

华中科技大学

数据中心技术课程实验报告

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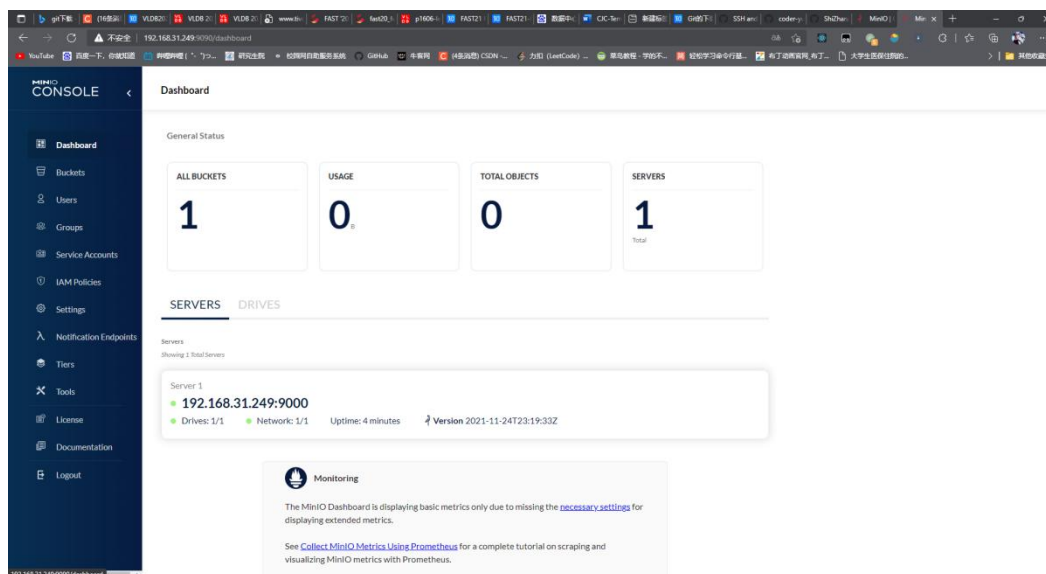
2022 年 1 月 11 日

实验一：环境部署

```
C:\WINDOWS\system32\cmd.exe

You are running an older version of MinIO released 1 month ago
Update: Run mc admin update

API: http://192.168.31.249:9000 http://192.168.224.1:9000 http://192.168.230.1:9000 http://127.0.0.1:9000
RootUser: hust
RootPass: hust_obs
Console: http://192.168.31.249:9090 http://192.168.224.1:9090 http://192.168.230.1:9090 http://127.0.0.1:9090
RootUser: hust
RootPass: hust_obs
Command-line: https://docs.min.io/docs/minio-client-quickstart-guide
$ mc.exe alias set myminio http://192.168.31.249:9000 hust hust_obs
Documentation: https://docs.min.io
```



实验二：性能观测

- (1) numClients=8
- numSamples=256
- 改变 objectSize

C:\WINDOWS\system32\cmd.exe	C:\WINDOWS\system32\cmd.exe	C:\WINDOWS\system32\cmd.exe	C:\WINDOWS\system32\cmd.exe	C:\WINDOWS\system32\cmd.exe
Results Summary for Write Operation(s) Total Transferred: 0.250 MB Total Throughput: 0.062 MB/s Total Duration: 11.488 s Number of Errors: 0	Results Summary for Write Operation(s) Total Transferred: 0.250 MB Total Throughput: 0.02 MB/s Total Duration: 10.930 s Number of Errors: 0	Results Summary for Write Operation(s) Total Transferred: 0.100 MB Total Throughput: 0.10 MB/s Total Duration: 9.774 s Number of Errors: 0	Results Summary for Write Operation(s) Total Transferred: 4.000 MB Total Throughput: 0.48 MB/s Total Duration: 8.276 s Number of Errors: 0	Results Summary for Write Operation(s) Total Transferred: 8.000 MB Total Throughput: 0.99 MB/s Total Duration: 8.116 s Number of Errors: 0
Write times Max: 0.938 s Write times 99th %ile: 0.920 s Write times 90th %ile: 0.622 s Write times 75th %ile: 0.363 s Write times 50th %ile: 0.308 s Write times 25th %ile: 0.272 s Write times Min: 0.116 s	Write times Max: 1.075 s Write times 99th %ile: 1.053 s Write times 90th %ile: 0.593 s Write times 75th %ile: 0.327 s Write times 50th %ile: 0.284 s Write times 25th %ile: 0.242 s Write times Min: 0.162 s	Write times Max: 0.702 s Write times 99th %ile: 0.634 s Write times 90th %ile: 0.385 s Write times 75th %ile: 0.319 s Write times 50th %ile: 0.276 s Write times 25th %ile: 0.247 s Write times Min: 0.141 s	Write times Max: 0.757 s Write times 99th %ile: 0.744 s Write times 90th %ile: 0.473 s Write times 75th %ile: 0.277 s Write times 50th %ile: 0.205 s Write times 25th %ile: 0.172 s Write times Min: 0.105 s	Write times Max: 0.983 s Write times 99th %ile: 0.937 s Write times 90th %ile: 0.480 s Write times 75th %ile: 0.247 s Write times 50th %ile: 0.199 s Write times 25th %ile: 0.163 s Write times Min: 0.112 s
Results Summary for Read Operation(s) Total Transferred: 0.250 MB Total Throughput: 0.60 MB/s Total Duration: 0.078 s Number of Errors: 0	Results Summary for Read Operation(s) Total Transferred: 0.250 MB Total Throughput: 3.65 MB/s Total Duration: 0.069 s Number of Errors: 0	Results Summary for Read Operation(s) Total Transferred: 1.000 MB Total Throughput: 15.67 MB/s Total Duration: 0.064 s Number of Errors: 0	Results Summary for Read Operation(s) Total Transferred: 4.000 MB Total Throughput: 49.58 MB/s Total Duration: 0.082 s Number of Errors: 0	Results Summary for Read Operation(s) Total Transferred: 8.000 MB Total Throughput: 80.64 MB/s Total Duration: 0.099 s Number of Errors: 0
Read times Max: 0.006 s Read times 99th %ile: 0.005 s Read times 90th %ile: 0.004 s Read times 75th %ile: 0.003 s Read times 50th %ile: 0.002 s Read times 25th %ile: 0.002 s Read times Min: 0.001 s	Read times Max: 0.005 s Read times 99th %ile: 0.004 s Read times 90th %ile: 0.003 s Read times 75th %ile: 0.002 s Read times 50th %ile: 0.002 s Read times 25th %ile: 0.002 s Read times Min: 0.001 s	Read times Max: 0.004 s Read times 99th %ile: 0.004 s Read times 90th %ile: 0.003 s Read times 75th %ile: 0.002 s Read times 50th %ile: 0.002 s Read times 25th %ile: 0.001 s Read times Min: 0.001 s	Read times Max: 0.005 s Read times 99th %ile: 0.005 s Read times 90th %ile: 0.004 s Read times 75th %ile: 0.003 s Read times 50th %ile: 0.002 s Read times 25th %ile: 0.002 s Read times Min: 0.001 s	Read times Max: 0.007 s Read times 99th %ile: 0.007 s Read times 90th %ile: 0.005 s Read times 75th %ile: 0.004 s Read times 50th %ile: 0.003 s Read times 25th %ile: 0.002 s Read times Min: 0.001 s
Cleaning up 256 objects...	Cleaning up 256 objects...	Cleaning up 256 objects...	Cleaning up 256 objects...	

256

1024

4096

16384

32768

Total Throughput 随着 objectSize 变大而变大

(2) numSamples=256

objectSize=1024

改变 numClients

C:\WINDOWS\system32\cmd.exe	C:\WINDOWS\system32\cmd.exe	C:\WINDOWS\system32\cmd.exe	C:\WINDOWS\system32\cmd.exe	C:\WINDOWS\system32\cmd.exe
Results Summary for Write Operation(s) Total Transferred: 0.250 MB Total Throughput: 0.03 MB/s Total Duration: 7.870 s Number of Errors: 0	Results Summary for Write Operation(s) Total Transferred: 0.250 MB Total Throughput: 0.03 MB/s Total Duration: 8.477 s Number of Errors: 0	Results Summary for Write Operation(s) Total Transferred: 0.250 MB Total Throughput: 0.02 MB/s Total Duration: 11.422 s Number of Errors: 0	Results Summary for Write Operation(s) Total Transferred: 0.250 MB Total Throughput: 0.02 MB/s Total Duration: 10.990 s Number of Errors: 0	Results Summary for Write Operation(s) Total Transferred: 0.250 MB Total Throughput: 0.02 MB/s Total Duration: 10.624 s Number of Errors: 0
Write times Max: 0.493 s Write times 99th %ile: 0.484 s Write times 90th %ile: 0.165 s Write times 75th %ile: 0.122 s Write times 50th %ile: 0.101 s Write times 25th %ile: 0.081 s Write times Min: 0.041 s	Write times Max: 0.997 s Write times 99th %ile: 0.955 s Write times 90th %ile: 0.524 s Write times 75th %ile: 0.288 s Write times 50th %ile: 0.197 s Write times 25th %ile: 0.164 s Write times Min: 0.108 s	Write times Max: 1.759 s Write times 99th %ile: 1.735 s Write times 90th %ile: 1.021 s Write times 75th %ile: 0.873 s Write times 50th %ile: 0.850 s Write times 25th %ile: 0.496 s Write times Min: 0.355 s	Write times Max: 2.526 s Write times 99th %ile: 2.525 s Write times 90th %ile: 1.692 s Write times 75th %ile: 1.474 s Write times 50th %ile: 1.330 s Write times 25th %ile: 1.050 s Write times Min: 0.919 s	Write times Max: 4.797 s Write times 99th %ile: 4.743 s Write times 90th %ile: 3.406 s Write times 75th %ile: 2.796 s Write times 50th %ile: 2.429 s Write times 25th %ile: 2.166 s Write times Min: 0.386 s
Results Summary for Read Operation(s) Total Transferred: 0.250 MB Total Throughput: 2.73 MB/s Total Duration: 0.094 s Number of Errors: 0	Results Summary for Read Operation(s) Total Transferred: 0.250 MB Total Throughput: 3.89 MB/s Total Duration: 0.064 s Number of Errors: 0	Results Summary for Read Operation(s) Total Transferred: 0.250 MB Total Throughput: 4.00 MB/s Total Duration: 0.062 s Number of Errors: 0	Results Summary for Read Operation(s) Total Transferred: 0.250 MB Total Throughput: 3.27 MB/s Total Duration: 0.076 s Number of Errors: 0	Results Summary for Read Operation(s) Total Transferred: 0.250 MB Total Throughput: 3.00 MB/s Total Duration: 0.083 s Number of Errors: 0
Read times Max: 0.004 s Read times 99th %ile: 0.004 s Read times 90th %ile: 0.002 s Read times 75th %ile: 0.002 s Read times 50th %ile: 0.001 s Read times 25th %ile: 0.001 s Read times Min: 0.001 s	Read times Max: 0.004 s Read times 99th %ile: 0.004 s Read times 90th %ile: 0.003 s Read times 75th %ile: 0.002 s Read times 50th %ile: 0.002 s Read times 25th %ile: 0.001 s Read times Min: 0.001 s	Read times Max: 0.009 s Read times 99th %ile: 0.008 s Read times 90th %ile: 0.005 s Read times 75th %ile: 0.004 s Read times 50th %ile: 0.003 s Read times 25th %ile: 0.002 s Read times Min: 0.001 s	Read times Max: 0.023 s Read times 99th %ile: 0.023 s Read times 90th %ile: 0.013 s Read times 75th %ile: 0.009 s Read times 50th %ile: 0.006 s Read times 25th %ile: 0.004 s Read times Min: 0.001 s	Read times Max: 0.060 s Read times 99th %ile: 0.057 s Read times 90th %ile: 0.031 s Read times 75th %ile: 0.020 s Read times 50th %ile: 0.014 s Read times 25th %ile: 0.009 s Read times Min: 0.002 s

4

8

16

32

64

(3) numClients=8

objectSize=1024

改变 numSamples

```

C:\WINDOWS\system32\cmd.exe
Total Duration: 1.368 s
Number of Errors: 0
-----
Write times Max: 0.134 s
Write times 90th Ntile: 0.111 s
Write times 75th Ntile: 0.073 s
Write times 50th Ntile: 0.059 s
Write times 25th Ntile: 0.023 s
Write times Min: 0.013 s

Results Summary for Read Operation(s)
Total Transferred: 0.250 MB
Total Throughput: 1.58 MB/s
Total Duration: 0.155 s
Number of Errors: 0
-----
Read times Max: 0.031 s
Read times 90th Ntile: 0.016 s
Read times 75th Ntile: 0.003 s
Read times 50th Ntile: 0.006 s
Read times 25th Ntile: 0.004 s
Read times Min: 0.001 s

Cleaning up 256 objects...
Deleting a batch of 256 objects in range [0, 255]... Succeeded
Successfully deleted 256/256 objects in 384.3942ms

C:\WINDOWS\system32\cmd.exe
Number of Errors: 0
-----
Write times Max: 0.104 s
Write times 90th Ntile: 0.104 s
Write times 75th Ntile: 0.073 s
Write times 50th Ntile: 0.042 s
Write times 25th Ntile: 0.029 s
Write times Min: 0.011 s

Results Summary for Read Operation(s)
Total Transferred: 1.000 MB
Total Throughput: 1.62 MB/s
Total Duration: 0.619 s
Number of Errors: 0
-----
Read times Max: 0.023 s
Read times 90th Ntile: 0.014 s
Read times 75th Ntile: 0.008 s
Read times 50th Ntile: 0.004 s
Read times 25th Ntile: 0.003 s
Read times Min: 0.001 s

Cleaning up 1024 objects...
Deleting a batch of 1024 objects in range [0, 999]... Succeeded
Deleting a batch of 24 objects in range [1000, 1023]... Succeeded
Successfully deleted 1024/1024 objects in 1.091631s

C:\WINDOWS\system32\cmd.exe
Write times 90th Ntile: 0.117 s
Write times 75th Ntile: 0.077 s
Write times 50th Ntile: 0.041 s
Write times 25th Ntile: 0.023 s
Write times Min: 0.009 s

Results Summary for Read Operation(s)
Total Transferred: 4.000 MB
Total Throughput: 2.08 MB/s
Total Duration: 1.924 s
Number of Errors: 0
-----
Read times Max: 0.026 s
Read times 90th Ntile: 0.014 s
Read times 75th Ntile: 0.006 s
Read times 50th Ntile: 0.003 s
Read times 25th Ntile: 0.002 s
Read times Min: 0.001 s

Cleaning up 4096 objects...
Deleting a batch of 1000 objects in range [0, 999]... Succeeded
Deleting a batch of 1000 objects in range [1000, 1999]... Succeeded
Deleting a batch of 1000 objects in range [2000, 2999]... Succeeded
Deleting a batch of 1000 objects in range [3000, 3999]... Succeeded
Deleting a batch of 96 objects in range [4000, 4095]... Succeeded
Successfully deleted 4096/4096 objects in 3.2212018s

C:\WINDOWS\system32\cmd.exe
Number of Errors: 0
-----
Write times Max: 0.457 s
Write times 90th Ntile: 0.143 s
Write times 75th Ntile: 0.083 s
Write times 50th Ntile: 0.044 s
Write times 25th Ntile: 0.030 s
Write times Min: 0.009 s

Results Summary for Read Operation(s)
Total Transferred: 16.000 MB
Total Throughput: 1.36 MB/s
Total Duration: 8.025 s
Number of Errors: 0
-----
Read times Max: 0.255 s
Read times 90th Ntile: 0.016 s
Read times 75th Ntile: 0.007 s
Read times 50th Ntile: 0.005 s
Read times 25th Ntile: 0.003 s
Read times Min: 0.001 s

Cleaning up 16384 objects...
Deleting a batch of 1000 objects in range [0, 999]... Succeeded
Deleting a batch of 1000 objects in range [1000, 1999]... Succeeded

C:\WINDOWS\system32\cmd.exe
Total Throughput: 0.15 MB/s
Total Duration: 212.701 s
Number of Errors: 0
-----
Write times Max: 1.073 s
Write times 90th Ntile: 0.141 s
Write times 75th Ntile: 0.085 s
Write times 50th Ntile: 0.046 s
Write times 25th Ntile: 0.030 s
Write times Min: 0.008 s

Results Summary for Read Operation(s)
Total Transferred: 32.000 MB
Total Throughput: 1.37 MB/s
Total Duration: 16.219 s
Number of Errors: 0
-----
Read times Max: 0.009 s
Read times 90th Ntile: 0.014 s
Read times 75th Ntile: 0.006 s
Read times 50th Ntile: 0.003 s
Read times 25th Ntile: 0.003 s
Read times Min: 0.001 s

Cleaning up 32768 objects...
```

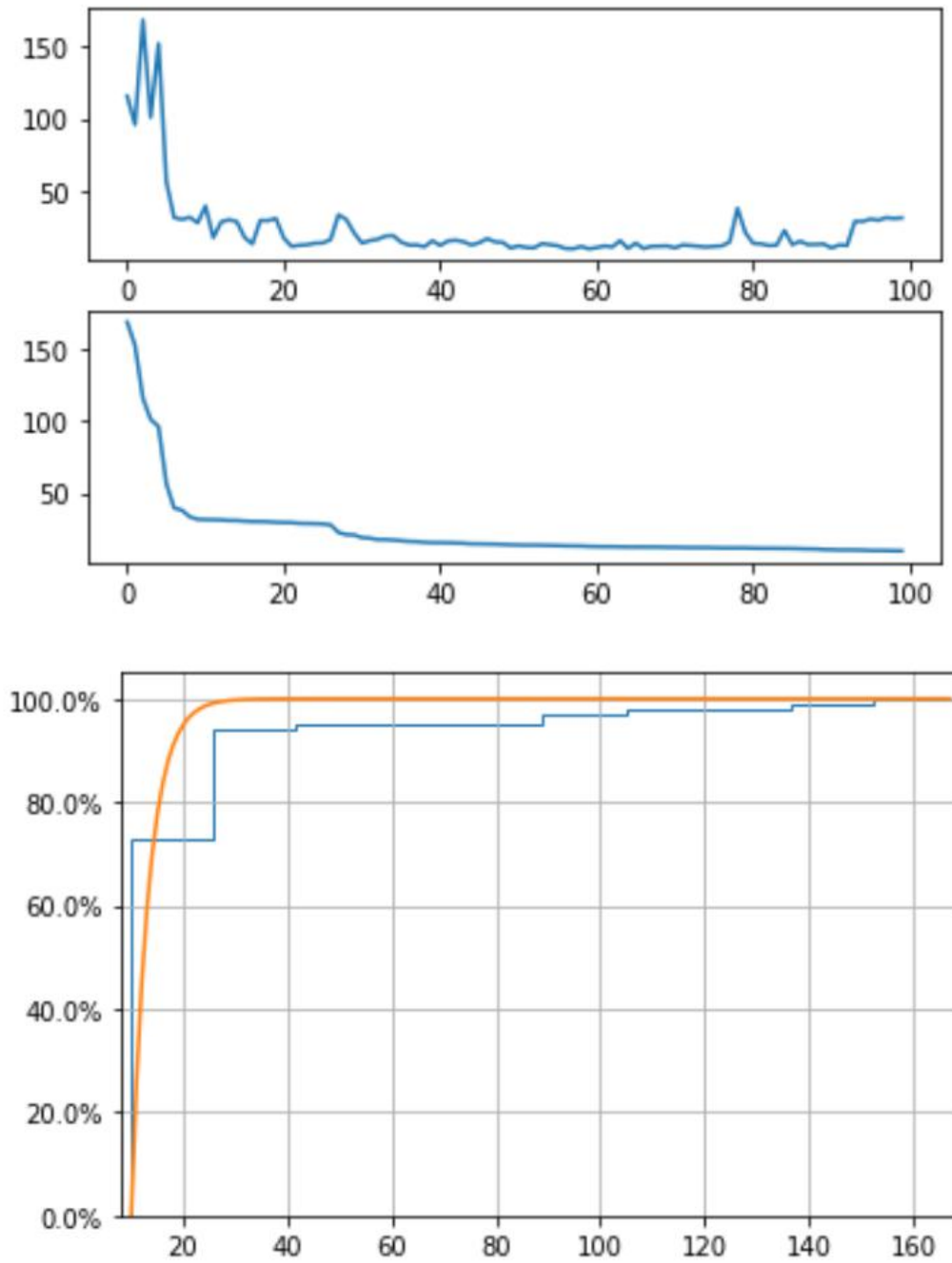
从上至下，从左至右的 numSamples 依次是 256、1024、4096、16384、32768

Total Duration 明显升高，Total transferred 成倍数增长，而 Total throughput 没有规律性的变化

实验三：尾延迟

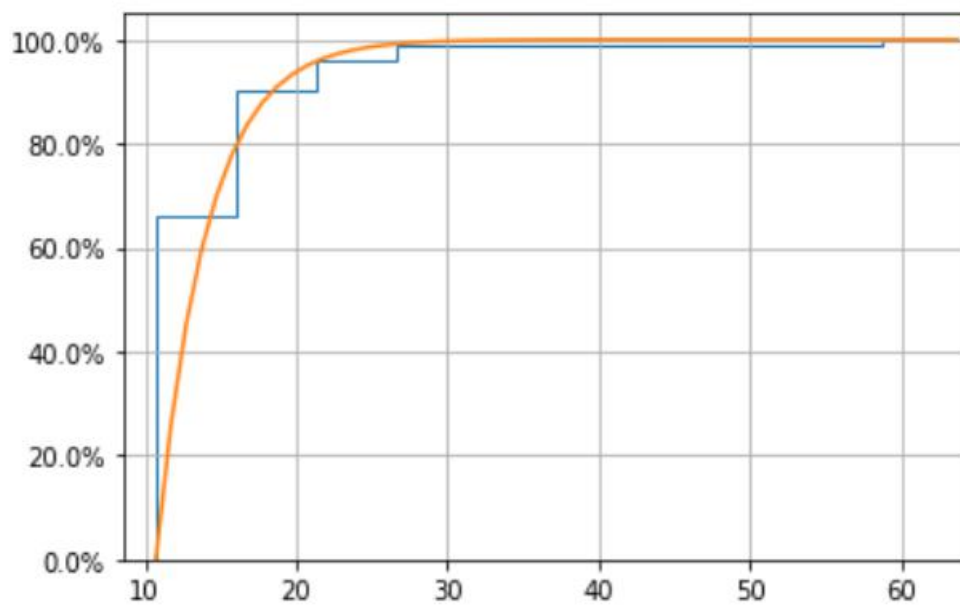
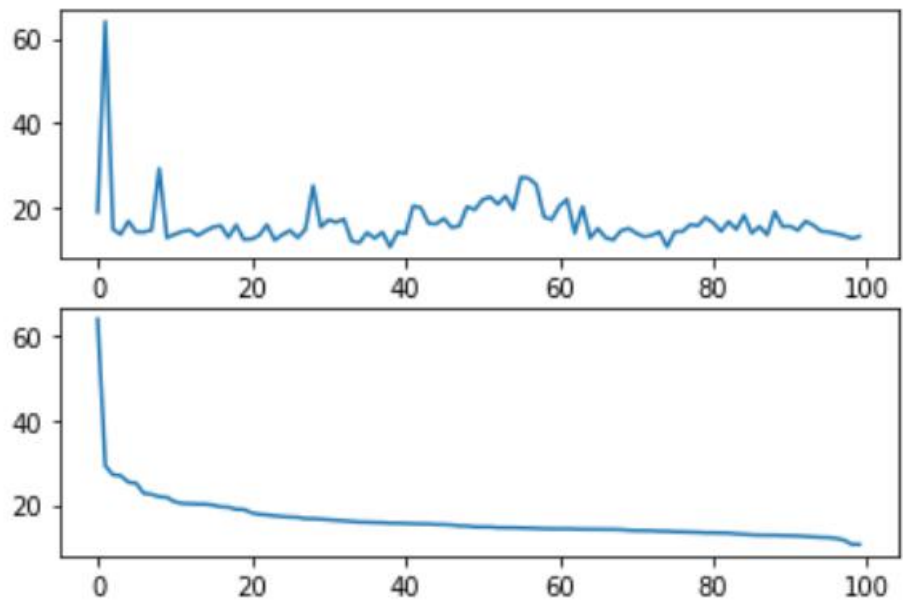
运行初始代码，观测尾延迟现象。

大部分请求都在 10ms 以内完成，有部分请求延迟较高，尾延迟现象导致任务执行延迟较高，甚至达到 160ms。



利用关联请求的方式优化尾延迟的问题，设置 40ms 的阈值，超过 40ms 未完成的请求重新发一次。

优化后的情况如下：



可以观察到，尾延迟现象得到了明显的优化，几乎全部任务都在 30ms 以内完成。