Building Scalable Distributed Systems

Assignment 1

Git Repository: https://github.com/akksshah/building-scalable-distributed-systems

Client Design Description

The entry point for the application is in through the ClientApp.java class.
The clientApp verifies the config.properties properties through the ConfigParameter.java class.
Once the properties have been loaded, the ClientApp gives the configuration to the StoreFactory.

The StoreFactory simulates the opening of stores staggered across 3 time zones as required to emulate in the given spec. The storeFactory creates threads equal to the number of stores to emulate as provided in the spec. Each of the "Store" is a Runnable thread. The job of the thread is to make request to the server a total of numPurchase request per hour the store is opened.

The storeFactory provides a shared latch/countdown to each of the store opened in that time zone. Once the count reaches 0, the storeFactory launches another phase.

The storeFactory provides a shared counter (a synchronized counter) that keeps track of the total number of successful requests the store was able to make and a total of failed request.

For the client in part2
The storeFactory also maintains a list of RequestTracker objects tha store information about the request made by the store. For example, it stores the time when the request was made, when the response was returned by the server, the status code it received in the response and the type of request it made.

This list is then used to understand the system capacity and the MetricsGenerator can then be used to derive insights from the same.

The design that I chose to use was to implement something similar to Singleton design. The counter and requestTracker list are something whose references are provided to each thread/store.

Client Part 1 Output:

32 threads:

```
Run:        ClientApp  ×

    ▶    ↑    /Library/Java/JavaVirtualMachines/jdk-15.0.2.jdk/Contents/Home/bin/java ...
              Starting Execution at: 2021-02-15 13:46:27.752
    🔧   ↓    Total request sent: 17280
         ⇥    Total request successful: 17280
         ⇥↓   Total unsuccessful request: 0
    📷        Total wall time: 21639ms
         🖨    Throughput: 822.8571428571429
    🦋        Ending execution at: 2021-02-15 13:46:49.404
    🔁   🗑
              Process finished with exit code 0
    ▣

    📌
```
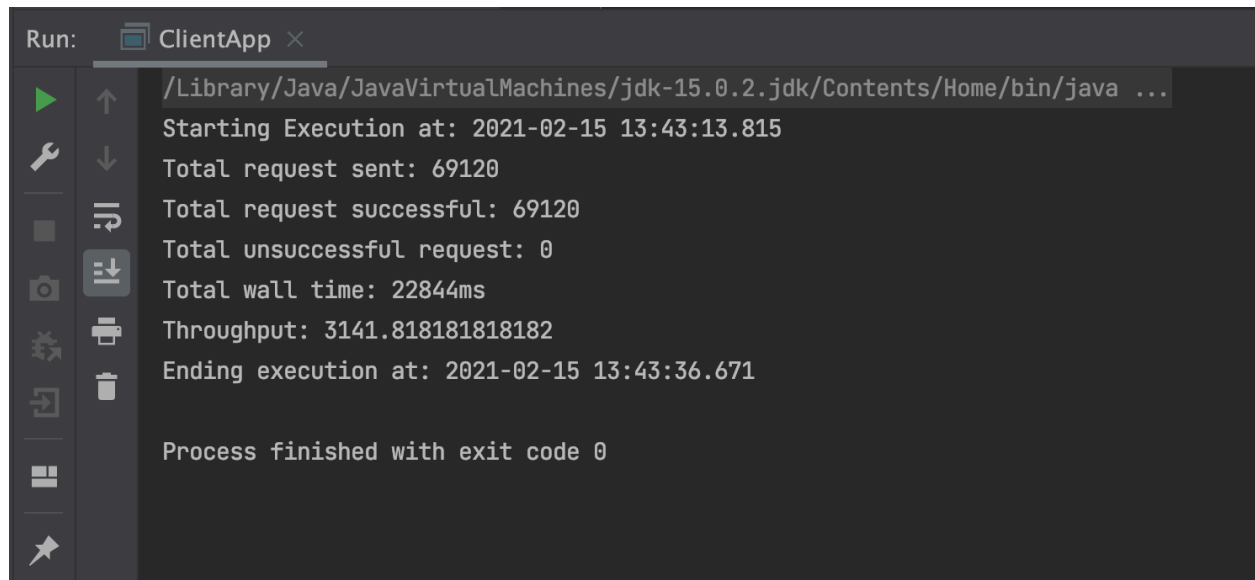
64 threads:

```
Run:        ClientApp  ×

    ▶    ↑    /Library/Java/JavaVirtualMachines/jdk-15.0.2.jdk/Contents/Home/bin/java ...
              Starting Execution at: 2021-02-15 13:45:09.823
    🔧   ↓    Total request sent: 34560
         ⇥    Total request successful: 34560
              Total unsuccessful request: 0
         ⇥↓   Total wall time: 22021ms
    📷        Throughput: 1570.909090909091
         🖨    Ending execution at: 2021-02-15 13:45:31.854
    🦋   🗑
    🔁        Process finished with exit code 0

    ▣

    📌
```
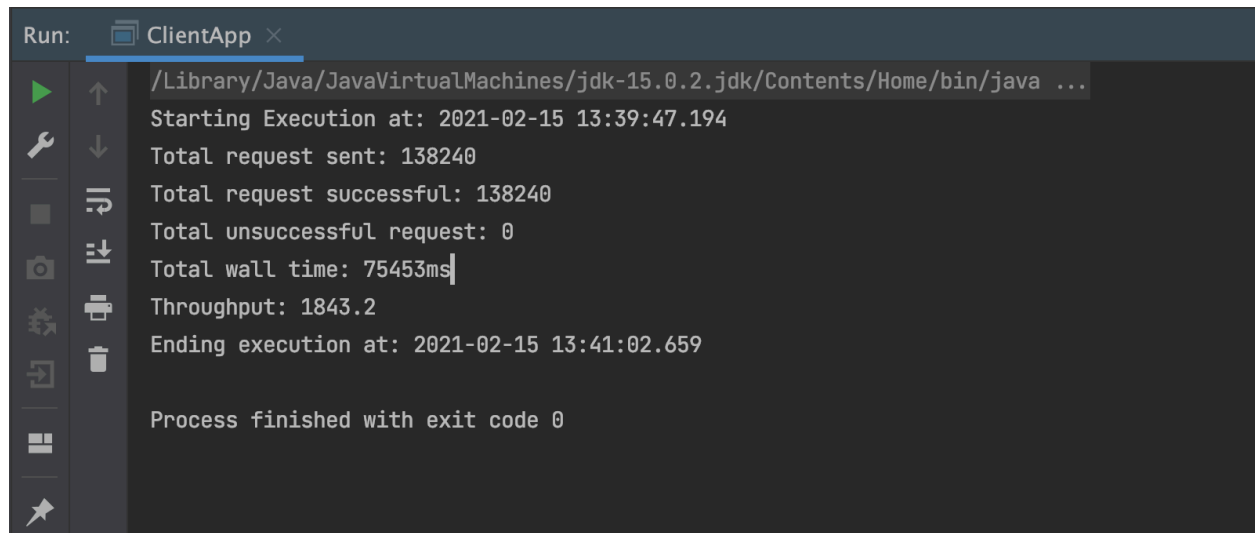
128 threads:

```
Run:     ☐ ClientApp ✕

▶    ↑     /Library/Java/JavaVirtualMachines/jdk-15.0.2.jdk/Contents/Home/bin/java ...
            Starting Execution at: 2021-02-15 13:43:13.815
🔧   ↓     Total request sent: 69120
⬛   ⇥     Total request successful: 69120
            Total unsuccessful request: 0
📷   ⬇     Total wall time: 22844ms
🖨        Throughput: 3141.818181818182
🗑        Ending execution at: 2021-02-15 13:43:36.671

⧉         Process finished with exit code 0

📌
```
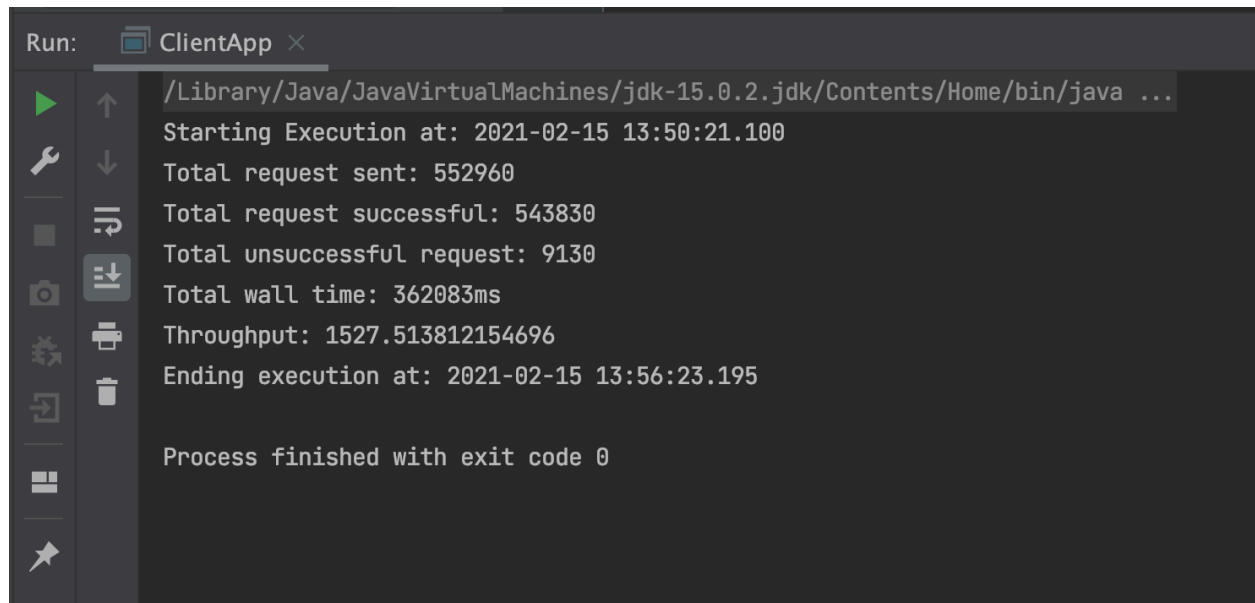
256 threads:

```
Run:     ☐ ClientApp ✕

▶    ↑     /Library/Java/JavaVirtualMachines/jdk-15.0.2.jdk/Contents/Home/bin/java ...
            Starting Execution at: 2021-02-15 13:39:47.194
🔧   ↓     Total request sent: 138240
⬛   ⇥     Total request successful: 138240
            Total unsuccessful request: 0
📷   ⬇     Total wall time: 75453ms
🖨        Throughput: 1843.2
🗑        Ending execution at: 2021-02-15 13:41:02.659

⧉         Process finished with exit code 0

📌
```
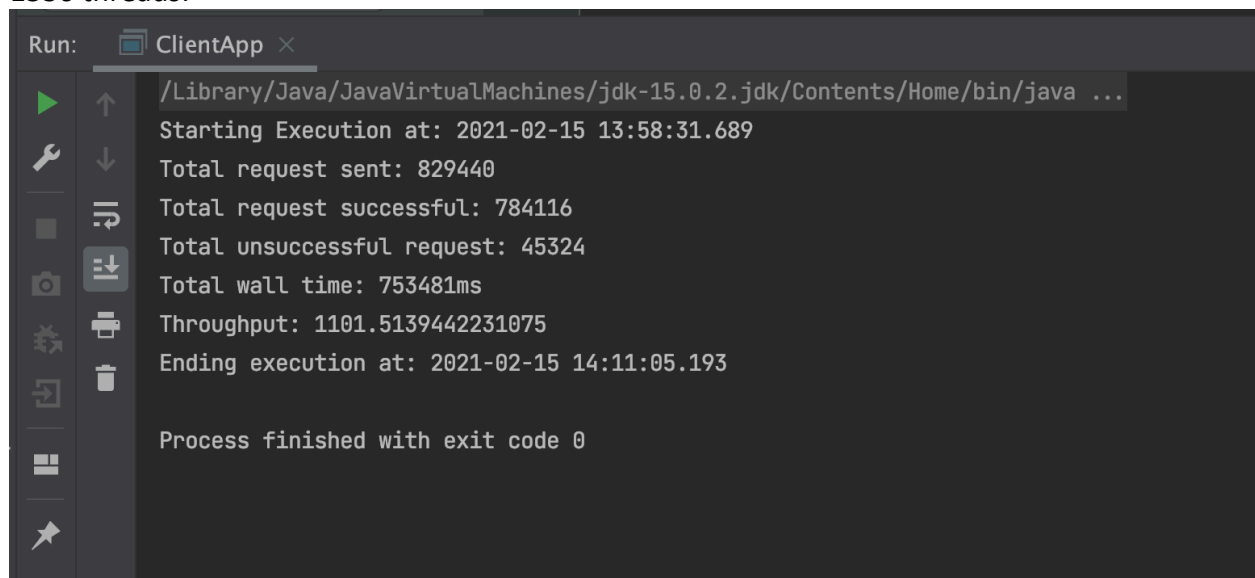
1024 threads:

```
Run:        ClientApp  ×

    /Library/Java/JavaVirtualMachines/jdk-15.0.2.jdk/Contents/Home/bin/java ...
    Starting Execution at: 2021-02-15 13:50:21.100
    Total request sent: 552960
    Total request successful: 543830
    Total unsuccessful request: 9130
    Total wall time: 362083ms
    Throughput: 1527.513812154696
    Ending execution at: 2021-02-15 13:56:23.195

    Process finished with exit code 0
```
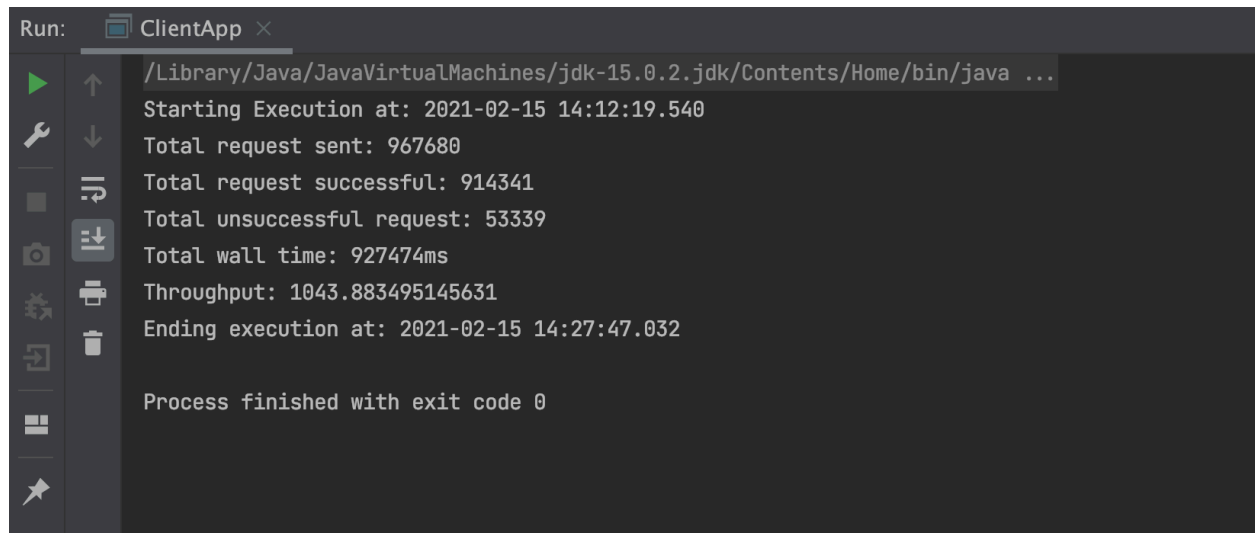
1536 threads:

```
Run:        ClientApp  ×

    /Library/Java/JavaVirtualMachines/jdk-15.0.2.jdk/Contents/Home/bin/java ...
    Starting Execution at: 2021-02-15 13:58:31.689
    Total request sent: 829440
    Total request successful: 784116
    Total unsuccessful request: 45324
    Total wall time: 753481ms
    Throughput: 1101.5139442231075
    Ending execution at: 2021-02-15 14:11:05.193

    Process finished with exit code 0
```
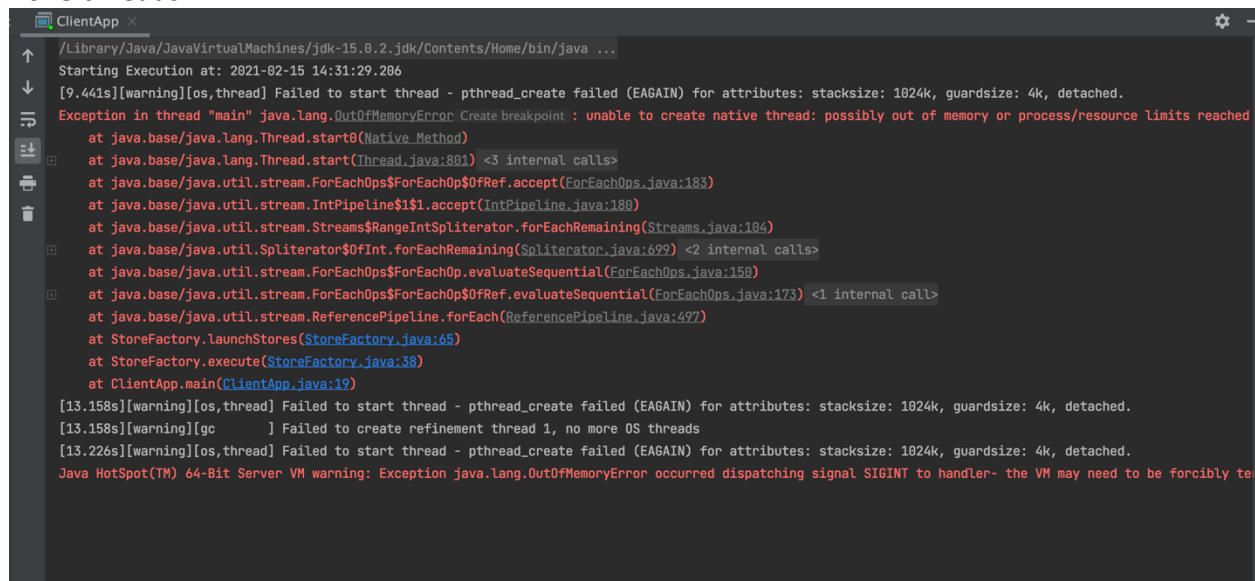
1792 threads:

```
Run:    ClientApp  ×

▶    ↑    /Library/Java/JavaVirtualMachines/jdk-15.0.2.jdk/Contents/Home/bin/java ...
🔧   ↓    Starting Execution at: 2021-02-15 14:12:19.540
          Total request sent: 967680
     ⇥    Total request successful: 914341
     ⬇    Total unsuccessful request: 53339
⬛        Total wall time: 927474ms
📷   🖨    Throughput: 1043.883495145631
🐞   🗑    Ending execution at: 2021-02-15 14:27:47.032

�", 
📌        Process finished with exit code 0
```

2048 threads:

```
ClientApp  ×                                                                                                          ⚙  —
↑    /Library/Java/JavaVirtualMachines/jdk-15.0.2.jdk/Contents/Home/bin/java ...
↓    Starting Execution at: 2021-02-15 14:31:29.206
     [9.441s][warning][os,thread] Failed to start thread - pthread_create failed (EAGAIN) for attributes: stacksize: 1024k, guardsize: 4k, detached.
⇥    Exception in thread "main" java.lang.OutOfMemoryError Create breakpoint : unable to create native thread: possibly out of memory or process/resource limits reached
⬇        at java.base/java.lang.Thread.start0(Native Method)
     ⊞   at java.base/java.lang.Thread.start(Thread.java:801) <3 internal calls>
🖨        at java.base/java.util.stream.ForEachOps$ForEachOp$OfRef.accept(ForEachOps.java:183)
🗑        at java.base/java.util.stream.IntPipeline$1$1.accept(IntPipeline.java:180)
         at java.base/java.util.stream.Streams$RangeIntSpliterator.forEachRemaining(Streams.java:104)
     ⊞   at java.base/java.util.Spliterator$OfInt.forEachRemaining(Spliterator.java:699) <2 internal calls>
         at java.base/java.util.stream.ForEachOps$ForEachOp.evaluateSequential(ForEachOps.java:150)
     ⊞   at java.base/java.util.stream.ForEachOps$ForEachOp$OfRef.evaluateSequential(ForEachOps.java:173) <1 internal call>
         at java.base/java.util.stream.ReferencePipeline.forEach(ReferencePipeline.java:497)
         at StoreFactory.launchStores(StoreFactory.java:65)
         at StoreFactory.execute(StoreFactory.java:38)
         at ClientApp.main(ClientApp.java:19)
     [13.158s][warning][os,thread] Failed to start thread - pthread_create failed (EAGAIN) for attributes: stacksize: 1024k, guardsize: 4k, detached.
     [13.158s][warning][gc      ] Failed to create refinement thread 1, no more OS threads
     [13.226s][warning][os,thread] Failed to start thread - pthread_create failed (EAGAIN) for attributes: stacksize: 1024k, guardsize: 4k, detached.
     Java HotSpot(TM) 64-Bit Server VM warning: Exception java.lang.OutOfMemoryError occurred dispatching signal SIGINT to handler- the VM may need to be forcibly te
```
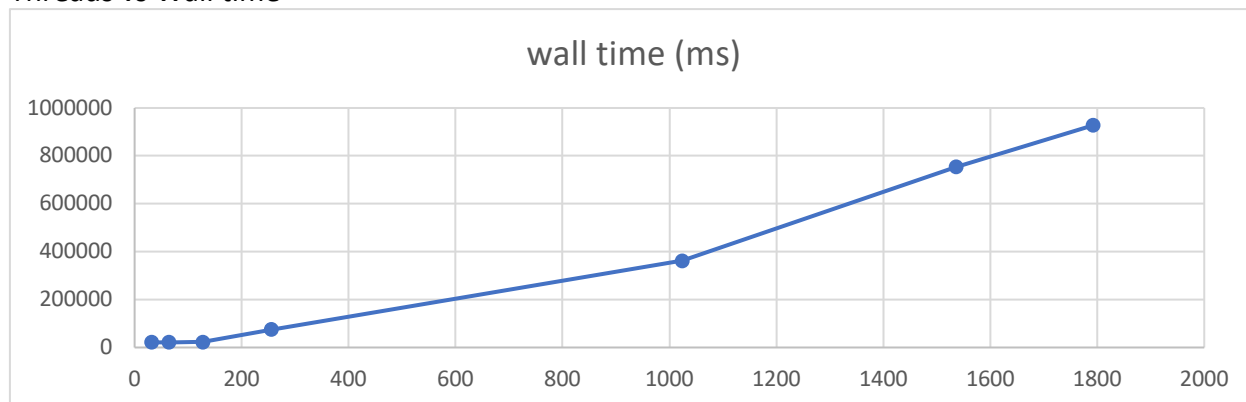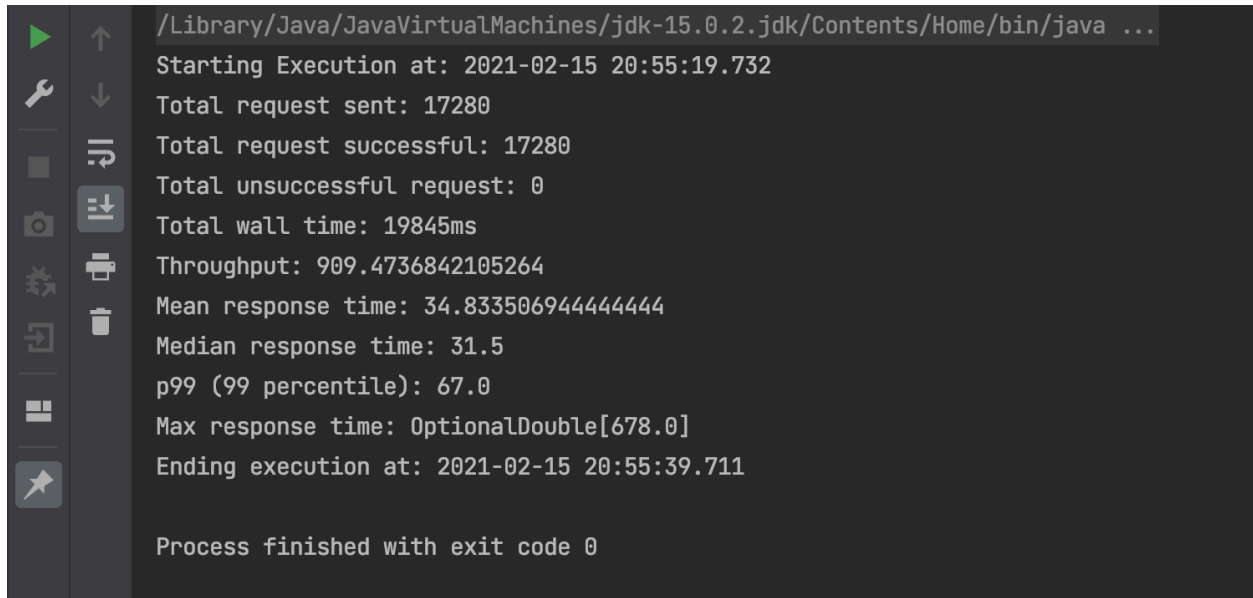
Note: When I tried to emulate 2048 stores, that is when my client started to throw exceptions caused as I was out of memory/resource limit
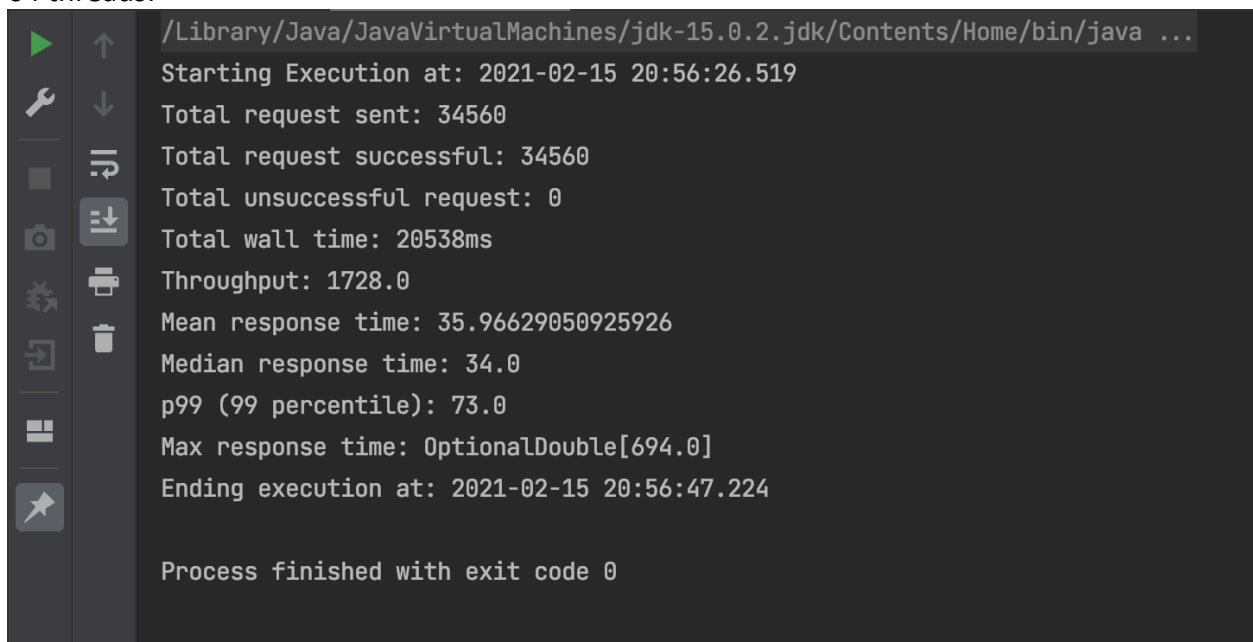
Threads vs Wall time

wall time (ms)

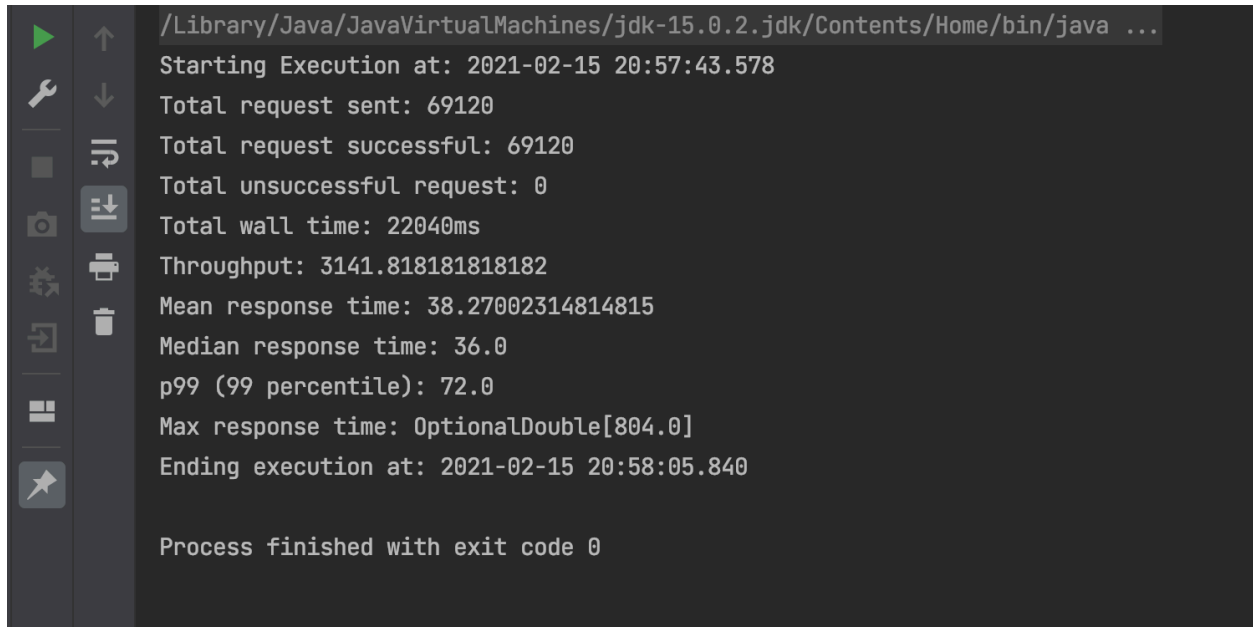# Client Part 2 Output:

32 threads:

```
/Library/Java/JavaVirtualMachines/jdk-15.0.2.jdk/Contents/Home/bin/java ...
Starting Execution at: 2021-02-15 20:55:19.732
Total request sent: 17280
Total request successful: 17280
Total unsuccessful request: 0
Total wall time: 19845ms
Throughput: 909.4736842105264
Mean response time: 34.833506944444444
Median response time: 31.5
p99 (99 percentile): 67.0
Max response time: OptionalDouble[678.0]
Ending execution at: 2021-02-15 20:55:39.711

Process finished with exit code 0
```

64 threads:

```
/Library/Java/JavaVirtualMachines/jdk-15.0.2.jdk/Contents/Home/bin/java ...
Starting Execution at: 2021-02-15 20:56:26.519
Total request sent: 34560
Total request successful: 34560
Total unsuccessful request: 0
Total wall time: 20538ms
Throughput: 1728.0
Mean response time: 35.96629050925926
Median response time: 34.0
p99 (99 percentile): 73.0
Max response time: OptionalDouble[694.0]
Ending execution at: 2021-02-15 20:56:47.224

Process finished with exit code 0
```
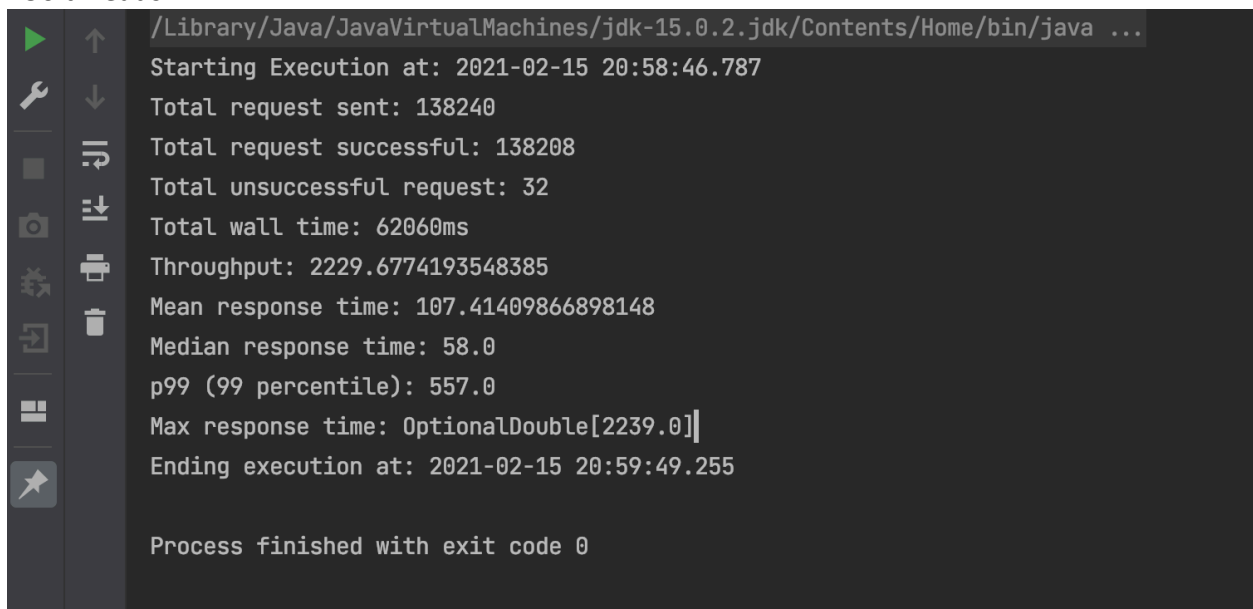
128 threads:

```
  ▶  ↑    /Library/Java/JavaVirtualMachines/jdk-15.0.2.jdk/Contents/Home/bin/java ...
  🔧  ↓    Starting Execution at: 2021-02-15 20:57:43.578
           Total request sent: 69120
  ■  ⇥    Total request successful: 69120
  ↕        Total unsuccessful request: 0
  📷        Total wall time: 22040ms
  🖨        Throughput: 3141.818181818182
           Mean response time: 38.27002314814815
  🗑        Median response time: 36.0
           p99 (99 percentile): 72.0
  ⏻        Max response time: OptionalDouble[804.0]
           Ending execution at: 2021-02-15 20:58:05.840
  📌

           Process finished with exit code 0
```

256 threads

```
  ▶  ↑    /Library/Java/JavaVirtualMachines/jdk-15.0.2.jdk/Contents/Home/bin/java ...
  🔧  ↓    Starting Execution at: 2021-02-15 20:58:46.787
           Total request sent: 138240
  ■  ⇥    Total request successful: 138208
  ↕        Total unsuccessful request: 32
  📷        Total wall time: 62060ms
  🖨        Throughput: 2229.6774193548385
           Mean response time: 107.41409866898148
  🗑        Median response time: 58.0
           p99 (99 percentile): 557.0
  ⏻        Max response time: OptionalDouble[2239.0]
           Ending execution at: 2021-02-15 20:59:49.255
  📌

           Process finished with exit code 0
```
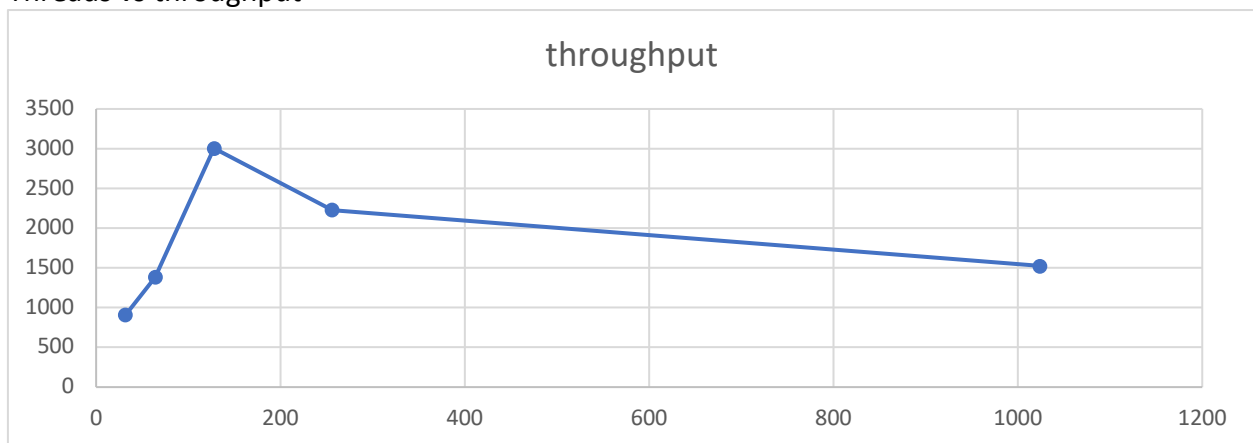
1024 threads:

```
/Library/Java/JavaVirtualMachines/jdk-15.0.2.jdk/Contents/Home/bin/java ...
Starting Execution at: 2021-02-15 21:00:54.250
Total request sent: 552960
Total request successful: 542624
Total unsuccessful request: 10336
Total wall time: 360590ms
Throughput: 1536.0
Mean response time: 619.2910373263888
Median response time: 31.5
p99 (99 percentile): 10127.0
Max response time: OptionalDouble[19182.0]
Ending execution at: 2021-02-15 21:06:55.634

Process finished with exit code 0
```

Threads vs throughput

throughput

Threads vs mean response time

mean responsetime