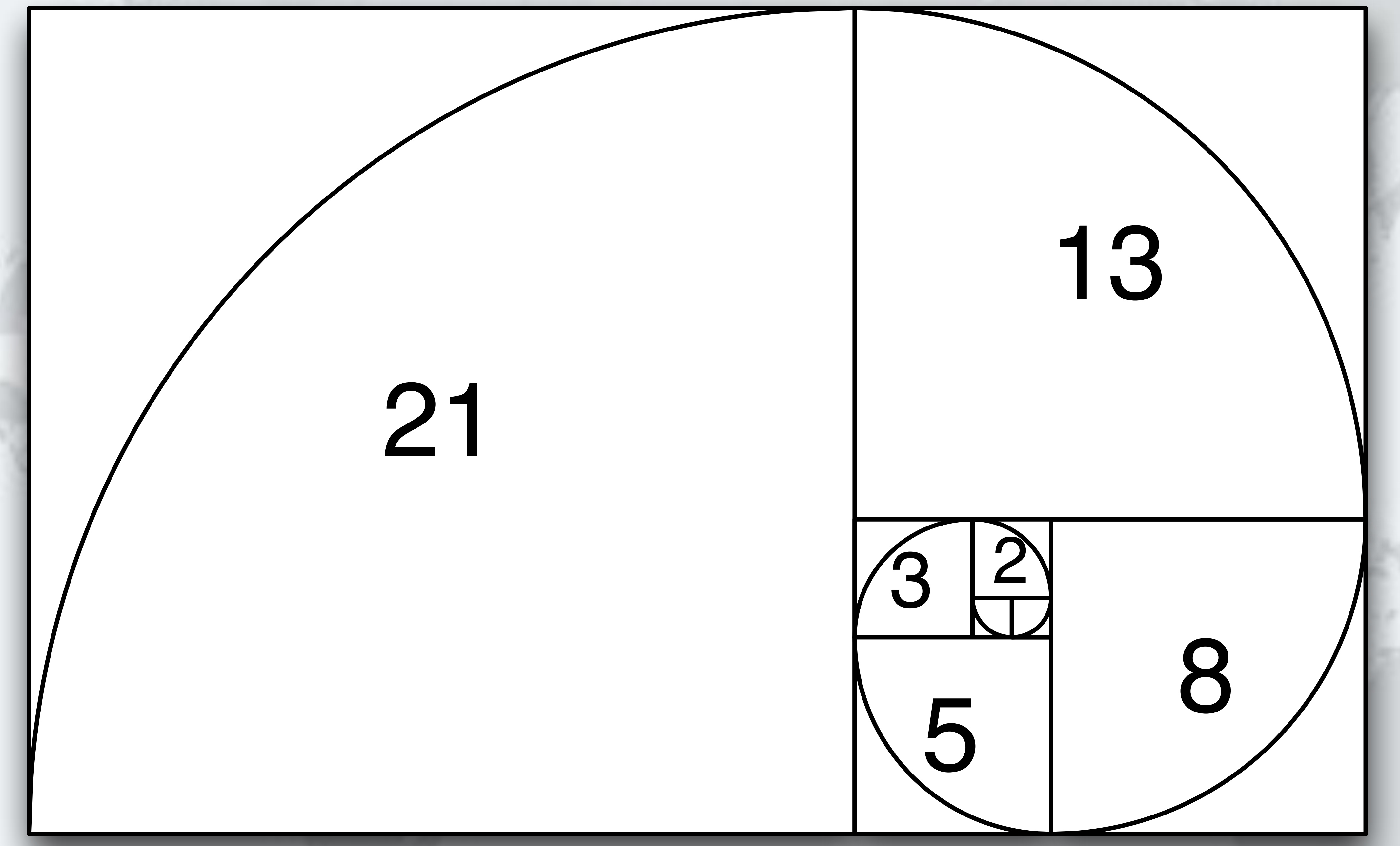


ManagedBlocker



Speeding Up Fibonacci

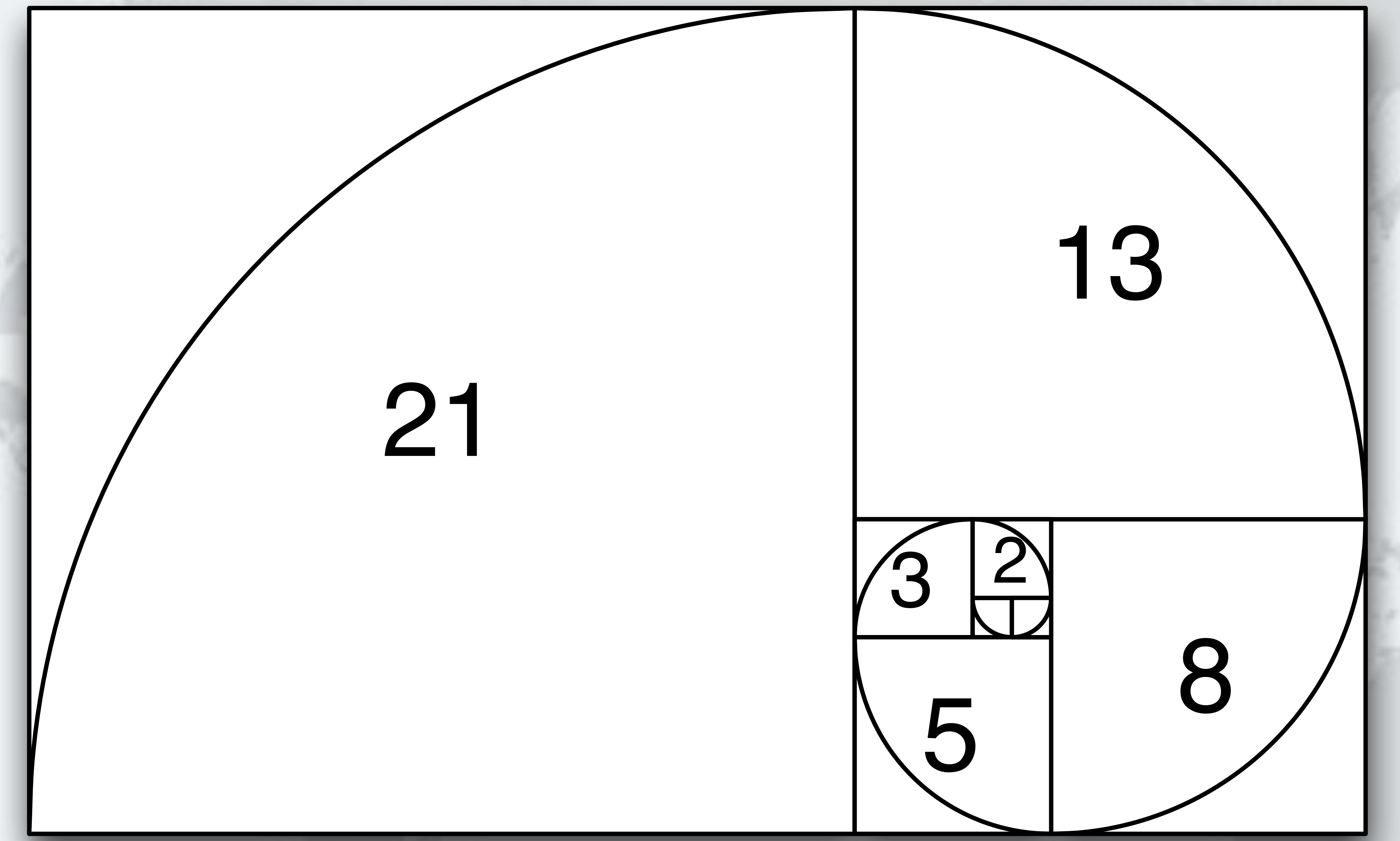
- By Leonardo of Pisa
  - F0 = 0
  - F1 = 1
  - Fn = Fn-1 + Fn-2
- Thus the next number is equal to the sum of the two previous numbers
  - e.g. 0, 1, 1, 2, 3, 5, 8, 13, 21, …
- The numbers get large quickly, like Australian rabbit population did



Naive Implementation

- **Taking our recursive definition**
  - $F_0 = 0, F_1 = 1$
  - $F_n = F_{n-1} + F_{n-2}$
- **Converting this into Java:**

```
public long f(int n) {
  if (n <= 1) return n;
  return f(n-1) + f(n-2);
}
```

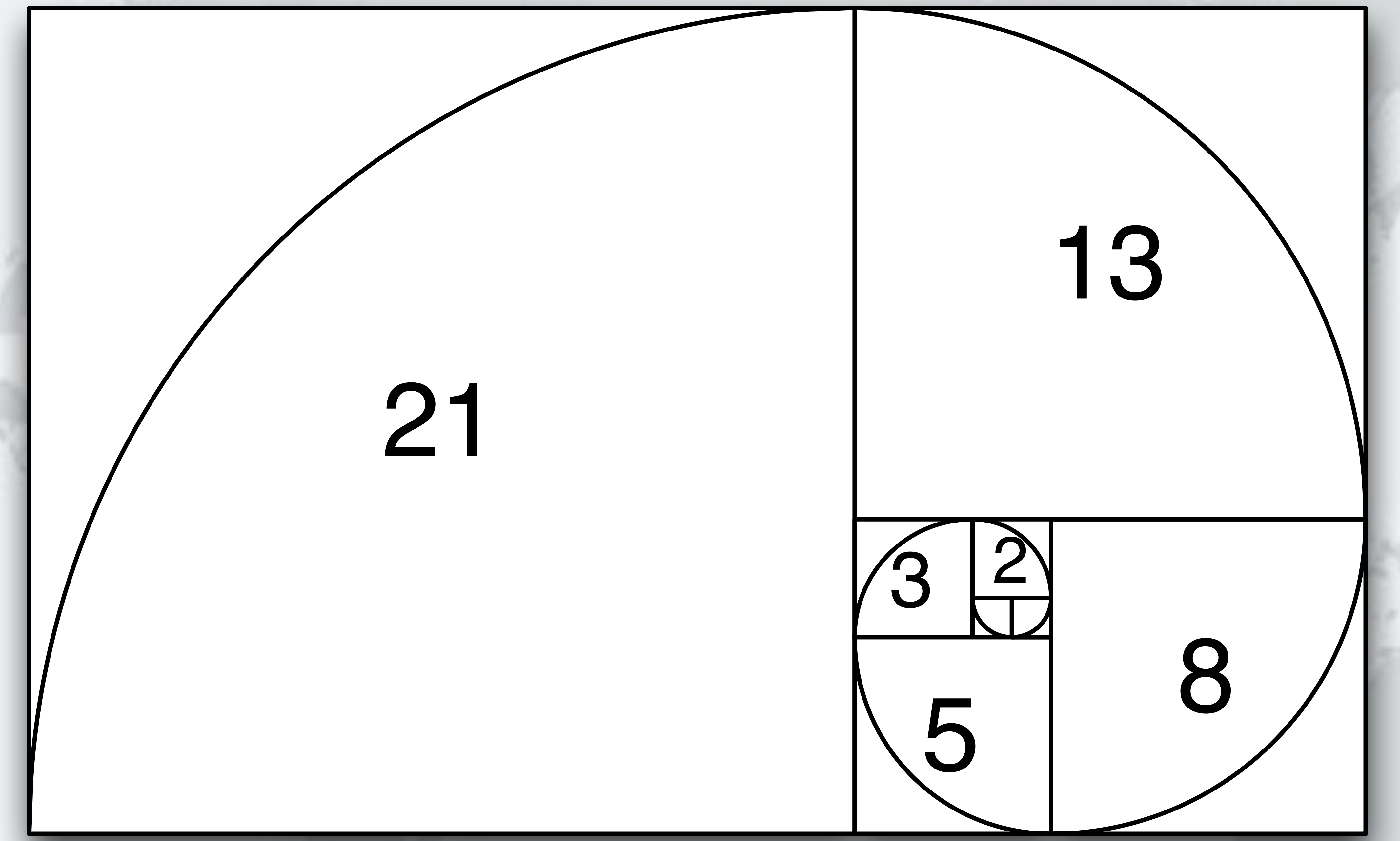


- **But this has exponential time complexity, so gets terribly slow**

2nd Attempt at Coding Fibonacci

- **Iterative algorithm**

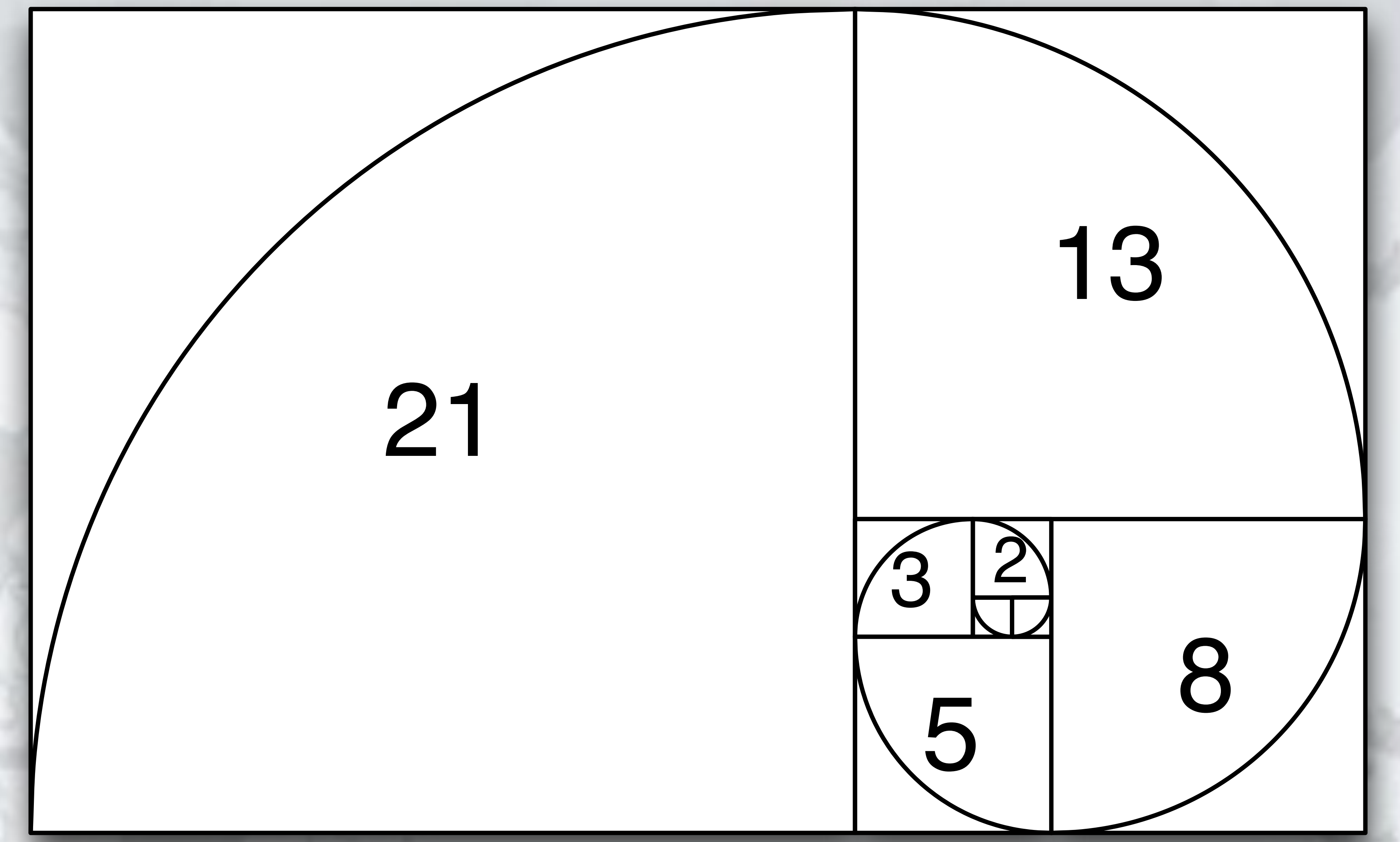
```
public static long f(int n) {
  long n0 = 0, n1 = 1;
  for (int i = 0; i < n; i++) {
    long temp = n1;
    n1 = n1 + n0;
    n0 = temp;
  }
  return n0;
}
```



- **Linear time complexity**
  - **f(1_000_000_000) in 1.7 seconds**
    - **However, long overflows so the result is incorrect**
    - **We can use BigInteger, but its add() is also linear, so time is quadratic**

3rd Attempt Dijkstra's Sum of Squares

- **Dijkstra's clever formula**
  - $F_{2n-1} = F_{n-1}^2 + F_n^2$
  - $F_{2n} = (2 \times F_{n-1} + F_n) \times F_n$
- **Logarithmic time complexity**
  - **Multiply in Java BigInteger**
    - **Karatsuba complexity is $O(n^{1.585})$**
    - **3-way Toom Cook complexity is $O(n^{1.465})$**
    - **Prior to Java 8, multiply() had complexity $O(n^2)$**
    - **BigInteger.multiply() single-threaded in Java - we'll fix that later**



Demo 1: Dijkstra's Sum of Squares

- **We implement this algorithm using BigInteger**
  - $F_{2n-1} = F_{n-1}^2 + F_n^2$
  - $F_{2n} = (2 \times F_{n-1} + F_n) \times F_n$

Demo 2: Parallelize Our Algorithm

- **We can parallelize by using common Fork/Join Pool**
  - **Next we fork() the 1st task, do the 2nd and then join 1st**

```
ForkJoinTask<BigInteger> f0_task = new RecursiveTask<BigInteger>() {
    protected BigInteger compute() {
        return f(half - 1);
    }
}.fork();
BigInteger f1 = f(half);
BigInteger f0 = f0_task.join();
```

Demo 3: Parallelize BigInteger

- **Let's hack fork/join into:**
  - **multiplyToomCook3()**
  - **squareToomCook3()**
- **These probably won't reach the threshold**
  - **multiplyKaratsuba()**
  - **squareKaratsuba()**

Demo 4: Cache Results

- **Dijkstra's Sum of Squares needs to work out some values several times. Cache results to avoid this.**
  - **Careful to avoid a memory leak**
    - **No static maps**

Demo 5: Reserved Caching Scheme

- **Instead of calculating same value twice:**
  - **Use putIfAbsent() to insert special placeholder**
  - **If result is null, we are first and start work**
  - **If result is the placeholder, we wait**

Demo 6: ManagedBlocker

- **ForkJoinPool is configured with *desired parallelism***
  - **Number of active threads**
  - **ForkJoinPool mostly used with CPU intensive tasks**
- **If one of the FJ Threads has to block, a new thread can be started to take its place**
  - **This is done with the ManagedBlocker**
- **We use ManagedBlocker to keep parallelism high**

Questions?

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